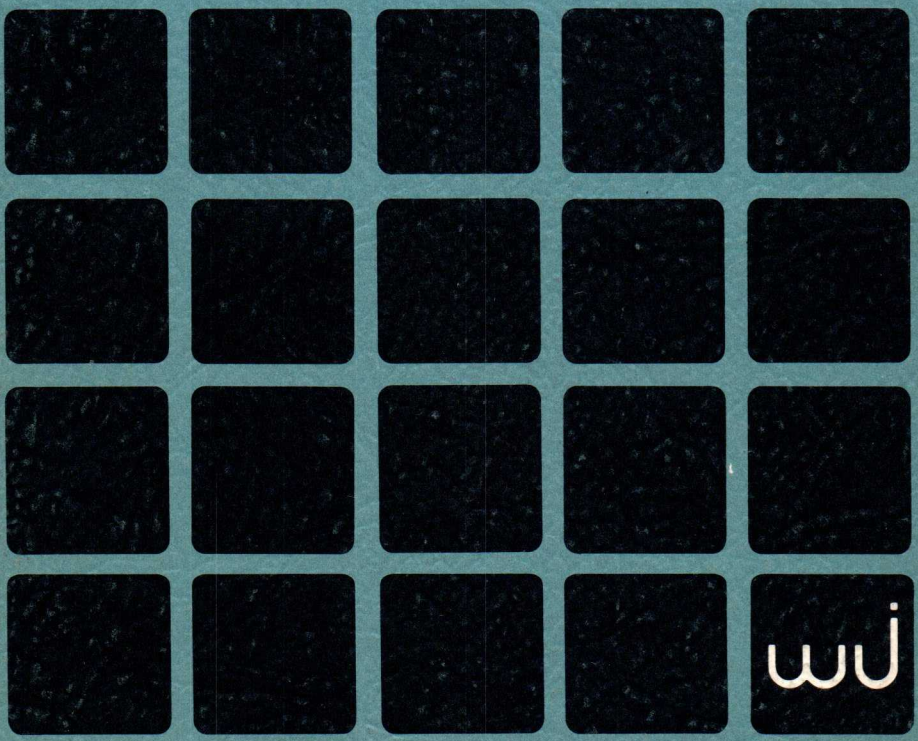
# WATKINS-JOHNSON

OCTOBER 1972

## MICROWAVE DEVICES TECHNICAL DATA



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# INTRODUCTION

The Technical Data Sheets in this catalog are arranged in numerical order. Complete specifications, performance curves and mechanical data are provided on a variety of microwave devices.

For your convenience, the contents of this catalog are listed in the Selection Guide by frequency range under one of the following headings:

1) Low-Noise Transistor Amplifiers
2) Low-Noise TWT Amplifiers
3) Power Tubes
4) Power Amplifiers
5) Solid State Sources
6) Backward-Wave Oscillators
7) Replacement BWOs
8) YIG Filters

The Selection Guide begins on page 4.

Customer Service information is provided on page 2; our local Representatives and Sales Offices are shown on page 3. For additional information on the complete line of W-J products, contact our Representative or Sales Office in your area, or call Applications Engineering at Watkins-Johnson.

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**Ordering Information —Overseas**

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Indianapolis 46217
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Rochester 14619
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Racal Electronics Pty. Ltd.
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MEGEXIMPORT-ZURICH

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Telex: 847578
Cable: WJUKW-WINDSOR

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8033 Planegg
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Telephone: (0811) 71 36 57
Telex: 528401
Cable: WJDBM-MUNCHEN

# SELECTION GUIDE

## LOW-NOISE TRANSISTOR AMPLIFIERS

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 50–500 MHz | WJ-5030 | 3.5 dB Noise Figure |
| 0.5– 1.0 GHz | WJ-736 | 4.0 dB Noise Figure |
| 0.5– 1.0 GHz | WJ-738 | 4.0 dB Noise Figure |
| 1.0– 2.0 GHz | WJ-737 | 6.0 dB Noise Figure |
| 1.0– 2.0 GHz | WJ-739 | 6.0 dB Noise Figure |
| 1.0– 4.0 GHz | WJ-6007 | 7.5 dB Noise Figure |
| 2.0– 4.0 GHz | WJ-5004-4 | 7.0 dB Noise Figure |
| 2.0– 4.0 GHz | WJ-5004-132 | 5.5 dB Noise Figure |
| 2.0– 4.0 GHz | WJ-5005 | 8.0 dB Noise Figure |
| 2.0– 4.0 GHz | WJ-5206 | Miniature Thin-Film |
| 2.0– 4.0 GHz | WJ-5096 | 8.5 dB Noise Figure |
| 2.0– 4.5 GHz | WJ-5090-4 | 8.0 dB Noise Figure |
| 2.6– 5.2 GHz | WJ-5090-13 | 8.0 dB Noise Figure |
| 2.9– 3.1 GHz | WJ-5108 Series | 4.5 dB Noise Figure |
| 3.4– 4.2 GHz | WJ-5102 Series | 7.5 dB Noise Figure |

## LOW-NOISE TWT AMPLIFIERS

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 0.5– 1.0 GHz | WJ-278 | Standard Series |
| 0.5– 1.0 GHz | WJ-404 | Gain-Matched |
| 0.5– 2.0 GHz | WJ-397 | Ultra-Wide Band |
| 1.0– 2.0 GHz | WJ-268 | Standard Series |
| 1.0– 2.0 GHz | WJ-294 | Compact |
| 1.0– 2.0 GHz | WJ-374 | Dual-Helix |
| 1.0– 2.0 GHz | WJ-405 | Gain-Matched |
| 1.0– 2.0 GHz | WJ-457 | Battery-Operable |
| 1.0– 2.6 GHz | WJ-268-2 | Standard Series |
| 1.0– 2.6 GHz | WJ-280 | Standard Series |
| 1.0– 4.0 GHz | WJ-442 | Ultra-Wide Band |
| 2.0– 4.0 GHz | WJ-269 | Standard Series |
| 2.0– 4.0 GHz | WJ-295 | Compact |
| 2.0– 4.0 GHz | WJ-375 | Dual-Helix |
| 2.0– 4.0 GHz | WJ-406 | Gain-Matched |
| 2.0– 4.0 GHz | WJ-422 | High Dynamic Range/ Ultra-Low Noise |
| 2.0– 4.0 GHz | WJ-458 | Battery-Operable |
| 2.0– 4.0 GHz | WJ-462 | Miniature PPM |
| 2.0– 4.0 GHz | WJ-477 | 100 mW Power |
| 2.0– 4.0 GHz | WJ-486 | TWT Limiter |
| 2.0– 4.0 GHz | WJ-3003 | 100 mW Power |
| 2.0– 4.5 GHz | WJ-281 | Standard Series |
| 2.0– 8.0 GHz | WJ-343 | Ultra-Wide Band |
| 2.2– 2.3 GHz | WJ-355 | Ultra-Low Noise |
| 2.3– 4.5 GHz | WJ-269-1 | Standard Series |
| 2.6– 5.2 GHz | WJ-381 | Compact |
| 2.6– 5.2 GHz | WJ-482 | High Dynamic Range/ Ultra-Low Noise |

# LOW-NOISE TWT AMPLIFIERS (Cont'd)

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 4.0– 8.0 GHz | WJ-271 | Standard Series |
| 4.0– 8.0 GHz | WJ-271-30 | Standard Series |
| 4.0– 8.0 GHz | WJ-286 | Standard Series |
| 4.0– 8.0 GHz | WJ-296 | Compact |
| 4.0– 8.0 GHz | WJ-376 | Dual-Helix |
| 4.0– 8.0 GHz | WJ-407 | Gain-Matched |
| 4.0– 8.0 GHz | WJ-423 | High Dynamic Range/ Ultra-Low Noise |
| 4.0– 8.0 GHz | WJ-459 | Battery-Operable |
| 4.0– 8.0 GHz | WJ-463 | Miniature PPM |
| 4.0– 8.0 GHz | WJ-476 | 100 mW Power |
| 4.0– 8.0 GHz | WJ-485 | TWT Limiter |
| 4.0– 8.0 GHz | WJ-3004 | 100 mW Power |
| 7.0–11.0 GHz | WJ-276-2 | Standard Series |
| 7.0–11.0 GHz | WJ-396 | Ultra-Low Noise |
| 7.0–11.0 GHz | WJ-484 | TWT Limiter |
| 8.0–12.0 GHz | WJ-276 | Standard Series |
| 8.0–10.0 GHz | WJ-363-3 | Standard Series |
| 8.0–12.0 GHz | WJ-287 | Standard Series |
| 8.0–12.0 GHz | WJ-297 | Compact |
| 8.0–12.0 GHz | WJ-345 | Ultra-Low Noise |
| 8.0–12.0 GHz | WJ-363 | Standard Series |
| 8.0–12.0 GHz | WJ-377 | Dual-Helix |
| 8.0–12.0 GHz | WJ-408 | Gain-Matched |
| 8.0–12.0 GHz | WJ-424 | High Dynamic Range/ Ultra-Low Noise |
| 8.0–12.0 GHz | WJ-460 | Battery-Operable |
| 8.0–12.0 GHz | WJ-464 | Miniature PPM |
| 8.0–12.0 GHz | WJ-472 | 100 mW Power |
| 8.0–12.0 GHz | WJ-3005 | 100 mW Power |
| 8.0–18.0 GHz | WJ-437 | Ultra-Wide Band |
| 8.5– 9.3 GHz | WJ-345-7 | Ultra-Low Noise |
| 8.5– 9.6 GHz | WJ-345-11 | Ultra-Low Noise |
| 10.0–12.0 GHz | WJ-363-4 | Standard Series |
| 12.0–18.0 GHz | WJ-307 | Standard Series |
| 12.0–18.0 GHz | WJ-342 | Compact |
| 12.0–18.0 GHz | WJ-371 | Ultra-Low Noise |
| 12.0–18.0 GHz | WJ-425 | Ultra-Low Noise |
| 12.0–18.0 GHz | WJ-461 | Battery-Operable |
| 12.0–18.0 GHz | WJ-465 | Miniature PPM |
| 12.0–18.0 GHz | WJ-465-1 | Miniature PPM |
| 12.0–18.0 GHz | WJ-3006 | 100 mW Power |
| 18.0–26.5 GHz | WJ-393 | Millimeter LNTWA |
| 20.5–40.0 GHz | WJ-338 | Millimeter LNTWA |

## POWER TUBES

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 1.0– 2.0 GHz | WJ-340 | 1,000 Watts Gridded |
| 1.0– 2.0 GHz | WJ-3500 | 1 Watt Compact |
| 2.0– 2.2 GHz | WJ-445-1 | 1 Watt Low Distortion |
| 2.0– 4.0 GHz | WJ-3501 | 1 Watt Compact |
| 2.0– 4.0 GHz | WJ-3850 | 25 Watts Gridded |
| 2.0– 4.0 GHz | WJ-3851 | 50 Watts Gridded |
| 2.2– 2.3 GHz | WJ-395-1 | 100 Watts High Efficiency |
| 2.2– 2.3 GHz | WJ-448-1 | 50 Watts High Efficiency |
| 2.2– 2.3 GHz | WJ-448-2 | 15/90 Watts High Efficiency |
| 2.2– 2.4 GHz | WJ-274 Series | 9 to 28 Watts High Efficiency |
| 2.2– 2.4 GHz | WJ-274-2 | 20 Watts High Efficiency |
| 2.2– 2.4 GHz | WJ-274-8 | 10/20 Watts High Efficiency |
| 2.2– 2.4 GHz | WJ-398-1 | 20 Watts High Impact |
| 2.5– 3.5 GHz | WJ-368-3 | 120/50 Watts Pulsed |
| 4.0– 8.0 GHz | WJ-3502 | 1 Watt Compact |
| 4.0– 8.0 GHz | WJ-3641 | 200 Watts Power |
| 4.0– 8.0 GHz | WJ-3802 | 4 Watts Low Noise |
| 4.0– 8.0 GHz | WJ-3860 | 25 Watts Gridded |
| 4.0– 8.0 GHz | WJ-3861 | 50 Watts Gridded |
| 4.4– 5.8 GHz | WJ-369-3 | 120/50 Watts Pulsed |
| 5.0– 8.5 GHz | WJ-231-5 | 35 Watts Wideband |
| 5.4– 5.7 GHz | WJ-346 | 20,000 Watts Power |
| 5.4– 5.9 GHz | WJ-228 | 12,000 Watts Power |
| 5.9– 6.4 GHz | WJ-440-4 | 600 Watts CW Power |
| 6.0– 8.0 GHz | WJ-284-5 | 200 Watts Power |
| 7.0–11.0 GHz | WJ-391 | 5 Watts Power |
| 7.0–11.0 GHz | WJ-3804 | 3 Watts Low Noise |
| 7.0–12.4 GHz | WJ-3503 | 1 Watt Compact |
| 8.0–12.4 GHZ | WJ-3642 | 175 Watts Power |
| 8.0–12.4 GHz | WJ-3805 | 3 Watts Low Noise |
| 8.0–12.4 GHz | WJ-3805-1 | 5 Watts Low Noise |
| 8.0–16.0 GHz | WJ-3806 | 3 Watts Low Noise |
| 11.5–14.0 GHz | WJ-446 | 5 Watts Low Distortion |
| 12.0–18.0 GHz | WJ-3807 | 2 Watts Low Noise |

## POWER AMPLIFIERS

| | | |
|---|---|---|
| DC– 160 MHz | WJ-3650 | 125 Watt EBS |
| 1.0–18.0 GHz | WJ-1181 Series | 1- to 15-watt TWTAs |
| 1.0– 2.0 GHz | WJ-5201 Series | 1-Watt Thin-Film SSA |
| 1.25– 1.35 GHz | WJ-5200 | 1-Watt SSA |
| 1.42– 1.6 GHz | WJ-4539 | 20-Watt CW Cavity |
| 1.435–1.540 GHz | WJ-4540A | 100-Watt CW Cavity |
| 2.0– 4.0 GHz | WJ-5202-4 | 100-Milliwatt SSA |
| 2.2– 2.3 GHz | WJ-4523 | 20-Watt CW Cavity |
| 2.2– 2.3 GHz | WJ-1171 Series | 9 to 24 Watt TWTAs |
| 2.2– 2.4 GHz | WJ-1176 | 10/20 Watt TWTA |
| 2.2– 2.4 GHz | WJ-1014-1 | 20-Watt TWTA |
| 2.0–12.0 GHz | WJ-1184 | Medium Power TWTA |
| 5.4– 5.9 GHz | WJ-1051-1 | 45-Watt Pulsed TWTA |
| 7.0–11.0 GHz | WJ-1115 | 3-Watt TWTA |
| 12.4–18.0 GHz | WJ-1179 | 2 Watts with Serrodyne Capability |

## SOLID STATE SOURCES

| | | |
|---|---|---|
| 0.25–0.5 GHz | WJ-2811 | 100 mW Varactor-Tuned Oscillator |
| 0.5– 1.0 GHz | WJ-571 | 10 mW YIG-Tuned Transistor Oscillator |

## SOLID STATE SOURCES (Cont'd)

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 0.5– 1.0 GHz | WJ-700 | +5 dBm Harmonic Generator |
| 0.5– 1.0 GHz | WJ-2800 | 100 mW Varactor-Tuned Oscillator |
| 0.6–18.0 GHz | WJ-5130-2 | 200 MHz Input Multiplier |
| 1.0– 2.0 GHz | WJ-569 | 10 mW YIG-Tuned Transistor Oscillator |
| 1.0– 2.0 GHz | WJ-701 | +3 dBm Harmonic Generator |
| 1.0– 2.0 GHz | WJ-2803 | 100 mW Varactor-Tuned Oscillator |
| 1.0– 2.0 GHz | WJ-2803-50 | 50 mW Varactor-Tuned Oscillator |
| 1.4– 2.4 GHz | WJ-2810 | 50 mW Varactor-Tuned Oscillator |
| 2.0– 4.0 GHz | WJ-572 | 2 mW YIG-Tuned Transistor Oscillator |
| 2.0– 4.0 GHz | WJ-702 | 0 dBm Harmonic Generator |
| 2.0– 4.0 GHz | WJ-2804-10 | 10 mW Varactor-Tuned Oscillator |
| 2.0– 4.0 GHz | WJ-2804-20 | 20 mW Varactor-Tuned Oscillator |
| 2.0– 4.0 GHz | WJ-2804-40 | 40 mW Varactor-Tuned Oscillator |
| 4.0– 5.6 GHz | WJ-2817 | 20 mW Varactor-Tuned Oscillator |
| 4.0– 6.0 GHz | WJ-2817-1 | 20 mW Varactor-Tuned Oscillator |
| 4.0– 8.0 GHz | WJ-703 | −25 dBm Harmonic Generator |
| 4.0– 8.0 GHz | WJ-2806-6 | 20 mW Dual-Band Varactor-Tuned Oscillator |
| 4.0– 8.0 GHz | WJ-2812 | 20 mW Voltage-Controlled Oscillator |
| 5.6– 8.0 GHz | WJ-2818 | 20 mW Varactor-Tuned Oscillator |
| 6.0– 8.0 GHz | WJ-2818-1 | 20 mW Varactor-Tuned Oscillator |
| 8.0–12.0 GHz | WJ-704 | −25 dBm Harmonic Generator |
| 8.0–12.4 GHz | WJ-5008 | 10 mW YIG-Tuned Bulk GaAs Oscillator |
| 8.0–12.4 GHz | WJ-5008-1 | 10 mW YIG-Tuned Bulk GaAs Oscillator |
| 8.5– 9.6 GHz | WJ-2807-3 | 10 mW Varactor-Tuned Oscillator |
| 12.4–18.0 GHz | WJ-5041 | 6 mW YIG-Tuned Bulk GaAs Oscillator |
| 12.4–18.0 GHz | WJ-5041-1 | 6 mW YIG-Tuned Bulk GaAs Oscillator |
| 10.0–16.0 GHz | WJ-5041-3 | 6 mW YIG-Tuned Bulk GaAs Oscillator |

## BACKWARD-WAVE OSCILLATORS

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 0.5– 1.0 GHz | SE-223 | 30 mW Unshielded |
| 1.0– 2.0 GHz | SE-214A | 100 mW Unshielded |
| 1.0– 2.6 GHz | SE-214 | 30 mW Unshielded |
| 1.4– 2.5 GHz | SE-219 | 100 mW Unshielded |
| 1.4– 2.5 GHz | SE-219A | 100 mW Unshielded |

# BACKWARD-WAVE OSCILLATORS (Cont'd)

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 1.7– 4.2 GHz | SE-215 | 30 mW Unshielded |
| 2.0– 4.0 GHz | SE-215A | 75 mW Unshielded |
| 2.0– 4.0 GHz | SE-310 | 50 mW Compact |
| 2.0– 4.0 GHz | WJ-2018 | 70 mW Magnetically/RFI Shielded |
| 2.0– 4.0 GHz | WJ-2024 | 50 mW Compact |
| 2.0– 4.0 GHz | WJ-2040-2 | 50 mW Magnetically/RFI Shielded |
| 2.0– 4.0 GHz | WJ-2051 | 30 mW Magnetically/RFI Shielded |
| 2.0– 4.5 GHz | WJ-2014 | 50 mW Unshielded |
| 2.0– 4.5 GHz | WJ-2040 | 50 mW Magnetically/RFI Shielded |
| 2.0– 6.0 GHz | WJ-2032 | 10 mW Magnetically/RFI Shielded |
| 2.6– 5.2 GHz | SE-310-3 | 50 mW Compact |
| 2.6– 5.2 GHz | WJ-2038 | 50 mW Magnetically/RFI Shielded |
| 3.5– 6.75 GHz | SE-221 | 40 mW Unshielded |
| 3.5– 6.75 GHz | WJ-2049 | 40 mW Unshielded |
| 3.7– 8.3 GHz | SE-211B | 15 mW Unshielded |
| 4.0– 8.0 GHz | SE-211A | 30 mW Unshielded |
| 4.0– 8.0 GHz | SE-304 | 20 mW Compact |
| 4.0– 8.0 GHz | WJ-2015 | 50 mW Unshielded |
| 4.0– 8.0 GHz | WJ-2019 | 30 mW Magnetically/RFI Shielded |
| 4.0– 8.0 GHz | WJ-2025 | 20 mW Compact |
| 4.0– 8.0 GHz | WJ-2030 | 50 mW Compact |
| 4.0– 8.0 GHz | WJ-2034 | 60 mW Magnetically/RFI Shielded |
| 4.0– 8.0 GHz | WJ-2045 | 50 mW Magnetically/RFI Shielded |
| 4.0– 8.0 GHz | WJ-2047 | 40 mW Unshielded |
| 4.0– 8.6 GHz | WJ-2050 | 30 mW Magnetically/RFI Shielded |
| 4.0–10.0 GHz | WJ-2044 | 20 mW Magnetically/RFI Shielded |
| 5.3– 6.0 GHz | SE-217 | 100 mW Unshielded |
| 7.0–12.4 GHz | SE-209 | 10 mW Unshielded |
| 7.0–12.4 GHz | WJ-2001 | 25 mW Unshielded |
| 7.0–12.4 GHz | WJ-2039-1 | 40 mW Magnetically/RFI Shielded |
| 7.0–16.0 GHz | WJ-2067 | 15 mW Magnetically/RFI Shielded |
| 7.5–11.0 GHz | WJ-2042 | 30 mW Magnetically/RFI Shielded |
| 8.0–12.4 GHz | SE-313 | 50 mW Compact |
| 8.0–12.4 GHz | WJ-2001-1 | 50 mW Unshielded |
| 8.0–12.4 GHz | WJ-2006 | 50 mW Magnetically/RFI Shielded |
| 8.0–12.4 GHz | WJ-2008 | 100 mW Unshielded |
| 8.0–12.4 GHz | WJ-2008-2 | 80 mW Unshielded |
| 8.0–12.4 GHz | WJ-2020 | 50 mW Magnetically/RFI Shielded |
| 8.0–12.4 GHz | WJ-2027 | 50 mW Compact |
| 8.0–12.4 GHz | WJ-2033-1 | 100 mW Magnetically/RFI Shielded |
| 8.0–12.4 GHz | WJ-2039 | 80 mW Magnetically/RFI Shielded |
| 8.0–18.0 GHz | WJ-2068 | 10 mW Magnetically/RFI Shielded |
| 8.2–12.4 GHz | SE-209A | 20 mW Unshielded |
| 8.2–12.4 GHz | SE-303 | 20 mW Compact |
| 8.2–12.4 GHz | WJ-2026 | 20 mW Compact |
| 9.5–13.0 GHz | WJ-2004 | 10 mW Magnetically/RFI Shielded |
| 10.0–20.0 GHz | WJ-2065 | 5 mW Magnetically/RFI Shielded |
| 10.0–15.5 GHz | SE-220 | 10 mW Unshielded |
| 10.0–15.5 GHz | WJ-2069 | 50 mW Magnetically/RFI Shielded |
| 12.4–18.0 GHz | SE-216 | 10 mW Unshielded |
| 12.4–18.0 GHz | SE-307 | 20 mW Compact |
| 12.4–18.0 GHz | SE-307A | 20 mW Compact |
| 12.4–18.0 GHz | WJ-2003 | 40 mW Unshielded |
| 12.4–18.0 GHz | WJ-2007 | 40 mW Magnetically/RFI Shielded |
| 12.4–18.0 GHz | WJ-2021 | 40 mW Magnetically/RFI Shielded |
| 12.4–18.0 GHz | WJ-2028 | 20 mW Compact |
| 12.4–18.0 GHz | WJ-2043 | 40 mW Magnetically/RFI Shielded |
| 12.4–18.0 GHz | WJ-2052 | 20 mW Magnetically/RFI Shielded |
| 12.4–18.0 GHz | WJ-2056 | 40 mW Magnetically/RFI Shielded |
| 14.0–17.0 GHz | SE-308 | 10 mW Compact |
| 14.0–17.0 GHz | SE-308A | 10 mW Compact |

## BACKWARD-WAVE OSCILLATORS (Cont'd)

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 14.0–17.0 GHz | WJ-2029 | 10 mW Compact |
| 18.0–26.5 GHz | SE-218 | 20 mW Unshielded |
| 18.0–26.5 GHz | WJ-2022 | 20 mW Magnetically/RFI Shielded |
| 18.0–26.5 GHz | WJ-2057 | 20 mW Magnetically/RFI Shielded |
| 26.5–40.0 GHz | SE-222 | 10 mW Unshielded |
| 26.5–40.0 GHz | WJ-2041 | 10 mW Magnetically/RFI Shielded |
| 26.5–40.0 GHz | WJ-2058 | 10 mW Magnetically/RFI Shielded |

## REPLACEMENT BWOs

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 1.0– 2.0 GHz | SE-214A-50 | 100 mW Unshielded |
| 1.0– 2.6 GHz | SE-214-50 | 25 mW Unshielded |
| 1.4– 2.5 GHz | SE-219-50 | 100 mW Unshielded |
| 1.7– 4.2 GHz | SE-215-50 | 40 mW Unshielded |
| 1.7– 4.2 GHz | WJ-2018-51 | 30 mW Magnetically/RFI Shielded |
| 2.0– 4.0 GHz | SE-215A-50 | 80 mW Unshielded |
| 2.0– 4.0 GHz | WJ-2018-50 | 75 mW Magnetically/RFI Shielded |
| 2.6– 5.2 GHz | WJ-2038-50 | 50 mW Magnetically/RFI Shielded |
| 3.5– 6.75 GHz | SE-221-50 | 45 mW Unshielded |
| 3.5– 6.75 GHz | WJ-2049-50 | 40 mW Unshielded |
| 3.7– 8.3 GHz | SE-211B-50 | 15 mW Unshielded |
| 3.7– 8.3 GHz | WJ-2019-51 | 20 mW Magnetically/RFI Shielded |
| 4.0– 8.0 GHz | SE-211A-50 | 30 mW Unshielded |
| 4.0– 8.0 GHz | WJ-2019-50 | 30 mW Magnetically/RFI Shielded |
| 7.0–12.4 GHz | WJ-2001-51 | 25 mW Unshielded |
| 7.0–12.4 GHz | WJ-2020-51 | 25 mW Magnetically/RFI Shielded |
| 7.0–12.4 GHz | WJ-2039-51 | 40 mW Magnetically/RFI Shielded |
| 8.0–12.4 GHz | SE-209A-50 | 20 mW Unshielded |
| 8.0–12.4 GHz | WJ-2001-50 | 50 mW Unshielded |
| 8.0–12.4 GHz | WJ-2020-50 | 50 mW Magnetically/RFI Shielded |
| 8.0–12.4 GHz | WJ-2039-50 | 80 mW Magnetically/RFI Shielded |
| 10.0–15.5 GHz | SE-220-50 | 20 mW Unshielded |
| 12.4–18.0 GHz | WJ-2003-50 | 40 mW Unshielded |
| 12.4–18.0 GHz | WJ-2056-50 | 50 mW Magnetically/RFI Shielded |
| 12.4–18.0 GHz | WJ-2060-50 | 50 mW Magnetically/RFI Shielded |
| 18.0–26.5 GHz | SE-218-50 | 20 mW Unshielded |
| 18.0–26.5 GHz | WJ-2057-50 | 20 mW Magnetically/RFI Shielded |
| 18.0–26.5 GHz | WJ-2061-50 | 25 mW Magnetically/RFI Shielded |
| 26.5–40.0 GHz | SE-222-50 | 10 mW Unshielded |
| 26.5–40.0 GHz | WJ-2058-50 | 7 mW Magnetically/RFI Shielded |
| 26.5–40.0 GHz | WJ-2062-50 | 10 mW Magnetically/RFI Shielded |

## YIG FILTERS

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 0.5– 1.0 GHz | WJ-723 | Three-Stage |
| 1.0– 2.0 GHz | WJ-611 | Compact Two-Stage |
| 1.0– 2.0 GHz | WJ-615 | Compact Four-Stage |
| 1.0– 2.0 GHz | WJ-619 | Compact Dual Two-Stage |
| 1.0– 2.0 GHz | WJ-634 | Two-Stage Hybrid |
| 1.0– 2.0 GHz | WJ-638 | Four-Stage Hybrid |
| 1.0– 2.0 GHz | WJ-648 | Dual Two-Stage Hybrid |
| 1.0– 2.0 GHz | WJ-724 | Three-Stage |

# YIG FILTERS (Cont'd)

| Frequency Range | Type Number | Remarks |
|---|---|---|
| 1.0– 2.3 GHz | WJ-627 | YIG Magnetometer |
| 1.0– 5.0 GHz | WJ-652 | Mechanically Tuned |
| 1.0–12.4 GHz | WJ-756 | Compact Three-Stage |
| 1.0–18.0 GHz | WJ-795 | Compact Two-Stage |
| 2.0– 4.0 GHz | WJ-612 | Compact Two-Stage |
| 2.0– 4.0 GHz | WJ-616 | Comact Four-Stage |
| 2.0– 4.0 GHz | WJ-620 | Compact Dual Two-Stage |
| 2.0– 4.0 GHz | WJ-635 | Two-Stage Hybrid |
| 2.0– 4.0 GHz | WJ-639 | Four-Stage Hybrid |
| 2.0– 4.0 GHz | WJ-649 | Dual Two-Stage Hybrid |
| 2.0– 4.0 GHz | WJ-725 | Three-Stage |
| 2.0–12.4 GHz | WJ-623 | Multi-Octave Compact |
| 4.0– 8.0 GHz | WJ-613 | Compact Two-Stage |
| 4.0– 8.0 GHz | WJ-617 | Compact Four-Stage |
| 4.0– 8.0 GHz | WJ-621 | Compact Dual Two-Stage |
| 4.0– 8.0 GHz | WJ-636 | Two-Stage Hybrid |
| 4.0– 8.0 GHz | WJ-640 | Four-Stage Hybrid |
| 4.0– 8.0 GHz | WJ-650 | Dual Two-Stage Hybrid |
| 4.0– 8.0 GHz | WJ-726 | Three-Stage |
| 8.0–12.4 GHz | WJ-614 | Compact Two-Stage |
| 8.0–12.4 GHz | WJ-618 | Compact Four-Stage |
| 8.0–12.4 GHz | WJ-622 | Compact Dual Two-Stage |
| 8.0–12.4 GHz | WJ-637 | Two-Stage Hybrid |
| 8.0–12.4 GHz | WJ-641 | Four-Stage Hybrid |
| 8.0–12.4 GHz | WJ-651 | Dual Two-Stage Hybrid |
| 8.0–12.4 GHz | WJ-727 | Three-Stage |

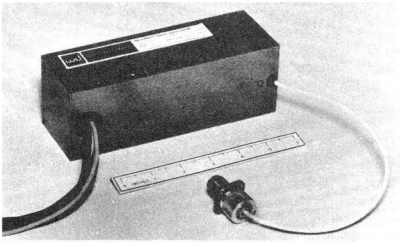
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-209

TECHNICAL DATA • September 1965



The type SE-209 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet-focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The SE-209 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 7-12.4 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 12-80 | 10 Min |
| Power Output Variation | db | | 10 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 2 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | db | 60 | 45 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7.5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 2 | 4 Max |
| Tuning Curve Slope | | | |
| Low End (7.0 GHz) | MHz/V | 8.5 | |
| Mid-Frequency (9.7 GHz) | MHz/V | 3.9 | |
| High End (12.4 GHz) | MHz/V | 1.5 | |
| Grid r.f. Cutoff Voltage | V | -10 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 28 | 35 Max |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pf | 28 | 35 Max |
| Capacitance; R.F. connector center pin and housing to all other Electrodes | pf | 135 | 150 Max |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.9 | 0.6-1.2 Min/Max |
| Cathode Current | mA | 9 | 12 Max |
| Helix Voltage Range | V | 310-2000 | 250-2100 Min/Max |
| Helix Current | mA | 1.5 | 3 Max |
| Anode Voltage | V | 160 | 215 Max |
| Anode Current | mA | 1 | 2 Max |

## MECHANICAL DATA

Weight 6.0 lbs Max
Color Code for 18" Flying Leads

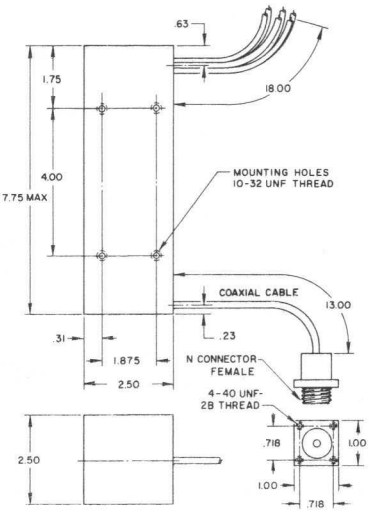
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female

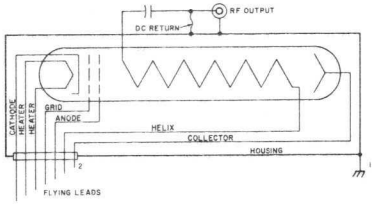
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



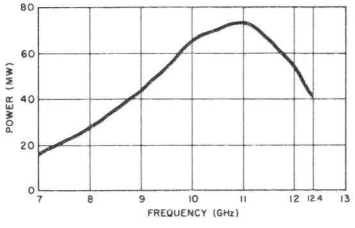

## SCHEMATIC DIAGRAM



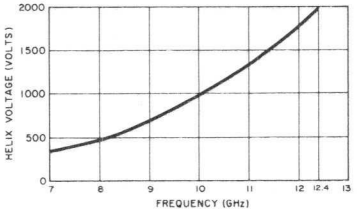

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



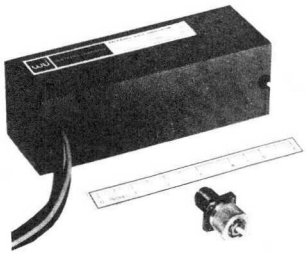
# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1969 *

## BACKWARD-WAVE OSCILLATOR
## SE-209A

The type SE-209A BWO is a single-helix, voltage tunable oscillator. This permanent-magnet focused wideband oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The SE-209A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. With all voltages isolated from both tube housing and the RF output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | ABSOLUTE RATINGS | TYPICAL VALUES |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 8.0 - 12.4 |
| Power Output Into Load With VSWR=1.25 | mW | 25 - 50 | 20 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5 : 1 Max |
| Frequency Pulling Into 2 : 1 Load (Any Phase) | MHz | 1 | 2 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | dB | 60 | 45 Min |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-Term Sensitivity to Heater Voltage | MHz/V | 7.5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 2 | |
| Tuning Curve Slope | | | |
| Low End (8.2 GHz) | MHz/V | 7.0 | |
| Mid-Frequency (10.3 GHz) | MHz/V | 3.5 | |
| High End (12.4 GHz) | MHz/V | 1.5 | |
| Grid RF Cutoff Voltage | V | -10 | -20 Max |
| Capacitance; Cathode to All Other Electrodes, Including Heater | pF | 28 | 35 Max |
| Capacitance; Grid to All Other Electrodes at Power Input Connector | pF | 28 | 35 Max |
| Capacitance; RF Connector Center Pin and Housing to All Other Electrodes | pF | 135 | 150 Max |
| Heater Voltage | V | | 6.3 ± 5% |
| Heater Current | A | 0.9 | 0.6 Min<br>1.2 Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 480 - 2000 | 450 Min<br>2100 Max |
| Helix Current | mA | 1.5 | 3 Max |
| Anode Voltage | V | 150 | 215 Max |
| Anode Current | mA | 0.5 | 2 Max |

*Supersedes Technical Data Sheet SE-209A Dated September 1965

# SE-209A

## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height | 2.5 Inches (64 mm) |
| Width | 2.5 Inches (64 mm) |
| Length | 7.75 Inches (197 mm) |
| Weight | 6 Pounds (2.72 kg) Max. |

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

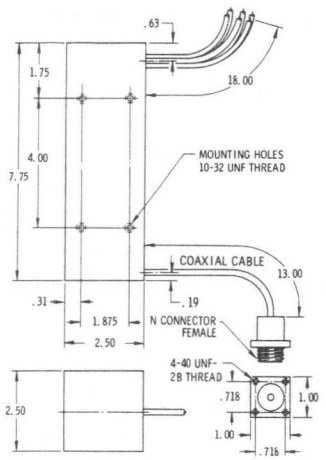
RF Output Connector, Type N Female

## ENVIRONMENTAL CHARACTERISTICS

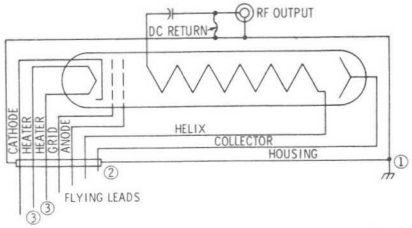
Separation From Passive Magnetic Materials, 2" Min

No Forced Air Cooling Required, Below $+60^{\circ}$ C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

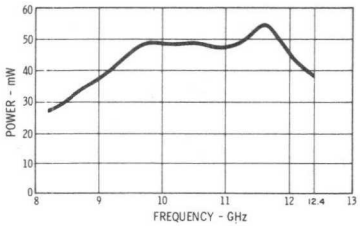



① For safety, Housing should be grounded through mounting screws.

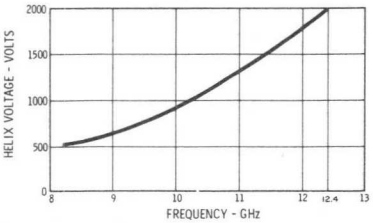
② 50 - 100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR SE-209A-50

The SE-209A-50 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment.

The SE-209A-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 8.0–12.4 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 25–50 | 20 Min. |
| Power Output Variation | dB | | 7 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1 | 2 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to Total Spurious Output | dB | 60 | 45 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7.5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 2 | |
| Tuning Curve Slope | | | |
| Low End (8.2 GHz) | MHz/V | 7.0 | |
| Mid-Frequency (10.3 GHz) | MHz/V | 3.5 | |
| High End (12.4 GHz) | MHz/V | 1.5 | |
| Grid RF Cutoff Voltage | V | −10 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 28 | 35 Max. |
| Capacitance; Grid to all other Electrodes, at Power Input Plug | pF | 28 | 35 Max. |
| Capacitance; RF Connector Center Pin and Housing to all other Electrodes | pF | 135 | 150 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.9 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 500–2000 | 450–2100 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# SE-209A-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 7.75 inches (197 mm) max.
Weight, 6 lbs. (2.72 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

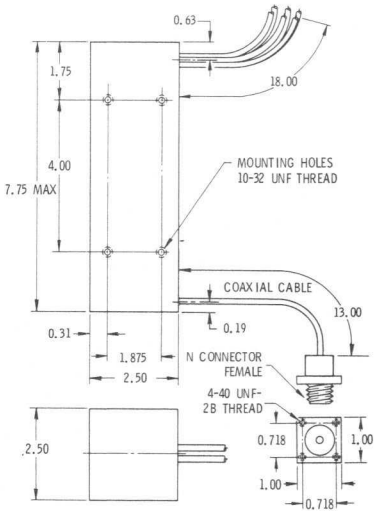
Mounting Position, Any

RF Output Connector, Type N Female on Balun

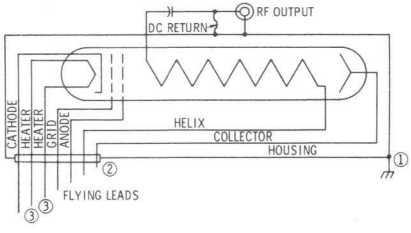
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

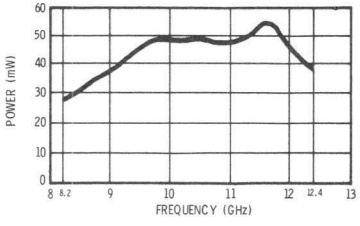
## OUTLINE DRAWING



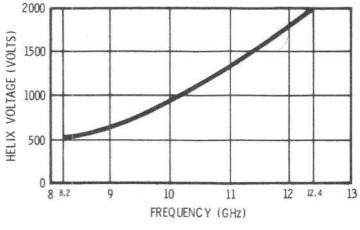

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

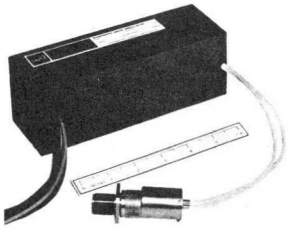
# TECHNICAL DATA

WATKINS-JOHNSON

# SE-211A

## BACKWARD-WAVE OSCILLATOR

September 1965



The type SE-211A BWO is a bifilar (dual helix), voltage tunable oscillator. The permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-211A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4-8 | |
| Power Output into a Load with VSWR = 1.25 | mW | 30-70 | 30 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | db | 35 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 5.9 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.7 | |
| High End (8.0 GHz) | MHz/V | 2.0 | |
| Grid r.f. Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 30 | 45 Max |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pf | 30 | 45 Max |
| Capacitance; Helix to all other Electrodes | pf | 100 | 150 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.9 | 0.6-1.2 Min/Max |
| Cathode Current | mA | 9 | 12 Max |
| Helix Voltage | V | 310-1825 | 250-1900 Min/Max |
| Helix Current | mA | 1.5 | 3 Max |
| Anode Voltage | V | 135 | 215 Max |
| Anode Current | mA | 0.5 | 2 Max |

## MECHANICAL DATA

Wieght, 6.0 lbs Max
Color Code for 18" Flying Leads

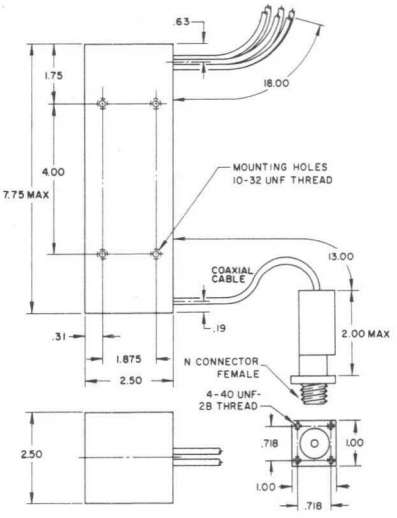
| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

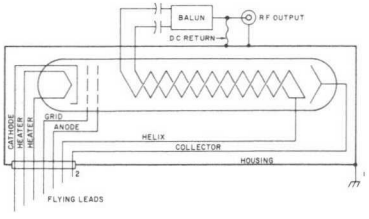
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



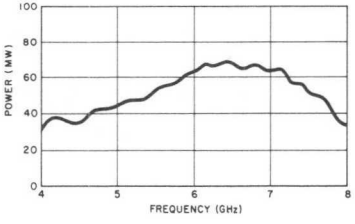

## SCHEMATIC DIAGRAM



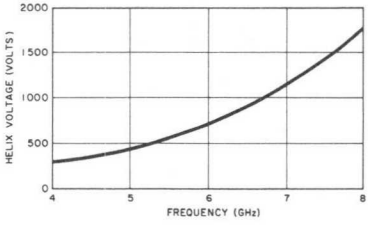

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

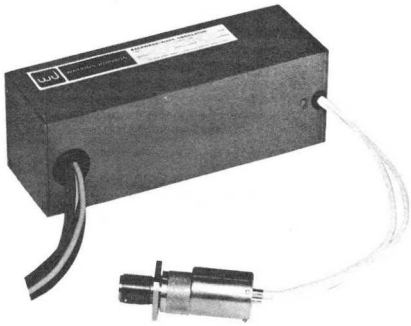
DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## SE-211A-50

The SE-211A-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-211A-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4–8 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 30–70 | 30 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB / 250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 35 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 5.9 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.7 | |
| High End (8.0 GHz) | MHz/V | 2.0 | |
| Grid RF Cutoff Voltage | V | –7 | –25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 30 | 45 Max. |
| Capacitance; Grid to all other Electrodes, at Power Input Plug | pF | 30 | 45 Max. |
| Capacitance; Helix to all other Electrodes | pF | 100 | 150 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.9 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 9 | 12 Max. |
| Helix Voltage Range | V | 310–1825 | 250–1900 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 135 | 215 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# SE-211A-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 7.75 inches (197 mm) max.
Weight, 6.5 lbs. (2.95 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

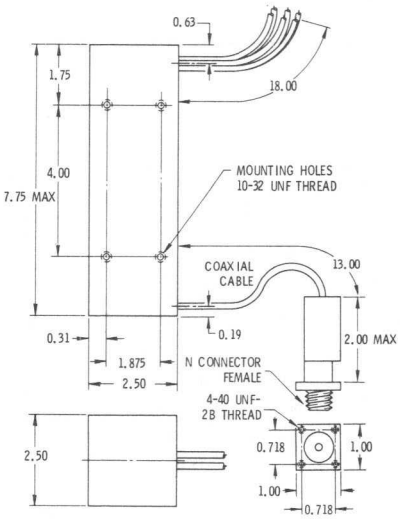
Mounting Position, Any

RF Output Connector, Type N Female on Balun

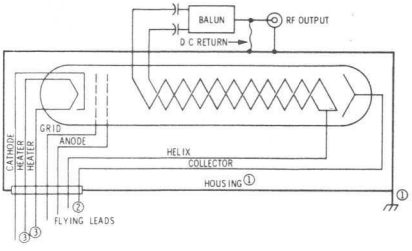
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

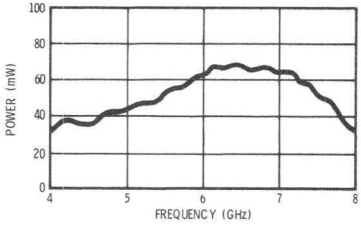
## OUTLINE DRAWING



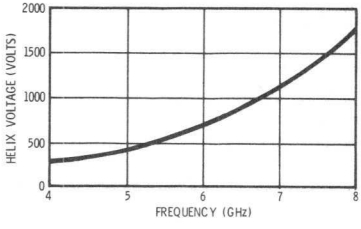

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

# TECHNICAL DATA

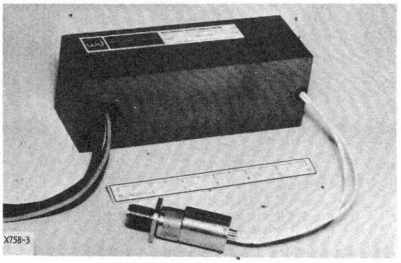
WATKINS-JOHNSON

# SE-211B

## BACKWARD-WAVE OSCILLATOR

November 1968 *

The type SE-211B BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), and other electronic equipment. The SE-211B features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. All voltages are isolated from both tube housing and the RF output terminal. Packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.




## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 3.7-8.3 |
| Power Output into a Load with VSWR = 1.25 | mW | 35-100 | 15 Min |
| Power Output Variation | db | | 8 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | db | 35 | 20 Min |
| Ratio of Signal to all Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 4 | 7 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (3.7 GHz) | MHz/V | 6.4 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.7 | |
| High End (8.3 GHz) | MHz/V | 1.6 | |
| Grid r.f Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 30 | 45 Max |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pf | 30 | 45 Max |
| Capacitance; Helix to all other Electrodes | pf | 100 | 150 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4 - 1.2 Min/Max |
| Cathode Current | | 9 | 12 Max |
| Helix Voltage Range | mA | 250-2000 | 200-2100 Min/Max |
| Helix Current | mA | 1.5 | 3.0 Max |
| Anode Voltage | V | 150 | 215 Max |
| Anode Current | mA | 0.1 | 2.0 Max |

* Supersedes SE-211B Technical Data Sheet dated September 1965.

## MECHANICAL DATA

Weight, 6.0 lbs Max
Color Code for 18" Flying Leads

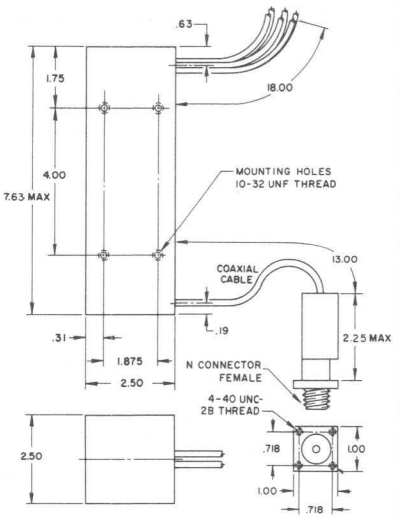
| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N
Female on Balun

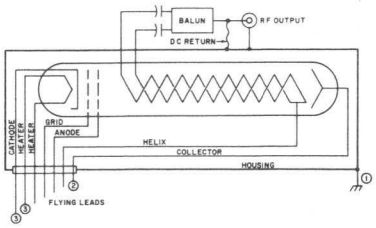
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



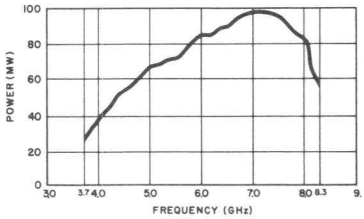

Notes:

① For safety, housing should be grounded through mounting screws.

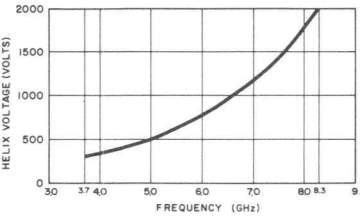
② 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

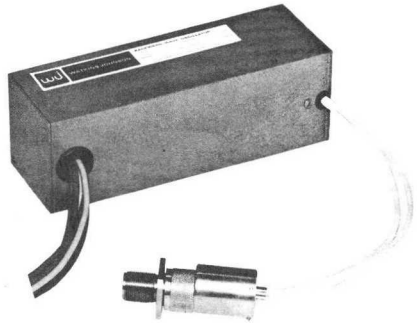
DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## SE-211B-50

The SE-211B-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-211B-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 3.7–8.3 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 25–100 | 15 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 35 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 4 | |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (3.7 GHz) | MHz/V | 6.4 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.7 | |
| High End (8.3 GHz) | MHz/V | 1.6 | |
| Grid RF Cutoff Voltage | V | –7 | –25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 30 | 45 Max. |
| Capacitance; Grid to all other Electrodes, at Power Input Plug | pF | 30 | 45 Max. |
| Capacitance; Helix to all other Electrodes | pF | 100 | 150 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.9 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 9 | 12 Max. |
| Helix Voltage Range | V | 250–2000 | 200–2100 Min./Max. |
| Helix Current | mA | 1.5 | 3.0 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | 0.5 | 2.0 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# SE-211B-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 7.75 inches (197 mm) max.
Weight, 6.5 lbs. (2.95 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

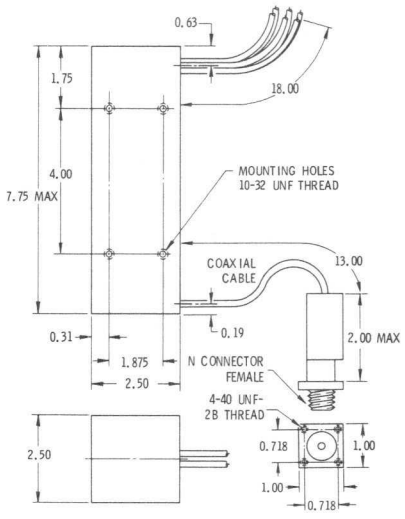
Mounting Position, Any

RF Output Connector, Type N Female on Balun

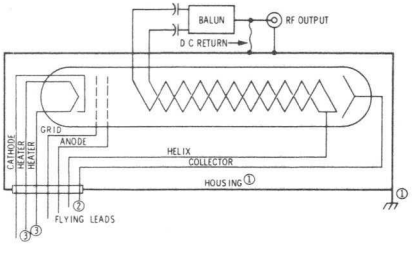
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

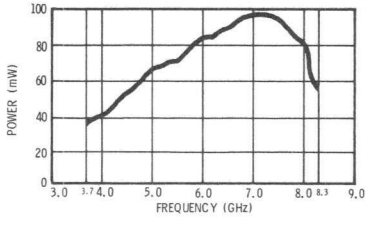
## OUTLINE DRAWING



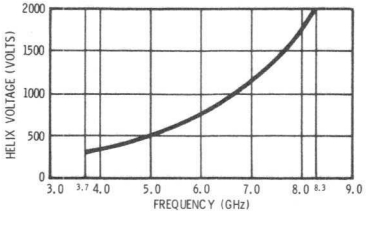

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

(1) For safety, housing should be grounded through mounting screws.

(2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

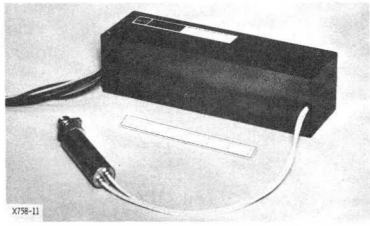
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-214

December 1967




The type SE-214 BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-214 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 1-2.6 | |
| Power Output into Load VSWR = 1.25 | mW | 50-350 | 30 Min |
| Power Output Variation | db | | 11 Max |
| Fine Grain Variation | db/40 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 5 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | db | 40 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.2 | 0.5 Max |
| Sensitivity to Grid Voltage | MHz/V | 5 | 10 Max |
| Tuning Curve Slope | | | |
| Low End (1.0 GHz) | MHz/V | 3.8 | |
| Mid-Frequency (1.8 GHz) | MHz/V | 1.4 | |
| High End (2.6 GHz) | MHz/V | 0.56 | |
| Grid r.f. Cutoff Voltage | | -7 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 15 | 25 Max |
| Capacitance; Grid to all other Electrodes at Power | pf | 20 | 25 Max |
| Capacitance; Helix to all other Electrodes | pf | 370 | 400 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.85 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 11 | 17 Max |
| Helix Voltage Range | V | 190-1500 | 170-1600 Min/Max |
| Helix Current | mA | 1.5 | 4 Max |
| Anode Voltage | V | 95 | 215 Max |
| Anode Current | mA | 1 | 1.5 Max |

## MECHANICAL DATA

Weight, 14.5 lbs Max
Color Code for 18" Flying Leads

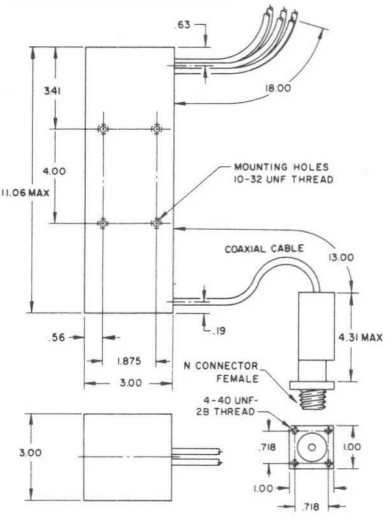
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

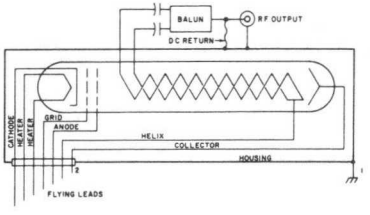
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min.
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



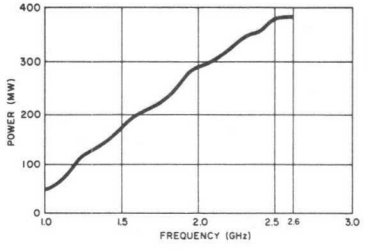

## SCHEMATIC DIAGRAM



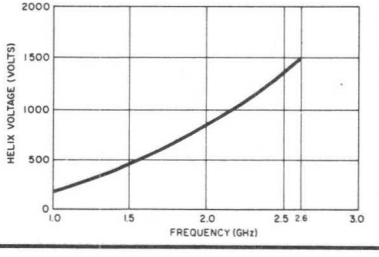

[1] For safety, housing should be grounded through mounting screws.

[2] 50-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

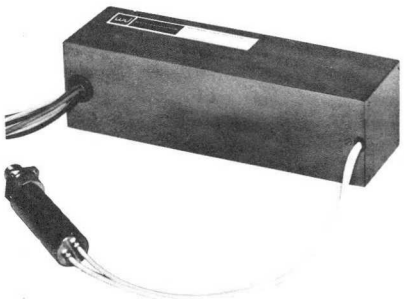
FEBRUARY 1971

## BACKWARD-WAVE OSCILLATOR SE-214-50

The SE-214-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-214-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 1—2.6 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 50—350 | 25 Min. |
| Power Output Variation | dB | | 11 Max. |
| Fine Grain Variation | dB/50 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Fulling Into 2:1 Load (Any Phase) | MHZ | 2 | 5 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 40 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.2 | |
| Sensitivity to Grid Voltage | MHz/V | 5 | |
| Tuning Curve Slope | | | |
| Low End (1.0 GHz) | MHz/V | 3.8 | |
| Mid-Frequency (1.8 GHz) | MHz/V | 1.4 | |
| High End (2.6 GHz) | MHz/V | 0.56 | |
| Grid RF Cutoff Voltage | V | —7 | —25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 15 | 35 Max. |
| Capacitance; Grid to all other Electrodes, at Power Input Plug | pF | 20 | 35 Max. |
| Capacitance; Helix to all other Electrodes | pF | 370 | 400 Max. |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | 0.85 | 0.4—1.2 Min./Max. |
| Cathode Current* | mA | 11 | 17 Max. |
| Helix Voltage Range | V | 190—1500 | 170—1600 Min./Max. |
| Helix Current | mA | 1.5 | 4 Max. |
| Anode Voltage | V | 95 | 215 Max. |
| Anode Current | mA | 1 | 1.5 Max. |

*Set cathode current to final test data value furnished with tube.

# SE-214-50

## MECHANICAL CHARACTERISTICS

Height, 3 inches (76 mm)
Width, 3 inches (76 mm)
Length, 11 inches (279 mm) max.
Weight, 14.5 lbs. (6.58 Kg) max.
Color Code for 18" Flying Leads

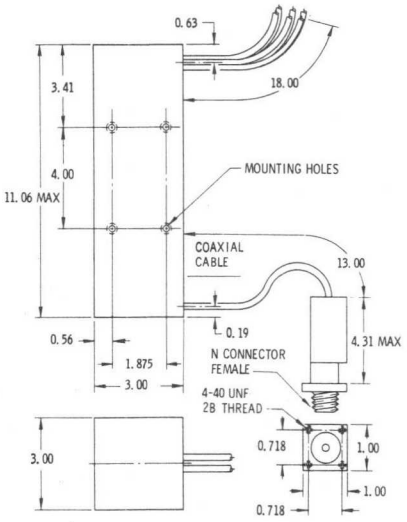
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

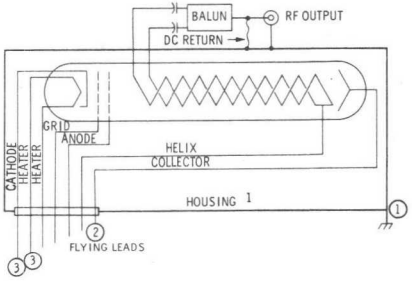
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min.
No Forced Air Cooling Required Below +60°C Ambient.

## OUTLINE DRAWING



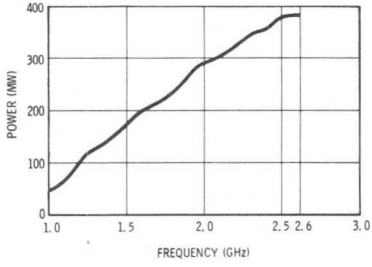

## SCHEMATIC DIAGRAM



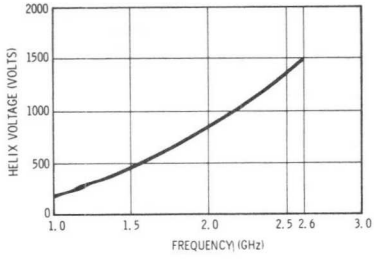

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45—150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



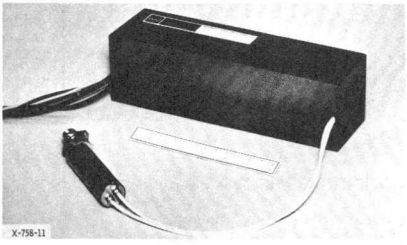
# TECHNICAL DATA

WATKINS-JOHNSON

# SE-214A

## BACKWARD-WAVE OSCILLATOR

September 1968*


X-758-11

The type SE-214A BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-214A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 1-2.0 | |
| Power Output into Load VSWR = 1.25 | mW | 110-450 | 100 Min |
| Power Output Variation | db | | 8 Max |
| Fine Grain Variation | db/50MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 5 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | db | 35 | 25 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 4 | 8 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.3 | 0.7 Max |
| Sensitivity to Grid Voltage | MHz/V | 1.5 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (1.0 GHz) | MHz/V | 1.4 | |
| Mid-Frequency (1.5 GHz) | MHz/V | .9 | |
| High End (2.0 GHz) | MHz/V | .7 | |
| Grid r.f. Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 15 | 25 Max |
| Capacitance; Grid to all other Electrodes, at Power Input Plug | pf | 20 | 25 Max |
| Capacitance; Helix to all other Electrodes | pf | 370 | 400 Max. |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.72 | 1.2 Max |
| Cathode Current | mA | 12 | 17 Max |
| Helix Voltage Range | V | 335-1450 | 310-1485 Min/Max |
| Helix Current | mA | 2 | 4.0 Max |
| Anode Voltage | V | 100 | 215 Max |
| Anode Current | mA | 0.8 | 1.5 Max |

* Supersedes SE-214 A Technical Data Sheet Dated September 1965

## MECHANICAL DATA

Weight, 14.5 lbs Max
Color Code for 18" Flying Leads

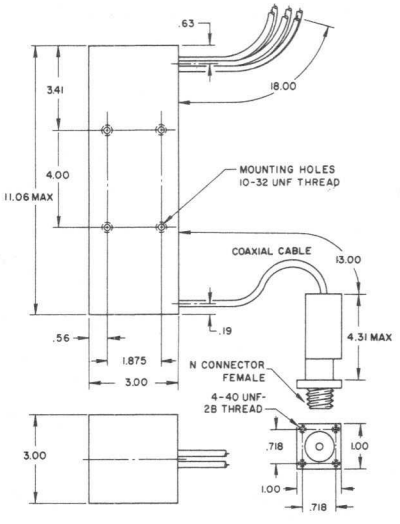
| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any
RF Output Connector, Type N Female on Balun

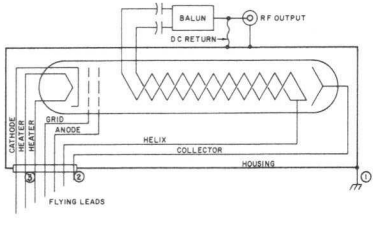
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



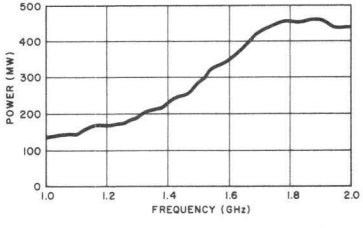

Notes:

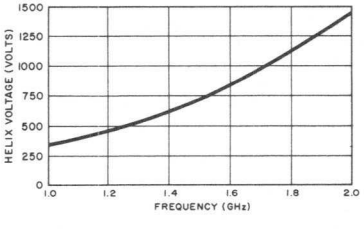
(1) For safety, housing should be grounded through mounting screws.

(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT



# TECHNICAL DATA

WATKINS-JOHNSON

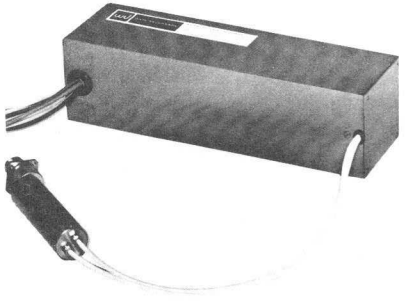
FEBRUARY 1971

## BACKWARD-WAVE OSCILLATOR SE-214A-50

The SE-214A-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-214A-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 1–2.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 110–450 | 100 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB / 50 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 2 | 8 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 35 | 25 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 4 | |
| Sensitivity to Anode Voltage | MHz/V | 0.3 | |
| Sensitivity to Grid Voltage | MHz/V | 1.5 | |
| Tuning Curve Slope | | | |
| Low End (1.0 GHz) | MHz/V | 1.4 | |
| Mid-Frequency (1.5 GHz) | MHz/V | .9 | |
| High End (2.0 GHz) | MHz/V | .7 | |
| Grid RF Cutoff Voltage | V | –7 | –25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 15 | 35 Max. |
| Capacitance; Grid to all other Electrodes, at Power Input Plug | pF | 20 | 35 Max. |
| Capacitance; Helix to all other Electrodes | pF | 370 | 400 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.85 | 0.4 – 1.2 Max. |
| Cathode Current * | mA | 12 | 17 Max. |
| Helix Voltage Range | V | 315–1450 | 300–1537 Min./Max. |
| Helix Current | mA | 2 | 4.0 Max. |
| Anode Voltage | V | 100 | 215 Max. |
| Anode Current | mA | 0.8 | 1.5 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# SE-214A-50

## MECHANICAL CHARACTERISTICS

Height, 3 inches (76 mm)
Width, 3 inches (76 mm)
Length, 11 inches (279 mm) max.
Weight, 14.5 lbs. (6.58 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

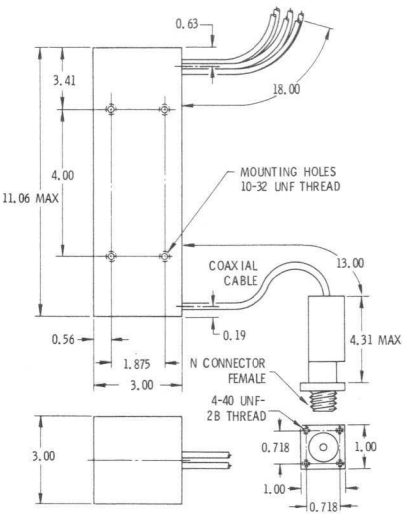
Mounting Position, Any

RF Output Connector, Type N Female on Balun

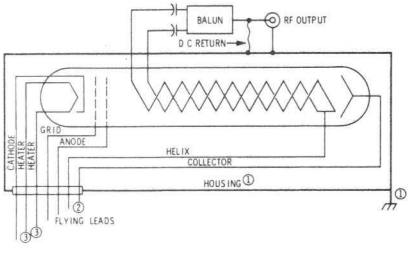
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

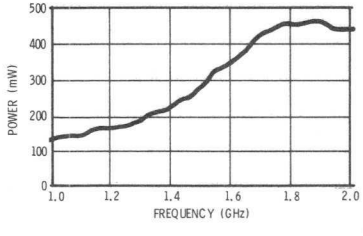
## OUTLINE DRAWING



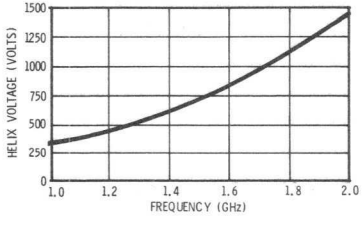

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

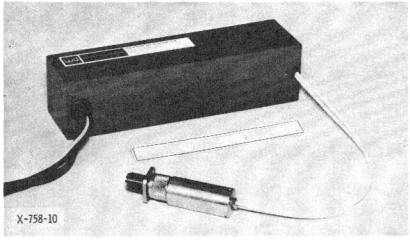
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-215

September 1968*




The type SE-215 BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The SE-215 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARICTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 1.7-4.2 | |
| Power Output into a Load with VSWR = 1.25 | mW | 40-300 | 30 Min |
| Power Output Variation | db | | 9 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 5 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | db | 30 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 2 | 8 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.25 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (1.7 GHz) | MHz/V | 2.7 | |
| Mid-Frequency (2.95 GHz) | MHz/V | 1.4 | |
| High End (4.2 GHz) | MHz/V | .75 | |
| Grid r.f. Cutoff Voltage | V | -8 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 18 | 25 Max |
| Capacitance; Grid to all other Electrodes at Power Input Plug | pf | 18 | 25 Max |
| Capacitance; Helix to all other Electrodes | pf | 250 | 300 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.72 | 0.6-1.2 Min/Max |
| Cathode Current | mA | 8 | 15 Max |
| Helix Voltage | V | 235-2030 | 200-2150 Min/Max |
| Helix Current | mA | 2 | 4 Max |
| Anode Voltage | V | 130 | 220 Max |
| Anode Current | mA | 0.6 | 1.5 Max |

* Supersedes SE-215 Technical Data Sheet Dated September 1965

## MECHANICAL DATA

Weight, 7.25 lbs Max
Color Code for 18" Flying Leads

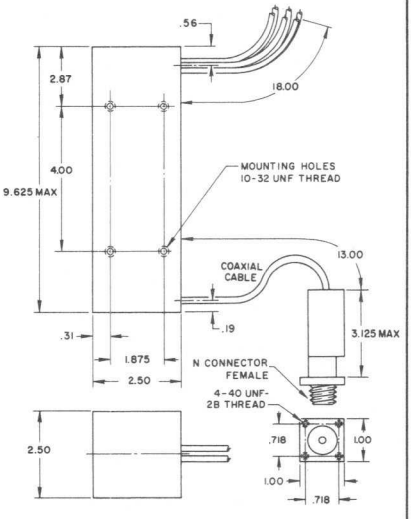
| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

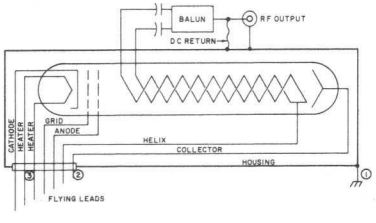
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



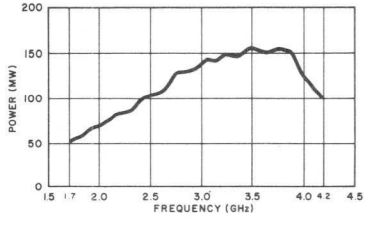

Notes:

(1) For safety, housing should be grounded through mounting screws.

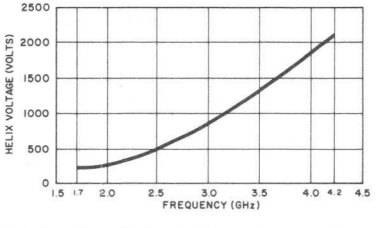
(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR SE-215-50

The SE-215-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment.

The SE-215-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 1.7–4.2 |
| Power Output into Load with VSWR = 1.25:1 | mW | 40–300 | 40 Min. |
| Power Output Variation | dB | | 9 Max. |
| Fine Grain Variation | dB / 100 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 2 | 5 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 2 | |
| Sensitivity to Anode Voltage | MHz/V | 0.25 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (1.7 GHz) | MHz/V | 2.7 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 1.4 | |
| High End (4.2 GHz) | MHz/V | .75 | |
| Grid RF Cutoff Voltage | V | −8 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 18 | 35 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 18 | 35 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 250 | 300 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.9 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 8 | 15 Max. |
| Helix Voltage Range | V | 235–2030 | 200–2150 Min./Max. |
| Helix Current | mA | 2 | 4 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.6 | 1.5 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# SE-215-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 9.6 inches (244 mm) max.
Weight, 7.25 lbs. (3.29 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

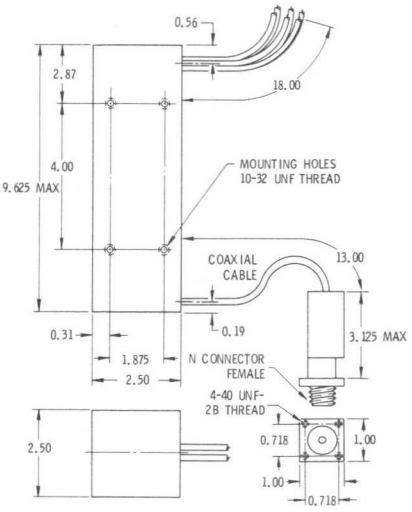
Mounting Position, Any

RF Output Connector, Type N Female on Balun

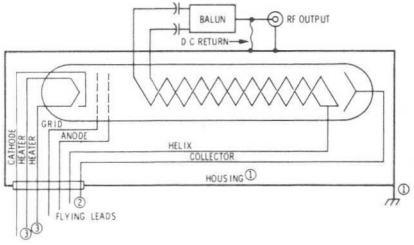
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING



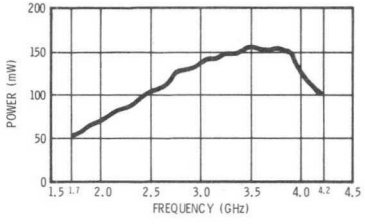

## SCHEMATIC DIAGRAM



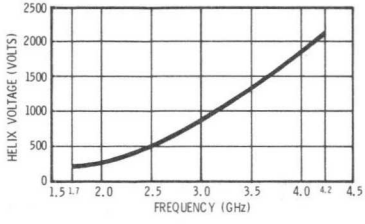

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



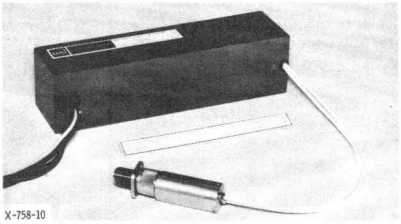
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-215A

September 1968*


X-758-10

The type SE-215A BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), and ECM equipment. The SE-215A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2-4 | |
| Power Output into a Load with VSWR = 1.25 | mW | 100-300 | 75 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 5 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | db | 30 | 25 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 2 | 8 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.25 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 2.5 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 1.4 | |
| High End (4.0 GHz) | MHz/V | .85 | |
| Grid r.f. Cutoff Voltage | V | -8 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 18 | 25 Max |
| Capacitance; Grid to all other Electrodes at Power Input Plug | pf | 18 | 25 Max |
| Capacitance; Helix to all other Electrodes | pf | 250 | 300 Max |
| Heater | V | | 6.3±5% |
| Heater Current | A | 0.72 | 0.4 - 1.2 Min/Max |
| Cathode Current | mA | 8 | 15 Max |
| Helix Voltage Range | V | 330-1800 | 300-2000 Min/Max |
| Helix Current | mA | | 3.0 Max |
| Anode Voltage | V | 130 | 215 Max |
| Anode Current | mA | 0.6 | 1.5 Max |

* Supersedes SE-215A Technical Data Sheet Dated September 1965

## MECHANICAL DATA

Weight, 7.25 lbs Max
Color Code for 18" Flying Leads

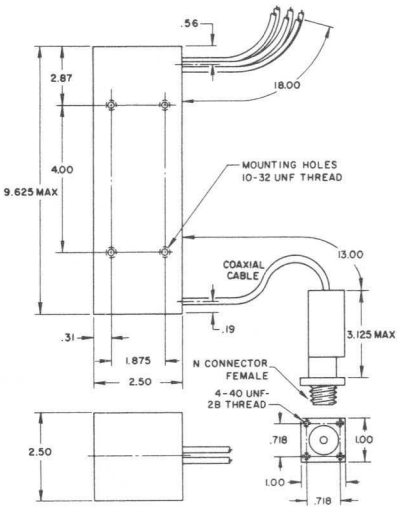
| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N
Female on Balun

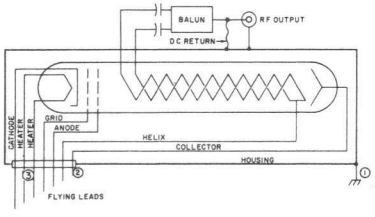
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

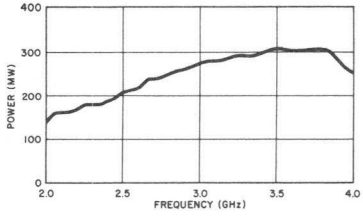
## OUTLINE DRAWING



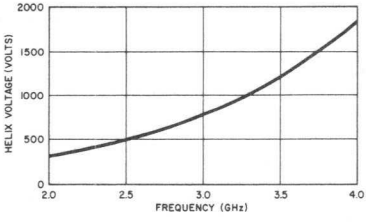

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




Notes:

(1) For safety, housing should be grounded through mounting screws.

(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

# TECHNICAL DATA

WATKINS-JOHNSON

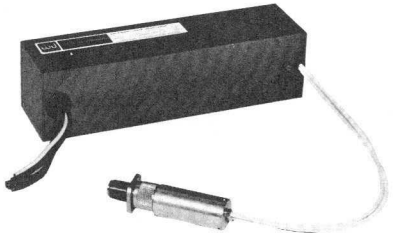
DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR SE-215A-50

The SE-215A-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment.

The SE-215A-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 2–4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 100–300 | 80 Min. |
| Power Output Variation | dB | | 7 Max. |
| Fine Grain Variation | dB / 250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 2 | 5 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 2 | |
| Sensitivity to Anode Voltage | MHz/V | 0.25 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 2.5 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 1.4 | |
| High End (4.0 GHz) | MHz/V | .85 | |
| Grid RF Cutoff Voltage | V | –8 | –25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 18 | 35 Max. |
| Capacitance; Grid to all other Electrodes, at Power Input Plug | pF | 18 | 35 Max. |
| Capacitance; Helix to all other Electrodes | pF | 250 | 300 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.72 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 8 | 15 Max. |
| Helix Voltage Range | V | 330–1800 | 300–2000 Min./Max. |
| Helix Current | mA | 0.5 | 3.0 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.6 | 1.5 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# SE-215A-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 9.6 inches (244 mm) max.
Weight, 7.25 lbs. (3.29 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

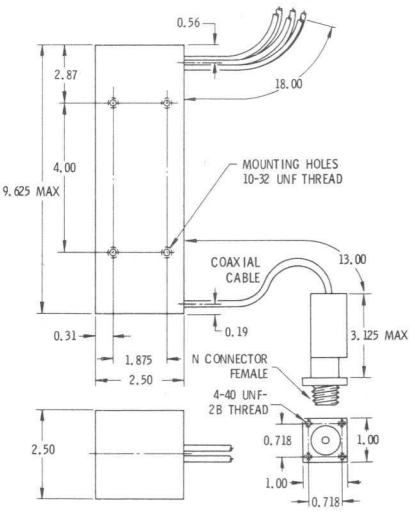
Mounting Position, Any

RF Output Connector, Type N Female on Balun

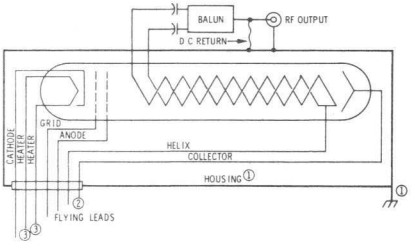
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

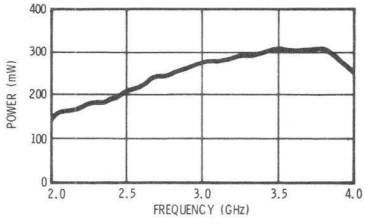
## OUTLINE DRAWING



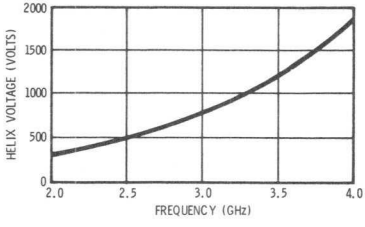

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

(1.) For safety, housing should be grounded through mounting screws.

(2.) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

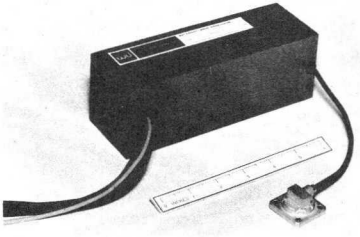
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-216

TECHNICAL DATA • September 1965



The type SE-216 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet-focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-216 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 12.4-18 | |
| Power Output into Load VSWR = 1.25 | mW | 15-70 | 10 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 3:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 2 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | db | 48 | 40 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.5 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 8.7 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Grid r.f. Cutoff Voltage | V | -15 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 25 | 40 Max |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pf | 25 | 40 Max |
| Capacitance; Helix to all other Electrodes and Capsule | pf | 100 | 125 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.9 | 0.6-1.2 Min/Max |
| Cathode Current | mA | 7 | 12 Max |
| Helix Voltage Range | V | 530-1900 | 500-2000 Min/Max |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 160 | 215 Max |
| Anode Current | mA | 1 | 2 Max |

## MECHANICAL DATA

Weight, 6.0 lbs Max
Color Code for 18" Flying Leads

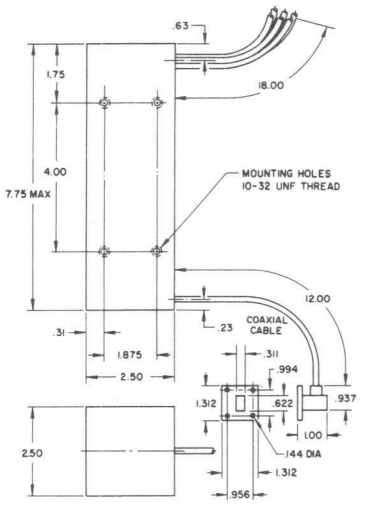
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type UG-419/U Waveguide Adapter

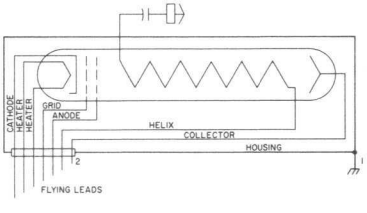
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



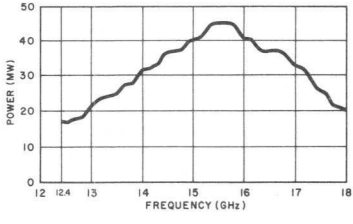

## SCHEMATIC DIAGRAM



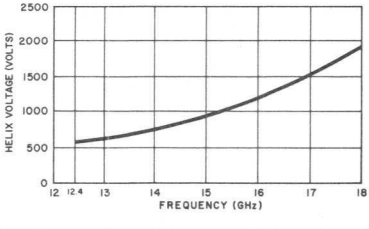

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



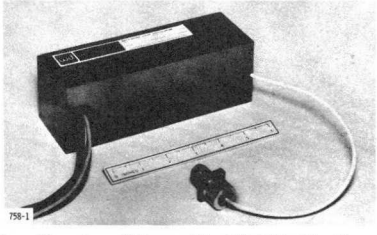
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-217

September 1965




The type SE-217 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-217 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 5.3-6.0 | |
| Power Output into Load with VSWR = 1.25 | mW | 120-160 | 100 Min |
| Power Output Variation | db | | 3 Max |
| Fine Grain Variation | db/100 MHz | | 1.5 Max |
| Tube VSWR | | | 2:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 5 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | db | 52 | 40 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 1.5 | 2 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 2.5 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (5.3 GHz) | MHz/V | 3.3 | |
| Mid-Frequency (5.65 GHz) | MHz/V | 2.8 | |
| High End (6.0 GHz) | MHz/V | 2.3 | |
| Grid r.f. Cutoff Voltage | V | -10 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 18 | 25 Max |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pf | 12 | 20 Max |
| Capacitance; Helix to all other Electrodes and Housing | pf | 135 | 160 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 1.0 | 1.2 Max |
| Cathode Current | mA | 14 | 20 Max |
| Helix Voltage Range | V | 480-740 | 440-800 Min/Max |
| Helix Current | mA | 5 | 8 Max |
| Anode Voltage | V | 100 | 215 Max |
| Anode Current | mA | 0.7 | 2.0 Max |

## MECHANICAL DATA

Weight, 6.0 lbs Max
Color Code for 18" Flying Leads

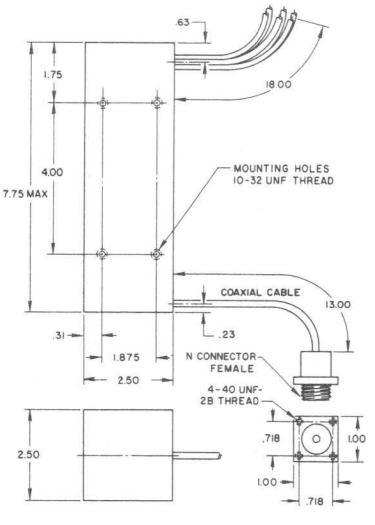
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female

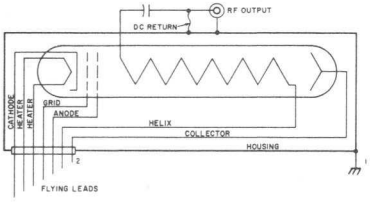
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



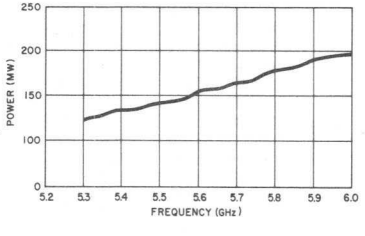

## SCHEMATIC DIAGRAM



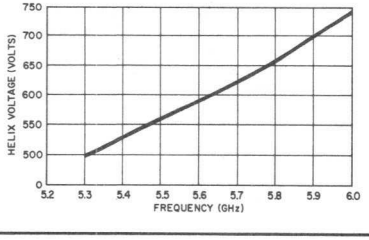

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1969*

## BACKWARD-WAVE OSCILLATOR
## SE-218

The SE-218 is a single-helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-218 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.


### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 18-26.5 |
| Power Output into Load with VSWR = 1.25:1 | mW | 25-50 | 20 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 6 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | dB | 50 | 40 Min. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Sensitivity to Heater Voltage | MHz/V | 35 | |
| Sensitivity to Anode Voltage | MHz/V | 1.0 | |
| Sensitivity to Grid Voltage | MHz/V | 10 | |
| Tuning Curve Slope | | | |
| Low End (18 MHz) | MHz/V | 12.3 | |
| Mid-Frequency (22.5 MHz) | MHz/V | 7 | |
| High End (26.5 MHz) | MHz/V | 3.5 | |
| Grid RF Cutoff Voltage | V | −10 | −20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 30 | 50 Max. |
| Capacitance; Grid to all other Electrodes and Housing | pF | 20 | 50 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 70 | 120 Max. |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.67 | 0.4-1.2 |
| Cathode Current[1] | mA | 6 | 10 Max. |
| Helix Voltage Range | V | 530-1800 | 450-2000 |
| Helix Current | mA | 1.5 | 2.5 Max. |
| Anode Voltage | V | 180 | 250 Max. |
| Anode Current | mA | 0.2 | 1 Max. |

[1]Set cathode current to Final Test Data value furnished with tube.

*Supersedes SE-218 Technical Data Sheet dated September 1965.

# SE-218

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 5.25 inches (133 mm)
Weight, 4 lbs. (1.81 Kg) Max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

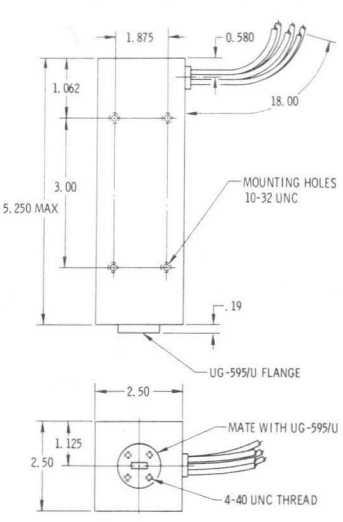
RF Output Connector, UG-595/U Flange

## ENVIRONMENTAL CHARACTERISTICS

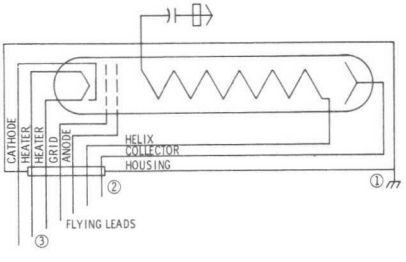
Separation from Passive Magnetic Materials, 2 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



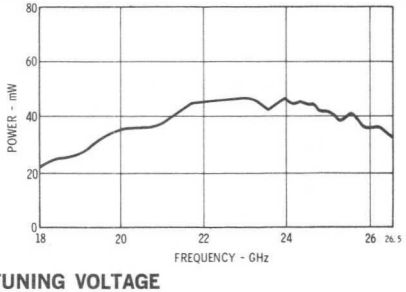

Notes:

① For safety, housing should be grounded through mounting screws.

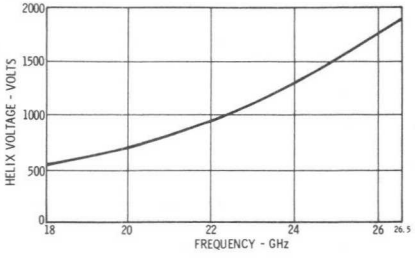
② 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must never be positive with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

JANUARY 1971

## BACKWARD-WAVE OSCILLATOR
## SE-218-50


The type SE-218-50 is a single helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-218-50 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 18-26.5 |
| Power Output into Load with VSWR = 1.25:1 | mW | 25-50 | 20 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 6 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | dB | 50 | 40 Min. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Sensitivity to Heater Voltage | MHz/V | 35 | |
| Sensitivity to Anode Voltage | MHz/V | 1.0 | |
| Sensitivity to Grid Voltage | MHz/V | 10 | |
| Tuning Curve Slope | | | |
| Low End (18 MHz) | MHz/V | 12.3 | |
| Mid-Frequency (22.5 MHz) | MHz/V | 7 | |
| High End (26.5 MHz) | MHz/V | 3.5 | |
| Grid RF Cutoff Voltage | V | −10 | −25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 30 | 50 Max. |
| Capacitance; Grid to all other Electrodes and Housing | pF | 20 | 50 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 70 | 120 Max. |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.67 | 0.4-1.2 |
| Cathode Current[1] | mA | 6 | 10 Max. |
| Helix Voltage Range | V | 520-1800 | 400-2050 |
| Helix Current | mA | 1.5 | 2.5 Max. |
| Anode Voltage | V | 180 | 215 Max. |
| Anode Current | mA | 0.2 | 1 Max. |

[1]Set cathode current to Final Test Data value furnished with tube.

## SE-218-50

### MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 6.75 inches (171 mm)
Weight, 6 lbs. (2.72 Kg) Max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

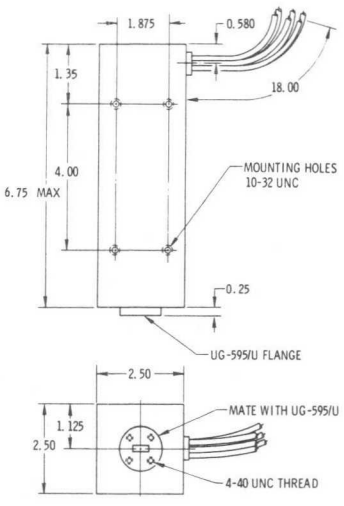
RF Output Connector, UG-595/U Flange

### ENVIRONMENTAL CHARACTERISTICS

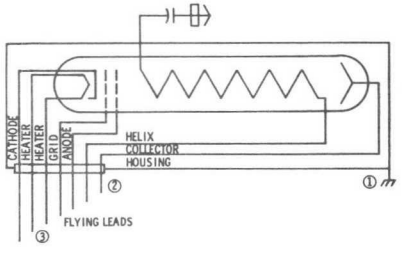
Separation from Passive Magnetic Materials, 2 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

### OUTLINE DRAWING




### SCHEMATIC DIAGRAM



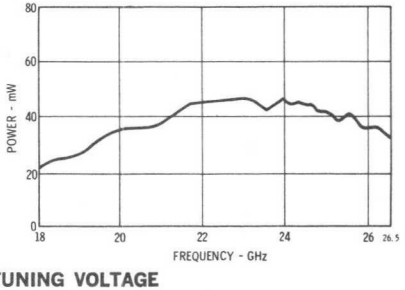

Notes:

(1) For safety, housing should be grounded through mounting screws.

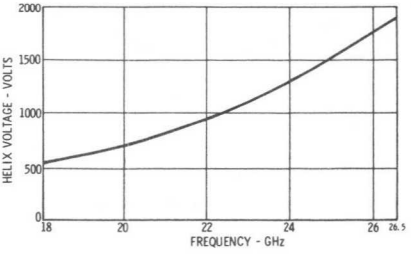
(2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

### POWER OUTPUT




### TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

JANUARY 1969

## BACKWARD-WAVE OSCILLATOR
## SE-219

The type SE-219 BWO is a bifilar (dual helix), voltage-tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-219 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Frequency Band | GHz | | 1.4 - 2.5 |
| Power Output into Load VSWR = 1.25 | mW | 110 - 250 | 100 Min |
| Power Output Variation | dB | | 8 Max |
| Fine Grain Variation | dB/50 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 5 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | dB | 40 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-Term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.2 | 0.5 Max |
| Sensitivity to Grid Voltage | MHz/V | 5 | 10 Max |
| Tuning Curve Slope | | | |
| Low-End (1.4 GHz) | MHz/V | 1.8 | |
| Mid-Frequency (1.95 GHz) | MHz/V | 1.05 | |
| High-End (2.5 GHz) | MHz/V | 0.7 | |
| Grid RF Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 15 | 25 Max |
| Capacitance; Grid to all other Electrodes at Power Input Connector | pF | 20 | 25 Max |
| Capacitance; Helix to all other Electrodes | pF | 440 | 475 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.85 | 0.4-1.2 |
| Cathode Current | mA | 11 | 17 Max |
| Helix Voltage Range | V | 370-1385 | 350-1450 |
| Helix Current | mA | 1.5 | 4 Max |
| Anode Voltage | V | 95 | 215 Max |
| Anode Current | mA | 1 | 1.5 Max |

## MECHANICAL CHARACTERISTICS

Height, 3 Inches (76 mm)
Width, 3 Inches (76 mm)
Length, 11 Inches (279 mm)
Weight, 14.5 lbs. (6.58 kg.) max.
Color Code for 18" Flying Leads

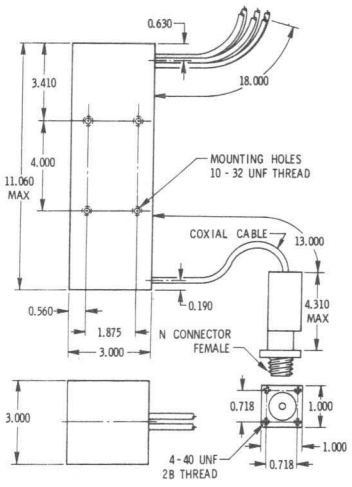
| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any
RF Output Connector, Type N Female on Balun

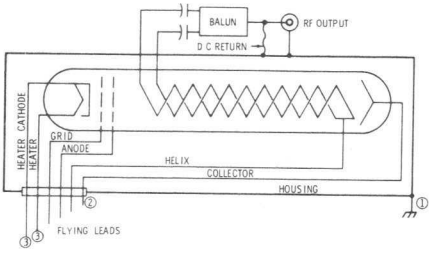
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



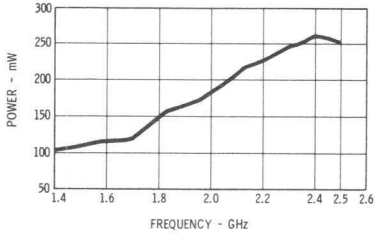

Notes:

(1) For safety, housing should be grounded through mounting screws.

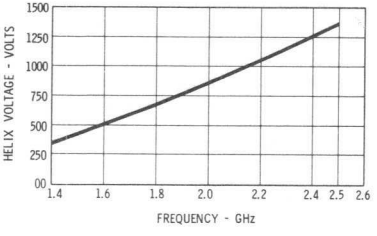
(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

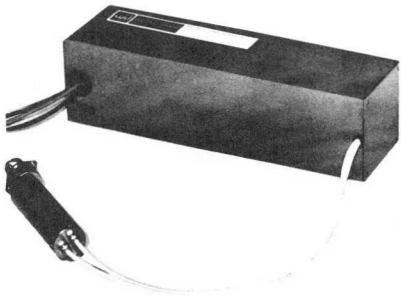
FEBRUARY 1971

## BACKWARD-WAVE OSCILLATOR SE-219-50

The SE-219-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-219-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 1.4–2.5 |
| Power Output into Load with VSWR = 1.25:1 | mW | 110–350 | 100 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/50 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 2 | 5 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 40 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.2 | |
| Sensitivity to Grid Voltage | MHz/V | 5 | |
| Tuning Curve Slope | | | |
| Low End (1.4 GHz) | MHz/V | 1.8 | |
| Mid-Frequency (1.95 GHz) | MHz/V | 1.05 | |
| High End (2.5 GHz) | MHz/V | 0.7 | |
| Grid RF Cutoff Voltage | V | −7 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 15 | 35 Max. |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pF | 20 | 35 Max. |
| Capacitance; Helix to all other Electrodes | pF | 440 | 475 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.85 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 11 | 17 Max. |
| Helix Voltage Range | V | 370–1385 | 350–1450 Min./Max. |
| Helix Current | mA | 1.0 | 4 Max. |
| Anode Voltage | V | 95 | 215 Max. |
| Anode Current | mA | 1 | 1.5 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# SE-219-50

## MECHANICAL CHARACTERISTICS

Height, 3 inches (76 mm)
Width, 3 inches (76 mm)
Length, 11 inches (279 mm) max.
Weight, 14.5 lbs. (6.58 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

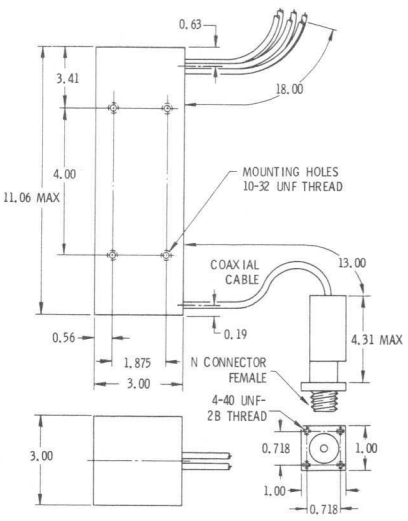
Mounting Position, Any

RF Output Connector, Type N Female on Balun

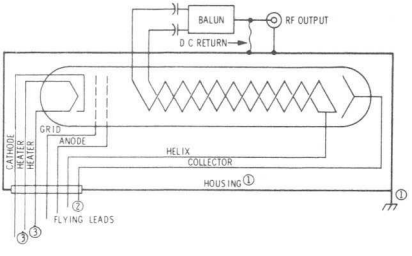
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 4 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

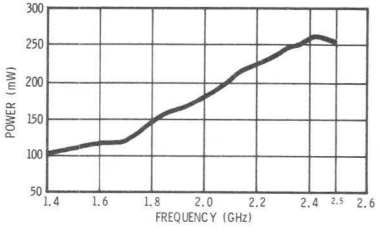
## OUTLINE DRAWING



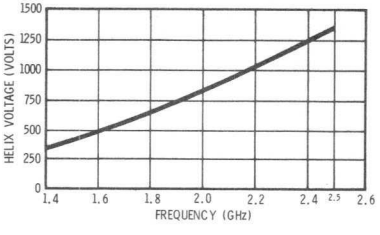

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

(1.) For safety, housing should be grounded through mounting screws.

(2.) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

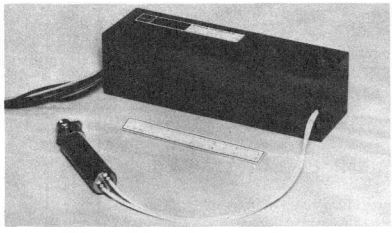
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-219A

TECHNICAL DATA • March 1966



The type SE-219A BWO is a bifilar (dual helix), voltage-tunable oscillator. This permanent-magnet-focused wide-band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-219A features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 1.4-2.5 | |
| Power Output into Load VSWR = 1.25 | mW | 110-350 | 100 Min |
| Power Output Variation | dB | | 8 Max |
| Fine Grain Variation | dB/100 MHz | | 3 Max |
| Tube VSWR | | | 2.0:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 5 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | dB | 40 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-Term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.2 | 0.5 Max |
| Sensitivity to Grid Voltage | MHz/V | 5 | 10 Max |
| Tuning Curve Slope | | | |
| Low-End (1.4 GHz) | MHz/V | 1.8 | |
| Mid-Frequency (1.95 GHz) | MHz/V | 1.05 | |
| High-End (2.5 GHz) | MHz/V | 0.7 | |
| Grid RF Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 15 | 25 Max |
| Capacitance; Grid to all other Electrodes at Power Input Connector | pF | 20 | 25 Max |
| Capacitance; Helix to all other Electrodes | pF | 440 | 475 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.85 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 11 | 17 Max |
| Helix Voltage Range | V | 370-1385 | 350-1450 Min/Max |
| Helix Current | mA | 1.5 | 4 Max |
| Anode Voltage | V | 95 | 215 Max |
| Anode Current | mA | 1 | 1.5 Max |

## MECHANICAL DATA

Weight, 14.5 lbs Max
Color Code for 18" Flying Leads

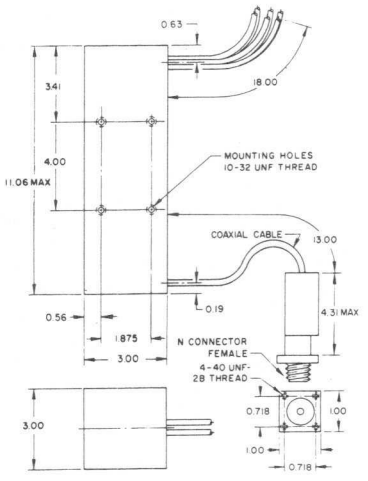
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

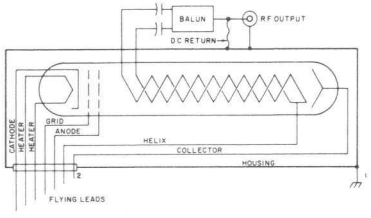
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min
No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING



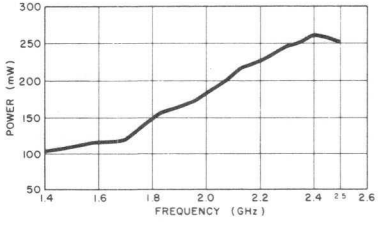

## SCHEMATIC DIAGRAM



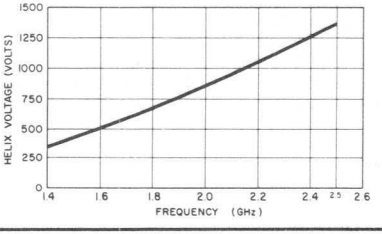

[1] For Safety, housing should be grounded through mounting screws.

[2] 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



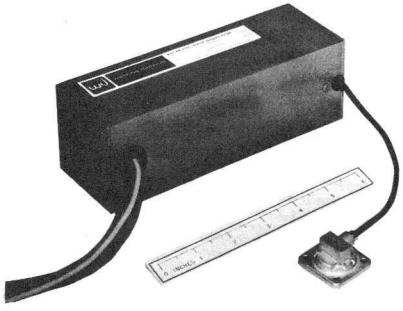
# TECHNICAL DATA

WATKINS-JOHNSON

JULY 1967

## BACKWARD-WAVE OSCILLATOR
## SE-220

The type SE-220 is a single helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-220 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packing.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 10.0-15.5 |
| Power Output into Load with VSWR = 1.25:1 | mW | 12-40 | 10 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (10.0 GHz) | MHz/V | 7 | |
| Mid-Frequency (12.8 GHz) | MHz/V | 4 | |
| High End (15.5 GHz) | MHz/V | 2 | |
| Grid RF Cutoff Voltage | V | −10 | −20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 25 | 40 Max. |
| Capacitance; Grid to all other Electrodes and Housing | pF | 25 | 40 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 150 | 175 Max. |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | 0.95 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 7 | 10 Max. |
| Helix Voltage Range | V | 580-2200 | 550-2250 Min/Max |
| Helix Current | mA | 2 | 3 Max. |
| Anode Voltage* | V | 150 | 215 Max. |
| Anode Current | mA | 0.7 | 1.5 Max. |

*Set anode voltage to Final Test Data value furnished with tube.

# SE-220

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64mm)
Length, 7.75 inches (197 mm)
Weight, 6.0 lbs. (2.72 Kg) Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |
| Cathode | Yellow |

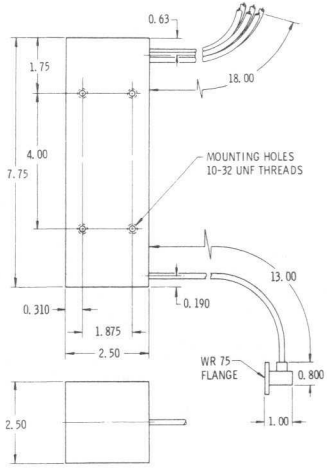
Mounting Position, any
RF Output Connector, WR 75 Waveguide Flange

## ENVIRONMENTAL CHARACTERISTICS

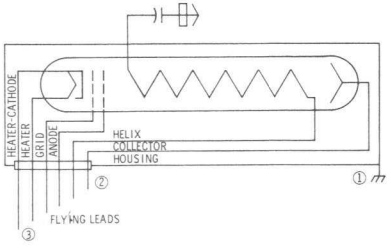
Separation from Passive Magnetic Materials 2 in. Min.

No Forced Air Cooling Required Below 60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

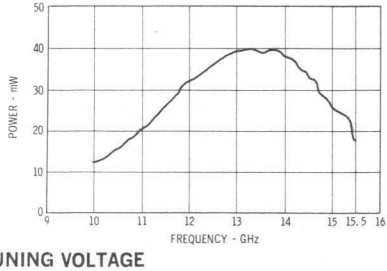



①For safety, housing should be grounded through mounting screws.

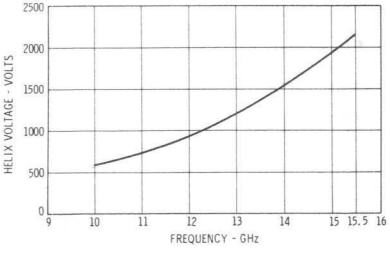
②50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③Heater must never be positive with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE

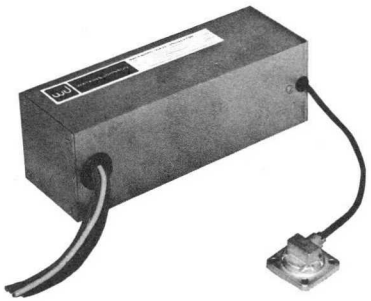


# TECHNICAL DATA

WATKINS-JOHNSON

JANUARY 1971

## BACKWARD-WAVE OSCILLATOR
## SE-220-50



The type SE-220-50 is a single helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-220-50 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 10.0-15.5 |
| Power Output into Load with VSWR = 1.25:1 | mW | 23-48 | 20 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (10.0 GHz) | MHz/V | 7 | |
| Mid-Frequency (12.8 GHz) | MHz/V | 4 | |
| High End (15.5 GHz) | MHz/V | 2 | |
| Grid RF Cutoff Voltage | V | −10 | −25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 25 | 40 Max. |
| Capacitance; Grid to all other Electrodes and Housing | pF | 25 | 40 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 150 | 175 Max. |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | 0.9 | 0.4-1.2 Min/Max |
| Cathode Current * | mA | 7 | 10 Max. |
| Helix Voltage Range | V | 580-2200 | 550-2250 Min/Max |
| Helix Current | mA | 2 | 3 Max. |
| Anode Voltage* | V | 150 | 215 Max. |
| Anode Current | mA | 0.7 | 1.5 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# SE-220-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64mm)
Length, 7.75 inches (197 mm)
Weight, 6.0 lbs. (2.72 Kg) Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |
| Cathode | Yellow |

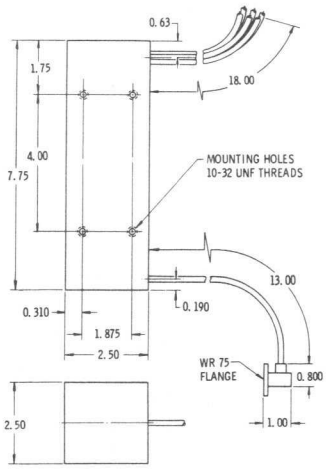
Mounting Position, any
RF Output Connector, WR 75 Waveguide Flange

## ENVIRONMENTAL CHARACTERISTICS

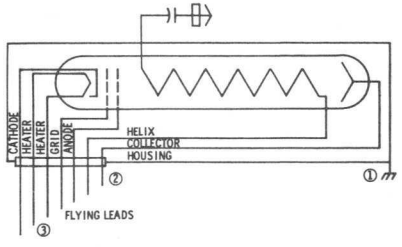
Separation from Passive Magnetic Materials 2 in. Min.

No Forced Air Cooling Required Below 60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

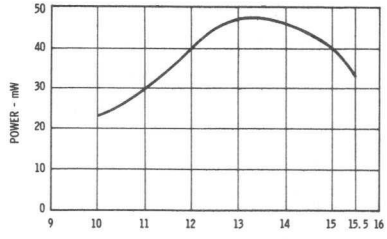



①For safety, housing should be grounded through mounting screws.

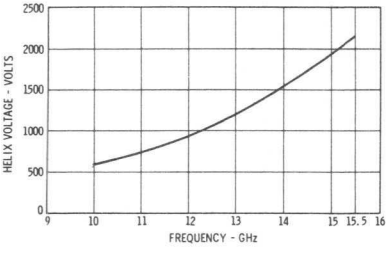
②45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



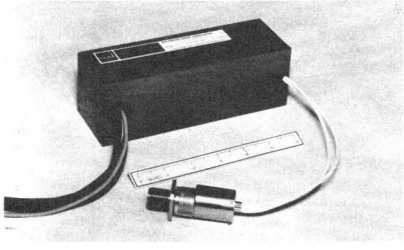
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-221

September 1965



The type SE-221 BWO is a bifilar (dual helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment. The SE-221 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. With all voltages isolated from both tube housing and the r.f. output terminal, packaging problems are simplified, since the tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 3.5-6.75 | |
| Power Output into a Load with VSWR = 1.25 | mW | 50-130 | 40 Min |
| Power Output Variation | db | | 7 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | db | 30 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (3.5 GHz) | MHz/V | 5.6 | |
| Mid-Frequency (5.1 GHz) | MHz/V | 2.2 | |
| High End (6.75 GHz) | MHz/V | 1.6 | |
| Grid r.f. Cutoff Voltage | V | -7 | -20 Max |
| Collector Voltage Above Helix (Note 1) | V | 50-150 | 300 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pf | 30 | 45 Max |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pf | 30 | 45 Max |
| Capacitance; Helix to all other Electrodes | pf | 100 | 150 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.85 | 0.6-1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 400-2040 | 350-2100 Min/Max |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 175 | 250 Max |
| Anode Current | mA | 0.5 | 2 Max |

## MECHANICAL DATA

Weight, 6.0 lbs Max
Color Code for 18" Flying Leads

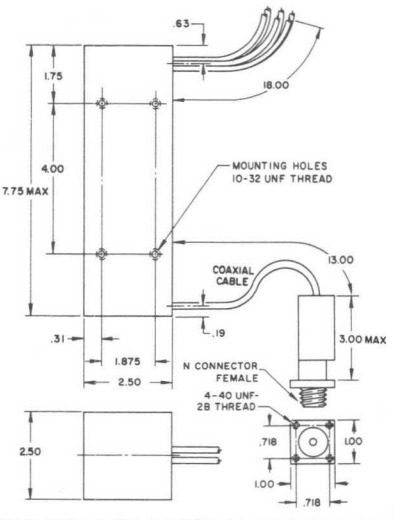
| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

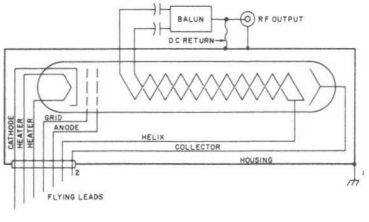
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



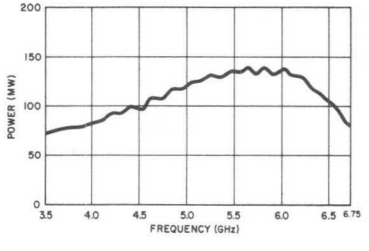

## SCHEMATIC DIAGRAM



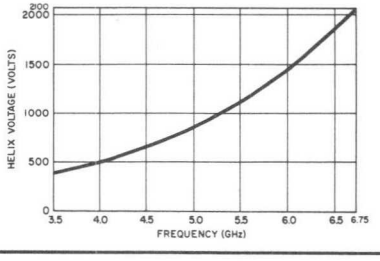

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

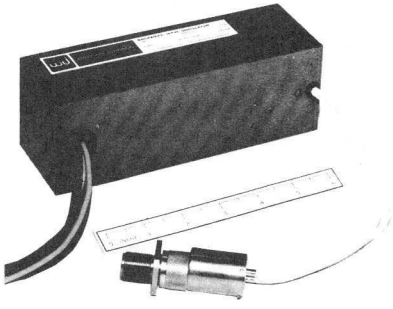
DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## SE-221-50

The SE-221-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The SE-221-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 3.5–6.75 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50–130 | 45 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (3.5 GHz) | MHz/V | 3.5 | |
| Mid-Frequency (5.1 GHz) | MHz/V | 2.5 | |
| High End (6.75 GHz) | MHz/V | 1.1 | |
| Grid RF Cutoff Voltage | V | –7 | –25 Max. |
| Collector Voltage Above Helix | V | 50–150 | 300 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 30 | 45 Max. |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pF | 30 | 45 Max. |
| Capacitance; Helix to all other Electrodes | pF | 100 | 150 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.85 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 400–2040 | 350–2100 Min./Max. |
| Helix Current | mA | 2 | 3 Max. |
| Anode Voltage | V | 175 | 215 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# SE-221-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 7.75 inches (197 mm) max.
Weight, 6 lbs. (2.72 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

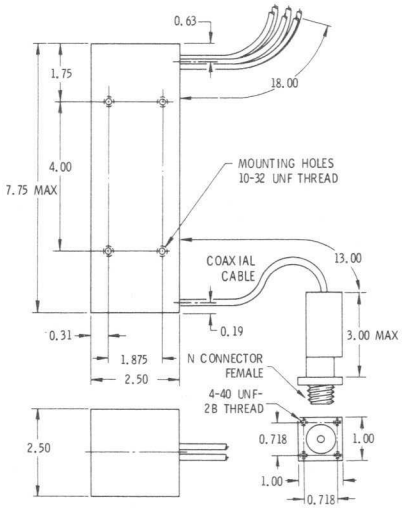
Mounting Position, Any

RF Output Connector, Type N Female on Balun

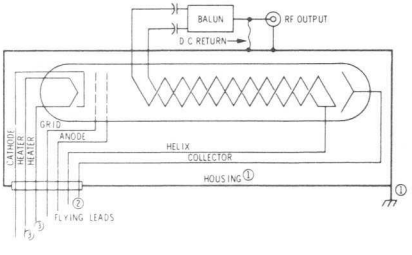
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



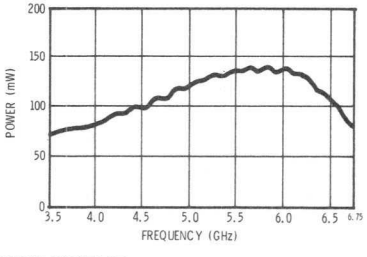

**Notes:**

① For safety, housing should be grounded through mounting screws.

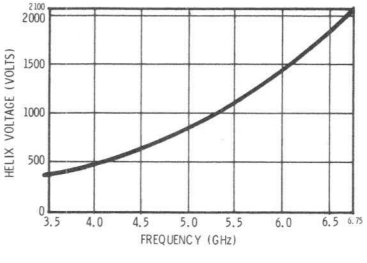
② 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1969*

## BACKWARD-WAVE OSCILLATOR
## SE-222

The SE-222 is a single-helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-222 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.


### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 26.5-40 |
| Power Output into Load with VSWR = 1.25:1 | mW | 10-35 | 10 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/500 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 6 | 18 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 30 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 25 | |
| Tuning Curve Slope | | | |
| Low End (26.5 GHz) | MHz/V | 20 | |
| Mid-Frequency (33.25 GHz) | MHz/V | 10 | |
| High End (40 GHz) | MHz/V | 6 | |
| Grid RF Cutoff Voltage | V | −7 | −20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 35 | 50 Max. |
| Capacitance; Grid to all other Electrodes and Housing | pF | 25 | 50 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 60 | 100 Max. |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.65 | 0.4-1.2 |
| Cathode Current[1] | mA | 4 | 5 Max. |
| Helix Voltage Range | V | 520-1900 | 500-2100 |
| Helix Current | mA | 1.0 | 1.5 Max. |
| Anode Voltage | V | 150 | 250 Max. |
| Anode Current | mA | 0.05 | 0.7 Max. |

[1]Set cathode current to Final Test Data value furnished with tube.

*Supersedes SE-222 Technical Data Sheet dated July 1967.

# SE-222

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 5.25 inches (133 mm)
Weight, 3.75 lbs. (1.70 Kg) Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |
| Cathode | Yellow |

Mounting Position, Any

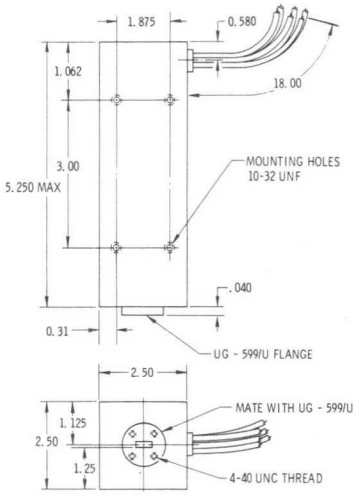
RF Output Connector mates to UG599/U Waveguide Flange

## ENVIRONMENTAL CHARACTERISTICS

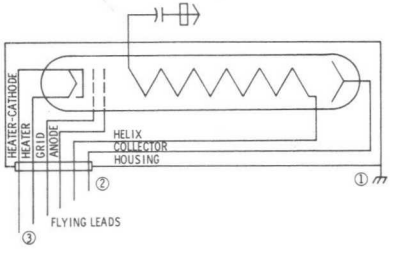
Separation from Passive Magnetic Materials 4 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



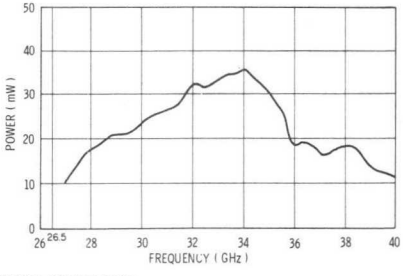

Notes:

(1) For safety, housing should be grounded through mounting screws.

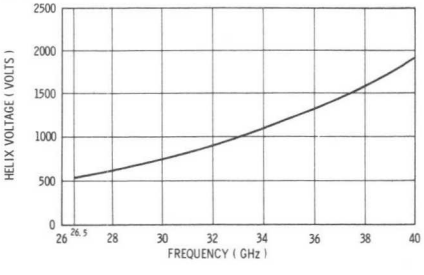
(2) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must never be positive with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

JANUARY 1971

## BACKWARD-WAVE OSCILLATOR
## SE-222-50

The type SE-222-50 is a single helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide-band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in frequency diversity transmitters and in electronic test sets. The SE-222-50 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easy packaging.


### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 26.5-40 |
| Power Output into Load with VSWR = 1.25:1 | mW | 12-35 | 10 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 6 | 18 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 30 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 25 | |
| Tuning Curve Slope | | | |
| Low End (26.5 GHz) | MHz/V | 20 | |
| Mid-Frequency (33.25 GHz) | MHz/V | 10 | |
| High End (40 GHz) | MHz/V | 6 | |
| Grid RF Cutoff Voltage | V | −7 | −25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 35 | 50 Max. |
| Capacitance; Grid to all other Electrodes and Housing | pF | 25 | 50 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 60 | 100 Max. |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.65 | 0.4-1.2 |
| Cathode Current[1] | mA | 4 | 5 Max. |
| Helix Voltage Range | V | 520-1900 | 480-2050 |
| Helix Current | mA | 1.0 | 1.5 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | 0.05 | 0.7 Max. |

[1]Set cathode current to Final Test Data value furnished with tube.

# SE-222-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 6.75 inches (171 mm)
Weight, 5.0 lbs. (2.27 Kg) Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |
| Cathode | Yellow |

Mounting Position, Any

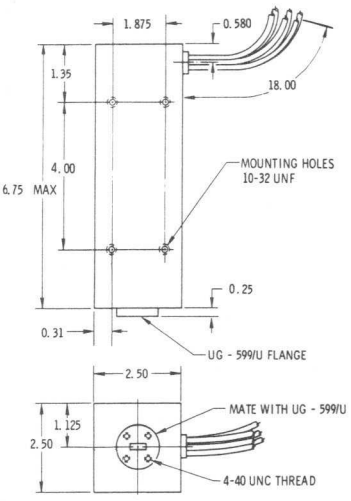
RF Output Connector mates to UG599/U Waveguide Flange

## ENVIRONMENTAL CHARACTERISTICS

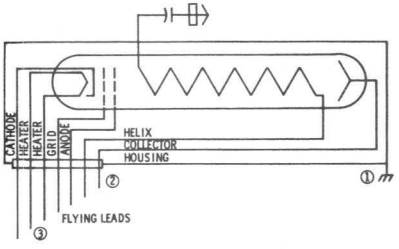
Separation from Passive Magnetic Materials 4 in. Min.

No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



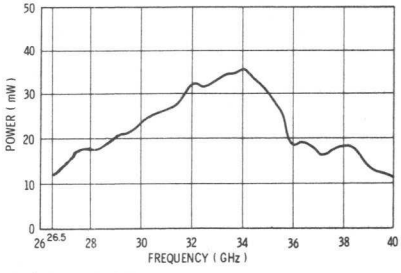

Notes:

(1) For safety, housing should be grounded through mounting screws.

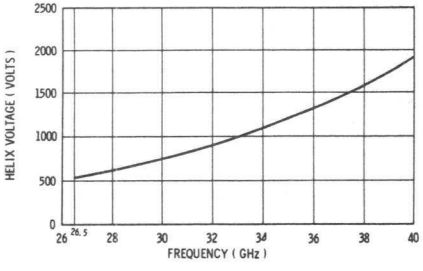
(2) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

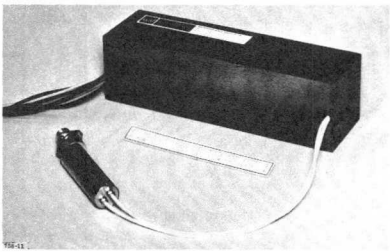
WATKINS-JOHNSON

# SE-223

## BACKWARD-WAVE OSCILLATOR

January 1967

The type SE-223 BWO is a bifilar (dual helix), voltage tunable oscillator utilizing a permanent-magnet focusing system. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, as master oscillators in frequency diversity transmitters and in electronic test sets. The SE-223 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easier packaging.



## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 0.5–1.0 | |
| Power Output into Load with VSWR = 1.25 | mW | 60–230 | 30 Min |
| Power Output Variation | dB | | 10 Max |
| Fine Grain Variation | dB/25 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 5 | 10 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | dB | 40 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | 2.0 Max |
| Sensitivity to Grid Voltage | MHz/V | 5 | 10 Max |
| Tuning Curve Slope | | | |
| Low End (0.5 GHz) | MHz/V | 1.6 | |
| Mid-Frequency (0.75 GHz) | MHz/V | 0.9 | |
| High End (1.0 GHz) | MHz/V | 0.7 | |
| Grid R. F. Cutoff Voltage | | −7 | −20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 50 | 60 Max |
| Capacitance; Grid to all other Electrodes including Housing | pF | 25 | 30 Max |
| Capacitance; Helix to all other Electrodes | pF | 250 | 300 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 1.4 | 1.0–1.65 Min/Max |
| Cathode Current | mA | 11 | 17 Max |
| Helix Voltage Range | V | 170–720 | 150–750 Min/Max |
| Helix Current | mA | 2 | 4 Max |
| Anode Voltage | V | 100 | 215 Max |
| Anode Current | mA | 1 | 1.5 Max |

## MECHANICAL DATA

Weight, 15 lbs Max

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

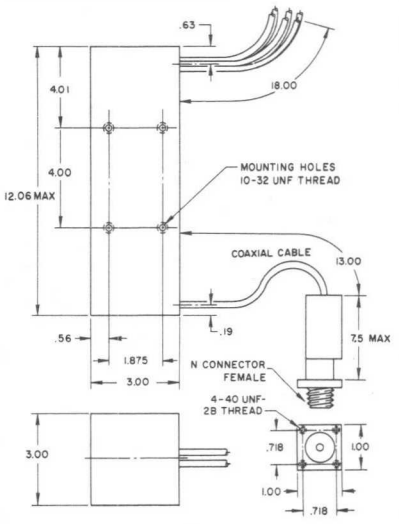
RF Output Connector, Type N Female on Balun

## ENVIRONMENTAL DATA

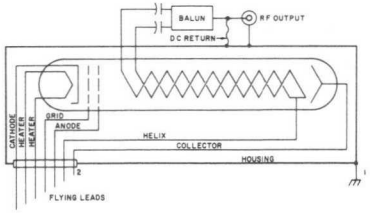
Separation from Passive Magnetic Materials, 4 in. Min

No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



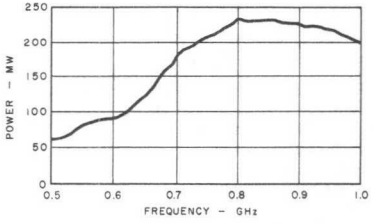

## SCHEMATIC DIAGRAM



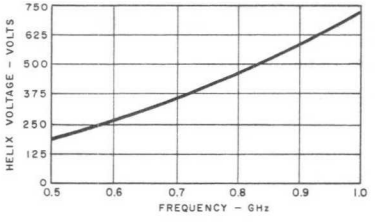

[1] For safety, housing should be grounded through mounting screws.

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE

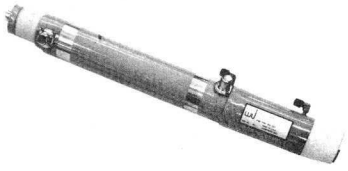


# TECHNICAL DATA

WATKINS-JOHNSON

JANUARY 1971

# GRIDDED HIGH-GAIN TRAVELING-WAVE AMPLIFIER WJ-228



The WJ-228 is a high-power, high-gain C-band traveling-wave amplifier for pulsed operation. This tube is of rugged, light-weight construction backed by production experience gained through the manufacture of large quantities of this type. The WJ-228 produces 14 kw power output with 0.5 watt drive. It employs a high-mu grid which permits modulation of the beam by means of a 500-volt pulse.

The slow-wave circuit is of the coupled-cavity design which is all metal-ceramic construction. The tube is designed to withstand shock and vibration. A temperature-compensating jacket is employed over the ferrite ppm magnet stack to eliminate any appreciable change in characteristics over a wide range of operating temperatures.

By means of a high-convergence gridded gun, the peak cathode loading can be minimized ($2A/cm^2$) which in turn extends the life of the tube. In addition, the integral focusing system requires no alignment and leakage fields are negligible.

The WJ-228 employs an insulated collector for increased efficiency by means of collector depression. The collector cooling jacket is at ground potential to eliminate electrical insulation in the coolant system. Since the WJ-228 may be operated at duty cycles up to 0.028, average power in excess of 340 watts is available.

## SPECIFICATIONS

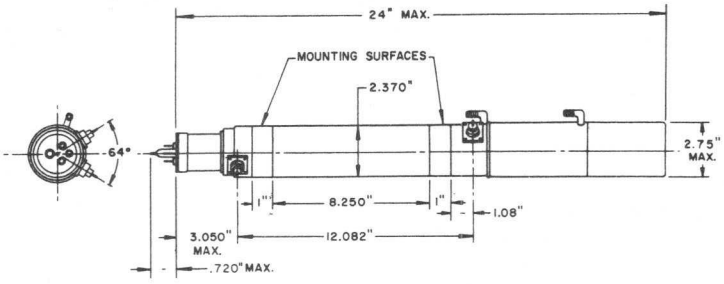
| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 5.4 - 5.9 GHz | 5.4 - 5.9 GHz |
| Power output (peak) | | |
| Average of six points [1] | 14 kw | 12 kw |
| Lowest point in band | — | 6 kw |
| Gain (at 0.5 w drive) | | |
| Average of six points [1] | 44.4 dB | 43.8 dB |
| Lowest point in band | 41.2 dB | 40.8 dB |
| Gain variation (at 0.5 w drive —6 points) | ±0.6 dB | ±1.5 dB |
| **ELECTRICAL REQUIREMENTS** | **Typical** | **Range** |
| Cathode voltage | 23.0 kV | 23.0 ±1.0 kV |
| Collector depression voltage | 11.5 kV | 12.0 ±0.5 kV |
| Collector current | | |
| Without drive or depression | 3.6 A peak | 3.0 A peak min. |
| With drive, without depression | 3.3 A peak | 2.9 A peak min. |
| With drive and depression | 2.6 A peak | 2.0 A peak min. |

° Supersedes WJ-228 Technical Data Sheet dated August 1967.

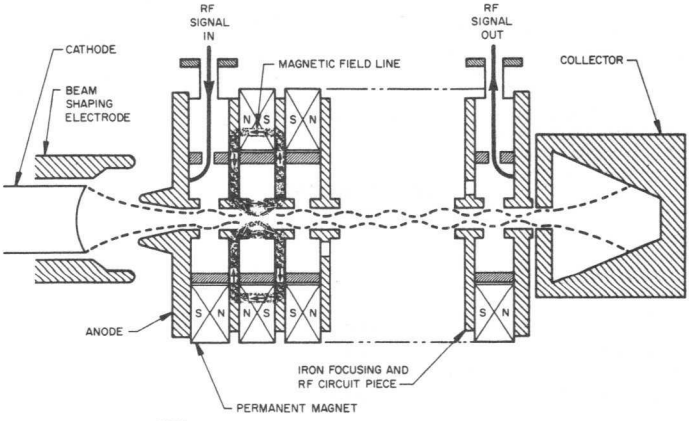
[1] At equal increments of 100 MHz

## OUTLINE DRAWING

# WJ-228




## RF AND MAGNETIC CIRCUIT




NOTE:

THE MAGNETIC CIRCUIT IS INTEGRAL WITH THE RF CIRCUIT. IT CAN BE SEEN THAT A SECTION OF THE CAVITY WALL ALSO SERVES AS A FLUX GUIDE FOR THE MAGNETIC FOCUSING CIRCUIT.

# WJ-228

## SPECIFICATIONS (Cont'd)

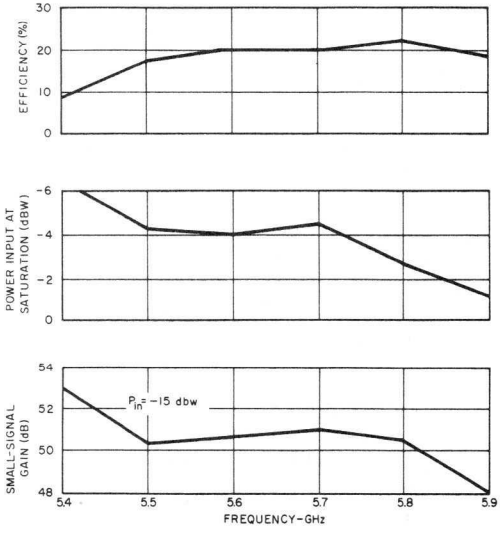
| | | |
|---|---|---|
| Body current | | |
| Without drive or depression | 0.5 A peak | 0.7 A peak max. |
| With drive, without depression | 0.8 A peak | 1.2 A peak max. |
| With drive and depression | 1.7 A peak | 2.3 A peak max. |
| Duty cycle | 0.024 | 0.028 max. |
| Pulse duration | 2 μsec | 5 μsec max. |
| Grid pulse voltage | 450 v peak | 420 - 500 v |
| Grid bias voltage | —250 v | —250 ±5 v |
| Grid current | 0.5 A peak | 0.7 A max. |
| Grid capacitance (to all else) | 35 pF | 45 pF max. |
| Circuit and anode voltage | Ground | Ground |
| Heater voltage | 12 V 60 Hz ac | 12.5 V max. |
| Heater current | 2.3 A | 2.5 A max. |
| Ion pump voltage | +3.0 kv to collector | 3.0 ±0.15 kV |
| Ion pump current, operating | 1.0 μA | 20 μA max. |

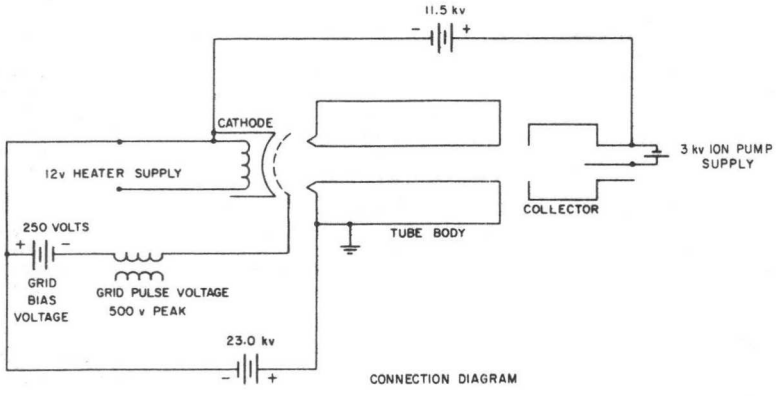
**MECHANICAL**

Weight (including ion pump) . . . . . 14 lbs. (6.35 kg)
RF connectors[2] . . . . . Modified 50-ohm coax
Coolant flow
Depressed . . . . . 0.3 gpm of water — 10 psig pressure drop max.
Non-depressed . . . . . 0.5 gpm of water — 18 psig pressure drop max.

[2]Coaxial to either "C" band waveguide or type N coax adaptors can be provided if desired

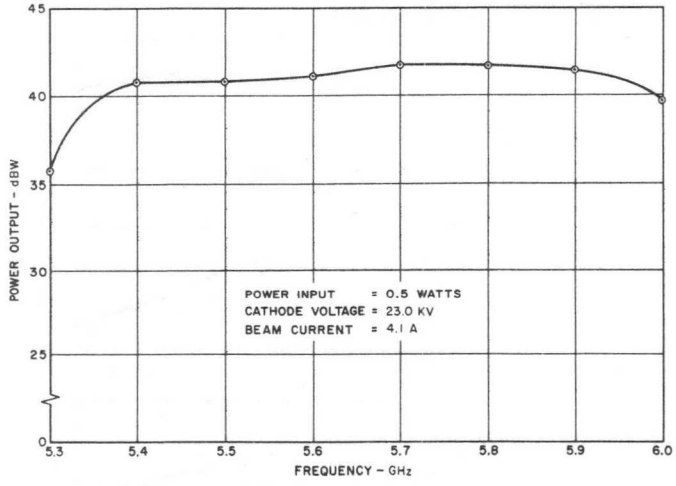
## TYPICAL PERFORMANCE CHARACTERISTICS






CONNECTION DIAGRAM

## POWER OUTPUT VS. FREQUENCY




POWER OUTPUT vs FREQUENCY

# TECHNICAL DATA

WATKINS-JOHNSON

September 1968 *

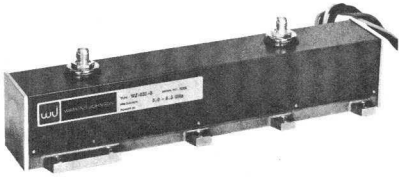
## 5.0 TO 8.5 GHz 35-WATT CW PPM-FOCUSED TRAVELING-WAVE TUBE

## WJ-231-5

Watkins-Johnson WJ-231-5 is a versatile, wide-band traveling-wave tube employing periodic-permanent-magnet focusing. Providing a guaranteed CW power output of 35 watts from 5.0 to 8.5 GHz, the WJ-231-5 is the basic tube used in the WJ-1015 satellite amplifier and the WJ-364 commercial amplifier. A separate power supply, the WJ-1024, is also available for operating the WJ-231-5. This power supply is available in versions for laboratory or military environments.

This TWT represents the end product of a series of developmental and production units fabricated for a high-reliability space program. Its design employs many of the techniques and components proven sucessful in earlier models of Watkins-Johnson medium-power traveling-wave tubes, e.g., stacked metal-ceramic electron-gun assembly, precision-aligned PPM focusing components, and beryllia wedge-supported helix structure.

Typical values of overall efficiency, saturation gain, and saturated power output are shown in the specifications below. Although the WJ-231-5 is listed for use between 5.0 and 8.5 GHz, it is capable of operating over an extended frequency range



from 4.0 to 9.0 GHz. In such application, the tube can be expected to produce a typical saturated output power of 35 watts and typical saturation gain of 30 dB. The gain, which is minimum at band edge, may be improved at one end of the band by slight adjustment of anode and helix voltages; this will result in a gain decrease at the opposite band edge. By operating the collector depressed, an overall efficiency of 23% is guaranteed. More than 26% is typical from 4.0 to 9.0 GHz, and, over narrower frequency ranges, efficiencies exceeding 30% can be achieved.

## SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.4 to 9.0 GHz | 5.0 to 8.5 GHz |
| Saturation Gain | 34 dB | 30 dB, min. |
| Saturation Power Output | 38 W | 35 W, min. |
| Small Signal Gain | 40 dB | 36 dB, min. |
| Efficiency (with collector depression) | 26 to 30 % | 23%, min. |
| Noise Figure | 30 dB | 35 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 5.5 V | 5.5 ±0.3 V |
| Heater Current | 0.8 A | 1.0 A, max. |
| Anode Voltage | 4750 V | 4750 ±150 V |
| Anode Current | 0.1 mA | 1.0 mA, max. |
| Helix Voltage | 4600 V | 4600 ±150 V |
| Helix Current | 2 mA | 8 mA, max. |
| Collector Voltage | 2000 V | 1800 to 3000 V |
| Collector Current | 60 mA | 70 mA, max. |
| Cathode Current | 62 mA | 70 mA, max. |

*Supersedes WJ-231-5 Technical Bulletin, Volume 8, No. 11; July 1966

# WJ-231-5

## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height (connectors included) | 3.20 inches (81mm) |
| Width | 3.20 inches (81 mm) |
| Length | 12.50 inches (318 mm) |
| Weight | 4.50 lbs. (2.04 Kg) |
| Cooling | Conduction |
| Focusing | PPM |
| RF Connector | TNC, female |
| DC Connections | 12 inch flying leads |

## ENVIRONMENTAL CHARACTERISTICS

Can be qualified to meet requirements of MIL-E-5400.

**FIG. 1. TYPICAL PERFORMANCE CHARACTERISTICS**

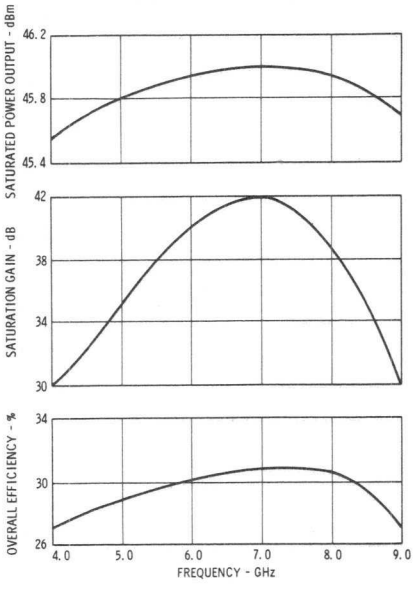
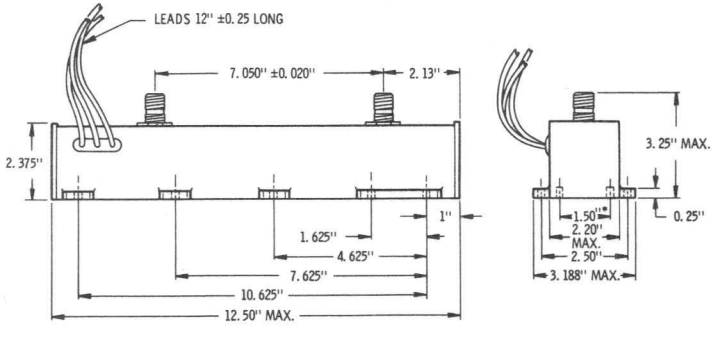
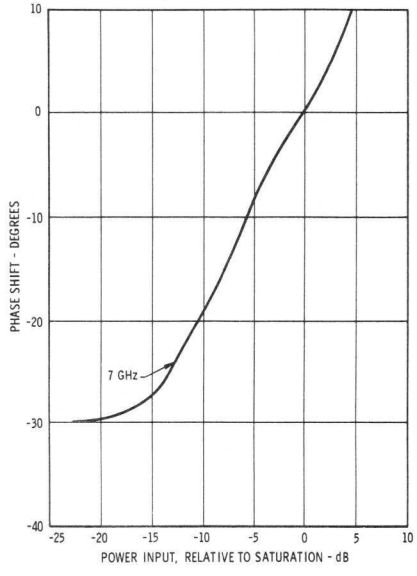



**FIG. 2. OUTLINE DRAWING**




OPTIONAL MODEL WITHOUT MOUNTING FLANGES ALSO AVAILABLE.

* DISTANCE BETWEEN MOUNTING HOLES WITH 8-32 UNC (SST INSERTS) 1/4" DP (10) PLACES ON MODELS WITHOUT MOUNTING FLANGES.



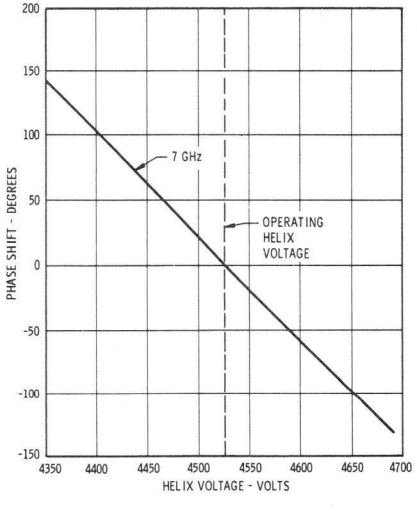
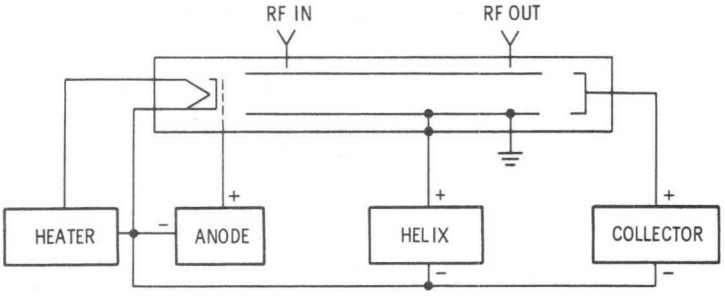
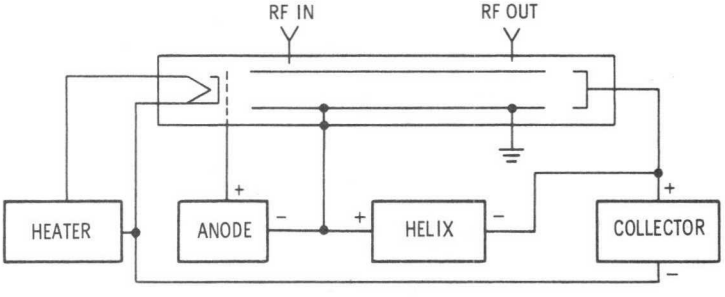




**FIG. 3. TYPICAL PHASE CHARACTERISTICS**




HEATER 0-6 VOLTS AC AT 1 AMPERE MAXIMUM
ANODE 0-5000 VOLTS AT 1 mA MAXIMUM
HELIX 0-4800 AT 10 mA MAXIMUM
COLLECTOR 1800-2200 VOLTS AT 70 mA MAXIMUM

PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION.




HEATER 0-6 VOLTS AC AT 1A MAXIMUM
ANODE 0-200 VOLTS AT 1 mA MAXIMUM
HELIX 0-3000 VOLTS AT 10 mA MAXIMUM
COLLECTOR 1800-2200 VOLTS AT 70 mA MAXIMUM

NOTE: WITH THIS CONFIGURATION, THE ANODE SUPPLY CANNOT CUT OFF TUBE EMISSION.

CONNECTION FOR HIGH EFFICIENCY POWER SUPPLY DESIGN AS USED IN A TYPICAL WATKINS-JOHNSON POWER SUPPLY.

**FIG. 4. SUGGESTED POWER SUPPLY CONNECTION DIAGRAMS**

# TECHNICAL DATA

WATKINS-JOHNSON

April 1967*

## 1.0 TO 2.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

# WJ-268

- "JUST PLUG IT IN"
- NOISE FIGURE 5.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-268 is the L-band member of the Watkins-Johnson family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the WJ-268's performance in the 1.0 to 2.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-268 provides low noise figure (many production amplifiers exhibit noise figures of less than 4 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54°C$ to $+71°C$. The environmental characteristics of the WJ-268 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0 to 2.0 GHz | 1.0 to 2.0 GHz |
| Noise Figure, Terminal | 4.5 dB | 5.0 db, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | −5 dBm | −10 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range [1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |

*This Technical Data Sheet presents up-to-date information on the WJ-268, first described in Technical Bulletin Volume 5, No. 2; March, 1963.

# WJ-268

## MECHANICAL CHARACTERISTICS

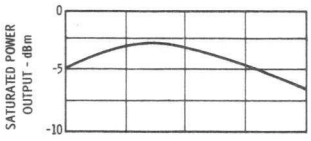
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . . DM9601-3P
RF Connections (50 ohms, nominal) . . . . . Type N, jack
Reference Drawing Number . . . . 290000

## ENVIRONMENTAL CHARACTERISTICS[2]

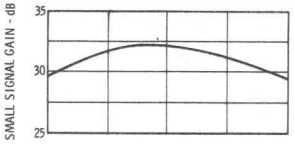
Temperature, Operating . . —54°C to +71°C
Vibration
0.10 Inch, Double Amplitude . . 5 to 45 Hz
10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

1. Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
2. These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

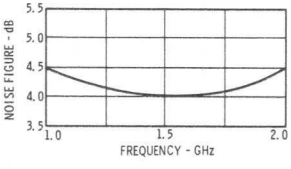
## POWER



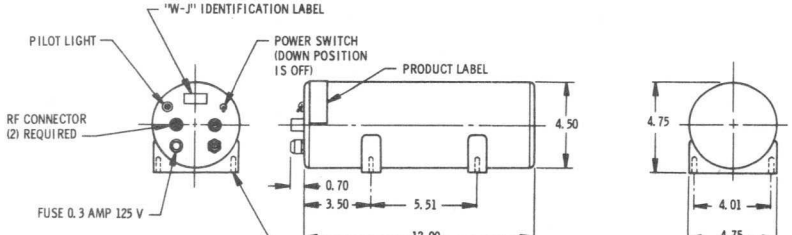

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601 - 3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

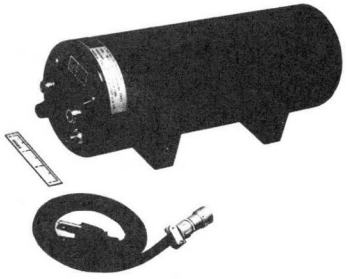
# TECHNICAL DATA

WATKINS-JOHNSON

June 1968 *

## WJ-268-2

## 1.0 TO 2.6 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY



- "JUST PLUG IT IN"
- NOISE FIGURE 5.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-268-2 is an extended frequency version of the Watkins-Johnson family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, this amplifier's performance in the 1.0 to 2.6 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-268-2 provides low noise figure (many production amplifiers exhibit noise figures of less than 4 dB), low cost per-operating-hour and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained, adjustment-free, and requires only 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-268-2 meet or exceed the corresponding requirements of MIL-E-5400, Class 2 Specification.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0 to 2.6 GHz | 1.0 to 2.6 GHz |
| Noise Figure, Terminal | 4.5 dB | 5.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | −5 dBm | −10 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 14 W | |
| Primary Current | 175 mA | |

*This Technical Data Sheet presents up-to-date information on the WJ-268-2, first described in Technical Bulletin Volume 5, No. 6; August, 1963.

# WJ-268-2

## ENVIRONMENTAL CHARACTERISTICS

Temperature (Operating) . . . . . −54°C to +71°C
Vibration
0.10 Inch, Double Amplitude . . . . . 5 to 45 Hz
10 g, Single Amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

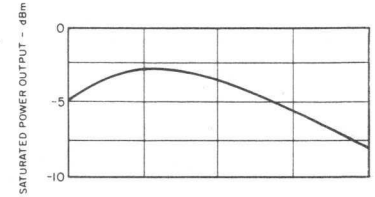
## MECHANICAL CHARACTERISTICS

Amplifier Length
(excluding connectors) . . . . . 12 inches, max.
Amplifier Height and Width . . . . 4.75 inches, max.
Amplifier Weight . . . . . 17 lbs., max.
Primary Power Connection,
Deutsch Receptacle . . . . . DM9601-3P
RF Connections
(50 ohms, nominal) . . . . . Type N, jack
Reference Drawing Number . . . . . 290000

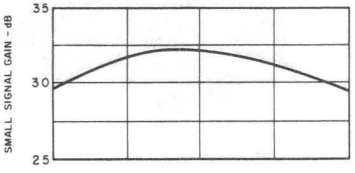
Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

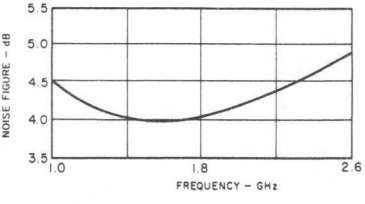
## POWER



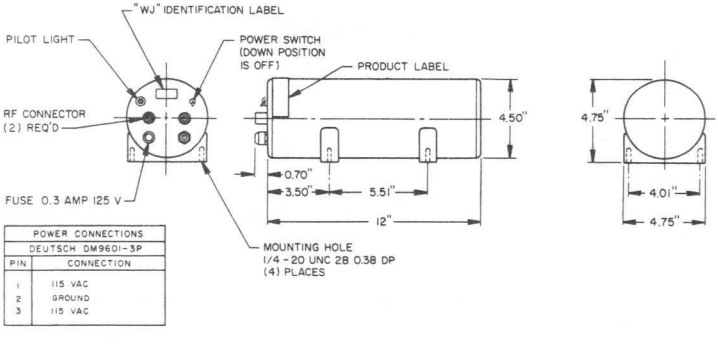

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601-3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

February 1967*

## 2.0 TO 4.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-269

- "JUST PLUG IT IN"
- NOISE FIGURE 5.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-269 is one of the original members of Watkins-Johnson's family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the WJ-269's performance in the 2.0 to 4.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-269 provides low noise figure (many production amplifiers exhibit noise figures of less than 5 dB), low cost per-operating-hour and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54°C$ to $+71°C$. The environmental characteristics of the WJ-269 meet or exceed the corresponding requirements of MIL-E-5400, Class 2 Specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise Figure, Terminal | 4.8 dB | 5.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | −3 dBm | −10 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |

* This Technical Data Sheet presents up-to-date information on the WJ-269, first described in Technical Bulletin Volume 5, No. 3; March, 1963.

# WJ-269

## ENVIRONMENTAL CHARACTERISTICS[2]

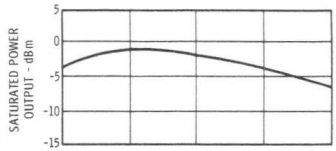
Temperature (Operating) . . −54°C to +71°C
Vibration
0.10 Inch, Double Amplitude . . 5 to 45 Hz
10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

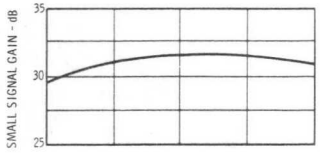
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . DM9601-3P
RF Connections (50 ohms, nominal . . . . . Type N, jack
Reference Drawing Number . . . . 290000

1. Every amplifier will meet the guaranteed performance specifications for any voltage and frequency lying within these ranges.
2. These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

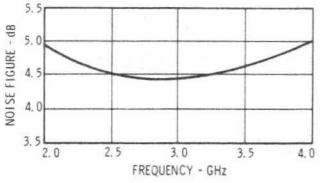
## POWER



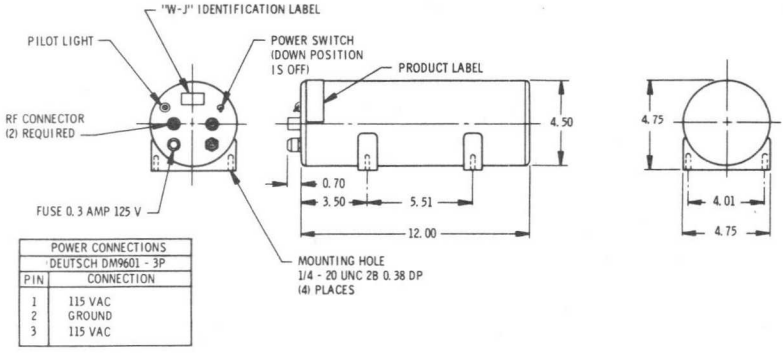

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601 - 3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

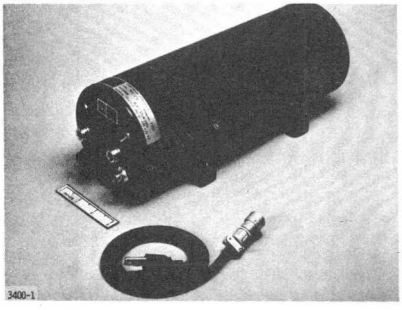
WATKINS-JOHNSON

# WJ-269-1

July 1968 *

## 2.3 TO 4.5 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 6.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 ENVIRONMENT




The WJ-269-1 is one of the original members of Watkins-Johnson's family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the performance of the WJ-269-1 in the 2.3 to 4.5 GHz range was unparalleled by other devices. Today, this performance still remains better than any other commercially available unit, and thousands of units are in use throughout the world. The WJ-269-1 provides low noise figures (many production amplifiers exhibit noise figures of less than 5 dB), low cost per-operating-hour and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained, adjustment-free and requires only 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-269-1 meet or exceed the corresponding requirements of MIL-E-5400, Class 2 Specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.3 to 4.5 GHz | 2.3 to 4.5 GHz |
| Noise Figure, Terminal | 5.3 dB | 6.0 dB, max. |
| Gain, Small Signal | 28 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | −5 dBm | −10 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Current | 170 mA | |
| Primary Power | 14 W | |

*This Technical Data Sheet presents up-to-date information on the WJ-269-1 first described in Technical Bulletin Volume 5, No. 7; August, 1963.

# WJ-269-1

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature (Operating) . . . . . −54°C to +71°C
Vibration
0.10 Inch, Double Amplitude . . . . . 5 to 45 Hz
10 g, Single Amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

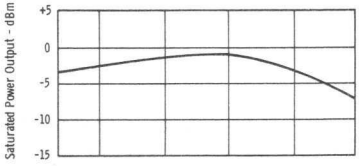
## MECHANICAL CHARACTERISTICS

Amplifier Length
(excluding connectors) . . . . . 12 inches, max.
Amplifier Height and Width . . . . 4.75 inches, max.
Amplifier Weight . . . . . 17 lbs., max.
Primary Power Connection,
Deutsch Receptacle . . . . . DM9601-3P
RF Connections
(50 ohms, nominal) . . . . . Type N, jack
Reference Drawing Number . . . . . 290000

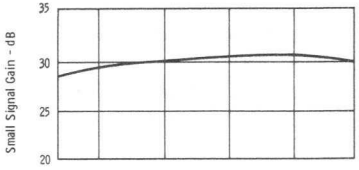
[1]Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

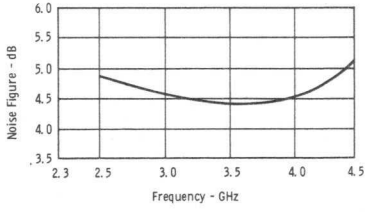
## POWER



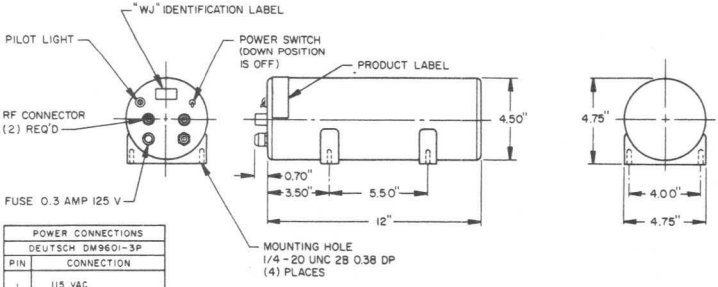

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601-3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

March 1967 *

## 4.0 TO 8.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-271

- "JUST PLUG IT IN"
- NOISE FIGURE 6.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-271 is the C-band member of the Watkins-Johnson family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the WJ-271's performance in the 4.0 to 8.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-271 provides low noise figure (many production amplifiers exhibit noise figures of less than 6 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54°C$ to $+71°C$. The environmental characteristics of the WJ-271 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0 to 8.0 GHz | 4.0 to 8.0 GHz |
| Noise Figure, Terminal | 5.5 dB | 6.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +3.0 dBm | −5.0 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |

* This Technical Data Sheet presents up-to-date information on the WJ-271, first described in Technical Bulletin Volume 6, No. 2; February, 1964.

# WJ-271

## ENVIRONMENTAL CHARACTERISTICS

Temperature (Operating) . . −54°C to +71°C
Vibration
0.10 Inch, Double Amplitude . . 5 to 45 Hz
10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

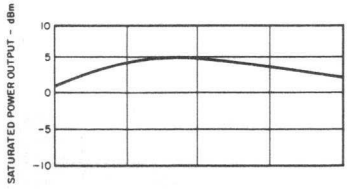
## MECHANICAL CHARACTERISTICS

Amplifier Length
(excluding connectors) . . 12 inches, max.
Amplifier Height and Width . 4.75 inches, max.
Amplifer Weight . . . . . 17 lbs, max.
Primary Power Connection,
Deutsch Receptacle . . . . DM9601-3P
RF Connections
(50 ohms, nominal) . . . . Type N, jack
Reference Drawing Number . . . . 290000

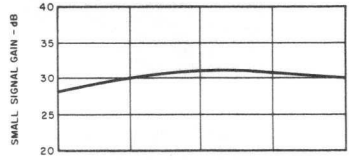
Every amplifer will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

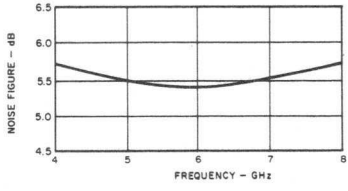
## POWER



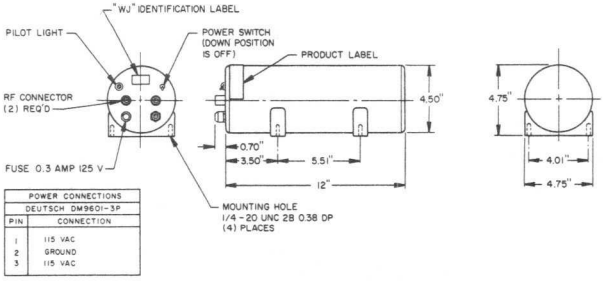

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601-3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

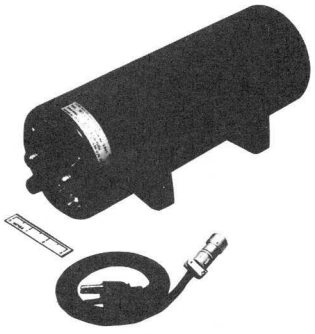
# TECHNICAL DATA

WATKINS-JOHNSON

AUGUST 1970*

## 4.0 TO 8.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-271-30



- "JUST PLUG IT IN"
- NOISE FIGURE 7.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

The WJ-271-30 is a full C-band member of the WJ-271 family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1963, the WJ-271's performance in the 4.0 to 8.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-271 family provides low noise figure (many production amplifiers exhibit noise figures of less than 6 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-271-30 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0 to 8.0 GHz | 4.0 to 8.0 GHz |
| Noise Figure, Terminal | 6.3 dB | 7.0 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +3.0 dBm | −5.0 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 14 W | |
| Primary Current | 175 mA | |

1. Every amplifer will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

*Supersedes WJ-271-30 Technical Data Sheet dated JUNE 1970.

# WJ-271-30

## ENVIRONMENTAL CHARACTERISTICS[2]

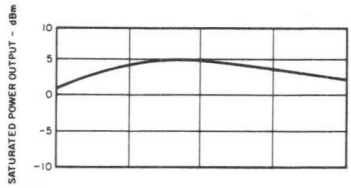
| | |
|---|---|
| Temperature (Operating) | −54°C to +71°C |
| Vibration | |
| 0.10 Inch, Double Amplitude | 5 to 45 Hz |
| 10 g, Single Amplitude | 45 to 500 Hz |
| Shock | 15 g, 11 ms |

## MECHANICAL CHARACTERISTICS

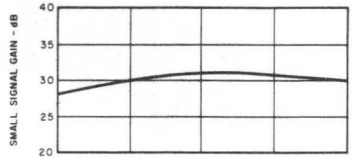
| | |
|---|---|
| Height | 4.75 inches (121 mm) max. |
| Width | 4.75 inches (121 mm) max. |
| Length (excluding connectors) | 12 inches (305 mm) max. |
| Weight | 17 lbs. (7.71 Kg) |
| Primary Power Connection Deutsch Receptacle | DM9601-3P |
| RF Connections (50 ohms, nominal) | Type N, jack |
| Reference Drawing Number | 290000 |

2. These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

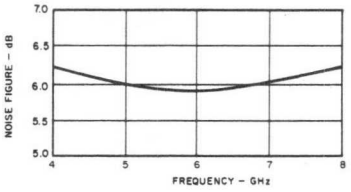
## POWER



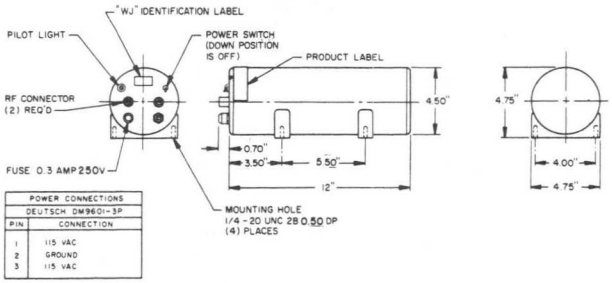

## GAIN




## NOISE




## OUTLINE DRAWING



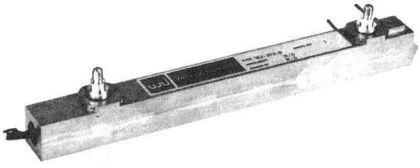

| POWER CONNECTIONS | |
|---|---|
| DEUTSCH DM9601-3P | |
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1972

## HIGH-EFFICIENCY TELEMETRY TWTs FOR SATELLITES AND DEEP SPACE PROBES WJ-274 SERIES



- DC TO RF EFFICIENCY > 40%
- ULTRA-HIGH RELIABILITY
- LIGHTWEIGHT
- SPACE-QUALIFIED
- MAGNETICALLY COMPENSATED

The WJ-274 series of medium power, high-efficiency, traveling-wave tubes was developed to meet the requirements of telemetry transmitters for satellites and deep space probes. They exhibit overall efficiency (including heater power) of 40% minimum when optimized above 18 watts and 38% minimum when optimized between 8 and 18 watts. Metal-ceramic construction is just one of many design features that ensure maximum reliability and long life operation. These TWTs perform during and after extreme temperature, vibration, shock and static acceleration, and they have provision for magnetic compensation when required to reduce stray fields below 0.1 gamma at a distance of 6 feet from the tube on the major axis.

**WJ-274-6**
As of January 1, 1972, the WJ-274-6 had accumulated over 30,000 hours of continuous operation in a vacuum-environment, life test program. It was the first space-qualified TWT ever built and delivered with more than 40% overall efficiency (43% at 25 watts).

**WJ-274-9**
This dual-mode 10/20 watt TWT was designed and delivered for use aboard the Earth Resources Technology Satellites A and B scheduled for launch in 1972. The WJ-274-9 is identical to the WJ-274-6 except for incorporating a lower perveance gun to ensure positive anode voltage operation in both modes.

**WJ-274-10**
Exhibiting greater than 40% efficiency at the 10 watt level, the WJ-274-10 was designed and delivered as an integral part of the WJ-1171-1 TWTA for use on the Pioneer space probe, scheduled for Jupiter fly-by in 1973. This TWT uses the mechanical and thermal design of the WJ-274-6, but incorporates a modified helix support structure for optimization at a lower power level. The tube is magnetically clean.

**WJ-274-11**
This biologically sterile TWT is part of the WJ-1185 amplifier package developed for use as the communication link aboard the Viking lander scheduled for soft landing on Mars in 1976. It is similar to the WJ-274-9, except that it delivers 28 watts power and has a modified outline to conform to the specific requirements of the WJ-1185 package. Overall efficiency is in excess of 45%.

**WJ-274-12**
Identical to the WJ-274-9 except for a lighter weight magnesium capsule and a higher dual mode power level of 28 and 14 watts, the WJ-274-12 exhibits greater than 45% efficiency at the 28 watt level and greater than 38% at the 14 watt level. It will provide the telemetry channel for the Helios probe scheduled to fly by the sun in 1975. The tube is magnetically clean.

### GUARANTEED SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | WJ-274-6 | WJ-274-9 | | WJ-274-10 | WJ-274-11 | WJ-274-12 | |
|---|---|---|---|---|---|---|---|
| | | Low Power Mode | High Power Mode | | | Low Power Mode | High Power Mode |
| Frequency Range (GHz) | 2.2-2.4 | 2.20-2.28 | 2.20-2.28 | 2.29-2.30 | 2.29-2.30 | 2.29-2.30 | 2.29-2.30 |
| Saturation Power Output (Watts, Min.) | 25 | 11 | 22 | 9 | 28.2 | 14 | 28.5 |
| Saturation Gain (dB, min.) | 30 | 28 | 31 | 34 | 29 | 30 | 33 |

# WJ-274 SERIES

## GUARANTEED SPECIFICATIONS (Cont'd)

| PERFORMANCE CHARACTERISTICS (Cont'd) | WJ-274-6 | WJ-274-9 | | WJ-274-10 | WJ-274-11 | WJ-274-12 | |
|---|---|---|---|---|---|---|---|
| | | Low Power Mode | High Power Mode | | | Low Power Mode | High Power Mode |
| Overall Efficiency, including Heater (% minimum) | 40 | 32 | 41 | 39 | 42 | 36 | 42 |
| Noise Power Density (dBm/MHz) | −35 | −25 | −30 | −29 | −38 | −30 | −30 |
| Harmonic Power (dB Below Carrier at Saturation, min.)[2] | −15 | −12 | −15 | −15 | −15 | −12 | −15 |
| Group Delay Variation (nanosec/MHz) | | <0.1 | <0.1 | | <0.1 | <0.1 | <0.1 |
| **ELECTRICAL CHARACTERISTICS** | | | | | | | |
| Heater Voltage (Volts) | 2.5-3.5 | 2.3-3.0 | 2.3-3.0 | 2.0-2.8 | 2.3-3.0 | 2.3-3.0 | 2.3-3.0 |
| Heater Current (Amp, max.) | 1 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Anode Voltage (Volts)[3] | 1600-1800 | 1400-1700 | 1500-1800 | 1400-1600 | 1800-2200 | 1500-1700 | 1800-2200 |
| Anode Current (mA, max.) | 1.3 | 1.0 | 0.5 | 0.3 | 0.5 | 0.8 | 0.5 |
| Helix Voltage (Volts)[3] | 1500-1700 | 1300-1500 | 1400-1700 | 950-1060 | 1400-1700 | 1300-1500 | 1400-1700 |
| Helix Current (mA, max.) | 10 | 6 | 10 | 6 | 10 | 6 | 10 |
| Collector Voltage (Volts)[3] | 1000-1200 | 800-1000 | 940-1100 | 700-750 | 975-1175 | 850-950 | 975-1175 |
| Collector Current (mA, max.) | 50 | 30 | 50 | 25 | 52 | 32 | 52 |

**MECHANICAL CHARACTERISTICS**

| | WJ-274-6 | WJ-274-9 | WJ-274-10 | WJ-274-11 | WJ-274-12 |
|---|---|---|---|---|---|
| Tube Length (Inches) | 9.8 | 9.8 | 9.2 | 9.6 | 10.48 |
| Tube Height Excluding Conn. (Inches) | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Tube Width (Inches) | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Tube Weight (Pounds) | 1.3 | 1.3 | 1.0 | 1.2 | 1.0 |
| DC Connectors | Flying Leads | Flying Leads | Flying Leads | Flying Leads | Flying Leads |
| RF Connectors | 3MM (Female) | 3MM (Female) | 3MM (Female) | 3MM (Female) | 3MM (Female) |
| Cooling | Conduction from Bottom Surface | Conduction from Bottom Surface | Conduction from Bottom Surface | Conduction from Bottom Surface | Conduction from Bottom Surface |
| Focusing | PPM | PPM | PPM | PPM | PPM |

NOTES:
1. Overall efficiency is defined as the RF Output Power divided by the total DC Input Power including heater power.
2. Harmonic Power level below fundamental varies with driver. See graph for more specific data.
3. These voltages are referenced to the cathode. Helix is operated at ground potential.

## GUARANTEED SPECIFICATIONS (Cont'd)

### ENVIRONMENTAL CHARACTERISTICS*

| | |
|---|---|
| Heat Sink Temperature | −20°C to +85°C |
| Vibration | |
| a) Sinusoidal (2 min/octave) | 0.5 inch, double amplitude, 5 to 18 Hz, ±20 g peak, 18 to 2000 Hz |
| b) Random (5 min/axis) | 0.1 $g^2$/Hz, 20 to 2000 Hz |
| Acceleration (1 min/axis) | 100 g |
| Shock | 75 g, 11 ms |

*Certain models have been qualified to significantly higher levels than shown here.

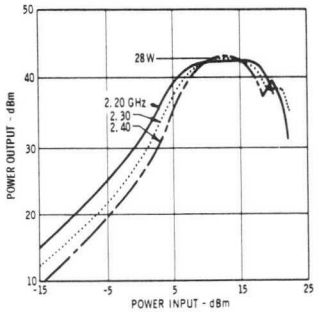



**Fig. 1 Typical Transfer Curve for Single-Mode TWT**

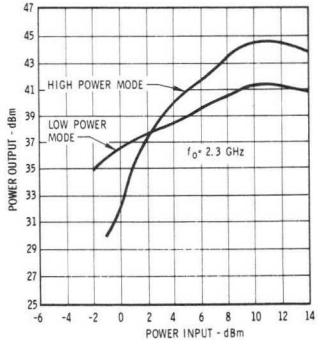



**Fig. 2 Typical Transfer Curve for Dual-Mode TWT**

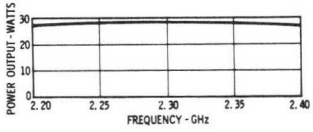



**Fig. 3 Typical Power Output vs. Frequency for WJ-274 Series of TWTs.**

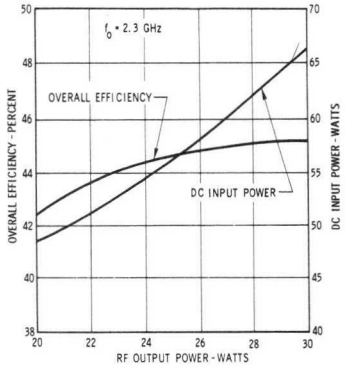



**Fig. 4 Typical Overall Efficiency and DC Input Power vs. RF Output Power for WJ-274 Series.**

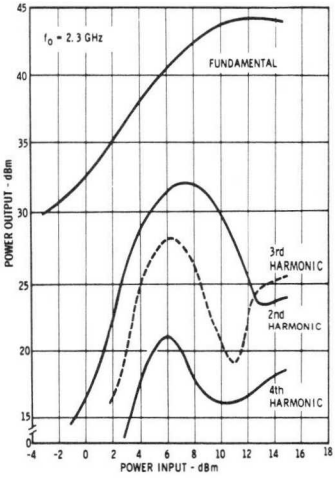
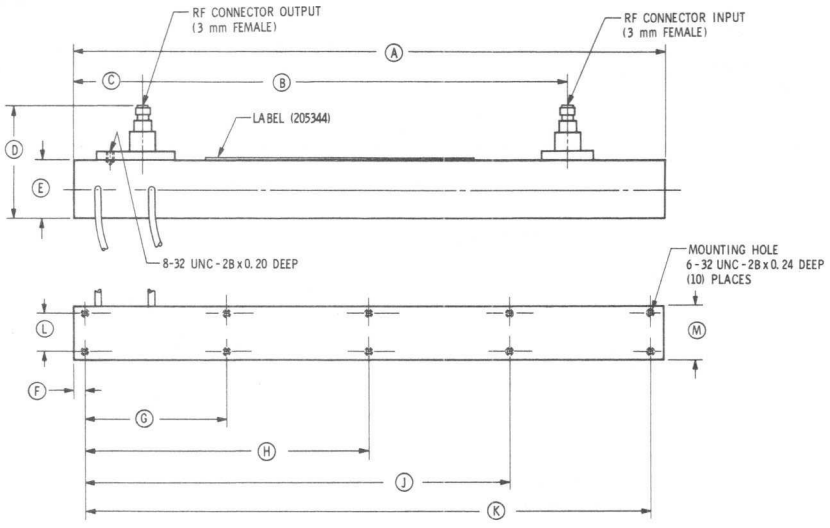



**Fig. 5 Typical Power Levels for Harmonics of WJ-274 Series**

# WJ-274 SERIES

## OUTLINE DRAWING




| | DIMENSIONS (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | WJ-274-6 | | WJ-274-9 | | WJ-274-10 | | WJ-274-11 | | WJ-274-12 | |
| | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. |
| A | —— | 9.880 | —— | 9.880 | 9.08 | 9.140 | —— | 9.600 | —— | 10.480 |
| B | 7.09 | 7.10 | 7.09 | 7.10 | 5.980 | 6.000 | 7.055 | 1.135 | 7.055 | 7.135 |
| C | 1.100 | 1.150 | 1.100 | 1.150 | 1.100 | 1.150 | 1.125 | 1.175 | 1.40 | 1.45 |
| D | 1.62 | 1.72 | 1.62 | 1.72 | 1.604 | 1.704 | 1.62 | 1.72 | 1.62 | 1.72 |
| E | 0.880 | 0.920 | 0.880 | 0.920 | 0.864 | 0.904 | 0.880 | 0.920 | 0.880 | 0.920 |
| F | 0.170 | 0.180 | 0.170 | 0.180 | 0.170 | 0.180 | 0.165 | 0.195 | 0.46 | 0.49 |
| G | 2.370 | 2.380 | 2.370 | 2.380 | 2.120 | 2.130 | 2.215 | 2.225 | 2.370 | 2.380 |
| H | 4.745 | 4.755 | 4.745 | 4.755 | 4.070 | 4.080 | 4.615 | 4.625 | 4.745 | 4.755 |
| J | 7.120 | 7.130 | 7.120 | 7.130 | 6.020 | 6.030 | 7.015 | 7.025 | 7.120 | 7.130 |
| K | 9.495 | 9.505 | 9.495 | 9.505 | 8.430 | 8.440 | 9.235 | 9.245 | 9.495 | 9.505 |
| L | 0.645 | 0.655 | 0.645 | 0.655 | 0.624 | 0.644 | 0.645 | 0.655 | 0.645 | 0.655 |
| M | 0.880 | 0.920 | 0.880 | 0.920 | 0.864 | 0.904 | 0.880 | 0.920 | 0.880 | 0.920 |

| ELECTRICAL CONNECTIONS (DC) | | |
|---|---|---|
| WIRE DESIGNATION | COLOR | LENGTH |
| ANODE | WHITE W/GREEN TRACE | 12 INCHES NOM. |
| COLLECTOR | WHITE W/RED TRACE | |
| HEATER | WHITE W/BROWN TRACE | |
| HEATER/CATHODE | WHITE W/YELLOW TRACE | |
| HELIX | WHITE W/ORANGE TRACE | |

# TECHNICAL DATA

WATKINS-JOHNSON

June 1967

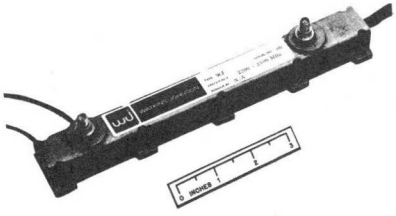
## 2.2 TO 2.4 GHz
## COMPACT 20-WATT TRAVELING-WAVE TUBE
## FOR SPACE COMMUNICATIONS AND TELEMETRY
## WJ-274-2

The WJ-274-2 is a medium power traveling-wave tube developed to meet the requirements of satellite and deep-space transmitter applications where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 30%. The metal-ceramic construction of the WJ-274-2 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, shock, and static acceleration.

The WJ-274-2 will deliver 20 watts of output power over the frequency range of 2.2 to 2.4 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 10 to 35 watts can be provided while maintaining a fixed value of gain without significantly affecting efficiency. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain an optimum condition for any desired power level. Efficiency generally improves with an increased power level for the tube, enabling the user to cover a range of power requirements with one tube.

The power output, gain, and efficiency are very nearly constant over the specified frequency range, as shown in Fig. 1. The noise characteristics of the tube shown in Fig. 3 are for undriven (carrier off)



and saturation drive (carrier on) conditions, with and without a low-pass filter at the tube's output. The power transfer curves of Fig. 4 show that the output power at saturation is relatively unchanged with a substantial change in drive power.

A number of variations of the WJ-274-2 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications. Manufactured under rigid quality assurance specifications, versions of this tube have also been qualified for space applications.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.2–2.4 GHz | 2.2–2.4 GHz |
| Power Output, Saturated | 22 W | 20 W, min. |
| Gain, Saturation | 35 dB | 30 dB, min. |
| Efficiency[1] | 33% | 30%, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 3.0 V | 2.5 to 3.5 V |
| Heater Current | 0.8 A | 0.7 to 1.0 A |
| Anode Voltage | 1820 V | 1820 ± 100V |
| Anode Current | 0.4 mA | 1.0 mA, max. |
| Helix Voltage | 1620 V | 1620 ± 100V |
| Helix Current | 5.6 mA | 10.0 mA, max. |
| Collector Voltage | 1115V | 1115 ± 55V |
| Collector Current | 46 mA | 54 mA, max. |
| Cathode Current | 52 mA | 54 mA, max. |

## WJ-274-2

### ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Heat Sink Temperature | −20°C to +85°C |
| Vibration | |
| a) Sinusoidal (2 min/octave) | 0.5 inch, double amplitude, 5 to 18 Hz, ±20 g peak, 18 to 2000 Hz |
| b) Random (5 min/axis) | 0.1 $g^2$/Hz, 20 to 2000 Hz |
| Acceleration (1 min/axis) | 100 g |
| Shock | 75 g,11 ms |

### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height (excluding connectors) | 0.9 inches (23 mm) max. |
| Width | 1 inch (25 mm) max. |
| Length | 9.2 inches (234 mm) max. |
| Weight | 18 ounces (510 g) |
| RF Connectors | OSM, female |
| DC Connectors | Flying Leads |
| Cooling | Conduction from bottom surface |

[1]Efficiency is defined as the minimum RF output power across the band, divided by the total dc power input, including heater power.

**FIG. 1**
**RF ELECTRICAL PERFORMANCE CHARACTERISTICS**

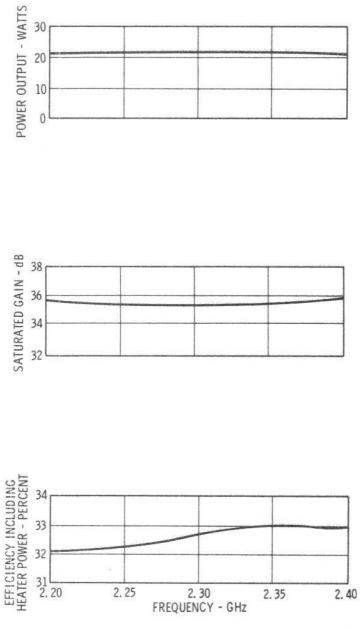
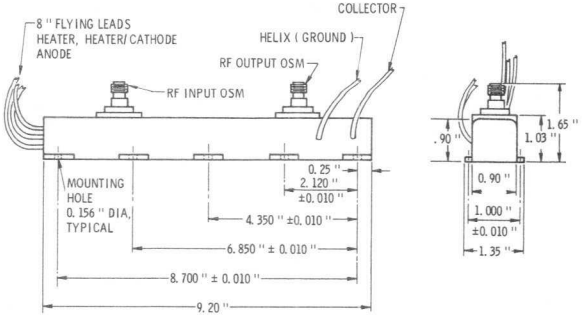
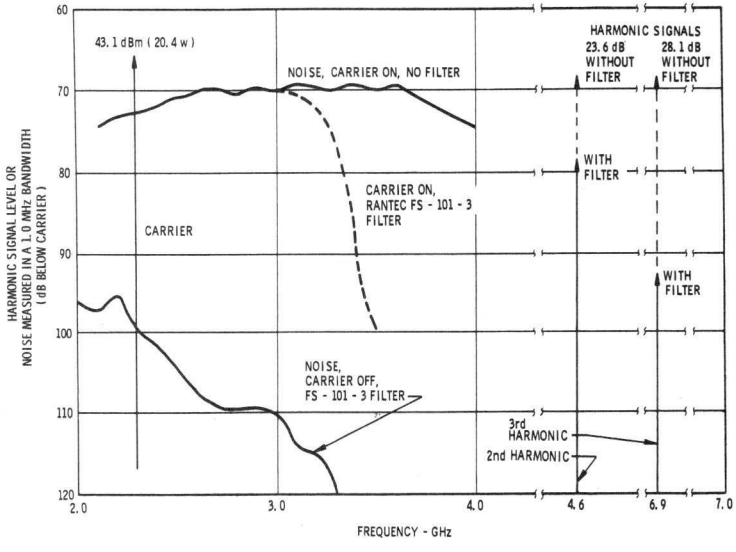


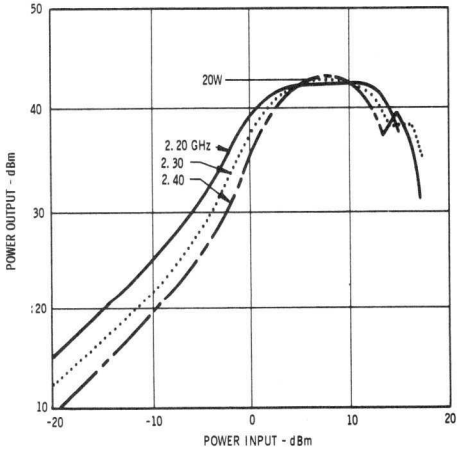

**FIG. 2 OUTLINE DRAWING**

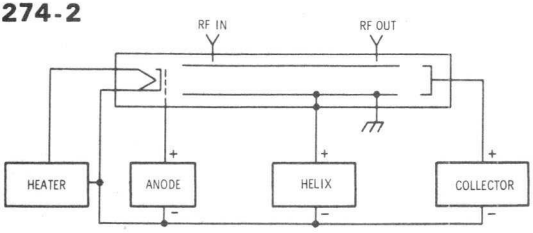


## FIG. 3 TYPICAL NOISE AND HARMONIC CHARACTERISTICS




## FIG. 4 TYPICAL POWER TRANSFER CHARACTERISTICS





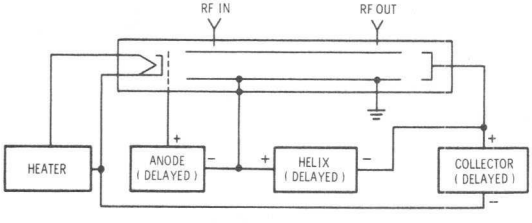

HEATER 2.5–3.5 VOLTS AC AT 1 AMPERE MAXIMUM
ANODE 1720–1920 VOLTS AT 1 mA MAXIMUM
HELIX 1520–1720 AT 10 mA MAXIMUM
COLLECTOR 1060–1170 VOLTS AT 54 mA MAXIMUM

NOTE:
TO ENSURE THAT THE TWT IS OPERATED PROPERLY, IT IS SUGGESTED THAT VOLTAGES BE APPLIED AS FOLLOWS:

1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT FILAMENT CURRENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILAMENT VOLTAGE TO STABILIZE.
2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT COLLECTOR CURRENT DOES NOT EXCEED MAXIMUM VALUE.
3. SET ADJUSTABLE OVERCURRENT DISCONNECT CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY INCREASE HELIX VOLTAGE TO SPECIFIED VALUE.
4. SLOWLY INCREASE ANODE VOLTAGE TO SPECIFIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 μSEC IF HELIX CURRENT EXCEEDS MAXIMUM VALUE.

**FIG. 5 PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-274-2**




HEATER 2.5–3.5 VOLTS AC AT 1 AMPERE MAXIMUM.
ANODE 1720–1920 VOLTS AT 1 mA MAXIMUM (SUM OF ANODE, HELIX, AND COLLECTOR SUPPLIES)
HELIX 1520–1720 VOLTS AT 10 mA MAXIMUM (SUM OF HELIX AND COLLECTOR SUPPLIES)
COLLECTOR 1060–1170 VOLTS AT 54 mA MAXIMUM

NOTE:
WITH THIS CONFIGURATION, ANODE SUPPLY CANNOT CUTOFF TUBE EMISSION. TO PREVENT DAMAGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:

1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FILAMENT RESISTANCE CHANGE AS TEMPERATURE RISES.
2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINIMUM.

**CAUTION**

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 μSEC IF MAXIMUM VALUE IS EXCEEDED.

**FIG. 6 PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR WJ-274-2.**

# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-274-8

January 1968

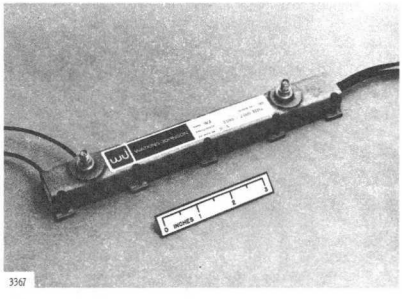
## 2.2 TO 2.4 GHz COMPACT VARIABLE POWER LEVEL TRAVELING-WAVE TUBE FOR SPACE COMMUNICATIONS AND TELEMETRY

The WJ-274-8 is a medium power traveling-wave tube developed to meet the requirements of satellite and deep-space transmitter applications where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 24%. The metal-ceramic construction of the WJ-274-8 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, shock, and static acceleration.

The WJ-274-8 will deliver 20 watts of output power over the frequency range of 2.2 to 2.4 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 10 to 35 watts can be provided while maintaining a fixed value of gain without significantly affecting efficiency. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain an optimum condition for any desired power level. Efficiency generally improves with an increased power level for the tube, enabling the user to cover a range of power requirements with one tube.

The power transfer curves of Fig. 1 show that the output power at saturation is relatively unchanged



3367

with a substantial change in drive power, and for constant drive, the tube can give 11.75 W or 22.3 W at constant efficiency.

A number of variations of the WJ-274-8 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications. Manufactured under rigid quality assurance specifications, versions of this tube have also been qualified for space applications.

## SPECIFICATIONS

| | 10 W MODE | | 20 W MODE | |
|---|---|---|---|---|
| **PERFORMANCE** | **Typical** | **Guaranteed** | **Typical** | **Guaranteed** |
| Frequency | 2.2-2.4 GHz | 2.2-2.4 GHz | 2.2-2.4 GHz | 2.2-2.4 GHz |
| Power Output, Saturated | 11.75 W | 10 W | 22.3 W | 20 W |
| Gain, Saturation | 31 dB | 29 dB | 34 dB | 32 dB |
| Efficiency | 28% | 24% | 28% | 24% |
| **ELECTRICAL REQUIREMENTS** | **10 W MODE** | | **20 W MODE** | |
| TWT Voltages | **Typical** | **Range** | **Typical** | **Range** |
| Anode (VDC) | 1563 | 1563 ±100 | 2057 | 2057 ±100 |
| Helix (VDC) | 1515 | 1515 ±100 | 1640 | 1640 ±100 |
| Collector (VDC) | 951 | 951 ±100 | 1252 | 1252 ±100 |
| Heater (VRMS) | 3.5 | 3.5 ±0.5 | 3.5 | 3.5 ±0.5 |
| TWT Currents | | | | |
| Anode (mA) | 0.4 | 0.5 max. | 0.4 | 0.5 max. |
| Helix (mA) | 5.0 | 10.0 max. | 8.0 | 10.0 max. |
| Collector (mA) | 30.8 | 40.0 max. | 46.1 | 60.0 max. |
| Heater (A) | 0.8 | 0.9 max. | 0.8 | 0.9 max. |

# WJ-274-8

## ENVIRONMENTAL CHARACTERISTICS

Heat Sink Temperature ..... −20°C to +85°C

Vibration

a. Sinusoidal
(2 min/octave) 0.5 inch double amplitude, 5 to 18 cps ±20 g, peak, 18 to 2000 cps

b. Random
(5 min/axis) 20-59 cps at 0. 4 $g^2$/cps
59-126 cps at 9 dB/octave
126-700 cps at 0. 4 $g^2$/cps
700-900 cps at −18 dB/octave
900-2000 cps at 0.09 $g^2$/cps

Acceleration (1 min/axis) ..... 100 g

Shock ..... 75 g, 11 ms

## MECHANICAL CHARACTERISTICS

Tube Length ..... 9.2 inches, max.

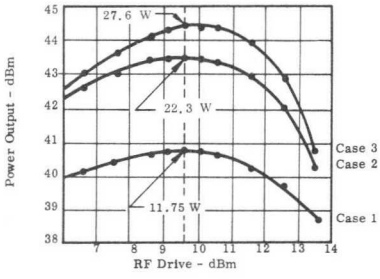
Tube Cross-Section
(excluding connectors 0.95 x 1.35 inch, max.

RF Connectors ..... OSM (Female)

DC Connectors ..... Flying Leads

Tube Weight ..... 20 ounces, max.

Cooling ..... Conduction from bottom surface

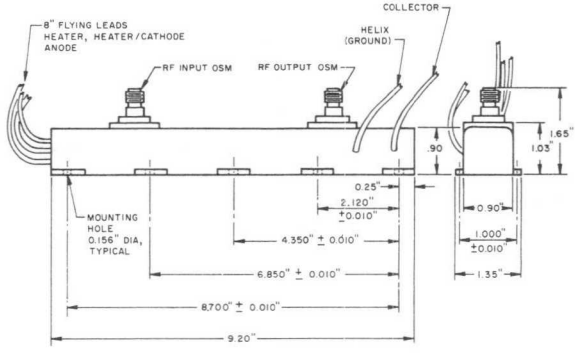


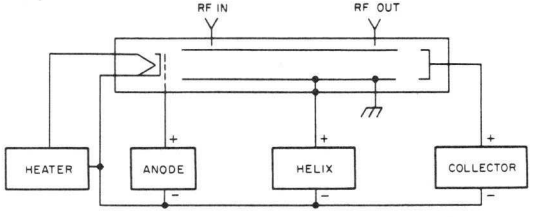

**FREQUENCY: 2300 MHz**

| | Case 1 | Case 2 | Case 3 |
|---|---|---|---|
| Power Output (W) ..... | 11.75 | 22.3 | 27.6 |
| Drive (dBm) ..... | 9.6 | 9.6 | 9.6 |
| Overall Efficiency (%) ..... | 28.4 | 28.9 | 26.7 |
| Gain (dB) ..... | 31.2 | 33.9 | 34.8 |

**FIG. 1 PERFORMANCE CHARACTERISTICS**

**FIG. 2. OUTLINE DRAWING**






**10 W MODE**
HEATER 3.0-4.0 VOLTS AC AT 0.9 A MAXIMUM
ANODE 1463-1663 VOLTS at 0.5 mA MAXIMUM
HELIX 1415-1615 AT 10 mA MAXIMUM
COLLECTOR 851-1051 VOLTS AT 40 mA MAXIMUM

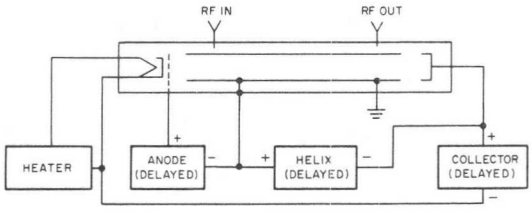
**20 W MODE**
HEATER 3.0-4.0 VOLTS AC AT 0.9 A MAXIMUM
ANODE 1957-2157 VOLTS AT 0.5 mA MAXIMUM
HELIX 1540-1740 AT 10 mA MAXIMUM
COLLECTOR 1152-1352 VOLTS AT 60 mA MAXIMUM

NOTE:
TO ENSURE THAT THE TWT IS OPERATED PROPERLY, IT IS SUGGESTED THAT VOLTAGES BE APPLIED AS FOLLOWS:

1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT FILAMENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILAMENT VOLTAGE TO STABILIZE.
2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED.
3. SET ADJUSTABLE OVERCURRENT DISCONNECT CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY INCREASE HELIX VOLTAGE TO SPECIFIED VALUE.
4. SLOWLY INCREASE ANODE VOLTAGE TO SPECIFIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 $\mu$SEC IF HELIX CURRENT EXCEEDS MAXIMUM VALUE.

**FIG. 3. PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-274-8.**




**10 W MODE**

HEATER 3.0-4.0 VOLTS AC AT 0.9 A MAXIMUM
ANODE 1463-1663 VOLTS (sum of Anode, Helix, and Collector Supplies) at 0.5 mA maximum
HELIX 1415-1615 VOLTS (sum of Helix and Collector Supplies) at 10 mA maximum
COLLECTOR 851-1051 VOLTS AT 40 mA MAXIMUM

**20 W MODE**

HEATER 3.0-4.0 VOLTS AC AT 0.9 A MAXIMUM
ANODE 1957-2157 VOLTS AT 0.5 mA MAXIMUM
HELIX 1540-1740 AT 10 mA MAXIMUM
COLLECTOR 1152-1352 VOLTS AT 60 mA MAXIMUM

NOTE:
WITH THIS CONFIGURATION, ANODE SUPPLY CAN NOT CUTOFF TUBE EMISSION. TO PREVENT DAMAGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:

1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FILAMENT RESISTANCE CHANGE AS TEMPERATURE RISES.
2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINIMUM.

**CAUTION**

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 $\mu$SEC IF MAXIMUM VALUE IS EXCEEDED.

**FIG. 4. PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR WJ-274-8.**

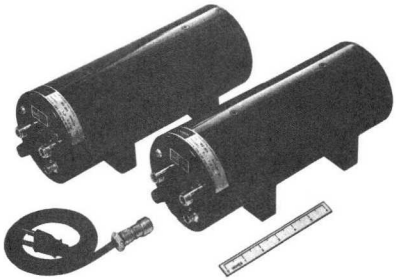
# TECHNICAL DATA

WATKINS-JOHNSON

January 1967 *

## X-BAND LOW-NOISE TWT AMPLIFIERS WITH INTEGRAL POWER SUPPLY

## WJ-276 AND WJ-276-2



- NOISE FIGURE 8.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN MTBF 20,000+HOURS
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2

The WJ-276 and WJ-276-2 are the original members of Watkins-Johnson Company's X-band family of low-noise TWT amplifiers with integral power supply operating from 115 volts a.c. The WJ-276 covers 8.0 to 12.0 GHz and the WJ-276-2 covers 7.0 to 11.0 GHz — otherwise both amplifiers have identical electrical and mechanical characteristics.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-276 and WJ-276-2. With a proven MTBF in excess of 20,000 hours (99% confidence level), hundreds of these units today are providing reliable operation in widespread application throughout the world. The amplifiers' outstanding electrical performance and long-term reliability have made them the standard of the industry.

Both these amplifiers are completely self-contained units. They are adjustment-free and require only an ac line-voltage input. The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material without adversely affecting the amplifiers' performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of both amplifiers meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| Performance | TYPICAL | GUARANTEED |
|---|---|---|
| Frequency | | |
| WJ-276 | 8.0 to 12.0 GHz | 8.0 to 12.0 GHz |
| WJ-276-2 | 7.0 to 11.0 GHz | 7.0 to 11.0 GHz |
| Noise Figure, Terminal | 7.5 dB | 8.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +3 dBm | −5.0 dBm |

| Electrical Requirements | TYPICAL | RANGE[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |

* *This Technical Data Sheet presents up-to-date information on the WJ-276 and WJ-276-2, first described in Technical Bulletin, Volume 5, No. 9; October 1963.*

# WJ-276 AND WJ-276-2

## ENVIRONMENTAL CHARACTERISTICS [2]

Temperature, Operating . . −54° to +71°C
Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz
b. 10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

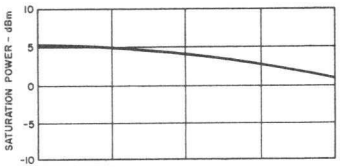
## MECHANICAL CHARACTERISTICS

Amplifier Length
(excluding connectors) . . 12.0 inches, max.
Amplifier Height and Width . 4.75 inches, max.
Weight . . . . . 17 pounds, max.
Primary Power Connection,
Deutsch Receptacle . . . . . DM9601-3P
RF Connections
(50 ohms, nominal) . . . . . Type N, jack
Reference Drawing No. . . . . 290000

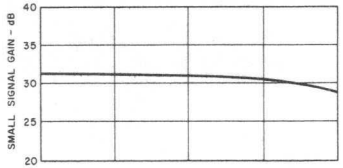
[1] Every amplifier will meet the guaranteed performance specifications for any voltage or frequency lying within these ranges.

[2] These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

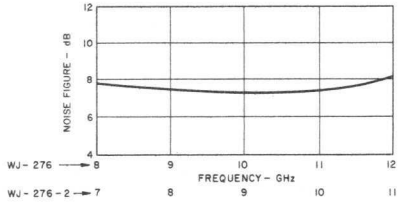
## POWER



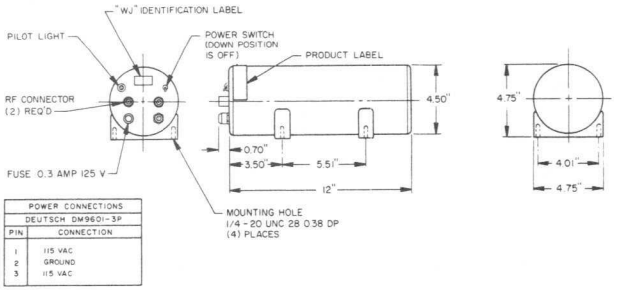

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS | |
|---|---|
| DEUTSCH DM9601-3P | |
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

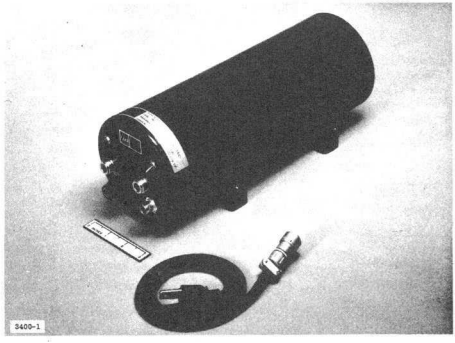
WATKINS-JOHNSON

# WJ-278

June 1967

## 0.5 TO 1.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 4.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION




The WJ-278 is the P-band member of the Watkins-Johnson family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1964, the WJ-278's performance in the 0.5 to 1.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With hundreds of units in use throughout the world, the WJ-278 provides low noise figure ( most production amplifiers exhibit noise figures of less than 4 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54°C$ to $+71°C$. The environmental characteristics of the WJ-278 meet or exceed the corresponding requirements of MIL-E-5400, Class 2 Specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 0.5 to 1.0 GHz | 0.5 to 1.0 GHz |
| Noise Figure, Terminal | 3.7 dB | 4.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | −4 dBm | −10 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |

* Information on this Technical Data Sheet supercedes information contained in WJ-278 Technical Data Sheet, dated March 1967.

# WJ-278

## ENVIRONMENTAL CHARACTERISTICS

Temperature (Operating) . . −54°C to +71°C
Vibration
0.10 Inch, Double Amplitude . . 5 to 45 Hz
10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

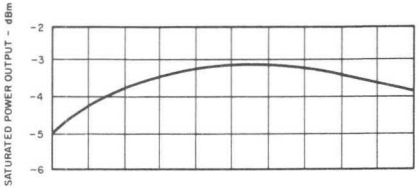
## MECHANICAL CHARACTERISTICS

Amplifier Length
(excluding connectors) . . 12 inches, max.
Amplifier Height and Width . 4.75 inches, max.
Amplifer Weight . . . . . 17 lbs, max.
Primary Power Connection,
Deutsch Receptacle . . . . DM9601-3P
RF Connections
(50 ohms, nominal) . . . . Type N, jack
Reference Drawing Number . . . . 290000

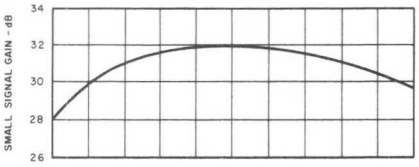
Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

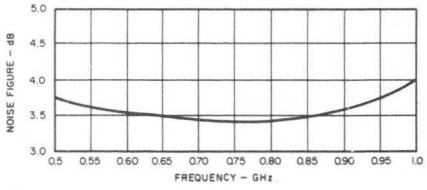
## POWER



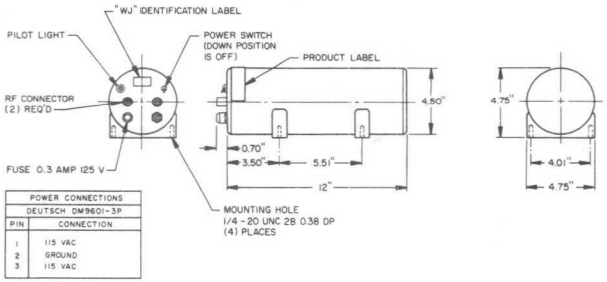

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601-3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

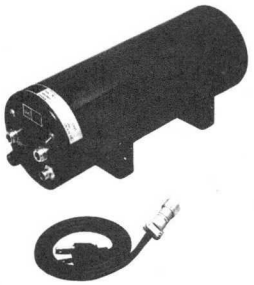
WATKINS-JOHNSON

January 1967

## 1.0 TO 2.6 GHz LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-280

- NOISE FIGURE 8.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN MTBF 20,000+ HOURS
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2



The WJ-280 extends the Watkins-Johnson Company family of low-noise permanent-magnet traveling-wave amplifiers. The WJ-280, with a typical noise figure of 6.5 dB, has been specially designed for applications where higher gain and increased power output are required over a broader frequency band.

Like other amplifiers in Watkins-Johnson Company's family of low-noise amplifiers, the WJ-280 incorporates an integral power supply, making the unit completely self-contained, adjustment-free and requiring only an ac line-voltage input. This permanent-magnet focused tube has been designed into a completely shielded package which enables side-by-side operation in stacked arrays or next to ferromagnetic material without any adverse effect.

The tube may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. The environmental characteristics of the WJ-280 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

The same conservative design and careful processing techniques which have given long life in other Watkins-Johnson low-noise tubes have also been extended to this amplifier.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0–2.6 GHz | 1.0–2.6 GHz |
| Noise Figure, Terminal | 6.5 dB | 8.0 dB max. |
| Gain, Small Signal | 40 dB | 35 dB min. |
| VSWR, Input and Output | 1.5:1 | 2:1 max. |
| Power Output | − 2 dBm | − 7 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |

** This Technical Data Sheet presents up-to-date information on the WJ-280, first described in Technical Bulletin, Volume 5, No. 11; November 1963.*

# WJ-280

## ENVIRONMENTAL CHARACTERISTICS[2]

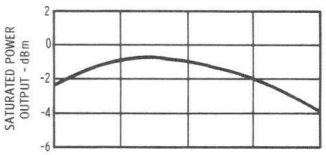
Temperature, Operating . . −54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz
b. 10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

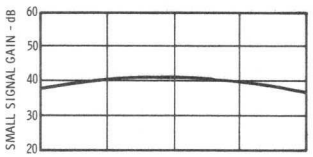
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . . DM9601-3P
RF Connections (50 ohms, nominal) . . . . . Type N, jack
Reference Drawing No. . . . . 290000

1. Every amplifier will meet the guaranteed performance specifications for any voltage and frequency lying within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

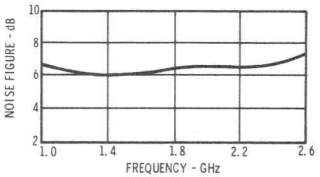
## POWER



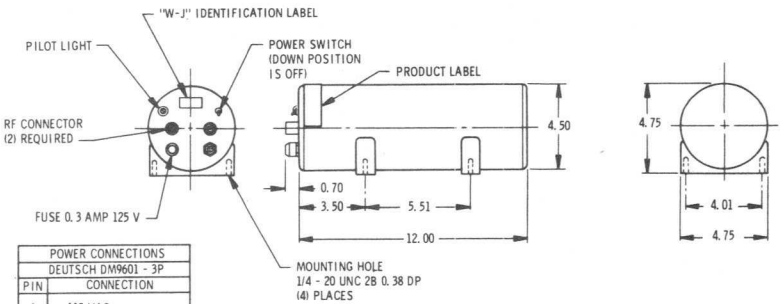

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601 - 3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-281

January 1967 *

## 2.0 TO 4.5 GHz LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- NOISE FIGURE 8.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN MTBF 20,000+ HOURS
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2

The WJ-281 is an extension of Watkins-Johnson Company's family of high gain, low-noise traveling-wave amplifiers. This amplifier has a permanent-magnet focused TWT with a typical noise figure of 7.0 dB and a typical small signal gain of 40 dB.

Like other units of the Watkins-Johnson Company family of low-noise amplifiers, the WJ-281 incorporates an integral power supply, making the unit completely self-contained, adjustment-free and requiring only an ac line-voltage input. The permanent-magnet focused TWT has been designed into a completely shielded package which enables side-by-side operation in stacked arrays or placement next to ferromagnetic material without any adverse effect.

The WJ-281 covers a frequency range of 2.0 to 4.5 GHz with a minimum small-signal gain of 35 dB. The saturated power output of the tube is nominally 1 milliwatt with a guaranteed maximum noise figure of 8.0 dB.

The tube may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of over 10 g, at frequencies up to 500 Hz. The environmental characteristics of the WJ-281 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

The same conservative design and rigid manufacturing process control which have given long life in other Watkins-Johnson low-noise tubes have been extended to this amplifier. Tubes of similar design are exceeding operating life times of 20,000 hours.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0–4.5 GHz | 2.0–4.5 GHz |
| Noise Figure, Terminal | 6.0 dB | 8.0 dB max. |
| Gain, Small Signal | 40 dB | 35 dB min. |
| VSWR, Input and Output | 1.5:1 | 2:1 max. |
| Power Output | −2 dBm | −7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |

*This Technical Data Sheet presents up-to-date information on the WJ-281, first described in Technical Bulletin, Volume 6, No. 3; February 1964.

# WJ-281

## ENVIRONMENTAL CHARACTERISTICS

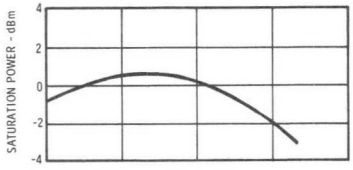
Temperature, Operating . . −54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz
b. 10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

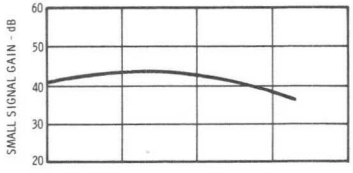
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . . DM9601-3P
RF Connections (50 Ohms, nominal) . . . . . Type N, jack
Reference Drawing No. . . . . 290000

1. Every amplifier will meet the guaranteed performance specifications for any voltage and frequency lying within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

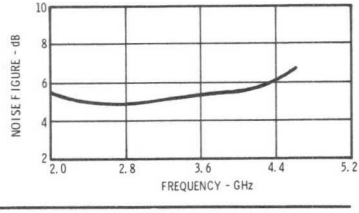
## POWER



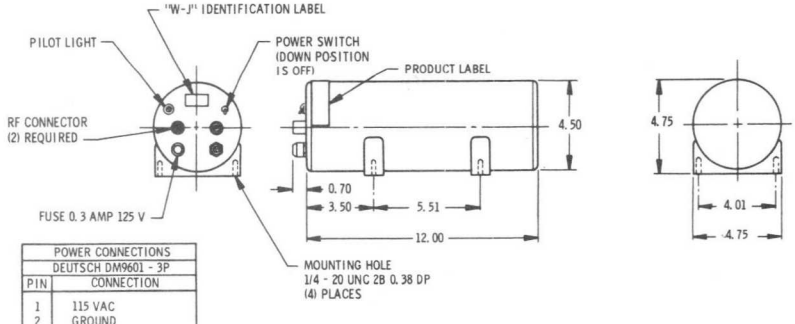

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601 - 3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-284-5

## 6.0 TO 8.0 GHz, 200 WATT CW, PPM-FOCUSED TRAVELING-WAVE TUBE

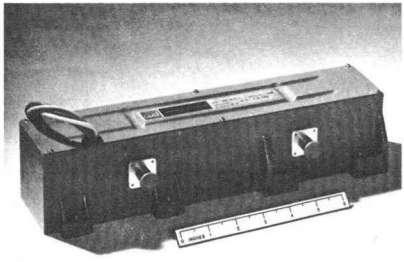
April 1967

The WJ-284-5 is a 200 watt CW conduction-cooled traveling-wave tube developed for use in airborne and missile applications. Although the tube is designed for 200 watts output power, it can be operated at power levels as low as 100 watts by means of a simple adjustment that controls the beam current. The saturation gain at the lower power output level is approximately 25 dB.

The WJ-284-5, constructed of metal-ceramic materials, incorporates design features to assure the maximum in reliable, long-life operation. This tube has been qualified for missile and airborne applications, and will meet the environmental conditions given on the Tentative Specification sheet. Outline dimensions for the WJ-284-5 are illustrated in Figure 1. Although the WJ-284-5 guaranteed frequency range is from 6.0 to 8.0 GHz, the tube is capable of being operated at greater bandwidths as shown in Figure 2. Figure 3 illustrates a typical transfer curve for the tube operating at 6.6 GHz.

To illustrate the effect voltage variations have upon the performance of the tube, a curve showing saturated power output and saturation gain versus frequency as a function of helix voltage is contained in Figure 4. Helix voltage is the voltage between the helix and cathode. Note that the power output is relatively insensitive to helix voltage whereas saturation gain is affected. For example, over the frequency range from 6.2 to 7.0 GHz, the saturation gain will change by 0.8 dB for a 1% change in helix voltage.

Helix current, with and without RF drive, versus collector voltage variation is shown in Figure 5. Note that at the nominal operating point the helix current is relatively insensitive to collector voltage variation,



3345

and the RF power output and gain remain unchanged.

Typical power supply configurations that will satisfactorily operate the WJ-284-5 are illustrated in Figures 6 and 7. It is recommended that protection for the helix of the tube be provided by employing "crow-bar" circuitry which will ensure voltage decay within 100 $\mu$sec after either the helix or collector power supply is turned off. Also recommended is an overload current circuit which removes all voltages within 100 $\mu$sec when the helix current exceeds 10 mA. The tube should not be operated into a load with VSWR greater than 1.4, to prevent damage to the helix which might result from the addition of incident and returned power.

Other versions of the WJ-284-5 are available at reduced power level, with liquid cooling, which meet less critical environmental specifications.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 5.0 to 9.0 GHz | 6.0 to 8.0 GHz |
| Power Output, Saturated | 210 W | 200 W, min. * |
| Gain, Saturation | 34 dB | 30 dB, min. |
| Efficiency | 25% | 23%, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 7.0 V | 6.5 to 8.5 V |
| Heater Current | 1.5 A | 1.4 to 1.6 A |
| Anode Voltage | 6750V | 6750 ± 400V |
| Anode Current | 0.2 mA | 1 mA max. |
| Helix Voltage | 6750 V | 6750 ± 150 V |
| Helix Current | 2.8 mA | 10.0 mA max. |
| Collector Voltage | 4200 V | 4100–4400 V |
| * into 1.15 max. VSWR load — Collector Current | 197 mA | 210 mA max. |
| * into 1.15 max. VSWR load — Cathode Current | 200 mA | 210 mA max. |

# WJ-284-5

## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Heat Sink Temperature | −20° to +60°C |
| Vibration | 5 to 2000 Hz, 5 g rms sinusoidal |
| Shock | 50 g, 11 ms, half sine |
| Altitude | 0 to 50,000 feet |
| Load VSWR | 1.4, max. |

## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Tube Length | 12.5 inches max. |
| Tube Cross-section (excluding connectors) | 2.75 x 3.125, max. |
| RF Connectors | TNC (Female) |
| DC Connectors | Flying leads |
| Weight | 10 pounds, max. |
| Cooling | Conduction from bottom surface |

Efficiency is defined as the minimum RF output power across the band, divided by the total dc power input, including heater power.

## TYPICAL PERFORMANCE CHARACTERISTICS

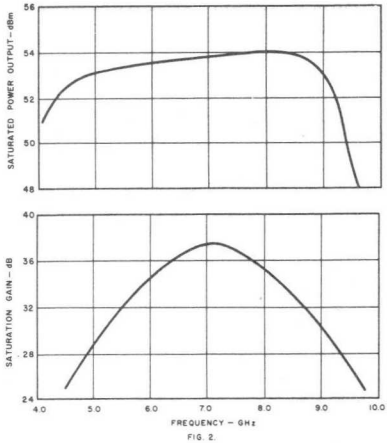



FIG. 2.

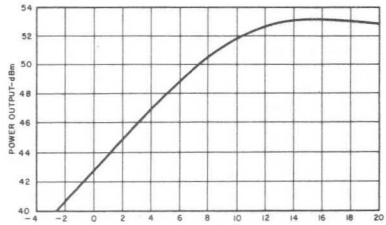
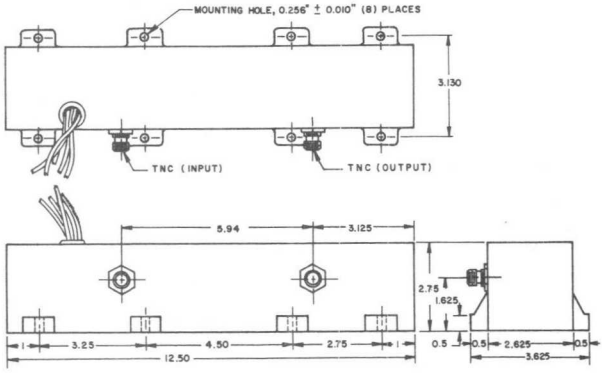



FIG. 3.

## OUTLINE DRAWING

FIG. 1



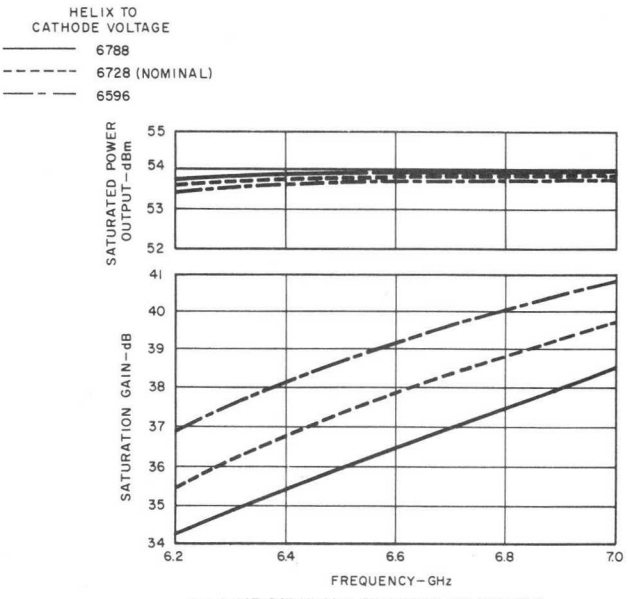



FIG. 4. SATURATION GAIN FOR THE WJ-284-5 VERSUS FREQUENCY AND AS A FUNCTION OF HELIX VOLTAGE.

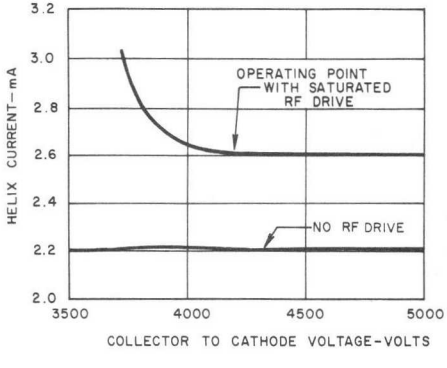
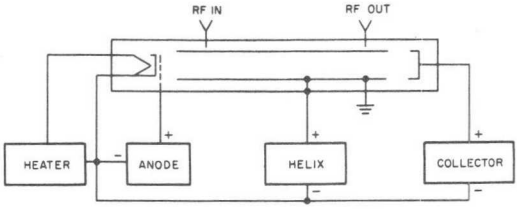



FIG. 5. HELIX CURRENT VERSUS COLLECTOR VOLTAGE FOR THE WJ-284-5 TWT. DATA ARE SHOWN WITH AND WITHOUT RF DRIVE. THE RF POWER OUTPUT REMAINS UNCHANGED AS THE COLLECTOR VOLTAGE IS VARIED. THE CATHODE CURRENT IS 200 mA.




HEATER 7.0–8.0 VOLTS AC AT 1.6 A MAXIMUM
ANODE 6350–7150 VOLTS AT 1 mA MAXIMUM
HELIX 6600–6900 VOLTS AT 10 mA MAXIMUM
COLLECTOR 4100–4400 VOLTS AT 210 mA MAXIMUM

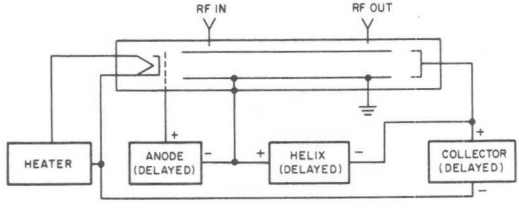
NOTE:

TO ENSURE THAT THE TWT IS OPERATED PROPERLY, IT IS SUGGESTED THAT VOLTAGES BE APPLIED AS FOLLOWS:

1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT FILAMENT CURRENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILAMENT VOLTAGE TO STABILIZE.
2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT COLLECTOR CURRENT DOES NOT EXCEED MAXIMUM VALUE.
3. SET ADJUSTABLE OVERCURRENT DISCONNECT CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY APPLY HELIX VOLTAGE TO SPECIFIED VALUE.
4. SLOWLY APPLY ANODE VOLTAGE TO SPECIFIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 μSEC IF HELIX CURRENT EXCEEDS MAXIMUM VALUE.

FIGURE 6. PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR THE WJ-284-5




HEATER 7.0–8.0 VOLTS AC AT 1.6 A MAXIMUM
ANODE 6350–7150 VOLTS AT 1 mA MAXIMUM (SUM OF ANODE, HELIX, AND COLLECTOR SUPPLIES)
HELIX 6600–6900 VOLTS AT 10 mA MAXIMUM (SUM OF HELIX AND COLLECTOR SUPPLIES)
COLLECTOR 4100–4400 VOLTS AT 210 mA MAXIMUM

NOTE:

WITH THIS CONFIGURATION, ANODE SUPPLY CANNOT CUT OFF TUBE EMISSION. TO PREVENT DAMAGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:

1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FILAMENT RESISTANCE CHANGE AS TEMPERATURE RISES.
2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINIMUM.

**CAUTION**

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 μSEC IF MAXIMUM VALUE IS EXCEEDED.

FIGURE 7. PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR THE WJ-284-5

# TECHNICAL DATA

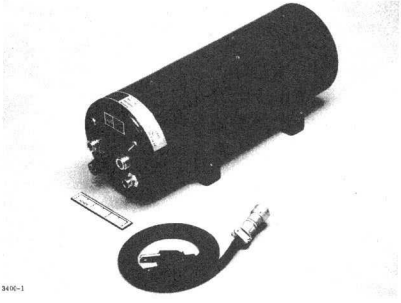
WATKINS-JOHNSON

# WJ-286

July 1967

## 4.0 to 8.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- LOW-NOISE FIGURE: 8.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- INTEGRAL POWER SUPPLY
- C-BAND OPERATION
- LOW-VOLTAGE INPUT
- ADJUSTMENT-FREE PERFORMANCE



3406-1

The WJ-286 is the C-band member of the Watkins-Johnson family of high-gain low-noise amplifiers with integral solid-state power supply. The same conservative design and rigid manufacturing process control which have given long life in other Watkins-Johnson low-noise tubes have been extended to this amplifier.

Like other units of the Watkins-Johnson Company family of low-noise amplifiers, the WJ-286 incorporates an integral power supply, making the unit completely self-contained, adjustment-free and requiring only an ac line-voltage input. The permanent-magnet focused TWT has been designed into a completely shielded package which enables side-by-side operation in stacked arrays or placement next to ferromagnetic material without any adverse effect.

The tube may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of over 10 g, at frequencies up to 500 Hz. The environmental characteristics of the WJ- 286 meet the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0 to 8.0 GHz | 4.0 to 8.0 GHz |
| Noise figure, terminal | 6.5 dB | 8.0 dB, max. |
| Gain, Small Signal | 38 dB | 35 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +5.0 dBm | —5 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 25W | |

# WJ-286

## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature, Operating | −54°C to +71°C |
| Vibration | |
| 0.10 Inch, Double Amplitude | 5 to 45 Hz |
| 10 g, Single Amplitude | 45 to 500 Hz |
| Shock | 15 g, 11 ms |

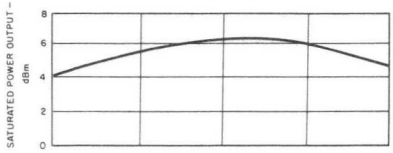
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Amplifier Length (excluding connectors) | 12 inches, max. |
| Amplifier Height and Width | 4.75 inches, max. |
| Amplifier Weight | 17 lbs., max. |
| Primary Power Connection, Deutsch Receptacle | DM9601-3P |
| RF Connections (50 ohms, nominal) | Type N, jack |
| Reference Drawing Number | 290000 |

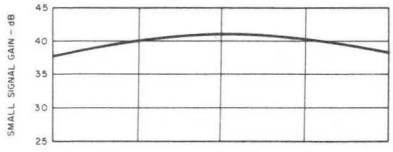
Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

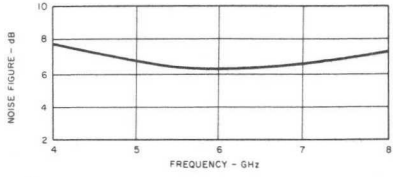
## POWER



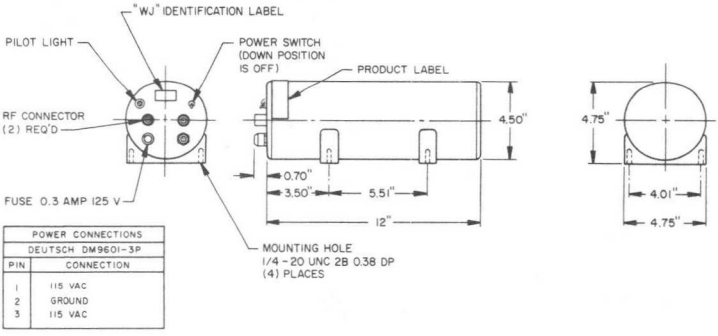

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601-3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

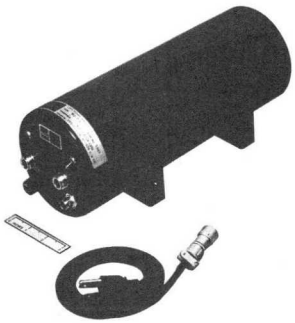
# TECHNICAL DATA

WATKINS-JOHNSON

August 1967

## 8.0 to 12.0 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-287



- LOW-NOISE FIGURE: 10.0 dB MAXIMUM
- X-BAND OPERATION
- PERMANENT-MAGNET FOCUSING
- INTEGRAL POWER SUPPLY
- LOW-VOLTAGE INPUT
- ADJUSTMENT-FREE PERFORMANCE

The WJ-287 is the X-band member of the Watkins-Johnson family of high-gain low-noise amplifiers with integral solid-state power supply. The same conservative design and rigid manufacturing process control which have given long life in other Watkins-Johnson low-noise tubes have been extended to this amplifier.

Like other units of the Watkins-Johnson Company family of low-noise amplifiers, the WJ-287 incorporates an integral power supply, making the unit completely self-contained, adjustment-free and requiring only an ac line-voltage input. The permanent-magnet focused TWT has been designed into a completely shielded package which enables side-by-side operation in stacked arrays or placement next to ferromagnetic material without any adverse effect.

The tube may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of over 10 g, at frequencies up to 500 Hz. The environmental characteristics of the WJ-287 meet the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 8.0 to 12.0 GHz | 8.0 to 12.0 GHz |
| Noise figure, terminal | 8.5 dB | 10 dB max. |
| Gain, Small Signal | 38 dB | 35 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +5.0 dBm | —5 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 25W | |

# WJ-287

## ENVIRONMENTAL[2] CHARACTERISTICS

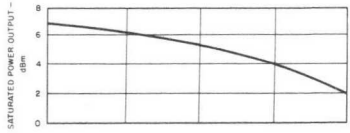
Temperature, operating ..... —54°C to +71°C
Vibration
a. .10 inch, double amplitude.....5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

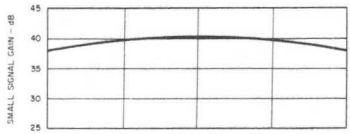
Height ..... 4.75 inches (121 mm) max.
Width ..... 4.75 inches (121 mm) max.
Length (excluding connectors) ..... 12 inches (305 mm) max.
Weight ..... 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch receptacle ..... DM9601-3P
RF Connections (50 ohms, nominal) ... Type N, jack
Reference Drawing Number ..... 290000

[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.
[2]These environmental characteristics meet the respective requirements for MIL-E-5400, Class 2.

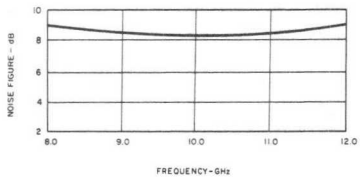
## POWER



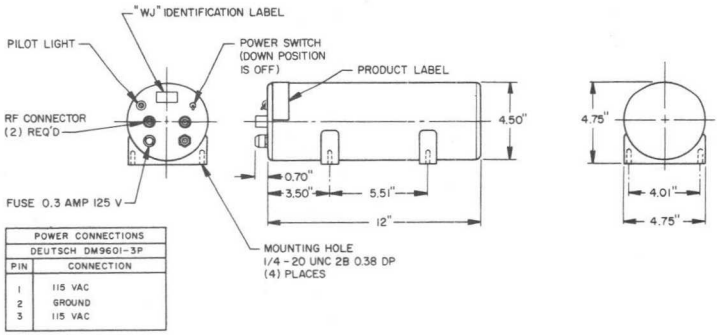

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601-3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

February 1967

## 1.0 TO 2.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-294

- "JUST PLUG IT IN"
- NOISE FIGURE 8.0 dB MAXIMUM
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE

The WJ-294 is the L-band member of Watkins-Johnson's family of compact traveling-wave amplifiers. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjustment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source. A 28-volt dc version of the WJ-294 is also available on special order.

Although guaranteed to produce a noise figure not exceeding 8.0 dB, a typical WJ-294 production unit can be expected to yield a much lower noise figure over the major segment of the 1.0 to 2.0 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below the 7.0 dB line.

The WJ-294 will meet or exceed respective environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-294. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

More than twenty specialized versions of the WJ-294 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0 to 2.0 GHz | 1.0 to 2.0 GHz |
| Noise Figure, Terminal | 7.0 dB | 8.0 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +9.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ± 10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-294

## MECHANICAL CHARACTERISTICS[2]

| | |
|---|---|
| Height | 3.4 inches (86 mm) max. |
| Width | 3.4 inches (86 mm) max. |
| Length (excluding connectors) | 9.5 inches (241 mm) max. |
| Weight | 6 pounds (2.72 Kg) max. |
| Primary Power Connection, Deutsch Receptacle | DM9601-3P |
| RF Connections (50 ohms, nominal) | Type N, jack |
| Reference Drawing Number | 290003 |

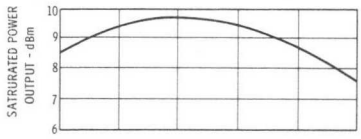
## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature, Operating | −54°C to +71°C |
| Vibration | |
| a. 0.10 Inch, Double Amplitude | 5 to 45 Hz |
| b. 10 g, Single Amplitude | 45 to 500 Hz |
| Shock | 15 g, 11 ms |

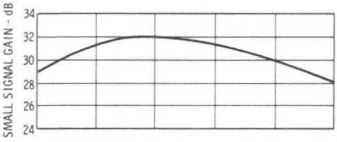
[1]Every tube will meet the guaranteed performance specifications within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

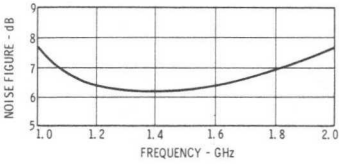
## POWER



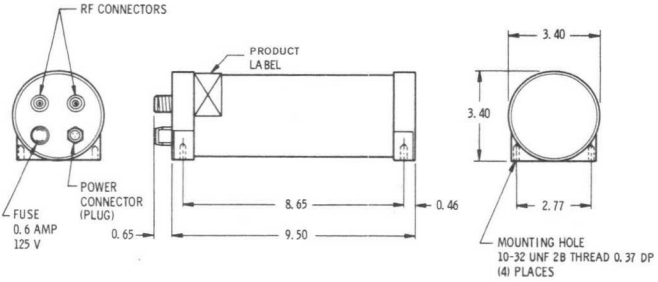

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-295

## 2.0 TO 4.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

February 1967

- "JUST PLUG IT IN"
- NOISE FIGURE 8.5 dB MAXIMUM
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE

The WJ-295 is the S-band member of Watkins-Johnson's family of compact traveling wave amplifiers. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjustment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source. A 28-volt dc version of the WJ-295 is also available on special order.

Although guaranteed to produce a noise figure not exceeding 8.5 dB, a typical WJ-295 production unit can be expected to yield a much lower noise figure over the major segment of the 2.0 to 4.0 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below the 7.5 dB line.

The WJ-295 will meet or exceed respective environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54°C$ to $+71°C$.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-295. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

More than twenty specialized versions of the WJ-295 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise Figure, Terminal | 7.5 dB | 8.5 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +10.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-295

## MECHANICAL CHARACTERISTICS

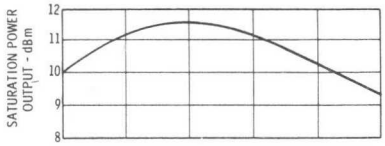
| | |
|---|---|
| Height | 3.4 inches (86 mm) max. |
| Width | 3.4 inches (86 mm) max. |
| Length (excluding connectors) | 9.5 inches (241 mm) max. |
| Weight | 6 pounds (2.72 Kg) max. |
| Primary Power Connection, Deutsch Receptacle | DM9601-3P |
| RF Connections (50 ohms, nominal) | Type N, jack |
| Reference Drawing Number | 290003 |

## ENVIRONMENTAL CHARACTERISTICS

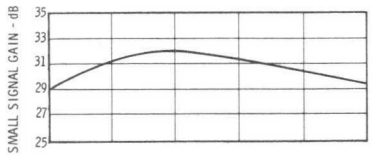
| | |
|---|---|
| Temperature, Operating | −54°C to +71°C |
| Vibration | |
| a. 0.10 Inch, Double Amplitude | 5 to 45 Hz |
| b. 10 g, Single Amplitude | 45 to 500 Hz |
| Shock | 15 g, 11 ms |

1. Every tube will meet the guaranteed performance specifications within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

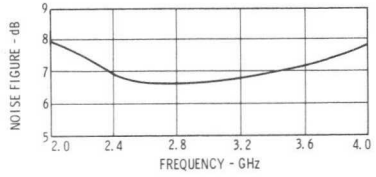
## POWER



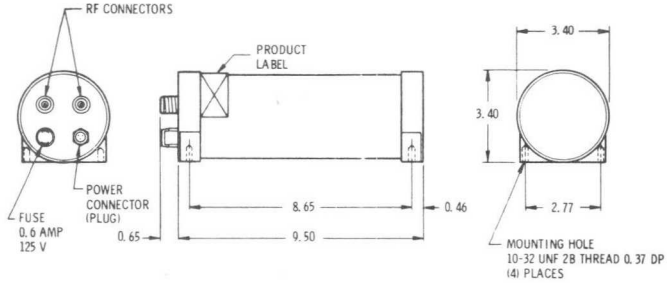

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-296

February 1967

## 4.0 TO 8.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 9.0 dB MAXIMUM
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE

The WJ-296 is the C-band member of Watkins-Johnson's family of compact traveling-wave amplifiers. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjusment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source. A 28-volt dc version of the WJ-296 is also available on special order.

Although guaranteed to produce a noise figure not exceeding 9.0 dB, a typical WJ-296 production unit can be expected to yield a much lower noise figure over the major segment of the 4.0 to 8.0 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below the 8.0 dB line.

The WJ-296 will meet or exceed respective environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-296. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

More than twenty specialized versions of the WJ-296 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0 to 8.0 GHz | 4.0 to 8.0 GHz |
| Noise Figure, Terminal | 8.0 dB | 9.0 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +11.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-296

## ENVIRONMENTAL CHARACTERISTICS [2]

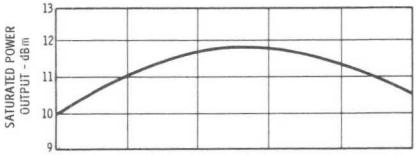
Temperature, Operating . . −54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude 5 to 45 Hz
b. 10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

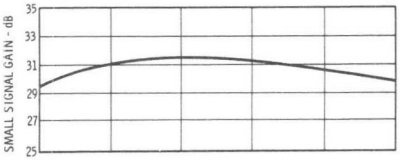
Height . . . . . 3.4 inches (86 mm) max.
Width . . . . . 3.4 inches (86 mm) max.
Length (excluding connectors) . . . . . 9.5 inches (241 mm) max.
Weight . . . . . 6 pounds (2.72 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . DM9601-3P
RF Connections (50 ohms, nominal) . . . . . Type N, jack
Reference Drawing Number . . . . 290003

1. Every tube will meet the guaranteed performance specifications within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

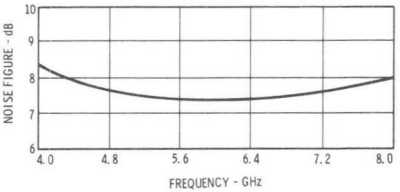
## POWER



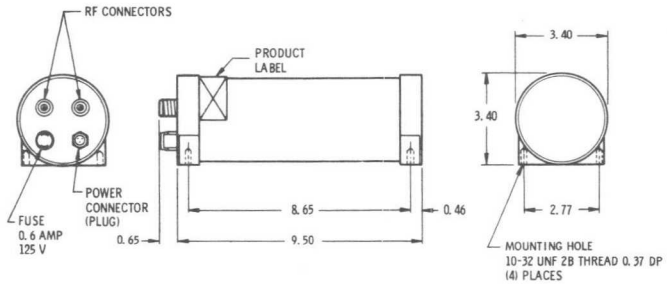

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-297

## 8.0 TO 12.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

February 1967

- "JUST PLUG IT IN"
- NOISE FIGURE 10.0 dB MAXIMUM
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE

The WJ-297 is the X-band member of Watkins-Johnson's family of compact traveling wave amplifiers. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjustment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source. A 28-volt dc version of the WJ-297 is also available on special order.

Although guaranteed to produce a noise figure not exceeding 10.0 dB, a typical WJ-297 production unit can be expected to yield a much lower noise figure over the major segment of the 8.0 to 12.0 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below the 9.0 dB line.

The WJ-297 will meet or exceed respective environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54°C$ to $+71°C$.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-297. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

More than twenty specialized versions of the WJ-297 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 8.0 to 12.0 GHz | 8.0 to 12.0 GHz |
| Noise Figure, Terminal | 9.0 dB | 10.0 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +10.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-297

## ENVIRONMENTAL CHARACTERISTICS[2]

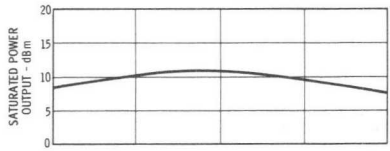
Temperature, Operating . . −54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz
b. 10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

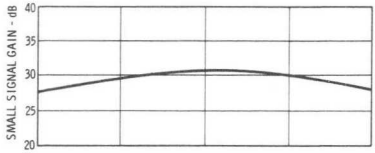
Height . . . . . 3.4 inches (86 mm) max.
Width . . . . . 3.4 inches (86 mm) max.
Length (excluding connectors) . . . . . 9.5 inches (241 mm) max.
Weight . . . . . 6 pounds (2.72 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . DM9601-3P
RF Connections (50 ohms, nominal) . . . . . Type N, jack
Reference Drawing Number . . . . 290003

1. Every tube will meet the guaranteed performance specifications within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

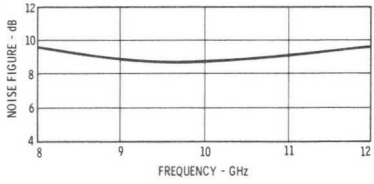
## POWER



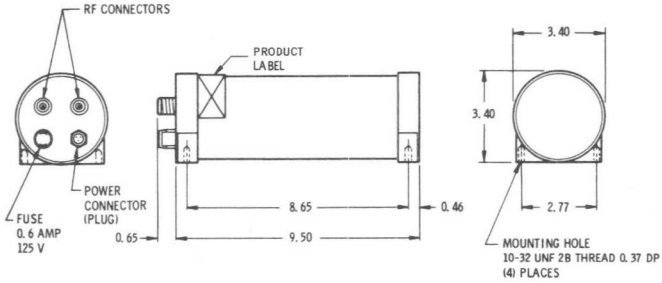

## GAIN




## NOISE




## OUTLINE DRAWING



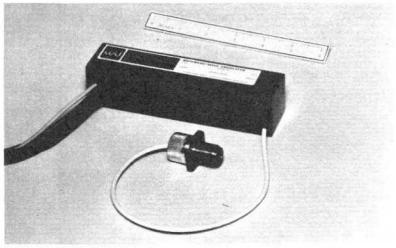
# TECHNICAL DATA

WATKINS-JOHNSON

# SE-303

## BACKWARD-WAVE OSCILLATOR

TECHNICAL DATA • August 1965



The type SE-303 is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and r.f. connector for easier packaging.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 8.2-12.4 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 25-100 | 20 Min |
| Power Output Variation | db | | 8 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.8 | 1.5 Max |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term sensitivity to Heater Voltage | MHz/V | 5.5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.3 | 1.0 Max |
| Sensitivity to Grid Voltage | MHz/V | 2 | 4 Max |
| Tuning Curve Slope | | | |
| Low End (8.2 GHz) | MHz/V | 6.5 | |
| Mid-Frequency (10.3 GHz) | MHz/V | 3.3 | |
| High End (12.4 GHz) | MHz/V | 1.7 | |
| Grid r.f. Cutoff Voltage | V | -10 | -20 Max |
| Capacitance; Cathode to all Other Electrodes and Case | pf | 18 | 25 Max |
| Capacitance; Grid to all Other Electrodes and Case | pf | 18 | 25 Max |
| Capacitance; Helix and Collector to all Other Electrodes and Case | pf | 70 | 100 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | .75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 485-1850 | 450-2000 Min/Max |
| Anode Voltage* | V | 125 | 200 Max |
| Anode Current | mA | 0.3 | 2 Max |

*Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 1.5 lbs Max
Color Code for 18" Flying Leads

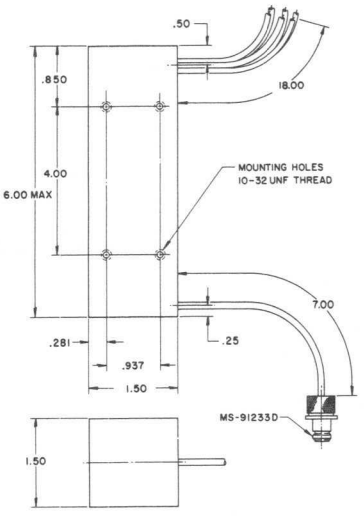
| | |
|---|---|
| Heater | Brown |
| Heater-Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female

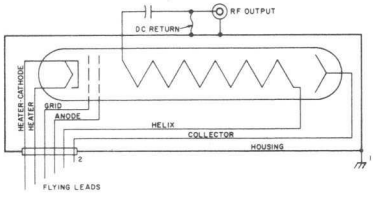
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING



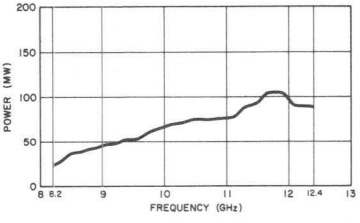

## SCHEMATIC DIAGRAM



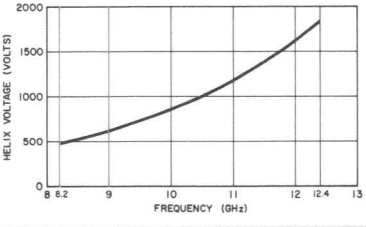

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



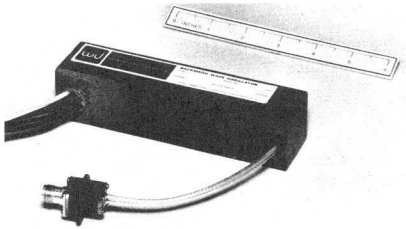
# TECHNICAL DATA

WATKINS-JOHNSON

August 1965

## BACKWARD-WAVE OSCILLATOR

# SE-304



The type SE-304 BWO is a bifilar (dual-helix) voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4.0-8.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 30-70 | 20 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 0.6 | 1.0 |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | db | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage at 6 GHz | MHz/V | 3.5 | 6 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.0 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 6.0 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.5 | |
| High End (8.0 GHz | MHz/V | 1.7 | |
| Grid r.f. Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode to all other Electrodes, inc. Heater | pf | 18 | 25 Max |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pf | 18 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Case | pf | 90 | 125 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | .75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 6 | 12 Max |
| Helix Voltage Range | V | 280-1710 | 250-1800 Min/Max |
| Anode Voltage* | V | 100 | 200 Max |
| Anode Current | mA | 0.3 | 2 Max |

*Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 1-1/2 lbs Max
Color Code for 18" Flying Leads

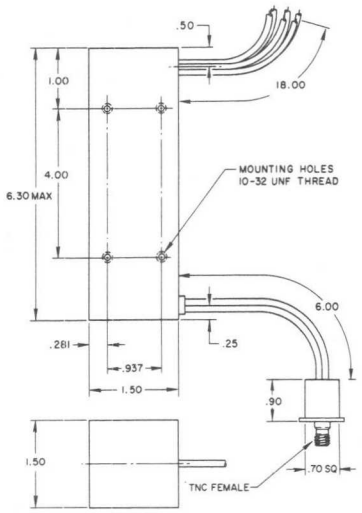
| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any
RF Output Connector, TNC Female

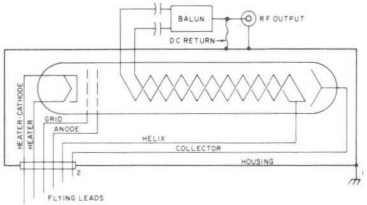
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING



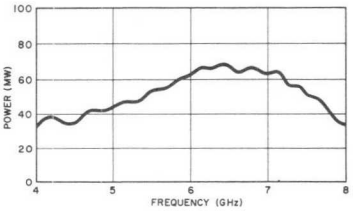

## SCHEMATIC DIAGRAM



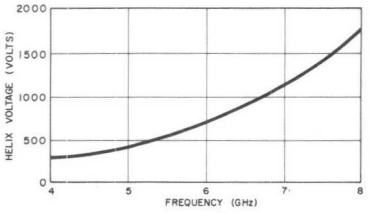

[1]For safety, housing should be grounded through mounting screws.

[2]24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



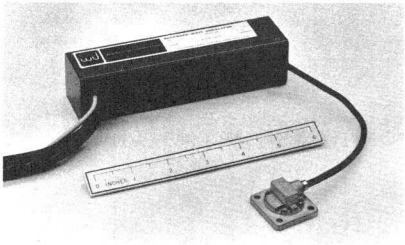
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-307

TECHNICAL DATA • August 1965



The type SE-307 is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and r.f. connector for easier packaging.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 12.4-18.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 25-85 | 20 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.0 | 1.5 Max |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.0 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 8.7 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Grid r. f. Cutoff Voltage | V | -10 | -20 Max |
| Capacitance; Cathode to all Other Electrodes including Heater | pf | 15 | 20 Max |
| Capacitance; Grid to all Other Electrodes at Power Input Connector | pf | 18 | 25 Max |
| Capacitance; Helix and Collector to all Other Electrodes and Case | pf | 80 | 110 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | .75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 570-1980 | 500-2100 Min/Max |
| Anode Voltage* | V | 150 | 200 Max |
| Anode Current | mA | 0.5 | 2 Max |

*Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 1.5 lbs Max
Color Code for 18" Flying Leads

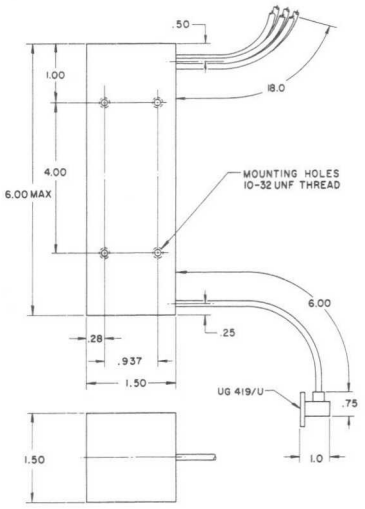
| | |
|---|---|
| Heater | Brown |
| Heater-Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any
RF Output Connector, UG-419/U
Waveguide Flange

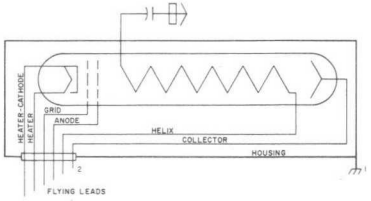
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING



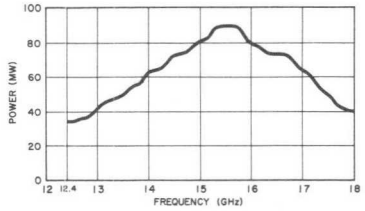

## SCHEMATIC DIAGRAM



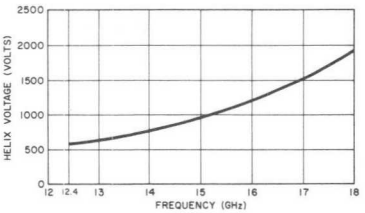

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



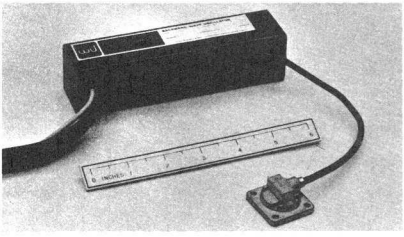
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-307A

TECHNICAL DATA • August 1965



The type SE-307A is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package is comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with the anode circuit. All voltages are isolated from the housing and r.f. connector for easier packaging.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 12.4-18.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 25-85 | 20 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.0 | 1.5 Max |
| Ratio of Signal to Noise Power 30 MHz from Carrier | db/MHz | 95 | 85 Min |
| Long-term sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.0 Max |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 8.7 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Capacitance; Cathode to All Other Electrodes, including Heater | pf | 15 | 20 Max |
| Capacitance; Helix and Collector to All Other Electrodes and Case | pf | 80 | 110 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 570-1980 | 500-2100 Min/Max |
| Anode Voltage* | V | 150 | 200 Max |
| Anode Current | mA | 0.5 | 2 Max |

*Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 1-1/2 lbs Max
Mounting Position, any
Color Code for 18" Flying Leads

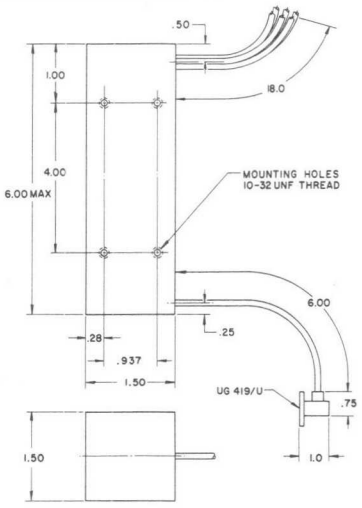
| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

RF Output Connector, UG-419/U
Waveguide Flange

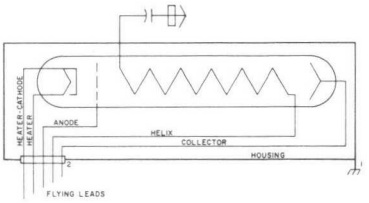
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING



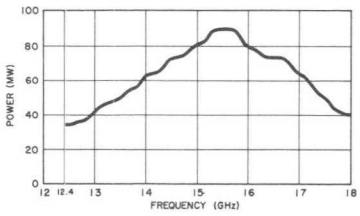

## SCHEMATIC DIAGRAM



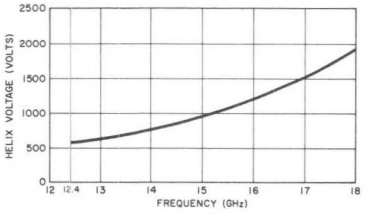

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

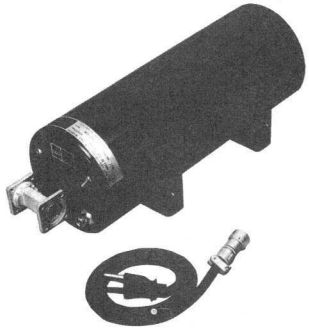
WATKINS-JOHNSON

# WJ-307

March 1967*

## 12 TO 18 GHz LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 10.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



The WJ-307 is one of the original members of Watkins-Johnson's family of Standard low-noise amplifiers with integral solid-state power supply. When introduced to the microwave industry in 1964, the WJ-307's performance in the 12.0 to 18.0 GHz range was unparalleled by other devices. Today, this performance still remains better than or comparable to any commercially available unit. With many units in use throughout the world, the WJ-307 provides low noise figure (many production amplifiers exhibit noise figures of less than 9 dB), low cost per-operating-hour, and high field-proven reliability (MTBF's in excess of 20,000 hours with 99% confidence level).

This proven amplifier is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-307 meet or exceed the corresponding requirements of MIL-E-5400: Temperature, Class 2; Vibration, Curve III.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 12.0 to 18.0 GHz | 12.0 to 18.0 GHz |
| Noise Figure, Terminal | 8.5 dB | 10.0 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +3.0 dBm | −5 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |

* This Technical Data Sheet presents up-to-date information on the WJ-307, first described in Technical Bulletin Vol. 6, No. 9; September, 1964.

# WJ-307

## ENVIRONMENTAL CHARACTERISTICS[2]

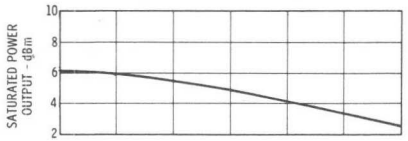
Temperature (Operating) . . −54°C to +71°C
Vibration
0.10 Inch Double Amplitude . . 5 to 30 Hz
5 g, Single Amplitude . . . 30 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

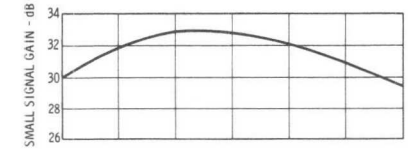
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 18 pounds (8.16 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . DM9601-3P
RF Connections Waveguide Flange UG-541/U
Reference Drawing Number . . . . 290027

1. Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.
2. These environmental charateristics meet or exceed the respective requirements of MIL-E-5400: Temperature, Class 2; Vibration, Curve III.

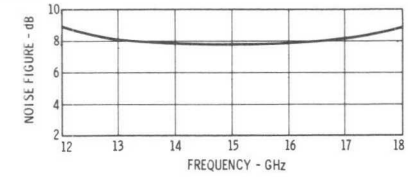
## POWER



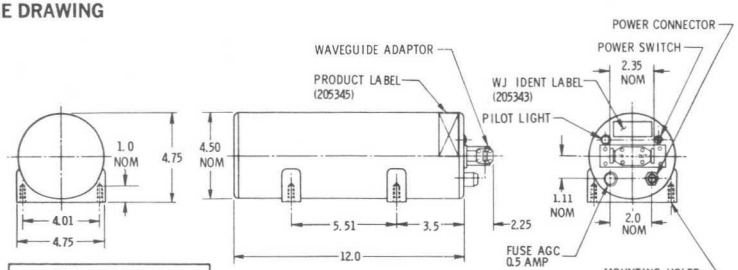

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS | |
|---|---|
| BENDIX: PT-07C-8-3P (PLUG) PT-07C-8-3S (SOCKET) | |
| PIN | CONNECTIONS |
| A | 117 VAC |
| B | GROUND |
| C | 117 VAC |

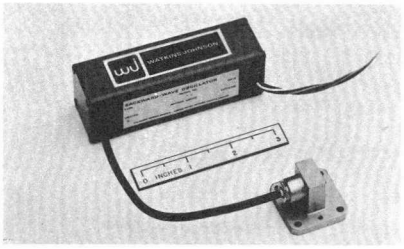
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-308

August 1965



The type SE-308 is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and r. f. connector for easier packaging.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 14.0-17.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 15-30 | 10 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.9 | 1.5 Max |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.5 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (14 GHz) | MHz/V | 10.5 | |
| Mid-Frequency (15.5 GHz) | MHz/V | 8.0 | |
| High End (17 GHz) | MHz/V | 6.0 | |
| Grid r.f. Cutoff Voltage | V | -10 | -20 Max |
| Capacitance; Cathode to all Other Electrodes including Heater | pf | 15 | 20 Max |
| Capacitance; Grid to all Other Electrodes at Power Input Connector | pf | 18 | 25 Max |
| Capacitance; Helix and Collector to all Other Electrodes and Case | pf | 80 | 110 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | .75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 7 | 12 Max |
| Helix Voltage Range | V | 405-760 | 375-800 Min/Max |
| Anode Voltage* | V | 150 | 200 Max |
| Anode Current | mA | 0.5 | 2 Max |

*Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 1 lb Max
Color Code for 18" Flying Leads

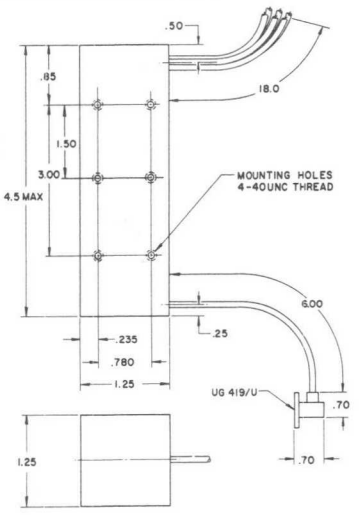
| | |
|---|---|
| Heater | Brown |
| Heater-Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any
RF Output Connector, UG-419/U
Waveguide Flange

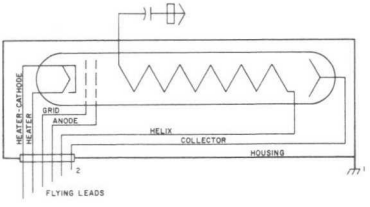
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING



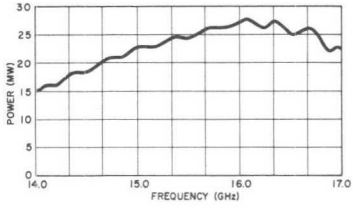

## SCHEMATIC DIAGRAM



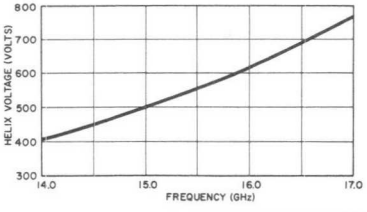

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



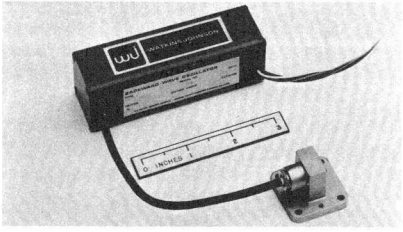
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-308A

TECHNICAL DATA • August 1965



The type SE-308A is a single-helix, voltage tunable oscillator utilizing a permanent-magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The size and weight of this package are comparable to electrostatically-focused BWOs in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency vs. voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with the anode circuit. All voltages are isolated from the housing and r. f. connector for easier packaging.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 14.0-17.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 15-30 | 10 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.9 | 1.5 Max |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.5 Max |
| Tuning Curve Slope | | | |
| Low End (14 GHz) | MHz/V | 10.5 | |
| Mid-Frequency (15.5 GHz) | MHz/V | 8.0 | |
| High End (17 GHz) | MHz/V | 6.0 | |
| Capacitance; Cathode to all Other Electrodes inc. Heater | pf | 15 | 20 Max |
| Capacitance; Helix and Collector to all Other Electrodes and Case | pf | 80 | 110 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | .75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 7 | 12 Max |
| Helix Voltage Range | V | 405-760 | 375-800 Min/Max |
| Anode Voltage* | V | 150 | 200 Max |
| Anode Current | mA | 0.5 | 2 Max |

*Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 1 lb Max
Color Code for 18" Flying Leads

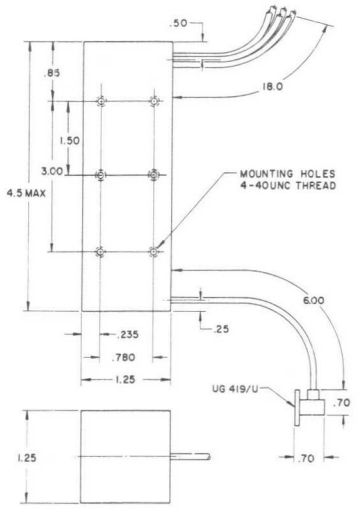
| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any
RF Output Connector, UG-419/U
Waveguide Flange

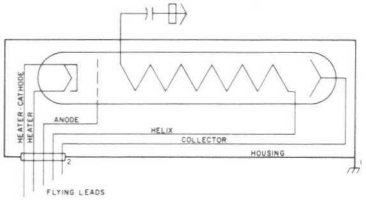
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
Designed to Meet or Exceed MIL-E-5400, Class II Environment
No Forced Air Cooling Required

## OUTLINE DRAWING



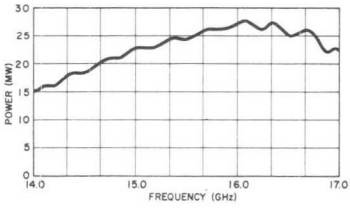

## SCHEMATIC DIAGRAM



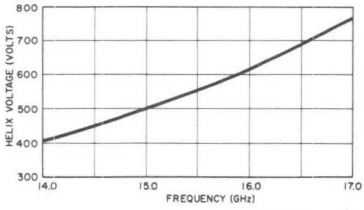

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



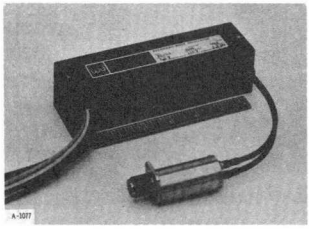
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# SE-310

September 1967



The SE310 is a bifilar (dual) helix, voltage tunable oscillator utilizing a permanent magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The SE-310 is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in signal generators. Fine grain variation of frequency versus voltage is extremely low. The SE-310 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2.0 - 4.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 60 - 330 | 50 Min |
| Power Output Variation | dB | | 9 Max |
| Fine Grain Variation | dB/250 MHz | | 4 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 4 | 6 |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage at 3 GHz | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 6 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 4.5 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 2.5 | |
| High End (4.0 GHz) | MHz/V | 1 | |
| Grid r.f. Cutoff Voltage | V | -8 | -20 Max |
| Capacitance: Cathode to all other Electrodes and Housing | pF | 20 | 30 Max |
| Capacitance: Grid to all other Electrodes and Housing | pF | 16 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 230 | 260 Max |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | .75 | 0.4 -1.2 Min/Max |
| Cathode Current* | mA | 12.5 | 15 Max |
| Helix Voltage Range | V | 290-1320 | 275-1400 Min/Max |
| Anode Voltage | V | 130 | 215 Max |
| Anode Current | mA | 0.1 | 2 Max |
| Helix Current | mA | 1.8 | 3 Max |

* Set Cathode current to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 3-1/2 lbs Max
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

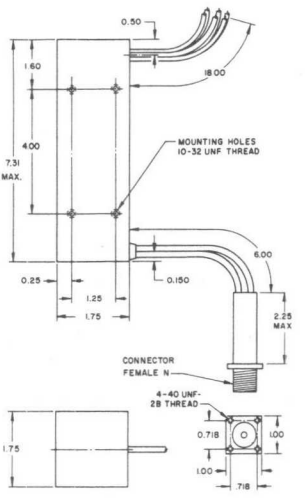
Mounting Position, any
RF Output Connector, Type N Female

## ENVIRONMENTAL DATA

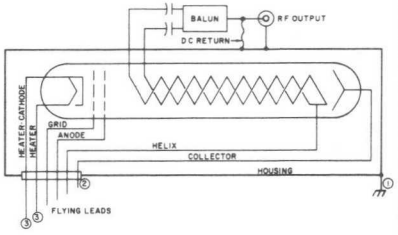
Separation from Passive Magnetic Materials, 4 in. Min

Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

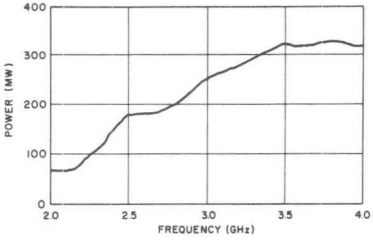



① For safety, housing should be grounded through mounting screws.

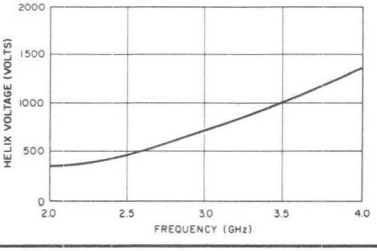
② 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must never be positive with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



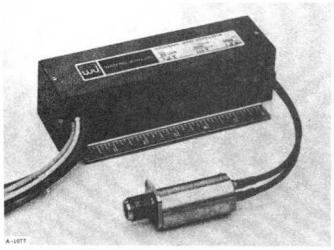
# TECHNICAL DATA

WATKINS-JOHNSON

# SE-310-3

## BACKWARD-WAVE OSCILLATOR

September 1967



The SE-310-3 is a bifilar (dual) helix, voltage tunable oscillator utilizing a permanent magnet focusing system. The miniature square package features rugged construction and capability to withstand severe environmental conditions defined in MIL-E-5400, Class 2. The SE-310-3 is ideal for space, airborne and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, and as a signal source in signal generators. Fine grain variation of frequency versus voltage is extremely low. The SE-310-3 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2.6-5.2 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 65-230 | 50 Min |
| Power Output Variation | dB | | 8 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 3 | 6 |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage at 6 GHz | MHz/V | 3.0 | -- |
| Sensitivity to Anode Voltage | MHz/V | 0.8 | -- |
| Sensitivity to Grid Voltage | MHz/V | 8 | -- |
| Tuning Curve Slope | | | |
| Low End (2.6 GHz) | MHz/V | 4.2 | -- |
| Mid-Frequency (3.9 GHz) | MHz/V | 2 | -- |
| High End (5.2 GHz) | MHz/V | 1 | -- |
| Grid r.f. Cutoff Voltage | V | -5 | -20 Max |
| Capacitance: Cathode to all other Electrodes and Housing | pF | 20 | 30 Max |
| Capacitance: Grid to all other Electrodes and Housing | pF | 20 | 30 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 230 | 260 Max |
| Heater Voltage | Vdc | -- | 6.3±5% |
| Heater Current | A | .75 | 0.4-1.2 Min/Max |
| Cathode Current* | mA | 10 | 15 Max |
| Helix Voltage Range | V | 365-1830 | 345-1920 Min/Max |
| Helix Current | mA | 1.3 | 3 Max |
| Anode Voltage | V | 110 | 215 Max |
| Anode Current | mA | 0.1 | 2 Max |

* Set Cathode current to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 3-1/2 lbs Max
Color Code for 18" Flying Leads

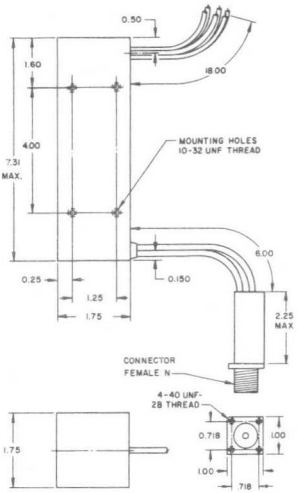
| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any
RF Output Connector, Type N Female

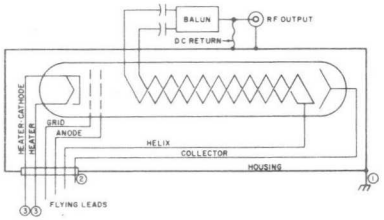
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 4 in. Min
Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

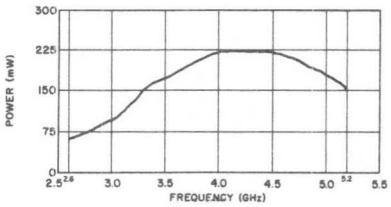



① For safety, housing should be grounded through mounting screws.

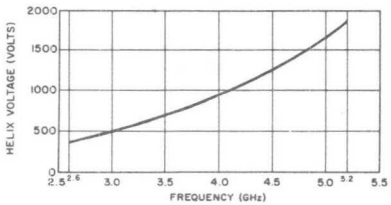
② 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

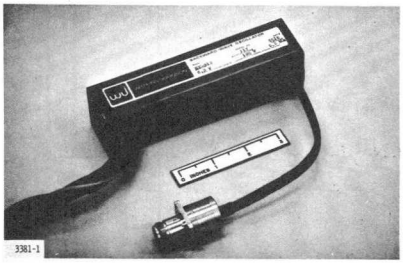
WATKINS-JOHNSON

# SE-313

## BACKWARD-WAVE OSCILLATOR

November 1968*

The type SE-313 BWO is a bifilar (dual helix) voltage tunable oscillator utilizing permanent-magnet focusing. The miniature square package features rugged construction and capability to withstand severe environmental conditions. The size and weight of this package are comparable to electrostatically-focused BWO's in this band, but with superior performance, reliability, and reduced power supply requirements. Thus, it is ideal for space, airborne, and shipboard applications as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators, etc. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. Helix and collector should be grounded to the housing for high altitude operation.




## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 8.0-12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60-150 | 50 Min |
| Power Output Variation | db | | 6 Max |
| Fine Grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.6 | 2.0 Max |
| Ratio of Signal to 2nd Harmonic Output | db | 30 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | 1.0 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 7.2 | |
| Mid-Frequency (10.0 GHz) | MHz/V | 4.6 | |
| High End (12.4 GHz) | MHz/V | 2.7 | |
| Grid r.f. Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode and Grid to all Other Electrodes and Case | pf | 40 | 50 Max |
| Capacitance; Helix and Collector to all Other Electrodes and Case | pf | 150 | 175 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 450-1495 | 425-1600 Min/Max |
| Anode Voltage[1] | V | 150 | 250 Max |
| Anode Current | mA | 0.1 | 2 Max |

[1] Set Anode Voltage to Final Test Data value furnished with tube.

* Supersedes SE-313 Technical Data Sheet dated August 1965.

## MECHANICAL DATA

Weight, 1-1/2 lbs Max
Color Code for 18" Flying Leads

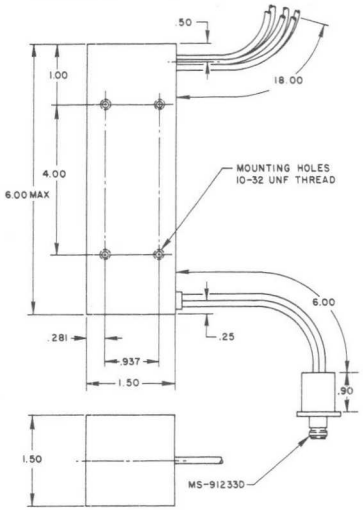
| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any
RF Output Connector, Type N Female

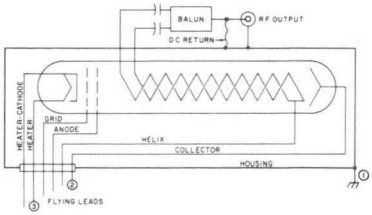
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



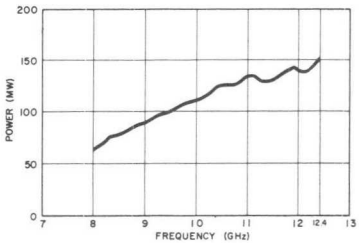

Notes:

(1) For safety, housing should be grounded through mounting screws.

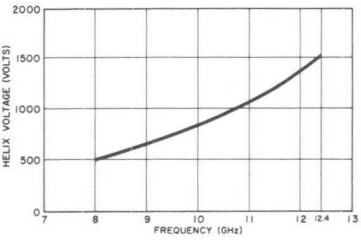
(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



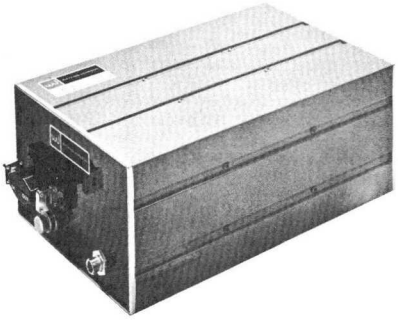
# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970*

## 26.5 TO 40.0 GHz
## LOW-NOISE TRAVELING-WAVE AMPLIFIER
## WITH INTEGRAL POWER SUPPLY
## WJ-338

- "JUST PLUG IT IN"
- NOISE FIGURE: 14.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED



The WJ-338 is the first of a new family of standard low-noise TWA's developed by Watkins-Johnson Company for use in $K_a$-band. Users can expect long life and trouble-free performance from this amplifier, which exhibits the same conservative design and rigid manufacturing process control as other members of the standard series. Permanent-magnet focusing allows side-by-side operation in stacked arrays or next to ferromagnetic material without adverse effect. The integral power supply, which requires only an ac line-voltage input, makes the amplifier a completely self-contained unit.

The WJ-338 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of over 2 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of 0°C to 50°C.

Other members of the WJ-338 family are also available with higher gain and/or noise figure over a narrow frequency band.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 26.5 to 40.0 GHz |
| Noise Figure, Terminal[1] | 13.5 dB | 14.5 dB, max. |
| Gain, Small Signal | 28 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2.5:1, max. |
| Power Output | 10 dBm | 5 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[2] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | 30 W, max. |

[1]Noise figure is as read on a standard HP 340B Meter utilizing a standard AIL 07096 noise source.
[2]Every tube will meet the guaranteed performance specifications for any voltage lying within these ranges.
*Supersedes WJ-338 Technical Data Sheet dated January 1969.

# WJ-338

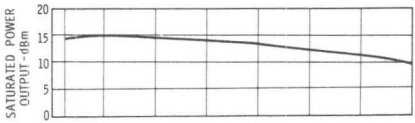
## ENVIRONMENTAL CHARACTERISTICS

Temperature Operating . . . . . 0 to 50°C
Vibration
a. 0.01 Inch, Double Amplitude . . . 5 to 63 Hz
b. 2 g, Single Amplitude . . . . . 63 to 500 Hz

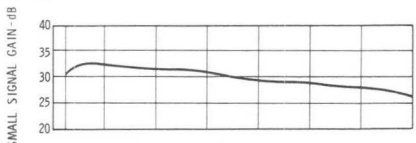
## MECHANICAL CHARACTERISTICS

Height . . . . . 5.08 inches (129 mm) max.
Width . . . . . 7.45 inches (189 mm) max.
Length (excluding connectors) . . . . 12.18 inches (309 mm) max.
Weight . . . . . 27 pounds (12.2 Kg) max.
Primary Power Connection, Bendix Receptacle . . . . . PT07C-8-3P
RF Connectors (WR-42 Waveguide) . . . . . UG 599/U flange

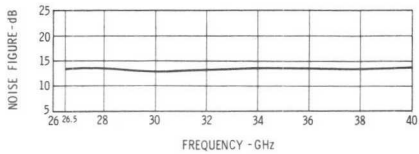
## POWER



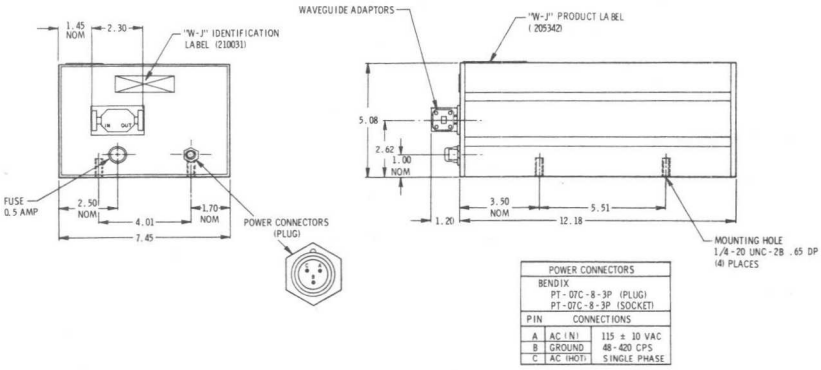

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX PT-07C-8-3P (PLUG) PT-07C-8-3P (SOCKET) | | |
| PIN | CONNECTIONS | |
| A | AC (IN) | 115 ± 10 VAC |
| B | GROUND | 48-420 CPS |
| C | AC (HOT) | SINGLE PHASE |

# TECHNICAL DATA

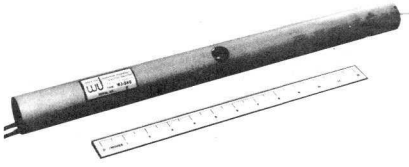
WATKINS-JOHNSON

September 1968 *

## 1.0 TO 2.0 GHz GRIDDED 1-KILOWATT TRAVELING-WAVE TUBE WJ-340

The WJ-340 is a high-power, octave-bandwidth traveling-wave-tube designed for operation in L-band. Of rugged, lightweight construction, the WJ-340 uses a brazed helix structure supported on beryllia wedges, with a metal-ceramic envelope. The gridded, solid beam electron gun operates at a perveance of 5 x $10^{-6}$. A high-mu grid permits beam modulation with a 275-volt pulse, with pulse durations down to less than 100 ns. Beam focusing is accomplished by means of a solenoid having a 15-inch field of 520 oersteds. The TWT and solenoid may be air-cooled as an integral unit, or the solenoid may be separately water-cooled.

Tube performance can be altered somewhat by variation of the voltages and currents. Although the basic WJ-340 is designed for operation at a duty cycle of 0.01, factory modified versions with higher duty cycle capability are available on special order. These special tubes have slightly modified collectors which may, or may not, require water cooling, depending on the specific duty cycle.



## SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0 to 2.0 GHz | 1.0 to 2.0 GHz |
| Power output (pulsed) | 1.2 kW | 1.0 kW, min. |
| Gain at saturation | 33 dB | 30 dB, min. |
| Load VSWR | 2:1 | 2:1, max. |
| Duty Cycle | 0.01 | 0.01, max. |

| ELECTRICAL REQUIREMENTS | | |
|---|---|---|
| Cathode voltage | 5.0 kV | 4.7 to 5.2 kV |
| Beam current | 1.8 amps | 1.7 to 2.0 amps |
| Heater voltage | 7.5 volts | 7.0 to 8.0 volts |
| Heater current | 2.2 amps | 2.0 to 2.4 amps |
| Grid pulse voltage | 275 volts | 250 to 300 volts |
| Grid bias voltage | —200 volts | —200 volts (fixed) |
| Grid current | 0.5 amps | 0.4 to 0.6 amps |
| Grid capacitance | 50 pF | 40 to 60 pF |
| Circuit voltage, anode and collector | Ground | Ground |
| Pulse duration | 5 $\mu$sec | 0.1 to 10 $\mu$sec |
| Magnetic field | 525 gauss | 600 gauss max. |
| Solenoid voltage | 60 volts | 55 to 65 volts |
| Solenoid current | 8.0 amps | 7.5 to 8.5 amps |

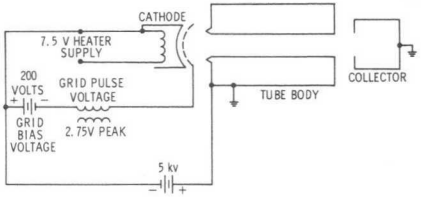
*Supersedes WJ-340 Technical Bulletin, Volume 8, No. 1; January 1966

# WJ-340

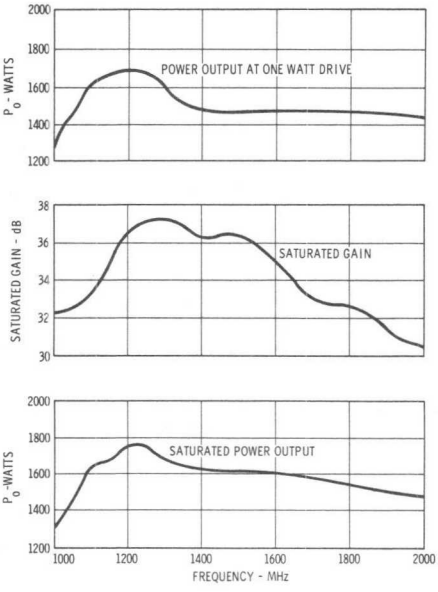
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Diameter | 1.5 inches (38 mm) |
| Length | 18.25 inches (464 mm) |
| Weight | 3 lbs. (1.36 Kg) |
| RF Connections | TNC, female |
| DC Connections | Flying Leads |
| Cooling | Forced Air |
| Solenoid Length | 15 inches |
| Solenoid Diameter | 4.5 inches |
| Solenoid Weight | 15 lbs. |

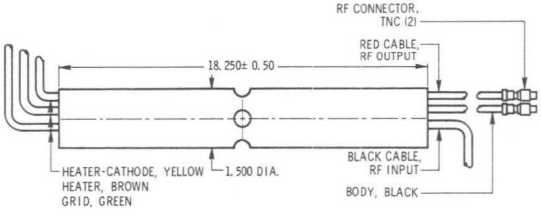
## BLOCK DIAGRAM OF TYPICAL POWER SUPPLY FOR WJ-340




## TYPICAL POWER OUTPUT AND GAIN CURVES




## OUTLINE DRAWING OF WJ-340, EXCLUDING SOLENOID



# TECHNICAL DATA

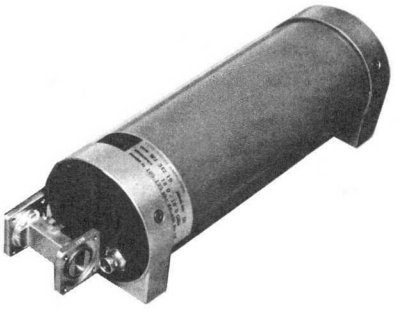
WATKINS-JOHNSON

February 1967

## 12.0 TO 18.0 GHz COMPACT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

# WJ-342

- "JUST PLUG IT IN"
- NOISE FIGURE 12 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS NEEDED
- 115 VOLT, 48 TO 420 Hz OPERATION
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



The WJ-342, a compact and wide dynamic range Ku-band amplifier, is the latest addition to the Watkins-Johnson family of PM-focused integral power supply traveling-wave amplifiers.

This compact amplifier has a typical noise figure of 10 dB and saturated power output of +10 dBm. Weighing less than 6.5 pounds, the WJ-342 measures less than 12 inches long, including waveguide adaptors. Typical power drain from a 115-volt ac source is 20 watts. The WJ-342 offers a guaranteed noise figure of 12 dB over the 12.0 to 18.0 GHz band at 25 dB minimum gain with +7.0 dBm minimum output power.

Reliable operation is achieved in any orientation. The environmental characteristics of the WJ-342 meet the requirements of MIL-E-5400 Specification. Like other members of its family, the WJ-342 is conservatively designed for long-life and trouble-free performance. Various versions of the standard model are available offering improved narrow-band performance, wider frequency coverage, and lower power drain.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 12.0–18.0 GHz | 12.0–18.0 GHz |
| Noise Figure, Terminal | 9.5 dB | 12.0 dB, max. |
| Gain, Small Signal | 28 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +10 dBm | +7 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range [1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-342

## ENVIRONMENTAL CHARACTERISTICS[2]

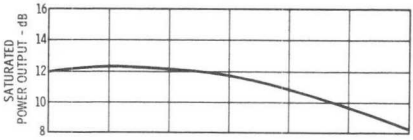
Temperature (Operating) . . −54°C to +71°C
Vibration
a) 0.10 Inch, Double Amplitude . . 5 to 30 Hz
b) 5 g, Single Amplitude . . . 30 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

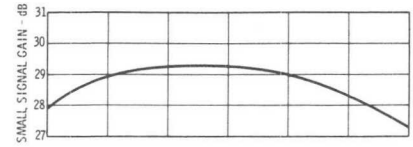
Height . . . . . 3.4 inches (86 mm) max.
Width . . . . . 3.4 inches (86 mm) max.
Length (excluding connectors) . . . . . 9.5 inches (241 mm) max.
Weight . . . . . 6.5 pounds (2.95 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . DM9601-3P
RF Connections (Waveguide) . . UG-541/U Choke Flange
Reference Drawing Number . . . . 290034

1. Every tube will meet the guaranteed performance specifications within these ranges.
2. These environmental characteistics meet or exceed the respective requirements of MIL-E-5400 temperature Class 2, Vibration Curve III.

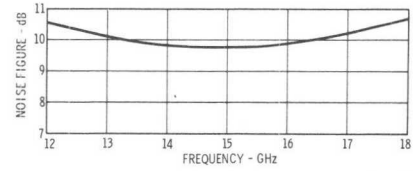
## POWER



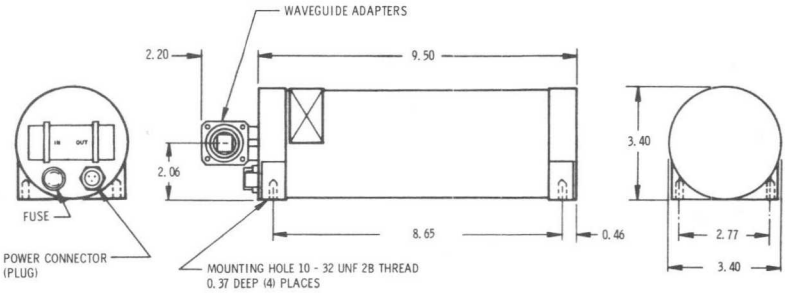

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

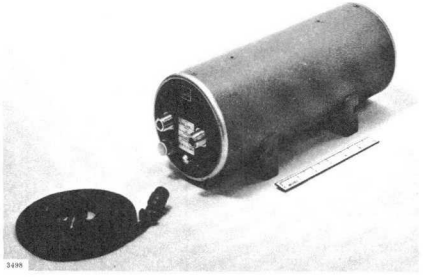
WATKINS-JOHNSON

# WJ-343

August 1968*

## 2.0 to 8.0 GHz LOW-NOISE, TRAVELING-WAVE TUBE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 7.5 dB
- S-C BANDS RANGE
- ADJUSTMENT-FREE OPERATION
- PERMANENT MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



The WJ-343 is one of a series of ultra-wide band LNTWAs developed by Watkins-Johnson Company for use in sensitive, ultra-wide-bandwidth receiver equipments. It offers economy of space, weight and price over two single-octave amplifiers covering the same frequency range. It features the same long-life design, rugged construction and adjustment-free operation characteristics of Watkins-Johnson's line of octave-band, low-noise amplifiers.

The WJ-343 may be mounted in any orientation and is built to withstand the shock, vibration, and temperature specifications of MIL-E-5400, Class 2. Magnetic shielding allows operation next to similar units, or to ferromagnetic material, without degredation of performance.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 - 8.0 GHz | 2.0 - 8.0 GHz |
| Noise figure, terminal | 6.0 dB | 7.5 dB max. |
| Gain, small signal | 28 dB | 25 dB |
| Gain variation, small signal | ±3 dB | |
| VSWR, input and output | 1.5:1 | 2.5:1 max. |
| Power output | +5 dBm | 0 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 V ac | 115 ±10 V ac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 25 watts | |

* Supersedes WJ-343 Technical Data Sheet dated November 1967

# WJ-343

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature . . . . . —54° to +71°C
Vibration
a. 0.10 inch, double amplitude . . . . 5 to 45 Hz
b. 5 g, single amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

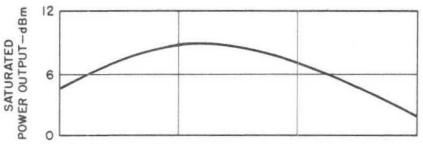
## MECHANICAL CHARACTERISTICS

Amplifier length
(excluding connectors) . . . . . 12 inches, max.
Amplifier height and width . . . . 4.75 inches, max.
Weight . . . . . 18 lbs., max.
Primary power connection,
Bendix receptacle . . . . . PT07C-8-3P
RF connections
(50 ohms nominal) . . . . . Type N, jack

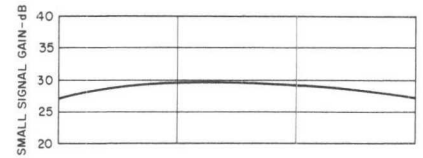
[1]Meets guaranteed performance specifications for any voltage within these ranges.

[2]Environmental characteristics meet or exceed respective requirements for MIL-E-5400, Class 2.

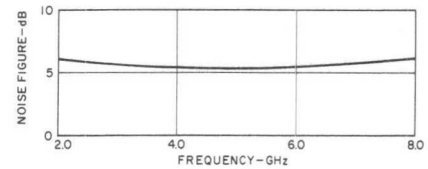
POWER



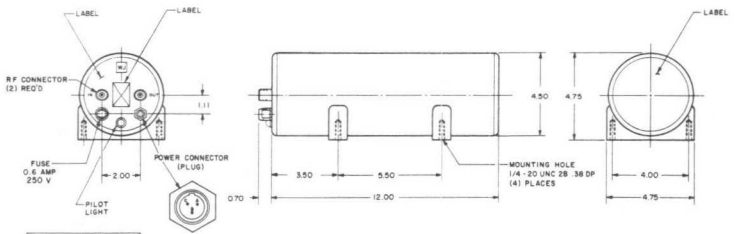

GAIN




NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX PTO7C-8-3P (PLUG) MS3116E-8-35(SR)(SOC) | | |
| PIN | CONNECTION | |
| C | AC LINE (HOT) | 105-125 VAC |
| B | GROUND | 48-420 CPS |
| A | AC LINE | SINGLE PHASE |

# TECHNICAL DATA

WATKINS-JOHNSON

## 8 TO 12 GHz, ULTRA LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

**WJ-345,-7,-11**

- **"JUST PLUG IT IN"**
- **NOISE FIGURE 7.0 dB MAXIMUM OVER FULL FREQUENCY BAND**
- **NOISE FIGURE 5.5 dB MAXIMUM OVER SELECTED FREQUENCY RANGES**
- **PROVEN RELIABILITY**
- **MEETS TEMPERATURE, VIBRATION AND SHOCK REQUIREMENTS OF MIL-E-5400, CLASS 2**

WJ-345 is the 8 to 12 GHz member of a family of PM-focused amplifiers providing ultra-low-noise capability in a completely self-contained, adjustment-free package. Its only requirement is a 115 volt AC line voltage input (48 to 420 Hz). Other versions of this amplifier provide guaranteed noise figures ranging from 5.5 dB to 7.0 dB depending on the specified bandwidth. Helix gain control, anode blanking and other special applications can be provided on all models.

All versions of this amplifier family may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. The environmental characteristics of the WJ-345 family meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency: | | |
| WJ-345 | 8 to 12 GHz | 8 to 12 GHz |
| WJ-345-7 | 8.5 to 9.3 GHz | 8.5 to 9.3 GHz |
| WJ-345-11 | 8.5 to 9.6 GHz | 8.5 to 9.6 GHz |
| Noise Figure, Terminal: | | |
| WJ-345 | 6.0 dB | 7.0 dB |
| WJ-345-7 | 5.0 dB | 6.0 dB |
| WJ-345-11 | 5.0 dB | 6.0 dB |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output: | | |
| WJ-345 | 0 dBm | −5 dBm |
| WJ-345-7 | 0 dBm | −3 dBm |
| WJ-345-11 | −3 dBm | −5 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 10 W | |

*Supersedes WJ-345, -7, -11 Technical Data Sheet dated September 1968.

# WJ-345,-7,-11

## ENVIRONMENTAL CHARACTERISTICS

Temperature . . . . . −55°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude . . . 5 to 30 Hz
b. 5 g, Single Amplitude . . . . . 30 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

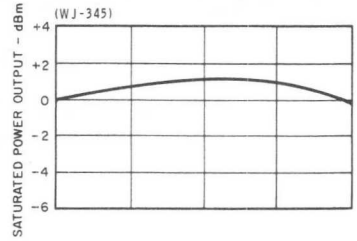
Amplifier Length
(excluding connectors) . . . . . 12 inches, max.
Amplifier Height and Width . . . . 4.75 inches, max.
Amplifier Weight . . . . . 18 lbs., max.
Primary Power Connection,
Bendix Plug PT 07C-8-3P
Bendix Socket PT 07C-8-3S
Reference Drawing Number . . . . . 290121

NOTES:

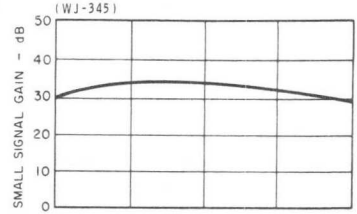
Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.

These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

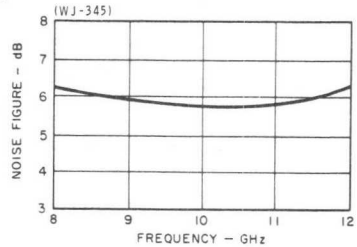
**POWER**



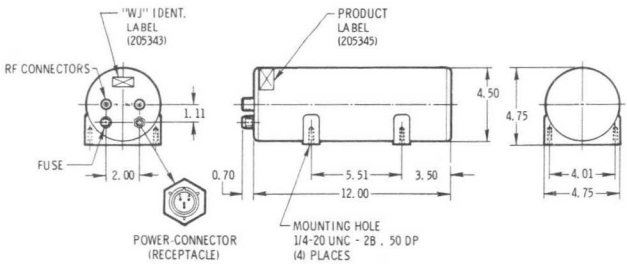

**GAIN**




**NOISE**




## OUTLINE DRAWING




| RF CONNECTORS | |
|---|---|
| INPUT: | TYPE N - JACK |
| OUTPUT: | TYPE N - JACK |

| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT 07C-8-3P (RECP) MS 3116 E-8-3S (SR) (PLUG | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 105 - 125 VAC |
| B | GROUND | 48 - 420 Hz |
| A | AC | SINGLE PHASE |

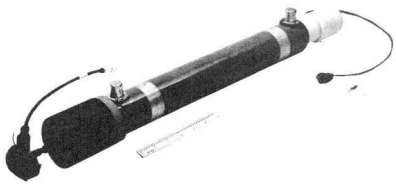
# TECHNICAL DATA

WATKINS-JOHNSON

September 1967

## GRIDDED HIGH-GAIN C-BAND TRAVELING-WAVE AMPLIFIER

## WJ-346



The WJ-346 is a high-power, high-gain, C-band traveling-wave amplifier designed for pulsed operation. It produces 20 kW power with a minimum of 50 dB gain, and employs a high-mu grid which permits modulation of the beam by means of a 550-volt pulse.

The slow-wave circuit is of coupled-cavity design, which includes all metal-ceramic construction. A temperature-compensating jacket is employed over the ferrite PPM magnetic stack to eliminate any appreciable change in characteristics over a wide range of operating temperatures. Minimization of peak cathode loading ($2A/cm^2$), by means of a high-convergence gridded gun, extends the life of the tube. In addition, the integral focusing system requires no alignment and leakage fields are negligible.

The WJ-346 employs a forced air-cooled collector which may be run at ground potential or insulated for collector current measurement. The tube is also equipped with an ion pump which prolongs tube life during long-term storage and aids in lengthening overall tube life.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 5.35-5.75 GHz | 5.4-5.7 GHz |
| Power output (peak) | | |
| Average of four points[1] | 22 kW | 20 kW |
| Lowest point in band | — | 16 kW |
| Gain | | |
| Average of six points[1] | 57 dB | 50 dB |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Cathode voltage | 26.0 kV | 26.0 ±1.0 kV |
| Collector current | | |
| Without drive | 5.0 A peak | 5.5 A peak min. |
| With drive | 4.4 A peak | 4.0 A peak min. |
| Body current | | |
| Without drive | 1.0 A peak | 1.4 A peak max. |
| With drive | 1.6 A peak | 2.0 A peak max. |
| Duty cycle | 0.003 | .005 max. |
| Pulse duration | 8 μsec | 5 μsec max. |
| Grid pulse voltage | 500 V peak | 400 to 600 V |
| Grid bias voltage | −200 V | −200 ±5 V |
| Grid current | 0.8 A peak | 1.2 A max. |
| Grid capacitance (to all else) | 35 pF | 45 pF max. |
| Circuit and anode voltage | Ground | Ground |
| Heater voltage | 12 V 60 Hz ac | 12.5 V max. |
| Heater current | 2.3 A | 2.5 A max. |
| Ion pump voltage | +3.0 kV to collector | 3.0 ±0.15 kV |
| Ion pump current, operating | 1.0 μA | 20 μA max. |

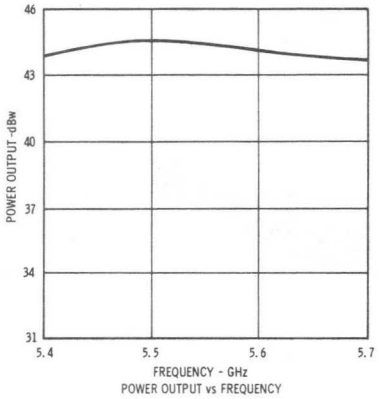
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Weight (including ion-pump) | 18.5 lbs. (8.39 Kg) |
| RF connectors[2] | Modified 50-ohm coax |
| Coolant | |
| Forced air | 75 CFM |

[1]At equal increments of 100 MHz
[2]Coaxial to either "C" band waveguide or type N coax adaptors can be provided if desired

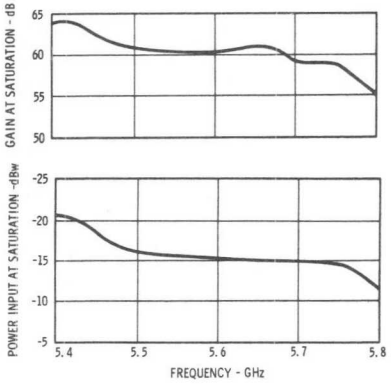
## WJ-346

### POWER OUTPUT VS. FREQUENCY

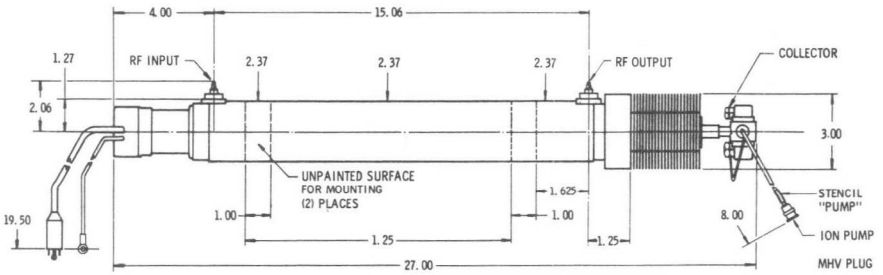



POWER OUTPUT vs FREQUENCY

### TYPICAL PERFORMANCE CHARACTERISTICS

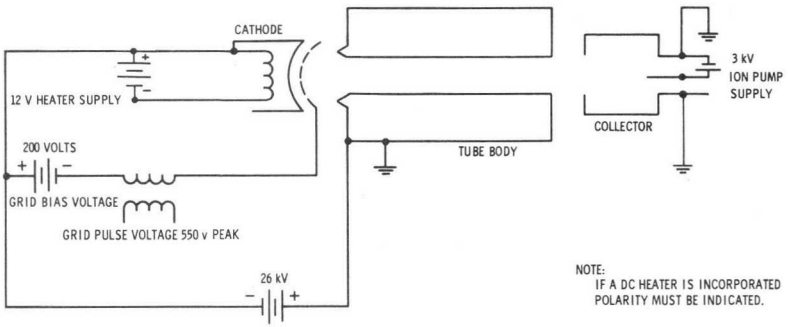



### OUTLINE DRAWING



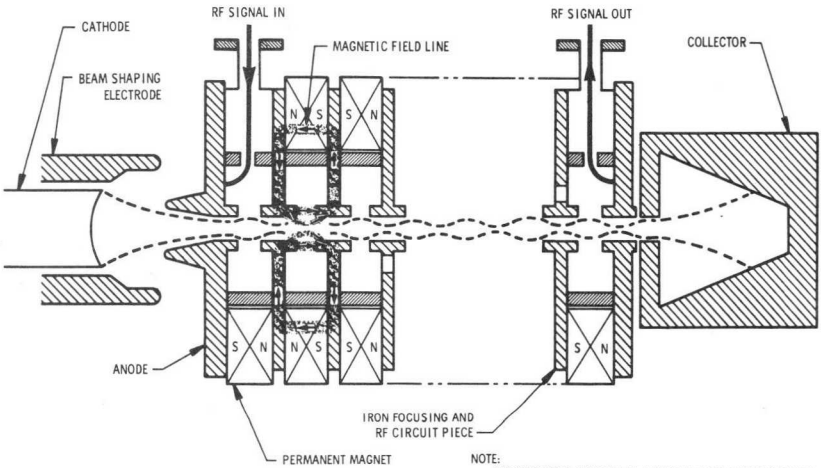
# WJ-346

## CONNECTION DIAGRAM




NOTE:
IF A DC HEATER IS INCORPORATED POLARITY MUST BE INDICATED.

## RF AND MAGNETIC CIRCUIT




NOTE:
THE MAGNETIC CIRCUIT IS INTEGRAL WITH THE RF CIRCUIT. IT CAN BE SEEN THAT A SECTION OF THE CAVITY WALL ALSO SERVES AS A FLUX GUIDE FOR THE MAGNETIC FOCUSING CIRCUIT.

# TECHNICAL DATA

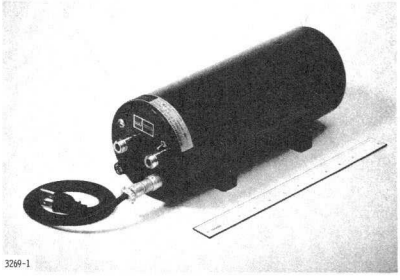
WATKINS-JOHNSON

# WJ-355

July 1968 *

## 2.2 TO 2.3 GHz LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 3.7 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED
- MEETS MIL-E-5400, CLASS 2 ENVIRONMENT



3269-1

Designed especially for space communication and telemetry applications, the WJ-355 exhibits one of the lowest noise figures of any traveling-wave amplifier currently available in a completely packaged unit. Although guaranteed not to exceed 3.7 dB, the WJ-355 typically exhibits less than 3.4 dB noise figure across the 2.2 to 2.3 GHz spectrum for which it is designed to operate. This amplifier, like most Watkins-Johnson low-noise amplifiers, comes in a single package complete with its own integral 115 volt ac power supply, which operates equally well from commercial 60 Hz power or from 400 Hz power characteristically available in aircraft.

This is a ready-to-operate amplifier. No adjustments are required upon receipt, nor are readjustments required during the amplifier's long life.

Other low-noise units, similar to the WJ-355, are attaining MTBF's in excess of 20,000 hours with a 99 percent confidence level. This long life, which gives the WJ-355 an extremely low cost per operating hour, is a result of the advanced design and careful processing techniques for which the Watkins-Johnson Company is noted.

The amplifier may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-355 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.2 to 2.3 GHz | 2.2 to 2.3 GHz |
| Noise Figure, Terminal | 3.4 dB | 3.7 dB max. |
| Gain, Small Signal | 30 dB | 25 dB min. |
| VSWR, Input and Output | 1.5:1 | 2:1 max. |
| Power Output | −3.0 dBm | −5.0 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Current | 170 mA | |
| Primary Power | 14 watts | |

*Supersedes WJ-355 Technical Bulletin, Volume 8, No. 4; January, 1966

# WJ-355

## ENVIRONMENTAL CHARACTERISTICS

Temperature ..... −54°C to +71°C
Vibration
a. .10 inch, double amplitude.....5 to 45 Hz
b. 10 g, single amplitude..... 45 to 500 Hz
Shock ..... 15 g, 11 ms

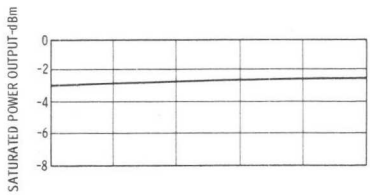
## MECHANICAL CHARACTERISTICS

Amplifier Length
(excluding connectors) ..... 12 inches, max.
Amplifier Height and Width....4.75 inches, max.
Weight ..... 17 pounds
Primary Power Connection,
Deutsch Receptacle ..... DM9601-3P
RF Connectors
(50 ohms, nominal) ..... Type N jack
Reference Drawing Number .....290000

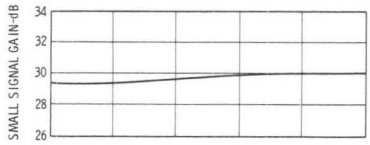
Every amplifier will meet the guaranteed performance specifications for any voltage lying within these ranges.

These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

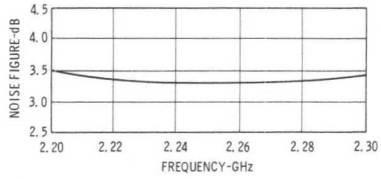
## POWER



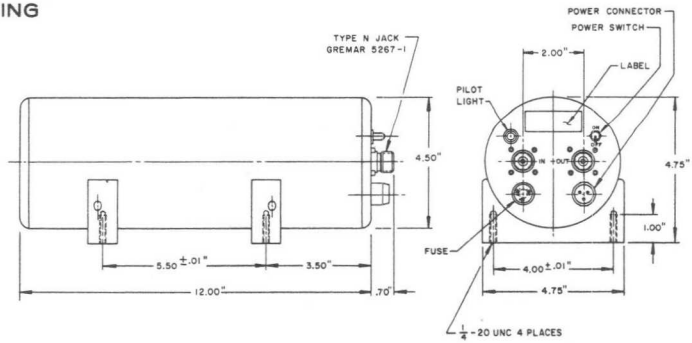

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS | |
|---|---|
| DEUTSCH DM9601-3P | |
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

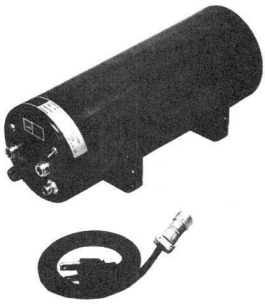
WATKINS-JOHNSON

# WJ-363

March 1967

## 8 TO 12 GHz, 20 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 8.0 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



The WJ-363 is one of the original members of Watkins-Johnson's family of PM-focused integral power supply amplifiers. Like its lower-power predecessors, the WJ-363 is completely self-contained, adjustment-free, and requires only a 115-volt ac line-voltage input (48 to 420 Hz).

This proven amplifier, with a typical noise figure of 7 dB, may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic material without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54°$ to $+71°C$. The environmental characteristics of the WJ-363 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 8 to 12 GHz | 8 to 12 GHz |
| Noise Figure, Terminal | 7 dB | 8 dB, max. |
| Gain, Small Signal | 35 dB | 30 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | 16 dBm | 13 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-363

## ENVIRONMENTAL CHARACTERISTICS [2]

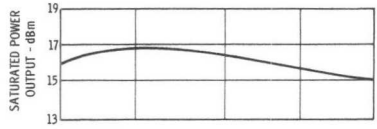
Temperature . . . . . −55°C to +71°C
Vibration
a) 0.10 Inch, Double Amplitude . 5 to 30 Hz
b) 5 g, Single Amplitude . . . 30 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

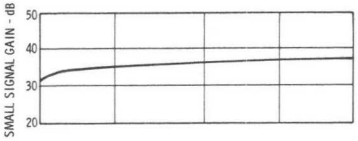
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 18 pounds (8.16 Kg) max.
Primary Power Connection,
Bendix Plug PT 07C-8-3P
Bendix Socket PT 07C-8-3S
Reference Drawing Number . . . . 290121

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

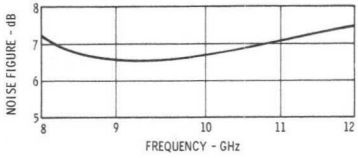
## POWER



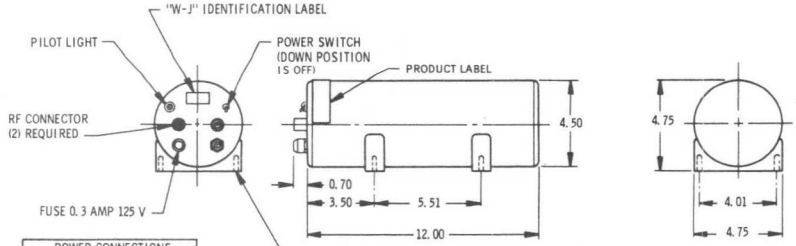

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS | |
|---|---|
| DEUTSCH DM9601 - 3P | |
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-363-3

March 1967

## 8 TO 10 GHz, 20 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 7 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

With the addition of the WJ-363-3 to its family of PM-focused integral power supply amplifiers, Watkins-Johnson Company increases the dynamic range of its X-Band low-noise amplifiers. Like its lower-power predecessors, the WJ-363-3 is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz).

This amplifier, with a typical noise-figure of 6 dB, may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54°$ to $+71°C$. The environmental characteristics of the WJ-363-3 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 8 to 10 GHz | 8 to 10 GHz |
| Noise Figure, Terminal | 6 dB | 7 dB, max. |
| Gain, Small Signal | 35 dB | 30 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | 16 dBm | 13 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ± 10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-363-3

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature . . . . . −54°C to +71°C
Vibration
a) 0.10 Inch, Double Amplitude . 5 to 30 Hz
b) 5 g, Single Amplitude . . . 30 to 500 Hz
Shock . . . . . 15 g, 11 ms

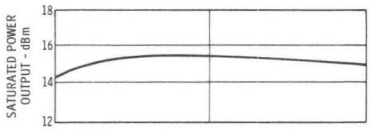
## MECHANICAL CHARACTERISTICS

Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 18 pounds (8.16 Kg) max.
Primary Power Connection,
Bendix Plug PT 07C-8-3P
Bendix Socket PT 07C-8-3S

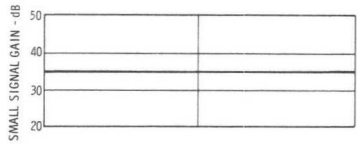
Reference Drawing Number . . . . 290121

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

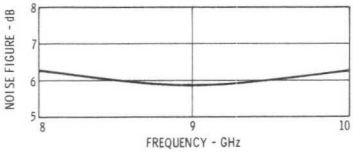
## POWER



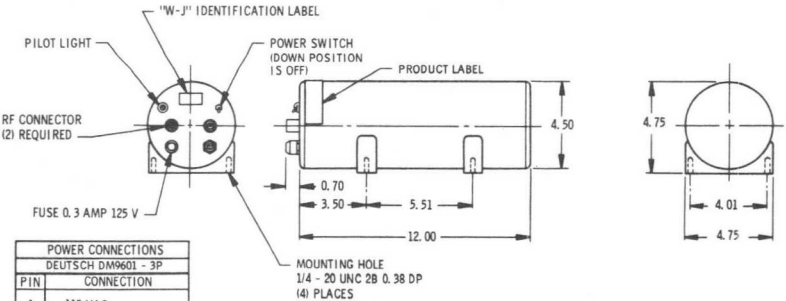

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS DEUTSCH DM9601 - 3P | |
|---|---|
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-363-4

April 1967

## 10 TO 12 GHz, 20 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 7.5 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION

With the addition of the WJ-363-4 to its family of low-noise amplifiers with integral solid-state power supplies, Watkins-Johnson Company increases the dynamic range of its X-Band low-noise amplifiers. Like its lower-power predecessors, the WJ-363-4 is completely self-contained, adjustment-free, and requires only a 115-volt ac line-voltage input (48 to 420 Hz).

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-363-4. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

This amplifier, with a typical noise figure of 6.5 dB, may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of $-54^{\circ}$ to $+71^{\circ}$C. The environmental characteristics of the WJ-363-4 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 10 to 12 GHz | 10 to 12 GHz |
| Noise Figure, Terminal | 6.5 dB | 7.5 dB, max. |
| Gain, Small Signal | 35 dB | 30 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | 16 dBm | 13 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-363-4

## ENVIRONMENTAL CHARACTERISTICS[2]

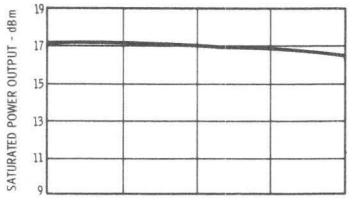
Temperature . . . . . −55°C to +71°C
Vibration
a) 0.10 Inch, Double Amplitude . 5 to 30 Hz
b) 5 g, Single Amplitude . . . 30 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

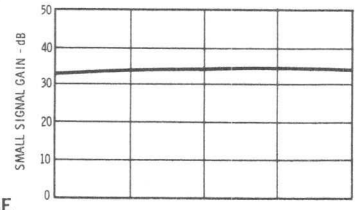
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 18 pounds (8.16 Kg) max.
Primary Power Connection,
Bendix Plug PT 07C-8-3P
Bendix Socket PT 07C-8-3S
Reference Drawing Number . . . . 290121

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

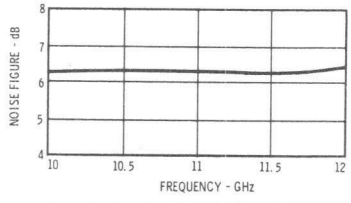
## POWER



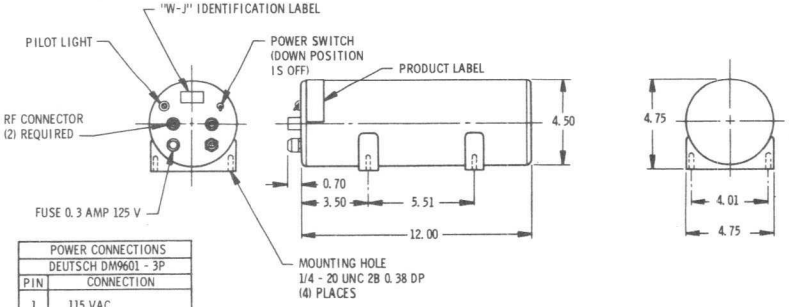

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS | |
|---|---|
| DEUTSCH DM9601 - 3P | |
| PIN | CONNECTION |
| 1 | 115 VAC |
| 2 | GROUND |
| 3 | 115 VAC |

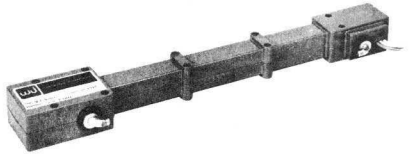
# TECHNICAL DATA

WATKINS-JOHNSON

## 2.5 TO 3.5 GHz 120/50 WATT (PULSE) GRIDDED DUAL-MODE TRAVELING-WAVE TUBE WJ-368-3

The WJ-368-3 is a PPM-focused, helix-type, traveling-wave tube designed to operate at 15% duty cycle with 120 watts output power and 5 mW RF drive power. It can, however, be used over a wide range of power levels, pulse lengths, frequencies, and duty cycles.

The high-mu gridded gun, wide-band helix interaction structure, and high average power capability of the WJ-368-3 allow a variety of applications. It may, for example, be used as a high-gain driver for high-power radar transmitters, as a high-gain driver or transmitter for ECM equipment, or as a radar transponder transmitter. In addition, it has been qualified for severe airborne environmental applications.



## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.5 - 4.0 GHz | 2.5 - 3.5 GHz |
| Power Output (Pulsed) | | |
| Mode A | 140 W | 120 W, min. |
| Mode B | 60 W | 50 W, min. |
| Gain at Rated Output Power | | |
| Mode A | 42 dB | 40 dB, min. |
| Mode B | 40 dB | 38 dB, min. |
| Duty Cycle | | |
| Mode A | | 15%, max. |
| Mode B | | 40%, max. |
| Pulse Length | | 100 $\mu$sec. max. |

| ELECTRICAL REQUIREMENTS | Typical | Range[3] or Maximum |
|---|---|---|
| Cathode Voltage[1] | | |
| Mode A | −4350 V | −4250 to −4450 V |
| Mode B | −3950 V | −3850 to −4050 V |
| Beam Pulse Current | | |
| Mode A | 240 mA | 275 mA max. |
| Mode B | 155 mA | 160 mA max. |
| Grid Bias Voltage[2] | −100 V | −75 to −100 V |
| Grid Pulse Voltage[2] | | |
| Mode A | +70 V | +40 to +100 V |
| Mode B | +40 V | +25 to +80 V |
| Grid Pulse Current | | |
| Mode A | 35 mA | 50 mA max. |
| Mode B | 20 mA | 30 mA max. |
| Helix Voltage | Ground | Ground |
| Helix Pulse Current | | |
| Mode A | 30 mA max. | 50 mA max. |
| Mode B | 10 mA | 50 mA max. |

* Supersedes WJ-368-3 Technical Data Sheet dated February 1968.

# WJ-368-3

## SPECIFICATIONS (Cont'd)

| | | |
|---|---|---|
| Collector Voltage[2] | | |
| Mode A | +3000 V | +2800 to +3300 V |
| Mode B | +3000 V | +2400 to +3300 V |
| Heater Voltage | 5.6 V | 5.3 to 5.8 V |
| Heater Current | 1.2 A | 1.4 A max. |

[1]Relative to ground.
[2]Relative to cathode.

[3]Every tube will meet the guaranteed performance specifications for a voltage and current lying in this range.

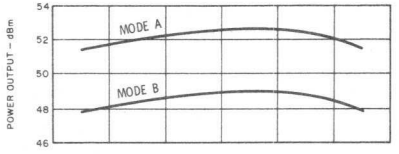
## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature | −55°C to +125°C |
| Altitude | 0 to 70,000 feet |
| Shock | 10 g, 11 ms |
| Vibration | |
| a. 0.3 inch, double amplitude | 5 to 23 Hz |
| b. 0.06 inch, double amplitude | 23 to 55 Hz |
| c. 6 g | 55 to 200 Hz |
| d. 3 g | 200 to 1500 Hz |

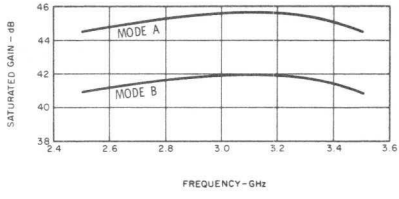
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Length | 13.5 inches (343 mm.) |
| Cross Section (excluding connectors) | 1.25 x 2.0 inches, max. |
| Weight | 2.5 lbs.(1.13 kg), max. |
| RF Connectors | OSM |
| Power Connections | Flying Leads |
| Cooling | Heat Sink |
| Focusing | PPM |

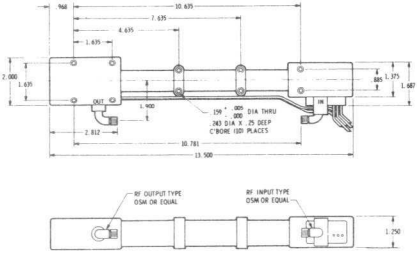
## POWER



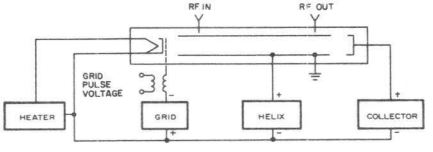

## GAIN




## OUTLINE DRAWING




## SCHEMATIC DIAGRAM




| VOLTAGE | MODE A | MODE B |
|---|---|---|
| HEATER | 5.3 to 5.8 | 5.3 to 5.8 |
| GRID BIAS | 75 to 100 | 75 to 100 |
| GRID PULSE | 40 to 100 | 25 to 80 |
| HELIX | 4250 to 4450 | 3850 to 4050 |
| COLLECTOR | 2800 to 3300 | 2400 to 3300 |

Preferred Power Supply Configuration for WJ-368-3

# TECHNICAL DATA

WATKINS-JOHNSON

## 4.4 TO 5.8 GHz 120/50 WATT (PULSE) GRIDDED DUAL-MODE TRAVELING-WAVE TUBE WJ-369-3

The WJ-369-3 is a PPM-focused, helix type, traveling-wave tube produced by Watkins-Johnson Company for use over a wide range of power levels, pulse lengths, frequencies, and duty cycles. It is designed to operate at 15% duty cycle with 120 watts output power and 5 mW RF drive power. Various other performance levels can be achieved by varying the specified voltages and currents. At low duty, for example, 100 watts output power can be achieved from 4.0 to 8.0 GHz with greater than 30 dB gain.

The high-mu gridded gun, wide-band helix interaction structure, and high average power capability of the WJ-369-3 allow several different applications. It may, for example, be used as a high-gain driver for high-power radar transmitters, as a high-gain driver or transmitter for ECM equipment, or as a radar transponder transmitter. In addition, it has been qualified for severe airborne environmental applications.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.2 - 6.2 GHz | 4.4 - 5.8 GHz |
| Power Output (Pulsed) | | |
| Mode A | 140 W | 120 W, min. |
| Mode B | 60 W | 50 W, min. |
| Gain at Rated Output Power | | |
| Mode A | 42 dB | 40 dB, min. |
| Mode B | 40 dB | 38 dB, min. |
| Duty Cycle | | |
| Mode A | | 15%, max. |
| Mode B | | 40%, max. |
| Pulse Length | | 100 $\mu$sec. max. |

| ELECTRICAL REQUIREMENTS | Typical | Range[3] or Maximum |
|---|---|---|
| Cathode Voltage[1] | | |
| Mode A | −5450 V | −5350 to −5550 V |
| Mode B | −4950 V | −4850 to −5150 V |
| Beam Pulse Current | | |
| Mode A | 190 mA | 220 mA max. |
| Mode B | 110 mA | 140 mA max. |
| Grid Bias Voltage[2] | −100 V | −75 to −100 V |
| Grid Pulse Voltage[2] | | |
| Mode A | +70 V | +60 to +100 V |
| Mode B | +40 V | +30 to +80 V |
| Grid Pulse Current | | |
| Mode A | 30 mA | 40 mA max. |
| Mode B | 10 mA | 30 mA max. |
| Helix Voltage | Ground | Ground |
| Helix Pulse Current | | |
| Mode A | 30 mA max. | 50 mA max. |
| Mode B | 10 mA | 30 mA max. |

* Supersedes WJ-369-3 Technical Data Sheet dated February 1968.

# WJ-369-3

## SPECIFICATIONS (Cont'd)

| | | |
|---|---|---|
| Collector Voltage[2] | | |
| Mode A | +3300 V | +3100 to +3300 V |
| Mode B | +3300 V | +2400 to +3300 V |
| Heater Voltage | 5.6 V | 5.3 to 5.8 V |
| Heater Current | 1.2 A | 1.4 A max. |

[1]Relative to ground.
[2]Relative to cathode.
[3]Every tube will meet the guaranteed performance specifications for a voltage and current lying in this range.

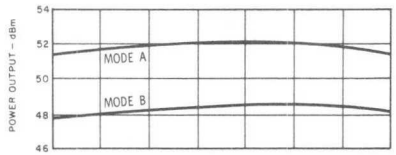
## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature | —55°C to +125°C |
| Altitude | 0 to 70,000 feet |
| Shock | 10 g, 11 ms |
| Vibration | |
| a. 0.3 inch, double amplitude | 5 to 23 Hz |
| b. 0.06 inch, double amplitude | 23 to 55 Hz |
| c. 6 g | 55 to 200 Hz |
| d. 3 g | 200 to 1500 Hz |

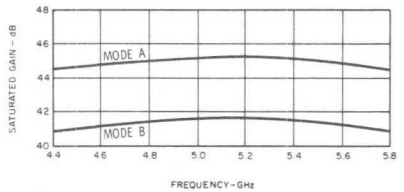
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Length | 12.25 inches (311mm), max. |
| Cross Section (excluding connectors) | 1.25 x 2.0 inches (32 x 51mm), max. |
| Weight | 2.2 lbs. (0.99 kg), max. |
| RF Connectors | OSM |
| Power Connections | Flying Leads |
| Cooling | Heat Sink |
| Focusing | PPM |

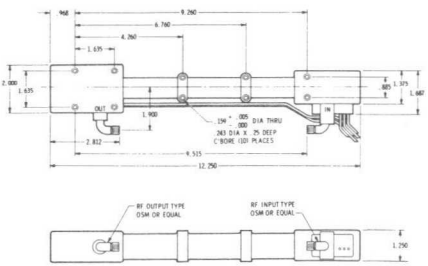
## POWER



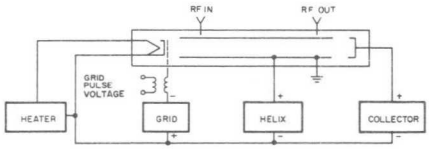

## GAIN




## OUTLINE DRAWING




## SCHEMATIC DIAGRAM




| VOLTAGE | MODE A | MODE B |
|---|---|---|
| HEATER | 5.3 to 5.8 | 5.3 to 5.8 |
| GRID BIAS | 75 to 100 | 75 to 100 |
| GRID PULSE | 60 to 100 | 30 to 80 |
| HELIX | 5350 to 5550 | 4850 to 5150 |
| COLLECTOR | 3100 to 3300 | 2400 to 3300 |

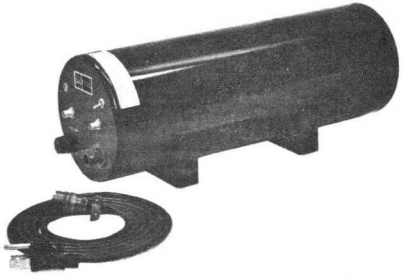
Preferred Power Supply Configuration for WJ-369-3

# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1969

## 12 TO 18 GHz
## LOW-NOISE TRAVELING-WAVE AMPLIFIER
## WITH INTEGRAL POWER SUPPLY
## WJ-371



- **"JUST PLUG IT IN"**
- **NOISE FIGURE 9.0 dB MAXIMUM**
- **PERMANENT-MAGNET FOCUSING**
- **PROVEN RELIABILITY**
- **NO ADJUSTMENTS NEEDED**
- **115 VOLT, 48 TO 420 Hz OPERATION**

WJ-371 is one of a family of PM-focused amplifiers developed by Watkins-Johnson for applications where wide dynamic range is required. The amplifier features the lowest guaranteed noise figure of any Ku-band unit plus a saturated power output of +12 dBm minimum, making it the amplifier with the widest dynamic range of any presently available commercial unit. Narrowband applications of 1 to 2 GHz can be provided with guaranteed noise figures approximately 1 dB less than the wideband version.

This proven amplifier is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-371 meet or exceed the corresponding requirements of MIL-E-5400: Temperature, Class 2; Vibration, Curve III.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 12.0 to 18.0 GHz | 12.0 to 18.0 GHz |
| Noise Figure, Terminal | 8.0 dB | 9.0 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +15 dBm | +12 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-371

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature (Operating) ..... −54°C to +71°C

Vibration
0.10 Inch Double Amplitude ..... 5 to 30 Hz
5g, Single Amplitude ..... 30 to 500 Hz

Shock ..... 15 g, 11ms

## MECHANICAL CHARACTERISTICS

Height ..... 4.75 inches (121 mm) max.

Width ..... 4.75 inches (121 mm) max.

Length (excluding connectors) ..... 13 inches (330 mm) max.

Weight ..... 18 pounds (8.16 Kg) max.

Primary Power Connection, Bendix Receptacle ..... PT07C-8-3P

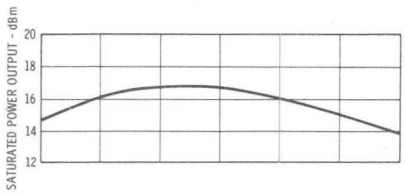
RF Connections ..... OSM Jack

Reference Drawing Number ..... 290240

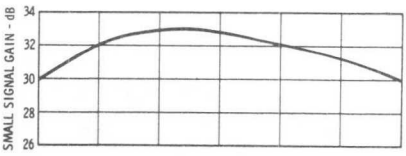
[1]Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968) ; Temperature, Class 2; Vibration, Curve III.

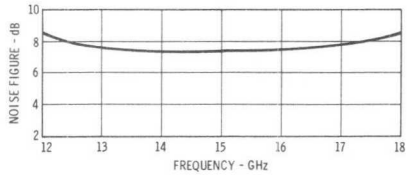
## POWER



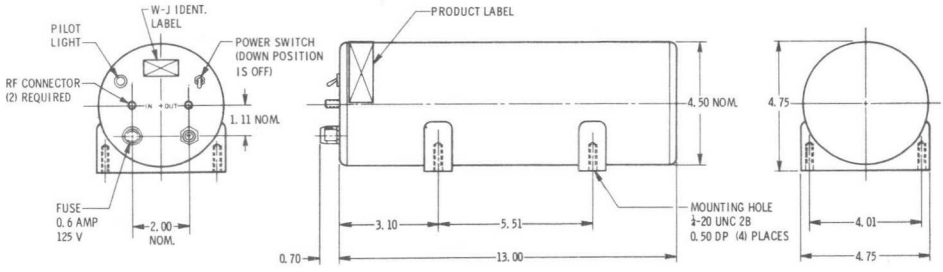

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT 07C-8-3P (RECP) MS 3116 E-8-3S (SR) (PLUG) | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 105-125 VAC |
| B | GROUND | 48-420 Hz |
| A | AC | SINGLE PHASE |

# TECHNICAL DATA

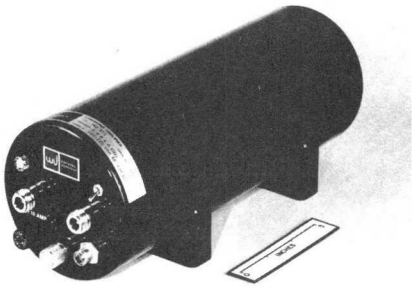
WATKINS-JOHNSON

APRIL 1970*

## 1.0 TO 2.0 GHz DUAL-HELIX LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-374

- "JUST PLUG IT IN"
- NEGLIGIBLE PERFORMANCE VARIATION DURING GAIN ADJUSTMENT
- NOISE FIGURE 5.5 dB MAXIMUM
- POWER OUTPUT 0 dBm MINIMUM
- PERMANENT-MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



The WJ-374 is one of a new series of dual-helix LNTWAs developed by Watkins-Johnson for use in systems where small signal gain may be adjusted without significant loss in power output or increase in noise figure. Application of a negative dc voltage allows reduction of gain from 25 to 0 dB while power output and noise figure remain relatively constant. In addition, the gain curve is extremely flat under reduced gain conditions.

The WJ-374 is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-374 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 1.0 to 2.0 GHz |
| Noise Figure, Terminal | 5.0 dB | 5.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +1 dBm | 0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |
| AGC Voltage | 0 to −20 V dc | 0 to −30 V dc |

*Supersedes WJ-374 Technical Data Sheet dated January 1969.

# WJ-374

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature, Operating . . −54° to +71°C
Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz
b. 10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

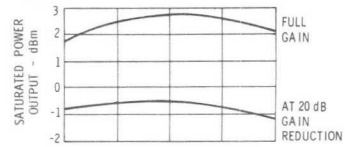
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 17 pounds (7.71 Kg) max.

Primary Power Connection, Deutsch Receptacle . . . . . DM9601-3P
RF Connections (50 ohms, nominal) . . . . . Type N, jack
AGC Connector . . . . . Type TNC, Jack
Reference Drawing No. . . . . 290012

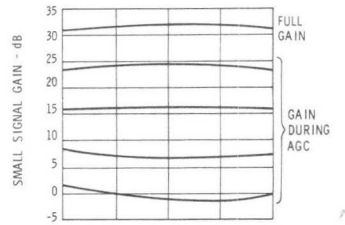
[1]Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

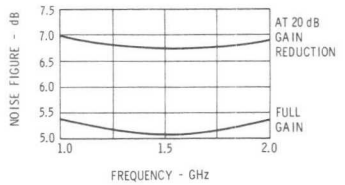
## POWER




## GAIN

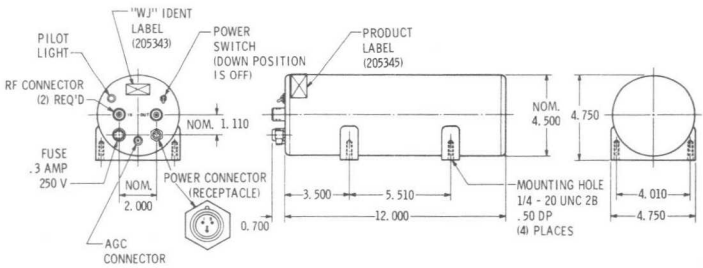



## NOISE




NOTE: THE AGC CURVES AT REDUCED GAIN LEVELS ARE TYPICAL CURVES.

## OUTLINE DRAWING




| RF CONNECTORS |
|---|
| INPUT: TYPE N-JACK |
| OUTPUT: TYPE N-JACK |

| POWER CONNECTORS | | |
|---|---|---|
| DEUTSCH DM9601-3P(RECP) DM9702-3S(PLUG) | | |
| PIN | CONNECTION | |
| 1 | 115±10 VAC | 48-420 Hz SINGLE PHASE |
| 2 | GROUND | |
| 3 | 115±10 VAC | |

| AGC CONNECTOR |
|---|
| TYPE: TNC JACK |

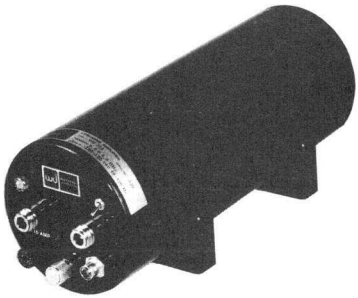
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970*

## 2.0 TO 4.0 GHz
## DUAL-HELIX LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY
## WJ-375

- "JUST PLUG IT IN"
- NEGLIGIBLE PERFORMANCE VARIATION DURING GAIN ADJUSTMENT
- NOISE FIGURE 5.5 dB MAXIMUM
- POWER OUTPUT 0 dBm MINIMUM
- PERMANENT-MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



The WJ-375 is one of a new series of dual-helix LNTWAs developed by Watkins-Johnson for use in systems where small signal gain may be adjusted without significant loss in power output or increase in noise figure. Application of a negative dc voltage allows reduction of gain from 25 to 0 dB while power output and noise figure remain relatively constant. In addition, the gain curve is extremely flat under reduced gain conditions.

The WJ-375 is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-375 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 2.0 to 4.0 GHz |
| Noise Figure, Terminal | 5.0 dB | 5.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +1 dBm | 0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |
| AGC Voltage | 0 to −25 V dc | 0 to −30 V dc |

*Supersedes WJ-375 Technical Data Sheet dated January 1969.

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature ..... −54°C to +71°C
Vibration
a. .10 inch, double amplitude ..... 5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 g, 11 ms

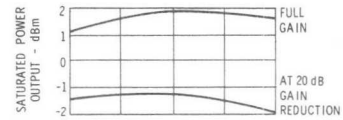
## MECHANICAL CHARACTERISTICS

Height ..... 4.75 inches (121 mm) max.
Width ..... 4.75 inches (121 mm) max.
Length (excluding connectors) ..... 12 inches (305 mm) max.
Weight ..... 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle ..... DM9601-3P
RF Connections (50 ohms, nominal) ..... Type N, jack
AGC Connector ..... Type TNC, Jack
Reference Drawing No. ..... 290012

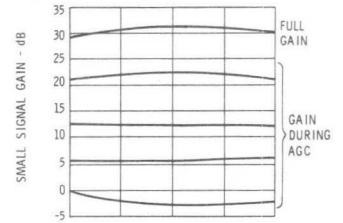
[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

[2]These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

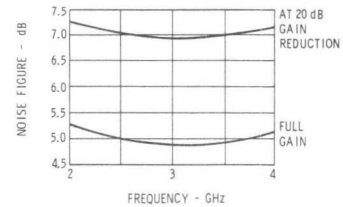
## POWER




## GAIN

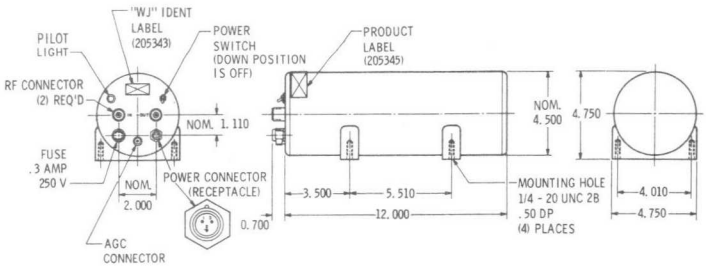



## NOISE




NOTE: THE AGC CURVES AT REDUCED GAIN LEVELS ARE TYPICAL CURVES.

## OUTLINE DRAWING




| RF CONNECTORS |
|---|
| INPUT: TYPE N-JACK |
| OUTPUT: TYPE N-JACK |

| POWER CONNECTORS | | |
|---|---|---|
| DEUTSCH DM9601-3P(RECP) DM9702-3S(PLUG) | | |
| PIN | CONNECTION | |
| 1 | 1/5±10 VAC | 48-420 Hz SINGLE PHASE |
| 2 | GROUND | |
| 3 | 1/5±10 VAC | |

| AGC CONNECTOR |
|---|
| TYPE: TNC JACK |

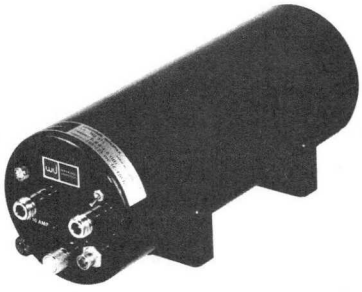
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970 *

## 4.0 TO 8.0 GHz
## DUAL-HELIX LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY
## WJ-376

- "JUST PLUG IT IN"
- NEGLIGIBLE PERFORMANCE VARIATION DURING GAIN ADJUSTMENT
- NOISE FIGURE 6.5 dB MAXIMUM
- POWER OUTPUT 0 dBm MINIMUM
- PERMANENT-MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



The WJ-376 is one of a new series of dual-helix LNTWAs developed by Watkins-Johnson for use in systems where small signal gain may be adjusted without significant loss in power output or increase in noise figure. Application of a negative dc voltage allows reduction of gain from 25 to 0 dB while power output and noise figure remain relatively constant. In addition, the gain curve is extremely flat under reduced gain conditions.

The WJ-376 is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-376 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 4.0 to 8.0 GHz |
| Noise Figure, Terminal | 6.0 dB | 6.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +2 dBm | 0 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |
| AGC Voltage | 0 to −40 V dc | 0 to −50 V dc |

*Supersedes WJ-376 Technical Data Sheet dated January 1969.

# WJ-376

## ENVIRONMENTAL CHARACTERISTICS[2]

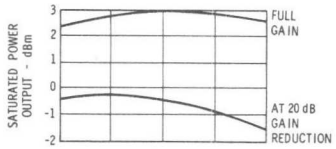
Temperature, Operating . . −54° to +71°C
Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz
b. 10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

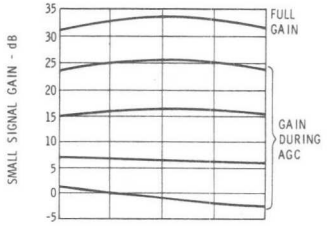
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . . DM9601-3P
RF Connections (50 ohms, nominal) . . . . . Type N, jack
AGC Connector . . . . . Type TNC, Jack
Reference Drawing No. . . . . 290012

[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
[2]These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

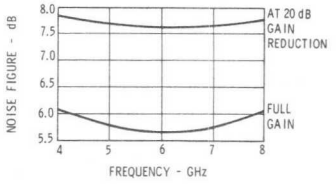
## POWER




## GAIN

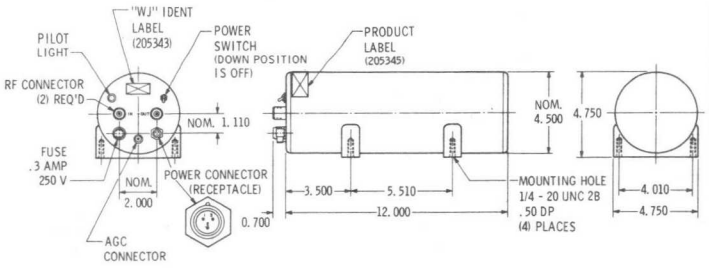



## NOISE




NOTE: THE AGC CURVES AT REDUCED GAIN LEVELS ARE TYPICAL CURVES.

## OUTLINE DRAWING




| RF CONNECTORS |
|---|
| INPUT: TYPE N-JACK |
| OUTPUT: TYPE N-JACK |

| POWER CONNECTORS | | |
|---|---|---|
| DEUTSCH DM9601-3P(RECP) DM9702-3S(PLUG) | | |
| PIN | CONNECTION | |
| 1 | 1/5±10 VAC | 48-420 Hz SINGLE PHASE |
| 2 | GROUND | |
| 3 | 1/5±10 VAC | |

| AGC CONNECTOR |
|---|
| TYPE: TNC JACK |

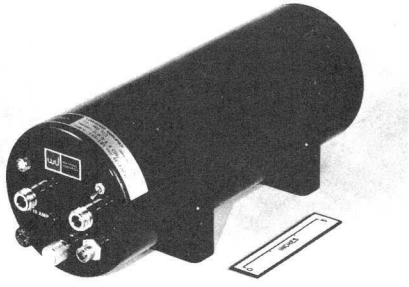
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970*

## 8.0 TO 12.0 GHz
## DUAL-HELIX LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY
## WJ-377

- "JUST PLUG IT IN"
- NEGLIGIBLE PERFORMANCE VARIATION DURING GAIN ADJUSTMENT
- NOISE FIGURE 8.0 dB MAXIMUM
- POWER OUTPUT 0 dBm MINIMUM
- PERMANENT-MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION



The WJ-377 is one of a new series of dual-helix LNTWAs developed by Watkins-Johnson for use in systems where small signal gain may be adjusted without significant loss in power output or increase in noise figure. Application of a negative dc voltage allows reduction of gain from 25 to 0 dB while power output and noise figure remain relatively constant. In addition, the gain curve is extremely flat under reduced gain conditions.

The WJ-377 is completely self-contained, adjustment-free, and requires only a 115 volt ac line-voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-377 meet the corresponding requirements of MIL-E-5400, Class 2 Specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 8.0 to 12.0 GHz |
| Noise Figure, Terminal | 7.5 dB | 8.0 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output, Saturated | +2 dBm | 0 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 W | |
| AGC Voltage | 0 to −50 V dc | 0 to −60 V dc |

*Supersedes WJ-377 Technical Data Sheet dated January 1969.

# WJ-377

## ENVIRONMENTAL CHARACTERISTICS[2]

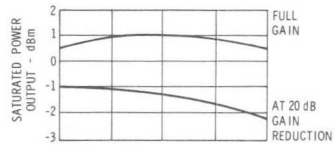
Temperature, Operating . . −54° to +71°C
Vibration
a. 0.10 Inch, Double Amplitude . 5 to 45 Hz
b. 10 g, Single Amplitude . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

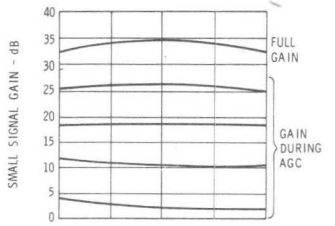
Height . . . . . 4.75 inches (121 mm) max.
Width . . . . . 4.75 inches (121 mm) max.
Length (excluding connectors) . . . . . 12 inches (305 mm) max.
Weight . . . . . 17 pounds (7.71 Kg) max.
Primary Power Connection, Deutsch Receptacle . . . . . DM9601-3P
RF Connections (50 ohms, nominal) . . . . . Type N, jack
AGC Connector . . . . . Type TNC, Jack
Reference Drawing No. . . . . 290012

[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
[2]These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

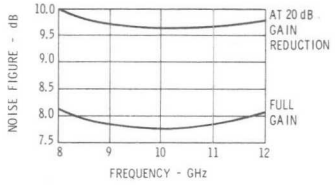
## POWER




## GAIN

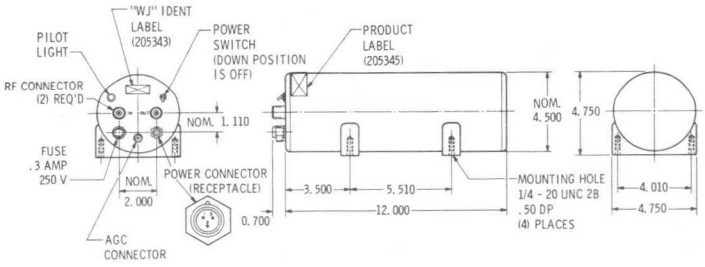



## NOISE




NOTE: THE AGC CURVES AT REDUCED GAIN LEVELS ARE TYPICAL CURVES.

## OUTLINE DRAWING




| RF CONNECTORS |
|---|
| INPUT: TYPE N-JACK |
| OUTPUT: TYPE N-JACK |

| POWER CONNECTORS | | |
|---|---|---|
| DEUTSCH DM9601-3P(RECP) DM9702-3S(PLUG) | | |
| PIN | CONNECTION | |
| 1 | 115±10 VAC | 48-420 Hz SINGLE PHASE |
| 2 | GROUND | |
| 3 | 115±10 VAC | |

| AGC CONNECTOR |
|---|
| TYPE: TNC JACK |

# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-381

March 1967

## 2.6 TO 5.2 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 9.5 dB MAXIMUM
- ADJUSTMENT FREE
- PERMANENT-MAGNET FOCUSING
- SPECIALIZED VERSIONS AVAILABLE

The WJ-381 is one of the Watkins-Johnson family of compact traveling-wave amplifiers designed to fill the increasing requirements for a "straddle-band" amplifier covering portions of S and C bands in a single device. Incorporating many of the time-tested features of its larger predecessors, this amplifier is only 9.5 inches long, 3.4 inches in height and width, and weighs 6.0 pounds. The amplifier is completely adjustment-free and has an integral solid-state power supply which operates from a 115-volt ac, 48 to 420 Hz source.

Although guaranteed to produce a noise figure not exceeding 9.5 dB, a typical WJ-381 production unit can be expected to yield a much lower noise figure over the major segment of the 2.6 to 5.2 GHz frequency range. The typical performance noise figure curve shown represents actual test figures taken from randomly selected amplifiers. Note that most of the curve appears below 8.5 dB.

The WJ-381 will meet or exceed environmental requirements of MIL-E-5400, Class 2 Specification. Rugged construction of the traveling-wave tube, permanent magnet, and power supply assembly assures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C.

The same conservative design and careful processing techniques responsible for the long life of other Watkins-Johnson low-noise amplifiers have been extended to the WJ-381. It can be predicted that they will yield an MTBF in excess of 18,500 hours (99% confidence level). The anticipated MTBF is based on extensive tests performed on this and similar tubes and power supply components.

Several specialized versions of the WJ-381 are available on special order. These amplifiers offer a lower noise figure over narrower bandwidths, phase and gain matching, extended and special frequency coverages, rigid differential phase and gain performance, automatic gain control, and inclusion of a unique blanking circuit to permit pulse times of a few nanoseconds. Details are available upon request.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.6 to 5.2 GHz | 2.6 to 5.2 GHz |
| Noise Figure, Terminal | 8.5 dB | 9.5 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +10.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 20 W | |

# WJ-381

## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature, Operating | −54°C to +71°C |
| Vibration | |
| a. 0.10 Inch, Double Amplitude | 5 to 45 Hz |
| b. 10 g, Single Amplitude | 45 to 500 Hz |
| Shock | 15 g, 11 ms |

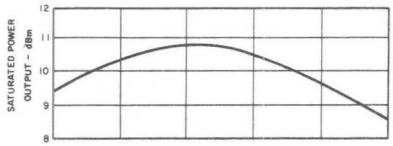
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Amplifier Length (excluding connectors) | 9.5 inches, max. |
| Amplifier Height and Width | 3.4 inches, max. |
| Amplifier Weight | 6.0 pounds |
| Primary Power Connection, Deutsch Receptacle | DM9601-3P |
| RF Connections (50 ohms, nominal) | Type N, jack |
| Reference Drawing Number | 290003 |

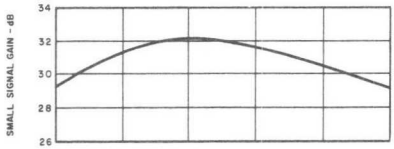
Every tube will meet the guaranteed performance specifications within these ranges.

These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

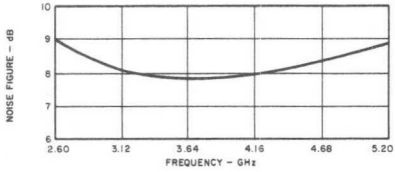
## POWER



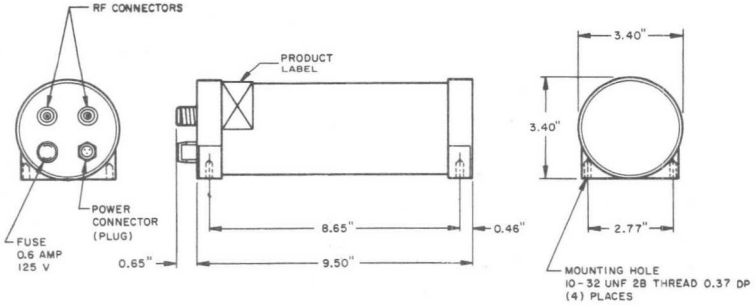

## GAIN




## NOISE




## OUTLINE DRAWING

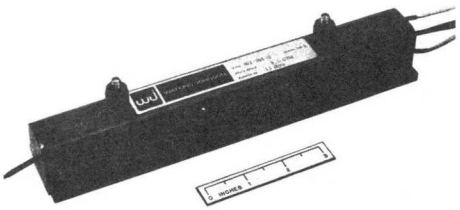


# TECHNICAL DATA

WATKINS-JOHNSON

July 1969*

## 7.0 TO 11.0 GHz, 5-WATT TRAVELING-WAVE TUBE WJ-391



- **OUTPUT POWER 5 WATTS MINIMUM**
- **PPM FOCUSING**
- **ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION**
- **EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION**

The WJ-391 is a medium-power traveling-wave tube for use in the 7.0 to 11.0 GHz frequency range. This tube provides 5 watts power output and 42 dB small signal gain. A unique feature of the WJ-391 is its very low fine structure gain variation, making it especially suitable for applications where gain variation and phase linearity are important. The use of periodic-permanent-magnet focusing and metal-ceramic construction results in a compact, lighweight tube that is especially suitable for use in airborne and space applications.

This traveling-wave tube is one of a family of space and missile qualified medium-power tubes, all of which use similar construction techniques. The compact, all metal-ceramic assembly provides a unit that can easily withstand the shock, vibration and temperature extremes that are encountered in missile launchings.

The PPM focusing system uses Alnico-8 magnets which make it insensitive to temperature variations over its operating range. Cooling of the tube is by conduction through the baseplate of the capsule. Operating efficiency of the WJ-391 can be improved by depressing the collector voltage below the helix voltage.

In addition the WJ-391 may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 7.0 to 11.0 GHz | 7.0 to 11.0 GHz |
| Saturated Power Output | 6 watts | 5 watts, min. |
| Small Signal Gain | 45 dB | 42 dB, min. |
| Small Signal Gain Variation | ±2 dB | ±3 dB, max. |
| Gross Fine Structure Small Signal Gain Variation | ±0.2 dB | ±0.5 dB |
| AM-PM Conversion (At 5 watts) | 4.5°/dB | 5°/dB, max. |
| Noise Figure | 27 dB | 30 dB, max. |

| ELECTRICAL REQUIREMENTS | TYPICAL | RANGE |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.0 to 6.6 volts |
| Anode Voltage | +50 volts | 0 to +100 volts |
| Helix Voltage | 3100 volts | 2800 to 3200 volts |
| Collector Voltage | 1800 volts | 1700 to 3200 volts |
| Cathode Current | 30 mA | 26 to 33 mA |
| Helix Current | 2 mA | 0.2 to 3 mA |
| Heater Current | 1.2 A | 1.0 to 1.4 A |

*Supersedes WJ-391 Technical Data Sheet Dated April 1969

# WJ-391

## MECHANICAL CHARACTERISTICS

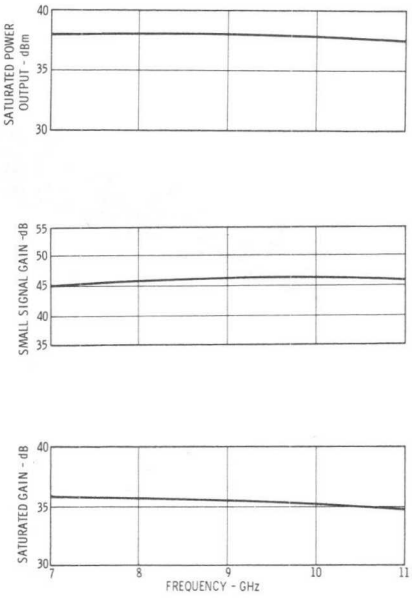
| | |
|---|---|
| Cooling | Conduction through baseplate |
| Height | 1.25 inches (32 mm) max. |
| Width | 1.85 inches (47 mm) max. |
| Length | 10.86 inches (276 mm) max. |
| Weight | 1.5 pounds (680 g) max. |
| Connectors | OSM |
| Focusing | PPM |

## ENVIRONMENTAL CAPABILITY[1]

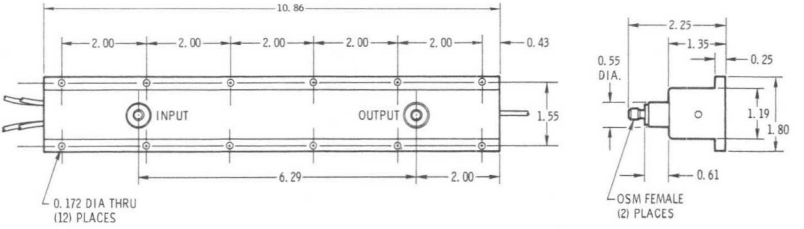
| | |
|---|---|
| Temperature | −54°C to +85°C (baseplate) |
| Vibration (120-2000 cycles) | 5 Grms |
| Shock | 20 G |
| Altitude | Any |

[1]Every tube can be qualified to meet requirements of MIL-E-5400.

## RF ELECTRICAL PERFORMANCE CHARACTERISTICS

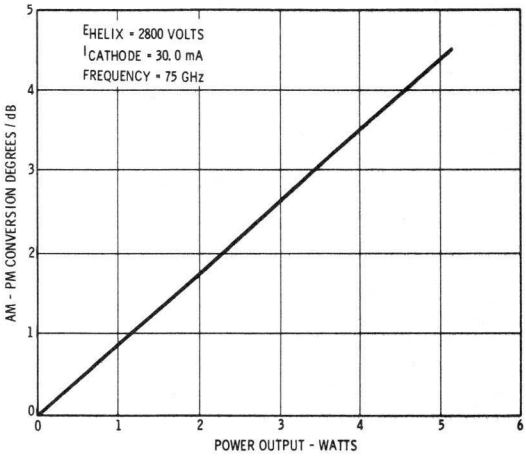



## OUTLINE DRAWING

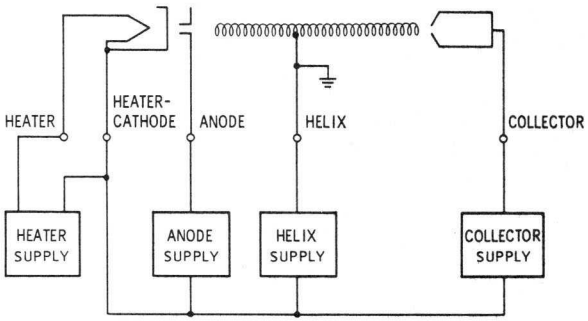


# WJ-391

## AM-PM CONVERSION




## SCHEMATIC DIAGRAM



# TECHNICAL DATA

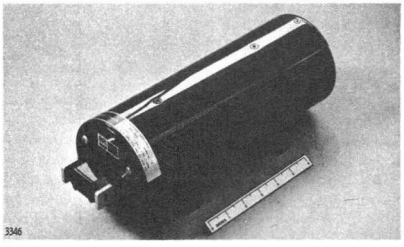
WATKINS-JOHNSON

# WJ-393

July 1968 *

## 18.0 TO 26.5 GHz, LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 13 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- NO ADJUSTMENTS NEEDED




The WJ-393 extends the Watkins-Johnson family of low-noise integral power supply permanent-magnet focused traveling-wave amplifiers into the millimeter wavelength region. This K-band amplifier offers a guaranteed maximum noise figure of 13 dB over the 18.0 to 26.5 GHz frequency range, but typically can be expected to yield a noise figure of less than 11 dB over much of the range. Saturated power output is 0 dBm minimum, and small signal gain is 25 dB minimum.

The WJ-393 amplifier package includes a shielded permanent magnet that is not adversely affected by adjacent PM tubes or ferromagnetic material. Also integral with the package is a factory-set power supply whose total power consumption from the 115-volt ac source is typically 5 watts. All components are regulated or compensated for full specification performance over the specified temperature range.

The same conservative design and careful processing techniques which are responsible for long life in other Watkins-Johnson low-noise amplifiers, have been extended to this amplifier. Similar amplifiers of this type have attained MTBF's in excess of 15,000 hours (99% confidence level). This low-cost-per-operating-hour performance is characteristic of the WJ-393 and all other amplifiers in this rugged family.

Installation and operation of the WJ-393 are simplified by rugged construction. When mounted in any orientation by the four threaded mounting holes, the WJ-393 can withstand vibrational forces of over 5 g at frequencies up to 500 Hz, and shock in any plane of over 15 g, 11 millisecond duration.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 18.0 to 26.5 GHz | 18.0 to 26.5 GHz |
| Noise Figure, Terminal[1] | 11 dB | 13 dB, max. |
| Gain, Small Signal | 28 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | 5 dBm | 0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[2] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 5 W | 10 W, max. |

*Supersedes WJ-393 Technical Bulletin, Volume 8, No. 14, October, 1966

# WJ-393

## ENVIRONMENTAL CHARACTERISTICS

Temperature, Operating ..... −54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude ...5 to 30 Hz
b. 5 g, Single Amplitude ..... 30 to 500 Hz
Shock ..... 15 g, 11 ms

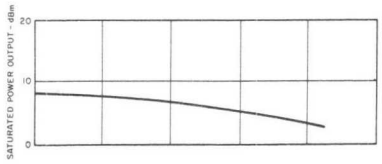
## MECHANICAL CHARACTERISTICS

Amplifier Length
(excluding connectors) ..... 12 inches, max.
Amplifier Cross Section ..... 4.75 inches, max.
Amplifier Weight ..... 18 pounds, max.
Primary Power Connection
Bendix receptacle ..... PT-07C-8-3P
RF Connectors
(WR-42 Waveguide) ..... UG-595/U flange

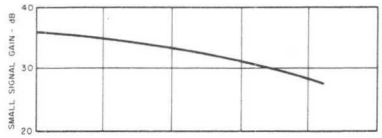
[1]Noise Figure is as read on a standard Hewlett-Packard Model 340B Noise Figure Meter utilizing a standard AIL 07053 noise source.

[2]Every amplifier will meet the guaranteed performance specifications for any voltage lying within these ranges.

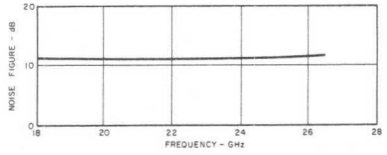
## POWER



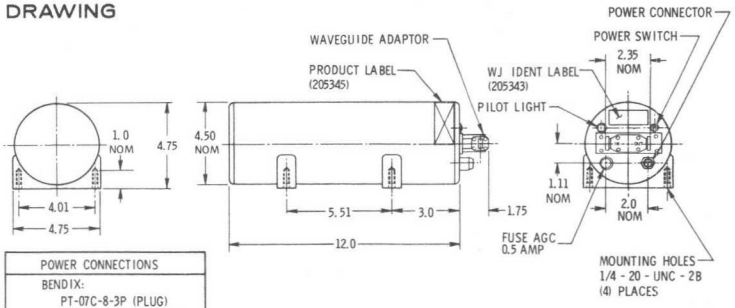

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTIONS | |
|---|---|
| BENDIX: PT-07C-8-3P (PLUG) PT-07C-8-3S (SOCKET) | |
| PIN | CONNECTIONS |
| A | 117 VAC |
| B | GROUND |
| C | 117 VAC |

# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-395-1

September 1968 *

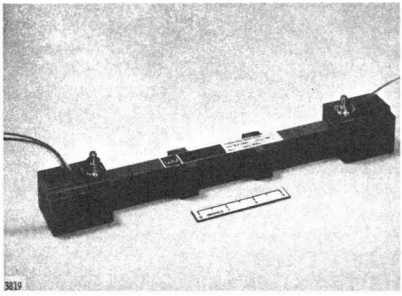
## 2.2 TO 2.3 GHz
## COMPACT, HIGH-EFFICIENCY, 100 WATT TRAVELING-WAVE TUBE FOR SPACE COMMUNICATIONS AND TELEMETRY

The WJ-395-1 traveling-wave tube is designed to meet the power amplifier requirements of earth orbit and deep-space missions where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 44%. The metal-ceramic construction of the WJ-395-1 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, shock, and static acceleration.

The WJ-395-1 will deliver 100 watts of output power over the frequency range of 2.2 to 2.3 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 60 to 120 watts can be provided while maintaining a fixed value of rf drive without significantly affecting efficiency. This is shown in Fig. 4. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain near optimum performance for any desired power level.

The power output, gain, and overall efficiency are very nearly constant over the guaranteed frequency range as shown in Fig. 1. Fig. 3 shows the rf performance characteristics as a function of helix voltage for various values of beam current. Note




that beam efficiency, not overall efficiency, is plotted in the lower curve. The points for maximum beam efficiency also correspond to maximum overall efficiency. These maximum efficiency points are indicated on the middle curve.

A number of variations of the WJ-395-1 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications. Manufactured under rigid quality assurance specifications, versions of this tube have also been qualified for space applications.

## SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency range | 2.2 to 2.3 GHz | 2.2 to 2.3 GHz |
| Saturation power output | 105 watts | 100 watts min. |
| Saturation gain | 36 dB | 33 dB min. |
| Overall efficiency, including heater[2] | 47 percent | 42 percent min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 4.3 volts | 4.0 to 5.0 volts |
| Heater current | 0.9 A | 1.0 A max. |
| Anode voltage[1] | 3640 volts | 3300 to 3800 volts |
| Anode current | 0.5 mA | 1.0 mA max. |
| Helix voltage[1] | 2590 volts | 2500 to 2800 volts |
| Helix current | 13 mA | 18 mA max. |
| Collector voltage[1] | 1960 volts | 1800 to 2300 volts |
| Collector current | 97 mA | 115 mA max. |

[1]These voltages are referenced to the cathode. Helix is operated at ground potential.
[2]Overall efficiency is defined as the RF output power, divided by the total dc input, including heater power.

* Supersedes WJ-395-1 Technical Data Sheet Dated July 1968

# WJ-395-1

## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Tube length | 13.5 inches max. |
| Tube width | 1.8 inches max. |
| Tube height, excluding connectors | 1.6 inches max. |
| Tube weight | 2.8 pounds max. |
| DC connectors | Flying leads |
| RF connectors | OSM (Female) |
| Cooling | Conduction from bottom surface |
| Focusing | PPM |

## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Heat Sink Temperature | −20°C to +85°C |
| Vibration | |
| a. Sinusoidal (2 min/octave) | 0.5 inch, double amplitude, 5 to 18 Hz, ±20 g peak, 18 to 2000 Hz |
| b. Random (5 min/axis) | 0.1 $g^2$/Hz, 20 to 2000 Hz |
| Acceleration (1 min/axis) | 100 g |
| Shock | 75 g, 11 ms |

FIG. 1 — SATURATION POWER OUTPUT, GAIN, AND OVERALL EFFICIENCY.

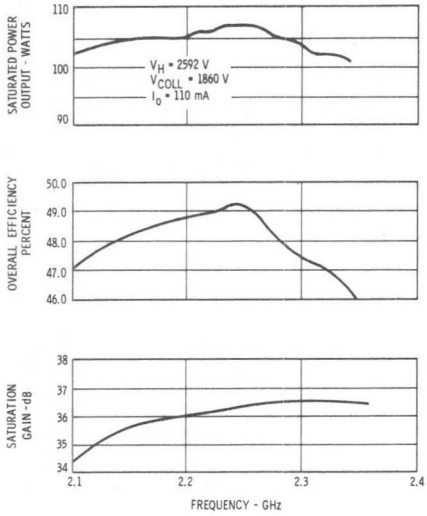
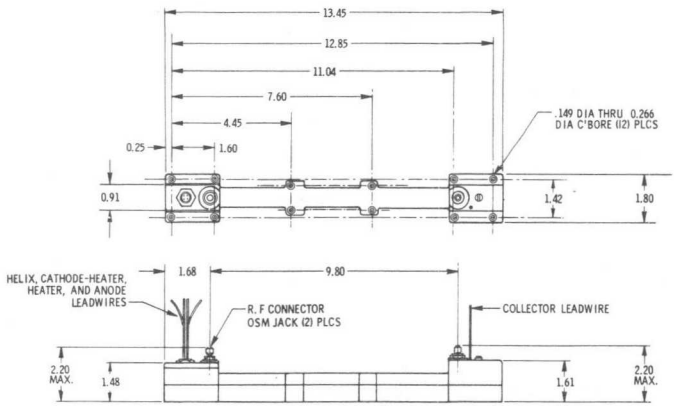
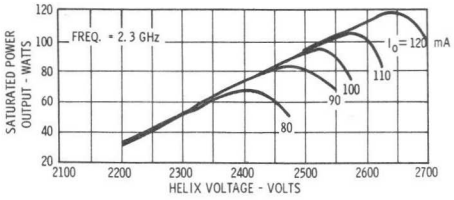
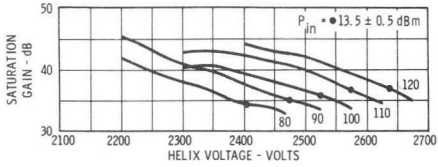



FIG. 2 — OUTLINE DRAWING





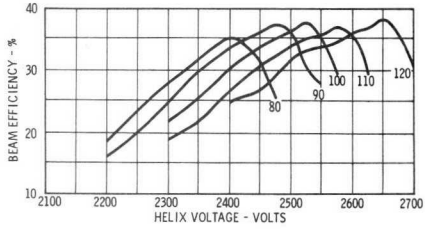
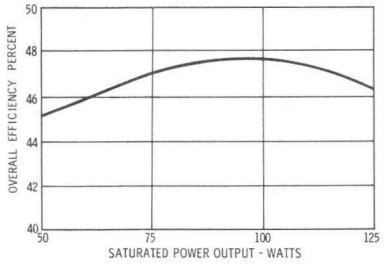




FIG. 3 — SATURATION POWER OUTPUT, SATURATION GAIN AND BEAM EFFICIENCY FOR VARIATION IN ELECTRODE VOLTAGES



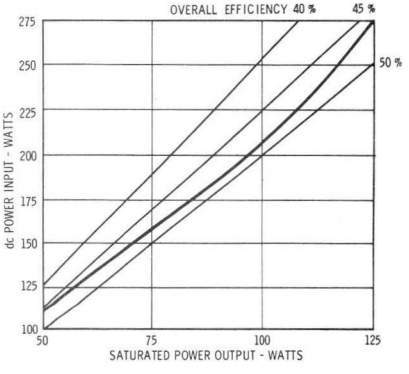
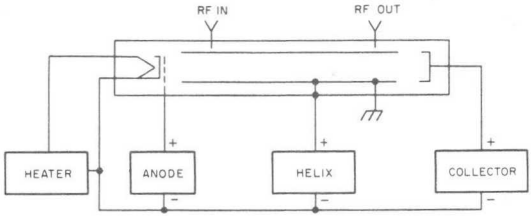




FIG. 4 — OVERALL EFFICIENCY AND TOTAL DC INPUT POWER AS A FUNCTION OF SATURATED POWER OUTPUT

Note: These curves represent constant RF input drive power and programmed anode, helix and collector voltages.



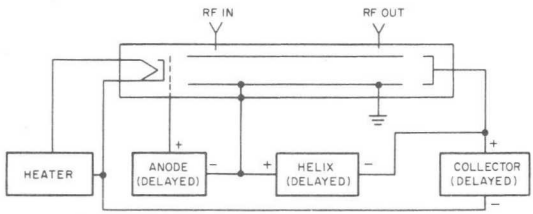

| | |
|---|---|
| HEATER | 3.5-4.5 VOLTS AC AT 1 AMPERE MAXIMUM |
| ANODE | 3300-3800 VOLTS AT 1 mA MAXIMUM |
| HELIX | 2500-2800 VOLTS AT 18 mA MAXIMUM |
| COLLECTOR | 1800-2300 VOLTS AT 115 mA MAXIMUM |

NOTE:
TO ENSURE THAT THE TWT IS OPERATED PROPERLY, IT IS SUGGESTED THAT VOLTAGES BE APPLIED AS FOLLOWS:

1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT FILAMENT CURRENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILAMENT VOLTAGE TO STABILIZE.
2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT COLLECTOR CURRENT DOES NOT EXCEED MAXIMUM VALUE.
3. SET ADJUSTABLE OVERCURRENT DISCONNECT CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY APPLY HELIX VOLTAGE TO SPECIFIED VALUE.
4. SLOWLY APPLY ANODE VOLTAGE TO SPECIFIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 μSEC IF HELIX CURRENT EXCEEDS MAXIMUM VALUE.

FIG. 5 PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-395-1




| | |
|---|---|
| HEATER | 3.5 VOLTS AC (TYPICAL) AT 1 A MAXIMUM |
| ANODE | 1050 VOLTS (TYPICAL) AT 1 mA MAXIMUM |
| HELIX | 630 VOLTS (TYPICAL) AT 18 mA MAXIMUM |
| COLLECTOR | 1960 VOLTS (TYPICAL) AT 115 mA MAXIMUM |

NOTE:
WITH THIS CONFIGURATION, ANODE SUPPLY CANNOT CUTOFF TUBE EMISSION. TO PREVENT DAMAGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:

1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FILAMENT RESISTANCE CHANGE AS TEMPERATURE RISES.
2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINIMUM.

CAUTION

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 μSEC IF MAXIMUM VALUE IS EXCEEDED.

FIG. 6 PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR WJ-395-1

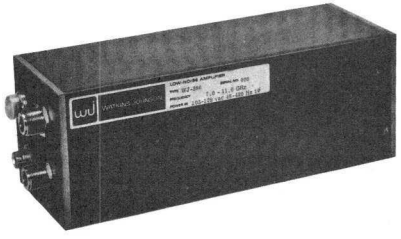
# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1970*

## 7 TO 11 GHz
## ULTRA LOW-NOISE TWT AMPLIFIER
## WITH INTEGRAL POWER SUPPLY
## WJ-396

- **"JUST PLUG IT IN"**
- **GUARANTEED 6.0 dB NOISE FIGURE**
- **SMALL SIZE 3.4 x 3.4 x 10.0 INCHES**
- **WEIGHT: 8.5 POUNDS**
- **MEETS MIL-E-5400, CLASS II ENVIRONMENT**



WJ-396 is the first of a new series of small, lightweight, ultra-low-noise traveling-wave amplifiers developed by Watkins-Johnson Company. Designed and built for long life with optimum performance, this amplifier is expected to attain an MTBF similar to that exhibited by certain of W-J's LNTWAs (over 15,000 hours at 99% confidence level). For special applications, the guaranteed noise figure can be lowered over the selected portions of the band.

Rugged construction allows the WJ-396 to withstand vibrational forces of over 5 g at frequencies up to 500 Hz, and over 15 g of shock in any plane for 11 millisecond duration. Shielded permanent-magnet focusing is unaffected by adjacent PM tubes or ferromagnetic material. An integral power supply consumes less than 10 watts of power from the 115-volt ac source. All components are regulated or compensated for full specification performance from −54°C to +71°C.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 7.0 to 11.0 GHz | 7.0 to 11.0 GHz |
| Noise figure, terminal (8.0 to 10.0 GHz)[1] | 5.5 dB | 6.0 dB |
| (7.0 to 8.0 GHz; 10.0 to 12.0 GHz) | 6.0 dB | 6.5 dB |
| Gain, small signal | 28 dB | 25 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | −5.0 dBm | |

| ELECTRICAL REQUIREMENTS | Typical | Range[2] |
|---|---|---|
| Primary voltage | 115 V ac | 115 ±10 V ac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 10 watts | |

1. Noise figure is as read on an HP Noise Figure Meter model 340 B, using HP Noise Sources model H 347 A and model X 347 A.
2. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

*Supersedes WJ-396 Technical Data Sheet dated March 1968.

# WJ-396

## ENVIRONMENTAL[3] CHARACTERISTICS

Temperature . . . . . —54°C to +71°C
Vibration
a. .10 inch, double amplitude . . . . . 5 to 30 Hz
b. 5 g, single amplitude . . . . . 30 to 2,000 Hz
Shock . . . . . 15 g, 11 ms

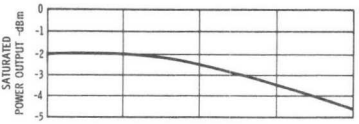
## MECHANICAL CHARACTERISTICS

Height . . . . . 3.4 inches (86 mm) max.
Width . . . . . 3.4 inches (86 mm) max.
Length (excluding connectors) . . . . . 10 inches (254 mm) max.
Weight . . . . . 8.5 lbs. (3.86 Kg) max.

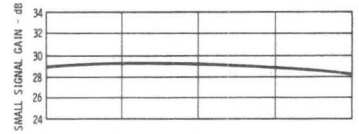
Primary power connection, Bendix . . . . PT-07C-8-3P
RF connectors (input and output) . . . . Type N Jack

3. These environmental characteristics meet or exceed the respective requirements for MIL-E-5400, Class 2.

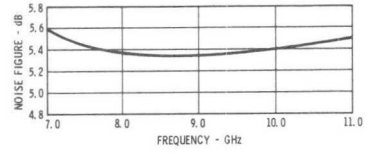
## POWER



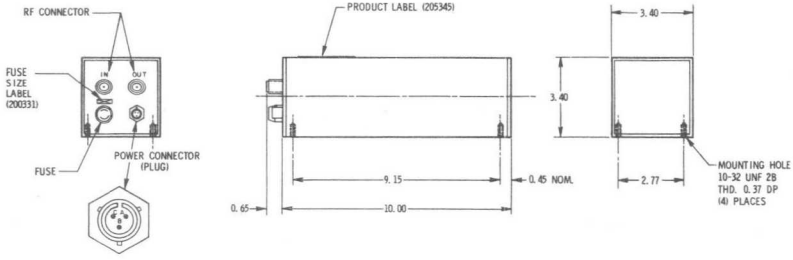

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT-07C-8-3P (PLUG) MS 3116E-8-3S(SR)SOC) | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 115±10 VAC |
| B | GROUND | 48-420 CPS |
| A | AC | SINGLE PHASE |

# TECHNICAL DATA

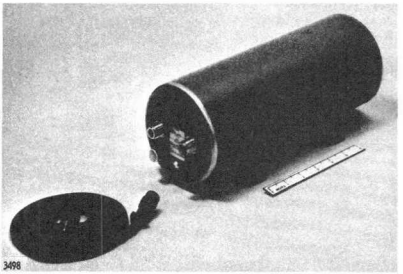
WATKINS-JOHNSON

# WJ-397

March 1968

## 0.5 TO 2.0 GHz LOW-NOISE, DOUBLE-OCTAVE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- NOISE FIGURE 7 dB MAXIMUM
- PERMANENT-MAGNET FOCUSING
- PROVEN RELIABILITY
- NO ADJUSTMENTS REQUIRED
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION




The WJ-397 is the first of another new series of low-noise traveling-wave amplifiers developed by Watkins-Johnson Company. Featuring an ultra-low noise figure (7.0 dB max.) across the P- and L-band frequency spectrum, this double-octave amplifier is ideal for use in sensitive, ultra-wide bandwidth receiver equipment applications. A guaranteed power output of 0 dBm adds to the overall capability of this amplifier.

The WJ-397 has the same long-life design, rugged construction, and adjustment-free operation characteristics of Watkins-Johnson's other octave-band, low-noise amplifiers. Magnetic shielding allows operation next to similar units or to ferromagnetic materials without degradation of performance. The amplifier may be mounted in any orientation, and is built to withstand the shock, vibration, and temperature specifications of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 0.5-2.0 GHz | 0.5-2.0 GHz |
| Noise figure, terminal | 6.0 dB | 7.0 dB max. |
| Gain, small signal | 29 dB | 25 dB |
| Gain variation, small signal | ±2 dB | |
| VSWR, input and output | 1.5:1 | 2.5:1 max. |
| Power output | +5 dBm | 0 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary voltage | 115 V ac | 115 ±10 V ac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 6 watts | 10 watts |

# WJ-397

## ENVIRONMENTAL CHARACTERISTICS

Temperature ..... −54° to +71°C
Vibration
a. 0.10 inch, double amplitude ... 5 to 45 Hz
b. 5g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 g, 11 ms

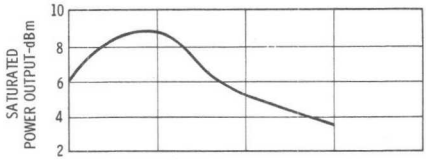
## MECHANICAL CHARACTERISTICS

Amplifier length
(excluding connectors) ..... 12 inches, max.
Amplifier height and width ... 4.75 inches, max.
Weight ..... 17 lbs, max.
Primary power connection,
Bendix receptacle ..... PT-07C-8-3P
RF connections
(50 ohms, nominal) ..... Type N, jack

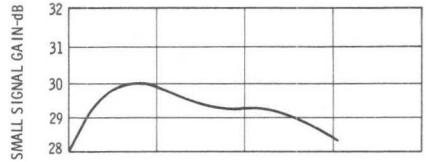
[1]Every tube will meet the guaranteed performance specifications for any voltage within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements for MIL-E-5400, Class 2.

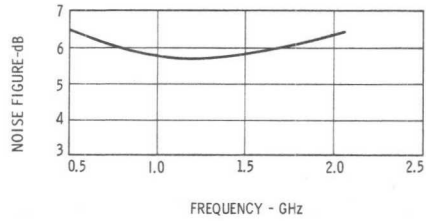
## POWER



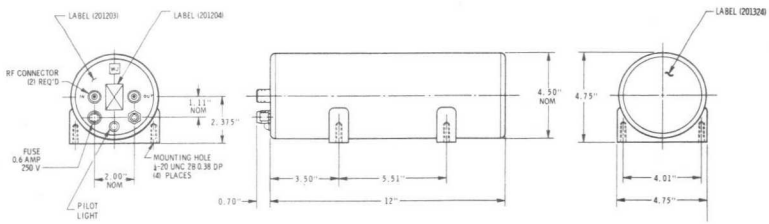

## GAIN




## NOISE




## OUTLINE DRAWING



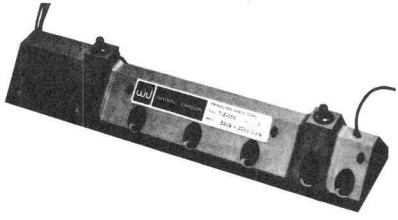
# TECHNICAL DATA

WATKINS-JOHNSON

January 1968

## 2.2 TO 2.4 GHz COMPACT 20-WATT TRAVELING-WAVE TUBE FOR SATELLITE APPLICATION AND HIGH IMPACT SHOCK LEVEL

**WJ-398-1**



The WJ-398-1 is a medium power traveling-wave tube developed to meet the requirements of satellite and deep-space transmitter applications where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 25%. The metal-ceramic construction of the WJ-398-1 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, static acceleration, and high impact shock levels, to 5,000 G, for 0.5 ms duration (such as may be experienced in a planetary hard-landing vehicle).

The WJ-398-1 will deliver 20 watts of output power over the frequency range of 2.2 to 2.4 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 10 to 25 watts can be provided while maintaining a fixed value of gain without significantly affecting efficiency. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain an optimum condition for any desired power level.

Efficiency generally improves with an increased power level for the tube, enabling the user to cover a range of power requirements with one tube.

The power output, gain, and efficiency are very nearly constant over the specified frequency range, as shown in Fig. 1. The power transfer curves of Fig. 3 show that the output power at saturation is relatively unchanged with a substantial change in drive power.

A number of variations of the WJ-398-1 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications; for example, engineering models have been tested to shock levels as high as 9500 G for 0.7 ms duration.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency range | 2.2-2.4 GHz | 2.2-2.4 GHz |
| RF power output | 22.4 watts | 20 watts min. |
| RF input for saturation | 2 dBm | 8 dBm max. |
| RF gain | 41 dB | 35 dB min. |
| Primary power | 75 watts | 80 watts max. |
| Overall efficiency | 30% | 25% |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.5 V | 6.0-7.0 V |
| Heater Current | 1.0 A | 0.8-1.2 A |
| Anode Voltage | 1895 V | 1895 ±100 V |
| Anode Current | 0.1 mA | 1.0 mA, max. |
| Helix Voltage | 1492 V | 1492 ±100 V |
| Helix Current | 6.0 mA | 10.0 mA, max. |
| Collector Voltage | 1100 V | 1100 ±55 V |
| Collector Current | 52 mA | 60 mA, max. |
| Cathode Current | 59 mA | 71 mA, max. |

# WJ-398-1

## ENVIRONMENTAL CHARACTERISTICS

Shock ..... 5,000 G average, 0.5 ms duration
Acceleration ..... 14 G, 5 minutes
Vibration, complex . . Superimposed
14 G rms noise (18 sec.)
5.0 G rms noise (600 sec.)
2.0 G rms sine 15-40 Hz (600 sec.)
9.0 G rms sine 40-250 Hz (600 sec.)
4.5 G rms sine 250-2000 Hz (600 sec.)
14 G rms noise (18 sec.)
Temperature ..... −10°C to +75°C

## MECHANICAL CHARACTERISTICS

Height (including connectors) .... 2 inches (51 mm)
Width ..... 2.5 inches (64 mm)
Length ..... 11 inches (279 mm)
Weight ..... 3.5 pounds (1.59 Kg)
RF Connector ..... OSM, female
DC Connections ..... 12 inch flying leads
RF connector ..... OSM female
DC connections ..... 12 inch flying leads

[1]Efficiency is defined as the minimum saturation RF output power across the band, divided by the total dc power input, including heater power.

**FIG. 1.**
**RF PERFORMANCE CHARACTERISTICS vs. FREQUENCY**

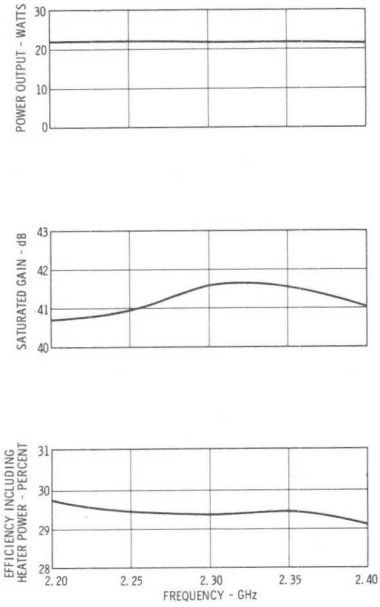



**FIG. 2. OUTLINE DRAWING**

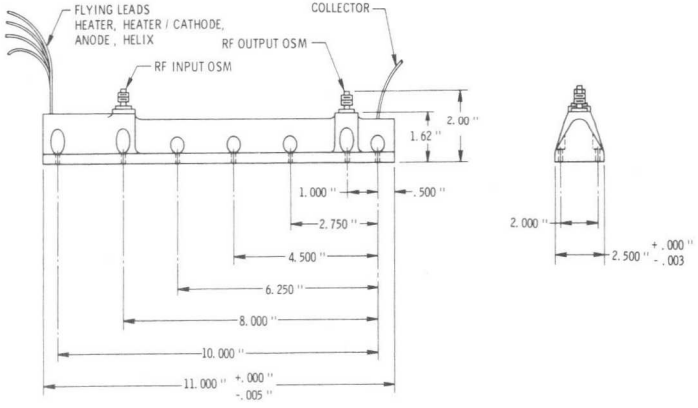


**FIG. 3. TYPICAL POWER TRANSFER CHARACTERISTICS**

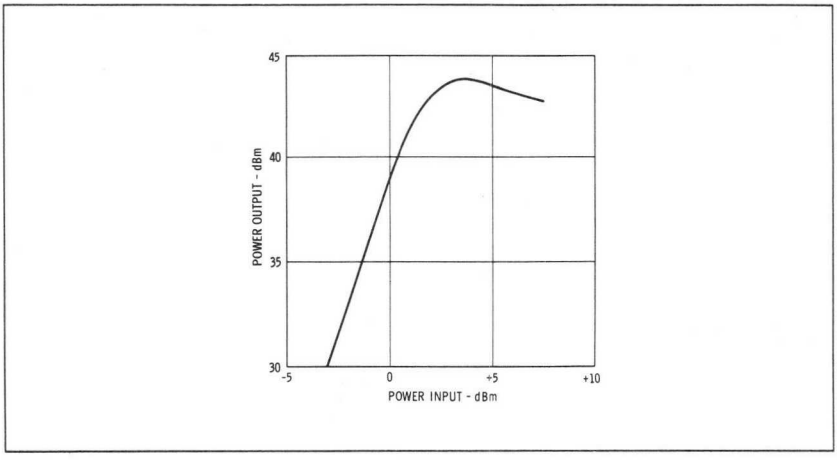
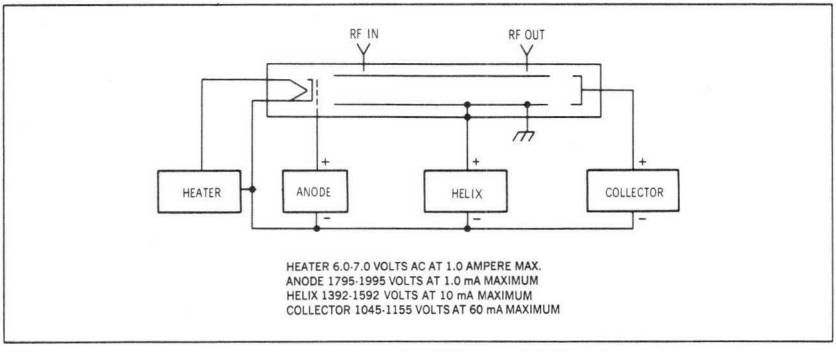



**FIG. 4.**
**PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-398-1.**




NOTE:

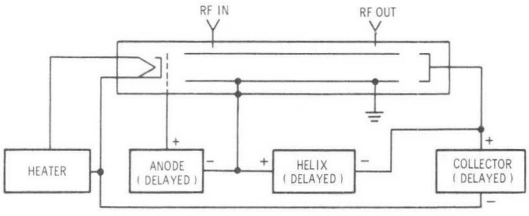
TO ENSURE THAT THE TWT IS OPERATED PROPERLY, IT IS SUGGESTED THAT VOLTAGES BE APPLIED AS FOLLOWS:

1. SLOWLY APPLY FILAMENT VOLTAGE UNTIL SPECIFIED VALUE IS REACHED, OBSERVING THAT FILAMENT DOES NOT EXCEED MAXIMUM VALUE. ALLOW AT LEAST 2 MINUTES FOR FILAMENT VOLTAGE TO STABILIZE.
2. SLOWLY APPLY COLLECTOR VOLTAGE UNTIL SPECIFIED VALUE IS REACHED.
3. SET ADJUSTABLE OVERCURRENT DISCONNECT CIRCUIT FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED, THEN SLOWLY INCREASE HELIX VOLTAGE TO SPECIFIED VALUE.
4. SLOWLY INCREASE ANODE VOLTAGE TO SPECIFIED VALUE, OBSERVING THAT CURRENT DOES NOT EXCEED MAXIMUM VALUE.

HELIX DISCONNECT CIRCUIT SHOULD FUNCTION SUCH THAT ALL VOLTAGES WILL BE DISABLED WITHIN 100 $\mu$SEC IF HELIX CURRENT EXCEEDS MAXIMUM VALUE.

## WJ-398-1

**FIG. 5. PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR WJ-398-1.**




HEATER 6.0-7.0 VOLTS AC AT 1.0 AMPERE MAX.
ANODE 1795-1995 VOLTS AT 1.0 mA MAXIMUM (sum of Anode, Helix, and Collector Supplies)
HELIX 1392-1592 VOLTS AT 10 mA MAXIMUM (sum of Helix and Collector Supplies)
COLLECTOR 1045-1155 VOLTS AT 60 mA MAXIMUM

NOTE:
WITH THIS CONFIGURATION, ANODE SUPPLY CAN NOT CUTOFF TUBE EMISSION. TO PREVENT DAMAGE TO TWT, VOLTAGES MUST BE APPLIED TO TWT IN THE FOLLOWING SEQUENCE:

1. APPLY HEATER VOLTAGE SLOWLY TO ALLOW FILAMENT RESISTANCE CHANGE AS TEMPERATURE RISES.
2. COLLECTOR, HELIX, AND ANODE VOLTAGES MAY BE APPLIED SIMULTANEOUSLY AFTER HEATER VOLTAGE HAS BEEN ON FOR 2 MINUTES MINIMUM.

**CAUTION**

HELIX OVERCURRENT DISCONNECT CIRCUIT MUST BE SET FOR MAXIMUM HELIX CURRENT VALUE SPECIFIED AND MUST DISCONNECT ALL VOLTAGES IN LESS THAN 100 $\mu$SEC IF MAXIMUM VALUE IS EXCEEDED.

# TECHNICAL DATA

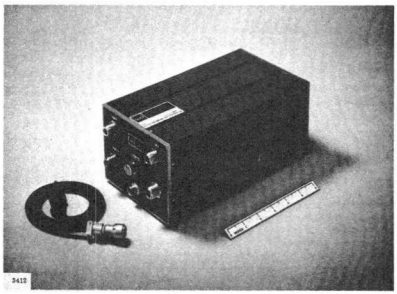
WATKINS-JOHNSON

# WJ-404

## 0.5 to 1.0 GHz LOW-NOISE TWT DUAL AMPLIFIER WITH INTEGRAL POWER SUPPLY

August 1967

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 8.5 dB max.
- POWER OUTPUT: + 5 dBm
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"



The WJ-404 is the P-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply. A low noise figure combined with high power output and small size are standard features of this amplifier. Its outstanding feature is gain matching between channels to provide a guaranteed maximum gain difference of 2.0 dB at any frequency within the operating range, and over the temperature range of −54°C to +55°C.

The WJ-404 is well suited for airborne military systems applications. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g at frequencies up to 500 Hz. Performance is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials.

## SPECIFICATIONS

| PERFORMANCE (Each Channel) | Typical | Guaranteed |
|---|---|---|
| Frequency | 0.5-1.0 GHz | 0.5-1.0 GHz |
| Noise figure, terminal | 7.0 dB | 8.5 dB max. |
| Gain, small signal | 28 dB | 25 dB min. |
| Gain, matching | 1.0 dB | 2.0 dB max. |
| Warm-up time | | 15 minutes max. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +7 dBm | +5 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 Vac | 115 ±10 Vac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 watts | |

# WJ-404

## ENVIRONMENTAL CHARACTERISTICS

Temperature, operating . . . . . −54°C to +55°C
Temperature, non-operating . . . −62°C to +85°C
Vibration
a. 0.10 inch, double amplitude . . . . 5 to 45 Hz
b. 5G, single amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 G, 11 ms
Altitude . . . . . 50,000 feet
Humidity . . . . . 95%

## MECHANICAL CHARACTERISTICS

Amplifier length
(excluding connectors) . . . . . 10.0 inches, max.
Amplifier height . . . . . 4.5 inches, max.
Amplifier width . . . . . 5.5 inches, max.
Weight . . . . . 14.5 pounds, max.
Primary power connection,
Bendix . . . . . PT-07C-8-3P
RF connections
(50 ohm, nominal) . . . . . Type N, Jack
Watkins-Johnson Outline Drawing . . . . . 290058

Each tube of the dual-amplifier package shall meet the performance specifications listed.

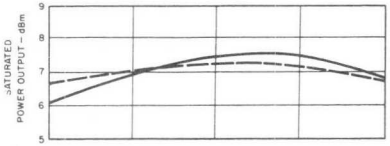
At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.

The amplifier shall meet all guaranteed parameters within the specified time.

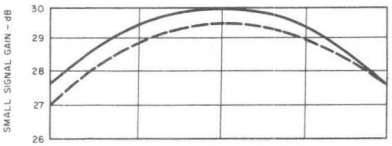
Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.

All performance specifications shall be met over the specified temperature range.

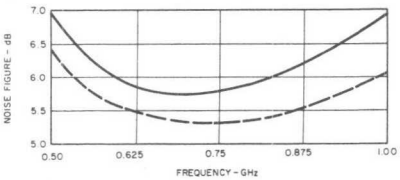
## POWER



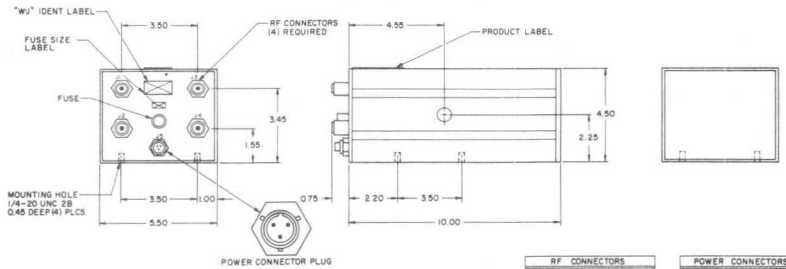

## GAIN




## NOISE




## OUTLINE DRAWING




| RF CONNECTORS | |
|---|---|
| INPUT: TYPE N-JACK (J1 & J3) | |
| OUTPUT: TYPE N-JACK (J2 & J4) | |

| POWER CONNECTORS | |
|---|---|
| BENDIX (J5) | |
| PT 07C -8-3P (PLUG) | |
| MS3116E-8-3S (SR) (SOC) | |
| PIN | CONNECTION |
| C | AC (HOT) 115±10 VAC |
| B | GROUND 48 – 420 Hz |
| A | AC SINGLE PHASE |

# TECHNICAL DATA

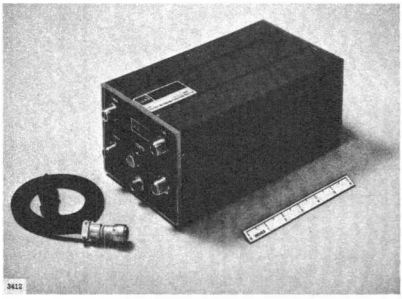
WATKINS-JOHNSON

# WJ-405

## 1 to 2 GHz LOW-NOISE TWT DUAL AMPLIFIER WITH INTEGRAL POWER SUPPLY

August 1967

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 8.5 dB max.
- POWER OUTPUT: + 7 dBm min.
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"



The WJ-405 is the L-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply. Its outstanding feature is gain matching between channels to provide a guaranteed maximum gain difference of 2.0 dB at any frequency within the operating range, and over the temperature range of −54°C to +55°C. Standard features include a low noise figure combined with high power output and small size.

Performance of the WJ-405 is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g at frequencies up to 500 Hz. The WJ-405 is well suited for airborne military systems applications.

## SPECIFICATIONS

| PERFORMANCE (Each Channel) | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0-2.0 GHz | 1.0-2.0 GHz |
| Noise figure, terminal | 7.0 dB | 8.5 dB max. |
| Gain, small signal | 30 dB | 25 dB min. |
| Gain, matching | 1.0 dB | 2.0 dB max. |
| Warm-up time | | 15 minutes max. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +9 dBm | +7 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 Vac | 115 ±10 Vac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 watts | |

# WJ-405

## ENVIRONMENTAL CHARACTERISTICS

Temperature, operating .....–54°C to +55°C
Temperature, non-operating ...–62°C to +85°C
Vibration
a. 0.10 inch, double amplitude....5 to 45 Hz
b. 5G, single amplitude.....45 to 500 Hz
Shock .....15 G, 11 ms
Altitude ..... 50,000 feet
Humidity ..... 95%

## MECHANICAL CHARACTERISTICS

Amplifier length
(excluding connectors).....10.0 inches, max.
Amplifier height.....4.5 inches, max.
Amplifier width .....5.5 inches, max.
Weight ..... 14.5 pounds, max.
Primary power connection,
Bendix ..... PT-07C-8-3P
RF connections
(50 ohm, nominal) ..... Type N, Jack
Watkins-Johnson Outline Drawing.....290058

Each tube of the dual-amplifier package shall meet the performance specifications listed.

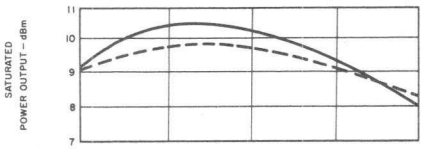
At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.

The amplifier shall meet all guaranteed parameters within the specified time.

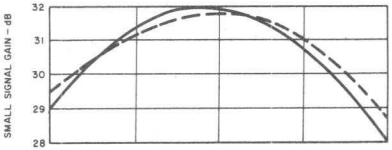
Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.

All performance specifications shall be met over the specified temperature range.

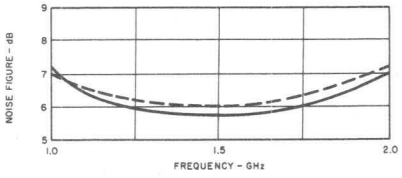
## POWER



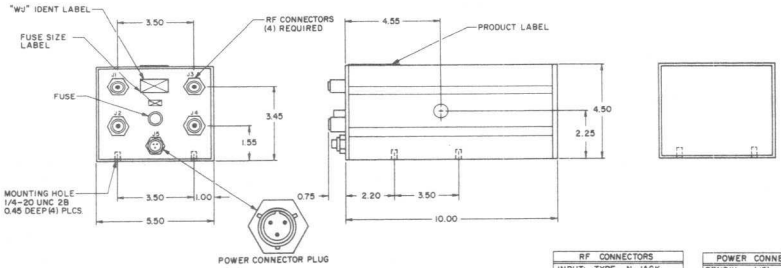

## GAIN




## NOISE




## OUTLINE DRAWING




| RF CONNECTORS |
|---|
| INPUT: TYPE N-JACK (J1 & J3) |
| OUTPUT: TYPE N-JACK (J2 & J4) |

| POWER CONNECTORS | | |
|---|---|---|
| BENDIX (J5) | | |
| PT 07C-8-3P (PLUG) | | |
| MS3116E-8-3S (SR) (SOC) | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 115±10 VAC |
| B | GROUND | 48-420 $H_z$ |
| A | AC | SINGLE PHASE |

# TECHNICAL DATA

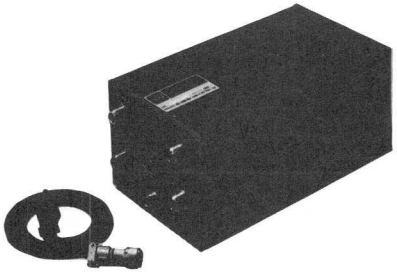
WATKINS-JOHNSON

# WJ-406

August 1967

## 2 to 4 GHz LOW-NOISE TWT DUAL AMPLIFIER WITH INTEGRAL POWER SUPPLY

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 8.5 dB max.
- POWER OUTPUT: + 7 dBm min.
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"



The WJ-406 is the S-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply. It combines the standard features (low noise figure/high power output/small size) of all W-J low-noise amplifiers with a special feature of this family: gain matching between channels to provide a guaranteed maximum gain difference of 2.0 dB at any frequency within the operating range, and over the temperature range of −54° to +55°C.

Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g at frequencies up to 500 Hz. In addition to these features, performance is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials, making the WJ-406 well suited for airborne military systems applications.

## SPECIFICATIONS

| PERFORMANCE (Each Channel)[1] | Typical | Guaranteed |
|---|---|---|
| Frequency[2] | 2.0-4.0 GHz | 2.0-4.0 GHz |
| Noise figure, terminal | 7.5 dB | 8.5 dB max. |
| Gain, small signal | 30 dB | 25 dB min. |
| Gain, matching | 1.0 dB | 2.0 dB max. |
| Warm-up time[3] | | 15 minutes max. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +10 dBm | +7 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[4] |
|---|---|---|
| Primary Voltage | 115 Vac | 115 ±10 Vac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 watts | |

# WJ-406

## ENVIRONMENTAL CHARACTERISTICS[5]

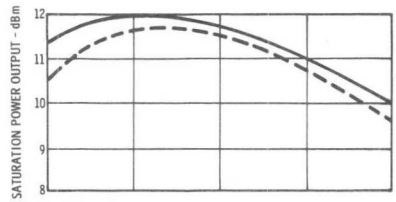
Temperature, operating . . . . . −54°C to +55°C
Temperature, non-operating . . . −62°C to +85°C
Vibration
a. 0.10 inch, double amplitude . . . 5 to 45 Hz
b. 5G, single amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 G, 11 ms
Altitude . . . . . 50,000 feet
Humidity . . . . . 95%

## MECHANICAL CHARACTERISTICS

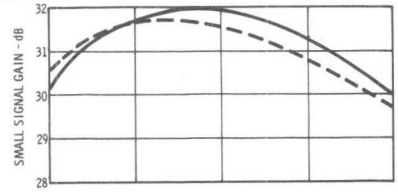
Height . . . . . 4.5 inches (114 mm) max.
Width . . . . . 5.5 inches (140 mm) max.
Length (excluding connectors) . . . . . 10 inches (254 mm) max.
Weight . . . . . 14.5 pounds (6.58 Kg) max.
Primary power connection, Bendix . . . . . PT-07C-8-3P
RF connections (50 ohm, nominal) . . . . . Type N, Jack
Watkins-Johnson Outline Drawing . . . . . 290058

1. Each tube of the dual-amplifier package shall meet the performance specifications listed.
2. At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.
3. The amplifier shall meet all guaranteed parameters within the specified time.
4. Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.
5. All performance specifications shall be met over the specified temperature range.

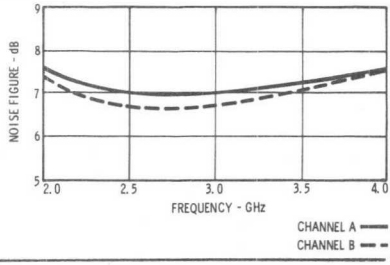
## POWER



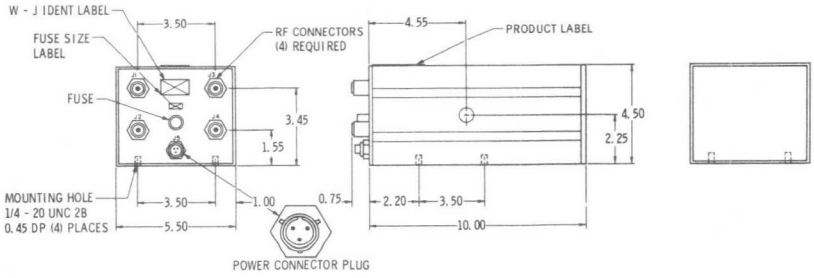

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

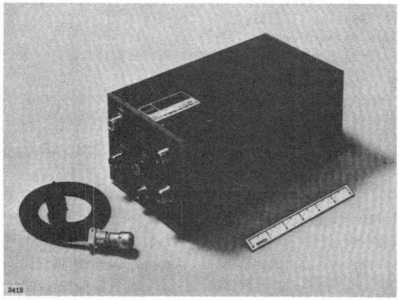
WATKINS-JOHNSON

# WJ-407

## 4 to 8 GHz LOW-NOISE TWT DUAL AMPLIFIER WITH INTEGRAL POWER SUPPLY

August 1967

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 9.0 dB max.
- POWER OUTPUT: + 7 dBm
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"



The WJ-407, C-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply, features gain matching between channels to provide a guaranteed maximum gain difference of 2.0 dB at any frequency within the operating range, and over the temperature range of −54°C to +55°C. Additional features, which are standard on all W-J low-noise amplifiers, include a low noise figure, high power output, and small size.

Performance of the WJ-407 is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials. Reliable operation under vibrational forces of 5g at frequencies up to 500 Hz is ensured by rugged construction of tube, magnet, and power supply. These operational features make the WJ-407 particularly suitable for airborne military systems applications.

## SPECIFICATIONS

| PERFORMANCE (Each Channel) | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0-8.0 GHz | 4.0-8.0 GHz |
| Noise figure, terminal | 7.5 dB | 9.0 dB max. |
| Gain, small signal | 29 dB | 25 dB min. |
| Gain, matching | 1.0 dB | 2.0 dB max. |
| Warm-up time | | 15 minutes max. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +10 dBm | +7 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 Vac | 115 ±10 Vac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 watts | |

# WJ-407

## ENVIRONMENTAL CHARACTERISTICS

Temperature, operating . . . . . –54°C to +55°C
Temperature, non-operating . . . –62°C to +85°C
Vibration
a. 0.10 inch, double amplitude . . . 5 to 45 Hz
b. 5G, single amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 G, 11 ms
Altitude . . . . . 50,000 feet
Humidity . . . . . 95%

## MECHANICAL CHARACTERISTICS

Amplifier length
(excluding connectors) . . . . . 10.0 inches, max.
Amplifier height . . . . . 4.5 inches, max.
Amplifier width . . . . . 5.5 inches, max.
Weight . . . . . 14.5 pounds, max.
Primary power connection,
Bendix . . . . . PT-07C-8-3P
RF connections
(50 ohm, nominal) . . . . . Type N, Jack
Watkins-Johnson Outline Drawing . . . . . 290058

Each tube of the dual-amplifier package shall meet the performance specifications listed.

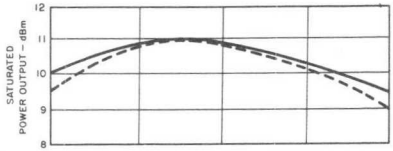
At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.

The amplifier shall meet all guaranteed parameters within the specified time.

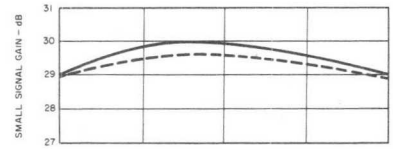
Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.

All performance specifications shall be met over the specified temperature range.

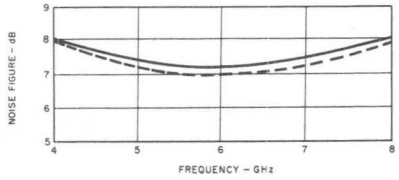
## POWER



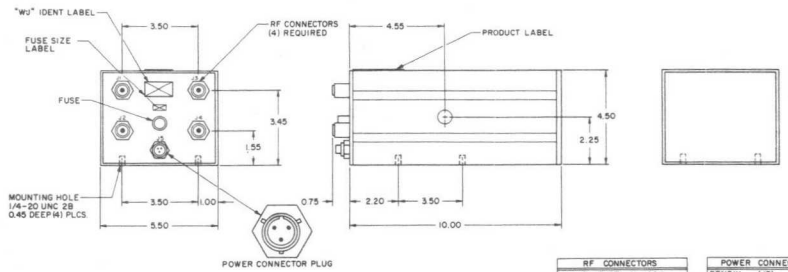

## GAIN




## NOISE




## OUTLINE DRAWING




| RF CONNECTORS | |
|---|---|
| INPUT: TYPE N-JACK (J1 & J3) | |
| OUTPUT: TYPE N-JACK (J2 & J4) | |

| POWER CONNECTORS | | |
|---|---|---|
| BENDIX (J5) | | |
| PT 07C-8-3P (PLUG) | | |
| MS3116E-8-3S (SR) (SOC) | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 115±10 VAC |
| B | GROUND | 48–420 Hz |
| A | AC | SINGLE PHASE |

# TECHNICAL DATA

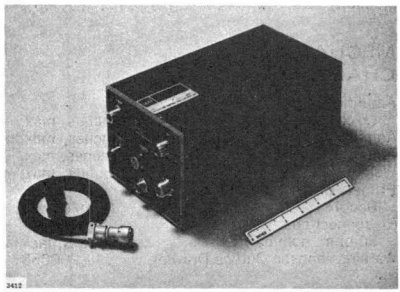
WATKINS-JOHNSON

# WJ-408

## 8 to 12 GHz LOW-NOISE TWT DUAL AMPLIFIER WITH INTEGRAL POWER SUPPLY

August 1967

- MATCHED GAIN: 2.0 dB max.
- NOISE FIGURE: 9.5 dB max.
- POWER OUTPUT: + 7 dBm min.
- PERMANENT MAGNET FOCUSING
- ADJUSTMENT FREE OPERATION
- "JUST PLUG IT IN"



The X-band member of Watkins-Johnson's newest family of low-noise dual amplifiers with PM focusing and integral power supply is designated WJ-408. Its outstanding feature is gain matching between channels to provide a guaranteed maximum difference of 2.0 dB at any frequency within the operating range and over the temperature range of −54°C to +55°C. Standard features include a low noise figure combined with high power output and small size.

The WJ-408 is well suited for airborne military systems applications. Rugged consruction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g at frequencies up to 500 Hz. Performance is unaffected by operation in stacked arrays or adjacent to ferromagnetic materials.

## SPECIFICATIONS

| PERFORMANCE (Each Channel) | Typical | Guaranteed |
|---|---|---|
| Frequency | 8.0-12.0 GHz | 8.0-12.0 GHz |
| Noise figure, terminal | 8.5 dB | 9.5 dB max. |
| Gain, small signal | 30 dB | 25 dB min. |
| Gain, matching | 1.0 dB | 2.0 dB max. |
| Warm-up time | | 15 minutes max. |
| VSWR, input and ouput | 1.5:1 | 2:1 max. |
| Power output | +10 dBm | +7 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary Voltage | 115 Vac | 115 ±10 Vac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 25 watts | |

# WJ-408

## ENVIRONMENTAL CHARACTERISTICS

Temperature, operating ..... —54°C to +55°C
Temperature, non-operating ... —62°C to +85°C
Vibration
a. .10 inch, double amplitude ..... 5 to 45 Hz
b. 5G, single amplitude ..... 45 to 500 Hz
Shock ..... 15 G, 11 ms
Altitude ..... 50,000 feet
Humidity ..... 95%

## MECHANICAL CHARACTERISTICS

Amplifier length
(excluding connectors) ..... 10.0 inches, max.
Amplifier height ..... 4.5 inches, max.
Amplifier width ..... 5.5 inches, max.
Weight ..... 14.5 pounds, max.
Primary power connection,
Bendix ..... PT-07C-8-3P
RF connections
50 ohm, nominal) ..... Type N, jack
Watkins-Johnson Outline Drawing ..... 290058

Each tube of the dual-amplifier package shall meet the performance specifications listed.

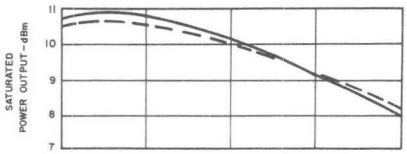
At any frequency within the band, the difference in small signal gain between the two channels shall not exceed the specified limit.

The amplifier shall meet all guaranteed parameters within the specified limit.

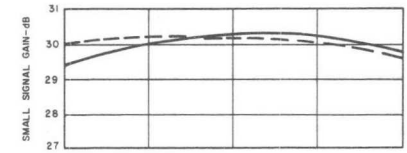
Each tube shall meet the guaranteed performance specifications within these primary voltage and frequency ranges.

All performance specifications shall be met over the specified temperature range.

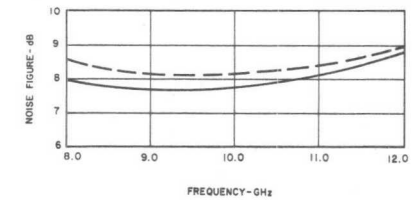
## POWER



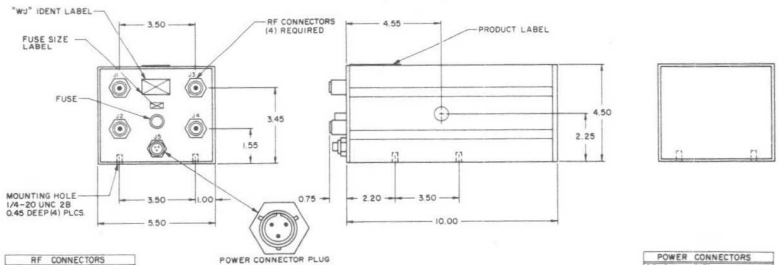

## GAIN




## NOISE




## OUTLINE DRAWING




| RF CONNECTORS |
|---|
| INPUT: TYPE N-JACK (J1 & J3) |
| OUTPUT: TYPE N-JACK (J2 & J4) |

| POWER CONNECTORS | | |
|---|---|---|
| BENDIX (J5) | | |
| PT 07C -8-3P (PLUG) | | |
| MS3116E-8-3S (SR) (SOC) | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 115 ± 10 VAC |
| B | GROUND | 48 – 420 $H_z$ |
| A | AC | SINGLE PHASE |

# TECHNICAL DATA

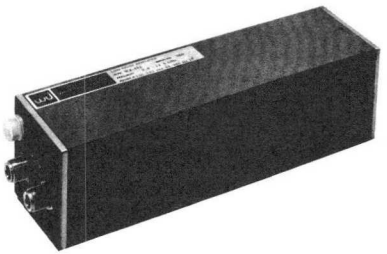
WATKINS-JOHNSON

# WJ-422

APRIL 1970 *

## 2 to 4 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- GUARANTEED +10 dBm POWER OUTPUT
- GUARANTEED 7.5 dB NOISE FIGURE ACROSS FULL S-BAND
- SMALL SIZE: 3x3x10.5 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT



The WJ-422 is one of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other S-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-422 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-422 meet the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise figure, terminal | 7.0 dB | 7.5 dB max. |
| Gain, Small Signal | 32 dB | 25 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +12 dBm | +10 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary Current | 120 mA | |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 10 watts | |

*Supersedes WJ-422 Technical Data Sheet dated February 1968.

# WJ-422

## ENVIRONMENTAL CHARACTERISTICS[2]

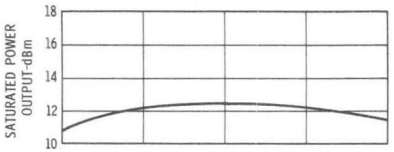
Temperature ..... —54° C to +71°C
Vibration
a. .10 inch, double amplitude ..... 5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 G, 11 ms

## MECHANICAL CHARACTERISTICS

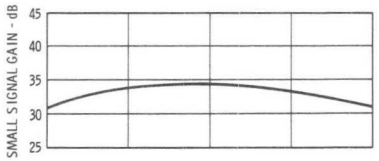
Height ..... 3inches (76 mm) max.
Width ..... 3 inches (76 mm) max.
Length (excluding connectors ..... 10.5 inches (267mm) max.
Weight ..... 6.5 pounds (2.95 Kg) max.
Primary power connection, Bendix receptacle ..... PT07C-8-3p
RF connections (50 ohms, nominal) ..... Type N, jack

1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
2. These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

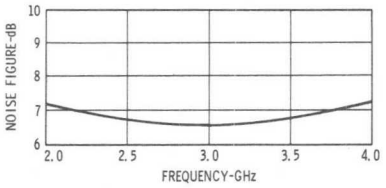
## POWER



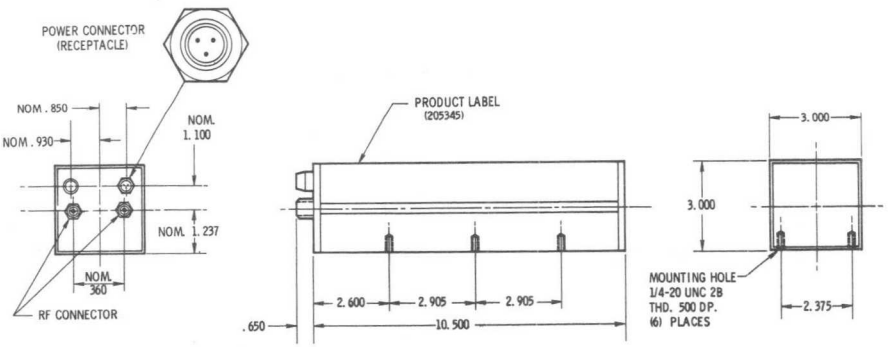

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

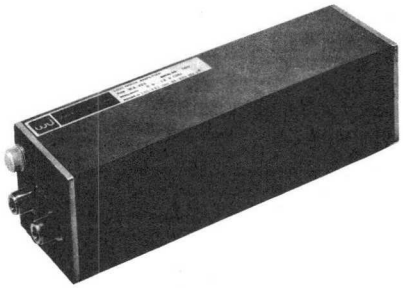
WATKINS-JOHNSON

# WJ-423

APRIL 1970 *

## 4 to 8 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- GUARANTEED 7.5 dB NOISE FIGURE ACROSS FULL C-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 3x3x10.5 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT



The WJ-423 is one of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. Featuring a wide dynamic range in a rugged and compact configuration, this tube produces 20 mW output power with 6.5 dB noise figure over half of the C-band frequency range. In addition, it is completely self-contained and adjustment-free, operating with only an ac line voltage input.

The WJ-423 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-423 meet the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0 to 8.0 GHz | 4.0 to 8.0 GHz |
| Noise figure, terminal | 7.0 dB | 7.5 dB max. |
| Gain, Small Signal | 32 dB | 25 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +12 dBm | +10 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 10 watts | |
| Primary current | 120 mA | |

*Supersedes WJ-423 Technical Data Sheet dated January 1968.

# WJ-423

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature ..... —54° C to +71°C
Vibration
a. .10 inch, double amplitude ..... 5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 G, 11 ms

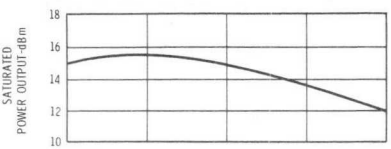
## MECHANICAL CHARACTERISTICS

Height ..... 3inches (76 mm) max.
Width ..... 3 inches (76 mm) max.
Length (excluding connectors ..... 10.5 inches (267mm) max.
Weight ..... 6.5 pounds (2.95 Kg) max.
Primary power connection, Bendix receptacle ..... PT07C-8-3p
RF connections (50 ohms, nominal) ..... Type N, jack

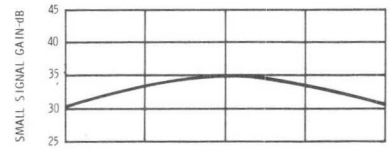
Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

These environmental characteristics meet the respective requirements for MIL-E-5400, Class 2.

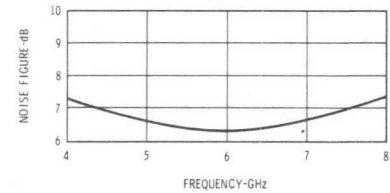
## POWER



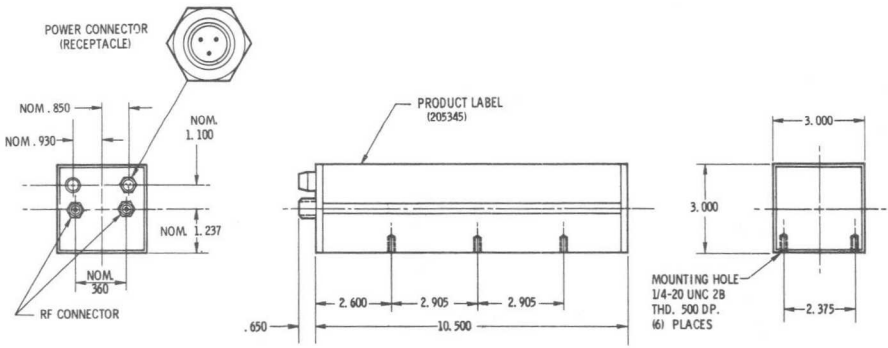

## GAIN




## NOISE




## OUTLINE DRAWING



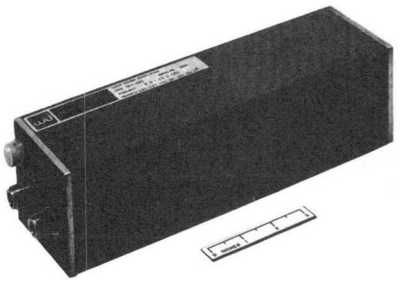
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970 *

## 8 TO 12 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-424

- "JUST PLUG IT IN"
- GUARANTEED 7.5 dB NOISE FIGURE ACROSS FULL X-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 3x3x10.5 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT



The WJ-424 is the first of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other X-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-424 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of —54° to +71°C. These environmental characteristics of the WJ-424 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 8.0 to 12.0 GHz | 8.0 to 12.0 GHz |
| Noise figure, terminal | 7.0 dB | 7.5 dB max. |
| Gain, Small Signal | 32 dB | 25 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | 13 dBm | 10 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary current | 120 mA | |
| Primary power | 10 watts | |

*Supersedes WJ-424 Technical Data Sheet dated January 1969.

# WJ-424

## ENVIRONMENTAL CHARACTERISTICS[2]

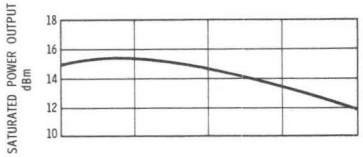
Temperature ..... —54° C to +71°C
Vibration
a. .10 inch, double amplitude .....5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 G, 11 ms

## MECHANICAL CHARACTERISTICS

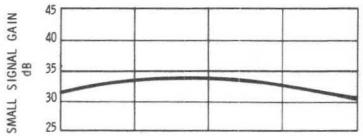
Height ..... 3inches (76 mm) max.
Width ..... 3 inches (76 mm) max.
Length (excluding connectors ..... 10.5 inches (267mm) max.
Weight ..... 6.5 pounds (2.95 Kg) max.
Primary power connection, Bendix receptacle ..... PT07C-8-3p
RF connections (50 ohms, nominal) ..... Type N, jack

[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
[2]These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

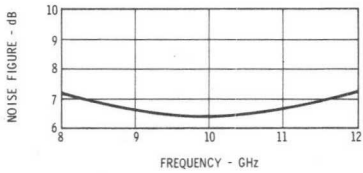
## POWER



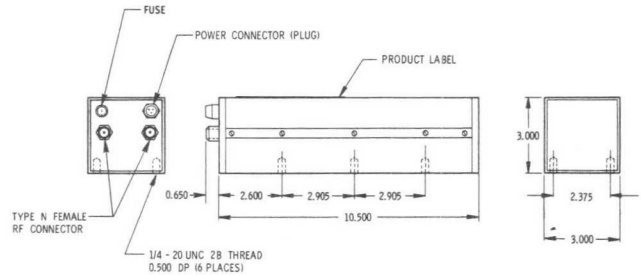

## GAIN




## NOISE




## OUTLINE DRAWING



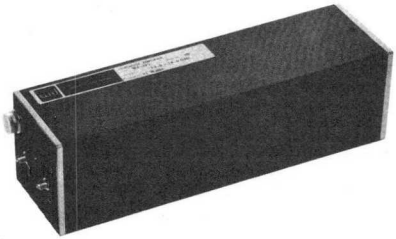
# TECHNICAL DATA

WATKINS-JOHNSON

JANUARY 1970

## 12 TO 18 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-425

- "JUST PLUG IT IN"
- GUARANTEED 10 dB NOISE FIGURE ACROSS FULL Ku-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 3 x 3 x 10.5 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT



The WJ-425 is one of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson to meet the increasing demand for reliable microwave devices. No other Ku-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-425 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-425 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 12.0 to 18.0 GHz |
| Noise figure, terminal[1] | 9 dB | 10 dB max. |
| Gain, Small Signal | 30 dB | 25 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | 13 dBm | 10 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[2] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary current | 150 mA | |
| Primary power | 17 watts | |

## WJ-425

### ENVIRONMENTAL[3] CHARACTERISTICS

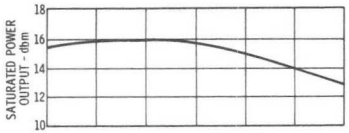
Temperature . . . . . –54°C to +71°C
Vibration
a. 0.10 inch, double amplitude . . . . . 5 to 45 Hz
b. 10 g, single amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 G, 11 ms

### MECHANICAL CHARACTERISTICS

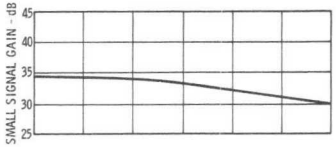
Height . . . . . 3 inches (76 mm) max.
Width . . . . . 3 inches (76 mm) max.
Length (excluding connectors) . . . . . 10.5 inches (267 mm) max.
Weight . . . . . 7 pounds (3.18 kg) max.
Primary power connection, Bendix receptacle . . . . . PTO7C-8-3p
RF connections (50 ohms, nominal) . . . . . Type OSM, Jack

1. Noise figure is as read on an HP Noise Figure Meter model 340 B, using HP Noise Sources model H 347 A and model X 347 A.
2. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.
3. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

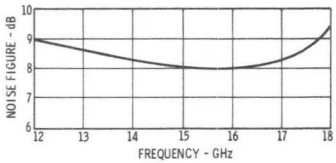
### POWER



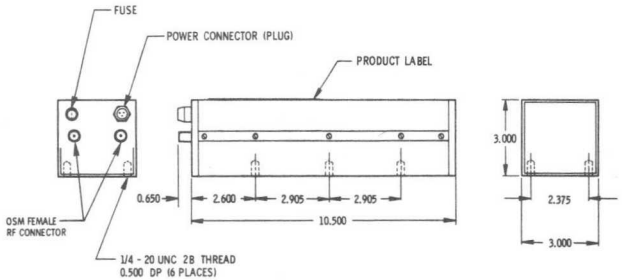

### GAIN




### NOISE



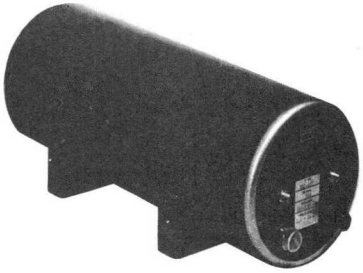

### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

## 8 TO 18 GHz
## LOW-NOISE TRAVELING-WAVE AMPLIFIER
## WITH INTEGRAL POWER SUPPLY
## WJ-437



- **"JUST PLUG IT IN"**
- **NOISE FIGURE 9.5 dB MAXIMUM**
- **PERMANENT-MAGNET FOCUSING**
- **NO ADJUSTMENTS NEEDED**
- **MEETS TEMPERATURE, VIBRATION AND SHOCK REQUIREMENTS OF MIL-E-5400, CLASS 2**

WJ-437 is one of a family of PM-focused, integral power supply traveling wave amplifiers built by Watkins-Johnson.

Covering the entire 8 to 18 GHz range, this amplifier typically exhibits a noise figure below 8.0 dB, a saturated power output above +5 dBm, and a small signal gain better than 30 dB across the band. This performance cannot even be challenged by any of the narrower band counterparts in the 8 to 18 GHz band. (Some WJ-437's have exhibited noise figures below 8.5 dB across the 8-18 GHz band.)

The amplifier is completely self-contained, adjustment free, and requires only a 115 volt ac line voltage input (48 to 420 Hz). The completely shielded package may be operated in any orientation, in stacked arrays or adjacent to ferromagnetic material, without adversely affecting the amplifier's performance.

With assurance of reliable operation under MIL-E-5400 (Temperature, Class 2; Vibration, Curve III), this broadband low noise amplifier allows unique applications as well as considerably enhancing prospects for existing ones.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 8.0 to 18.0 GHz | 8.0 to 18.0 GHz |
| Noise Figure, Terminal | 8.0 dB | 9.5 dB, max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2.5:1, max. |
| Power Output, Saturated | +5 dBm | +3 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 5 W | |

* Supersedes WJ-437 Technical Data Sheet dated December 1970.

# WJ-437

## ENVIRONMENTAL CHARACTERISTICS [2]

Temperature (Operating) ..... −54°C to +71°C
Vibration
0.10 Inch Double Amplitude ..... 5 to 30 Hz
5 g, Single Amplitude ..... 30 to 500 Hz
Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

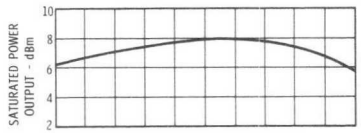
Height ..... 4.75 inches (121 mm) max.
Width ..... 4.75 inches (121 mm) max.
Length (excluding connectors) ..... 12 inches (305 mm) max.
Weight ..... 18 pounds (8.16 Kg) max.
Primary Power Connection, Bendix ..... PTO 7C-8-3P
RF Connections ..... SMA Female
Outline Drawing No. ..... 290210

NOTES:

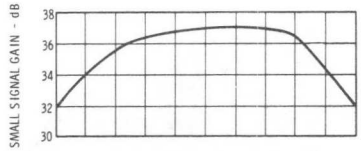
[1]Every amplifier will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400: Temperature, Class 2; Vibration, Curve III.

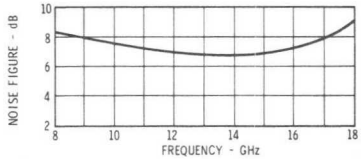
## POWER



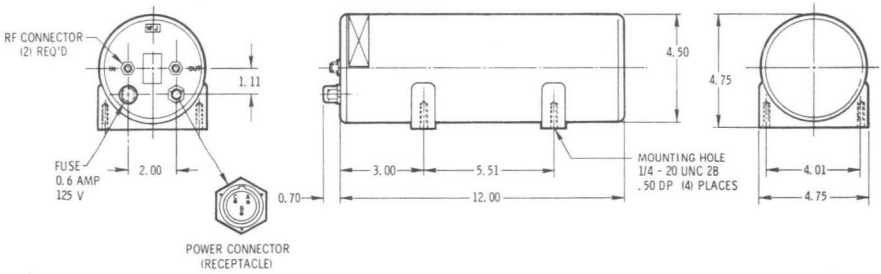

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT 07C-8-3P (RECEPTACLE) MS 3116 E-8-3S (PLUG) | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 105 - 125 VAC |
| B | GROUND | 48 - 420 Hz |
| A | AC | SINGLE PHASE |

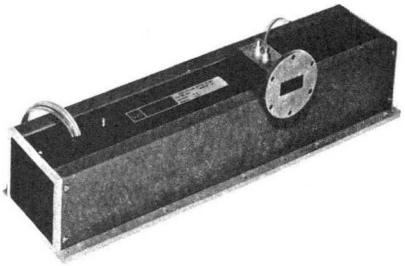
| RF CONNECTORS | |
|---|---|
| INPUT: | TYPE SMA FEMALE |
| OUTPUT: | TYPE SMA FEMALE |

# TECHNICAL DATA

WATKINS-JOHNSON

JUNE 1971

## 5.9 TO 6.4 GHz 600 WATT CW TRAVELING-WAVE TUBE WJ-440-4



The WJ-440-4 is a periodic-permanent-magnet (PPM) focused, 600 Watt CW traveling-wave tube designed for use in commercial satellite communication ground terminal equipments. It features a waveguide output for minimum VSWR and optimum phase, power output and gain performance across the 5.9 to 6.4 GHz frequency band. Forced air cooling is standard. A number of variations of the WJ-440-4 are available with performance optimized over different portions of the operating band, or over a full octave frequency band when fitted with a coaxial output.

### SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 5.9 — 6.5 GHz | 5.925 — 6.425 GHz |
| Power Output | 700 watts | 600 watts, min. |
| Gain | 40 dB | 30 dB at rated power |
| Load VSWR | | 2.0:1 max. |
| Group Delay | 0.67 nanosecond | 1.0 nanosecond, max. |
| **PRIMARY ELECTRICAL REQUIREMENTS** | | |
| Cathode Voltage | −8.4 kV | −8.0 to −9.0 kV |
| Cathode Current | 0.54 A | 0.49 to 0.55 amperes, max. |
| Circuit Voltage | Grounded | Grounded |
| Circuit Current | 18 mA | 15 to 40 mA, max. |
| Cathode to Collector Voltage | 4.8 kV | 4.5 to 5 kV |
| Collector Current | 0.522 | 0.475 to 0.55 amperes, max. |
| Filament Voltage | 6.3 V | 6.3 volts ±2% |
| Filament Current | 2.5 A | 2.5 ±0.5 amperes |
| **MECHANICAL CHARACTERISTICS** | | |
| Length | | 20.0 inches (50.8 cm), max. |
| Cross Section Excluding Connectors | | 3.5 x 4.0 inches (8.9 x 10.2 cm), max |
| Focusing | | PPM |
| Weight | | 17 pounds (7.75 kg), max. |
| Cooling, Forced Air | | 150 scfm (4.3 $m^3$/min.), min. with 65°C max. inlet temperature |
| Connectors | | |
| Output | | Type UG-344/U Flange |
| Input | | OSM |
| D.C. Flying Leads | | 12 inches |
| **ENVIRONMENTAL CHARACTERISTICS** | | |
| Altitude | | 10,000 feet (3,000 m) |
| Temperature | | Ambient −30° to ambient +65°C |

## PERFORMANCE CHARACTERISTICS

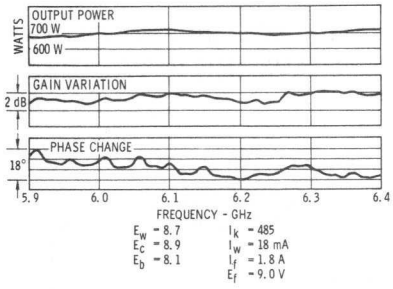



FIG. 1 - POWER, GAIN AND PHASE DATA RECORDED AT SATURATION.

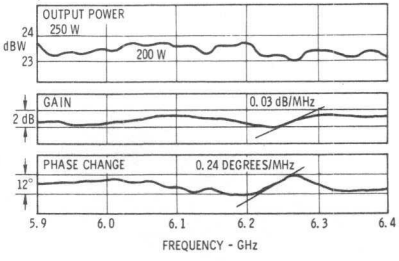



FIG. 2 - POWER OUTPUT, GAIN AND PHASE DATA IN THE LINEAR REGION.

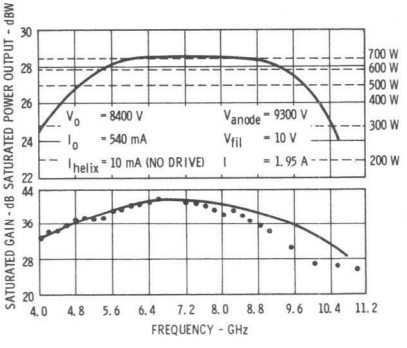



FIG. 3 - BROADBAND PERFORMANCE FOR WJ-440-4 WITH COAXIAL OUTPUT.

## PERFORMANCE CHARACTERISTICS (Cont'd)

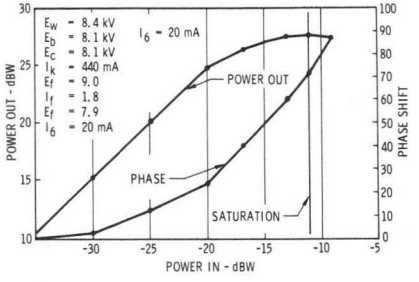



FIG. 4 - SIMULTANEOUS MEASUREMENT OF OUTPUT POWER AND PHASE CHANGE THROUGH THE TWT WITH DRIVE POWER. AT SATURATION THE AM TO PM CONVERSION IS 6°/dB.

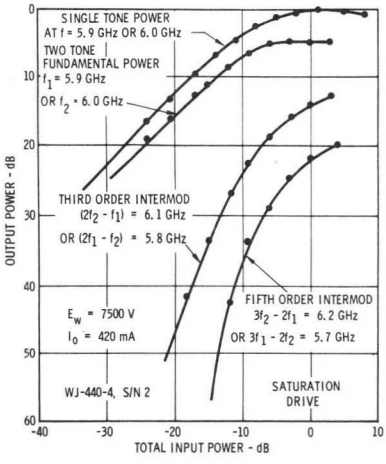
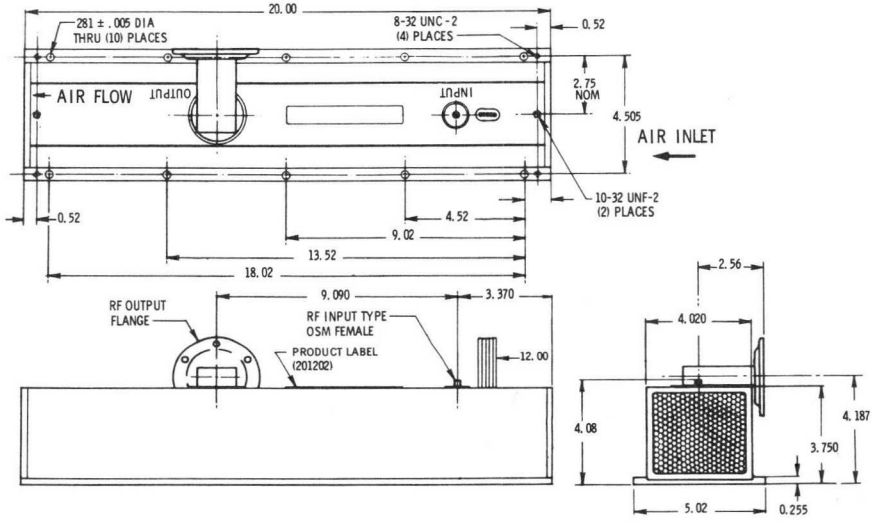



FIG. 5 - INTERMODULATION CHARACTERISTICS OF THE WJ-440-4, DRIVEN BY TWO SIGNALS OF EQUAL AMPLITUDE AT 5.9 AND 6.0 GHz.

## OUTLINE DRAWING



# TECHNICAL DATA

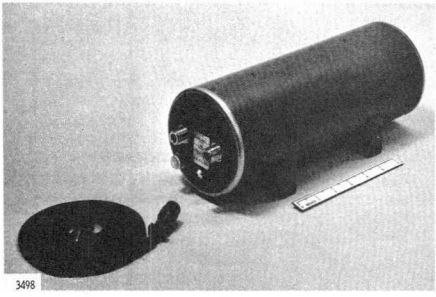
WATKINS-JOHNSON

# WJ-442

October 1968

## 1.0 to 4.0 GHz LOW-NOISE, TRAVELING-WAVE TUBE AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- NOISE FIGURE 7.0 dB
- L–S BANDS RANGE
- ADJUSTMENT-FREE OPERATION
- PERMANENT MAGNET FOCUSING
- MEETS MIL-E-5400, CLASS 2 SPECIFICATION


3498

The WJ-442 is one of a series of ultra-wide band LNTWAs developed by Watkins-Johnson Company for use in sensitive, ultra-wide-bandwidth receiver equipments. It offers economy of space, weight and price over two single-octave amplifiers covering the same frequency range. It features the same long-life design, rugged construction and adjustment-free operation characteristics of Watkins-Johnson's line of octave-band, low-noise amplifiers.

The WJ-442 may be mounted in any orientation and is built to withstand the shock, vibration, and temperature specifications of MIL-E-5400, Class 2. Magnetic shielding allows operation next to similar units, or to ferromagnetic material, without degradation of performance.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 1.0 - 4.0 GHz |
| Noise figure, terminal | 6.0 dB | 7.0 dB max. |
| Gain, small signal | 28 dB | 25 dB |
| Gain variation, small signal | ±3 dB | |
| VSWR, input and output | 1.5:1 | 2.5:1 max. |
| Power output | +3 dBm | 0 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 V ac | 115 ±10 V ac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 10 watts | |

[1]Every amplifier will meet the guaranteed performance specifications within these ranges.

# WJ-442

## ENVIRONMENTAL CHARACTERISTICS[2]

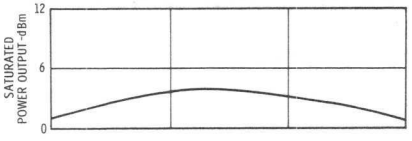
Temperature (Operating) . . . . . –54°C to +71°C
Vibration
0.10 Inch, Double Amplitude . . . . . 5 to 45 Hz
10 g, Single Amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

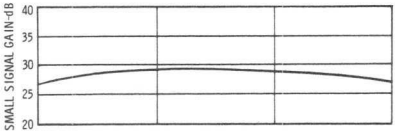
Amplifier Length
(excluding connectors) . . . . . 12 inches, max.
Amplifier Cross Section . . . . . 4.75 inches, max.
Amplifier Weight . . . . . 18 pounds, max.
Primary Power Connection
Bendix receptacle . . . . . PT-07C-8-3P
RF Connections
(50 ohms, nominal) . . . . . Type N, jack

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2.

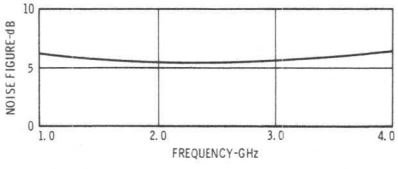
## POWER



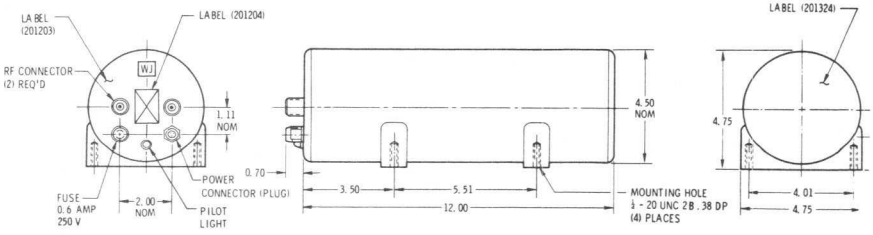

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT 07C - 8 - 3P (PLUG) MS 3116 E - 8 - 3S (SR) (SOC) | | |
| PIN | CONNECTION | |
| A | AC | 105 - 125 VAC |
| B | GROUND | 48 - 420 CPS |
| C | AC (HOT) | SINGLE PHASE |

# TECHNICAL DATA

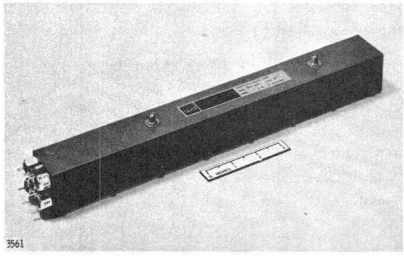
WATKINS-JOHNSON

# WJ-445-1

May 1968

## 2.0 TO 2.2 GHz, 1 WATT TRAVELING-WAVE TUBE

- OUTPUT POWER 1 WATT MINIMUM
- PPM FOCUSING
- EXTREMELY LOW DIFFERENTIAL TIME DELAY
- EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION
- VERY LOW PHASE NOISE




The WJ-445-1 medium power traveling-wave tube provides nearly distortionless power amplification of microwave signals in the frequency range of 2.0 to 2.2 GHz. The differential time delay and gain variations are extremely small when operated either at saturation or in the small signal region. In addition the AM/PM conversion coefficient can be reduced to a neglible value by operating down from saturation. As an example, AM/PM is typically less than 0.15°/dB at 17 dBm output, or less than 0.03°/dB at 10 dBm output.

The tube has been designed so as to introduce negligible spurious phase noise into the amplifying system. Positive ion drainage is provided effectively by operating the anode above and the collector below helix potential. This reduces both the AM and PM ion noise to an undetectable level.

The heater is isolated electrically from the cathode; with dc power to the filament the only phase noise introduced, even very close to the RF carrier is due to the inherent noise character of the tube and is related to its noise figure. This small residual PM is "white" in character, that is it is essentially independent of frequency.

The PPM focusing system uses Alnico-8 magnets which make it insensitive to temperature variations over its operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-445-1 is improved by depressing the collector voltage below the helix voltage.

In addition the WJ-445-1 may also be supplied with a very compact integral power supply, resulting in a fully integrated TWT amplifier.

## SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency range | 2.0 to 2.2 GHz | 2.0 to 2.2 GHz |
| Saturation power output | 2 watts | 1 watt, min. |
| Saturation gain | 31 dB | 30 dB, min. |
| Small signal gain | 36 dB | 35 dB, min. |
| Gross small signal gain variation | 0.2 dB | 0.5 dB, max. |
| Fine structure small signal gain variation | Less than .05 dB | 0.5 dB, max. |
| Differential time delay | ±0.1 ns | ±0.2 ns, max. |
| AM-PM conversion (at 1 watt) | 3.0°/dB | 4.0°/dB, max. |
| Noise figure | 27 dB | 29 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater voltage | 4.0 volts | 3.5 to 4.5 volts |
| Heater current | 0.8 A | 0.9 A max. |
| Anode voltage[1] | +1000 volts | 900 to 1100 volts |

# WJ-445-1

| SPECIFICATIONS (Cont'd) | Typical | Range |
|---|---|---|
| Anode current | Less than 0.1 mA | 1 mA, max. |
| Helix voltage[1] | +950 volts | 850 to 1050 volts |
| Helix current | 1.0 mA | 3 mA max. |
| Collector voltage[1] | +700 volts | 650 to 750 volts |
| Collector current | 20 mA | 25 mA max. |

NOTES: [1]These voltages are referenced to the cathode. Collector is operated at ground potential.

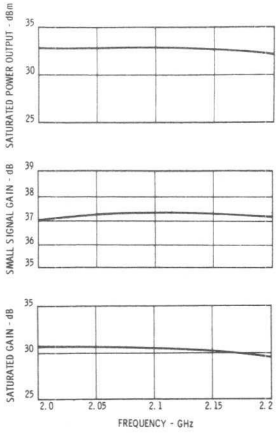
## MECHANICAL CHARACTERISTICS

Tube length ..... 13.75 inches, max.
Tube height, excluding connectors ..... 1.75 inch, max.
Tube width ..... 1.75 inch, max.
Tube weight ..... 2.5 lbs., max.
DC connectors ..... Solder Terminals
RF connectors ..... OSM (female)
Cooling ..... Conduction through baseplate
Focusing ..... PPM

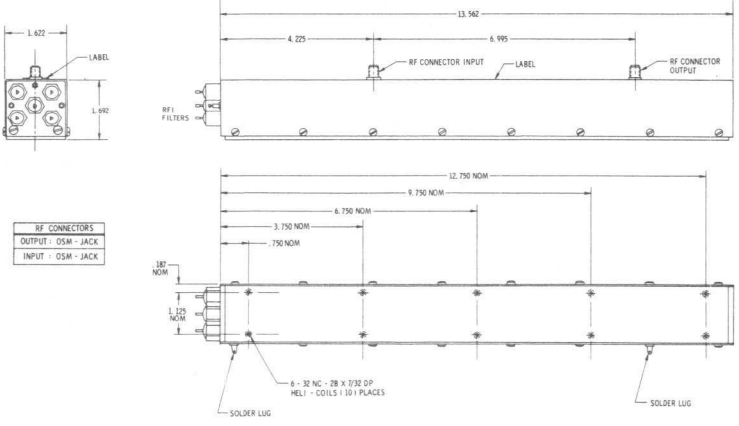
## ENVIRONMENTAL CHARACTERISTICS

Temperature ..... 0°C to 65°C (baseplate)
Vibration (120-2000 cycles) ..... 4 G rms
Shock ..... 20 G for 5 ms
Altitude ..... 0 to 12,000 ft.

## RF ELECTRICAL PERFORMANCE CHARACTERISTICS

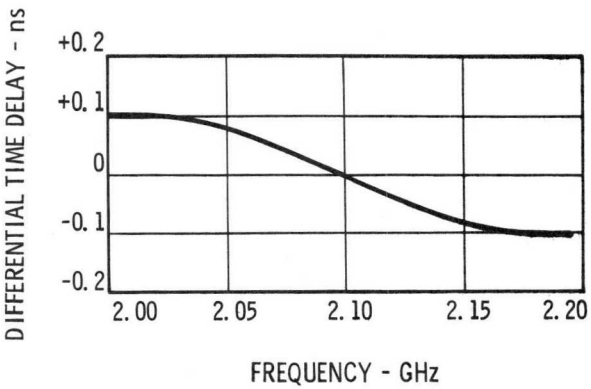



## OUTLINE DRAWING

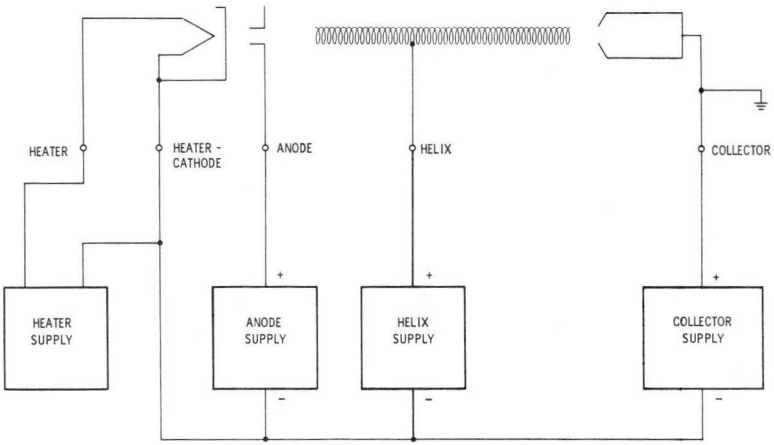


# WJ-445-1

## DIFFERENTIAL TIME DELAY




## TYPICAL POWER SUPPLY CONNECTIONS



# TECHNICAL DATA

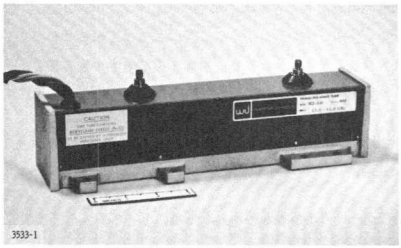
WATKINS-JOHNSON

# WJ-446

April 1968

## 11.5 TO 14.0 GHz 5 WATT CW TRAVELING WAVE TUBE

- OUTPUT POWER 5 WATTS MINIMUM
- PPM FOCUSING
- LOW PHASE AND GAIN VARIATION




The WJ-446 is one of a family of medium-power traveling-wave tubes designed by Watkins-Johnson Company for microwave amplification with a minimum of distortion.

The use of periodic-permanent-magnet focusing and metal-ceramic construction results in long life with trouble free operation. Ion drainage is provided to minimize the effects of aging during the life of the tube. The PPM-focusing system is temperature-compensated to make it insensitive to temperature variations over the operating range. The tube itself is cooled by conduction through the baseplate of the capsule.

The WJ-446 incorporates several special features. Operating efficiency, for instance, can be improved by depressing the collector voltage below the helix voltage. In addition, the tube may be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

## SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 11.5 to 14.0 GHz | 11.5 to 14.0 GHz |
| Saturation Power Output | 6 watts | 5 watts, min. |
| Saturation Gain | 34 dB | 32 dB, min. |
| Small Signal Gain | 41 dB | 39 dB, min. |
| Small Signal Gain Variation | ±0.5 dB | ±1 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.0 to 6.6 volts |
| Heater Current | 0.8 A | 1.0 A max. |
| Anode Voltage[1] | 3000 volts | 2800 to 3500 volts |
| Anode Current | 0.1 mA | 1.0 mA max. |
| Helix Voltage[1] | 4000 volts | 3800 to 4200 volts |
| Helix Current | 0.5 mA | 3 mA max. |
| Collector Voltage[1] | 2200 volts | 2000 to 4000 volts |
| Collector Current | 35 mA | 40 mA max. |

Notes: [1]All voltages are referenced to the cathode. Helix is operated at ground potential.

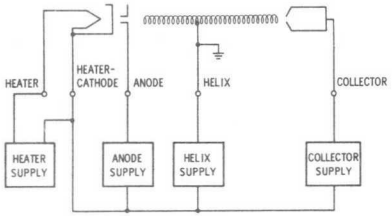
# WJ-446

## MECHANICAL CHARACTERISTICS

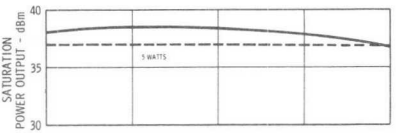
| | |
|---|---|
| Tube Length | 10.5 inches, max. |
| Tube Height, excluding connectors, | 2.5 inch, max. |
| Tube Width | 2.5 inch, max. |
| Tube Weight | 4.0 lbs. max. |
| DC Connectors | Flying Leads |
| RF Connectors | OSM (female) |
| Cooling | Conduction from bottom surface |
| Focusing | PPM |

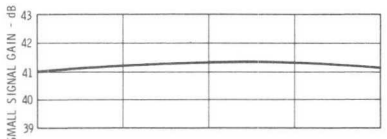
Can be qualified to meet requirements of MIL-E-5400.

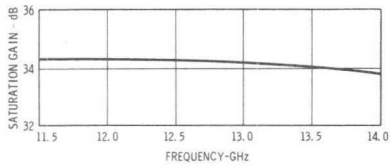
## TYPICAL POWER SUPPLY CONNECTIONS



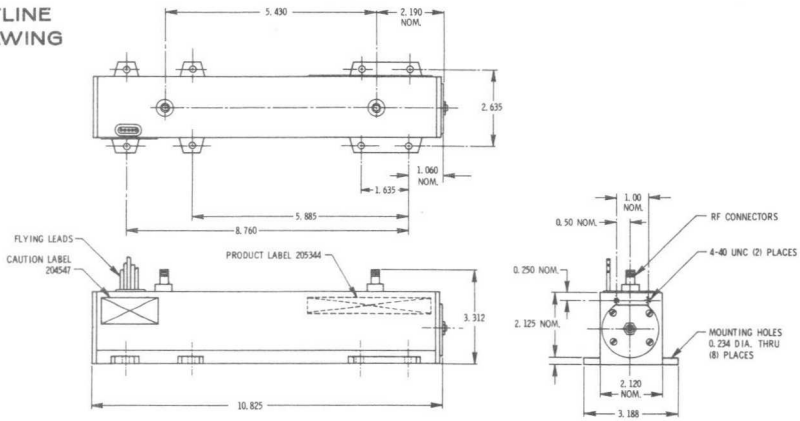

## RF ELECTRICAL PERFORMANCE CHARACTERISTICS




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-448-1

June 1968

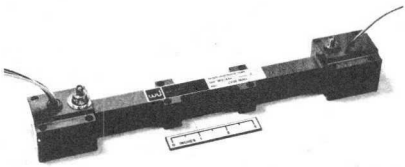
## 2.2 TO 2.3 GHz
## COMPACT, HIGH-EFFICIENCY, 50 WATT TRAVELING-WAVE TUBE FOR SPACE COMMUNICATIONS AND TELEMETRY

WJ-448-1 is a traveling-wave tube designed to meet the power amplifier requirements of earth-orbit and deep-space missions where high reliability, small size, light weight and maximum overall efficiency are essential.

This small, periodic-permanent-magnet focused TWT exhibits an overall efficiency, including heater power, above 40%. The metal-ceramic construction of the WJ-448-1 is just one of the design features used to assure the maximum in reliable, long-life operation. It has the ability to perform during and after extreme temperature, vibration, shock, and static acceleration.

The WJ-448-1 will deliver 50 watts of output power over the frequency range of 2.2 to 2.3 GHz. By operating the tube under different sets of voltage conditions, saturated output levels from 40 to 60 watts can be provided while maintaining a fixed value of rf drive without significantly affecting efficiency. Therefore, it is necessary to change only the helix, anode, and collector voltages to obtain near optimum performance for any desired power level.

The power output, gain, and efficiency are very nearly constant over the specified frequency range, as shown in Fig. 1. The power transfer curves of



3557-1

Fig. 3 and Fig. 4 show that the output power at saturation is relatively unchanged with a substantial change in drive power.

A number of variations of the WJ-448-1 are available which optimize performance at various other frequencies and power levels. The tube can be made to meet environmental conditions more stringent than those described in the Specifications. Versions of this tube can be manufactured and qualified to different levels of life and reliability for space applications.

## SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency range | 2.2 to 2.3 GHz | 2.2 to 2.3 GHz |
| Saturation power output | 50 watts | 50 watts min. |
| Saturation gain | 29 dB | 27 dB min. |
| Overall efficiency, including heater[1] | 43 percent | 40 percent, min. |

| ELECTRICAL CHARACTERISTICS | Typical | Range |
|---|---|---|
| Heater voltage | 3.8 volts | 3.5 to 4.5 volts |
| Heater current | 0.73 amps | 0.9 amps max. |
| Anode voltage[2] | 2500 volts | 2300 to 2700 volts |
| Anode current | 0.44 mA | 1.0 mA max. |
| Helix voltage[2] | 2280 volts | 2150 to 2350 volts |
| Helix current | 7.0 mA | 10 mA max. |
| Collector voltage[2] | 1530 volts | 1400 to 1650 volts |
| Collector current | 64.5 mA | 75 mA max. |

NOTES:
[1]Overall efficiency is defined as the RF output power divided by the total dc power input, including heater power.
[2]These voltages are referenced to the cathode. Helix is operated at ground potential.

# WJ-448-1

## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Tube length | 12.7 inches max. |
| Tube height, excluding connectors | 1.7 inches max. |
| Tube width | 1.9 inches max. |
| Tube weight | 34 ounces max. |
| DC connectors | Flying leads |
| RF connectors | OSM (Female) |
| Cooling | Conduction from bottom surface |
| Focusing | PPM |

## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Heat Sink Temperature | −20°C to +85°C |
| Vibration | |
| a. Sinusoidal (2 min/octave) | 0.5 inch, double amplitude, 5 to 18 cycles, ±20 g peak, 18 to 2000 cycles |
| b. Random (5 min/axis) | 0.1 g²/cycles, 20 to 2000 cycles |
| Acceleration (1 min/axis) | 100 g |
| Shock | 75 g, 11 ms |

**Fig. 1. WJ-448-1 Broadband Performance Characteristic.**

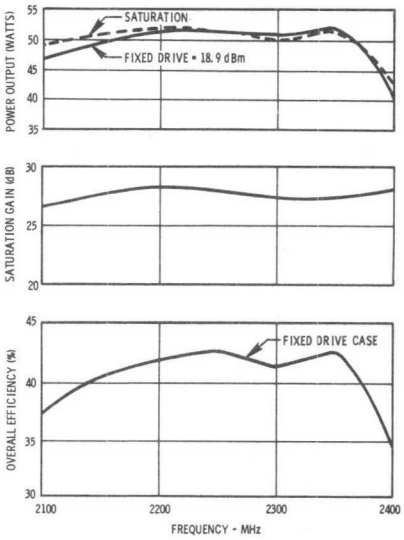
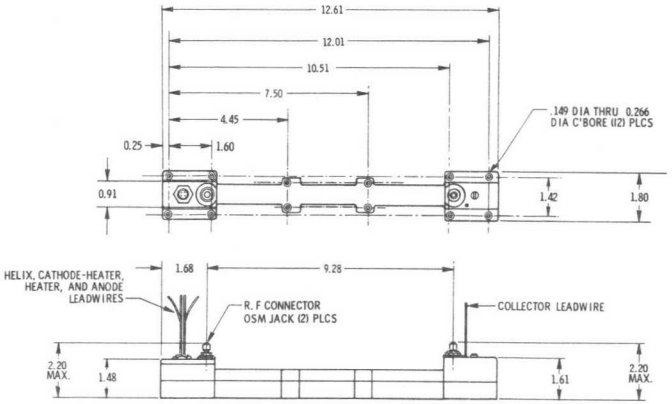



**Fig. 2. Outline Drawing.**



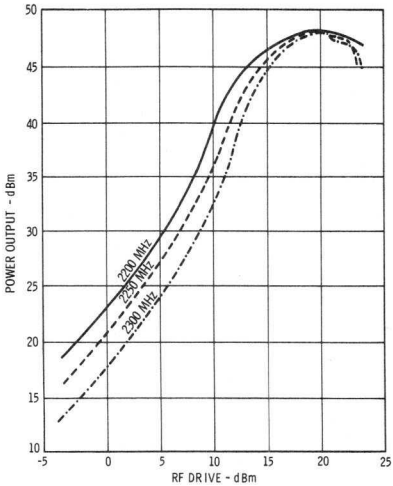



**Fig. 3. Typical WJ-448-1 Power Transfer Characteristic.**

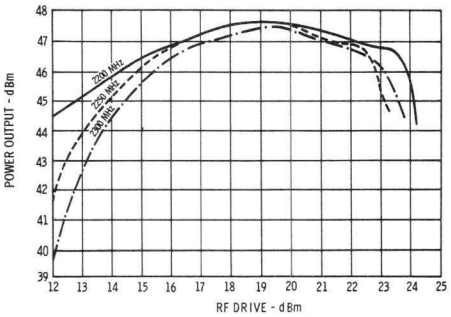
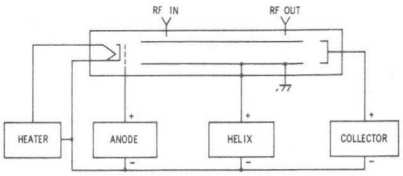



**Fig. 4. Typical WJ-448-1 Power Transfer Characteristic (Expanded).**



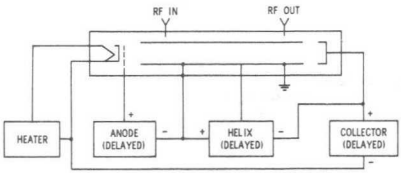

Heater 3.5-4.5 volts ac at 0.9 ampere maximum
Anode 2300-2700 volts at 1 mA maximum
Helix 2150-2350 at 10 mA maximum
Collector 1400-1650 volts at 75 mA maximum

NOTE:
To ensure that the TWT is operated properly, it is suggested that voltages be applied as follows:

1. Slowly apply filament voltage until specified value is reached, observing that filament current does not exceed maximum value. Allow at least 2 minutes for filament voltage to stabilize.
2. Slowly apply collector voltage until specified value is reached.
3. Set adjustable overcurrent disconnect circuit for maximum helix current value specified, then slowly increase helix voltage to specified value.
4. Slowly increase anode voltage to specified value, observing that current does not exceed maximum value.

Helix disconnect circuit should function such that all voltages will be disabled within 100 $\mu$sec if helix current exceeds maximum value.

**Fig. 5. Preferred connection for laboratory-type power supply configuration for WJ-448-1**




Heater 3.5-4.5 volts ac at 0.9 ampere maximum
Anode 0-550 volts at 1 mA maximum
Helix 500-950 volts at 10 mA maximum
Collector 1400-1650 volts at 75 mA maximum

NOTE:
With this configuration, anode supply cannot cutoff tube emission. To prevent damage to TWT, voltages must be applied to TWT in the following sequence:

1. Apply heater voltage slowly to allow filament resistance change as temperature rises.
2. Collector, helix, and anode voltages may be applied simultaneously after heater voltage has been on for 2 minutes minimum.

**CAUTION**

Helix overcurrent disconnect circuit must be set for maximum helix current value specified and must disconnect all voltages in less than 100 $\mu$sec if maximum value is exceeded.

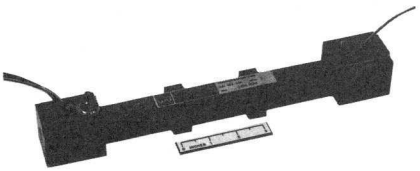
**Fig. 6. Preferred connection for high-density power supply configuration for WJ-448-1.**

# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1969

# 2.2 TO 2.3 GHz HIGH-EFFICIENCY TRAVELING-WAVE TUBE WITH VARIABLE POWER OUTPUT WJ-448-2



- 44% EFFICIENCY AT 50-WATT POWER LEVEL
- 15 TO 90 WATTS VARIABLE POWER OPERATION
- SUITABLE FOR AIRBORNE/SPACE APPLICATIONS
- SPACE-QUALIFIED MODEL AVAILABLE

WJ-448-2 is a high-efficiency TWT designed for use in systems where various power output levels may be required. High efficiency is maintained at the various power levels by operating the tube at saturation; the RF drive power remains at a fixed value while the three principal dc voltages applied to the tube are changed, allowing operation over a power output range as wide as 8 dB. Varying the power output of the system thus becomes a matter of programming the power supply voltages applied to the tube.

WJ-448-2 satisfies the power amplifier requirements of earth-orbit and deep-space missions where high reliability, small size, maximum overall efficiency and long life operation are essential. High performance is maintained during and after extreme temperature, vibration, shock and static acceleration. Its unique high-efficiency, variable-power features make it suitable for multi-power level and fixed-output requirements.

Figure 2 shows typical variable power performance of the WJ-448-2. The upper plot shows the overall efficiency that can be obtained as a function of RF output power. The lower plot shows the relationship between total dc input and RF output power; the diagonal lines represent lines of constant overall efficiency. From this plot, a systems designer can readily determine the input power required for a given output power.

Maximum efficiency (44%) of the WJ-448-2 occurs at the 50-watt level. The efficiency is greater than 40% over the range from 30 watts to 65 watts, and is greater than 30% over the extended range from 15 watts to 90 watts. It is important to note that the total saturation power range from 10 watts to 90 watts was obtained at a fixed RF input drive level of 17.5 dBm. Figure 3 shows the typical variations in electrode voltages necessary to achieve the different levels of RF output power.

The power output, gain and efficiency at a particular power output level are very nearly constant over the specified frequency range, as shown in figure 4 for the 50-watt level. The power transfer curves of figures 5 and 6 show that the output power at saturation is relatively unchanged with a substantial change in drive power.

Variations of the WJ-448 family of TWTs are available to optimize performance at other frequencies and power levels. Each tube can be made to meet environmental conditions more stringent than those described in the specifications. Manufactured under rigid quality assurance specifications, one version of this tube has been qualified for space applications; WJ-448-2 is also suitable for ground, airborne and shipboard applications.

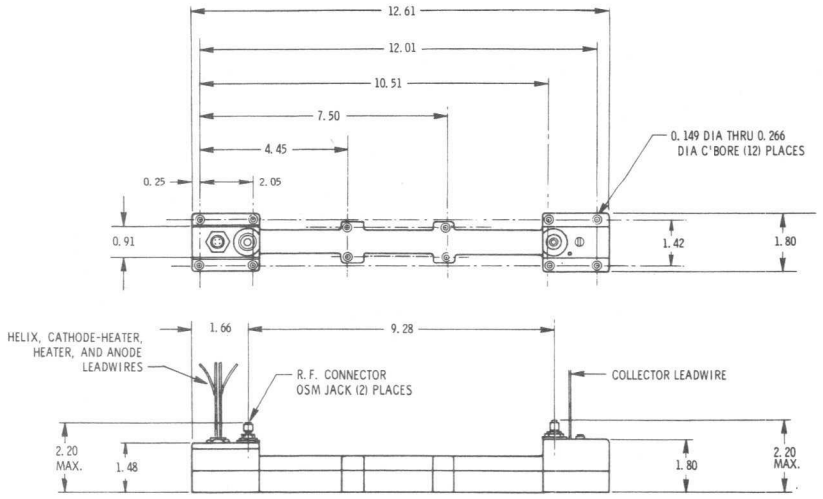
# WJ-448-2

## SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Wide Range | Typical Reduced Range | Guaranteed[1] |
|---|---|---|---|
| Frequency Range | 2.2-2.3 GHz | 2.2-2.3 GHz | 2.2-2.3 GHz |
| Saturation Power Output | 15-90 watts | 30-60 watts | 50 watts, min. |
| Variable Power Output Range | 7.8 dB | 3.0 dB | |
| Drive Power for Saturation | 17.5 dBm | 17.5 dBm | |
| Saturation gain | | | 27 dB, min. |
| Overall Efficiency, Including Heater[2] | 30 percent | 40 percent | 40 percent, min. |
| **ELECTRICAL CHARACTERISTICS[3,4]** | | | **Typical[5]** |
| Heater Voltage | 3.5-4.5 volts | 3.5-4.5 volts | 3.8 volts |
| Control Anode Voltage | 1300-3500 volts | 1800-2800 volts | 2500 volts |
| Blocking Anode Voltage | 1450-3650 volts | 1950-2950 volts | 2430 volts |
| Helix Voltage | 1900-2600 volts | 2100-2400 volts | 2280 volts |
| Collector Voltage | 1000-2300 volts | 1300-1750 volts | 1530 volts |
| Heater Current | 0.9 A max. | 0.9 A max. | 0.7 A |
| Control Anode Current | 1.0 mA max. | 1.0 mA max. | 0.2 mA |
| Blocking Anode Current | 1.0 mA max. | 1.0 mA max. | 0.5 mA |
| Helix Current | 13 mA max. | 10 mA max. | 7.0 mA |
| Collector Current | 125 mA max. | 95 mA max. | 65 mA |

1. Guaranteed performance is over the frequency range and at the power level shown.
2. Overall efficiency is defined as the RF output power divided by the total dc power input, including heater power.
3. All voltages referenced to the cathode. Helix is operated at ground potential. Blocking anode is operated at a fixed +150 volts above helix potential (ground).
4. The voltage ranges are the extremes required to adjust the tube over the power output range shown. Each power level requires a particular set of anode, helix, and collector voltages.
5. At the 50 watt power level.

**FIG. 1. OUTLINE DRAWING**



# WJ-448-2

## ENVIRONMENTAL CHARACTERISTICS

Heat Sink Temperature ..... −20°C to +85°C
Vibration
a. Sinusoidal
(2 min/octave .... 0.5 inch, double amplitude, 5 to 18 cycles, ±20 g peak, 18 to 2000 cycles
b. Random
(5 min/axis) .. 0.1 $g^2$/cycles, 20 to 2000 cycles
Acceleration (1min/axis) ..... 100 g
Shock ..... 75 g, 11 ms

## MECHANICAL CHARACTERISTICS

Tube length ..... 12.7 inches max.
Tube height, excluding connectors .. 1.9 inches max.
Tube width ..... 1.9 inches max.
Tube weight ..... 36 ounces max.
DC connectors ..... Flying leads
RF connectors ..... OSM (Jack)
Cooling ..... Conduction from bottom surface
Focusing ..... PPM
Color Code for 18" Flying Leads
Helix ..... Orange
Cathode Heater ..... Yellow
Heater ..... Brown
Control Anode ..... Green
Blocking Anode ..... Blue
Collector ..... Red

**FIG. 2. TYPICAL WJ-448-2 VARIABLE POWER OUTPUT PERFORMANCE**

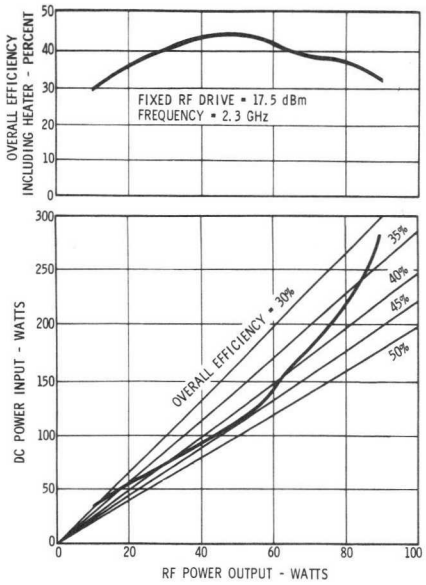



**FIG. 3. TYPICAL ELECTRODE VOLTAGES FOR THE WJ-448-2 FOR VARIABLE POWER OUTPUT OPERATION**

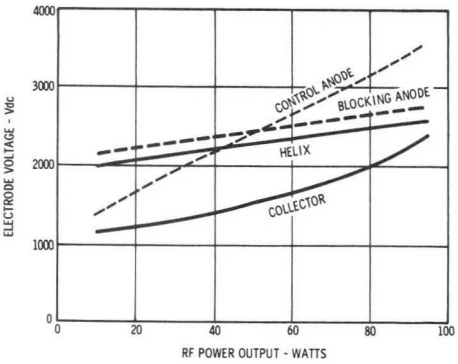



**FIG. 4. WJ-448-2 BROADBAND PERFORMANCE CHARACTERISTICS**

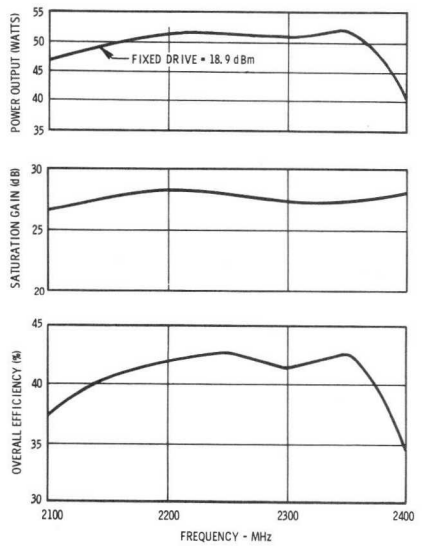


FIG. 5. TYPICAL WJ-448-2 POWER TRANSFER CHARACTERISTIC

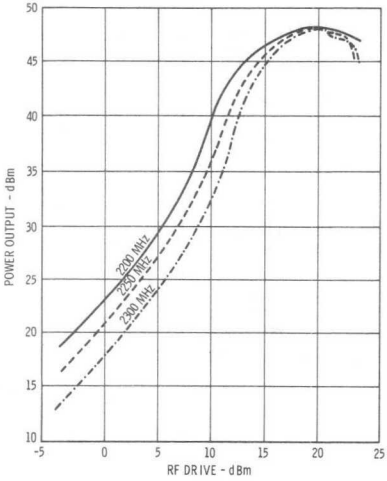



FIG. 6. TYPICAL WJ-448-2 POWER TRANSFER CHARACTERISTIC (EXPANDED)

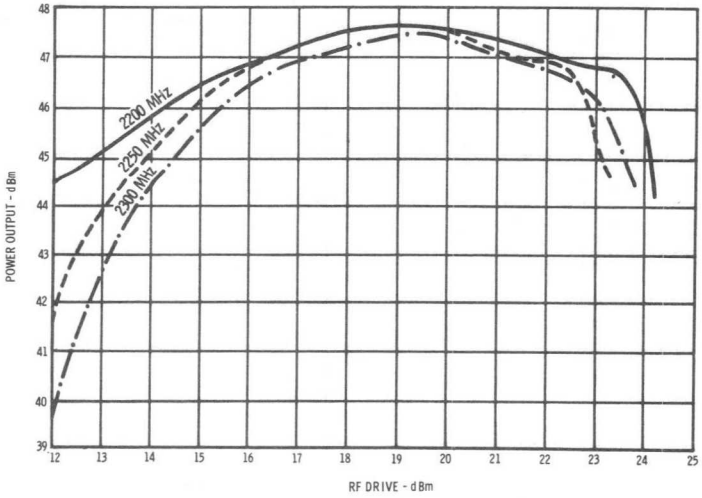
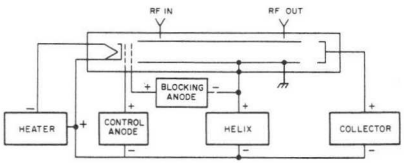


**FIG. 7. PREFERRED CONNECTION FOR LABORATORY-TYPE POWER SUPPLY CONFIGURATION FOR WJ-448-2**




Heater ..... 3.5-4.5 volts at 0.9 ampere maximum
Blocking Anode ..... 150 volts above helix at 1 mA maximum
Control Anode .. 1300-3500 volts at 1 mA maximum
Helix ..... 1900-2600 volts at 13 mA maximum
Collector .... 1000-2300 volts at 125 mA maximum

NOTE:
To ensure that the TWT is operated properly, it is suggested that voltages be applied as follows:

1. Slowly apply filament voltage until specified value is reached, observing that filament current does not exceed maximum value. Allow at least 2 minutes for filament voltage to stabilize.
2. Slowly apply collector voltage until specified value is reached, observing that collector current does not exceed maximum value.
3. Set adjustable overcurrent disconnect circuit for maximum helix current value specified, then slowly increase helix voltage to specified value.
4. Slowly increase anode voltages to specified value, observing that current does not exceed maximum value.

Helix disconnect circuit should function such that all voltages will be disabled within 100 $\mu$sec if helix current exceeds maximum value.

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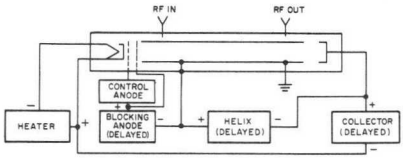
**FIG. 8. PREFERRED CONNECTION FOR HIGH-DENSITY POWER SUPPLY CONFIGURATION FOR WJ-448-2**




Heater ... 3.5-4.5 volts ac at 0.9 ampere maximum
Control Anode .. 1300-3500 volts at 1 mA maximum
Blocking Anode ..... 150 volts above helix at 1 mA maximum
Helix ..... 1900-2600 volts at 13 mA maximum
Collector .... 1000-2300 volts at 125 mA maximum

NOTE:
With this configuration, anode supply cannot cut off tube emission. To prevent damage to TWT, voltages must be applied to TWT in the following sequence:

1. Apply heater voltage slowly to allow filament resistance change as temperature rises.
2. Collector, helix, and anode voltages may be applied simultaneously after heater voltage has been on for 2 minutes minimum.

**CAUTION**

Helix overcurrent disconnect circuit must be set for maximum helix current value specified and must disconnect all voltages in less than 100 $\mu$sec if maximum value is exceeded.

# TECHNICAL DATA

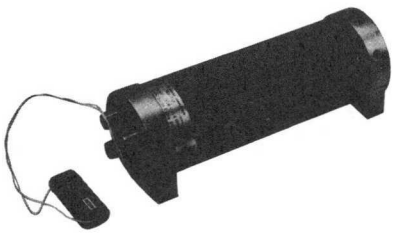
WATKINS-JOHNSON

FEBRUARY 1970*

## 1.0 TO 2.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY

## WJ-457

- **"JUST PLUG IT IN"**
- **POWER DRAIN 3.0 WATTS MAXIMUM**
- **NOISE FIGURE 8.0 dB MAXIMUM**
- **SMALL SIZE: 3.4 x 9.5 INCHES**
- **WEIGHT: 6.0 LBS.**
- **ADJUSTMENT-FREE**
- **PERMANENT-MAGNET FOCUSING**
- **MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE**



WJ-457 is the L-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-457 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-457 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0 to 2.0 GHz | 1.0 to 2.0 GHz |
| Noise Figure, Terminal | 7.0 dB | 8.0 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +9.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 23 V dc | 20 to 28 V dc |
| Primary Power | 2.5 W | 3 W, max. |

* Supersedes WJ-457 Technical Data Sheet dated October 1968.

# WJ-457

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature, Operating ..... −54°C to +71°C

Vibration
a. 0.10 Inch, Double Amplitude ..... 5 to 45 Hz
b. 10 g, Single Amplitude ..... 45 to 500 Hz

Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

Height ..... 3.4 inches (86 mm) max.

Width ..... 3.4 inches (86 mm) max.

Length (excluding connectors) ..... 9.5 inches (241 mm) max.

Weight ..... 6 lbs. (2.72 Kg) max.

Primary Power Connection, Erie Feedthrough ..... 1200-094, 1215-094

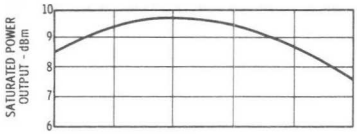
RF Connections (50 ohms, nominal) ..... Type N, Jack

Reference Drawing Number ..... 290197

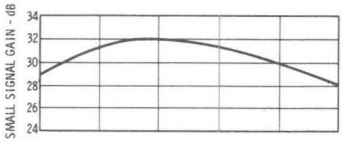
[1]Every tube will meet the guaranteed performance specifications within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

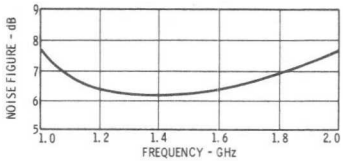
## POWER



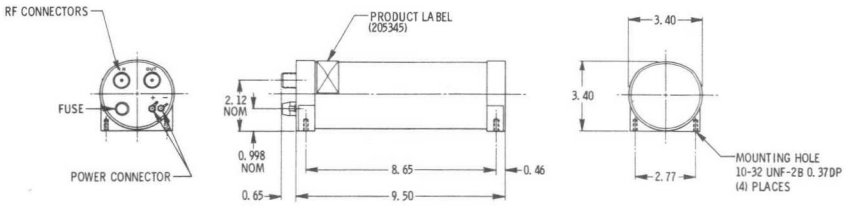

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

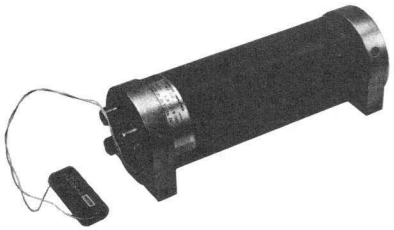
WATKINS-JOHNSON

FEBRUARY 1970*

## 2.0 TO 4.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY

## WJ-458

- "JUST PLUG IT IN"
- POWER DRAIN 3.0 WATTS MAXIMUM
- NOISE FIGURE 8.5 dB MAXIMUM
- SMALL SIZE: 3.4 x 9.5 INCHES
- WEIGHT: 6.0 LBS.
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE



WJ-458 is the S-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-458 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-458 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise Figure, Terminal | 7.5 dB | 8.5 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +10.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 23 V dc | 20 to 28 V dc |
| Primary Power | 2.5 W | 3 W, max. |

*Supersedes WJ-458 Technical Data Sheet dated October 1968.

## WJ-458

### ENVIRONMENTAL CHARACTERISTICS[2]

Temperature, Operating ..... −54°C to +71°C

Vibration
a. 0.10 Inch, Double Amplitude ..... 5 to 45 Hz
b. 10 g, Single Amplitude ..... 45 to 500 Hz

Shock ..... 15 g, 11 ms

### MECHANICAL CHARACTERISTICS

Height ..... 3.4 inches (86 mm) max.

Width ..... 3.4 inches (86 mm) max.

Length (excluding connectors) ..... 9.5 inches (241 mm) max.

Weight ..... 6 lbs. (2.72 Kg) max.

Primary Power Connection, Erie Feedthrough ..... 1200-094, 1215-094

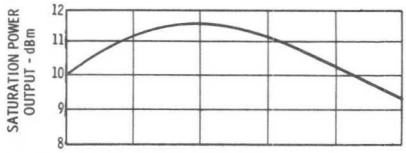
RF Connections (50 ohms, nominal) ..... Type N, Jack

Reference Drawing Number ..... 290197

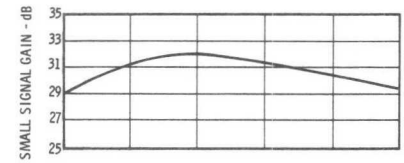
[1]Every tube will meet the guaranteed performance specifications within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

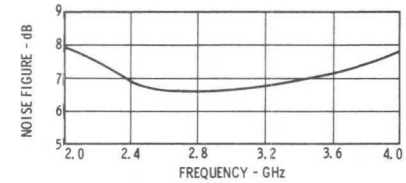
### POWER



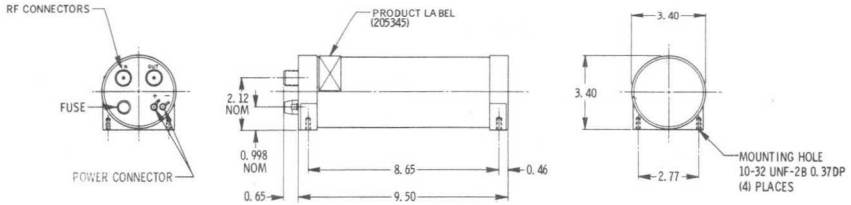

### GAIN




### NOISE




### OUTLINE DRAWING



# TECHNICAL DATA

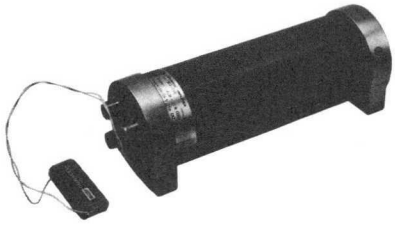
WATKINS-JOHNSON

FEBRUARY 1970*

## 4.0 TO 8.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY

## WJ-459

- "JUST PLUG IT IN"
- POWER DRAIN 3.0 WATTS MAXIMUM
- NOISE FIGURE 9.0 dB MAXIMUM
- SMALL SIZE: 3.4 x 9.5 INCHES
- WEIGHT: 6.0 LBS.
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE



WJ-459 is the C-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-459 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-459 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0 to 8.0 GHz | 4.0 to 8.0 GHz |
| Noise Figure, Terminal | 8.0 dB | 9.0 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +11.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 23 V dc | 20 to 28 V dc |
| Primary Power | 2.5 W | 3 W, max. |

*Supersedes WJ-459 Technical Data Sheet dated October 1968.

# WJ-459

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature, Operating ..... −54°C to +71°C

Vibration
a. 0.10 Inch, Double Amplitude ..... 5 to 45 Hz
b. 10 g, Single Amplitude ..... 45 to 500 Hz

Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

Height ..... 3.4 inches (86 mm) max.

Width ..... 3.4 inches (86 mm) max.

Length (excluding connectors) ..... 9.5 inches (241 mm) max.

Weight ..... 6 lbs. (2.72 Kg) max.

Primary Power Connection, Erie Feedthrough ..... 1200-094, 1215-094

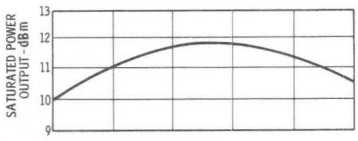
RF Connections (50 ohms, nominal) ..... Type N, Jack

Reference Drawing Number ..... 290197

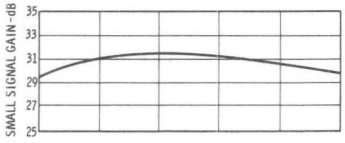
[1]Every tube will meet the guaranteed performance specifications within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

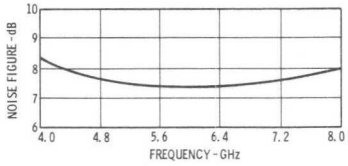
## POWER



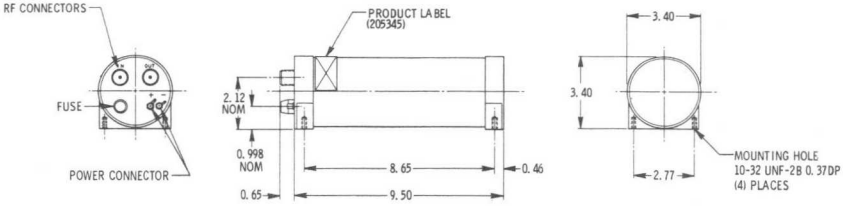

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1970*

## 8.0 TO 12.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY

## WJ-460

- **"JUST PLUG IT IN"**
- **POWER DRAIN 3.0 WATTS MAXIMUM**
- **NOISE FIGURE 10.0 dB MAXIMUM**
- **SMALL SIZE: 3.4 x 9.5 INCHES**
- **WEIGHT: 6.0 LBS.**
- **ADJUSTMENT-FREE**
- **PERMANENT-MAGNET FOCUSING**
- **MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE**

WJ-460 is the X-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-460 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-460 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 8.0 to 12.0 GHz | 8.0 to 12.0 GHz |
| Noise Figure, Terminal | 9.0 dB | 10.0 dB, max. |
| Gain, Small Signal | 30.0 dB | 25.0 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +10.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 23 V dc | 20 to 28 V dc |
| Primary Power | 2.5 W | 3 W, max. |

*Supersedes WJ-460 Technical Data Sheet dated October 1968.

# WJ-460

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature, Operating ..... −54°C to +71°C

Vibration
a. 0.10 Inch, Double Amplitude ..... 5 to 45 Hz
b. 10 g, Single Amplitude ..... 45 to 500 Hz

Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

Height ..... 3.4 inches (86 mm) max.

Width ..... 3.4 inches (86 mm) max.

Length (excluding connectors) ..... 9.5 inches (241 mm) max.

Weight ..... 6 lbs. (2.72 Kg) max.

Primary Power Connection, Erie Feedthrough ..... 1200-094, 1215-094

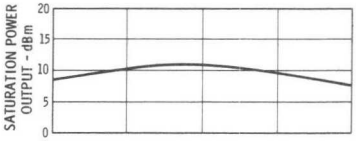
RF Connections (50 ohms, nominal) ..... Type N, Jack

Reference Drawing Number ..... 290197

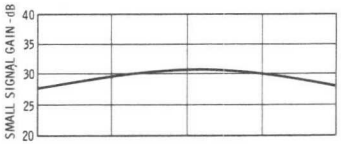
[1]Every tube will meet the guaranteed performance specifications within these ranges.

[2]These environmental characteristics meet or exceed the respective requirements of MIL-E-5400, Class 2 Specification.

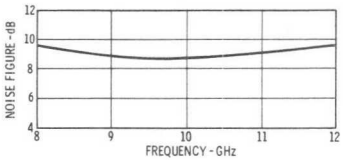
## POWER



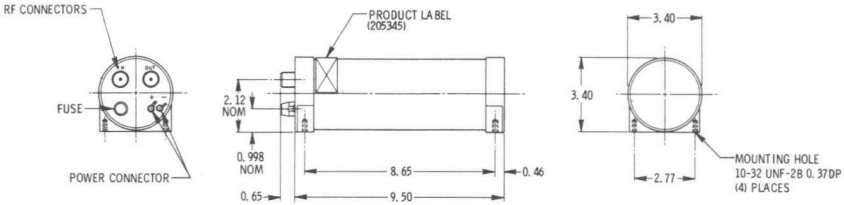

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

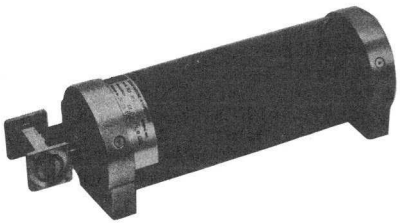
WATKINS-JOHNSON

FEBRUARY 1970 *

## 12.0 TO 18.0 GHz, COMPACT LOW-NOISE PERMANENT-MAGNET TRAVELING-WAVE AMPLIFIER WITH BATTERY-OPERABLE INTEGRAL POWER SUPPLY

## WJ-461

- "JUST PLUG IT IN"
- POWER DRAIN 3.0 WATTS MAXIMUM
- NOISE FIGURE 12.0 dB MAXIMUM
- SMALL SIZE: 3.4 x 9.5 INCHES
- WEIGHT: 6.5 LBS.
- ADJUSTMENT-FREE
- PERMANENT-MAGNET FOCUSING
- MORE THAN 20 SPECIALIZED VERSIONS AVAILABLE



WJ-461 is the Ku-band member of a new series of compact LNTWAs incorporating the Battery Operable, Integral Power Supply (BOIPS) feature. The introduction of BOIPS as a standard option allows W-J's compact amplifiers to be competitive with solid state amplifiers, particularly in size and power drain specifications, with the added advantage of production experience in all the popular microwave bands.

The WJ-461 is completely self-contained and adjustment-free, and requires only 20 to 28 V dc input for operation. It may be operated in any orientation. Rugged construction of the tube, magnet, and power supply assembly ensures reliable operation under vibrational forces of 10 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54°C to +71°C. The environmental characteristics of the WJ-461 meet or exceed the corresponding requirements of MIL-E-5400, class 2 specification.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 12.0 to 18.0 GHz | 12.0 to 18.0 GHz |
| Noise Figure, Terminal | 10.0 dB | 12.0 dB, max. |
| Gain, Small Signal | 28 dB | 25 dB, min. |
| VSWR, Input and Output | 1.5:1 | 2:1, max. |
| Power Output | +10.0 dBm | +7.0 dBm, min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary Voltage | 23 V dc | 20 to 28 V dc |
| Primary Power | 2.5 W | 3 W, max. |

*Supersedes WJ-461 Technical Data Sheet dated October 1968.

# WJ-461

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature, Operating ..... −54°C to +71°C

Vibration
- a. 0.10 Inch, Double Amplitude ..... 5 to 30 Hz
- b. 5 g, Single Amplitude ..... 30 to 500 Hz

Shock ..... 15 g. 11 ms

## MECHANICAL CHARACTERISTICS

Height ..... 3.4 inches (86 mm) max.

Width ..... 3.4 inches (86 mm) max.

Length (excluding connectors ..... 9.5 inches (241 mm) max.

Weight 6.5 lbs. ..... (2.95 Kg) max.

Primary Power Connection, Erie Feedthrough ..... 1200-094, 1215-094

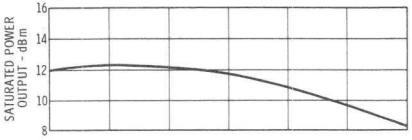
RF Connections (Waveguide) ..... UG-541/U Choke Flange

Reference Drawing Number ..... 290196

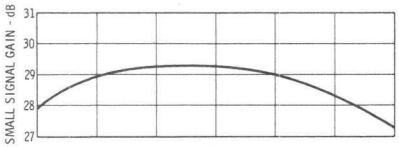
[1] Every tube will meet the guaranteed performance specifications within these ranges.

[2] These environmental characteristics meet or exceed the respective requirements of MIL-E-5400 temperature Class 2, Vibration Curve III.

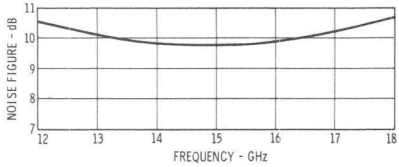
## POWER



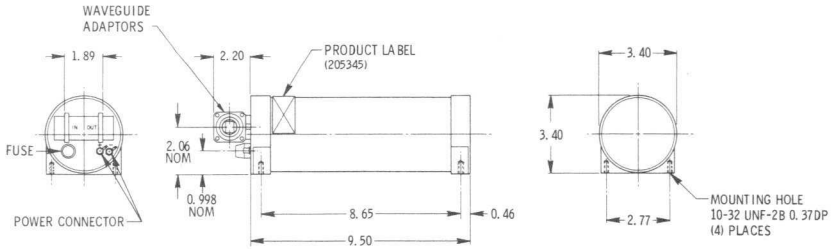

## GAIN




## NOISE




## OUTLINE DRAWING



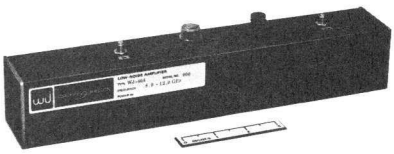
# TECHNICAL DATA

WATKINS-JOHNSON

OCTOBER 1969 *

## 2 TO 4 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-462



- "JUST PLUG IT IN"
- GUARANTEED 10.0 dB NOISE FIGURE ACROSS FULL S-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 2x2x11 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT

The WJ-462 is one of a family of periodic-permanent-magnet low-noise TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other S-band PPM low-noise TWT amplifier on the market today can match the power output/noise figure/gain/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-462 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-462 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise figure, terminal | 9.0 dB | 10.0 dB max. |
| Gain, small signal | 45 dB | 40 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +16 dBm | +10 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 10 watts | |

*Supersedes WJ-462 Technical Data Sheet dated November, 1968.

# WJ-462

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature . . . . . —54°C to +71°C
Vibration
a. .10 inch, double amplitude . . . . 5 to 45 Hz
b. 10 g, single amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 G, 11 ms

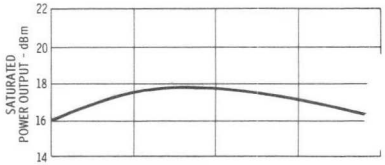
## MECHANICAL CHARACTERISTICS

Height (excluding connectors) . . . . . 2 inches (51 mm) max.
Width . . . . . 2 inches (51 mm) max.
Length . . . . . 11 inches (279 mm) max.
Weight . . . . . 3.5 pounds (1.56 Kg) max.
Primary Power Connection, Bendix receptacle . . . . . PT 07C-8-3P
RF Connections (50 ohms, nominal) . . . . OSM, jack

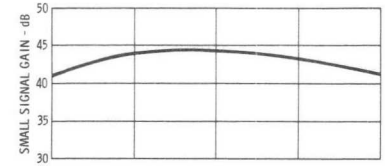
[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

[2]These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

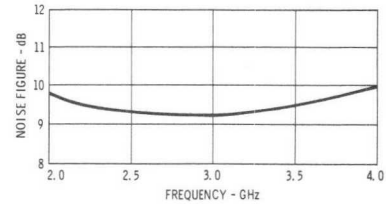
## POWER



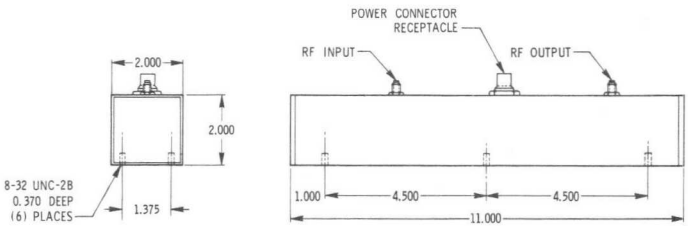

## GAIN




## NOISE




## OUTLINE DRAWING



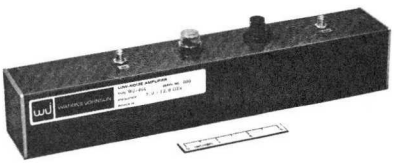
# TECHNICAL DATA

WATKINS-JOHNSON

November 1968

## 4 TO 8 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-463



- "JUST PLUG IT IN"
- GUARANTEED +10 dBm POWER OUTPUT
- GUARANTEED 10.0 dB NOISE FIGURE ACROSS FULL C-BAND
- SMALL SIZE: 2 x 2 x 11 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT

The WJ-463 is one of a family of periodic-permanent-magnet low noise TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other C-band PPM low noise TWT amplifier on the market today can match the power output/noise figure/gain/size combination offered by this amplifier. In addition it is completely self-contained and adjustment-free, operating with only an ac line voltage input.

The WJ-463 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-463 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0 to 8.0 GHz | 4.0 to 8.0 GHz |
| Noise figure, terminal | 9.0 dB | 10.0 dB max. |
| Gain, small signal | 45 dB | 40 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +15 dBm | +10 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 17 watts | |

# WJ-463

## ENVIRONMENTAL CHARACTERISTICS[2]

| | |
|---|---|
| Temperature | −54°C to +71°C |
| Vibration | |
| a. .10 inch, double amplitude | 5 to 45 Hz |
| b. 10 g, single amplitude | 45 to 500 Hz |
| Shock | 15 G, 11 ms |

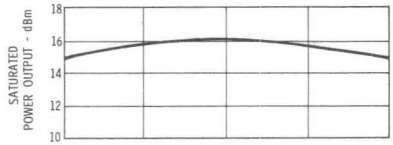
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height (excluding connectors) | 2 inches (51 mm) max. |
| Width | 2 inches (51 mm) max. |
| Length | 11 inches (279 mm) max. |
| Weight | 4 pounds (1.81 Kg) max. |
| Primary Power Connection, Bendix receptacle | PT 07C-8-3P |
| RF Connections (50 ohms, nominal) | OSM, jack |

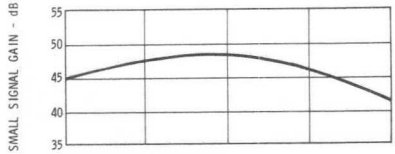
[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

[2]These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

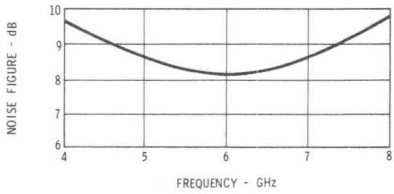
## POWER



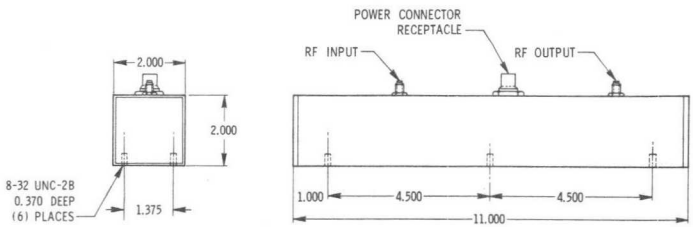

## GAIN




## NOISE




## OUTLINE DRAWING



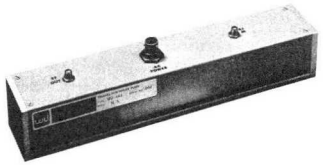
# TECHNICAL DATA

WATKINS-JOHNSON

AUGUST 1970*

## 8 TO 12 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-464



- "JUST PLUG IT IN"
- GUARANTEED 10.0 dB NOISE FIGURE ACROSS FULL X-BAND
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 2x2x11 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT

The WJ-464 is one of a family of periodic-permanent-magnet low noise TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other X-band PPM low-noise TWT amplifier on the market today can match the power output/noise figure/gain/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-464 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-464 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 8.0 to 12.0 GHz | 8.0 to 12.0 GHz |
| Noise figure, terminal | 9.0 dB | 10.0 dB max. |
| Gain, small signal | 45 dB | 40 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | 15 dBm | 10 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 10 watts | |
| Primary current | 130 mA | |

* Supersedes WJ-464 Technical Data Sheet dated September 1969.

# WJ-464

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature . . . . . —54°C to +71°C
Vibration
a. 0.10 inch, double amplitude . . . . . 5 to 45 Hz
b. 10 g, single amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 G, 11 ms

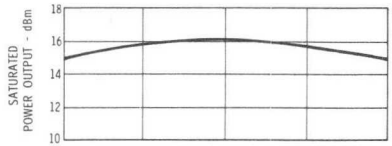
## MECHANICAL CHARACTERISTICS

Height (excluding connectors) . . . . . 2 inches (51 mm) max.
Width . . . . . 2 inches (51 mm) max.
Length . . . . . 11 inches (279 mm) max.
Weight . . . . . 3.5 pounds (1.56 kg) max.
Primary Power Connection, Bendix receptacle . . . . . PT 07-C-8-3P
RF Connections (50 ohms, nominal) . . . . . OSM, jack
Outline Drawing Number . . . . . 290238

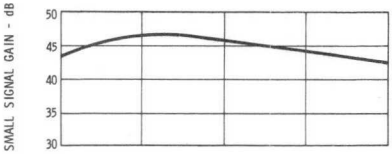
1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.

2. These environmental characteristics meet the respective requirements for MIL-E-5400, Class 2.

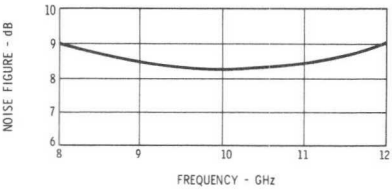
## POWER



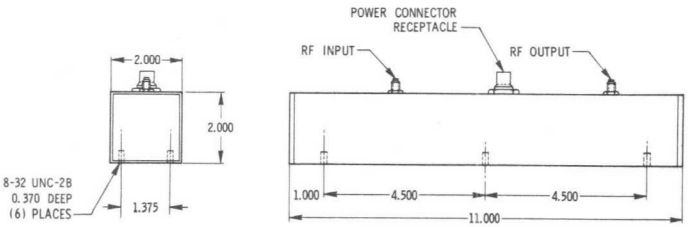

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

OCTOBER 1969

## 12 TO 18 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-465

- "JUST PLUG IT IN"
- GUARANTEED 12.5 dB NOISE FIGURE ACROSS FULL Ku-BAND
- GUARANTEED +13 dBm POWER OUTPUT
- SMALL SIZE: 3x3x11 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT

The WJ-465 is one of a family of periodic-permanent-magnet low-noise TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other Ku-band PPM low-noise TWT amplifier on the market today can match the power output/noise figure/gain/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-465 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-465 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | TYPICAL | GUARANTEED |
|---|---|---|
| Frequency | 12 to 18 GHz | 12 to 18 GHz |
| Noise figure, terminal | 11.5 dB | 12.5dB max. |
| Gain, small signal | 40 dB | 35 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output (saturation) | 14 dBm | +13 dBm min. |

| ELECTRICAL REQUIREMENTS | TYPICAL | RANGE[1] |
|---|---|---|
| Primary Voltage | 115 Vac | 115 ±10 Vac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 15 watts | |

# WJ-465

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature ..... −54°C to +71°C
Vibration
a. .10 inch, double amplitude .... 5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 G, 11 ms

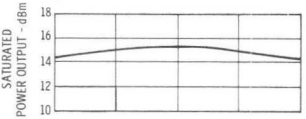
## MECHANICAL CHARACTERISTICS

Height ..... 3 inches (76 mm) max.
Width
(excluding connectors) .. 3 inches (76 mm) max.
Length ..... 11 inches (279 mm) max.
Weight ..... 5 pounds (2.27 Kg) max.
Primary power connection,
Bendix receptacle ..... PT07C-8-3p
RF Connections (Waveguide).. UG 541/U, RG 91/U

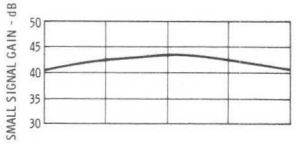
[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

[2]These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2.

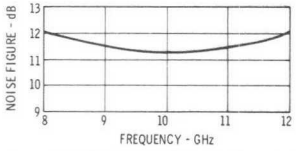
## POWER



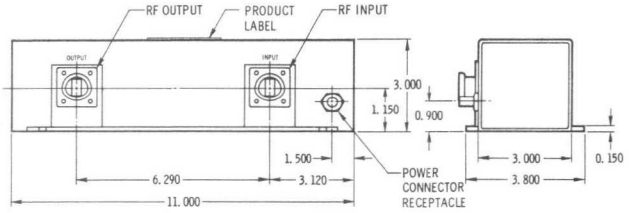

## GAIN




## NOISE




## OUTLINE DRAWING

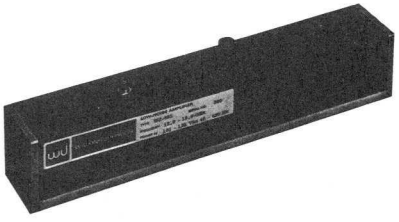


# TECHNICAL DATA

WATKINS-JOHNSON

## 12 TO 18 GHz MINIATURE PPM-FOCUSED LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-465-1



- **"JUST PLUG IT IN"**
- **GUARANTEED 11.5 dB NOISE FIGURE ACROSS FULL OPERATING BAND**
- **GUARANTEED +13 dBm POWER OUTPUT**
- **SMALL SIZE: 2 x 2 x 11 INCHES**
- **MEETS TEMPERATURE, VIBRATION AND SHOCK REQUIREMENTS OF MIL-E-5400, CLASS 2**

The WJ-465-1 is one of a family of periodic-permanent-magnet low-noise TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. Very few 12 to 18 GHz PPM low-noise TWT amplifiers on the market today can match the power output/noise figure/gain/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-465-1 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-465-1 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | TYPICAL | GUARANTEED |
|---|---|---|
| Frequency | 12 to 18 GHz | 12 to 18 GHz |
| Noise figure, terminal[1] | 10.5 dB | 11.5 dB max. |
| Gain, small signal | 45 dB | 40 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output (saturation) | 14 dBm | +13 dBm min. |

| ELECTRICAL REQUIREMENTS | TYPICAL | RANGE[2] |
|---|---|---|
| Primary Voltage | 115 Vac | 115 ±10 Vac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 15 watts | |

*Supersedes WJ-465-1 Technical Data Sheet dated July 1971.

# WJ-465-1

## ENVIRONMENTAL CHARACTERISTICS [3]

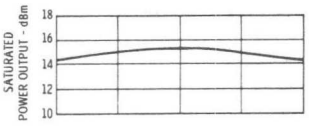
Temperature ..... −54°C to +71°C
Vibration
a. .10 inch, double amplitude .... 5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 G, 11 ms

## MECHANICAL CHARACTERISTICS

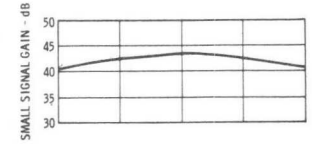
Height (excluding connectors) ..... 2 inches (51 mm) max.
Width ..... 2 inches (51 mm) max.
Length ..... 11 inches (279 mm) max.
Weight ..... 3.5 pounds (1.59 Kg) max.
Primary power connection, Bendix receptacle ..... PT07C-8-3p
RF Connections ..... SMA female
Reference Drawing ..... 290238

NOTES:
1. As read on an H-P Noise Source P347A and an H-P Noise Figure Meter Mod. 340 B.
2. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
3. These environmental characteristics meet the respective requirements of MIL-E-5400M, Class 2.

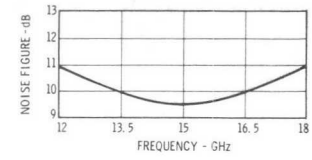
## POWER



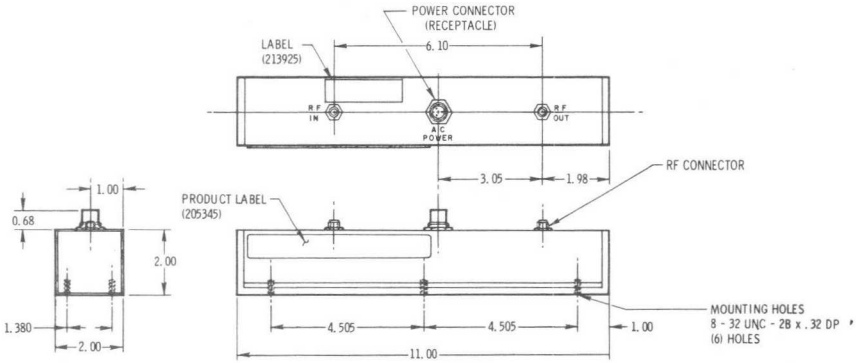

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX PT-07C-8-3P (RECEP) MS 3116E-8-3S (SR) (PLUG) | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 115 ± 10 VAC |
| B | GROUND | 48 - 420 CPS |
| A | AC | SINGLE PHASE |

| RF CONNECTORS | |
|---|---|
| INPUT: | TYPE SMA FEMALE |
| OUTPUT: | TYPE SMA FEMALE |

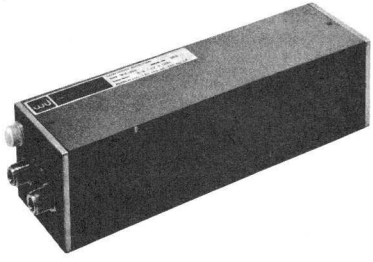
# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1969

## 8 TO 12 GHz 100 MILLIWATT LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-472

- **"JUST PLUG IT IN"**
- **GUARANTEED 100 mW POWER OUTPUT**
- **MAXIMUM 12 dB NOISE FIGURE ACROSS FULL X-BAND**
- **SMALL SIZE: 3 x 3 x 10.5 INCHES**



The WJ-472 is one of a family of 100-milliwatt single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson for applications where increased dynamic range is desired. No other X-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-472 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-472 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 8.0 to 12.0 GHz |
| Noise figure, terminal | 11 dB | 12 dB max. |
| Gain, Small Signal | 30 dB | 25 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | 21 dBm | 20 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary current | 220 mA | |
| Primary power | 20 watts | |

## WJ-472

### ENVIRONMENTAL CHARACTERISTICS[2]

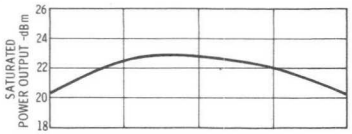
Temperature . . . . . —54°C to +71°C
Vibration
a. 0.10 inch, double amplitude . . . . . 5 to 30 Hz
b. 5 g, single amplitude . . . . . 30 to 500 Hz
Shock . . . . . 15 G, 11 ms

### MECHANICAL CHARACTERISTICS

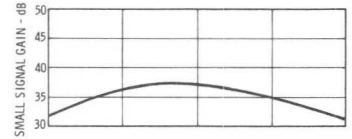
Height . . . . . 3 inches (76 mm) max.
Width . . . . . 3 inches (76 mm) max.
Length (excluding connectors) . . . . . 10.5 inches (267 mm) max.
Weight . . . . . 7 pounds (3.18 kg) max.
Primary power connection, Bendix receptacle . . . . . PTO7C-8-3p
RF connections (50 ohms, nominal) . . . . . Type N, jack

1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency lying within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

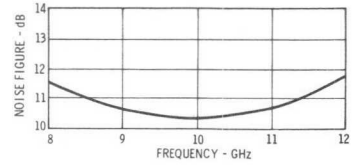
### POWER



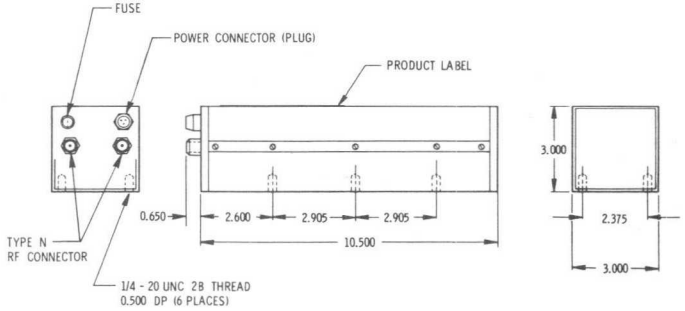

### GAIN




### NOISE




### OUTLINE DRAWING



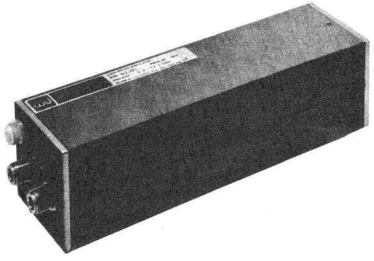
# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1969

## 4 TO 8 GHz 100 MILLIWATT LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-476

- **"JUST PLUG IT IN"**
- **GUARANTEED 100 mW POWER OUTPUT**
- **MAXIMUM 12 dB NOISE FIGURE ACROSS FULL C-BAND**
- **SMALL SIZE: 3 x 3 x 10.5 INCHES**



The WJ-476 is one of a family of 100-milliwatt single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson for applications where increased dynamic range is desired. Featuring a wide dynamic range in a rugged and compact configuration, this tube produces 100 mW output power with 12 dB noise figure. In addition, it is completely self-contained and adjustment-free, operating with only an ac line voltage input.

The WJ-476 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-476 meet the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 4.0 to 8.0 GHz |
| Noise figure, terminal | 11 dB | 12 dB max. |
| Gain, Small Signal | 30 dB | 25 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +21 dBm | +20 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary current | 220 mA | |
| Primary power | 20 watts | |

## WJ-476

### ENVIRONMENTAL CHARACTERISTICS

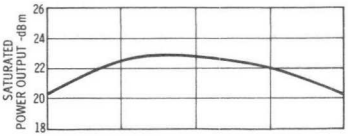
Temperature ..... −54°C to +71°C
Vibration
a. 0.10 inch, double amplitude.....5 to 30 Hz
b. 5 g, single amplitude.....30 to 500 Hz
Shock.....15 G, 11 ms

### MECHANICAL CHARACTERISTICS

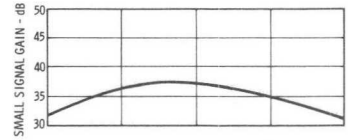
Height.....3 inches (76 mm) max.
Width.....3 inches (76 mm) max.
Length (excluding connectors) .....10.5 inches (267 mm) max.
Weight.....7 pounds (3.18 kg) max.
Primary power connection, Bendix receptacle .....PTO7C-8-3p
RF connections (50 ohms, nominal) .....Type N, jack

NOTE:
1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
2. These environmental characteristics meet the respective requirements of MIL-E-5400K, dated 24 May 68, class 2.

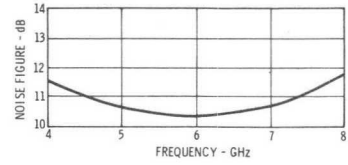
### POWER



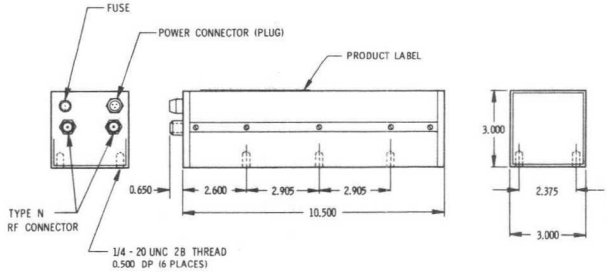

### GAIN




### NOISE




### OUTLINE DRAWING



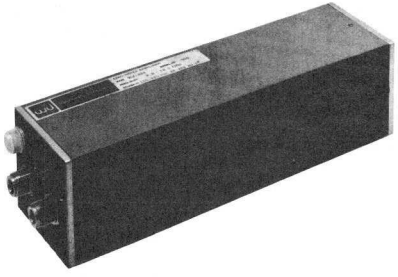
# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1969

## 2 TO 4 GHz 100 MILLIWATT LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-477

- **"JUST PLUG IT IN"**
- **GUARANTEED 100 mW POWER OUTPUT**
- **MAXIMUM 12 dB NOISE FIGURE ACROSS FULL S-BAND**
- **SMALL SIZE: 3 x 3 x 10.5 INCHES**



The WJ-477 is one of a family of 100-milliwatt single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson for applications where increased dynamic range is desired. No other S-band low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-477 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 5g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-477 meet the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 2.0 to 4.0 GHz |
| Noise figure, Terminal | 11 dB | 12 dB max. |
| Gain, Small Signal | 30 dB | 25 dB, min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +21 dBm | +20 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary current | 220 mA | |
| Primary power | 20 watts | |

# WJ-477

## ENVIRONMENTAL CHARACTERISTICS[2]

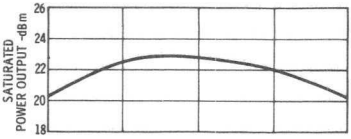
Temperature ..... −54°C to +71°C
Vibration
a) 0.10 Inch, Double Amplitude..... 5 to 30 Hz
b) 5 g, Single Amplitude..... 30 to 500 Hz
Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

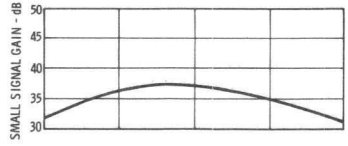
Height ..... 3 inches (76 mm) max.
Width ..... 3 inches (76 mm) max.
Length (excluding connectors)..... 10.5 inches (267 mm) max.
Weight..... 7.0 pounds (3.18 kg) max.
Primary power connection, Bendix receptacle ..... PTO7C-8-3p
RF conections (50 ohms, nominal)..... Type N, jack

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

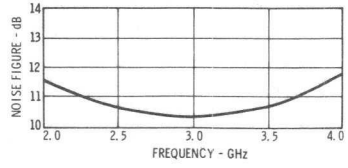
## POWER



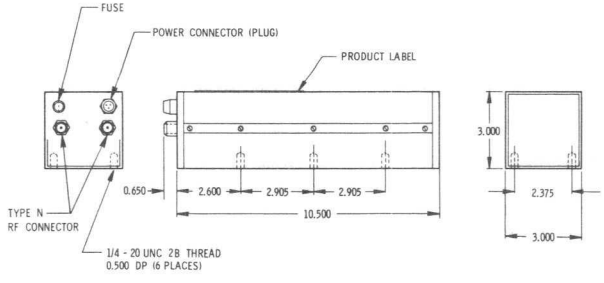

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

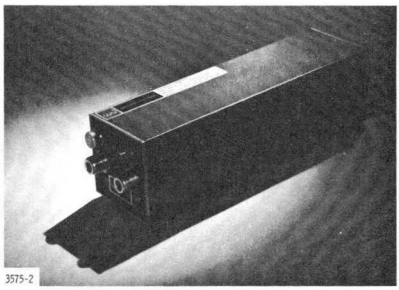
WATKINS-JOHNSON

# WJ-482

September 1968

## 2.6 TO 5.2 GHz LOW-NOISE TWT AMPLIFIER WITH INTEGRAL POWER SUPPLY

- "JUST PLUG IT IN"
- GUARANTEED +10 dBm POWER OUTPUT
- GUARANTEED 7.5 dB NOISE FIGURE
- SMALL SIZE: 3 x 3 x 11.25 INCHES
- MEETS MIL-E-5400, CLASS 2 ENVIRONMENT


3575-2

The WJ-482 is one of a family of single-reversal permanent-magnet TWT amplifiers developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. No other 2.6 to 5.2 GHz low-noise TWT amplifier on the market today can match the power output/noise figure/size combination offered by this amplifier. It is completely self-contained, and adjustment-free, operating with only an ac line voltage input.

The WJ-482 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibration forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-482 meet the corresponding requirements of MIL-E-5400, Class 2.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.6 to 5.2 GHz | 2.6 to 5.2 GHz |
| Noise Figure, terminal | 7.0 dB | 7.5 dB max. |
| Gain, Small Signal | 30 dB | 25 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power output | +12 dBm | +10 dBm min. |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary current | 150 mA | |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 12 watts | |

# WJ-482

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature, Operating ..... −54°C to +71°C
Vibration
a. 0.10 Inch, Double Amplitude... 5 to 45 Hz
b. 10 g, Single Amplitude..... 45 to 500 Hz
Shock ..... 15 g, 11 ms

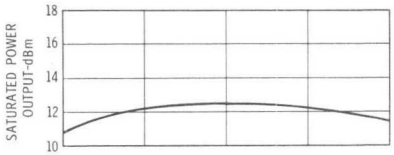
## MECHANICAL CHARACTERISTICS

Amplifier length
(excluding connectors).... 11.25 inches, max.
Amplifier height ..... 3 inches, max.
Amplifier width ..... 3 inches, max.
Weight ..... 7.5 pounds, max.
Primary power connection,
Bendix receptacle ..... PT07C-8-3p
RF connections
(50 ohms, nominal) ..... Type N, jack
Reference Drawing Number ..... 290229

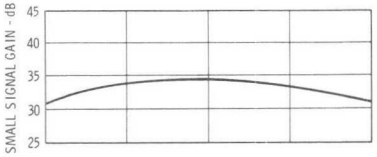
Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.

These environmental characteristics meet the respective requirements of MIL-E-5400, Class 2 Specification.

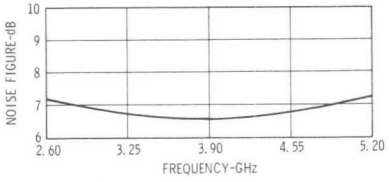
## POWER



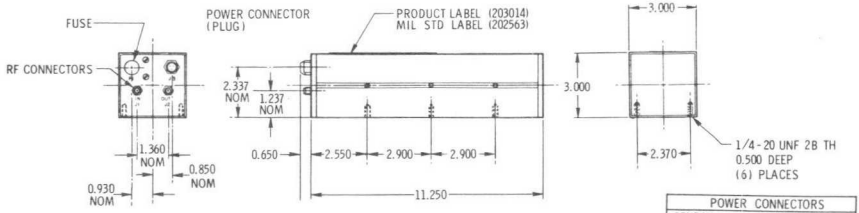

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: J 3<br>PT-07C-8-3P (PLUG)<br>MS 3116E-8-3S (SR) (SOC) | | |
| PIN | CONNECTION | |
| A | AC (HOT) | 115 ± 10 VAC |
| B | GROUND | 48 - 420 Hz |
| C | AC | SINGLE PHASE |

# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970 *

## 7 TO 11 GHz PPM-FOCUSED LOW-NOISE TWT LIMITER WITH INTEGRAL POWER SUPPLY

## WJ-484

- "JUST PLUG IT IN"
- GUARANTEED 10.0 dB VARIATION IN POWER OUTPUT OVER 35 dB POWER INPUT RANGE
- GUARANTEED +10 dBm POWER OUTPUT
- SMALL SIZE: 2x2x11 INCHES
- MEETS MIL-E-5400 CLASS II ENVIRONMENT AS SPECIFIED

The WJ-484 is one of a family of periodic-permanent-magnet low noise TWT limiters developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. It is completely self-contained, and adjustment free, operating with only an ac line voltage input.

The WJ-484 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-484 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 7.0 to 11.0 GHz |
| Noise figure, terminal | 11.0 dB | 12.0 dB max. |
| Gain, small signal | 40 dB | 38 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Saturation Power Output | +15 dBm | +10 dBm min. |
| Power Output Variation/35 dB Input Power Range (up to +0 dBm) | 9 dB | 10 dB |

| ELECTRICAL REQUIREMENTS[1] | Typical | Range |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 12 watts | |
| Primary current | 145 mA | |

* Supersedes WJ-484 Technical Data Sheet dated September 1969.

# WJ-484

## ENVIRONMENTAL CHARACTERISTICS[2]

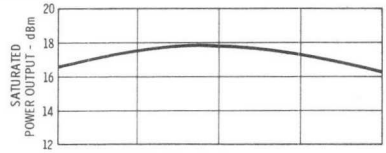
Temperature . . . . . —54°C to +71°C
Vibration
a. 0.10 inch, double amplitude . . . . . 5 to 45 Hz
b. 10 g, single amplitude . . . . . 45 to 500 Hz
Shock . . . . . 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

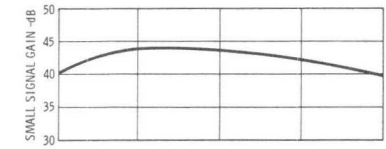
Height (excluding connectors) . . . . . 2 inches (51 mm) max.
Width . . . . . 2 inches (51 mm) max.
Length . . . . . 11 inches (279 mm) max.
Weight . . . . . 3.5 pounds (1.56 kg) max.
Primary power connection, Bendix receptacle . . . . . PTO7C-8-3p
RF connection (50 ohms, nominal) . . . . . OSM, jack
Outline Drawing . . . . . WJ No. 290238

NOTE:
1. Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
2. These environmental characteristics meet the respective requirements of MIL-E-5400K, dated 24 May 68, class 2.

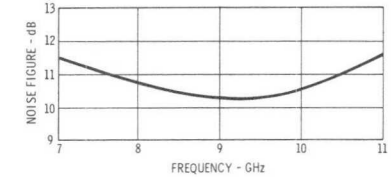
## POWER



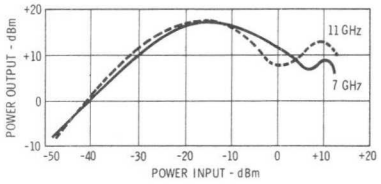

## GAIN



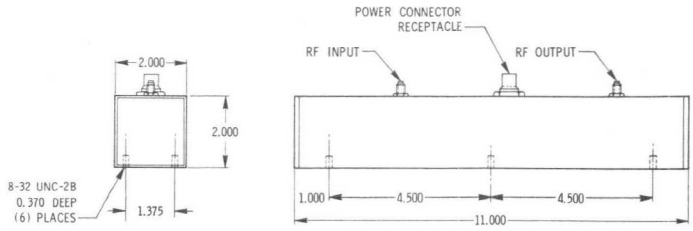

## NOISE




## OVERDRIVE




## OUTLINE DRAWING



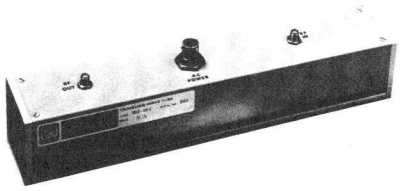
# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1969

## 4.0 TO 8.0 GHz PPM-FOCUSED LOW-NOISE TWT LIMITER WITH INTEGRAL POWER SUPPLY WJ-485

- "JUST PLUG IT IN"
- MAXIMUM 10.0 dB VARIATION IN POWER OUTPUT OVER 35 dB POWER INPUT RANGE
- GUARANTEED +12 dBm SATURATED POWER OUTPUT
- SMALL SIZE: 2 x 2 x 11 INCHES
- DESIGNED TO MEET MIL-E-5400 CLASS II ENVIRONMENT AS SPECIFIED



The WJ-485 is one of a family of periodic-permanent-magnet low noise TWT limiters developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. It is completely self-contained, and adjustment free, operating with only an ac line voltage input.

The WJ-485 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-485 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 4.0 to 8.0 GHz |
| Noise figure, terminal | 13.0 dB | 15.0 dB max. |
| Gain, small signal | 40 dB | 35 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power Output | 14 dBm | +12 dBm min. |
| Overdrive Power Output Variation for Input Variation of 35 dB | 9 dB | 10 dB max. |

| ELECTRICAL REQUIREMENTS[1] | Typical | Range |
|---|---|---|
| Primary Voltage | 115 V ac | 115 ±10 V ac |
| Primary Frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 10 watts | |

# WJ-485

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature ..... −54°C to +71°C

Vibration
a. .10 inch, double amplitude ..... 5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz

Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

Height
(excluding connectors) .. 2 inches (51 mm) max.

Width ..... 2 inches (51 mm) max.

Length ..... 11 inches (279 mm) max.

Weight ..... 3¾ pounds (1.70 Kg) max.

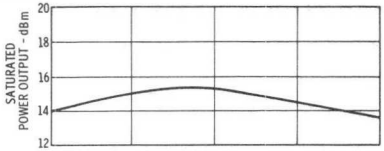
Primary power connection,
Bendix receptacle ..... PT07C-8-3p

RF connection (50 ohms, nominal) .....OSM, jack

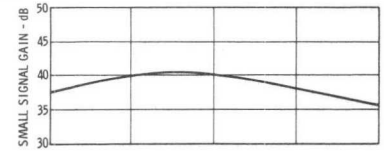
Outline Drawing No. ..... WJ-290238

NOTE:
[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
[2]These environmental characteristics meet the respective requirements of MIL-E-5400K, dated 24 May 68, class 2.

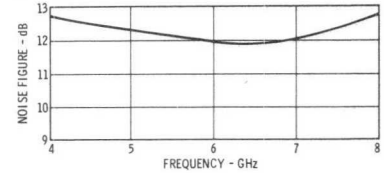
## POWER



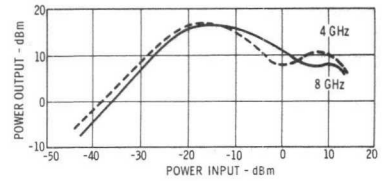

## GAIN



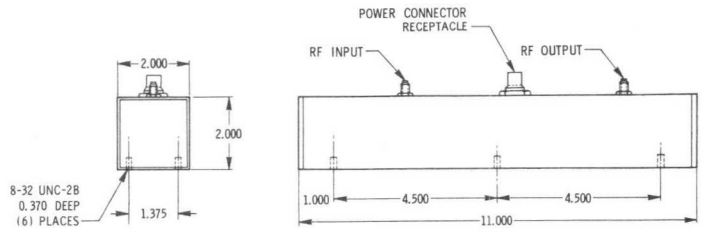

## NOISE




## OVERDRIVE




## OUTLINE DRAWING



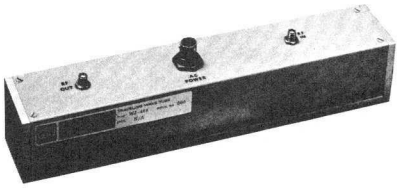
# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1969

## 2 TO 4 GHz PPM-FOCUSED LOW-NOISE TWT LIMITER WITH INTEGRAL POWER SUPPLY WJ-486

- **"JUST PLUG IT IN"**
- **MAXIMUM 10.0 dB VARIATION IN POWER OUTPUT OVER 35 dB POWER INPUT RANGE**
- **GUARANTEED +13 dBm POWER OUTPUT**
- **SMALL SIZE: 2x2x11 INCHES**
- **MEETS MIL-E-5400 CLASS II ENVIRONMENT**



The WJ-486 is one of a family of periodic-permanent-magnet low noise TWT limiters developed by Watkins-Johnson Company to meet the increasing demand for reliable microwave devices. It is completely self-contained, and adjustment free, operating with only an ac line voltage input.

The WJ-486 may be mounted in any orientation without degradation of performance. Rugged construction of the tube, magnet, and power supply ensures reliable operation under vibrational forces of 10g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. These environmental characteristics of the WJ-486 meet the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 2 to 4 GHz |
| Noise figure, terminal | 12.0 dB | 15 dB max. |
| Gain, small signal | 43 dB | 40 dB min. |
| VSWR, input and output | 1.5:1 | 2:1 max. |
| Power Output | +17 dBm | +13 dBm min. |
| Overdrive Power Output Variation for Input Variation of 35 dB | 7 dB | 10 dB max. |

| ELECTRICAL REQUIREMENTS[1] | Typical | Range |
|---|---|---|
| Primary voltage | 115 Vac | 115 ±10 Vac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary Power | 10 watts | |

# WJ-486

## ENVIRONMENTAL CHARACTERISTICS[2]

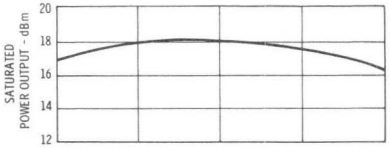
Temperature ..... −54°C to +71°C
Vibration
a. .10 inch, double amplitude ..... 5 to 45 Hz
b. 10 g, single amplitude ..... 45 to 500 Hz
Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

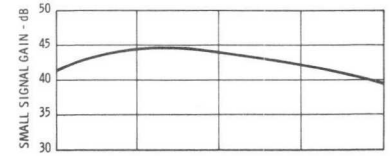
Height (excluding connectors).....2 inches (51 mm) max.
Width.....2 inches (51 mm) max.
Length.....11 inches (279 mm) max.
Weight ..... 3.5 pounds (1.59 Kg) max.
Primary power connection, Bendix receptacle .....PTO7C-8-3p
RF connection (50 ohms, nominal).....OSM, jack
Outline Drawing No. ..... WJ-290238

NOTE:
[1]Every tube will meet the guaranteed performance specifications for any primary voltage and frequency within these ranges.
[2]These environmental characteristics meet the respective requirements of MIL-E-5400K, dated 24 May 68, class 2.

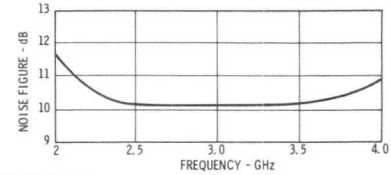
## POWER



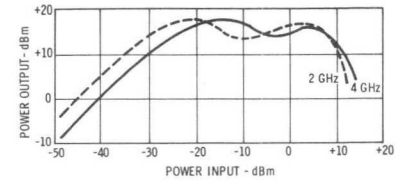

## GAIN



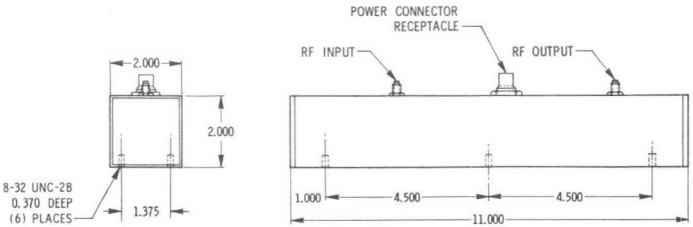

## NOISE




## OVERDRIVE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

* JULY 1971

## 1 TO 2 GHz YIG-TUNED TRANSISTOR OSCILLATOR WJ-569


The WJ-569 is one of a family of lightweight, electronically tuned, transistor oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full octave for this solid-state, microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The WJ-569 is designed for substantial derating of power dissipation in the transistor, resulting in extremely high reliability. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Complex auxiliary electrical circuitry is eliminated in the WJ-569. A self-regulating, proportional-controlled heater, which stabilizes the temperature of the YIG sphere, requires only the application of unregulated power for operation. The built-in dc biasing network, which provides over-voltage and reverse-polarity protection, requires only one voltage to drive the transistor.

Frequency tuning of the WJ-569 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-569 is magnetically shielded, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments.

YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, higher sweep rate, and different tuning sensitivity can be made to order. Other popular options include voltage-to-current drivers and FM or phase lock capabilities.

## SPECIFICATIONS

| RF PERFORMANCE[1] | Typical | Guaranteed |
|---|---|---|
| Tuning Range | | 1.0 to 2.0 GHz |
| Power Output | 30 mW | 20 mW, min. |
| Power Output Variation | 4 dB | 6 dB, max. |
| Ratio of Signal to 2nd Harmonic Output | 20 dB | 13 dB, min. |
| Ratio of Signal to In-band Spurious Outputs | 60 dB | 50 dB, min. |
| Sensitivity to Supply Voltage | 0.3 MHz/V | 1 MHz/V, max. |
| Frequency Drift 0°C to 60°C | 4 MHz | 8 MHz, max. |
| Pulling Figure, VSWR 1.5:1 at any phase | 3 MHz | |

NOTES: *Supersedes WJ-569 Data Sheet dated September 1968.
[1]Measured into a 50 ohm load.

# WJ-569

## SPECIFICATIONS (Cont'd)

### TUNING CHARACTERISTICS

| | | |
|---|---|---|
| Sweep Delay | 150$\mu$ sec | |
| Tuning Linearity (dc) | ±2 MHz | |
| Hysteresis | 1.5 MHz | 3 MHz, max. |
| Tuning Sensitivity | 5.7 MHz/mA | |
| Tuning Coil Resistance | 5 ohm | |
| Tuning Coil Inductance | 20 mH | |

### ELECTRICAL REQUIREMENTS

| | | |
|---|---|---|
| Oscillator Voltage, negative side ground[2] | 15 ±0.2 Vdc | |
| Oscillator Current | 40 mA | |
| YIG Heater Power at 0°C, Steady State[3] | 0.8 W | 1.5 W, max. |
| Voltage | 24 ±4 Vdc | 28 Volts, max. |

NOTES: [2]Protective biasing circuit employed to prevent transistor damage from over-voltage or reverse voltages.
[3]YIG heater is self-regulating, proportional-controlled, temperature-sensitive resistor.

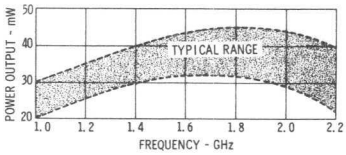
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Size, excluding RF Connector and solder terminals (width x length x height) | 1.45 x 1.45 x 1.45 inches (37 x 37 x 37 mm) |
| Weight, Including Magnetic Shielding | 9 ounces (255 g) max. |
| RF Output Connection | SMA Jack |
| Power Input | Solder Terminals |
| Outline Drawing No. | 290132 |

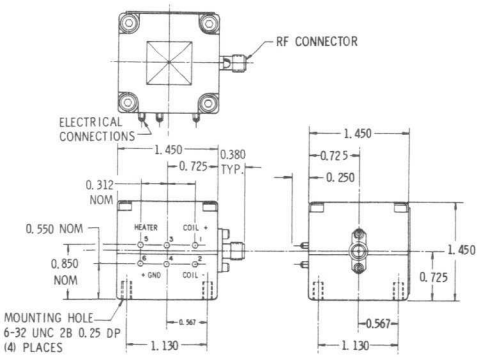
### TYPICAL ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature, operating | 0°C to +60°C |
| Temperature, non-operating | −62°C to +75°C |

### POWER OUTPUT VS. FREQUENCY




### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

* JULY 1971

## 0.5 TO 1.0 GHz YIG-TUNED TRANSISTOR OSCILLATOR WJ-571


The WJ-571 is one of a family of lightweight, electronically tuned, transistor oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full octave for this solid-state, microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The WJ-571 is designed for substantial derating of power dissipation in the transistor, resulting in extremely high reliability. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Complex auxiliary electrical circuitry is eliminated in the WJ-571. A self-regulating, proportional-controlled heater, which stabilizes the temperature of the YIG sphere, requires only the application of unregulated power for operation. The built-in dc biasing network, which provides over-voltage and reverse-polarity protection, requires only one voltage to drive the transistor.

Frequency tuning of the WJ-571 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-571 is magnetically shielded, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments.

YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, higher sweep rate, and different tuning sensitivity can be made to order. Other popular options include voltage-to-current drivers and FM or phase lock capabilities.

## SPECIFICATIONS

| RF PERFORMANCE[1] | Typical | Guaranteed |
|---|---|---|
| Tuning Range | | 0.5 to 1.0 GHz |
| Power Output | 35 mW | 20 mW, min. |
| Power Output Variation | 3 dB | 6 dB, max. |
| Ratio of Signal to 2nd Harmonic Output | 13 dB | 10 dB, min. |
| Ratio of Signal to In-band Spurious Outputs | 60 dB | 50 dB, min. |
| Sensitivity to Supply Voltage | 0.3 MHz/V | 1 MHz/V, max. |
| Frequency Drift 0°C to 60°C | 4 MHz | 8 MHz, max. |
| Pulling Figure, VSWR 1.5:1 at any phase | 2 MHz | |

*Supersedes WJ-571 Data Sheet dated May 1968.
[1]Measured into a 50 ohm load.

## SPECIFICATIONS (Cont'd)

### TUNING CHARACTERISTICS

| | | |
|---|---|---|
| Sweep Delay | 150μ sec | |
| Tuning Linearity (dc) | ±1 MHz | ±2 MHz max. |
| Hysteresis | 2 MHz | 3 MHz, max. |
| Tuning Sensitivity | 5.7 MHz/mA | |
| Tuning Coil Resistance | 5 ohm | |
| Tuning Coil Inductance | 20 mH | |

### ELECTRICAL REQUIREMENTS

| | | |
|---|---|---|
| Oscillator Voltage, positive side ground[2] | +15 ±0.2 Vdc | |
| Oscillator Current | 45 mA | |
| YIG Heater Power at 0°C, Steady State[3] | 0.8 W | 1.5 W, max. |
| YIG Heater Voltage | 24 ±4 Vdc | 28 Vdc max. |

NOTES:
[2]Protective biasing circuit employed to prevent transistor damage from over-voltage or reverse voltages.
[3]YIG heater is self-regulating, proportional-controlled, temperature-sensitive resistor.

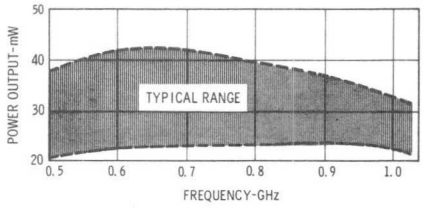
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Size, excluding RF Connector and solder terminals (width x length x height) | 1.45 x 1.45 x 1.45 inches (37 x 37 x 37 mm) |
| Weight, Including Magnetic Shielding | 9 ounces (255 g) max. |
| RF Output Connection | SMA Jack |
| DC Input Connection | Solder Terminals |
| Outline Drawing No. | 290132 |

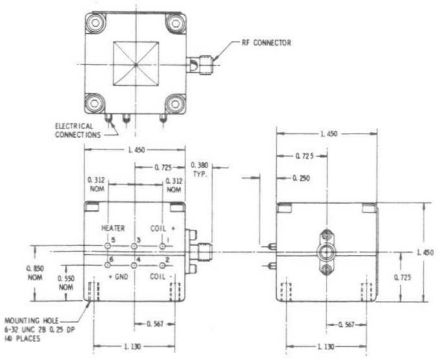
### TYPICAL ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature, operating | 0°C to +60°C |
| Temperature, non-operating | −65°C to +100°C |

### POWER OUTPUT VS. FREQUENCY




### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

## 2 TO 4 GHz YIG-TUNED TRANSISTOR OSCILLATOR WJ-572


The WJ-572 is one of a family of lightweight, electronically tuned, transistor oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full octave for this solid-state, microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The WJ-572 is designed for substantial derating of power dissipation in the transistor, resulting in extremely high reliability. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Complex auxiliary electrical circuitry is eliminated in the WJ-572. A self-regulating, proportional-controlled heater, which stabilizes the temperature of the YIG sphere, requires only the application of unregulated power for operation. The built-in dc biasing network, which provides over-voltage and reverse-polarity protection, requires only one voltage to drive the transistor.

Frequency tuning of the WJ-572 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-572 is magnetically shielded, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments.

YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, higher sweep rate, and different tuning sensitivity can be made to order. Other popular options include voltage-to-current drivers and FM or phase lock capabilities.

## SPECIFICATIONS

| RF PERFORMANCE [1] | Typical | Guaranteed |
|---|---|---|
| Tuning Range | | 2.0 to 4.0 GHz |
| Power Output | 8 mW | 4 mW, min. |
| Power Output Variation | 4 dB | 6 dB, max. |
| Ratio of Signal to 2nd Harmonic Output | 20 dB | 13 dB, min. |
| Ratio of Signal to In-band Spurious Outputs | 60 dB | 50 dB, min. |
| Sensitivity to Supply Voltage | 0.3 MHz/V | 1 MHz/V, max. |
| Frequency Drift 0°C to 60°C | 8 MHz | 12 MHz, max. |
| Pulling Figure, VSWR 1.5:1 at any phase | 3 MHz | |

| TUNING CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Sweep Delay | 150$\mu$ sec | |
| Tuning Linearity (dc) | ±4 MHz | ±5 MHz |
| Hysteresis | 2.5 MHz | 4 MHz, max. |
| Tuning Sensitivity | 11.5 MHz/mA | |
| Tuning Coil Resistance | 8 ohm | |
| Tuning Coil Inductance | 40 mH | |

*Supersedes WJ-572 Data Sheet dated October 1968.

[1]Measured into a 50 ohm load.

# WJ-572

## SPECIFICATIONS (Cont'd)

| ELECTRICAL REQUIREMENTS | Typical | Guaranteed |
|---|---|---|
| Oscillator Voltage, negative side ground[2] | +15 ±0.2 Vdc | |
| Oscillator Current | 40 mA | |
| YIG Heater Power at 0°C, Steady State[3] | 0.8 W | 1.5 W, max. |
| YIG Heater Voltage | 24 ±4 Vdc | 28 Vdc max. |

NOTES: [2]Protective biasing circuit employed to prevent transistor damage from over-voltage or reverse voltages.
[3]YIG heater is self-regulating, proportional-controlled, temperature-sensitive resistor.

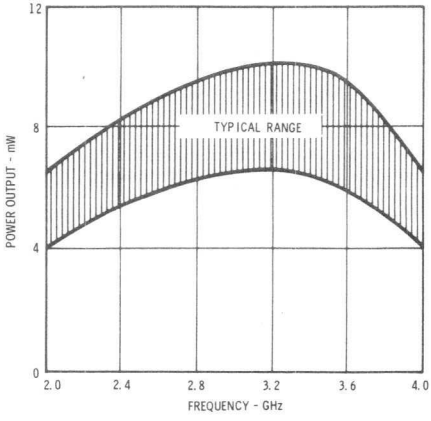
### MECHANICAL CHARACTERISTICS

Size, excluding RF Connector and solder terminals (width x length x height) . . . . . 1.45 x 1.45 x 1.45 inches (37 x 37 x 37 mm)
Weight, Including Magnetic Shielding . . . . . 9 ounces (255 g) max.
RF Output Connection . . . . . SMA Jack
DC Input Connection . . . . . Solder Terminals
Outline Drawing No. . . . . 295166

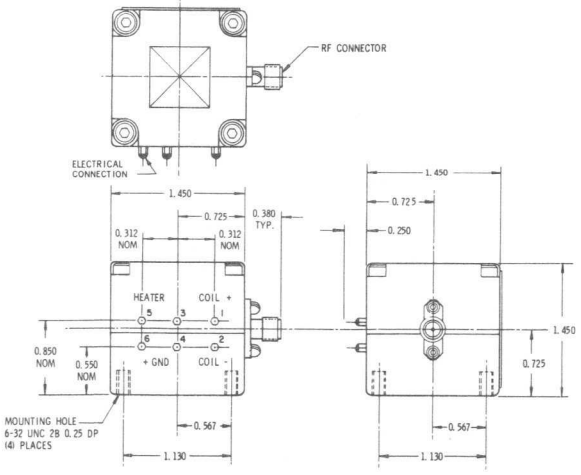
### TYPICAL ENVIRONMENTAL CHARACTERISTICS

Temperature, operating . . . . . 0°C to +60°C
Temperature, non-operating . . . −62°C to +75°C

### POWER OUTPUT VS. FREQUENCY




### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

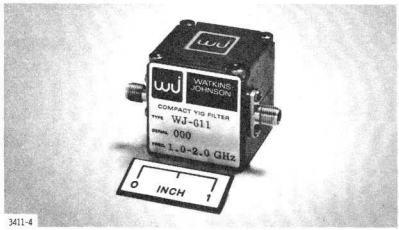
WJ-611

## 1 TO 2 GHz COMPACT TWO-STAGE YIG FILTER

September 1968

The WJ-611 is one of a family of compact YIG filters incorporating a self-shielding magnetic circuit. Features of this electronically tuned YIG filter include high reliability, long life, ruggedness, small size, and high thermal stability. In addition, the tuning power requirement is less than ¼ watt.

For specific requirements, the WJ-611 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



3411-4

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 1.0 to 2.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.5 dB | | 3.0 dB |
| Off Resonance Isolation (minimum) | 50 dB | | 40 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 2.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |

### TUNING CHARACTERISTICS

| | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±2 MHz |
| Hysteresis | 4 MHz |
| Frequency Drift over Temp. Range 0-60°C | 8 MHz |
| Zero Current Frequency | Not Biased |

### MECHANICAL CHARACTERISTICS

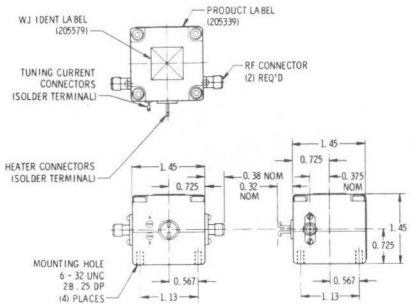
| | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290050 |

### HEATER CHARACTERISTICS

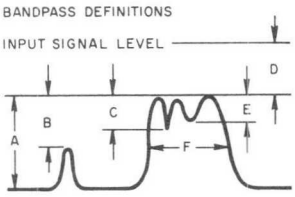
| | |
|---|---|
| Operating Voltage | 22 to 30 Volts |
| Operating Current: | |
| Surge at 0°C | 750 mA |
| Steady State at 0°C | 250 mA |

# WJ-611

## OUTLINE DRAWING

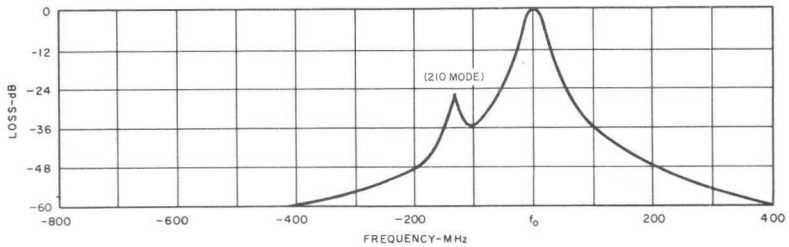



## MEASUREMENT DEFINITIONS

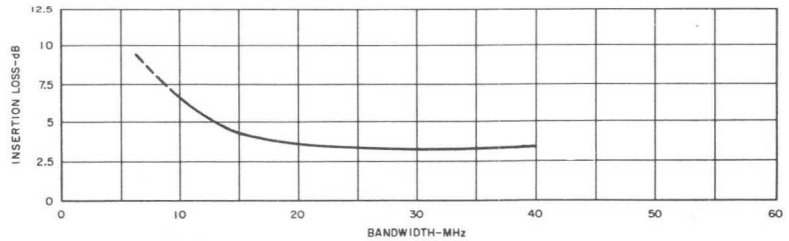



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

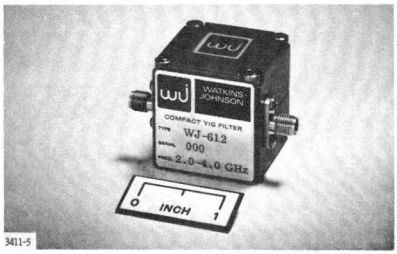
WJ-612

September 1968

## 2 TO 4 GHz COMPACT TWO-STAGE YIG FILTER

The WJ-612, one of a family of electronically tuned compact YIG filters produced by Watkins-Johnson Company, offers high reliability, long life, ruggedness, and high thermal stability in a small package. These features are primarily the result of a built-in self-shielding magnetic circuit. The tuning power requirement is less than 1 watt for this YIG filter.

The WJ-612 is available with several options. It can be produced to cover any frequency range in the S-band up to 1.2 octaves. Bandwidths other than specified are available between 10 and 50 MHz. The tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.




## SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 2.0 to 4.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.5 dB | | 3.0 dB |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |

### TUNING CHARACTERISTICS

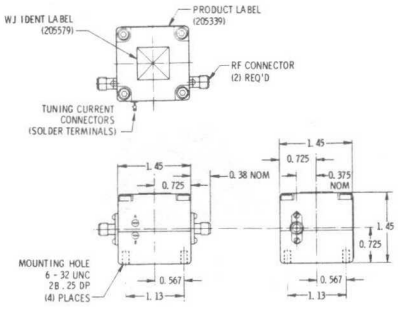
| | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1 ms |
| Deviation from Linear | ±3 MHz |
| Hysteresis | 10 MHz |
| Frequency Drift over Temp. Range 0-60°C | 8 MHz |
| Zero Current Frequency | Not Biased |

### MECHANICAL CHARACTERISTICS

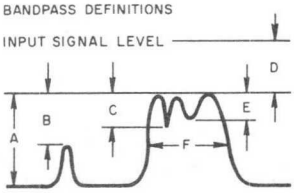
| | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290050 |

# WJ-612

## OUTLINE DRAWING

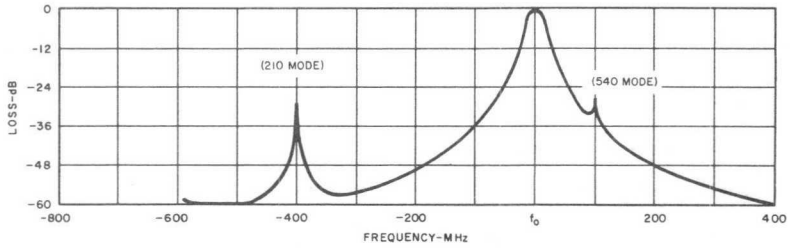



## MEASUREMENT DEFINITION

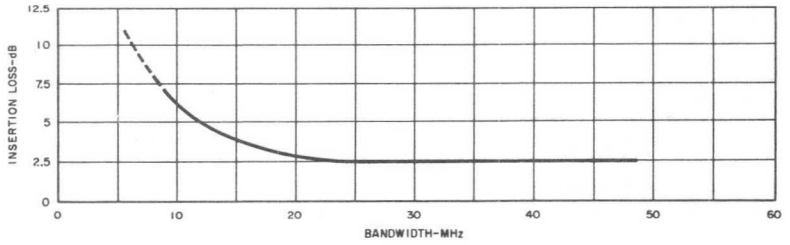



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

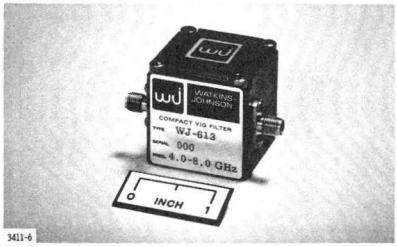
# WJ-613

## 4 TO 8 GHz COMPACT TWO-STAGE YIG FILTER

September 1968

The WJ-613 is one of a family of electronically tuned, compact YIG filters produced by Watkins-Johnson Company. A self-shielding magnetic circuit built into the WJ-613 ensures high reliability, long life, ruggedness, and high thermal stability in a compact filter. A low tuning power requirement (less than 2 watts) is also featured in this YIG filter.

For specific requirements, the WJ-613 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 10 and 60 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



3411-6

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 4.0 to 8.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 25 MHz |
| Insertion Loss (maximum) | 2.5 dB | | 3.0 dB |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |

### TUNING CHARACTERISTICS

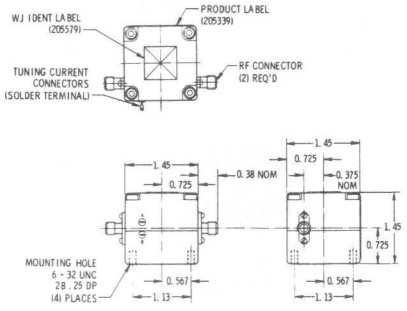
| | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1 ms |
| Deviation from Linear | ±5 MHz |
| Hysteresis | 20 MHz |
| Frequency Drift over Temp. Range 0-60°C | 10 MHz |
| Zero Current Frequency | Not Biased |

### MECHANICAL CHARACTERISTICS

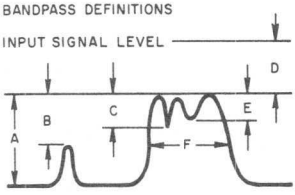
| | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290050 |

# WJ-613

## OUTLINE DRAWING

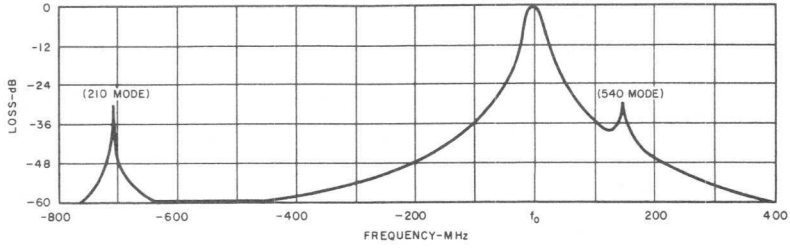



## MEASUREMENT DEFINITION

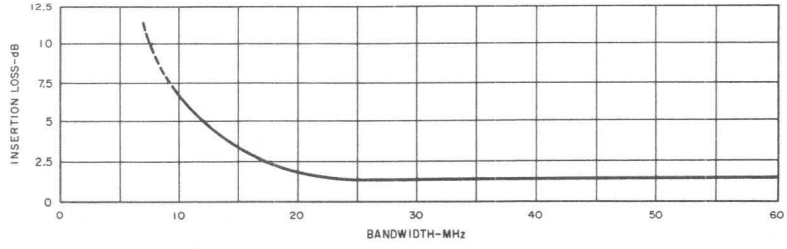



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1970 *

## 8 TO 12 GHz COMPACT TWO-STAGE YIG FILTER WJ-614

The WJ-614, one of a family of compact YIG filters incorporating a self-shielding magnetic circuit, features high reliability, long life,ruggedness, small size, and high thermal stability. The tuning power requirement for this electronically tuned YIG filter is less than 3.0 watts. The WJ-614 can be produced to cover any frequency range in the X-band up to 5 GHz. Bandwidths other than specified are available between 15 and 100 MHz.


## SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 8.0 to 12.4 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.0 dB | | 3.0 dB |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |

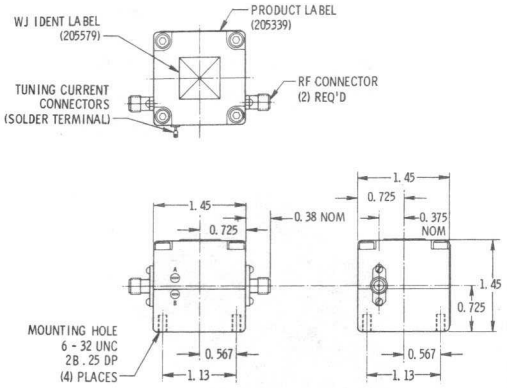
| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 5.5 ohms |
| Coil Inductance | 60 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±8 MHz |
| Hysteresis | 15 MHz |
| Frequency Drift over Temperature Range 0-60°C | 12 MHz |
| Zero Current Frequency | Not Biased |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches (36 x 36 x 36 mm) |
| Weight | 12 ounces (340 g) |
| RF Connectors | SMA Jack |
| Outline Drawing No. | 290050 |

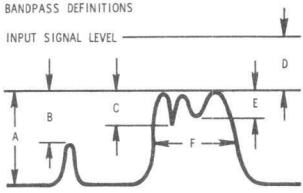
* Supersedes WJ-614 Technical Data Sheet dated September 1968.

# WJ-614

## OUTLINE DRAWING

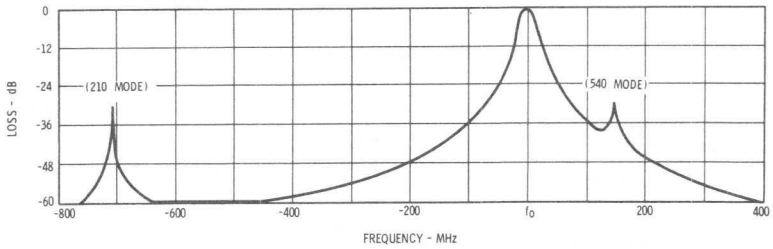



## MEASUREMENT DEFINITIONS

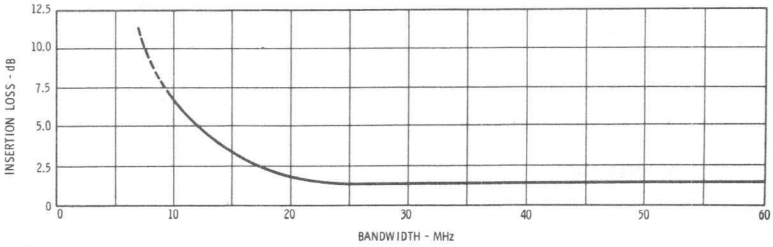



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

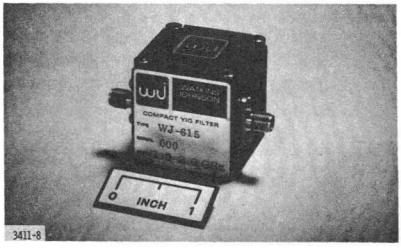
# WJ-615*

September 1968

## 1 TO 2 GHz COMPACT FOUR-STAGE YIG FILTER

The WJ-615 is one of a family of compact YIG filters incorporating a self-shielding magnetic circuit. Features of this electronically tuned YIG filter include high reliability, long life, ruggedness, small size, and high thermal stability. In addition, the tuning power requirement is less than ¼ watt.

For specific requirements, the WJ-615 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 50 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.




## SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 1.0 to 2.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.0 dB | | 6.0 dB |
| Off Resonance Isolation (minimum) | 80 dB | | 70 dB |
| Off Resonance Spurious (minimum) | | | 50 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR | 1.5:1 | | 2:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 24 dB | | |

### TUNING CHARACTERISTICS

| | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±2 MHz |
| Hysteresis | 4 MHz |
| Frequency Drift over Temp. Range 0-60°C | 8 MHz |
| Zero Current Frequency | Not Biased |

### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290050 |

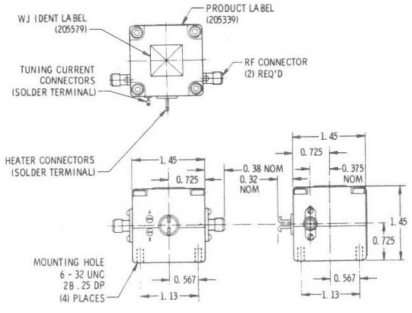
### HEATER CHARACTERISTICS

| | |
|---|---|
| Operating Voltage | 22 to 30 Volts |
| Operating Current: | |
| Surge at 0°C | 750 mA |
| Steady State at 0°C | 250 mA |

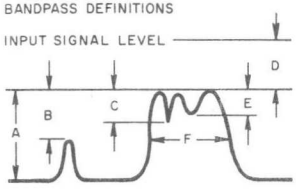
*Supersedes WJ-615 Data Sheet dated May 1968

# WJ-615

## OUTLINE DRAWING

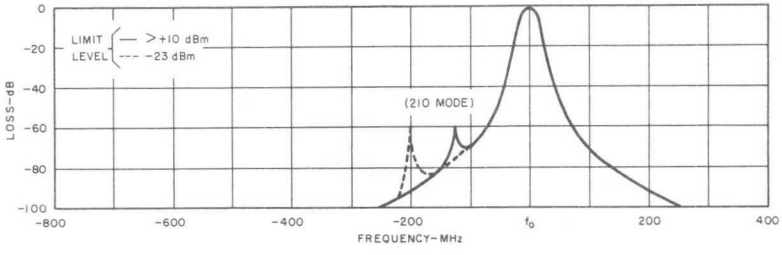



## MEASUREMENT DEFINITIONS

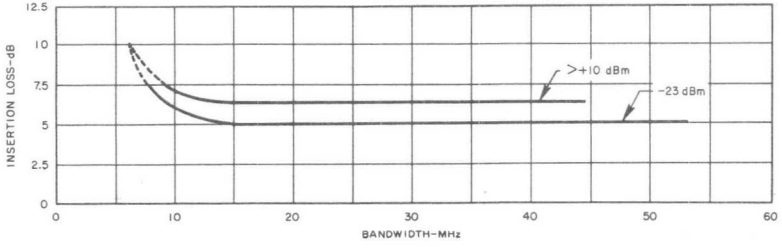



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

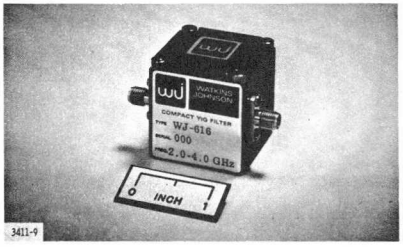
# WJ-616

September 1968

## 2 TO 4 GHz FOUR-STAGE COMPACT YIG FILTER

The WJ-616, one of a family of electronically tuned compact YIG filters produced by Watkins-Johnson Company, offers high reliability, long life, ruggedness, and high thermal stability in a small package. These features are primarily the result of a built-in self-shielding magnetic circuit. The tuning power requirement is less than 1 watt for this compact YIG filter.

The WJ-616 is available with several options. It can be produced to cover any frequency range in the S-band up to 1.2 octaves. Bandwidths other than specified are available between 8 and 50 MHz. The tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.




### SPECIFICATIONS

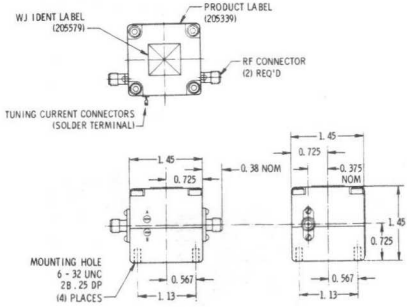
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 2.0 to 4.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.5 dB | | 5.0 dB |
| Off Resonance Isolation (minimum) | 80 dB | | 70 dB |
| Off Resonance Spurious (minimum) | | | 50 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 24 dB | | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±3 MHz |
| Hysteresis | 10 MHz |
| Frequency Drift over Temp. Range 0-60°C. | 8 MHz |
| Zero Current Frequency | Not Biased |

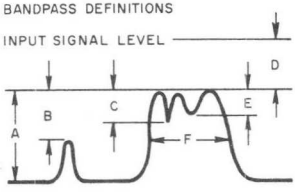
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290050 |

# WJ-616

## OUTLINE DRAWING

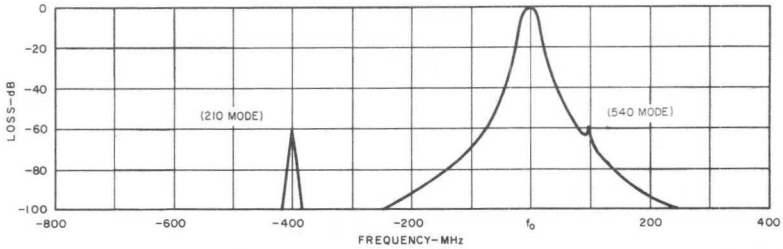



## MEASUREMENT DEFINITIONS

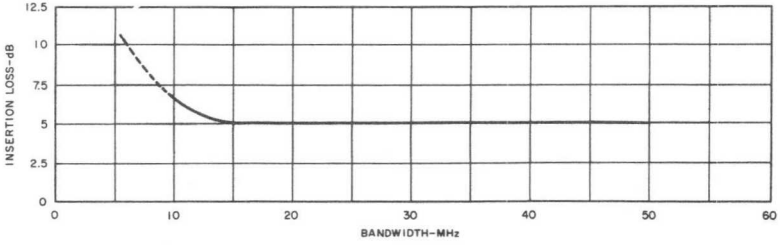



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

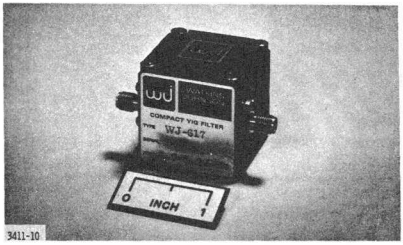
# WJ-617

September 1968

## 4 TO 8 GHz COMPACT FOUR-STAGE YIG FILTER

The WJ-617 is one of a family of electronically tuned compact YIG filters produced by Watkins-Johnson Company. A self-shielding magnetic circuit built into the WJ-617 ensures high reliability, long life, ruggedness, and high thermal stability in a compact filter. A low tuning power requirement (less than 2 watts) is also featured in this YIG filter

For specific requirements, the WJ-617 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 10 and 50 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.




## SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 4.0 to 8.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.5 dB | | 5.0 dB |
| Off Resonance Isolation (minimum) | 80 dB | | 70 dB |
| Off Resonance Spurious (minimum) | | | 50 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 24 dB | | |

### TUNING CHARACTERISTICS

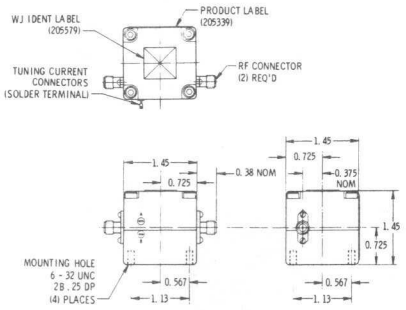
| | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±5 MHz |
| Hysteresis | 20 MHz |
| Frequency Drift over Temp. Range 0-60°C | 10 MHz |
| Zero Current Frequency | Not Biased |

### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290050 |

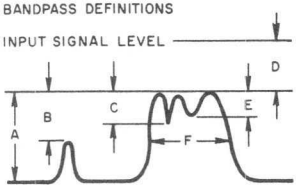
# WJ-617

## OUTLINE DRAWING



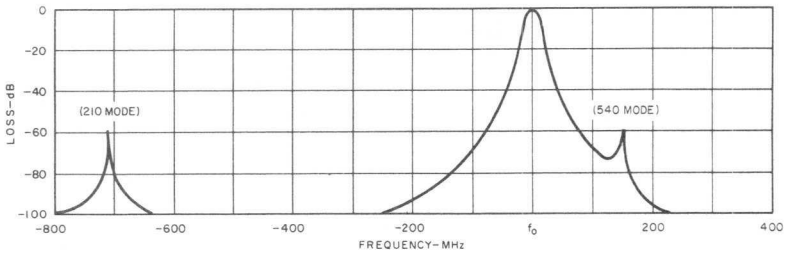

## MEASUREMENT DEFINITIONS

BANDPASS DEFINITIONS

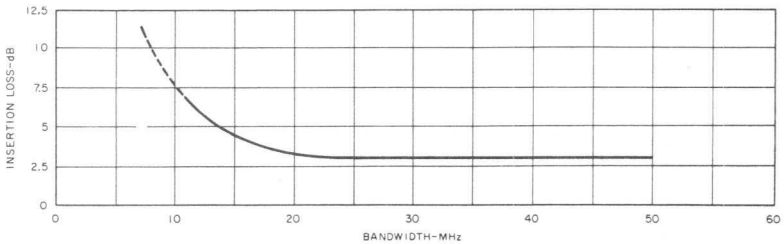



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



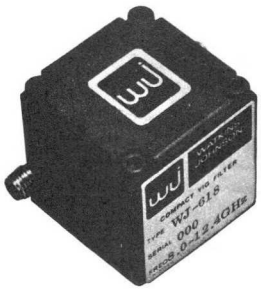
# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1970*

## 8 TO 12 GHz COMPACT FOUR-STAGE YIG FILTER WJ-618

The WJ-618, one of a family of compact YIG filters incorporating a self-shielding magnetic circuit, features high reliability, long life ruggedness, small size, and high thermal stability. The tuning power requirement for this electronically tuned YIG filter is less than 3.0 watts. The WJ-618 can be produced to cover any frequency range in the X-band up to 5 GHz. Bandwidths other than specified are available between 15 and 60 MHz.




## SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 8.0 to 12.4 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.5 dB | | 5.0 dB |
| Off Resonance Isolation (minimum) | 80 dB | | 70 dB |
| Off Resonance Spurious (minimum) | | | 50 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.5 dB | | 2.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 24 dB | | |

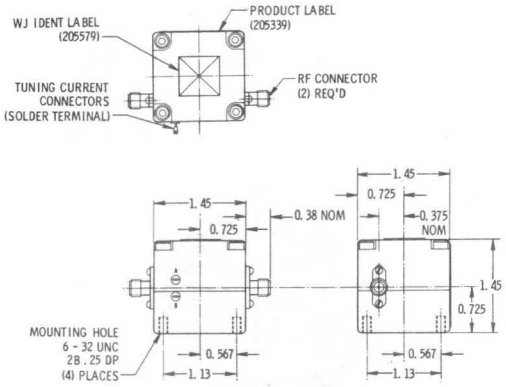
| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 5.5 ohms |
| Coil Inductance | 60 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±8 MHz |
| Hysteresis | 15 MHz |
| Frequency Drift over Temperature Range 0-60°C | 12 MHz |
| Zero Current Frequency | Not Biased |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches (36 x 36 x 36 mm) |
| Weight | 12 ounces (340 g) |
| RF Connectors | SMA Jack |
| Outline Drawing No. | 290050 |

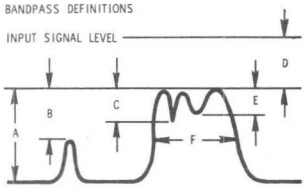
* Supersedes WJ-618 Technical Data Sheet dated September 1968.

# WJ-618

## OUTLINE DRAWING

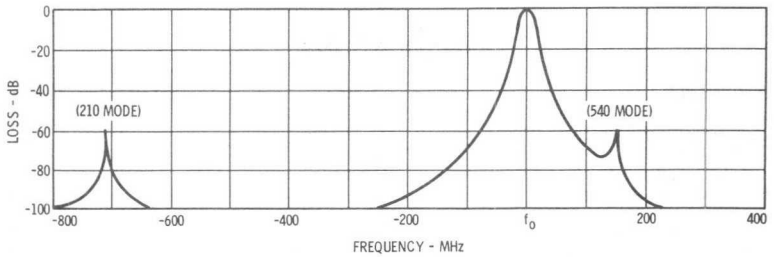



## MEASUREMENT DEFINITIONS

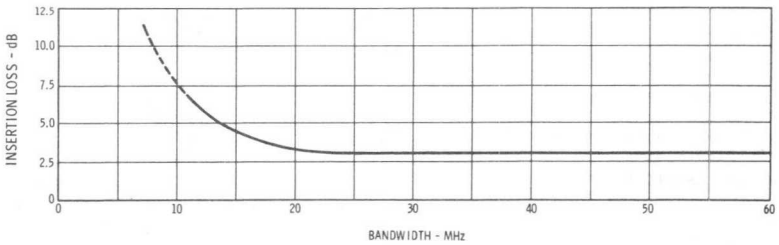



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

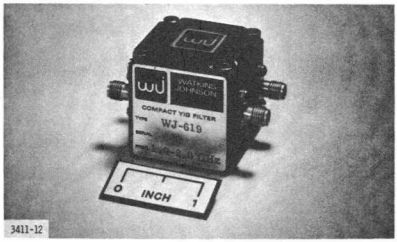
## WJ-619

September 1968*

## 1 TO 2 GHz COMPACT DUAL-CHANNEL TWO-STAGE YIG FILTER

The WJ-619 is one of a family of compact YIG filters incorporating a self-shielding magnetic circuit. Features of this electronically tuned YIG filter include high reliability, long life, ruggedness, small size, and high thermal stability. In addition, the tuning power requirement is less than ¼ watt.

For specific requirements, the WJ-619 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 60 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.




### SPECIFICATIONS

| RF PERFORMANCE (per channel) | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 1.0 to 2.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.0 dB | | 3.0 dB[1] |
| Off Resonance Isolation (minimum) | 50 dB | | 40 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 2.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |
| Isolation Between Channels (minimum) | 50 dB | | 40 dB |
| Frequency Tracking Between Channels | 4 MHz | | 6 MHz |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±2 MHz |
| Hysteresis | 4 MHz |
| Frequency Drift over Temp. Range 0-60°C | 8 MHz |
| Zero Current Frequency | Not Biased |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290051 |

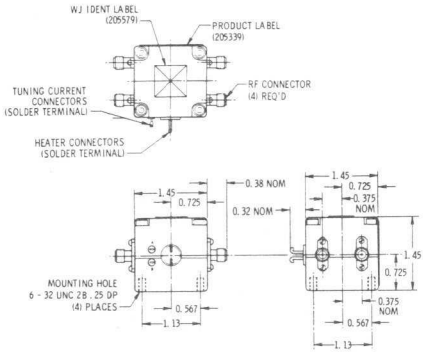
| HEATER CHARACTERISTICS | |
|---|---|
| Operating Voltage | 22 to 30 Volts |
| Operating Current: | |
| Surge at 0°C | 750 mA |
| Steady State at 0°C | 250 mA |

[1]Total of insertion loss of combined channels, passband spurious, and passband ripple not to exceed 8 db at any point of band.

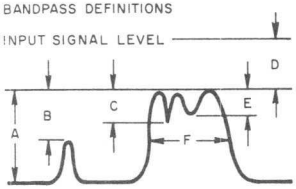
*Supersedes WJ-619 Data Sheet dated May 1968

# WJ-619

## OUTLINE DRAWING

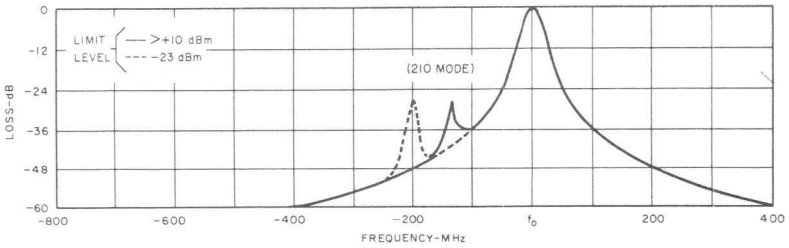



## MEASUREMENT DEFINITIONS

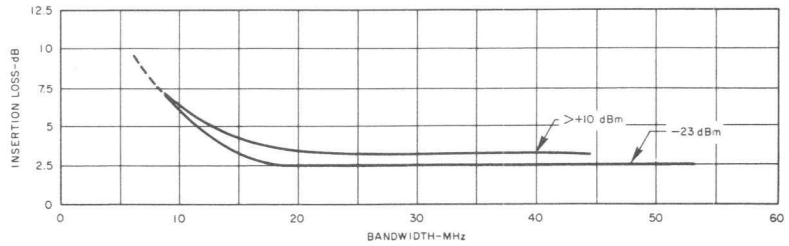



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

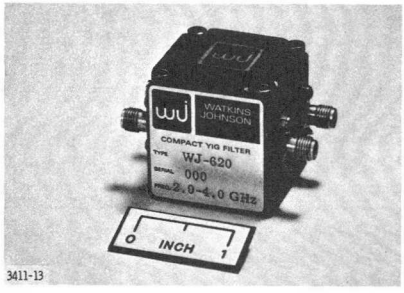
# WJ-620

September 1968

## 2 TO 4 GHz COMPACT DUAL-CHANNEL TWO-STAGE YIG FILTER

The WJ-620, one of a family of electronically tuned compact YIG filters produced by Watkins-Johnson Company, offers high reliability, long life, ruggedness, small size, and high thermal stability. These features are primarily attributed to a built-in self-shielding magnetic circuit. The tuning power requirement is less than 1 watt for this YIG filter.

The WJ-620 is available with several options. It can be produced to cover any frequency range in the S-band up to 1.2 octaves. Bandwidths other than specified are available between 10 and 70 MHz. The tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



3411-13

## SPECIFICATIONS

| RF PERFORMANCE (per channel) | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 2.0 to 4.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.0 dB | | 3.0 dB[1] |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |
| Isolation Between Channels | 50 dB | | 40 dB |
| Frequency Tracking Between Channels | 4 MHz | | 6 MHz |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±3 MHz |
| Hysteresis | 10 MHz |
| Frequency Drift over Temp. Range 0-60°C | 8 MHz |
| Zero Current Frequency | Not Biased |

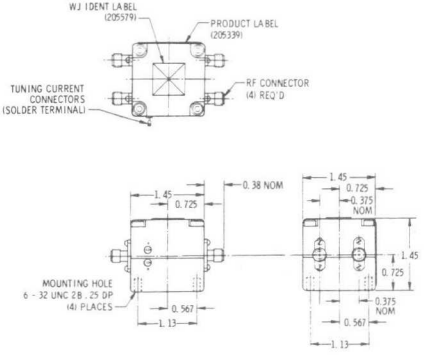
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290051 |

[1]Total of insertion loss of combined channels, passband spurious, and passband ripple not to exceed 8 db at any point of band.

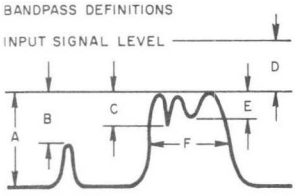
*Supersedes WJ-620 Data Sheet dated May 1968

# WJ-620

## OUTLINE DRAWING

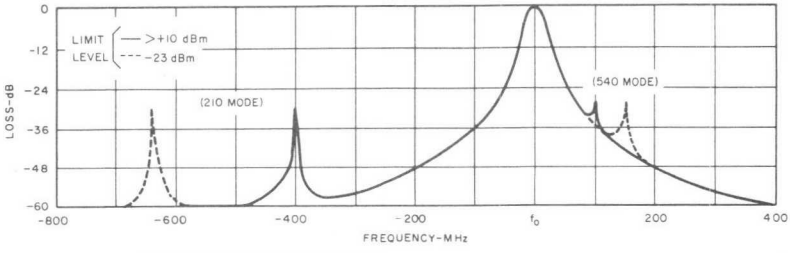



## MEASUREMENT DEFINITIONS

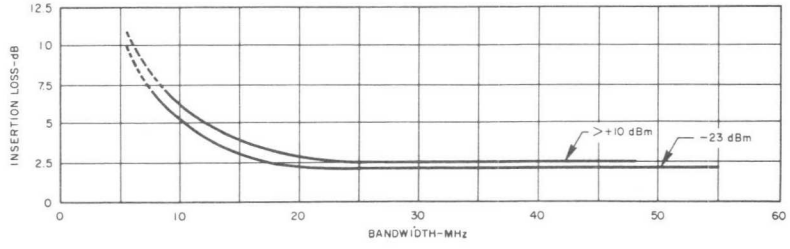



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

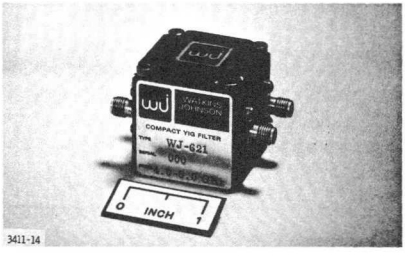
# WJ-621

September 1968 *

## 4 TO 8 GHz COMPACT DUAL-CHANNEL TWO-STAGE YIG FILTER

The WJ-621 is one of a family of electronically tuned, compact YIG filters produced by Watkins-Johnson Company. A self-shielding magnetic circuit built into the WJ-621 results in high reliability, long life, ruggedness, small size, and high thermal stability. A low tuning power requirement (less than 4 watts) is also a feature of this YIG filter.

For specific requirements, the WJ-621 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 10 and 80 MHz. In addition, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirement.



3411-14

### SPECIFICATIONS

| RF PERFORMANCE (per channel) | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 4.0 to 8.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 25 MHz |
| Insertion Loss (maximum) | 2.0 dB | | 3.0 dB[1] |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |
| Isolation Between Channels | 50 dB | | 40 dB |
| Frequency Tracking Between Channels | 4 MHz | | 8 MHz |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 10 ohms |
| Coil Inductance | 110 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±5 MHz |
| Hysteresis | 20 MHz |
| Frequency Drift over Temp. Range 0-60°C | 10 MHz |
| Zero Current Frequency | Not Biased |

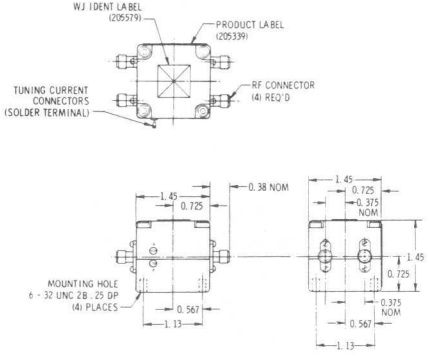
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches |
| Weight | 12 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290051 |

[1]Total of insertion loss of combined channels, passband spurious, and passband ripple not to exceed 8 db at any point of band.

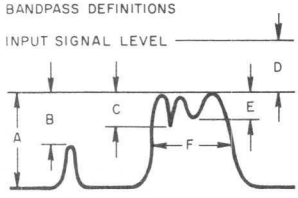
*Supersedes WJ-621 Data Sheet dated May 1968

# WJ-621

## OUTLINE DRAWING

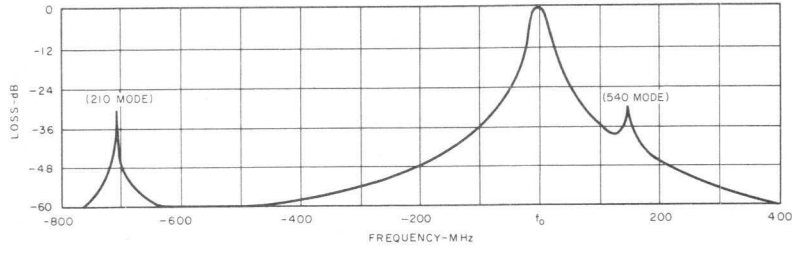



## MEASUREMENT DEFINITIONS

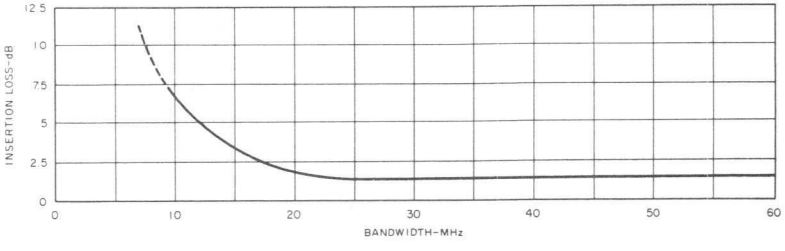



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1970*

## 8 TO 12.4 GHz COMPACT DUAL-CHANNEL TWO-STAGE YIG FILTER WJ-622

The WJ-622, one of a family of compact YIG filters which incorporate a self-shielding magnetic circuit, features high reliability, long life ruggedness, small size and high thermal stability. The tuning power requirement for this electronically tuned YIG filter is less than 3 watts. The WJ-622 can be produced to cover any frequency range in the X-band up to 5 GHz. Bandwidths other than specified are available between 15 and 100 MHz.


## SPECIFICATIONS

| RF PERFORMANCE (per channel) | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 8.0 to 12.4 GHz |
| Bandwidth (3 dB) (minimum) | | 20 MHz | |
| Insertion Loss (maximum) | 1.5 dB | | 3.0 dB[1] |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |
| Isolation Between Channels | 50 dB | | 40 dB |
| Frequency Tracking Error Between Channels (maximum) | 5 MHz | | 8 MHz |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 5.5 ohms |
| Coil Inductance | 60 mH |
| Time Constant | 1.0 ms |
| Deviation from Linear | ±8 MHz |
| Hysteresis | 15 MHz |
| Frequency Drift over Temperature Range 0-60°C | 12 MHz |
| Zero Current Frequency | Not Biased |

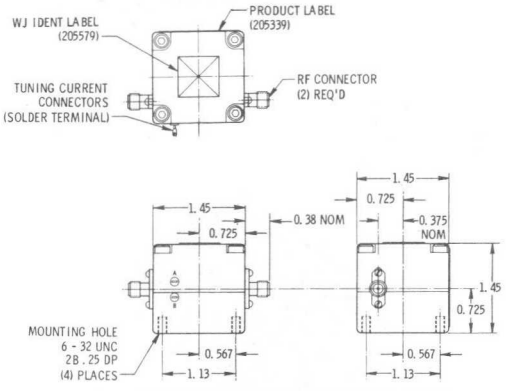
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 1.4 x 1.4 x 1.4 inches (36 x 36 x 36 mm) |
| Weight | 12 ounces (340 g) |
| RF Connectors | SMA Jack |
| Outline Drawing No. | 290051 |

1. Total of insertion loss of combined channels, passband spurious, and passband ripple not to exceed 8 db at any point of band.

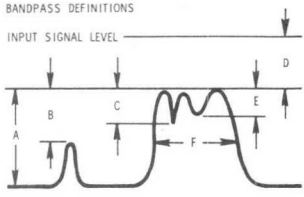
* Supersedes WJ-622 Technical Data Sheet dated September 1968.

# WJ-622

## OUTLINE DRAWING

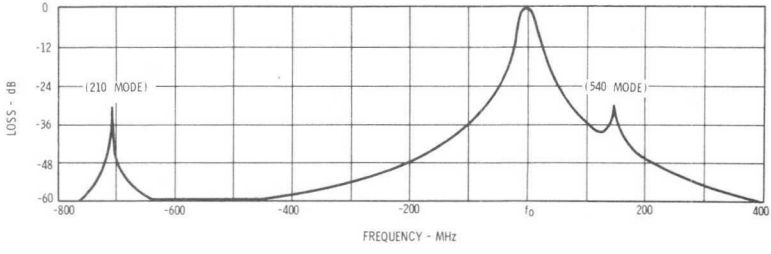



## MEASUREMENT DEFINITIONS

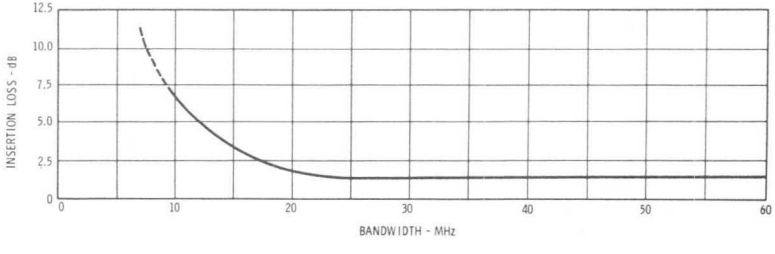



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

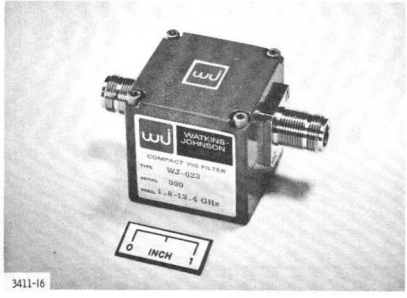
# WJ-623

## 2.0 to 12.4 GHz TWO-STAGE MULTI-OCTAVE COMPACT YIG FILTER

October 1968 *

Watkins-Johnson Company has developed a multi-octave ( 2.0 to 12.4 GHz ) YIG filter which adds a wide tuning range capability to the compact filter line. The WJ-623 is an electronically tuned YIG filter that features high reliability, long life, ruggedness, small size, and a low tuning power requirement (less than 3 watts). These features are primarily attributable to a self-shielded magnetic circuit built into the filter structure.

The WJ-623 is particularly suited for ultra-wide-band receiving and frequency measuring applications. For specific requirements, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirements. In addition, optional bandwidths are available for specific requirements between 15 and 80 MHz.



3411-16

## SPECIFICATIONS

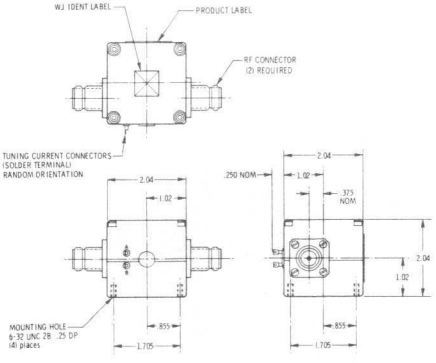
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency range | 1.8 to 12.4 GHz | | 2.0 to 12.4 GHz |
| Bandwidth (3 dB) | 35 MHz | 25 (min) 70 (max) MHz | |
| Insertion loss | <3 dB | | 4.0 dB (max) |
| Off resonance isolation, min. | | | 65 dB below 1 GHz<br>60 dB, 1-4 GHz<br>55 dB, 4-8 GHz<br>50 dB, 8-10 GHz<br>47 dB, 10-12.4 GHz |
| Directivity | Reciprocal | | |
| Passband ripple and spurious | <2.0 dB | | 3.0 dB (max) |
| VSWR, input and output, max. | <1.5:1 | | 2.0:1 |
| Limiting level, min. | | +10 dBm (2.0 - 12.4 GHz) | −23 dBm (1.8 - 2.0 GHz) |
| Selectivity | 12 dB/octave | | |
| Off resonance spurious— | | | |
| other than 210 mode | | | 50 dB down, min. |
| 210 mode | >30 | | 20 dB down, min. |
| **TUNING CHARACTERISTICS** | | | |
| Tuning current | | | 740 mA, max. |
| Coil resistance | | | 5.5 ohms ±10 percent |
| Coil inductance | | | 112 millihenries, ±10 percent |
| Switching time, max. | 5ms | | |
| Deviation from linear | 0.3 percent | | 0.5 percent max. |
| Temperature drift (0 to 55°C) | | | Note 1 |
| Hysteresis | | | 30 MHz max. |
| **MECHANICAL CHARACTERISTICS** | | | |
| Size | 2.0 x 2.0 x 2.0" max. | | |
| Weight | 30 ounces | | |
| RF connector | Type N female | | |
| Outline Drawing No. | 290056 | | |

*Supersedes WJ-623 Technical Data Sheet dated April 1968.

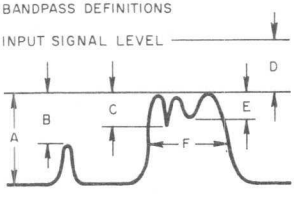
NOTE 1—At any frequency within the specified tuning range, temperature drift must not exceed the difference between the 3 dB bandwidth (in MHz) and 19 MHz. This measurement will be made for design verification only.

# WJ-623

## OUTLINE DRAWING

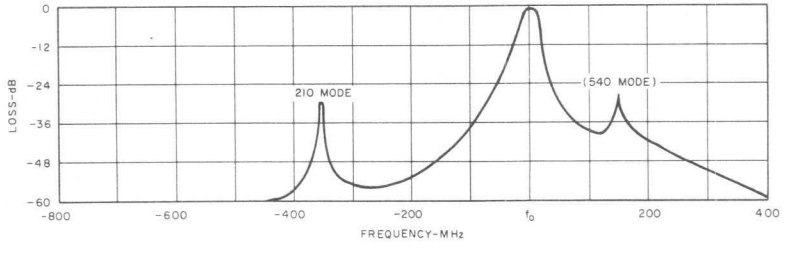



## MEASUREMENT DEFINITION

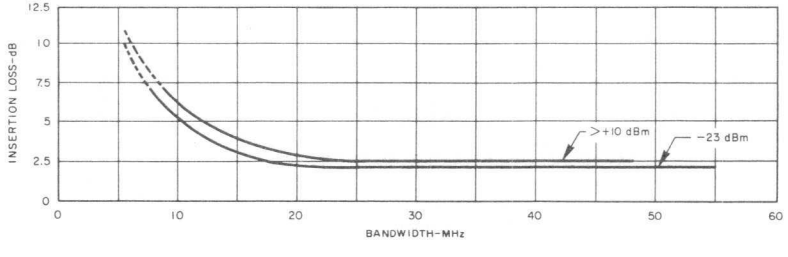



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE (TYPICAL)




## BANDWIDTH vs. LOSS (TYPICAL)



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-627

November 1968

## YIG MAGNETOMETER

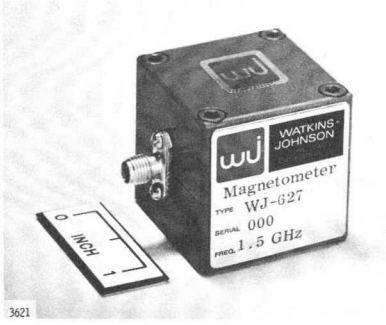
The WJ-627 magnetometer is a specialized application of the YIG tuned microwave transistor oscillators produced by the Watkins-Johnson Company. The magnetometer is capable of measuring pulsed and continuous wave magnetic fields of complex waveforms. The frequency response of the magnetometer extends to 100 MHz.

A change in magnetic field strength is translated directly to a shift of the oscillator frequency. The oscillator frequency can then be converted to an amplitude modulated signal by a suitable frequency discriminator.

Since the WJ-627 itself is magnetically shielded, the field to be measured is sampled with an external coil. The induced current created by a change in magnetic flux through the external sensor coil is fed to an internal driving coil which is in close proximity to a YIG resonator. The field induced in the internal coil modulates the oscillator frequency by changing the resonant frequency of the YIG. The zero field oscillator frequency is set with a biasing magnet.

At the option of the customer, the external sensor coil and a transmission line type microwave discriminator can be supplied to be used in conjunction with the WJ-627 magnetometer.

The YIG magnetometer can be adapted to measure small magnetic fields of one gauss or less; it may also be adapted to measure large magnetic fields of several hundred gauss. Typical dynamic range is 100:1.



3621

Built-in tuning coils are provided to sweep the oscillator for power output and frequency linearity measurements. The power output variation is small enough to allow direct detection with a microwave discriminator without amplitude limiting.

Since the magnetic field modulates a microwave frequency source, direct transmission of the information through space is possible.

## SPECIFICATIONS

| MAGNETOMETER PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Sensitivity range (direct) | | 0.5 to 50 gauss |
| (with 10 dB attenuator) | | 5.0 to 500 gauss |
| Dynamic range | 500:1 | 100:1 |
| Frequency response | 60 Hz to 100 MHz | |
| Sensitivity range of internal driving coil | 3-30 MHz/Ampere | |
| Temperature Coefficient of biasing magnet, 0°C to 50°C | 0.02%/°C | |

| RF PERFORMANCE | | |
|---|---|---|
| Center frequency | | 1.0 to 2.3 GHz |
| Frequency deviation | | ±100 MHz |
| Power output | | 10 mW |
| Power variations over ±100 MHz | | 1 dB |
| Frequency drift −30°C to 65°C | 5 MHz | 10 MHz max. |
| Sensitivity to supply voltage | | 1 MHz/volt |
| Pulling figure (1.5:1 VSWR) | | 5 MHz |
| Linearity of frequency deviation | | ±0.1% |

# WJ-627

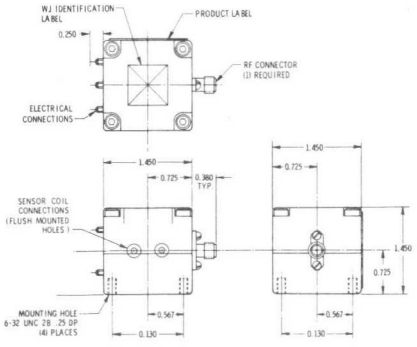
## ELECTRICAL REQUIREMENTS

| | |
|---|---|
| Oscillator voltage | 15 ±0.2 Vdc |
| Oscillator current | 50 mA |

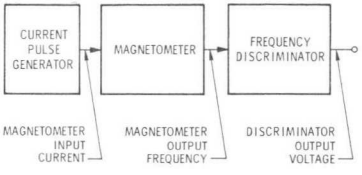
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Size, excluding RF Connector and solder terminals | 1.45 x 1.45 x 1.45 in. |
| Weight | 9 ounces |
| RF output connector | OSM, jack |
| Power input | Solder terminals with RFI shielding |
| Sensor coil | 2 pin Jack |

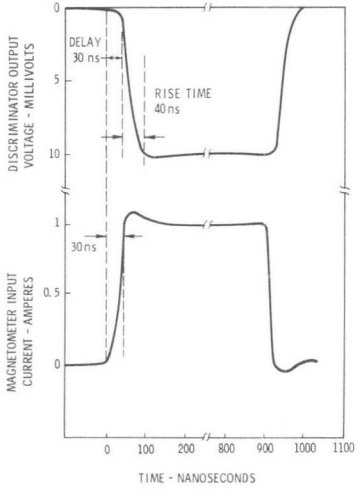
## OUTLINE DRAWING




## BLOCK DIAGRAM OF SYSTEM USED TO MEASURE THE MAGNETOMETER PULSE RESPONSE




## RESPONSE OF DISCRIMINATOR OUTPUT VOLTAGE TO A 1 MICROSECOND CURRENT PULSE INTO THE MAGNETOMETER



# TECHNICAL DATA

WATKINS-JOHNSON

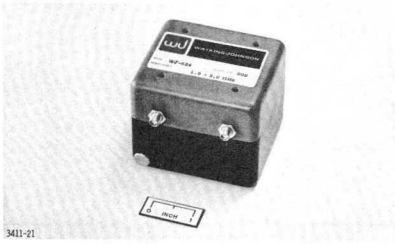
# WJ-634

## 1 to 2 GHz TWO-STAGE HYBRID YIG FILTER

September 1968

The WJ-634 is one of the two-stage members of a family of hybrid YIG-filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-634 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-634 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.




## SPECIFICATIONS

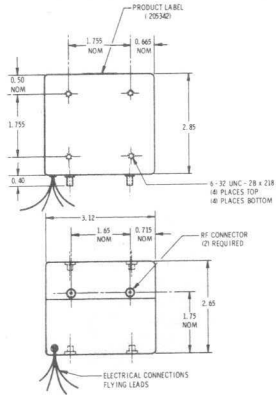
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 1.0 to 2.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.0 dB | | 3.5 dB |
| Off Resonance Isolation (minimum) | 50 dB | | 40 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 2.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±2 MHz |
| Hysteresis | 5 MHz |
| Frequency Drift over Temp. Range 0-60°C | 10 MHz |
| Zero Current Frequency | 0.95 GHz |

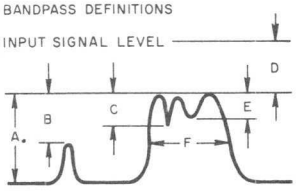
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.85 inches |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290096 |

| HEATER CHARACTERISTICS | |
|---|---|
| Operating Voltage | 22 to 30 Volts |
| Operating Current: | |
| Surge at 0°C | 750 mA |
| Steady State at 0°C | 250 mA |

# WJ-634 OUTLINE DRAWING

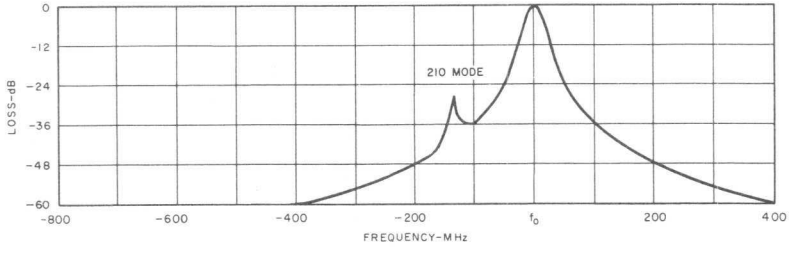



## MEASUREMENT DEFINITIONS

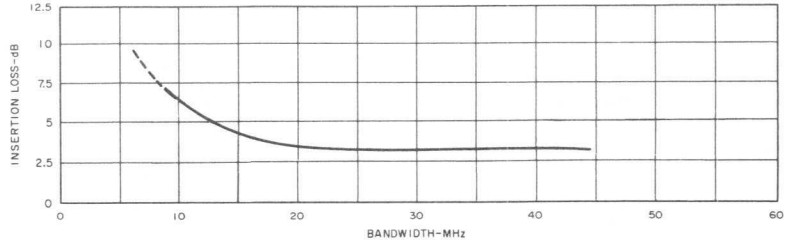



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1969

## 2 TO 4 GHz TWO-STAGE HYBRID YIG FILTER WJ-635

The WJ-635 is one of the two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-635 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-635 can be produced to cover any frequency range in the S-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


3411-22

### SPECIFICATIONS

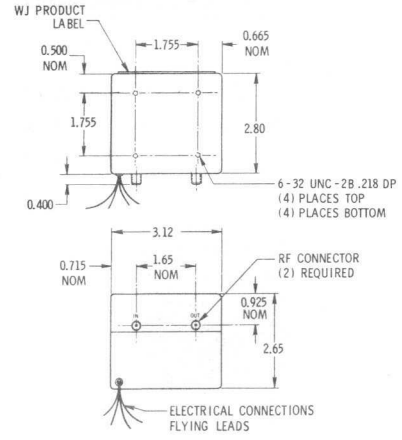
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 2.0 to 4.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.5 dB | | 3.5 dB |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±4 MHz |
| Hysteresis | 8 MHz |
| Zero Current Frequency | 1.95 GHz |

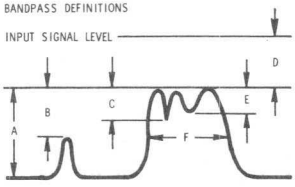
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290096 |

# WJ-635

## OUTLINE DRAWING

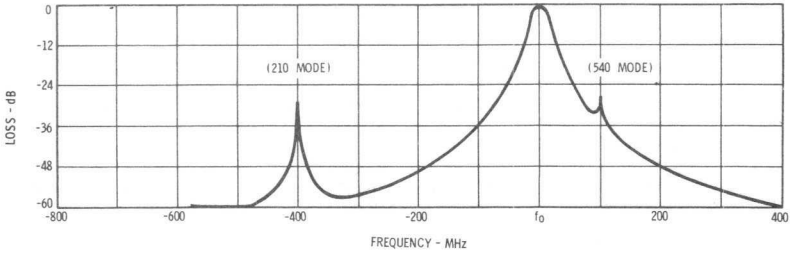



## MEASUREMENT DEFINITIONS

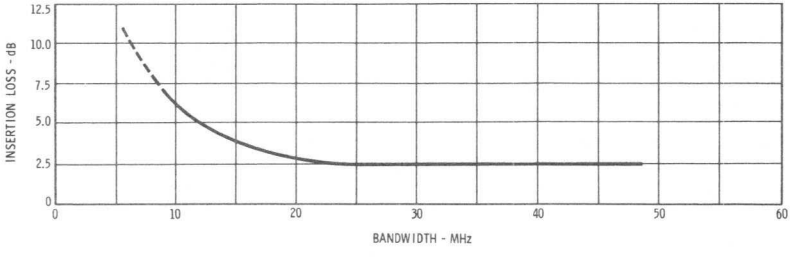



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

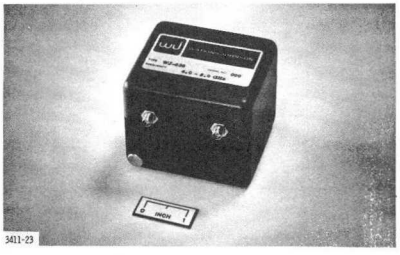
WATKINS-JOHNSON

MARCH 1969

## 4 TO 8 GHz TWO-STAGE HYBRID YIG FILTER WJ-636

The WJ-636 is one of the two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-636 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-636 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.




### SPECIFICATIONS

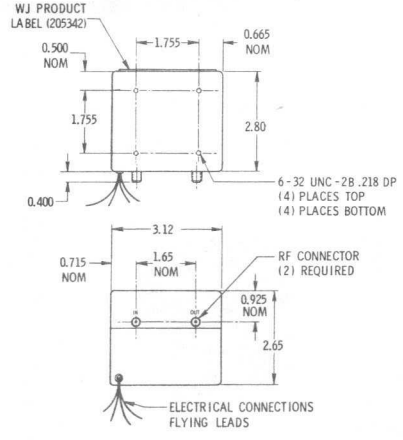
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 4.0 to 8.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 25 MHz |
| Insertion Loss (maximum) | 2.5 dB | | 3.0 dB |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±8 MHz |
| Hysteresis | 20 MHz |
| Zero Current Frequency | 3.9 GHz |

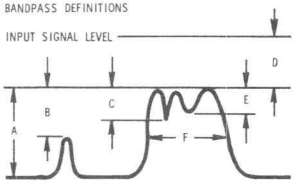
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290096 |

# WJ-636

## OUTLINE DRAWING

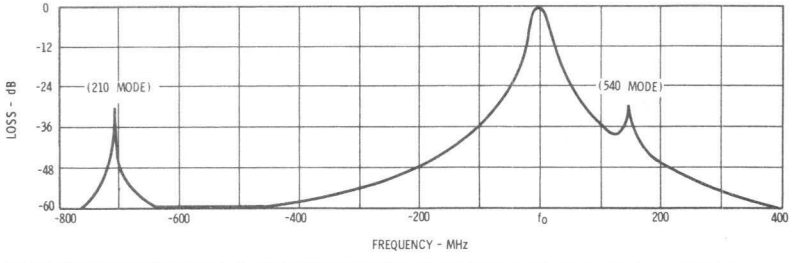



## MEASUREMENT DEFINITIONS

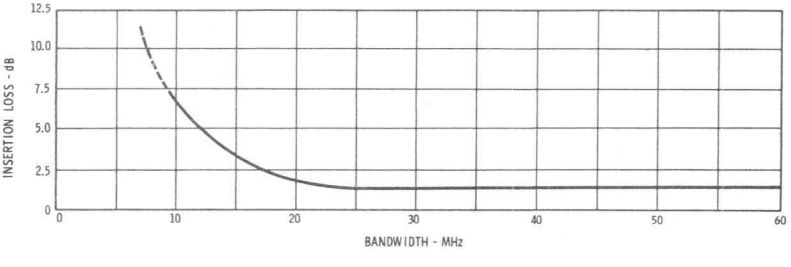



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969

## 8 TO 12.4 GHz TWO-STAGE HYBRID YIG FILTER WJ-637

The WJ-637 is one of the two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-637 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-637 can be modified to cover up to a 5000 MHz frequency range in the X-band. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


### SPECIFICATIONS

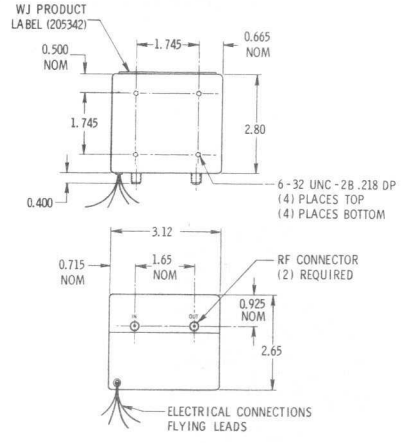
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 8.0 to 12.4 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.5 dB | | 3.0 dB |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±12 MHz |
| Hysteresis | 35 MHz |
| Zero Current Frequency | 7.9 GHz |

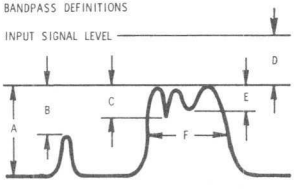
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290096 |

# WJ-637

## OUTLINE DRAWING

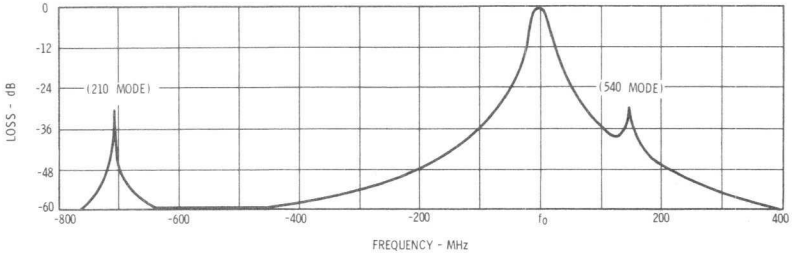



## MEASUREMENT DEFINITION

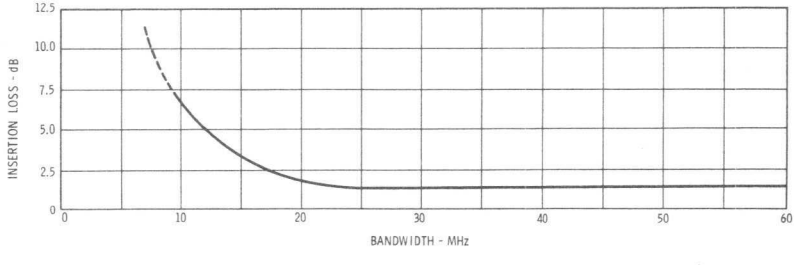



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1969

## 1 TO 2 GHz FOUR-STAGE HYBRID YIG FILTER WJ-638

The WJ-638 is one of the four-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-638 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-638 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


### SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 1.0 to 2.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 4.5 dB | | 6.0 dB |
| Off Resonance Isolation (minimum) | 80 dB | | 70 dB |
| Off Resonance Spurious (minimum) | | | 50 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 2.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 24 dB | | |

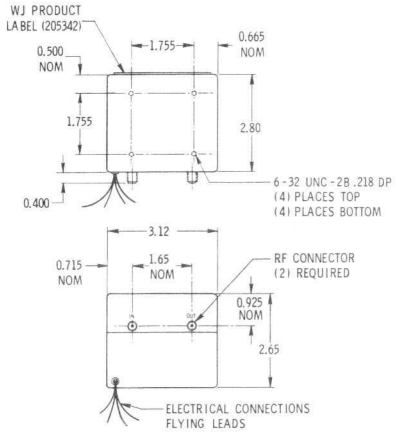
| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±2 MHz |
| Hysteresis | 5 MHz |
| Zero Current Frequency | 0.95 GHz |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290096 |

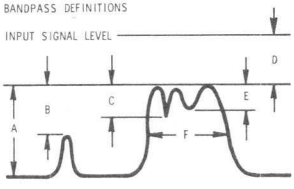
| HEATER CHARACTERISTICS | |
|---|---|
| Operating Voltage | 22 to 30 Volts |
| Operating Current: | |
| Surge at 0°C | 750 mA |
| Steady State at 0°C | 250 mA |

# WJ-638

## OUTLINE DRAWING

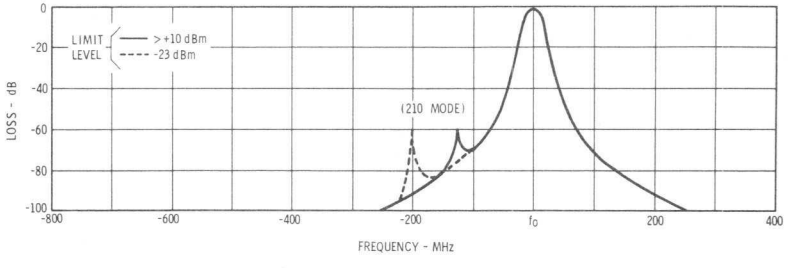



## MEASUREMENT DEFINITIONS

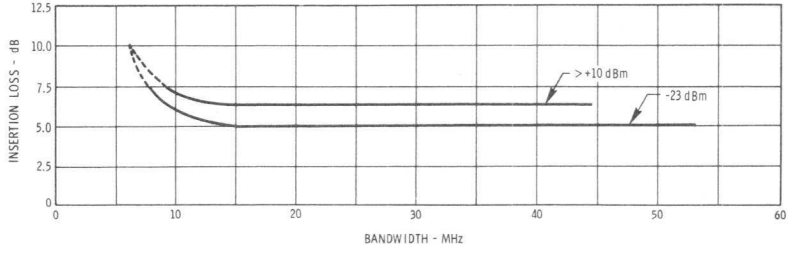



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

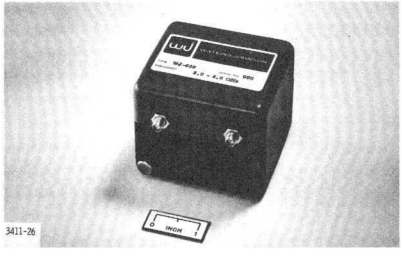
WATKINS-JOHNSON

MARCH 1969

## 2 TO 4 GHz FOUR-STAGE HYBRID YIG FILTER WJ-639

The WJ-639 is one of the four-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-639 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-639 can be produced to cover any frequency range in the S-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.




### SPECIFICATIONS

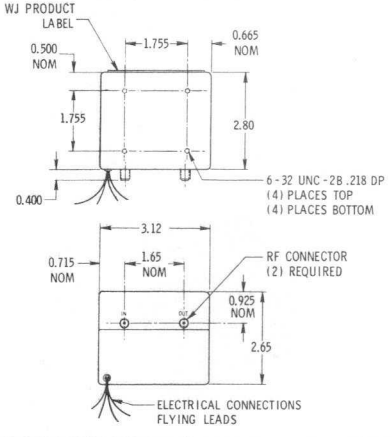
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 2.0 to 4.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.5 dB | | 5.0 dB |
| Off Resonance Isolation (minimum) | 80 dB | | 70 dB |
| Off Resonance Spurious (minimum) | | | 50 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 24 dB | | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±4 MHz |
| Hysteresis | 8 MHz |
| Zero Current Frequency | 1.95 GHz |

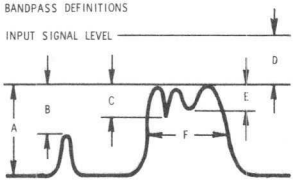
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290096 |

# WJ-639

## OUTLINE DRAWING

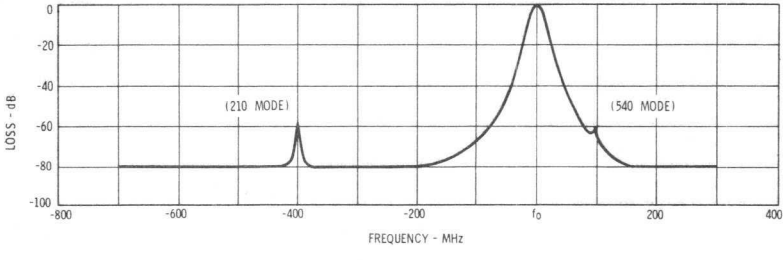



## MEASUREMENT DEFINITION

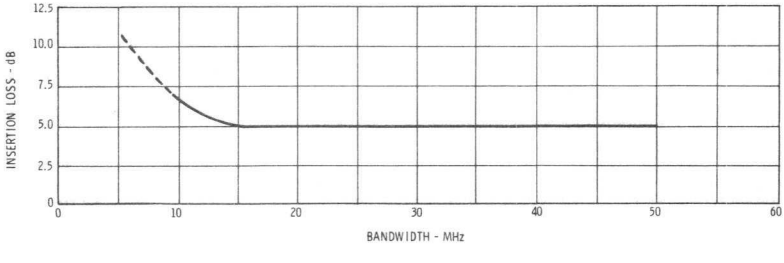



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

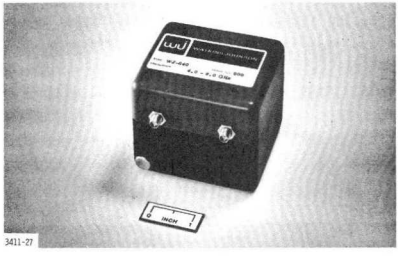
WATKINS-JOHNSON

MARCH 1969

## 4 TO 8 GHz FOUR-STAGE HYBRID YIG FILTER WJ-640

The WJ-640 is one of the four-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-640 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-640 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


3411-27

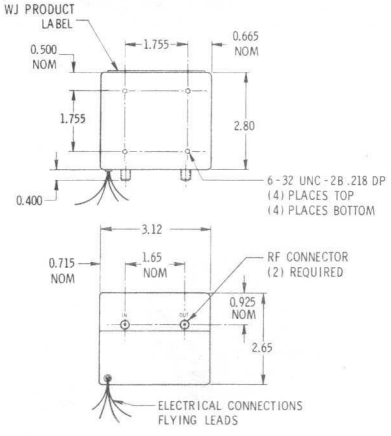
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 4.0 to 8.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.5 dB | | 5.0 dB |
| Off Resonance Isolation (minimum) | 80 dB | | 70 dB |
| Off Resonance Spurious (minimum) | | | 50 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 24 dB | | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±8 MHz |
| Hysteresis | 20 MHz |
| Zero Current Frequency | 3.9 GHz |

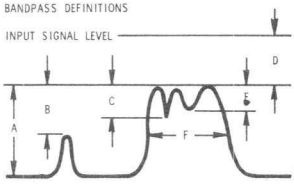
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290096 |

# WJ-640

## OUTLINE DRAWING

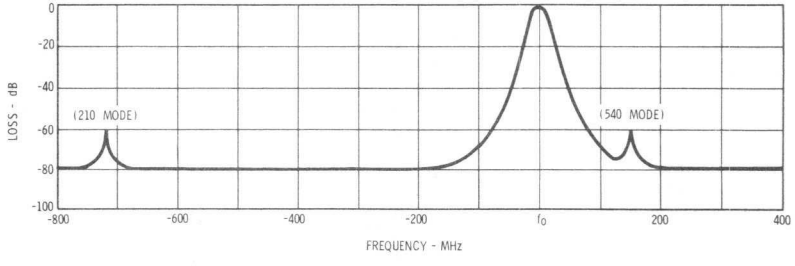



## MEASUREMENT DEFINITIONS

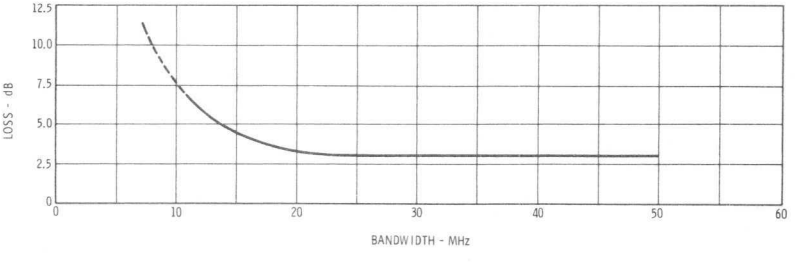



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969

## 8 TO 12.4 GHz FOUR-STAGE HYBRID YIG FILTER WJ-641

The WJ-641 is one of the four-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-641 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-641 can be modified to cover up to a 5000 MHz frequency range in the X-band. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


### SPECIFICATIONS

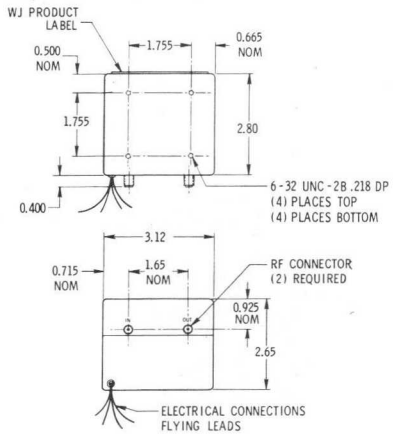
| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 8.0 to 12.4 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.5 dB | | 5.0 dB |
| Off Resonance Isolation (minimum) | 80 dB | | 70 dB |
| Off Resonance Spurious (minimum) | | | 50 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 24 dB | | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±12 MHz |
| Hysteresis | 35 MHz |
| Zero Current Frequency | 7.9 GHz |

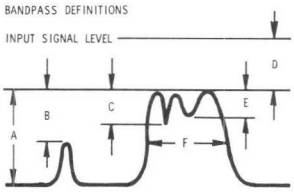
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290096 |

# WJ-641

## OUTLINE DRAWING

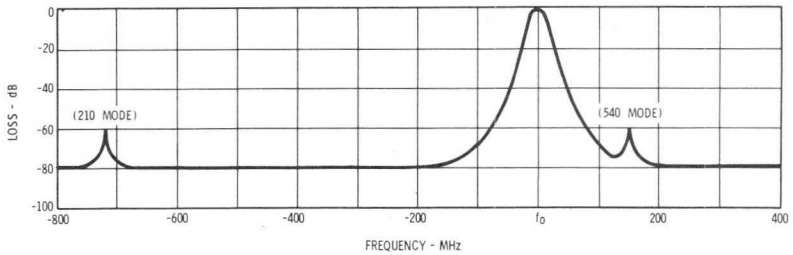



## MEASUREMENT DEFINITIONS

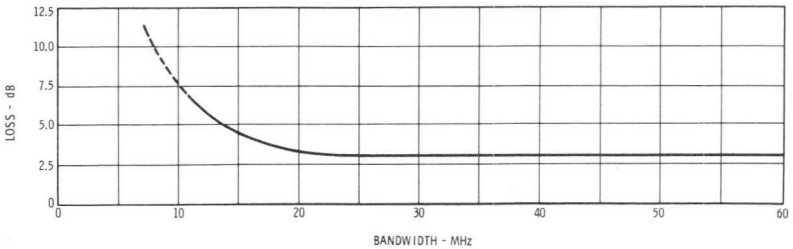



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1969

## 1 TO 2 GHz DUAL TWO-STAGE HYBRID YIG FILTER WJ-648

The WJ-648 is one of the dual two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-648 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-648 can be produced to cover any frequency range in the L-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


### SPECIFICATIONS

| RF PERFORMANCE (per channel) | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 1.0 to 2.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 3.0 dB | | 3.5 dB[1] |
| Off Resonance Isolation (minimum) | 50 dB | | 40 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 2.0 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |
| Isolation Between Channels (minimum) | 50 dB | | 40 dB |
| Tracking Error Between Channels (maximum) | 4 MHz | | 6 MHz |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±2 MHz |
| Hysteresis | 5 MHz |
| Zero Current Frequency | 0.95 GHz |

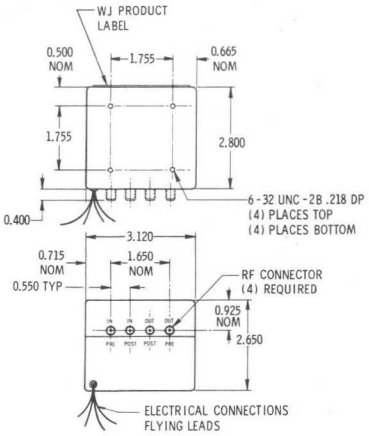
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290122 |

| HEATER CHARACTERISTICS | |
|---|---|
| Operating Voltage | 22 to 30 Volts |
| Operating Current: | |
| Surge at 0°C | 750 mA |
| Steady State at 0°C | 250 mA |

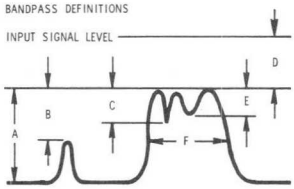
[1]Total of combined channels insertion loss, passband spurious, and passband ripple not to exceed 8 dB at any point in band.

## WJ-648

### OUTLINE DRAWING

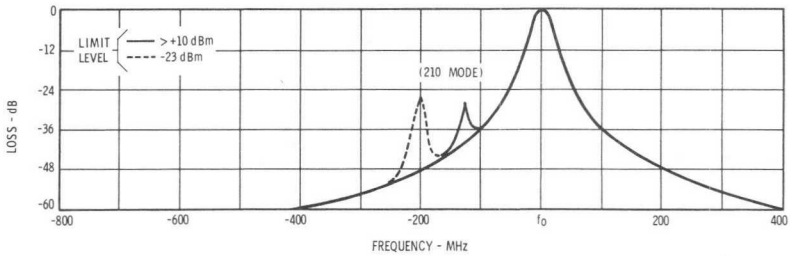



### MEASUREMENT DEFINITIONS

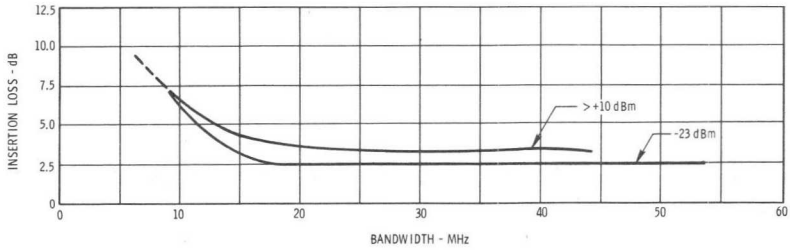



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

### SELECTIVITY CURVE




### BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1969

## 2 TO 4 GHz DUAL TWO-STAGE HYBRID YIG FILTER WJ-649

The WJ-649 is one of the dual two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-649 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-649 can be produced to cover any frequency range in the S-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


### SPECIFICATIONS

| RF PERFORMANCE (per channel) | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 2.0 to 4.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.5 dB | | 3.5 dB[1] |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 1.0 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |
| Isolation Between Channels (minimum) | 50 dB | | 40 dB |
| Tracking Error Between Channels (maximum) | 4 MHz | | 6 MHz |

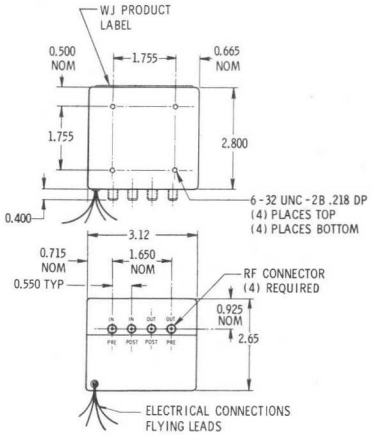
| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±4 MHz |
| Hysteresis | 8 MHz |
| Zero Current Frequency | 1.95 GHz |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290122 |

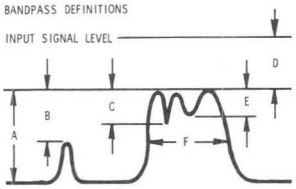
[1]Total of combined channels insertion loss, passband spurious, and passband ripple not to exceed 8 dB at any point in band.

## WJ-649

### OUTLINE DRAWING

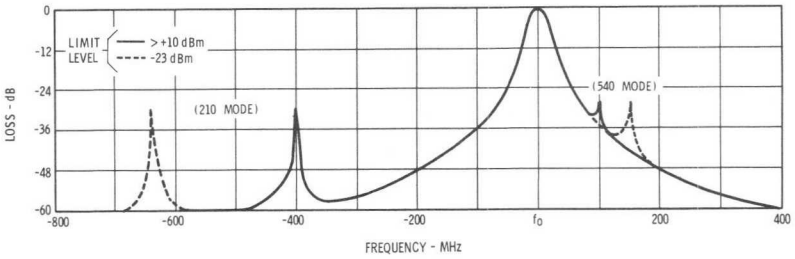



### MEASUREMENT DEFINITIONS

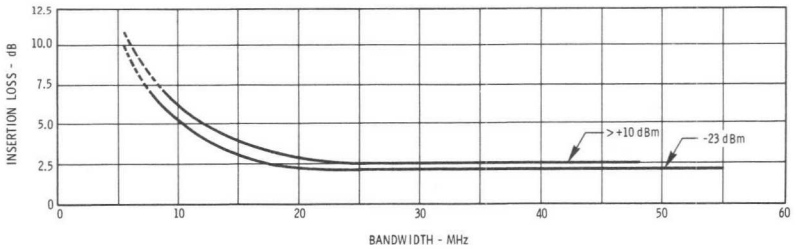



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

### SELECTIVITY CURVE




### BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1969

## 4 TO 8 GHz DUAL TWO-STAGE HYBRID YIG FILTER WJ-650

The WJ-650 is one of the dual two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-650 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-650 can be produced to cover any frequency range in the C-band up to 1.2 octaves. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


### SPECIFICATIONS

| RF PERFORMANCE (per channel) | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 4.0 to 8.0 GHz |
| Bandwidth (3 dB) (minimum) | | | 25 MHz |
| Insertion Loss (maximum) | 2.0 dB | | 3.0 dB[1] |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |
| Isolation Between Channels (minimum) | 50 dB | | 40 dB |
| Tracking Error Between Channels (maximum) | 4 MHz | | 8 MHz |

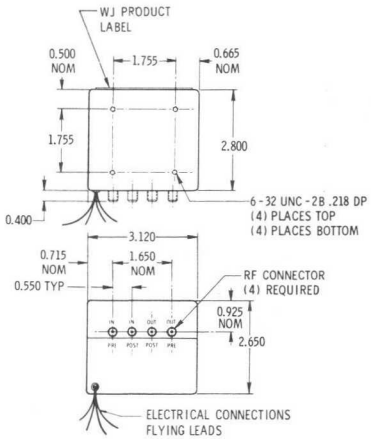
| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±8 MHz |
| Hysteresis | 20 MHz |
| Zero Current Frequency | 3.90 GHz |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290122 |

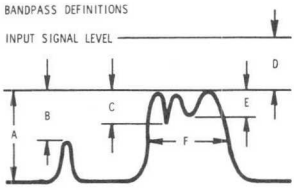
[1]Total of combined channels insertion loss, passband spurious, and passband ripple not to exceed 8 dB at any point in band.

# WJ-650

## OUTLINE DRAWING

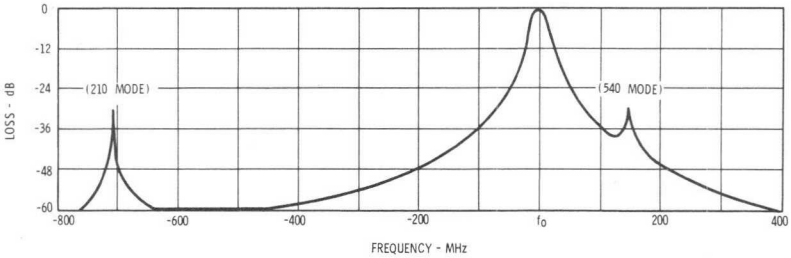



## MEASUREMENT DEFINITIONS

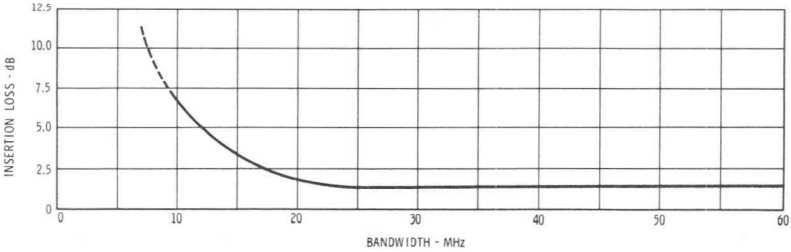



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969

## 8 TO 12.4 GHz DUAL TWO-STAGE HYBRID YIG FILTER WJ-651

The WJ-651 is one of the dual two-stage members of a family of hybrid YIG filters developed by Watkins-Johnson Company. It provides faster switching capability than the compact filter line, and has lower coil resistance and inductance, thereby simplifying driver design. The WJ-651 also features high tuning rate, low tuning power and high RF performance.

For specific requirements, the WJ-651 can be produced to cover up to a 5000 MHz frequency range in the X-band. Optional bandwidths are available for specific requirements between 8 and 40 MHz.


### SPECIFICATIONS

| RF PERFORMANCE (per channel) | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 8.0 to 12.4 GHz |
| Bandwidth (3 dB) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 2.5 dB | | 3.0 dB[1] |
| Off Resonance Isolation (minimum) | 60 dB | | 50 dB |
| Off Resonance Spurious (minimum) | | | 25 dB |
| Directivity | Reciprocal | | |
| Passband Ripple (maximum) | 0.5 dB | | 1.0 dB |
| Passband Spurious (maximum) | 0.5 dB | | 1.5 dB |
| Passband VSWR (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | +20 dBm | | +10 dBm |
| Selectivity (per octave) | 12 dB | | |
| Isolation Between Channels (minimum) | 50 dB | | 40 dB |
| Tracking Error Between Channels (maximum) | 5 MHz | | 8 MHz |

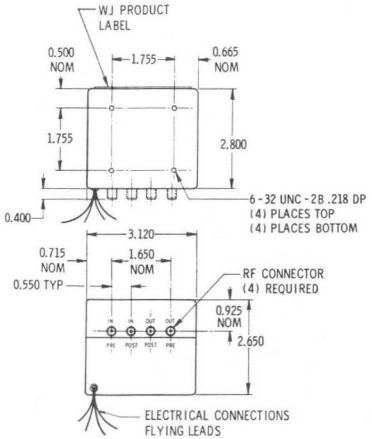
| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 6 MHz/mA |
| Coil Resistance | 2.5 ohms |
| Coil Inductance | 12 mH |
| Time Constant | 0.2 ms |
| Deviation from Linear | ±12 MHz |
| Hysteresis | 35 MHz |
| Zero Current Frequency | 7.9 GHz |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Size (excluding connectors) | 2.65 x 3.12 x 2.80 in. |
| Weight | 30 ounces |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290122 |

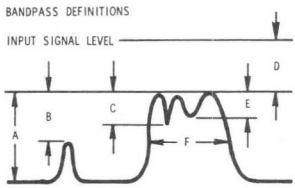
[1]Total of combined channels insertion loss, passband spurious, and passband ripple not to exceed 8 dB at any point in band.

# WJ-651

## OUTLINE DRAWING

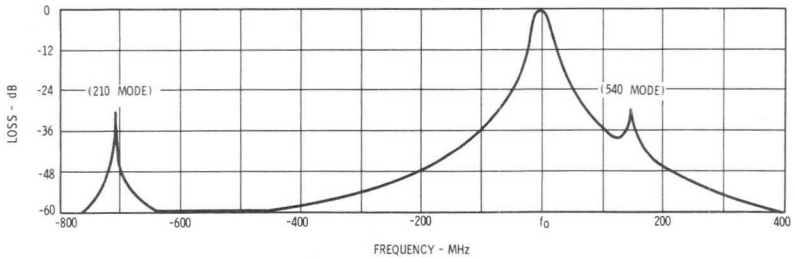



## MEASUREMENT DEFINITION

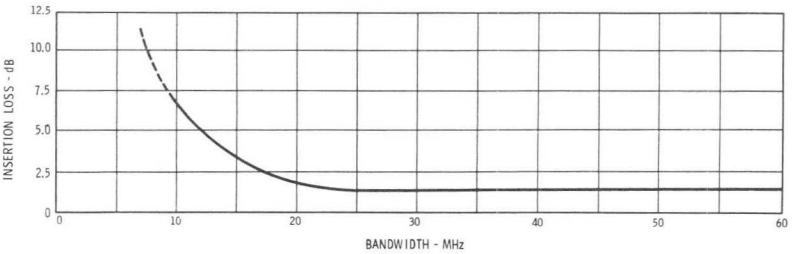



A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-652

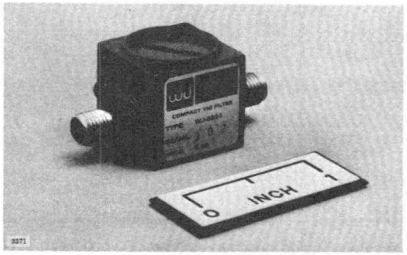
April 1967

## MECHANICALLY TUNED MINIATURE TWO-STAGE YIG FILTER

The WJ-652 is the first of a new family of Watkins-Johnson Company mechanically-tuned microwave YIG filters produced in a miniature, lightweight configuration to meet rugged environmental requirements. Measuring only ¾-inch cubed, this unit is tuned by means of a simple screwdriver adjustment. The WJ-652 and other members of this family of YIG filters have a tuning range of 500 MHz and are available with center frequencies of from 1 to 5 GHz.

The miniaturized design of the WJ-652 makes it particularly suitable for applications where space is at a premium. A large number of these filters can be physically stacked together to provide front-end multi-channel receiver configurations for various combinations of fixed frequencies with excellent channel isolation.

The WJ-652 filter may also be used in fixed-tuned limiter applications, offering either low or high level cutoff at −23 dBm or +18dBm, respectively.




### SPECIFICATIONS

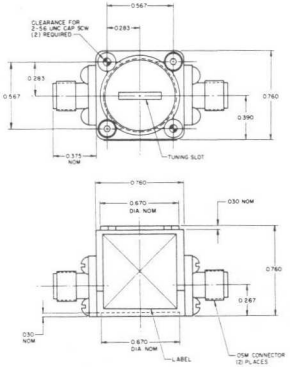
| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Center Frequency | | *1.0–5.0 GHz |
| Bandwidth at 3 dB | | 30±5 MHz |
| Insertion Loss | 2.0 dB, max | 3.0 dB, max. |
| Limiting: Low Level (1.0–3.3 GHz) | −23 dBm | |
| High Level (1.0–5.0 GHz) | >+10 dBm | |
| Off Resonance Isolation | | 45 dB, min. |
| Off Resonance Spurious | 30 dB, min. | 25 dB, min. |
| Pass Band VSWR | 1.5:1 | 2.0:1 |
| Selectivity | 12 dB/Octave | |
| Frequency Drift w/Temp. 0 to 50°C | | ±3 MHz, max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| * Tuning Range | $f_c$ ±250 MHz |
| Dimensions | ¾″ × ¾″ × ¾″ |
| Weight | 1 oz. |
| RF Connector Type | OSM |

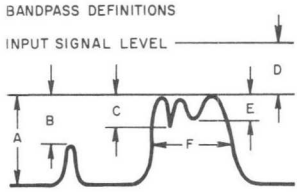
** The mechanical tuning adjustment allows for a tuning range of ±250 MHz anywhere over the frequency range. Center frequency requirement should be specified when unit is ordered.*

# WJ-652

## OUTLINE DRAWING

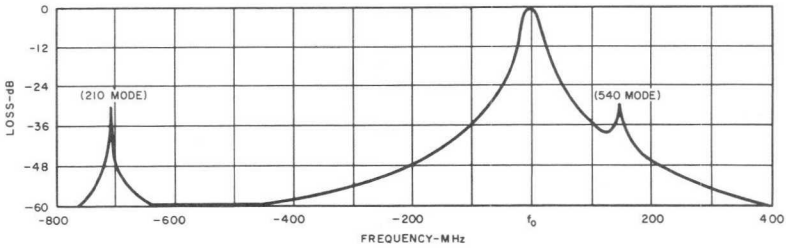



## MEASUREMENT DEFINITIONS

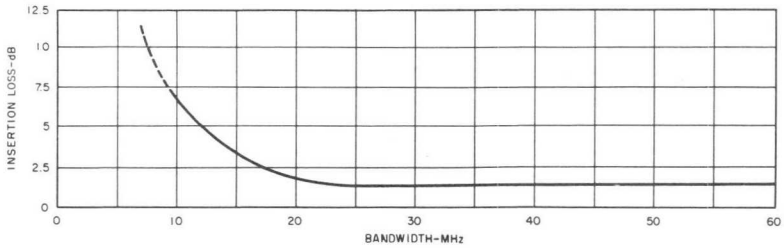



A – OFF RESONANCE ISOLATION
B – OFF RESONANCE SPURIOUS
C – PASS BAND SPURIOUS
D – INSERTION LOSS
E – PASS BAND RIPPLE
F – 3 dB BANDWIDTH

## SELECTIVITY CURVE




## BANDWIDTH vs. LOSS



# TECHNICAL DATA

WATKINS-JOHNSON

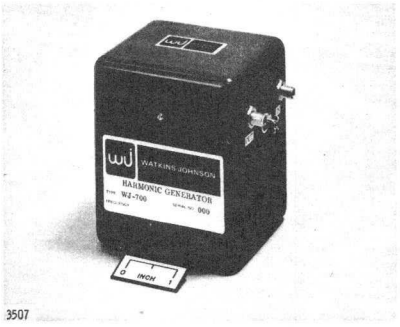
# WJ-700

September 1968*

## 0.5 TO 1.0 GHz YIG-TUNED HARMONIC GENERATOR

The WJ-700 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100 MHz signal source, produces high output power at any one of the 100 MHz harmonics in P-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-700 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-700 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG spheres in the three-stage filter circuit.



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A special feature of the WJ-700 is its compatibility with the WJ-723 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| | Typical | Guaranteed |
|---|---|---|
| **RF PERFORMANCE** | | |
| Frequency range | | 0.5 to 1.0 GHz |
| Power output, min. | +10 dBm | +5 dBm, Note 2 |
| Output impedance | 50 ohms | |
| Harmonic suppression ±100 MHz | 50 dB | 35 dB |
| Harmonic suppression, ±200 MHz and above | 70 dB | 50 dB |
| Input VSWR | 2.0:1 | |
| **ENVIRONMENTAL CHARACTERISTICS** | | |
| Operating Temperature | | −20° to +55°C |
| **TUNING CHARACTERISTICS** | | |
| Sensitivity | | 14 MHz/mA |
| Coil resistance | 6 ohms | |
| Coil inductance | 120 mH | |
| Time Constant | 50 μs | 100 μs max., Note 1 |

* Supersedes WJ-700 Technical Data Sheet Dated December 1967

# WJ-700

**RF INPUT CHARACTERISTICS**

| | |
|---|---|
| Drive frequency | 100 MHz |
| Drive power | +30 dBm max. |

**D.C. INPUT CHARACTERISTICS**

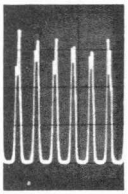
| | |
|---|---|
| Heater voltage | 24 ±4 volts |
| Heater current: | |
| Surge at −20°C | 750 mA max. |
| Steady state at −20°C | 150 mA max. |

**MECHANICAL CHARACTERISTICS**

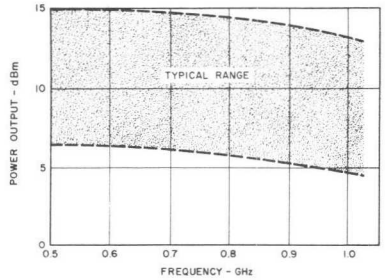
| | |
|---|---|
| Dimensions | 3.11" x 2.85" x 3.7" |
| Weight | 35 ounces |
| RF connectors | OSM female |
| Outline drawing number | 290160 |

**Notes:**
1. This measurement will be made for design verification only.
2. Maximum power output variation is 6 dB.

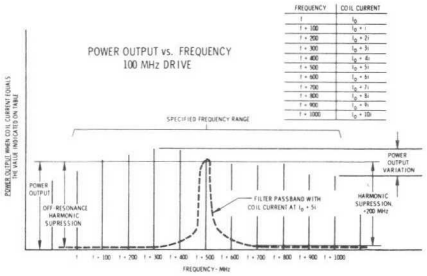
## 100 MHz HARMONICS DISPLAY



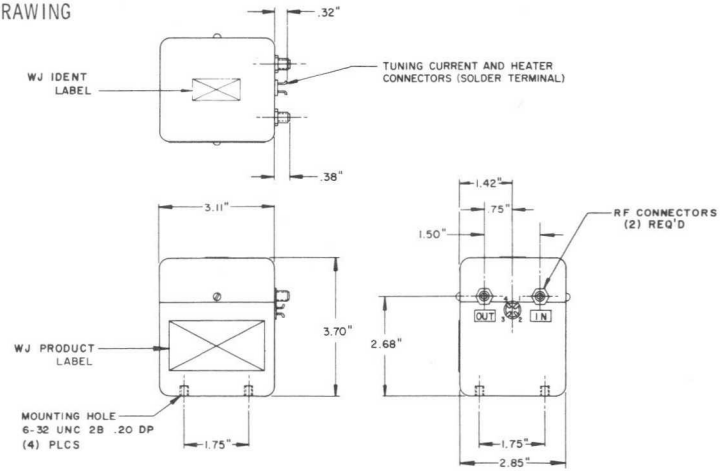
## POWER OUTPUT




## MEASUREMENT DEFINITIONS




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

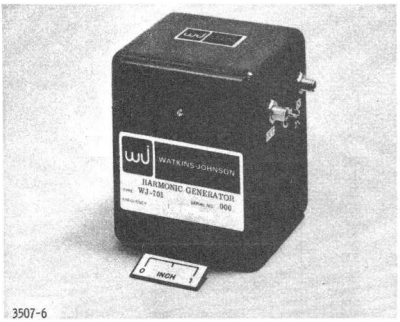
# WJ-701

September 1968*

## 1.0 TO 2.0 GHz YIG-TUNED HARMONIC GENERATOR

The WJ-701 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100 MHz signal source, produces high output power at any one of the 100 MHz harmonics in L-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-701 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-701 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG spheres in the three-stage filter circuit.



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A special feature of the WJ-701 is its compatibility with the WJ-724 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| | Typical | Guaranteed |
|---|---|---|
| **RF PERFORMANCE** | | |
| Frequency range | | 1.0 to 2.0 GHz |
| Power output, min. | +8 dBm | +3 dBm, Note 2 |
| Output impedance | 50 ohms | |
| Harmonic suppression ±100 MHz | 50 dB | 35 dB |
| Harmonic suppression, ±200 MHz and above | 70 dB | 50 dB |
| Input VSWR | 2.0:1 | |
| **ENVIRONMENTAL CHARACTERISTICS** | | |
| Operating Temperature | | −20° to +55°C |
| **TUNING CHARACTERISTICS** | | |
| Sensitivity | 14 MHz/mA | |
| Coil resistance | 6 ohms | |
| Coil inductance | 120 mH | |
| Time Constant | 50 μs | 100 μs max., Note 1 |

* Supersedes WJ-701 Technical Data Sheet Dated December 1967

# WJ-701

**RF INPUT CHARACTERISTICS**

| | |
|---|---|
| Drive frequency | 100 MHz |
| Drive power | +30 dBm max. |

**D.C. INPUT CHARACTERISTICS**

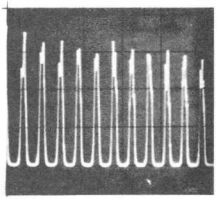
| | |
|---|---|
| Heater voltage | 24 ±4 volts |
| Heater current: | |
| Surge at −20°C | 750 mA max. |
| Steady state at −20°C | 150 mA max. |

**MECHANICAL CHARACTERISTICS**

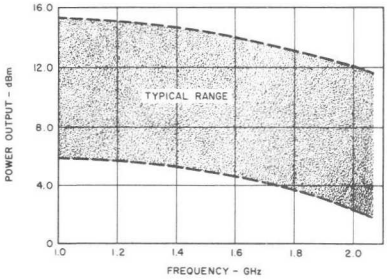
| | |
|---|---|
| Dimensions | 3.11" x 2.85" x 3.7" |
| Weight | 35 ounces |
| RF connectors | OSM female |
| Outline drawing number | 290160 |

**Notes:**
1. This measurement will be made for design verification only.
2. Maximum power output variation is 6 dB.

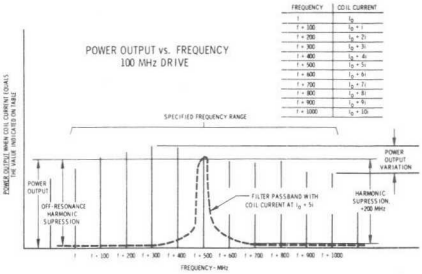
## 100 MHz HARMONICS DISPLAY



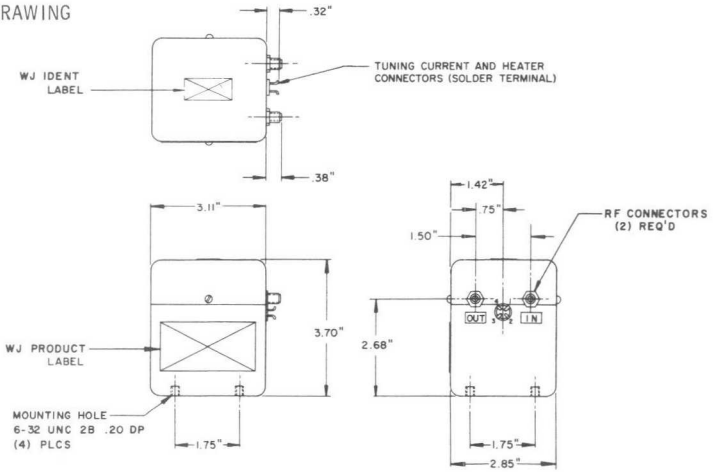
## POWER OUTPUT




## MEASUREMENT DEFINITIONS




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

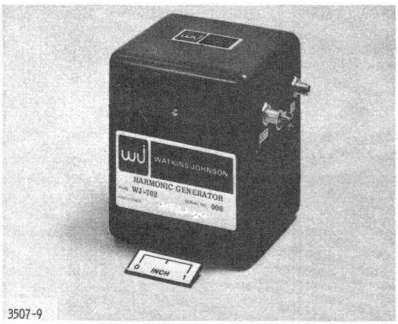
# WJ-702

September 1968 *

## 2.0 TO 4.0 GHz YIG-TUNED HARMONIC GENERATOR

The WJ-702 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100 MHz signal source, produces high output power at any one of the 100 MHz harmonics in S-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-702 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-702 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG spheres in the three-stage filter circuit.



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A special feature of the WJ-702 is its compatibility with the WJ-725 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency range | | 2.0 to 4.0 GHz |
| Power output, min. | +5 dBm | 0 dBm, Note 2 |
| Output impedance | 50 ohms | |
| Harmonic suppression ±100 MHz | 50 dB | 35 dB |
| Harmonic suppression, ±200 MHz and above | 70 dB | 50 dB |
| Input VSWR | 2.0:1 | |

| ENVIRONMENTAL CHARACTERISTICS | |
|---|---|
| Operating Temperature | −20° to +55°C |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| Sensitivity | 14 MHz/mA | |
| Coil resistance | 6 ohms | |
| Coil inductance | 120 mH | |
| Time Constant | 50 $\mu$s | 100 $\mu$s max., Note 1 |

* Supersedes WJ-702 Technical Data Sheet Dated December 1967

# WJ-702

**RF INPUT CHARACTERISTICS**

Drive frequency ..... 100 MHz
Drive power ..... +30 dBm max.

**D.C. INPUT CHARACTERISTICS**

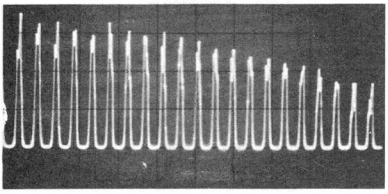
Heater voltage ..... 24 ±4 volts
Heater current:
Surge at —20°C ..... 750 mA max.
Steady state at —20°C ..... 150 mA max.

**MECHANICAL CHARACTERISTICS**

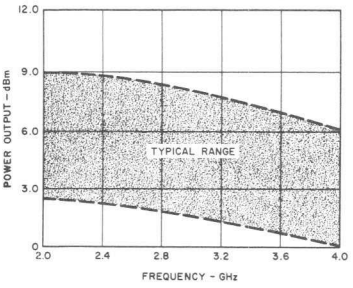
Dimensions ..... 3.11" x 2.85" x 3.7"
Weight ..... 35 ounces
RF connectors ..... OSM female
Outline drawing number ..... 290160

**Notes:**
1. This measurement will be made for design verification only.
2. Maximum power output variation to be 8 dB.

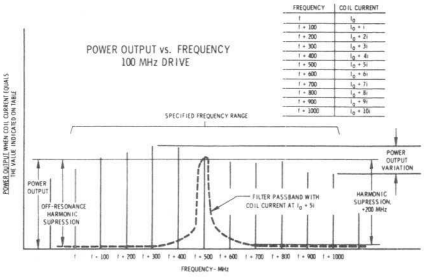
## 100 MHz HARMONICS DISPLAY



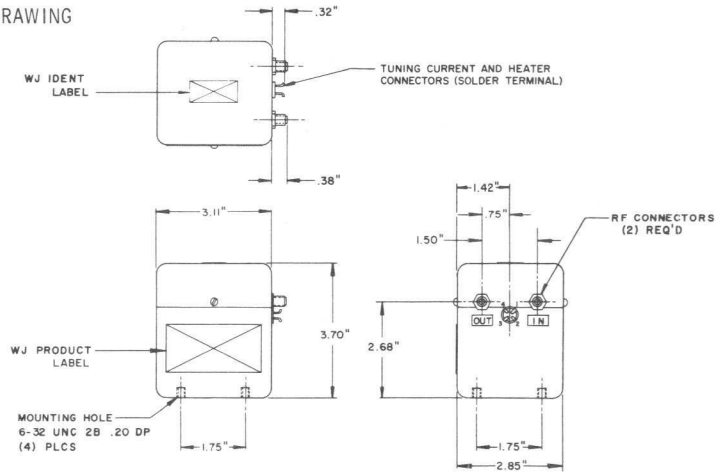
## POWER OUTPUT




## MEASUREMENT DEFINITIONS




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-703

November 1968

## 4.0 TO 8.0 GHz YIG-TUNED HARMONIC GENERATOR

The WJ-703 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100-MHz signal source, produces output power at any one of the 100-MHz harmonics in C-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-703 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-703 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG spheres in the three-stage filter circuit.


A special feature of the WJ-703 is its compatibility with the WJ-726 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| | Typical | Guaranteed |
|---|---|---|
| **RF PERFORMANCE** | | |
| Frequency range | | 4.0 to 8.0 GHz |
| Power output, min. | | −25 dBm, Note 2 |
| Output impedance | 50 ohms | |
| Harmonic suppression ±200 MHz | 45 dB | 35 dB |
| Off-resonance harmonic suppression, | 70 dB | 60 dB |
| Input VSWR | 1.5:1 | 2.0:1, Note 1 |
| **ENVIRONMENTAL CHARACTERISTICS** | | |
| Operating Temperature | | 10°C to 55°C |
| **TUNING CHARACTERISTICS** | | |
| Sensitivity | 12.5 MHz/mA | |
| Coil resistance | 3 ohms | |
| Coil inductance | 75 mH | |
| Time Constant | 50 μs | 100 μs max., Note 1 |

**Notes:**

1. This measurement will be made for design verification only.
2. Maximum power output variation to be 15 dB.

# WJ-703

### RF INPUT CHARACTERISTICS

Drive frequency ..... 100 MHz
Drive power ..... +30 dBm max.

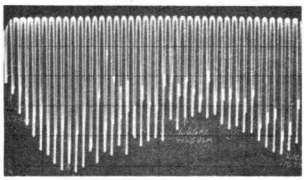
### D.C. INPUT CHARACTERISTICS

Heater voltage ..... 24 ±4 volts
Heater current:
Surge at 10°C .....750 mA max.
Steady state at 10°C .....150 mA max.

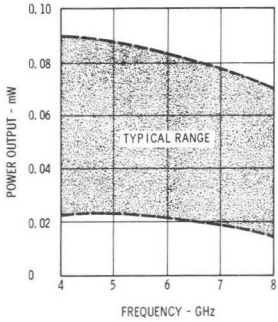
### MECHANICAL CHARACTERISTICS

Dimensions .....3.11 x 2.85 x 3.7 inches
Weight ..... 35 ounces
RF connectors ..... OSM jack
Outline drawing number ..... 290160

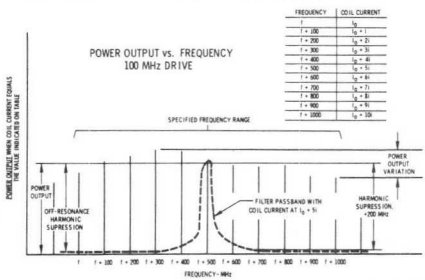
## 100 MHz HARMONICS DISPLAY



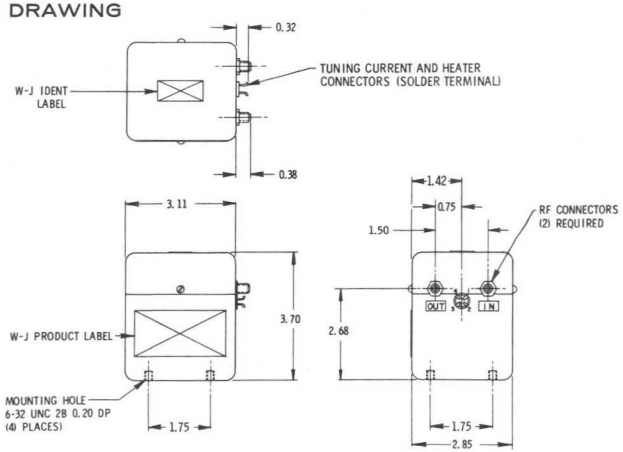
## POWER OUTPUT




## MEASUREMENT DEFINITIONS




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-704

November 1968

## 8.0 TO 12.0 GHz YIG-TUNED HARMONIC GENERATOR

The WJ-704 is one of a new family of solid state, electronically-tuned, harmonic generators developed by Watkins-Johnson Company. This generator, which is driven by a 100-MHz signal source, produces output power at any one of the 100-MHz harmonics in X-band. In fact, its power output is approximately 5 dB above that of an untuned comb generator at comparable frequencies. Fast switching makes it ideal for use as a first local oscillator in digitally tuned microwave receivers, or as a frequency-stable, digitally tuned microwave source.

The output frequency of the WJ-704 is selected by changing (in discrete, equally spaced steps) the current in the tuning coils, thus producing a magnetic bias for the YIG resonators. Stray magnetic fields are negligible, and the generator remains unaffected by moderate magnetic environments. For specific requirements, the WJ-704 may be varied to cover offset frequency ranges, alternate input drive frequencies, or changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportional controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperatures of the YIG spheres in the three-stage filter circuit.

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A special feature of the WJ-704 is its compatibility with the WJ-727 three-stage YIG filter. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency range | | 8.0 to 12.0 GHz |
| Power output, min. | | −25 dBm, Note 2 |
| Output impedance | 50 ohms | |
| Harmonic suppression ±200 MHz | 45 dB | 35 dB |
| Off-resonance harmonic suppression, | 70 dB | 60 dB |
| Input VSWR | 1.5:1 | 2.0:1, Note 1 |

| ENVIRONMENTAL CHARACTERISTICS | |
|---|---|
| Operating Temperature | 10°C to 55°C |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| Sensitivity | 12.5 MHz/mA | |
| Coil resistance | 3 ohms | |
| Coil inductance | 75 mH | |
| Time Constant | 50 $\mu$s | 100 $\mu$s max., Note 1 |

**Notes:**
1. This measurement will be made for design verification only.
2. Maximum power output variation to be 15 dB.

# WJ-704

**RF INPUT CHARACTERISTICS**

Drive frequency ..... 100 MHz
Drive power ..... +30 dBm max.

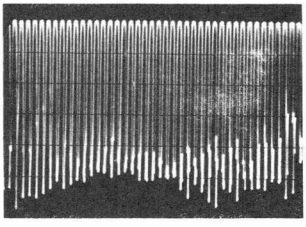
**D.C. INPUT CHARACTERISTICS**

Heater voltage ..... 24 ±4 volts
Heater current:
Surge at 10°C ..... 750 mA max.
Steady state at 10°C ..... 150 mA max.

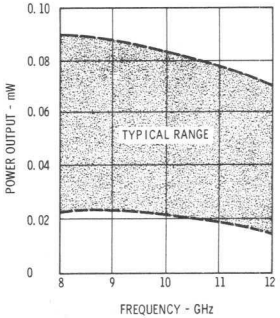
**MECHANICAL CHARACTERISTICS**

Dimensions ..... 3.11" x 2.85" x 3.7"
Weight ..... 35 ounces
RF connectors ..... OSM jack
Outline drawing number ..... 290160

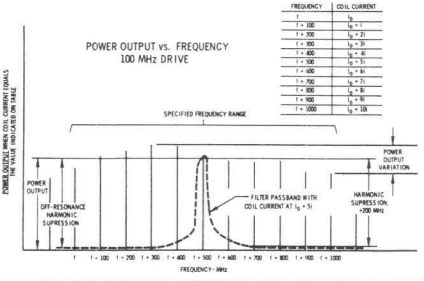
## 100 MHz HARMONICS DISPLAY



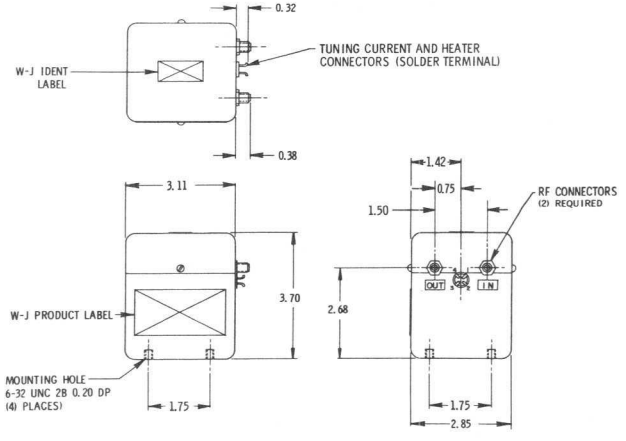
## POWER OUTPUT




## MEASUREMENT DEFINITIONS




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

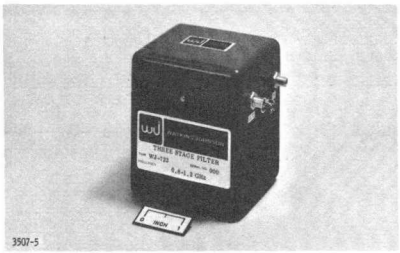
# WJ-723

## 0.5 TO 1.0 GHz THREE-STAGE YIG FILTER

September 1968

The WJ-723 is one of a new family of YIG filters designed for applications requiring electronically-controlled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-723 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-723 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres. This feature minimizes spurious responses and bandwidth variation over wide environmental temperature ranges.




A special feature of the WJ-723 is its compatibility with the WJ-700 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency range | | 0.5 to 1.0 GHz |
| Bandwidth, 3 db | 20 MHz | Note 1 |
| Insertion loss | 4 dB | Note 2 |
| Off-Resonance isolation | 70 dB | 60 dB min. |
| Off-Resonance spurious | 50 dB | 45 dB min. |
| Directivity | Reciprocal | |
| Passband ripple | 0.5 dB | Note 2 |
| Passband spurious | 1.0 dB | Note 2 |
| Passband VSWR | 1.5:1 | 2.0:1 max., Note 3 |
| Limiting level | +20 dBm | >+10 dBm |
| Selectivity | 18 dB/octave | |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| Sensitivity | 12.5 MHz/mA | |
| Coil resistance | 3 ohms | |
| Coil inductance | 75 mH | |
| Time constant | 50 μs | 100 μs max., Note 3 |
| Frequency deviation 10°C to 50°C | ±2 MHz | Note 1 |

1. Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.
2. Maximum combined insertion loss plus ripple and spurious shall not exceed 8 dB within ±5 MHz of center frequency.
3. This measurement will be made for design verification only.

## SPECIFICATIONS (Cont'd)

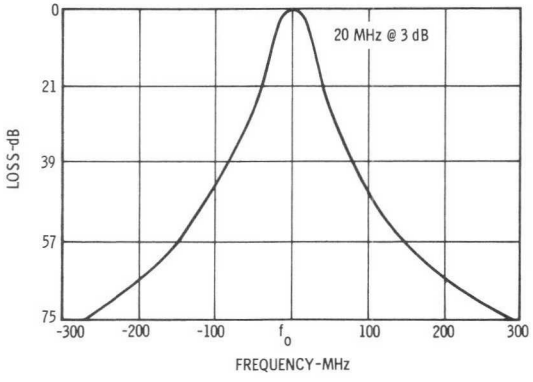
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Dimensions | 3.11 x 2.85 x 3.7 inches |
| Weight | 35 ounces |
| RF connector | OSM Jack |
| Outline drawing number | 290161 |

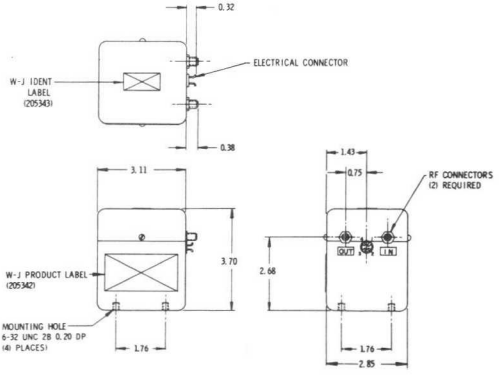
### HEATER CHARACTERISTICS

| | |
|---|---|
| Operating voltage | 24 ±4 volts |
| Operating current: | |
| Surge at 10°C | 750 mA |
| Steady state at 10°C | 150 mA |

## SELECTIVITY CURVE




## OUTLINE DRAWING




| CONNECTORS | |
|---|---|
| 1 + 2 | COIL |
| 3 + 4 | HEATERS |

# TECHNICAL DATA

WATKINS-JOHNSON

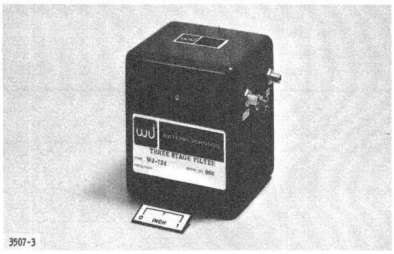
# WJ-724

## 1.0 TO 2.0 GHz THREE-STAGE YIG FILTER

September 1968

The WJ-724 is one of a new family of YIG filters designed for applications requiring electronically-controlled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-724 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-724 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres. This feature minimizes spurious responses and bandwidth variation over wide environmental temperature ranges.




A special feature of the WJ-724 is its compatibility with the WJ-701 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency range | | 1.0 to 2.0 GHz |
| Bandwidth, 3 db | 25 MHz | Note 1 |
| Insertion loss | 3 dB | Note 2 |
| Off-Resonance isolation | 70 dB | 60 dB min. |
| Off-Resonance spurious | 50 dB | 45 dB min. |
| Directivity | Reciprocal | |
| Passband ripple | 0.5 dB | Note 2 |
| Passband spurious | 1.0 dB | Note 2 |
| Passband VSWR | 1.5:1 | 2.0:1 max., Note 3 |
| Limiting level | +20 dBm | >+10 dBm |
| Selectivity | 18 dB/octave | |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| Sensitivity | 12.5 MHz/mA | |
| Coil resistance | 3 ohms | |
| Coil inductance | 75 mH | |
| Time constant | 50 μs | 100 μs max., Note 3 |
| Frequency deviation 10°C to 50°C | ±3 MHz | Note 1 |

1. Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.
2. Maximum combined insertion loss plus ripple and spurious shall not exceed 6 dB.
3. This measurement will be made for design verification only.

## SPECIFICATIONS (Cont'd)

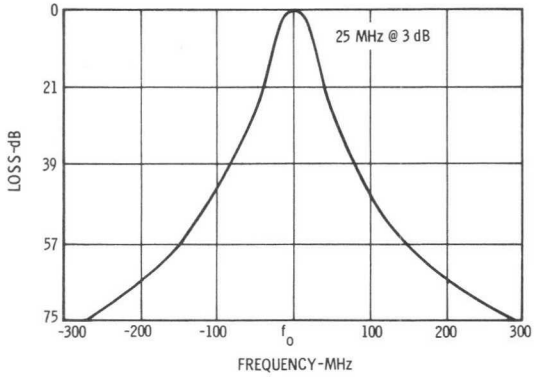
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Dimensions | 3.11 x 2.85 x 3.7 inches |
| Weight | 35 ounces |
| RF connector | OSM Jack |
| Outline drawing number | 290161 |

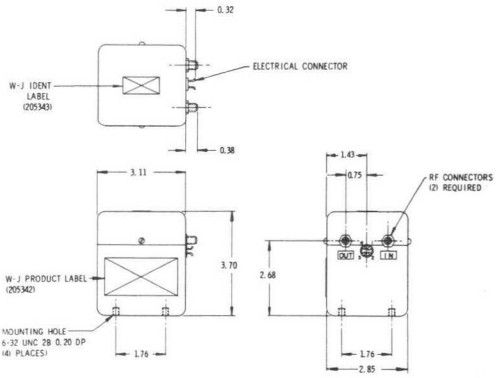
### HEATER CHARACTERISTICS

| | |
|---|---|
| Operating voltage | 24 ±4 volts |
| Operating current: | |
| Surge at 10°C | 750 mA |
| Steady state at 10°C | 150 mA |

## SELECTIVITY CURVE




## OUTLINE DRAWING




| CONNECTORS | |
|---|---|
| 1 + 2 | COIL |
| 3 + 4 | HEATERS |

# TECHNICAL DATA

WATKINS-JOHNSON

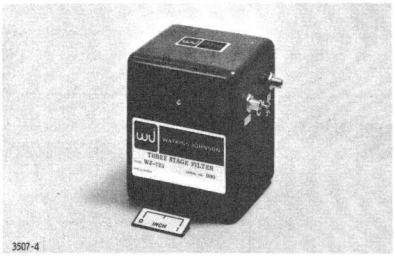
# WJ-725

## 2.0 TO 4.0 GHz THREE-STAGE YIG FILTER

September 1968

The WJ-725 is one of a new family of YIG filters designed for applications requiring electronically-controlled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-725 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-725 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres. This feature minimizes spurious responses and bandwidth variation over wide environmental temperature ranges.




A special feature of the WJ-725 is its compatibility with the WJ-702 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency range | | 2.0 to 4.0 GHz |
| Bandwidth, 3 db | 30 MHz | Note 1 |
| Insertion loss | 3 dB | Note 2 |
| Off-Resonance isolation | 70 dB | 60 dB min. |
| Off-Resonance spurious | 50 dB | 45 dB min. |
| Directivity | Reciprocal | |
| Passband ripple | 0.5 dB | Note 2 |
| Passband spurious | 1.0 dB | Note 2 |
| Passband VSWR | 1.5:1 | 2.0:1 max., Note 3 |
| Limiting level | +20 dBm | >+10 dBm |
| Selectivity | 18 dB/octave | |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| Sensitivity | 12.5 MHz/mA | |
| Coil resistance | 3 ohms | |
| Coil inductance | 75 mH | |
| Time constant | 50 μs | 100 μs max., Note 3 |
| Frequency deviation 10°C to 50°C | ±4 MHz | Note 1 |

1. Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.
2. Maximum combined insertion loss plus ripple and spurious shall not exceed 6 dB.
3. This measurement will be made for design verification only.

## SPECIFICATIONS (Cont'd)

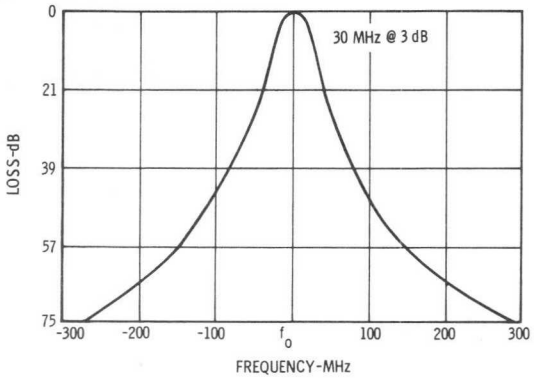
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Dimensions | 3.11 x 2.85 x 3.7 inches |
| Weight | 35 ounces |
| RF connector | OSM Jack |
| Outline drawing number | 290161 |

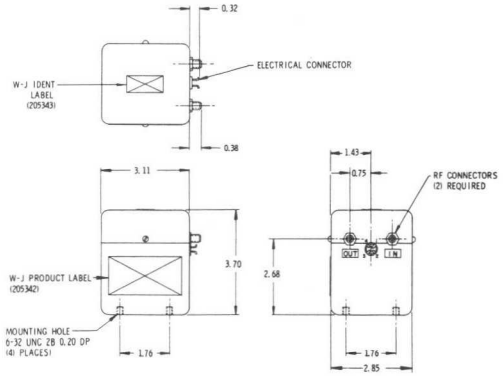
### HEATER CHARACTERISTICS

| | |
|---|---|
| Operating voltage | 24 ±4 volts |
| Operating current: | |
| Surge at 10°C | 750 mA |
| Steady state at 10°C | 150 mA |

### SELECTIVITY CURVE




### OUTLINE DRAWING




CONNECTORS

| | |
|---|---|
| 1 + 2 | COIL |
| 3 + 4 | HEATERS |

# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-726

## 4.0 TO 8.0 GHz THREE-STAGE YIG FILTER

September 1968

The WJ-726 is one of a new family of YIG filters designed for applications requiring electronically-controlled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-726 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-726 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres. This feature minimizes spurious responses and bandwidth variation over wide environmental temperature ranges.

3507-7

A special feature of the WJ-726 is its compatibility with the WJ-703 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency range | | 4.0 to 8.0 GHz |
| Bandwidth, 3 db | 35 MHz | Note 1 |
| Insertion loss | 3 dB | Note 2 |
| Off-Resonance isolation | 70 dB | 60 dB min. |
| Off-Resonance spurious | 50 dB | 45 dB min. |
| Directivity | Reciprocal | |
| Passband ripple | 0.5 dB | Note 2 |
| Passband spurious | 1.0 dB | Note 2 |
| Passband VSWR | 1.5:1 | 2.0:1 max., Note 3 |
| Limiting level | +20 dBm | >+10 dBm |
| Selectivity | 18 dB/octave | |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| Sensitivity | 12.5 MHz/mA | |
| Coil resistance | 3 ohms | |
| Coil inductance | 75 mH | |
| Time constant | 50 μs | 100 μs max., Note 3 |
| Frequency deviation 10°C to 50°C | ±6 MHz | Note 1 |

1. Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.
2. Maximum combined insertion loss plus ripple and spurious shall not exceed 6 dB.
3. This measurement will be made for design verification only.

## SPECIFICATIONS (Cont'd)

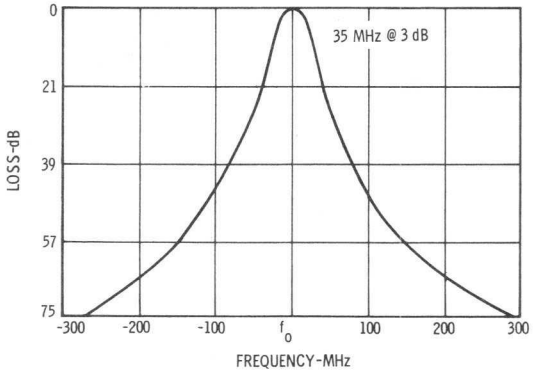
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Dimensions | 3.11 x 2.85 x 3.7 inches |
| Weight | 35 ounces |
| RF connector | OSM Jack |
| Outline drawing number | 290161 |

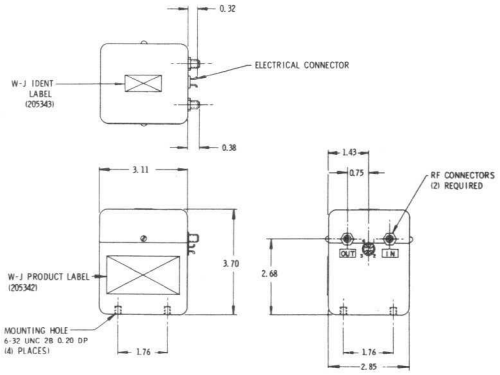
### HEATER CHARACTERISTICS

| | |
|---|---|
| Operating voltage | 24 ±4 volts |
| Operating current: | |
| Surge at 10°C | 750 mA |
| Steady state at 10°C | 150 mA |

## SELECTIVITY CURVE




## OUTLINE DRAWING




CONNECTORS

| | |
|---|---|
| 1 + 2 | COIL |
| 3 + 4 | HEATERS |

# TECHNICAL DATA

WATKINS-JOHNSON

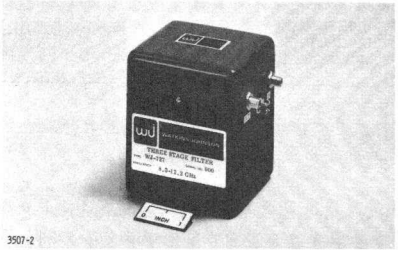
## WJ-727

## 8.0 TO 12.0 GHz THREE-STAGE YIG FILTER

September 1968

The WJ-727 is one of a new family of YIG filters designed for applications requiring electronically-controlled, fast switching from one frequency to another. Featuring high reliability, long life, rugged construction, and low insertion loss, this filter can be tuned to frequencies several hundred MHz apart in less than 100 microseconds. The three-resonator circuit provides a high selectivity figure of 18 dB per octave.

Accurate linear tuning of the WJ-727 is accomplished by changing the current in the tuning coils, thus altering the magnetic field at the YIG resonators. Stray magnetic fields are negligible, and the filter remains unaffected by moderate magnetic environments. For specific requirements, the WJ-727 may be varied to cover offset frequency ranges, to provide different values of instantaneous bandwidth and frequency stability over changes in ambient temperatures between −55°C and +80°C. A self-regulating, proportionally controlled heater, requiring only the application of unregulated power for operation, stabilizes the temperature of the YIG spheres.



3507-2

A special feature of the WJ-727 is its compatibility with the WJ-704 YIG-tuned harmonic generator. The resulting harmonic generator filter chain provides microwave harmonic energy with over 100 dB suppression of harmonics spaced ±200 MHz or more from the tuned harmonic when driven by less than one watt of 100 MHz fundamental signal.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency range | | 8.0 to 12.0 GHz |
| Bandwidth, 3 db | 35 MHz | Note 1 |
| Insertion loss | 3 dB | Note 2 |
| Off-Resonance isolation | 70 dB | 60 dB min. |
| Off-Resonance spurious | 50 dB | 45 dB min. |
| Directivity | Reciprocal | |
| Passband ripple | 0.5 dB | Note 2 |
| Passband spurious | 1.0 dB | Note 2 |
| Passband VSWR | 1.5:1 | 2.0:1 max., Note 3 |
| Limiting level | +20 dBm | >+10 dBm |
| Selectivity | 18 dB/octave | |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| Sensitivity | 12.5 MHz/mA | |
| Coil resistance | 3 ohms | |
| Coil inductance | 75 mH | |
| Time constant | 50 μs | 100 μs max., Note 3 |
| Frequency deviation 10°C to 50°C | ±8 MHz | Note 1 |

1. Bandwidth will be adequate to provide insertion loss below the specified value. The insertion loss measurement includes passband ripple and spurious modes (per Note 2), as well as the effects of temperature changes and non-linearities. Equally spaced tuning current steps will be used. The insertion loss will be measured at the worst point within ±5 MHz of the linearly calculated frequency corresponding to a particular tuning current.
2. Maximum combined insertion loss plus ripple and spurious shall not exceed 6 dB.
3. This measurement will be made for design verification only.

## SPECIFICATIONS (Cont'd)

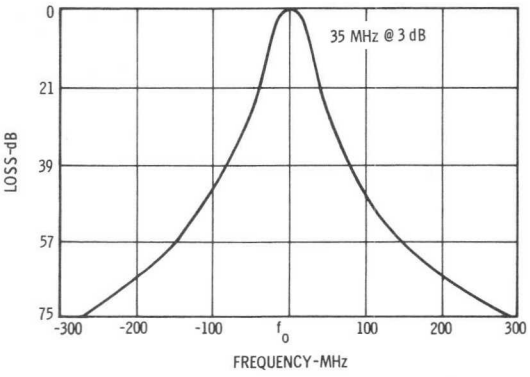
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Dimensions | 3.11 x 2.85 x 3.7 inches |
| Weight | 35 ounces |
| RF connector | OSM Jack |
| Outline drawing number | 290161 |

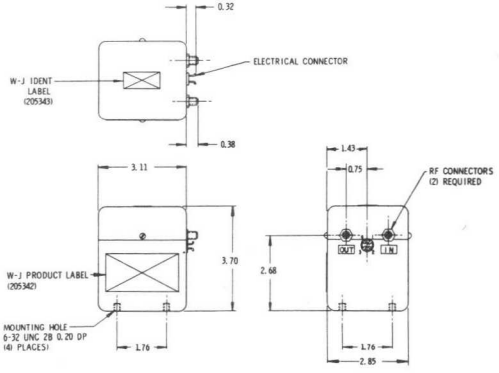
### HEATER CHARACTERISTICS

| | |
|---|---|
| Operating voltage | 24 ±4 volts |
| Operating current: | |
| Surge at 10°C | 750 mA |
| Steady state at 10°C | 150 mA |

## SELECTIVITY CURVE




## OUTLINE DRAWING




CONNECTORS

| | |
|---|---|
| 1 + 2 | COIL |
| 3 + 4 | HEATERS |

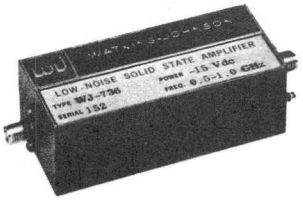
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970*

## 0.5 TO 1.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WJ-736

- **SMALL SIZE: 1.0 x 1.3 x 2.9 INCHES**
- **GUARANTEED 4.0 dB NOISE FIGURE**
- **GUARANTEED -3 dBm POWER OUTPUT**
- **MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT**
- **NO ADJUSTMENTS REQUIRED**




The WJ-736 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 4.0 dB and —3 dBm saturated power output. No other P-band amplifier on the market can match the power output/noise figure/size combination offered by this amplifier.

Modular construction ensures high reliability under adverse operating conditions. Calculated MTBF for this amplifier exceeds 250,000 hours. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-736 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 0.5 to 1.0 GHz | 0.5 to 1.0 GHz |
| Noise Figure (terminal) | 3.5 dB | 4.0 dB max. |
| Gain, Small Signal | 28 dB | 25 dB min. |
| Gain Variation | ±0.7 dB | ±1.0 dB max. |
| VSWR, Input and Output | 1.5:1 | 2.0:1 max. |
| Power Output, Saturated[1] | 0 dBm | —3 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for Third Order IM | +7 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | —15 volts |
| Primary Power | 0.5 watts |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400 Class II.

1. For 1 dB gain compression.

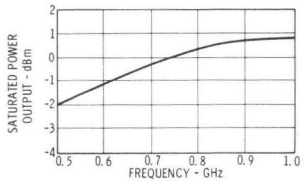
*Supersedes WJ-736 Technical Data Sheet dated March 1968.

# WJ-736

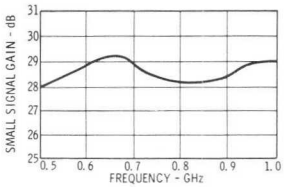
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height | 1.0 inches (25 mm) |
| Width | 1.3 inches (33 mm) |
| Length (less connectors) | 2.9 inches (74 mm) |
| Weight | 3 ounces (85 g) |
| RF Connectors | OSM jack |

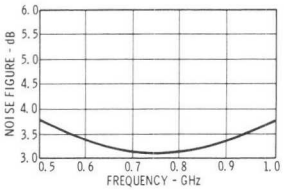
## POWER

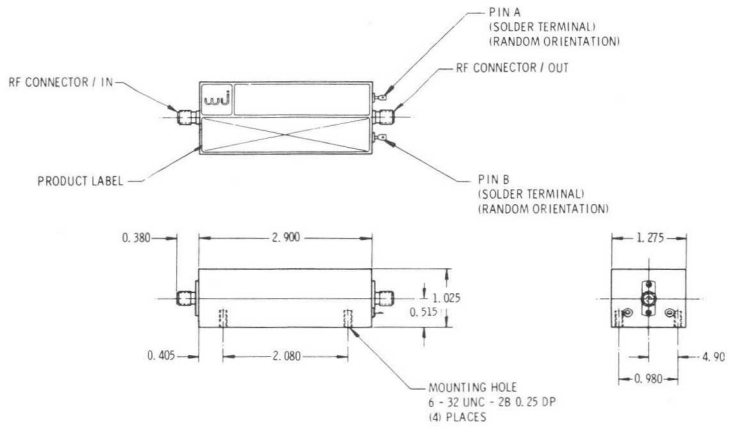



## GAIN




## NOISE



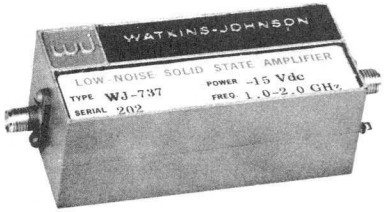
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970 *

## 1.0 TO 2.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER
## WJ-737

- **SMALL SIZE: 1.0 x 1.3 x 2.9 INCHES**
- **GUARANTEED 6.0 dB NOISE FIGURE**
- **GUARANTEED 0 dBm POWER OUTPUT**
- **MIL-E-5400 AND MIL-E-16400 CLASS II ENVIRONMENT DESIGN**
- **NO ADJUSTMENTS REQUIRED**




The WJ-737 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 6.0 dB and 0 dBm power output.[1] No other L-band amplifier on the market can match the power output/noise figure/size combination offered by this amplifier.

Modular construction ensures high reliability under adverse operating conditions. Calculated MTBF for this amplifier exceeds 225,000 hours. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-737 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0 to 2.0 GHz | 1.0 to 2.0 GHz |
| Noise Figure | 5.0 dB | 6.0 dB min. |
| Gain, Small Signal | 28 dB | 25 dB min. |
| Gain Variation | ±0.7 dB | ±1.0 dB max. |
| VSWR, Input and Output | 1.5:1 | 2.0:1 max. |
| Power Output[1] | +6 dBm | 0 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for Third Order IM | +10 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | —15 volts |
| Primary Power | 0.7 watts max. |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400 Class II.

1. For 1 dB gain compression.

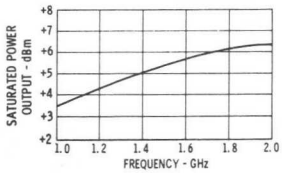
*Supersedes WJ-737 Technical Data Sheet dated May 1968.

# WJ-737

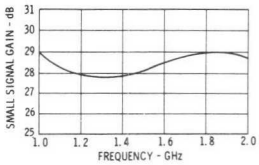
## MECHANICAL CHARACTERISTICS

Height ..... 1 inch (25 mm)
Width ..... 1.3 inches (33 mm)
Length (less connectors) ..... 2.9 inches (74 mm)
Weight ..... 3 ounces (85 g)
RF Connectors ..... OSM Jack

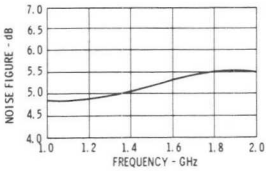
**POWER**



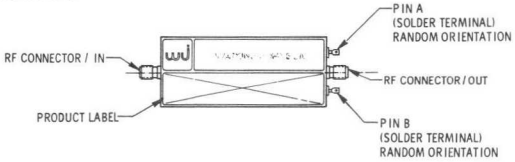

**GAIN**



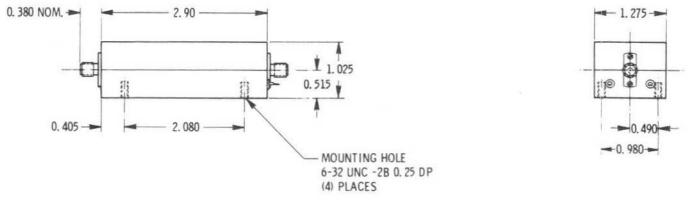

**NOISE**




## OUTLINE DRAWING




| ELECTRICAL CONNECTIONS | | |
|---|---|---|
| PIN | CONNECTIONS | |
| A | DC | -15 VOLTS |
| B | DC | GND |

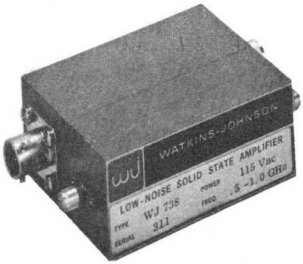


# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970*

## 0.5 TO 1.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-738




- **SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES**
- **GUARANTEED 4.0 dB NOISE FIGURE**
- **GUARANTEED -3 dBm POWER OUTPUT**
- **MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT DESIGN**
- **"JUST PLUG IT IN"**

The WJ-738 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 4.0 dB and —3 dBm saturated power output. No other P-band amplifier (with integral power supply) on the market can match the power output/noise figure/size combination offered by this amplifier. Plug it into most 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. Calculated MTBF for this amplifier exceeds 200,000 hours. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-738 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 0.5 to 1.0 GHz | 0.5 to 1.0 GHz |
| Noise Figure (terminal) | 3.5 dB | 4.0 dB max. |
| Gain, Small Signal | 28 dB | 25 dB min. |
| Gain Variation | ±0.7 dB | ±1.0 dB max. |
| VSWR, Input and Output | 1.5:1 | 2.0:1 max. |
| Power Output[1] | 0 dBm | —3 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for Third Order IM | +7 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | 115 ±10 volt ac |
| Primary Power | 2.5 watts max. |
| Primary Frequency | 48 to 420 Hz |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400 Class II.

1. For 1 dB gain compression.

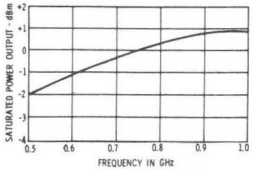
*Supersedes WJ-738 Technical Data Sheet dated May 1968.

# WJ-738

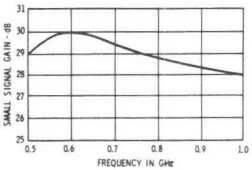
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height | 1.3 inches (33 mm) |
| Width | 2.3 inches (58 mm) |
| Length (less connectors) | 2.9 inches (74 mm) |
| Weight | 6.0 ounces (170g) |
| RF Connectors | OSM Jack |

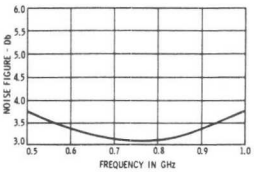
## POWER



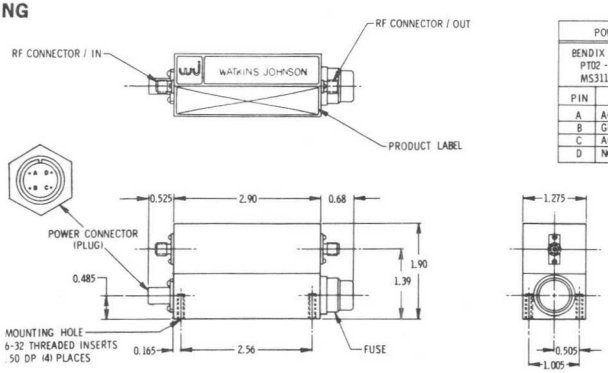

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX<br>PT02 - H - 8 - 4P (PLUG)<br>MS3116 - H - 8 - 4S (SOCKET) | | |
| PIN | CONNECTION | |
| A | AC (HOT) | 115 ± 10 VAC |
| B | GROUND | 48 - 420 CPS |
| C | AC | SINGLE PHASE |
| D | NONE | |

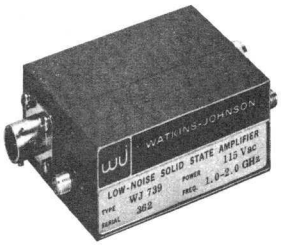
# TECHNICAL DATA

WATKINS-JOHNSON

*DECEMBER 1971

## 1.0 TO 2.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-739




- **SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES**
- **GUARANTEED 6.0 dB NOISE FIGURE**
- **GUARANTEED 0 dBm POWER OUTPUT**
- **MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT DESIGN**
- **"JUST PLUG IT IN"**

The WJ-739 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWA's. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 6.0 dB and 0 dBm power output.[1] No other L-band amplifier (with integral power supply) on the market can match the power output/noise figure/size combination offered by this amplifier. Plug it into most 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. Calculated MTBF for this amplifier exceeds 200,000 hours. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-739 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 1.0 to 2.0 GHz | 1.0 to 2.0 GHz |
| Noise Figure | 5.0 dB | 6.0 dB max. |
| Gain, Small Signal | 28 dB | 25 dB min. |
| Gain Variation | ±0.7 dB | ±1.0 dB max. |
| VSWR, Input and Output | 1.5:1 | 2.0:1 max. |
| Power Output[1] | +6 dBm | 0 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for Third Order IM | +10 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | 115 ±10 volt ac |
| Primary Power | 2.5 watts max. |
| Primary Frequency | 48 to 420 Hz |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the general requirements of MIL-E-16400 and MIL-E-5400 Class II.

1. For 1 dB gain compression.

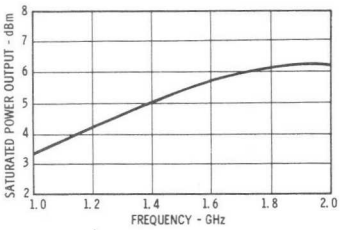
*Supersedes WJ-739 Technical Data Sheet dated July 1970.

# WJ-739

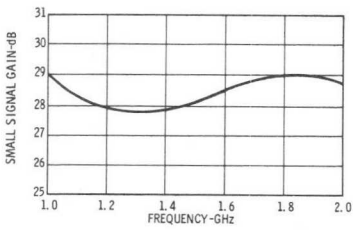
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height | 1.3 inches (33 mm) |
| Width | 2.3 inches (58 mm) |
| Length (less connectors) | 2.9 inches (74 mm) |
| Weight | 6.0 ounces (170g) |
| RF Connectors | OSM Jack |

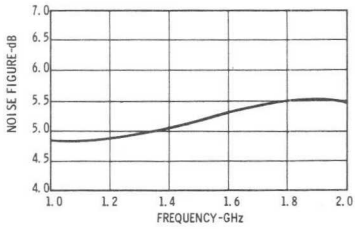
## POWER



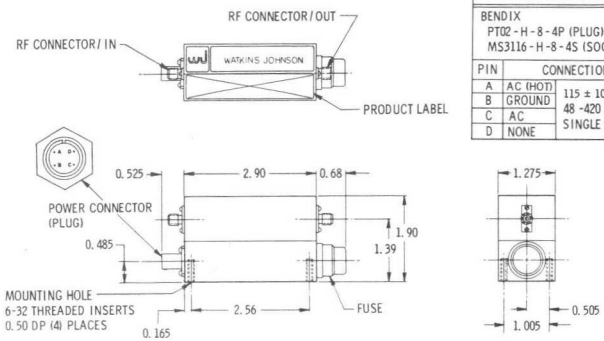

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX<br>PT02-H-8-4P (PLUG)<br>MS3116-H-8-4S (SOCKET) | | |
| PIN | CONNECTION | |
| A | AC (HOT) | 115 ± 10 VAC<br>48 -420 CPS<br>SINGLE PHASE |
| B | GROUND | |
| C | AC | |
| D | NONE | |

# TECHNICAL DATA

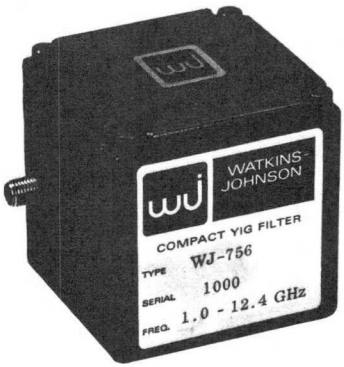
WATKINS-JOHNSON

OCTOBER 1969

## 1 TO 12.4 GHz THREE-STAGE MULTI-OCTAVE COMPACT YIG FILTER WJ-756

Watkins-Johnson has added a three-stage device to its multi-octave compact YIG filter line. This device offers increased off-resonance isolation (typically 75 dB) in a unit covering the 1 to 12.4 GHz frequency range. The compact magnetic design of this filter ensures high reliability, long life, ruggedness, small size, and a low tuning power requirement (less than 3 watts).

WJ-756 is particularly suited for ultra-wide bandwidth receiving and frequency measuring applications. For specific requirements, the tuning sensitivity may be changed to 9 MHz/mA without increasing the tuning power requirements. In addition, optional bandwidths are available for special applications.




### SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 1.0 to 12.4 GHz |
| Bandwidth ( 3dB ) (minimum) | | | 20 MHz |
| Insertion Loss (maximum) | 4.0 dB | | 7.5 dB |
| Off Resonance Isolation (minimum) | 75 dB | | 65 dB |
| Off Resonance Spurious (minimum) | | | 15 dB |
| Directivity | Reciprocal | | |
| Passband Ripple and Spurious (maximum) | 1.5 dB | | 2.0 dB |
| VSWR Input and Output (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | | | +10 dBm (2-12.4 GHz) |
| Selectivity | 18 dB/Octave | | —23 dBm (1-2 GHz) |

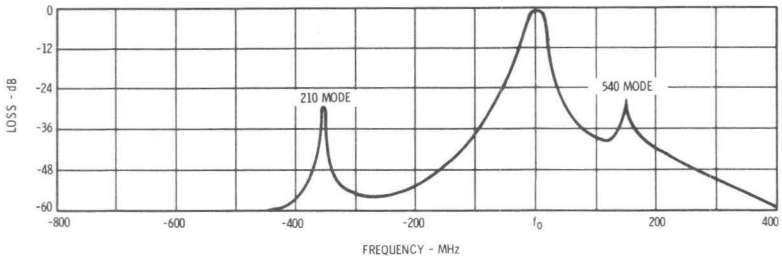
| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 17 MHz/mA |
| Coil Resistance | 5.5 ohms |
| Coil Inductance | 112 mH |
| Time Constant | 5 ms |
| Deviation from Linear (maximum) | ±0.25 percent |
| Hysteresis | 30 MHz |
| Frequency Drift over Temp. Range +10°C to +30°C | 15 MHz |

## SPECIFICATIONS (Cont'd)

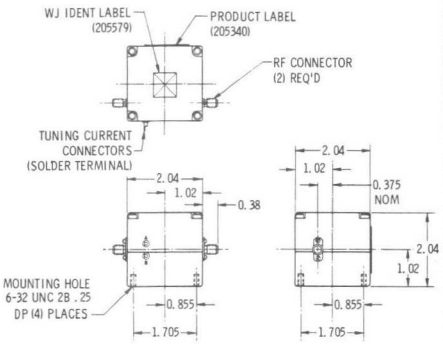
| MECHANICAL CHARACTERISTICS | Nominal |
|---|---|
| Size (excluding connectors) | 2.0 x 2.0 x 2.0 inches (51 x 51 x 51 mm) |
| Weight | 30 ounces (850 g) |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 290057 |

| HEATER CHARACTERISTICS | |
|---|---|
| Operating Voltage | 22 to 28 Volts |
| Operating Current: | |
| Surge at +10°C | 750 mA |
| Steady State at +10°C | 250 mA |

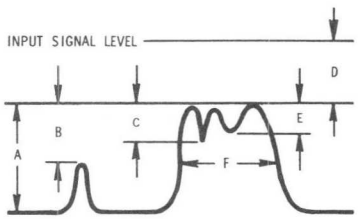
## SELECTIVITY CURVE (TYPICAL)




## OUTLINE DRAWING




## MEASUREMENT DEFINITIONS




A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

# TECHNICAL DATA

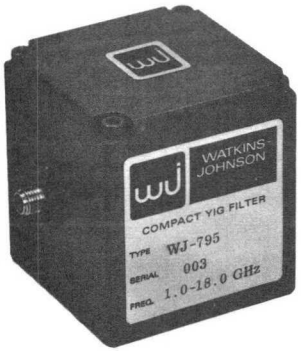
WATKINS-JOHNSON

JULY 1970*

## 1 TO 18 GHz TWO-STAGE MULTI-OCTAVE COMPACT YIG FILTER WJ-795

Watkins-Johnson has developed a multi-octave (1 to 18 GHz) YIG filter that adds a wide tuning range capability to the compact filter line. WJ-795 is an electronically tuned YIG filter that features high reliability, long life, ruggedness, small size, and a low tuning power requirement (less than 6 watts). These features are primarily attributable to a self-shielded magnetic circuit built into the filter structure.

WJ-795 is particularly suited for ultra-wide band receiving and frequency measuring applications. For specific requirements, the tuning sensitivity may be changed to 12 MHz/mA without increasing the tuning power requirements.




### SPECIFICATIONS

| RF PERFORMANCE | Typical | Nominal | Guaranteed |
|---|---|---|---|
| Frequency Range | | | 1.0 to 18.0 GHz |
| Bandwidth ( 3dB ) (minimum) | 35 MHz | | 20 MHz |
| Insertion Loss (maximum) | 4.0 dB | | 7.5 dB[1] |
| Off Resonance Isolation (minimum) | 55 dB | | 45 dB |
| Off Resonance Spurious (minimum) (−210 mode) | 25 dB | | 20 dB |
| Directivity | Reciprocal | | |
| Passband Ripple and Spurious (maximum) | 1.0 dB | | 2.0 dB |
| VSWR Input and Output (maximum) | 1.5:1 | | 2.0:1 |
| Limiting Level (minimum) | | | +10 dBm |
| Selectivity | | 12 dB/Octave | |

| TUNING CHARACTERISTICS | |
|---|---|
| Sensitivity | 24 MHz/mA |
| Coil Resistance | 7 ohms |
| Coil Inductance | 200 mH |
| Time Constant | 10 ms |
| Deviation from Linear | ±15 MHz |
| Hysteresis | 45 MHz |
| Frequency Drift over Temp. Range +10°C to +30°C | 15 MHz |

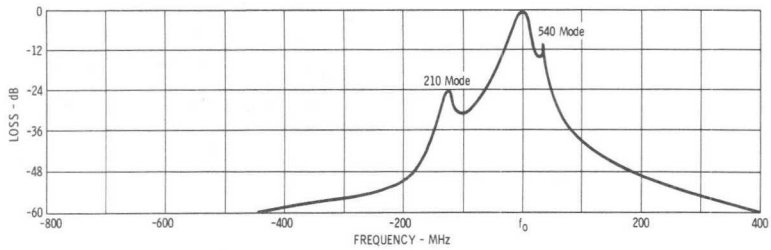
[1] Insertion loss variation shall not exceed 4 dB.
* Supersedes WJ-795 Technical Data Sheet dated October 1969.

# WJ-795

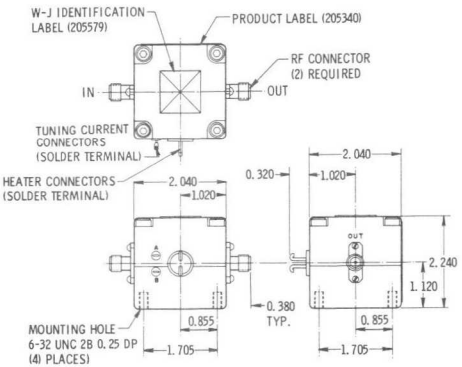
| MECHANICAL CHARACTERISTICS | Nominal |
|---|---|
| Size (excluding connectors) | 2.0 x 2.0 x 2.2 (51 x 51 x 56 mm) |
| Weight | 40 ounces (1.13 Kg) |
| RF Connectors | OSM Jack |
| Outline Drawing No. | 295051 |

| HEATER CHARACTERISTICS | |
|---|---|
| Operating Voltage | 22 to 28 Volts |
| Operating Current: | |
| Surge at +10°C | 750 mA |
| Steady State at +10°C | 250 mA |

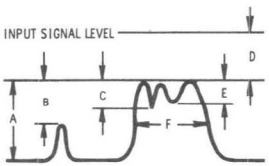
## SELECTIVITY CURVE (TYPICAL)




## OUTLINE DRAWING




## MEASUREMENT DEFINITIONS




A - OFF RESONANCE ISOLATION
B - OFF RESONANCE SPURIOUS
C - PASS BAND SPURIOUS
D - INSERTION LOSS
E - PASS BAND RIPPLE
F - 3 dB BANDWIDTH

# TECHNICAL DATA

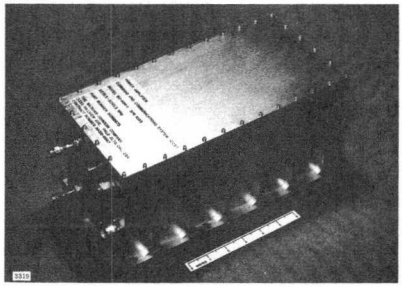
WATKINS-JOHNSON

# WJ-1014-1

March 1967

## 2.2 TO 2.4 GHz, SPACE QUALIFIED, 20 WATT MICROWAVE AMPLIFIER WITH INTEGRAL SOLID-STATE POWER SUPPLY

The WJ-1014-1 is a medium power, telemetry, microwave amplifier operating in S-band. It is a fully integrated package complete with traveling-wave tube, all solid-state power supply, RFI filtering, and telemetry output circuitry for monitoring the amplifier's operation. Originally developed for NASA for use in Saturn V vehicles, the WJ-1014-1 is environmentally qualified, both electrically and mechanically, for satellite and deep space probe applications where absolute reliability, small size, lightweight, and maximum overall efficiency are essential.



The amplifier package is designed to accept Watkins-Johnson's WJ-274 series of traveling-wave tubes, or other tubes of similar size and performance. The integral RF filter components provide high attenuation of spurious and harmonic outputs, but exhibit relatively low insertion loss. Units can be supplied without the band reject/harmonic filter and isolator components. In such case, a 15% increase in saturated power output can be expected.

The power output, gain, and efficiency are very nearly constant over the frequency range from 2.2 to 2.4 GHz. The power transfer curves show that the output power at saturation is relatively unchanged with a substantial change in drive power. Typically, output saturation can be realized with only 75 milliwatts of drive power. The noise characteristics of the amplifier are given for undriven and saturation drive conditions, with and without the RFI network at the tube's output.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 2.2 to 2.4 GHz | 2.2 to 2.4 GHz |
| Power Output, Saturated | 18 W | 16 W, min. |
| Efficiency | | |
| Overall Amplifier | 22% | 20%, min. |
| Traveling-Wave Tube | 33% | 30%, min. |
| Power Supply | 84% | 80%, min. |
| Power Output Variation | | |
| dB per 100 MHz | ±0.2 | ±0.4 |
| dB per 10 MHz | ±0.05 | ±0.1 |
| RF Drive for Saturated Output | 75 mW | 100 mW, max. |
| Maximum Load VSWR | | Infinity, any phase |
| Duty Cycle | | CW |
| Phase Linearity | 3°/10 MHz BW | 4°/10 MHz BW |
| Harmonic and Spurious Outputs[1] | | |
| Spurious Coherent | 70 dB | 65 dB |
| In-band Spurious | 65 dB | 60 dB |
| 2nd and 3rd Harmonic | 65 dB | 60 dB |
| 4th Harmonic | 85 dB | 80 dB |
| Noise Power Output (2.2–10 GHz) | 70 dB/MHz BW | 65 dB/MHz BW |
| On-Off Cycling | | 10,000, min. |

# WJ-1014-1

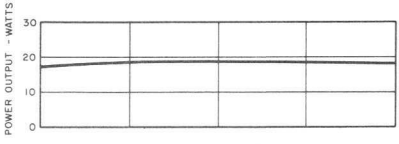
## ELECTRICAL CHARACTERISTICS

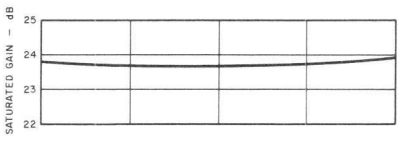
| | Typical | Range |
|---|---|---|
| Primary Voltage | 28 V dc | 28 ± 4 V dc |
| Primary Power | 85 W | |
| Telemetry Outputs | | |
| a) Regulator Voltage | | 0 to 5 V dc |
| b) High Voltage Status | | 0 to 5 V dc |
| c) Helix Current | | 0 to 5 V dc |
| d) Cathode Current | | 0 to 5 V dc |
| Filament Time Delay Before carrier. | | 90 to 150 secs. |

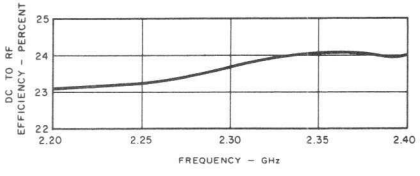
## MECHANICAL CHARACTERISTICS

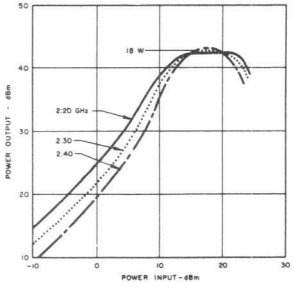
| | |
|---|---|
| Base Plate Dimensions | 6.6 x 12.8 inches |
| Amplifier Height (including baseplate) | 5.375 inches |
| Weight, Amplifier | 19 lbs. |
| Weight, Power Supply (including RFI filters) | 4.25 lbs. |
| Weight, TWT | 1.125 lbs. |
| Connectors | |
| a) RF Input | TNC |
| b) RF Output | Type N |
| c) Power and Telemetry | Bendix Pygmy PT07H-14-12P |

## TYPICAL PERFORMANCE CHARACTERISTICS



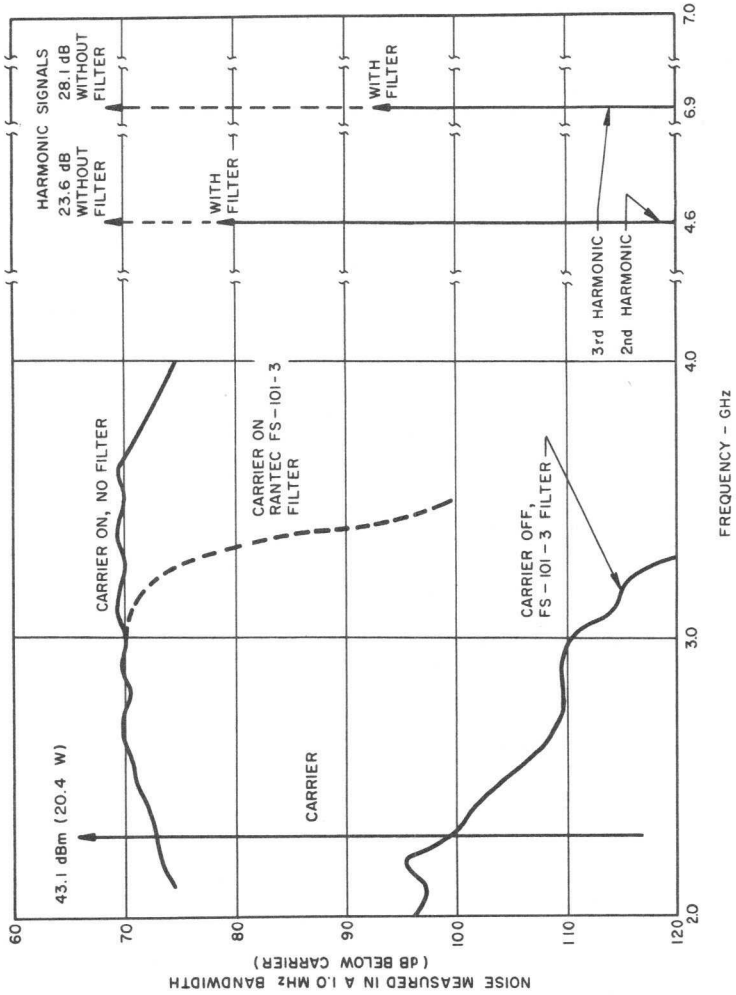



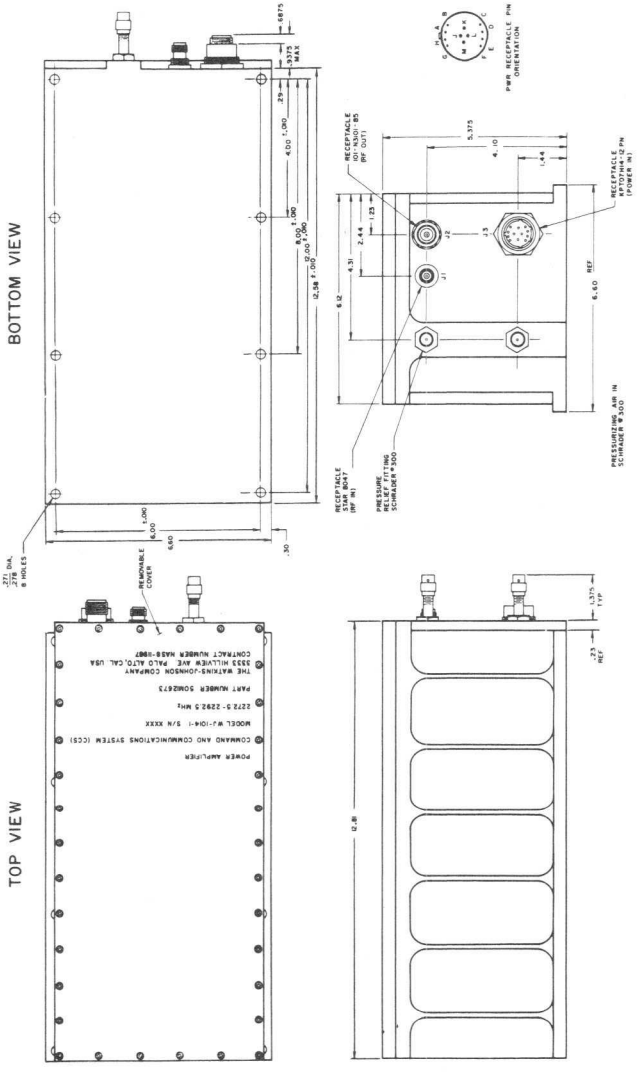



# WJ-1014-1

## TYPICAL NOISE AND HARMONIC CHARACTERISTICS



## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

SEPTEMBER 1970

## 5.4 TO 5.9 GHz 45-WATT PULSED TWT AMPLIFIER WJ-1051-1

- **POWER OUTPUT 50 WATTS MIN.**
- **GAIN AT RATED POWER 45 dB MIN.**
- **PULSE LENGTH STABILITY ±0.1 μSEC**
- **PULSE RISE AND FALL TIME 50 NANOSECONDS**

WJ-1051-1 is a broadband TWT amplifier designed for applications where stringent pulse characteristics are required. It is particularly suited for sophisticated, coherent, frequency-agile communication and navigation systems. In addition, it may be used either as a driver or as the output stage in advanced radar applications.

Pulse characteristics provided by the WJ-1051-1 include phase and amplitude stability during the entire pulse duration and extremely fast rise and fall times. These characteristics are obtained through the use of a hi-mu gridded traveling-wave tube (WJ-369) and a highly regulated grid modulator. The amplifier contains its own forced air cooling and protective overload features.

WJ-1051-1 can operate either as a fixed-pulse-length amplifier or as a pulse follower. It may be easily adapted to accommodate W-J TWTs other than WJ-369 to provide a wide range of allowable power outputs, duty cycles, and pulse widths over different frequency bands.

## SPECIFICATIONS

| ELECTRICAL PERFORMANCE | Guaranteed |
|---|---|
| Frequency | 5.4 to 5.9 GHz |
| Power Output | 45 watts min. |
| Gain at Rated Power | 45 dB, min. |
| Duty Factor | 5% max. |
| Phase Shift | 10° max., during 30 μsec pulse |
| Pulse Length | 30 μsec |
| Pulse Length Adjustability | ±2.0 μsec |
| Pulse Length Stability | ±0.1 μsec |
| Pulse Rise and Fall Time | 50 nanoseconds max. |
| Pulse Droop | 0.1 dB, max. |
| Modulator Input Impedance | 93 ±10 ohms |
| Protective Interlock | TWT grid pulse removed on absence of a 50 Vdc signal |

| ELECTRICAL REQUIREMENTS | Range |
|---|---|
| Input Voltage | 105 to 125 Vac, 47 to 68 Hz (380 Hz to 440 Hz optional) |
| Modulator Trigger | 60.0 ±10 V positive trigger, 1.0 ±0.5 μsec wide |

| ENVIRONMENTAL CHARACTERISTICS | |
|---|---|
| Temperature | +50°F to +100°F |
| Altitude | Normal ground |
| Vibration | Laboratory environment |
| Humidity | Room ambient |

Note 1: For extended performance in full C-band (4 to 8 GHz), power output is 25 watts, gain at rated power is 40 dB, and duty factor is 1.5%.

# WJ-1051-1

## MECHANICAL CHARACTERISTICS

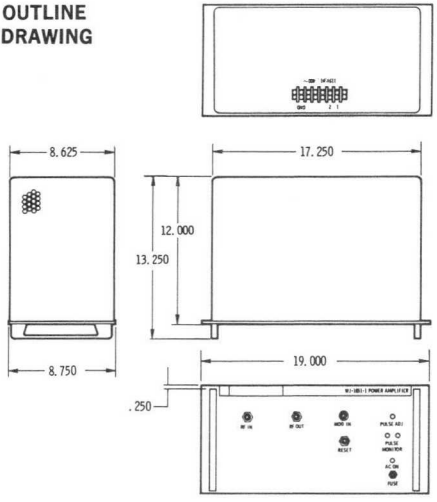
Size . . . . . 8.75 x 12.25 x 19 inches (222 x 311 x 483 mm)

Weight . . . . . 50 pounds (22.7 Kg)

Cooling . . . . . No external cooling required

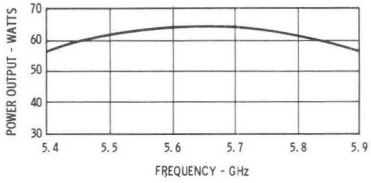
Connectors .a. Primary power — Terminal block
b. Trigger input — Type BNC
c. RF output — Type N
d. RF input — Type N
e. Bus interrupt — Terminal block

## OUTLINE DRAWING

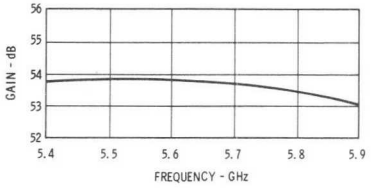



## TYPICAL PERFORMANCE CHARACTERISTICS

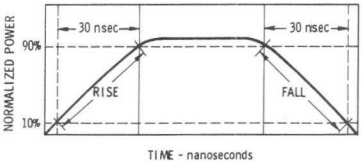
### POWER




### GAIN




### RISE AND FALL TIME

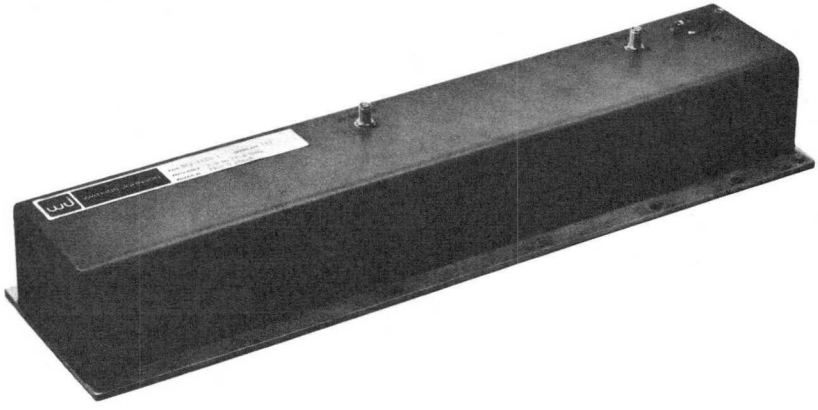


# TECHNICAL DATA

WATKINS-JOHNSON

OCTOBER 1969

## 7 TO 11 GHz MEDIUM-POWER MICROWAVE AMPLIFIER WJ-1115



- **INTEGRAL POWER SUPPLY**
- **SMALL SIZE**
- **HIGH POWER OUTPUT**
- **LOW NOISE FIGURE**
- **WIDE-BAND OPERATION**

Watkins-Johnson has developed a microwave amplifier with integral power supply for use in airborne ECM or data link systems. Designated WJ-1115, this amplifier provides 3 watts power output, 45 dB small signal gain, and 22 dB max. noise figure in X-band.

WJ-1115 weighs less than 6.5 lbs. and comes in a 2.3 x 3.0 x 16 inches package. In addition, it meets or exceeds the environmental requirements of MIL-E-5400, class II.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 7.0 to 12.4 GHz | 7.0 to 11.0 GHz |
| Saturation Output | 4.0 Watts | 3.0 Watts min. |
| Small Signal Gain | 48.0 dB | 45.0 dB min. |
| Gain Variation | 4.0 dB | 5.0 dB |
| Fine Grain Variation | 0.5 dB | 1.0 dB |
| Noise Figure | 19.0 dB | 22 dB max. |
| Warm up Time | | 3.0 - 4.0 minutes |

| ELECTRICAL CHARACTERISTICS | Nominal |
|---|---|
| Primary Power | |
| Voltage | 115/200 Vac, 3-phase, WYE connection |
| Frequency | 400 Hz ±20 Hz |
| Voltage Variation | ±10 volts, line to neutral |
| Power | 80 watts |

## WJ-1115

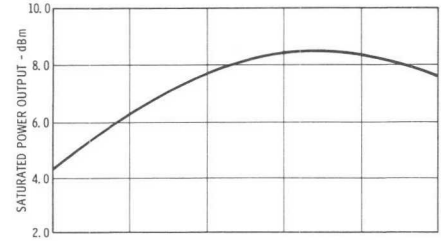
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Length | 16 inches (406 mm) |
| Cross-section, excluding connectors | 2.3 x 3 inches (58 x 76 mm) |
| Weight | 6.5 pounds (2.95 Kg) |
| Power Connection | Cannon, DEM-9p |
| RF Connectors | OSM, Jack |
| Cooling | Conduction |

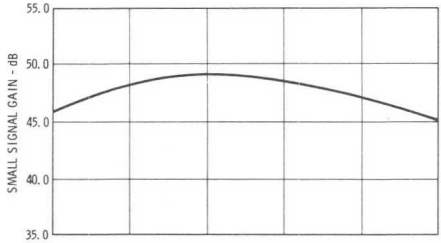
### ENVIRONMENTAL CHARACTERISTICS

Exceeds the environmental requirements of MIL-E-5400, class II.

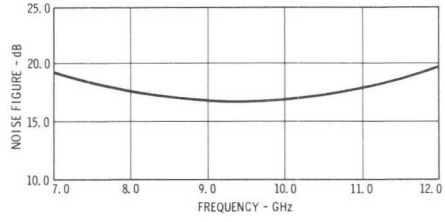
### POWER



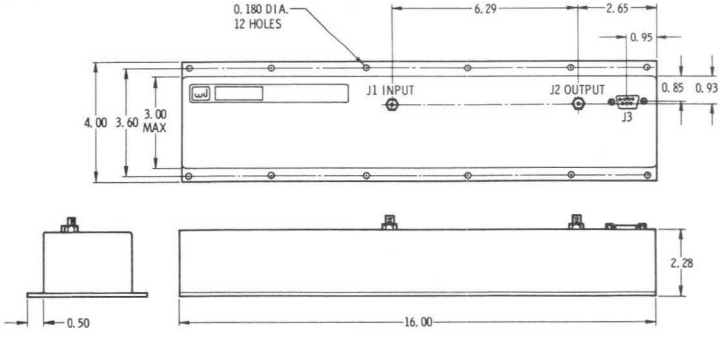

### GAIN




### NOISE




### OUTLINE DRAWING



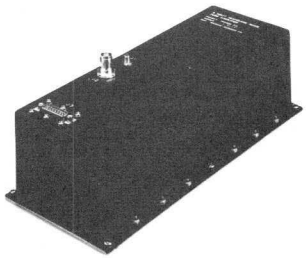
# TECHNICAL DATA

WATKINS-JOHNSON

JANUARY 1971

## HIGH-EFFICIENCY TWT AMPLIFIERS FOR DEEP-SPACE & SATELLITE APPLICATIONS WJ-1171 SERIES

- **dc to RF Efficiency > 36%**
- **Ultra-High Reliability**
- **Lightweight**
- **Space-Qualified**



The WJ-1171 series of TWT amplifiers was developed by Watkins-Johnson to meet the advanced telemetry and communication requirements of orbital and deep-space missions. Designed to survive severe environmental conditions with no degradation of performance, these rugged TWTAs exhibit long life, high efficiency, ultra-high reliability and extremely light weight.

One version of the basic amplifier, the WJ-1171-1, was developed specifically for use in the Pioneer F/G spacecraft, scheduled for launch in 1973-74. This TWTA will provide a minimum 24,000-hour mission life with high dc to RF efficiency and absolute minimum weight. It also features minimum residual and stray magnetic fields.

Other versions of the basic WJ-1171 are available; several are listed on the following pages. These TWTAs may be used in applications requiring higher or lower RF power, dual-mode operation, or unregulated dc input power operation. A variety of power monitor and filter combinations are also available.

Options for all versions include extended temperature ranges, increased vibration and shock levels, magnetic cleanliness, telemetry outputs up to 10 V full scale, and extended frequency ranges.

## APPLICATIONS NOTES

In the following tables, the RF power output is specified into a 1:1 load. Cold (non-operating) output VSWR is included to allow calculation of maximum power transfer into other than 1:1 loads. Additionally, it should be noted that no RF components, such as power monitors and filters, are included. An accurate estimate of the RF power output available when such components are included may be obtained by subtracting from the specified power output 0.3 dB for a power monitor alone, or 0.45 dB for a power monitor/harmonic filter combination.

The WJ-1171-1 is designed for operation from a moderately well-regulated buss. It requires only the use of a series dissipative helix regulator to achieve optimum performance. However, many spacecraft power systems employ unregulated busses. A version of the WJ-1171, employing a switching pre-regulator, is offered for such applications. In deciding which amplifier will afford maximum efficiency for a given power buss, the following guide-lines are helpful. A switching regulator has a fairly constant efficiency of approximately 90%. Therefore, if buss excursions of 10% or greater are to be encountered, a dissipative regulator will consume more power at "high line" than a switching regulator. Conversely, if less than 10% buss excursions are anticipated, a dissipative regulator will afford the most overall efficiency.

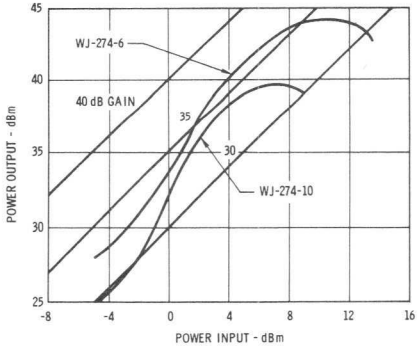
# WJ-1171 SERIES

## SPECIFICATIONS

| TWTA Model No. — (Associated TWT) — | WJ-1171-1 (WJ-274-10) | WJ-1171-2 (WJ-274-6) | WJ-1171-3 (WJ-274-9) | WJ-1171-4 (WJ-274-6) |
|---|---|---|---|---|
| **PERFORMANCE CAPABILITIES:** | | | | |
| Frequency | 2.2-2.3 GHz | 2.2-2.3 GHz | 2.2-2.3 GHz | 2.2-2.3 GHz |
| Sat. Power Output[1] | 9 watts | 24 watts | 12/24 watts | 24 watts |
| Efficiency Overall[2] | 33.6% | 36.8% | 30.6%/34.9% | 33.4% |
| Sat. Gain | 33 dB | 31 dB | 28/31 dB | 31 dB |
| Output VSWR (Cold) | 1.25:1 | 1.25:1 | 1.25:1 | 1.25:1 |
| **ELECTRICAL CHARACTERISTICS:** | | | | |
| Primary Voltage | +28 vdc ±3% | +28 vdc ±3% | +28 vdc ±3% | +24 to 32 vdc |
| Primary Power | 26 w @ 28 v −3%<br>26.8 w @ 28v<br>27.6w @ 28v +3% | 65.2 w @ 28 v −3%<br>67.2w @ 28v<br>69.1w @ 28v +3% | 39.2/68.7 @ 28v −3%<br>40.4/70.7 @ 28 v<br>41.6/72.8 @ 28 v +3% | 72 w @ 24 −32 v primary input |
| Telemetry Outputs: Cathode and Helix Currents, and Collector Temperature | 0 to ±3 vdc | 0 to ±3 vdc | 0 to ±3 vdc | 0 to ±3 vdc |
| Delay Time Before 100% Carrier Power | 90 to 150 sec | 90 to 150 sec | 90 to 150 sec | 90 to 150 sec |
| **MECHANICAL CHARACTERISTICS:** | | | | |
| Baseplate Dimensions | 4.44 x 11.00 in. (113 x 279 mm) | 4.44 x 11.00 in. (113 x 279 mm) | 4.58 x 12.00 in. (123 x 305 mm) | 5.40 x 11.00 in. (137 x 279 mm) |
| Height (excluding connectors) | 3 in. (76 mm) | 3 in. (76 mm) | 3 in. (76 mm) | 3 in. (76 mm) |
| Weight | 3.8 lbs. (1.72 Kg) | 4.2 lbs. (1.91 Kg) | 4.55 lbs. (2.06 Kg) | 5.0 lbs. (2.27 Kg) |
| Connector Types | TNC or | TNC or | TNC or | TNC or |
| RF In and Out | 3 mm female | 3 mm female | 3 mm female | 3 mm female |
| Power/TLM/CMD | Cannon Golden "D" | Cannon Golden "D" | Cannon Golden "D" | Cannon Golden "D" |

1. Power Output is specified into 1:1 load. Output VSWR is included in table to allow calculation in other than 1:1 loads.
2. Efficiency is specified at 28 v −3%. Since the regulators are dissipative (except for WJ-1171-4 which is a switching regulator design) power consumption and, therefore, efficiency vary with line voltage. See Electrical Characteristics.

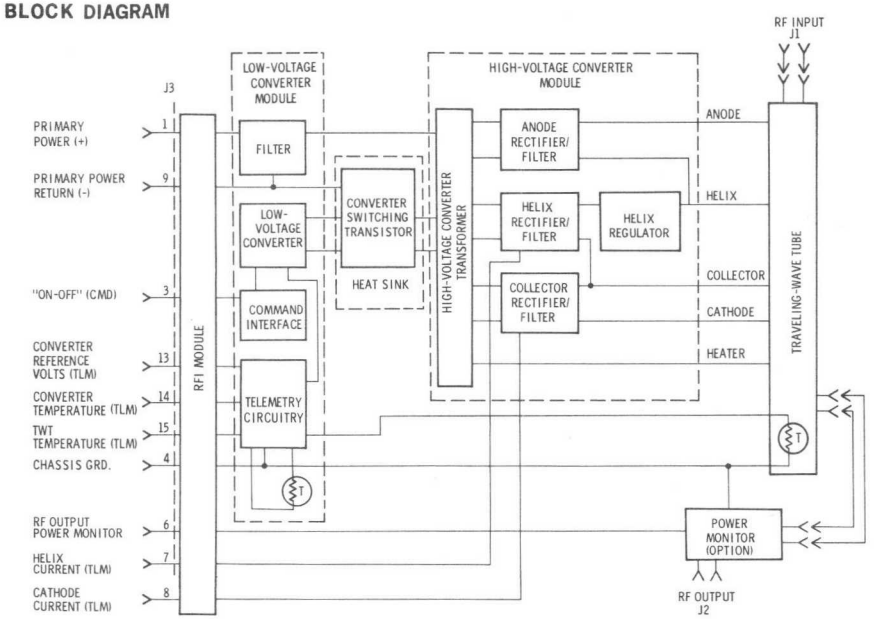
## PERFORMANCE CHARACTERISTICS



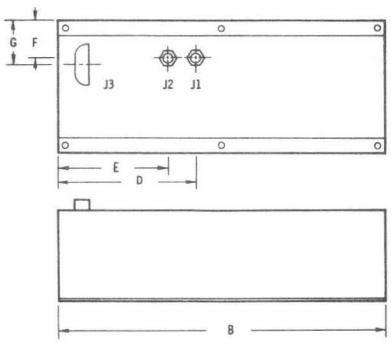

**Transfer curve of WJ-274-6 and WJ-274-10**

# WJ-1171 SERIES

## BLOCK DIAGRAM




## OUTLINE DRAWING




| MODEL NO. | DIMENSIONS IN INCHES | | | | | | | OVERALL WEIGHT (lbs.) |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | |
| 1171-1 | 4.44 | 11.00 | 3.00 | 5.00 | 3.75 | 1.00 | 1.500 | 3.8 |
| 1171-2 | 4.44 | 12.00 | 3.00 | 5.00 | 3.75 | 1.00 | 1.500 | 4.2 |
| 1171-3 | 4.85 | 12.00 | 3.00 | 5.00 | 3.75 | 1.00 | 1.500 | 4.55 |
| 1171-4 | 5.40 | 12.00 | 3.00 | 5.00 | 3.75 | 1.00 | 1.500 | 5.0 |

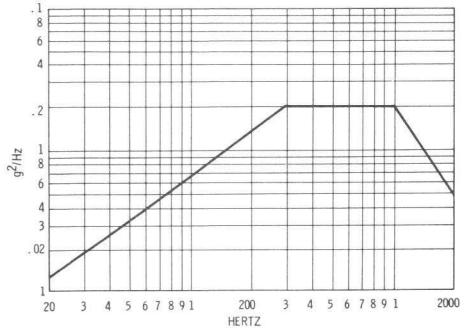
# WJ-1171 SERIES

## ENVIRONMENTAL CAPABILITIES

**1. Operating Temperature Range:**

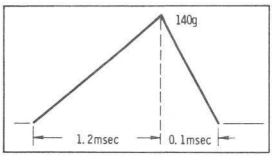
−25°C to +70°C (baseplate temp.)

**2. Vibration**



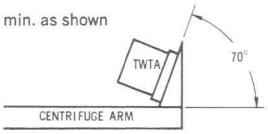

**Random vibration spectrum**

**3. Shock**




**4. Sustained Acceleration:**

37g for 3 min. as shown




**5. Operating Pressure:**

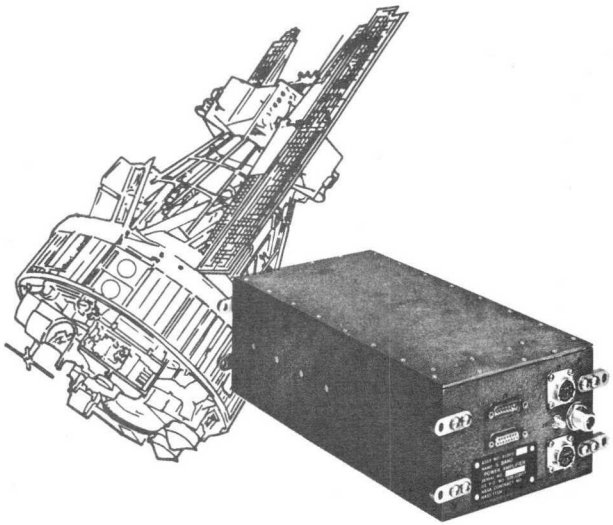
All models can operate without damage over an indefinite period at pressures from 2 atmospheres to $10^{-5}$ Torr.

# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1972

## HIGH-EFFICIENCY TWT AMPLIFIER FOR EARTH RESOURCES AND TECHNOLOGY SATELLITE WJ-1176



WJ-1176 is a traveling-wave tube amplifier developed to meet the advanced telemetry and communications requirements of the Earth Resources and Technology Satellite (ERTS) program. It is lightweight, yet rugged enough to survive the severe environmental conditions encountered during launch and orbital insertion.

Two RF output power levels (9 watts and 18 watts) are offered by this dual-mode amplifier. Remote selection of the desired output level may be accomplished at any time during the mission. An RF isolator and forward/reverse power monitor with extremely low insertion loss are an integral part of the amplifier.

WJ-1176 has an expected MTBF of 39,000 hours, making it ideal for other satellite and deep space probe applications with extended life requirements. Mechanically, the amplifier housing (a Nimbus module) can be replaced by an even lighter housing for ultimate weight savings. The amplifier is designed to accept the WJ-274 series of high-efficiency traveling-wave tubes.

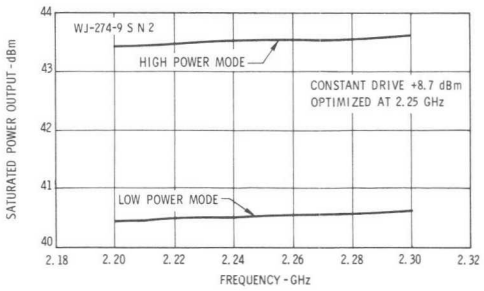
# WJ-1176

## SPECIFICATIONS

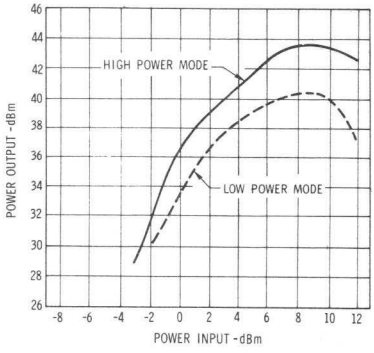
| PERFORMANCE CAPABILITIES | Low Power Mode | High Power Mode |
|---|---|---|
| Frequency | 2.2-2.4 GHz | 2.2-2.4 GHz |
| Saturated Power Output[1] | 10 watts | 20 watts |
| Efficiency | | |
| Overall amplifier (RF losses in isolator and cables at 0.4 dB) | 24% | 32% |
| Traveling-wave tube | 32% | 41% |
| Power supply | 81% | 84% |
| Saturated Gain | 27 dB min. | 30 dB min. |
| Output VSWR, Cold | 1.25:1 | 1.25:1 |
| **ELECTRICAL CHARACTERISTICS** | | |
| Primary Voltage[2] | −24.5 ±0.5 V | −24.5 ±0.5V |
| Primary Power | 42.5 watts max | 63.5 watts max. |
| Telemetry Outputs | | |
| Helix current, cathode current, collector temperature, and forward and reflected RF power | 0 to −6.4 Volts | |
| Heater, high voltage and power mode status | 0 or −7.5 Volts | |
| **ENVIRONMENTAL CHARACTERISTICS** | | |
| Heat Sink Temperature | −5°C to +45°C | |
| Vibration | | |
| a. Sinusoidal (1 min/octave) | 0.5 inch double amplitude, 5 to 2000cps 10g, 0 to peak | |
| b. Random (5 min/axis) | 20 to 2000cps @ .2g²/cps (20g RMS) | |
| Acceleration (5 min/axis) | 30g | |
| **MECHANICAL CHARACTERISTICS** | | |
| Baseplate Dimensions | 6 x 13 inches (15.2 x 33 cm) | |
| Height | 4 inches (10.2 cm) | |
| Weight | 10.5 pounds (4.76 kg) | |
| Connector Types | | |
| RF input | 3 mm female | |
| RF output | N type female | |
| Power | Cannon golden D | |
| Command | Cannon golden D | |
| Telemetry (analog) | Bendix FJT | |
| Telemetry (digital) | Bendix FJT | |

NOTES:

1. Power output is specified into 1:1 load. Output VSWR is included in table to allow calculation in other than 1:1 loads.
2. Input voltage ripple <250 millivolts peak-to-peak.

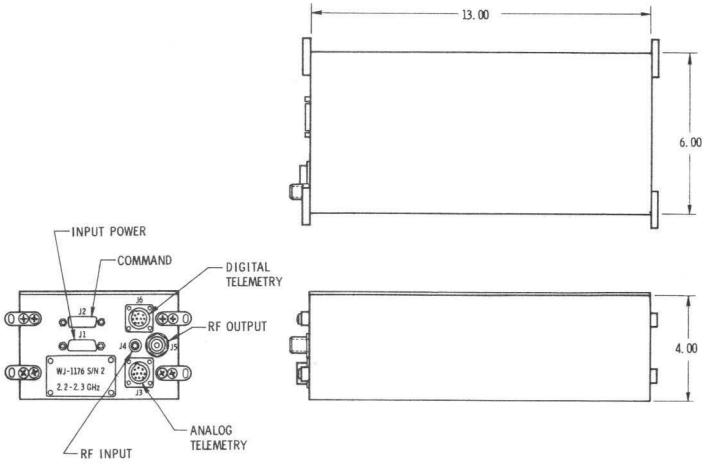



**Power Output versus Frequency with constant RF Drive**



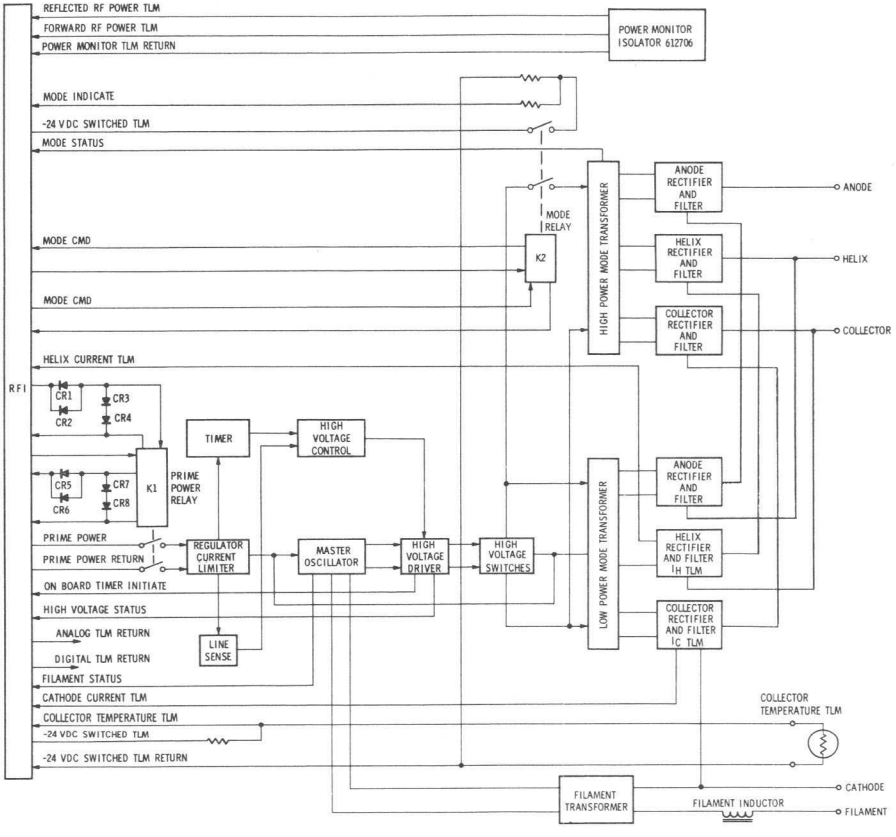

**Dual Mode Operation at 2.28 GHz**

## OUTLINE DRAWING



# WJ-1176

## SCHEMATIC DIAGRAM



# TECHNICAL DATA

WATKINS-JOHNSON

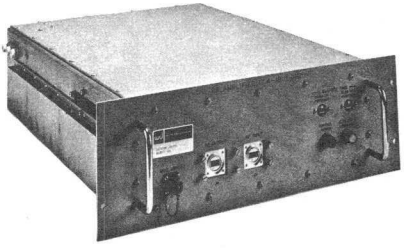
FEBRUARY 1971

## MICROWAVE RF AMPLIFIER WITH SERRODYNE CAPABILITY

## WJ-1179

Watkins-Johnson has developed a traveling-wave tube amplifier for applications such as Doppler return simulation and voltage-controlled phase or frequency shifting. Incorporating integral power, monitoring, control and modulation circuitry, this amplifier features the capability for serrodyne operation. A number of W-J power tubes may be adapted for use in the serrodyne system, giving users a wide choice of frequency band and RF power output.

Serrodyne operation denotes the ability of traveling-wave devices to shift the frequency of an input signal (in addition to amplification) by use of the phase shift versus circuit (helix to cathode) voltage inherent in such devices. Briefly, the operation is as follows: a modulating sawtooth voltage of proper amplitude is applied to the helix of the TWT. Depending on the polarity of the voltage, the output frequency of the TWT is shifted up or down, with respect to the input carrier, by an amount equal to the frequency of the sawtooth.



Provision has been made within this amplifier for logic input or switch-controlled optimization of the amplitude and dc level of the sawtooth voltage in order to allow operation over a wide RF range with fixed amplitude sawtooth voltage drive. A number of options are available which allow logic level or switch programming of other amplifier features up to and including a fully remote programming capability.

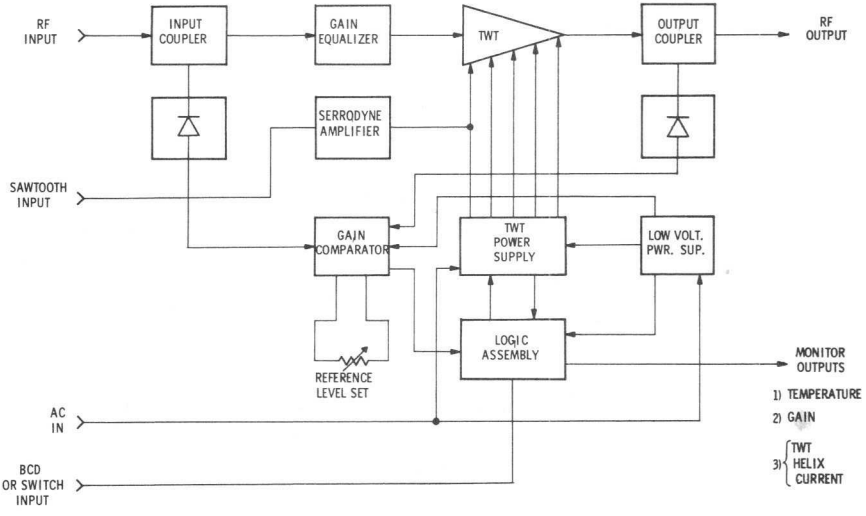
### SPECIFICATIONS

| | |
|---|---|
| **PERFORMANCE** | |
| Frequency | [1]12.4 to 18 GHz |
| Power Output, CW | 2 Watts |
| Small Signal Gain | 35 dB |
| Gain Flatness (full band) | ±2.5 dB |
| Doppler Frequency Shift | 10 Hz to 25 kHz |
| Voltage Controlled Phase Shift | $2\pi$ (360°) minimum |
| **ELECTRICAL REQUIREMENTS** | |
| Input Power | 200 v, 3-phase, 400 Hz (optional inputs available) |
| Modulating Sawtooth for Serrodyning | 5 volts, peak-to-peak |
| Phase Shift Control Voltage | 0 to 5 volts |
| **MECHANICAL CHARACTERISTICS** | |
| Height | 7 inches (178 mm) |
| Width | 19 inches (483 mm), rack mount |
| Length | 21 inches (533 mm) |
| Weight | 60 lbs. (27.2 kg) |
| Power and RF Connectors | As required |
| Cooling | Internal Forced Air |
| **ENVIRONMENTAL CHARACTERISTICS (Operating)** | |
| Temperature | 0 to 55°C |
| Altitude | to 10,000 ft. |
| Shock | 20 g, 11 ms |
| Vibration | MIL-STD 167 |
| RFI | MIL-I-6181 |
| **RELIABILITY** | MTBF greater than 3,000 hours per MIL HDBK 217A |

Notes: 1. TWTAs available in octave bands from 2 to 18 GHz.

# WJ-1179

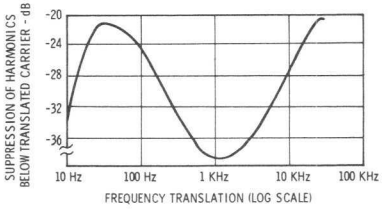
## SCHEMATIC DIAGRAM



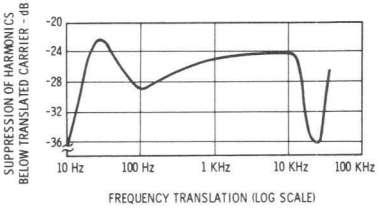

## SERRODYNE OPERATION

**A. Up-Translation**

SUPPRESSION OF SERRODYNE FREQUENCY HARMONICS IN OUTPUT SPECTRUM




**B. Down-Translation**

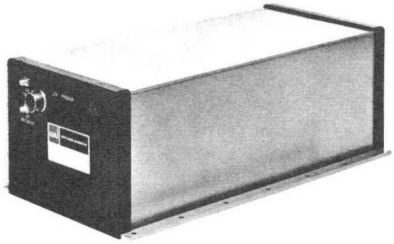


# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1972

## MICROWAVE TWT AMPLIFIERS
## WJ-1181 SERIES



- **CHOICE OF MANY TWTs**
- **LOW AM AND FM SPURIOUS**
- **NO ADJUSTMENT WHEN INTERCHANGING TWTs**
- **EASE OF MAINTENANCE**
- **115/230 VOLTS AT 47 TO 420 Hz**

The WJ-1181 series of TWT amplifiers provides a wide variety of power output, noise figure and gain specifications for octave bandwidth operation in the 1 to 18 GHz frequency range.

The key to this performance is a power supply whose output voltage is programmed by the TWT in use at any given time. An internal sensing network in the power supply is activated by a preset resistor value in the TWT to produce the precise operating voltages for that TWT. This unique feature permits TWT interchangeability without the usual integration adjustments and testing.

Each amplifier in the WJ-1181 series is powered by 115/230 volts at 47 to 420 Hz. Post helix and filament regulation provide extremely low helix supply ripple (typically less than 200 mV), making them attractive for any application where minimum AM or FM power-supply-induced modulation is desired. They are designed for shipboard or mobile use and meet all the requirements of MIL-E-16400. Optional operation to 70,000 feet is available for airborne equipment.

Where maintainability and spares stocking is a requirement, the WJ-1181 amplifiers offer plug-in printed circuit cards for simplified, low-cost logistics control. In addition, field replacements are quick and uncomplicated with the automatic, programmable mating of TWT and power supply.

These amplifiers can be modified to operate with any Watkins-Johnson TWT requiring 100 watts or less of dc power. Other available options include isolators, filters and equalizers internal to the package outline.

# WJ-1181 SERIES

## SPECIFICATIONS

| Amplifier Type | TWT Type | Frequency (GHz) | Saturated Power Output (Watts) | Small Signal Gain (dB) | Noise Figure (dB) |
|---|---|---|---|---|---|
| WJ-1181-1 | WJ-3500 | 1.0- 2.0 | 1 | 30 | 30 |
| WJ-1181-2 | WJ-3501 | 2.0- 4.0 | 1 | 30 | 30 |
| WJ-1181-3 | WJ-3800 | 2.0- 4.0 | 4 | 38 | 20 |
| WJ-1181-4 | WJ-3502 | 4.0- 8.0 | 1 | 30 | 30 |
| WJ-1181-5 | WJ-3802 | 4.0- 8.0 | 4 | 40 | 22 |
| WJ-1181-6 | WJ-3802-1 | 4.0- 8.0 | 15 | 46 | 22 |
| WJ-1181-7 | WJ-3503 | 7.0-12.4 | 1 | 30 | 30 |
| WJ-1181-8 | WJ-3804 | 7.0-11.0 | 3 | 43 | 22 |
| WJ-1181-9 | WJ-3805 | 8.0-12.4 | 3 | 42 | 22 |
| WJ-1181-10 | WJ-3805-1 | 8.0-12.4 | 5 | 60 | 22 |
| WJ-1181-11 | WJ-3806 | 8.0-16.0 | 3 | 38 | 24 |
| WJ-1181-12 | WJ-3504 | 12.0-18.0 | 1 | 30 | 30 |
| WJ-1181-13 | WJ-3807 | 12.0-18.0 | 2 | 38 | 25 |
| WJ-1181-14 | WJ-3515 | 2.6- 5.2 | 2 | 40 | 30 |
| WJ-1181-15 | WJ-3516 | 5.2-10.4 | 2 | 40 | 30 |

### ELECTRICAL REQUIREMENTS

Input Voltage ..... 115/230 Vac ±10%, single-phase 47 to 420 Hz
Power Consumption ..... 150 VA typical, 200 VA max.

### MECHANICAL CHARACTERISTICS

Size ..... 5.25 x 8 x 14.5 inches (133 x 203 x 368 mm)
Weight ..... 16 pounds (7.26 kg)
Cooling ..... Conduction through Mounting Surface
RF Input and Output Connectors ..... 3 mm SMA Female
Input Power and Monitoring Connector ..... Bendix SP-07CP-12-10P (Mating Connector Provided)

### ENVIRONMENTAL CAPABILITY

Temperature ..... −30°C to +70°C operating,
−65°C to +125°C non-operating
Vibration ..... 0.15 inch, Double Amplitude,
30 to 70 Hz, 20 grms, 70 to 500 Hz
Altitude ..... 10,000 feet
Note: Extended environmental characteristics available.

### MONITORS AND FAULT PROTECTION

WJ-1181 amplifiers provide analogs of TWT helix current and voltage for use with an external 200 μA meter. The TWT in a WJ-1181 is protected against helix over-current and high base plate temperature. If either event should occur, high voltage is removed with status monitoring provided by N.O. and N.C. relay contacts.

### MAINTAINABILITY

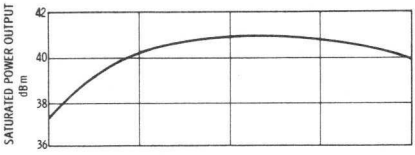
WJ-1181 amplifiers are field-maintainable to the defective PC card. Fault isolation can be done with a multimeter and repair with a screwdriver. Since no voltage adjustment is required for integration with other W-J MEPOLON TWTs having similar voltage ranges, spares stocking and repairs are simplified. The appropriate W-J Applications Engineer should be consulted for specific interchangeability options.

# WJ-1181 SERIES

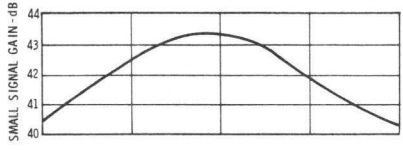
## RF ELECTRICAL PERFORMANCE CHARACTERISTICS FOR SELECTED AMPLIFIERS

### WJ-1181-5 (WJ-3802 TWT)

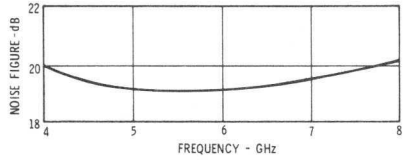
**POWER**




**GAIN**

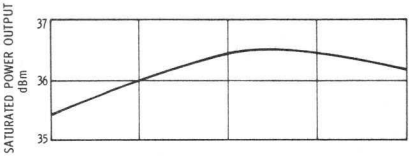



**NOISE**

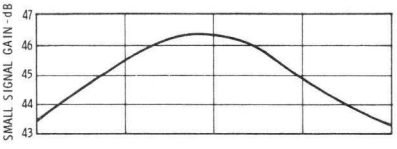



### WJ-1181-8 (WJ-3804 TWT)

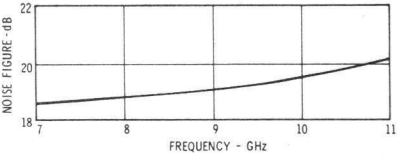
**POWER**




**GAIN**




**NOISE**

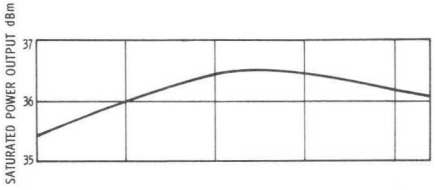


# WJ-1181 SERIES

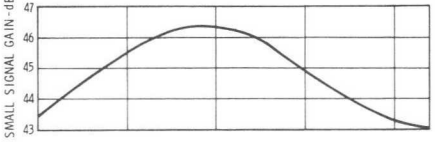
## RF ELECTRICAL PERFORMANCE CHARACTERISTICS FOR SELECTED AMPLIFIERS

WJ-1181-9 (WJ-3805 TWT):

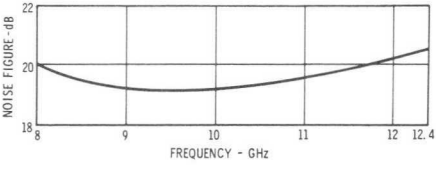
### POWER




### GAIN

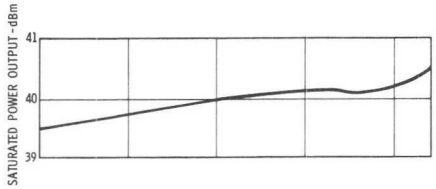



### NOISE

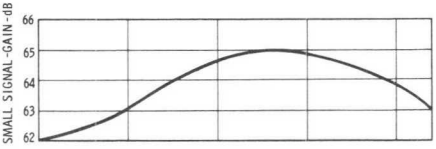



WJ-1181-10 (WJ-3805-1 TWT):

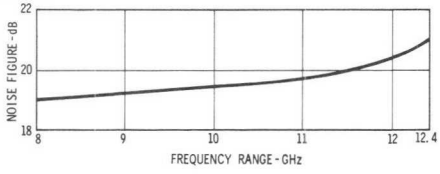
### POWER




### GAIN

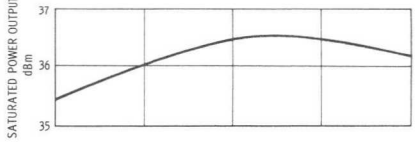



### NOISE

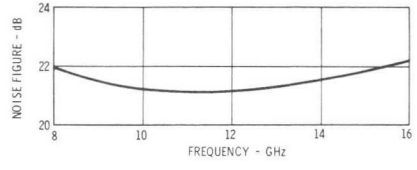



WJ-1181-11 (WJ-3806 TWT):

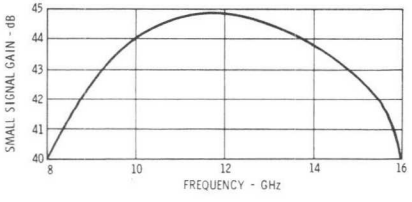
### POWER




### NOISE

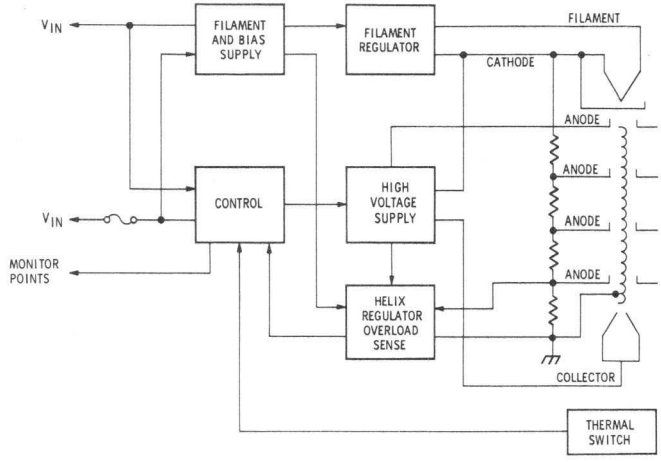



### GAIN

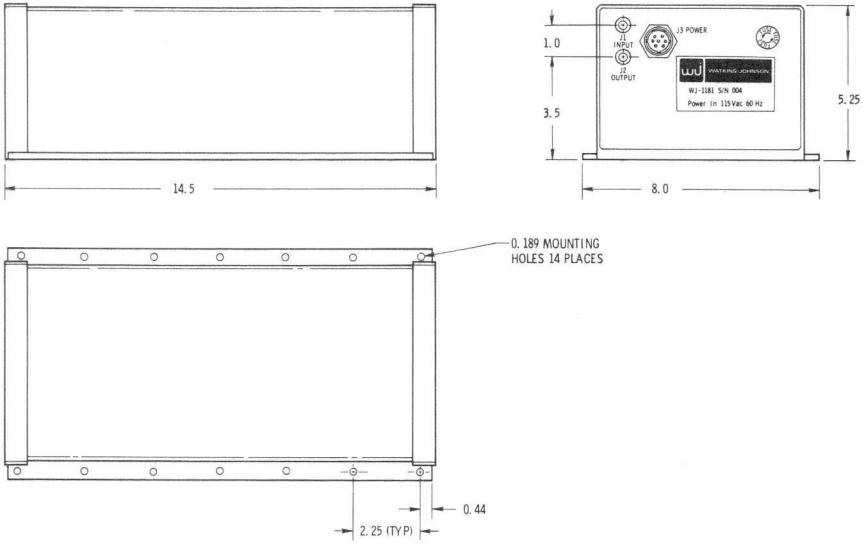


# WJ-1181 SERIES

## SCHEMATIC DIAGRAM



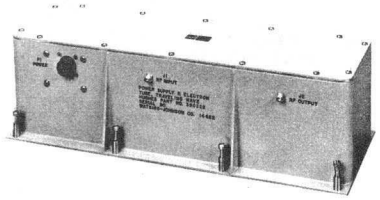

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

## MULTI-BAND RF AMPLIFIER
## WJ-1184



- COVERS 2 TO 12 GHz IN THREE BANDS
- SEPARATE AMPLIFIER AND INTEGRAL POWER SUPPLY FOR EACH BAND
- SMALL SIGNAL GAIN 15 TO 25 dB MINIMUM
- JUST PLUG IT IN

The WJ-1184 is a multi-band, medium power amplifier comprised of one solid state amplifier and two PPM-focused TWTs, each with an integral power supply. All bands may be utilized simultaneously.

The unit is completely self-contained and adjustment-free, requiring only an AC line voltage for operation. In addition, it may be mounted in any orientation with no degradation of performance.

### SPECIFICATIONS

| PERFORMANCE | Band 1 | Band 2 | Band 3 |
|---|---|---|---|
| Frequency Range | 2 to 4 GHz | 4 to 8 GHz | 8 to 12 GHz |
| Saturated Power Output, Min. | +13 dBm | +20 dBm | +20 dBm |
| Small Signal Gain | 20 ±5 dB | 30 ±5 dB | 30 ±5 dB |
| Total Gain Variation, Max. | 10 dB | 10 dB | 10 dB |
| Noise Figure, Max. | 20 dB | 30 dB | 30 dB |
| Distortion Level (First-order products, second and third harmonic from fundamental at output power, Min.) | 20 dB down | 17-20 dB down | 20 dB down |

| ELECTRICAL REQUIREMENTS | |
|---|---|
| Primary Voltage | 115 ±10 Vac, single or three phase |
| Primary Frequency | 380 to 420 Hz |
| Primary Power, Max. | 100 VA |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Height, Max. | 5 inches (127 mm) |
| Width (excluding connectors), Max. | 6.5 inches (165 mm) |
| Length, Max. | 16 inches (406 mm) |
| Weight, Max. | 30 pounds (13.6 kg) |
| Primary Power and Fault Indicator Connector | MS3124E-10-6P |
| RF Connectors | Type SMA Female |
| Cooling | Conduction through baseplate and convection through fins on rear |

# WJ-1184

## OUTLINE DRAWING

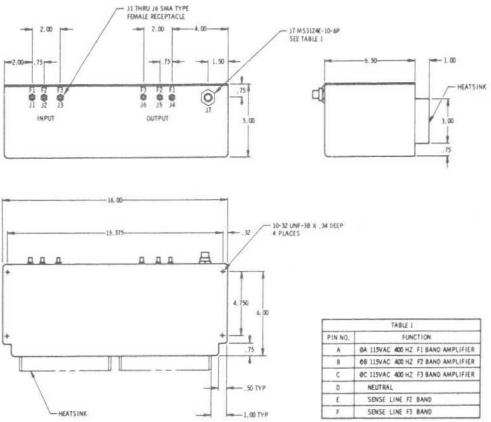
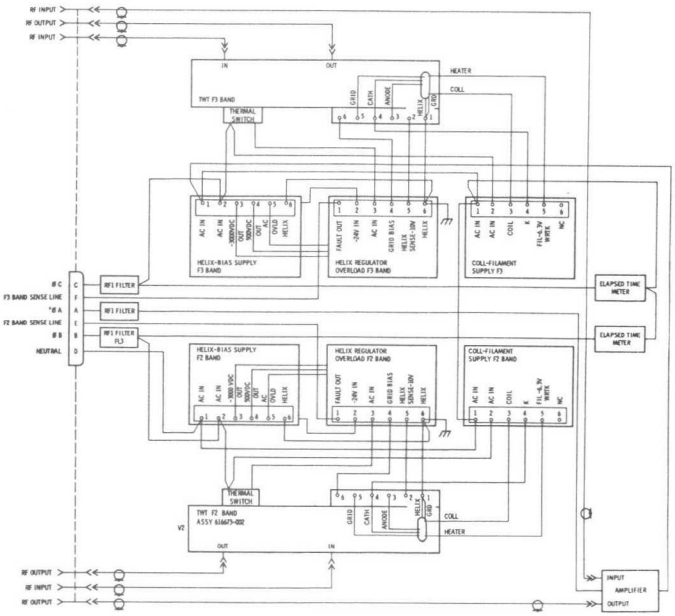



TABLE I

| PIN NO. | FUNCTION |
|---|---|
| A | ØA 115VAC 400 HZ F1 BAND AMPLIFIER |
| B | ØB 115VAC 400 HZ F2 BAND AMPLIFIER |
| C | ØC 115VAC 400 HZ F3 BAND AMPLIFIER |
| D | NEUTRAL |
| E | SENSE LINE F2 BAND |
| F | SENSE LINE F3 BAND |

## BLOCK DIAGRAM

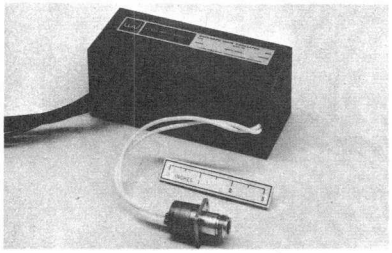


# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-2001

TECHNICAL DATA • March 1966



The type WJ-2001 BWO is a bifilar (dual-helix), voltage-tunable oscillator. This permanent-magnet-focused wide-band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The WJ-2001 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 7.0-12.4 | |
| Power Output (Load VSWR = 1.25) | mW | 35-175 | 25 Min |
| Power Output Variation | dB | | 10 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency pulling into 2:1 Load | MHz | 1.5 | 3 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Ratio of Signal to Second Harmonic Output | dB | 30 | 25 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low-End (7.0 GHz) | MHz/V | 9.2 | |
| Mid-Frequency (9.7 GHz) | MHz/V | 4.1 | |
| High-End (12.4 GHz) | MHz/V | 2.7 | |
| Grid RF Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode & Grid to all other Electrodes and Case | pF | 40 | 50 Max |
| Capacitance; Grid to all other Electrodes and Case | pF | 20 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Case | pF | 150 | 175 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 330-1495 | 300-1600 Min/Max |
| Helix Current | mA | 1.5 | 3 Max |
| Anode Voltage | V | 160 | 215 Max |
| Anode Current | mA | 0.5 | 2 Max |

## MECHANICAL DATA

Weight, 3.0 lbs Max
Color Code for 18" Flying Leads

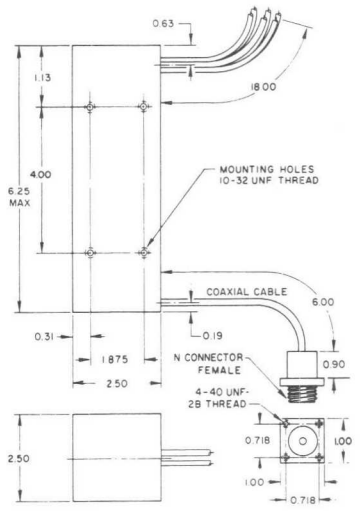
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

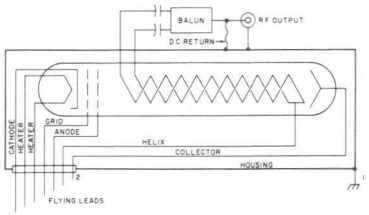
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING



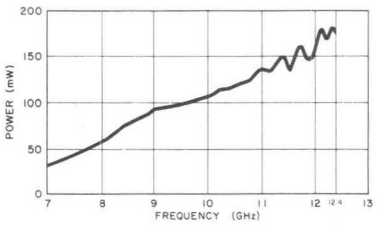

## SCHEMATIC DIAGRAM



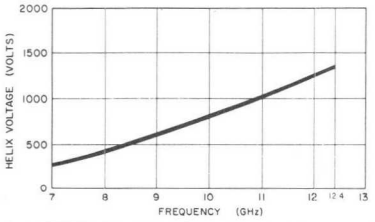

[1] For safety, housing should be grounded through mounting screws.

[2] 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

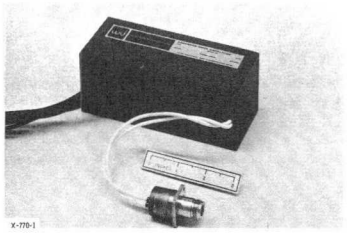
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2001-1

September 1965

The type WJ-2001-1 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet-focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability. Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment. The WJ-2001-1 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the r.f. output terminal. The tube housing and output connector can be grounded regardless of power supply configuration


X-770-1

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 8-12.4 | |
| Power Output (Load VSWR = 1.25) | mW | 60-175 | 50 Min |
| Power Output Variation | db | | 6 Max |
| Fine grain Variation | db/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency pulling into 2:1 Load | | 1.5 | 3 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | db/MHz | 95 | 85 Min |
| Ratio of Signal to Second Harmonic Output | db | 30 | 25 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 7.2 | |
| Mid-Frequency (10.2 GHz) | MHz/V | 4.6 | |
| High End (12.4 GHz) | MHz/V | 2.7 | |
| Grid r.f. Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode & Grid to all other Electrodes and Case | pf | 40 | 50 Max |
| Capacitance; Grid to all other Electrodes and Case | pf | 20 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Case | pf | 150 | 175 Max |
| Heater Voltage | V | | 6.3 ± 5% |
| Heater Current | A | 0.9 | 0.6-1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 450-1495 | 427-1600 Min/Max |
| Helix Current | mA | 1.5 | 3 Max |
| Anode Voltage | V | 160 | 215 Max |
| Anode Current | mA | 0.5 | 2 Max |

## MECHANICAL DATA

Weight, 3.0 lbs Max
Color Code for 18" Flying Leads

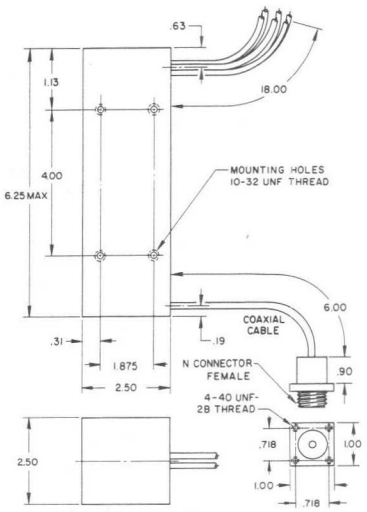
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

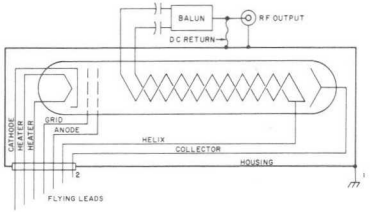
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



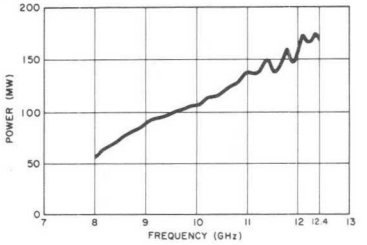

## SCHEMATIC DIAGRAM



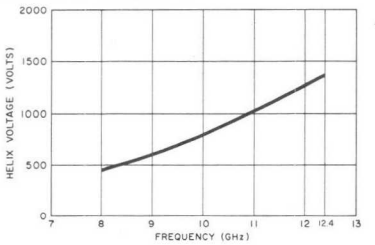

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

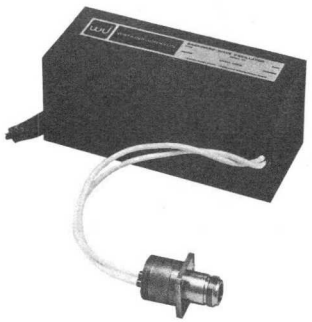
*JULY 1971

## BACKWARD-WAVE OSCILLATOR
## WJ-2001-50

The WJ-2001-50 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment.

The WJ-2001-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 8–12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60–175 | 50 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 7.2 | |
| Mid-Frequency (10.2 GHz) | MHz/V | 4.6 | |
| High End (12.4 GHz) | MHz/V | 2.7 | |
| Grid RF Cutoff Voltage | V | −7 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Housing | pF | 40 | 50 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 20 | 25 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 150 | 175 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.9 | 0.4–1.2 |
| | | | Min./Max. |
| Cathode Current[1] | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 450–1495 | 427–1600 |
| | | | Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 160 | 215 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

[1]Set cathode current to Final Test Data value furnished with tube.

*Supersedes WJ-2001-50 Technical Data Sheet dated December 1970.

# WJ-2001-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 6.25 inches (159 mm) max.
Weight, 6 lbs. (2.72 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

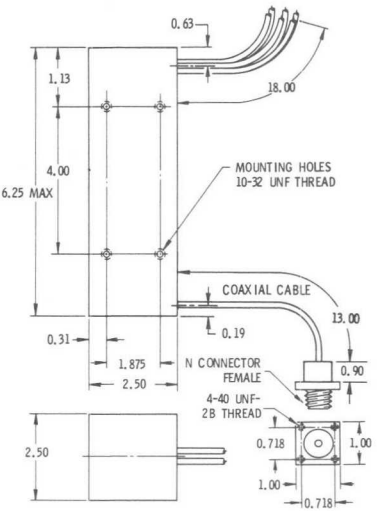
Mounting Position, Any

RF Output Connector, Type N Female on Balun

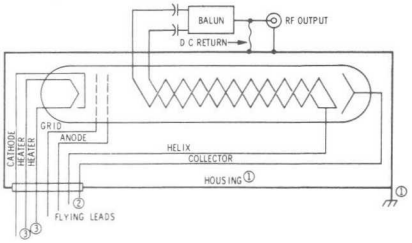
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

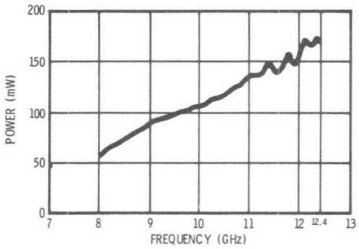
## OUTLINE DRAWING



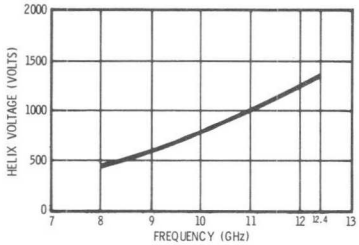

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

# TECHNICAL DATA

WATKINS-JOHNSON

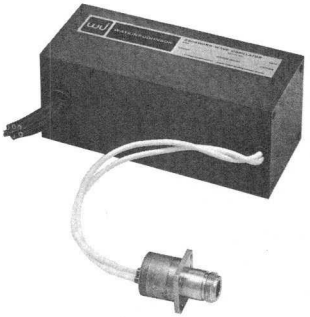
DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2001-51

The WJ-2001-51 BWO is a bifilar (dual-helix), voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include radar receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and ECM equipment.

The WJ-2001-51 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 7.0–12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 35–175 | 25 Min. |
| Power Output Variation | dB | | 10 Max. |
| Fine Grain Variation | dB / 250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (7.0 GHz) | MHz/V | 9.2 | |
| Mid-Frequency (9.7 GHz) | MHz/V | 4.8 | |
| High End (12.4 GHz) | MHz/V | 2.7 | |
| Grid RF Cutoff Voltage | V | –7 | –25 Max. |
| Capacitance; Cathode to all other Electrodes, including Housing | pF | 40 | 50 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 20 | 25 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 150 | 175 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 330–1495 | 300–1600 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 160 | 215 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2001-51

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 6.25 inches (159 mm) max.
Weight, 6 lbs. (2.72 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

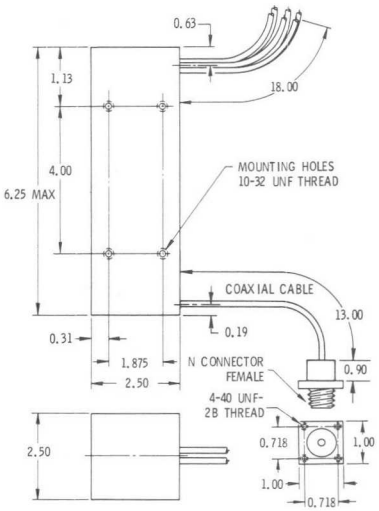
Mounting Position, Any

RF Output Connector, Type N Female on Balun

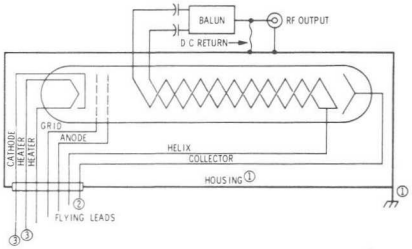
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



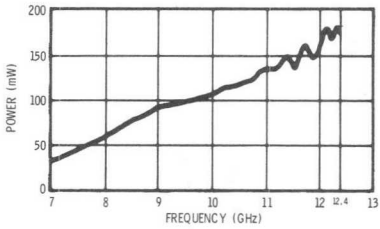

**Notes:**

(1) For safety, housing should be grounded through mounting screws.

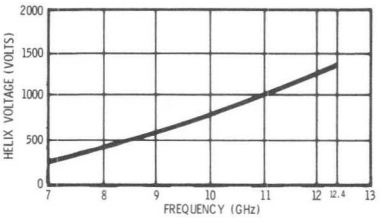
(2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

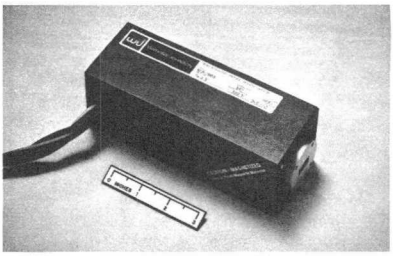
WATKINS-JOHNSON

# WJ-2003

## BACKWARD-WAVE OSCILLATOR

December 1966

The type WJ-2003 is a single-helix voltage tunable oscillator utilizing a permanent-magnet focusing system. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, as master oscillators in frequency diversity transmitters, and in electronic test sets. The WJ-2003 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easier packaging.



## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 12.4-18 | |
| Power Output into Load VSWR=1.25 | mW | 45-90 | 40 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 3:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 2 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.5 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 8.5 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 5.0 | |
| High End (18.0 GHz) | MHz/V | 2.3 | |
| Grid r.f. Cutoff Voltage | V | -8 | -20 Max |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pf | 30 | 40 Max |
| Capacitance; Grid to all other Electrodes including Housing | pf | 30 | 40 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pf | 125 * | 165 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | .75 | .4-1.2 Min/Max |
| Cathode Current | mA | 7 | 12 Max |
| Helix Voltage Range | V | 560-1925 | 530-2020 Min/Max |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 100 | 215 Max |
| Anode Current | mA | .1 | 2 Max |

## MECHANICAL DATA

Weight, 6.0 lbs Max
Color Code for 18" Flying Leads

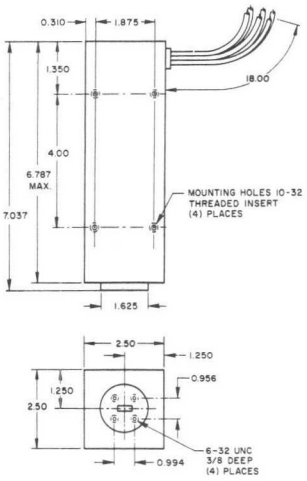
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Modified Type UG-419/U Waveguide Adapter

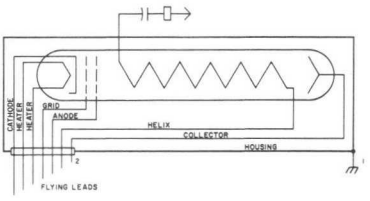
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



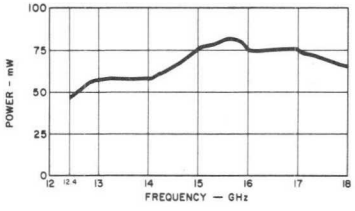

## SCHEMATIC DIAGRAM



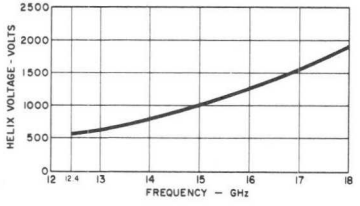

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2003-50

The WJ-2003-50 BWO is a single-helix, voltage tunable oscillator. This permanent-magnet focused wide band oscillator is well suited for use as a swept signal source in signal generators, particularly in view of its high stability.

Other applications include ECM receivers (as local oscillator), frequency diversity transmitters (as master oscillator), and other electronic equipment.

The WJ-2003-50 features smooth power over the band, low cathode current, and two control electrodes. The control grid makes possible power cutoff with low negative grid voltage. Power output can be modulated with either the grid or anode, or both. Cathode modulation with the grid grounded usually reduces FM caused by AM. Packaging problems are simplified, since all voltages are isolated from both tube housing and the RF output terminal. The tube housing and output connector can be grounded regardless of power supply configuration.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 12.4–18 |
| Power Output into Load with VSWR = 1.25:1 | mW | 45–90 | 40 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 3.1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1 | 2 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 8.5 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 5.0 | |
| High End (18.0 GHz) | MHz/V | 2.3 | |
| Grid RF Cutoff Voltage | V | −8 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 30 | 40 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 30 | 40 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 125 | 165 Max. |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | .75 | .4–1.2 Min./Max. |
| Cathode Current* | mA | 7 | 12 Max. |
| Helix Voltage Range | V | 560–1925 | 530–2020 Min./Max. |
| Helix Current | mA | 2 | 3 Max. |
| Anode Voltage | V | 100 | 215 Max. |
| Anode Current | mA | .1 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2003-50

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64 mm)
Length, 7 inches (178 mm) Max.
Weight, 6 lbs. (2.72 Kg) Max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

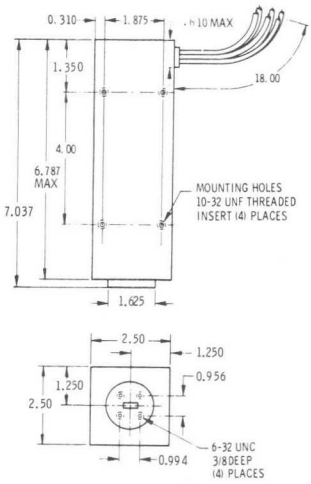
Mounting Position, Any

RF Output Connector, Modified
Type UG-419/U Waveguide Adapter

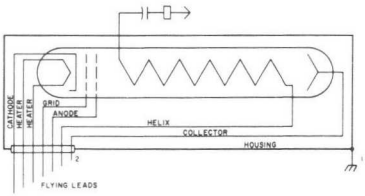
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING



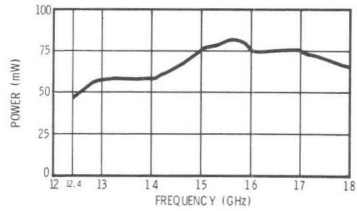

## SCHEMATIC DIAGRAM



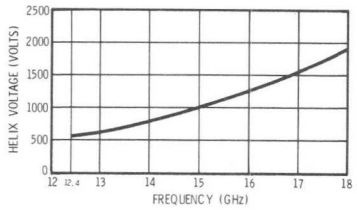

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2004

March 1966


The type WJ-2004 BWO is a magnetically shielded voltage tunable oscillator. Its miniature square package features rugged construction and capability to withstand the severe environmental conditions defined in MIL-E-5400, Class 2. Magnetic shielding reduces the external magnetic field strength to a level that allows normal operation of two BWO's side by side or directly on a steel plate. The tube's immunity to external ac or dc magnetic fields, together with minimal stray magnetic field makes the WJ-2004 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), and in frequency diversity transmitters in ECM equipment (as master oscillator). Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## ELECTRICAL CHARACTERISTICS, CW

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 9.5-13.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 12-30 | 10 Min |
| Power Output Variation | dB | | 5 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 3:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 4 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 25 | 15 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 1 | 2 Max |
| Sensitivity to Grid Voltage | MHz/V | 2 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (9.5 GHz) | MHz/V | 13 | |
| Mid-Frequency (11.0 GHz) | MHz/V | 9 | |
| High End (13.0 GHz) | MHz/V | 6 | |
| Grid RF Cutoff Voltage | V | -10 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater | pF | 20 | 25 |
| Capacitance; Grid to all other Electrodes, at Power Input Connector | pF | 20 | 25 |
| Capacitance; Helix and Collector to all other Electrodes and Case | pF | 100 | 120 |
| Heater Voltage | V dc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min/Max |
| Cathode Current | mA | 5 | 10 |
| Helix Voltage Range | V | 310/750 | 295/800 Min/Max |
| Anode Voltage * | V | 95 | 200 Max |
| Anode Current | mA | 0.3 | 2.0 Max |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 3.0 lbs Max
Color Code for 18" Flying Leads

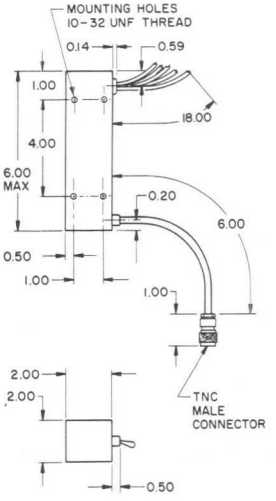
| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type TNC Male
Magnetically Shielded

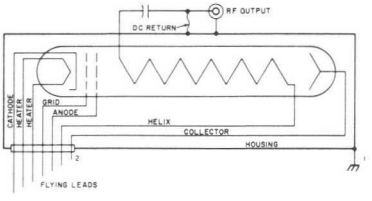
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 0 in. Min
Designed to Meet or Exceed MIL-E-5400, Class 2 Environment
No Forced Air Cooling Required

## OUTLINE DRAWING



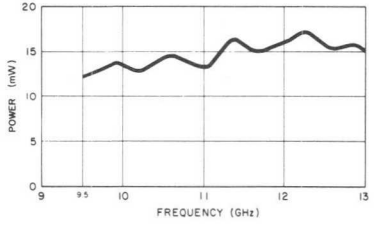

## SCHEMATIC DIAGRAM



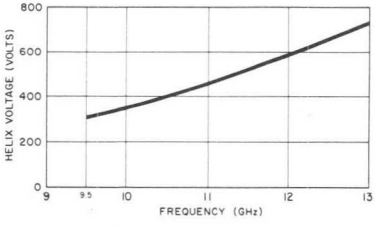

[1] For safety, housing should be grounded through mounting screws.

[2] 24-100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



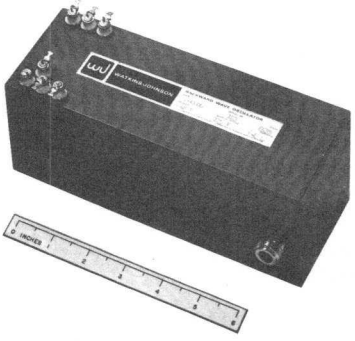
# TECHNICAL DATA

WATKINS-JOHNSON

JULY 1967

## BACKWARD-WAVE OSCILLATOR
## WJ-2006

The WJ-2006 is a shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 5 gauss ½ inch away from any point in the housing. RFI shielding and filtering allow the WJ-2006 to meet both MIL-I-26600, Class 1, and MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2006 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2006 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 8.0-12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60-175 | 50 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.6 | 1.5 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 7.2 | |
| Mid-frequency (10.0 GHz) | MHz/V | 4.6 | |
| High End (12.4 GHz) | MHz/V | 2.7 | |
| Grid RF Cutoff Voltage | V | —7 | —20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 36 | 50 |
| Capacitance; Grid to all other Electrodes including Housing | pF | 34 | 50 |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 160 | 185 |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 450-1495 | 425-1600 Min/Max |
| Helix Current | mA | 1.3 | 3 Max. |
| Anode Voltage* | V | 150 | 200 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

*Set anode voltage to Final Test Data value furnished with tube.

# WJ-2006

## MECHANICAL CHARACTERISTICS

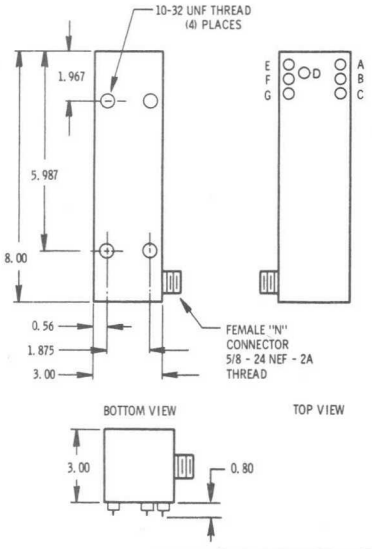
Height, 3 inches (76 mm)
Width, 3 inches (76 mm)
Length, 8 inches (203 mm)
Weight, 6.0 lbs. (2.72 Kg) Max.
DC Terminal Connections
- A — Anode
- B — Collector
- C — Helix
- D — Grid
- E — Cathode
- F — Heater
- G — Heater

Mounting Position, Any
RF Output Connector, Type N Female Magnetically Shielded

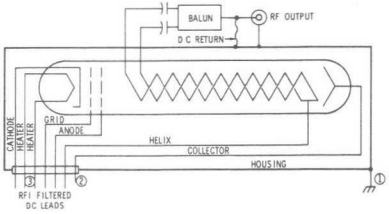
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required
RFI Shielded and Filtered to Meet MIL-D-26600 Line I or MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



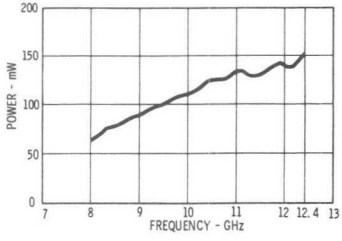

NOTES:

①For safety, housing should be grounded through mounting screws.

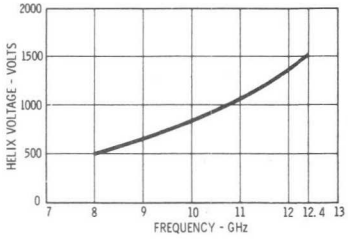
②24-100V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③Heater must never be positive with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-2007

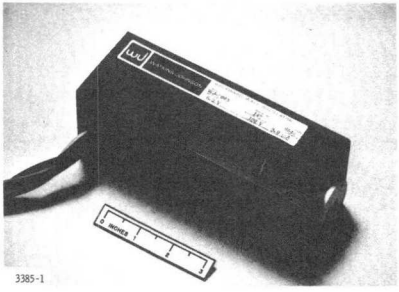
## BACKWARD-WAVE OSCILLATOR

November 1968

The WJ-2007 is a magnetically and RFI shielded voltage tunable oscillator utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Unsaturated magnetic shielding reduces the magnetic field strength at any point, 1/2 inch from the housing, to a value of less than 10 gauss. Interference requirements of MIL-STD-461 are met or exceeded by integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields, and extremely low RF radiation, makes the WJ-2007 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters, and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2007 delivers



3385-1

smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | | | 12.4 - 18.0 |
| Power Output Into Load With VSWR = 1.25 : 1 | mW | 50 - 110 | 40 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5 : 1 Max. |
| Frequency Pulling Into 2 : 1 Load (Any Phase) | MHz | 2.5 | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-Term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 5 | |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 7.2 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.2 | |
| High End (18.0 GHz) | MHz/V | 2.6 | |
| Grid RF Cutoff Voltage | V | -8 | -20 Max. |
| Capacitance; Cathode to All Other Electrodes, Including Heater and Housing | pF | 40 | 75 Max. |
| Capacitance; Grid to All Other Electrodes, Including Housing | pF | 40 | 75 Max. |
| Capacitance; Helix and Collector to All Other Electrodes and Housing | pF | 130 | 170 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4 Min.<br>1.2 Max. |
| Cathode Current | mA | 10 | 15 Max. |
| Helix Voltage Range | V | 560 - 1970 | 500 Min.<br>2100 Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage* | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 6.0 lbs. Max.
Color Code for 18" Flying Leads

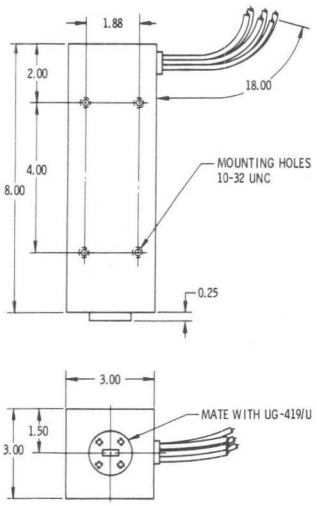
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Mate With UG 419/U Waveguide Flange
Magnetically Shielded

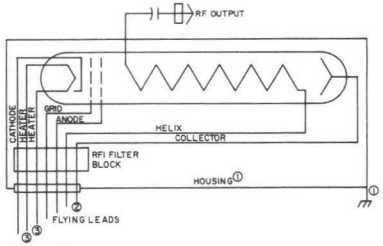
## ENVIRONMENTAL DATA

Separation From Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60° C Ambient
RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



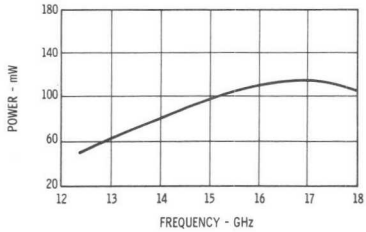

Notes:

① For safety, housing should be grounded through mounting screws.

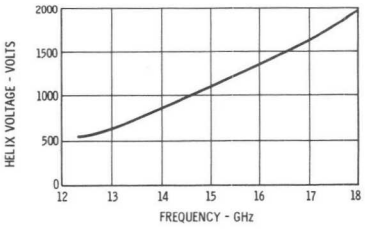
② 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



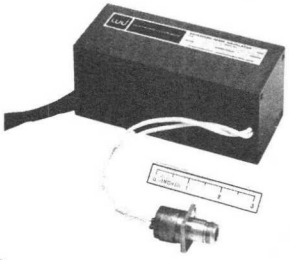
# TECHNICAL DATA

WATKINS-JOHNSON

JULY 1969*

## BACKWARD-WAVE OSCILLATOR WJ-2008

The WJ-2008 is a bifilar (dual) helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide band oscillator is well-suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers and master oscillators in frequency diversity transmitters and electronic test sets. Fine grain variation of frequency versus voltage is extremely low. The WJ-2008 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 8.0-12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 120-225 | 100 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7 | |
| Sensitivity to Anode Voltage | MHz/V | 1.5 | |
| Sensitivity to Grid Voltage | MHz/V | 6 | |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 5 | |
| Mid-Frequency (10.2 GHz) | MHz/V | 3 | |
| High End (12.4 GHz) | MHz/V | 2 | |
| Grid RF Cutoff Voltage | V | −15 | −20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 55 | 75 Max. |
| Capitance; Helix and Collector to all other Electrodes and Housing | pF | 220 | 250 Max. |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | 0.7 | 0.4 to 1.2 |
| Cathode Current[1] | mA | 10 | Min./Max. 14 Max. |
| Helix Voltage Range | V | 630-2075 | 600-2150 Min./Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |
| Helix Current | mA | 2 | 3 Max. |

[1]Set cathode current to Final Test Data value furnished with tube.

* Supersedes WJ-2008 Technical Data Sheet dated November 1967.

# WJ-2008

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64mm)
Length, 6.25 inches (159 mm) max.
Weight, 3 lbs. (1.36 Kg) Max.
Color Code for 18" Flying Leads

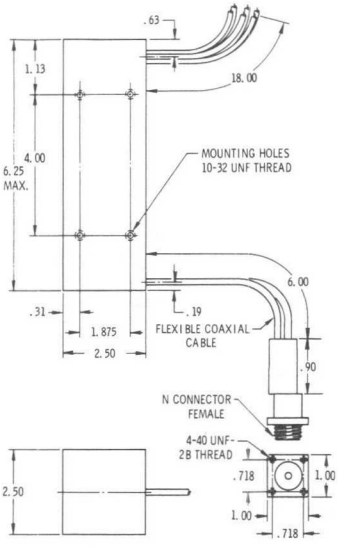
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female

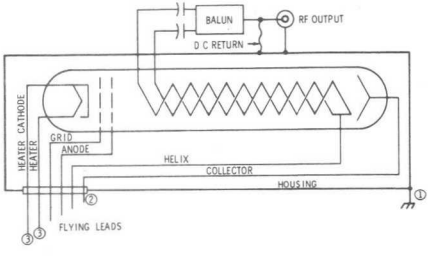
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



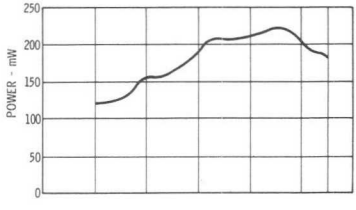

Notes:

(1) For safety, housing should be grounded through mounting screws.

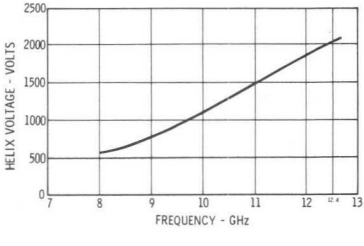
(2) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

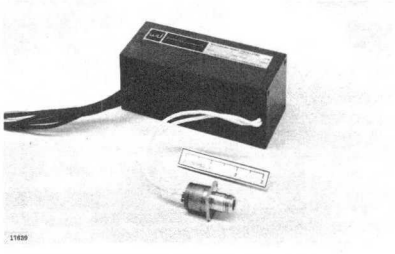
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2008-2

November 1967

The WJ 2008-2 is a bifilar (dual) helix, voltage tunable oscillator utilizing a permanent magnet focusing system. This wide band oscillator is well-suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers and master oscillators in frequency diversity transmitters and electronic test sets. Fine grain variation of frequency versus voltage is extremely low. The WJ 2008-2 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.



## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 8.0-12.4 | -- |
| Power Output into Load with VSWR = 1.25:1 | mW | 85-135 | 80 Min |
| Power Output Variation | dB | -- | 6 Max |
| Fine Grain Variation | dB/250 MHz | -- | 3 Max |
| Tube VSWR | -- | -- | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7 | -- |
| Sensitivity to Anode Voltage | MHz/V | 1.7 | -- |
| Sensitivity to Grid Voltage | MHz/V | 7 | -- |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 5.5 | -- |
| Mid-Frequency (10.2 GHz) | MHz/V | 3.5 | -- |
| High End (12.4 GHz) | MHz/V | 2 | -- |
| Grid r.f. Cutoff Voltage | V | -15 | -20 Max |
| Capacitance; Cathode to all other Electrodes incl. Heater and Housing | pF | 40 | 55 Max |
| Capacitance; Grid to all other Electrodes, incl. Housing | pF | 20 | 35 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 150 | 175 Max |
| Heater Voltage | Vdc | -- | 6.3 ±5% |
| Heater Current | A | 0.7 | 0.4 to 1.2 Min/Max |
| Cathode Current* | mA | 8 | 12 Max |
| Helix Voltage Range | V | 630-2075 | 600-2150 Min/Max |
| Anode Voltage | V | 120 | 215 Max |
| Anode Current | mA | 0.05 | 2 Max |
| Helix Current | mA | 1.2 | 3 Max |

*Set cathode current to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 3.0 lbs Max
Color Code for 18" Flying Leads

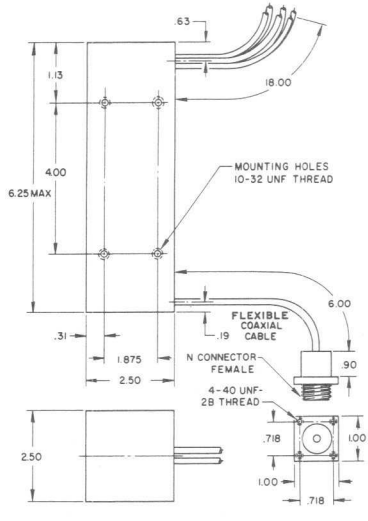
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female

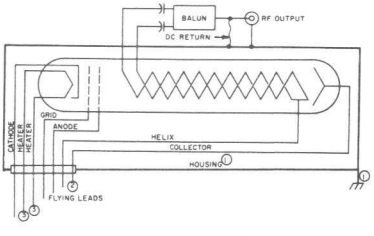
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, 2 in. Min
No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

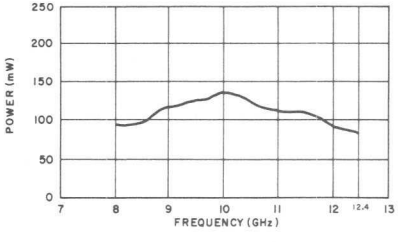



① For safety, housing should be grounded through mounting screws.

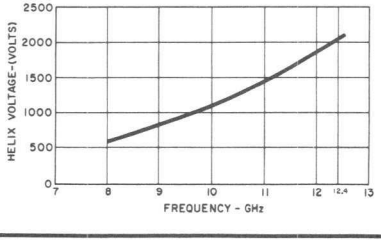
② 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



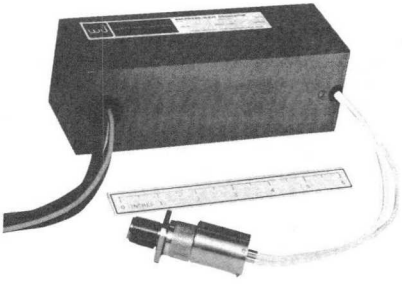
# TECHNICAL DATA

WATKINS-JOHNSON

AUGUST 1967

## BACKWARD-WAVE OSCILLATOR
## WJ-2014

The WJ-2014 is a 50 mW, 2.0 to 4.5 GHz voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent magnet focusing system. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, master oscillators in frequency diversity transmitters and electronic test sets. Fine grain variation of frequency versus voltage is extremely low. The WJ-2014 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the hounsing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 2.0-4.5 |
| Power Output into Load with VSWR = 1.25 | mW | 60-350 | 50 Min. |
| Power Output Variation | dB | | 9 Max. |
| Fine Grain Variation | dB/250 MHz | | 4 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 4 | 6 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage @ 3 GHz | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 6 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 4.5 | |
| Mid-Frequency (3.25 GHz) | MHz/V | 2.0 | |
| High End (4.5 GHz) | MHz/V | 0.8 | |
| Grid RF Cutoff Voltage | V | −8 | −20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 20 | 30 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 16 | 25 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 230 | 260 Max. |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current* | mA | 12.5 | 15 Max. |
| Helix Voltage | V | 290-1750 | 275-1800 Min/Max |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2014

## MECHANICAL CHARACTERISTICS

Height, 2.5 inches (64 mm)
Width, 2.5 inches (64mm)
Length, 7.75 inches (197 mm)
Weight, 6.5 lbs. (2.95 Kg) Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

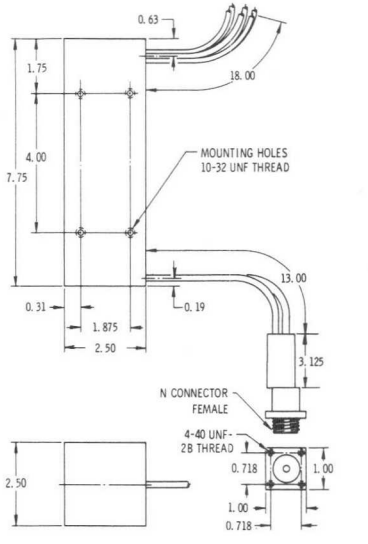
Mounting Position, Any
RF Output Connector, Type N, Female on Balun

## ENVIRONMENTAL CHARACTERISTICS

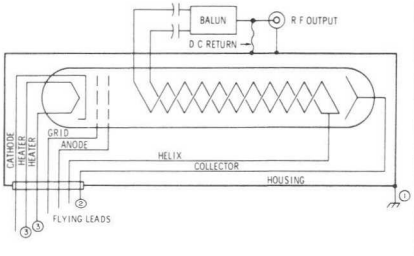
Separation from Passive Magnetic Materials 4 in. Min.

No Forced Air Cooling Required,
Below +60°C Ambient

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



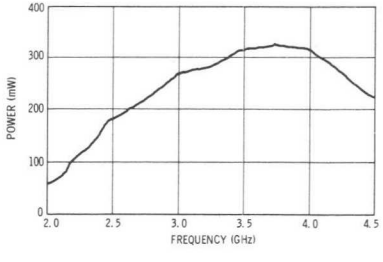

Notes:

①For safety, housing should be grounded through mounting screws.

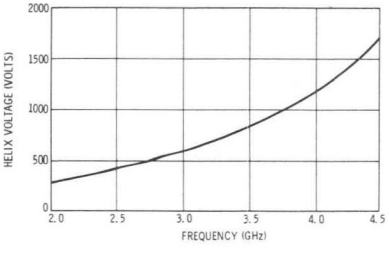
②50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



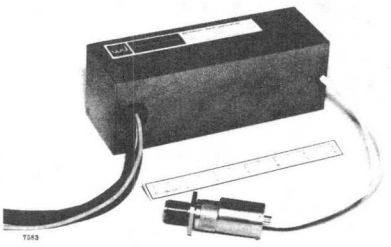
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2015

The type WJ-2015 BWO is a bifilar (dual helix) voltage-tunable oscillator utilizing a permanent-magnet focusing system. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, as master oscillators in frequency diversity transmitters and in electronic test sets. The WJ-2015 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for easier packaging.



## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4–8 | |
| Power Output into Load with VSWR = 1.25 | mW | 60–150 | 50 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | dB | 35 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 5.4 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.5 | |
| High End (8.0 GHz) | MHz/V | 1.9 | |
| Grid R F Cutoff Voltage | V | –7 | –20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 30 | 45 Max |
| Capacitance; Grid to all other Electrodes including Housing | pF | 30 | 45 Max |
| Capacitance; Helix to all other Electrodes | pF | 100 | 150 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.9 | 0.6–1.2 Min/Max |
| Cathode Current | mA | 8.5 | 15 Max |
| Helix Voltage | V | 345–2085 | 330–2150 Min/Max |
| Helix Current | mA | 1.5 | 3 Max |
| Anode Voltage | V | 135 | 215 Max |
| Anode Current | mA | 0.5 | 2 Max |

## MECHANICAL DATA

Weight, 6.0 lbs Max

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

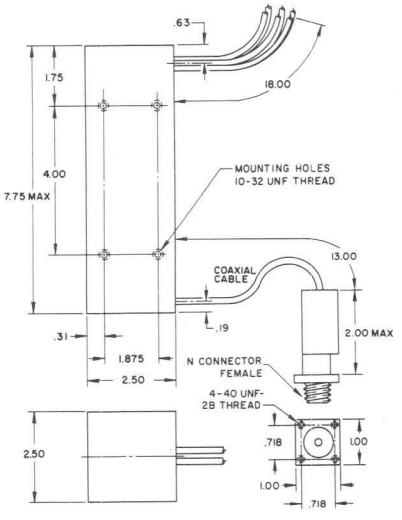
RF Output Connector, Type N Female on Balun

## ENVIRONMENTAL DATA

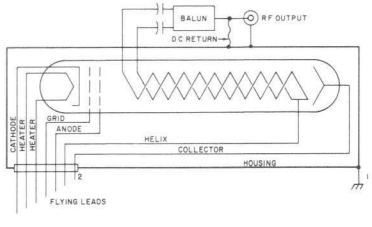
Separation from Passive Magnetic Materials, 4 in. Min

No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



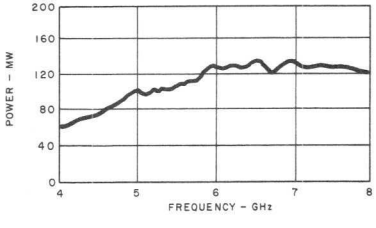

## SCHEMATIC DIAGRAM



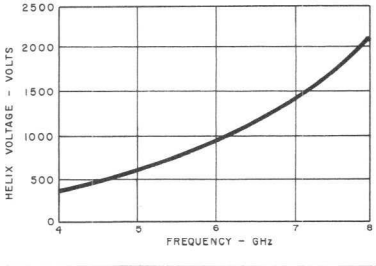

[1] For safety, housing should be grounded through mounting screws.

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



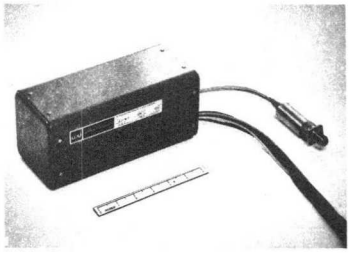
# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-2018

## BACKWARD-WAVE OSCILLATOR

June 1967



The WJ-2018 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2018 ideal for signal generating and sweeping equipment, for use in radar receivers (as local) oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2018 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2.0-4.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 90-360 | 70 Min |
| Power Output Variation | dB | | 8 Max |
| Fine Grain Variation | dB/100 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 4 | 8 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.4 | |
| Sensitivity to Grid Voltage | MHz/V | 2 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 3 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 1.7 | |
| High End (4.0 GHz) | MHz/V | 1 | |
| Grid RF Cutoff Voltage | V | -7 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 75 Max |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 75 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 245 | 275 Max |
| Heater Voltage | Vdc | 6.3 | 6.3±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 11 | 15 Max |
| Helix Voltage Range | V | 375-1735 | 308-2000 Min/Max |
| Helix Current | mA | 1.5 | 3 Max |
| Anode Voltage* | V | 150 | 215 Max |
| Anode Current | mA | 0.1 | 2 Max |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 9.7 lbs. Max.
Color Code for 18" Flying Leads

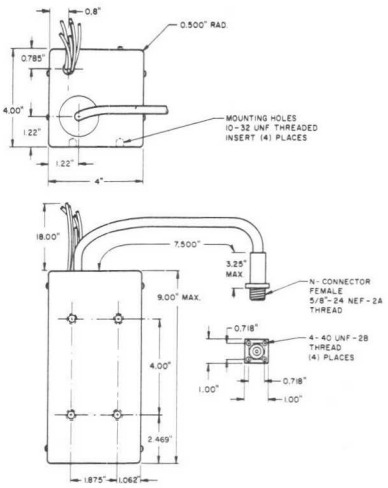
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

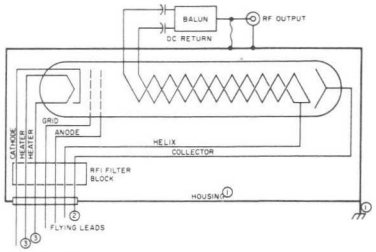
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below $+60^{\circ}$ C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



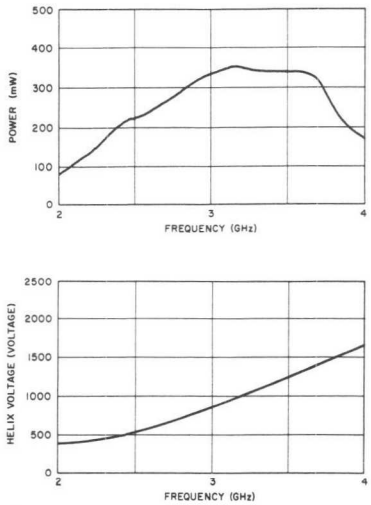

NOTES:

① For safety, housing should be grounded through mounting screws.

② 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must never be positive with respect to cathode.

## POWER OUTPUT



# TECHNICAL DATA

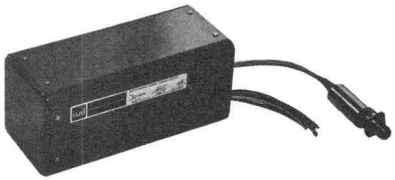
WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR WJ-2018-50

The WJ-2018-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2018-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low.

The WJ-2018-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 2.0–4.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 90–360 | 75 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB / 150 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 4 | 8 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.4 | |
| Sensitivity to Grid Voltage | MHz/V | 4 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 2.5 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 1.7 | |
| High End (4.0 GHz) | MHz/V | 1 | |
| Grid RF Cutoff Voltage | V | −7 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 245 | 275 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 11 | 15 Max. |
| Helix Voltage Range | V | 375–1735 | 308–2000 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2018-50

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 9 inches (229 mm) max.
Weight, 11.3 lbs. (5.13 Kg) max.

Color Code for 18" Flying Leads

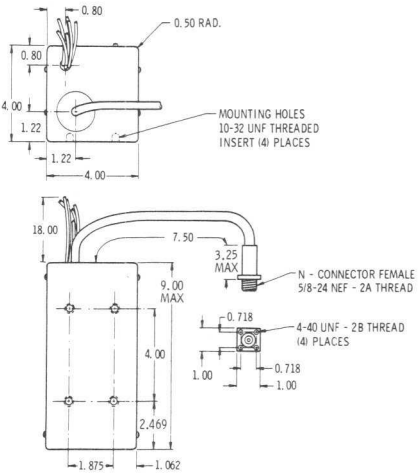
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

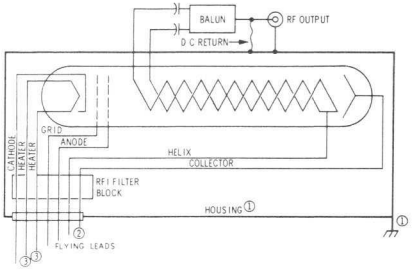
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded
Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



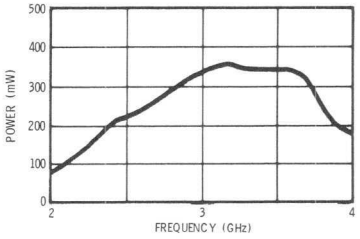

**Notes:**

(1) For safety, housing should be grounded through mounting screws.

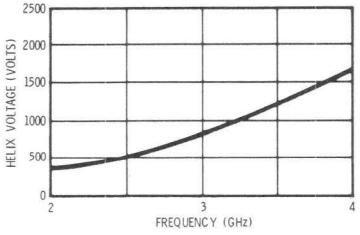
(2) 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

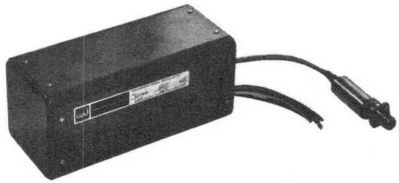
WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR WJ-2018-51

The WJ-2018-51 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2018-51 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.



The WJ-2018-51 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 1.7–4.2 |
| Power Output into Load with VSWR = 1.25:1 | mW | 90–360 | 30 Min. |
| Power Output Variation | dB | | 10 Max. |
| Fine Grain Variation | dB / 100 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 4 | 8 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.4 | |
| Sensitivity to Grid Voltage | MHz/V | 2 | |
| Tuning Curve Slope | | | |
| Low End (1.7 GHz) | MHz/V | 4.9 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 1.7 | |
| High End (4.2 GHz) | MHz/V | 0.7 | |
| Grid RF Cutoff Voltage | V | –7 | –25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 245 | 275 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 11 | 15 Max. |
| Helix Voltage Range | V | 270–1950 | 257–2200 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2018-51

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 9 inches (229 mm) max.
Weight, 11.3 lbs. (5.13 Kg) max.

Color Code for 18" Flying Leads

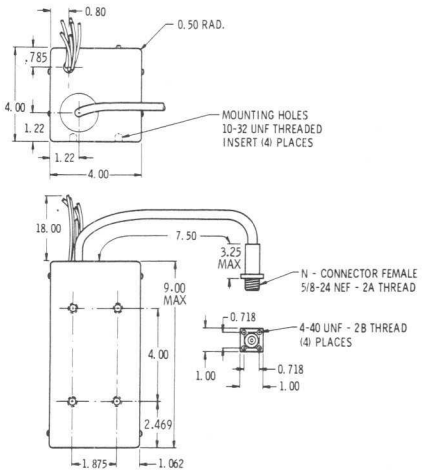
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

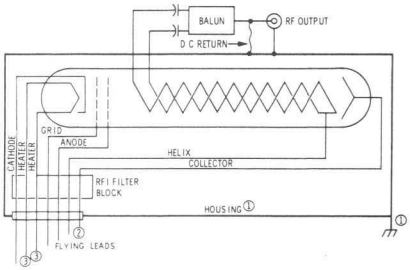
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded
Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING



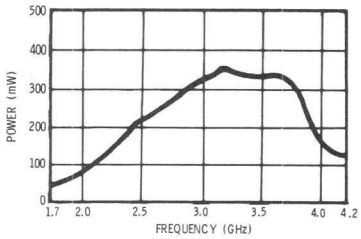

## SCHEMATIC DIAGRAM



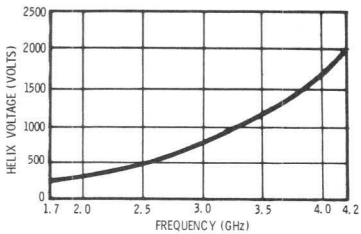

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

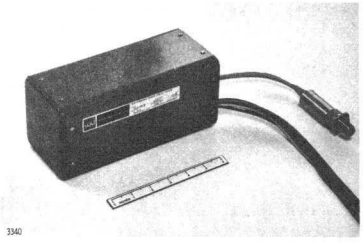
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2019

September 1968 *

The WJ-2019 is a shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 15 gauss 1-inch from any point of the housing. RFI shielding and filtering allow the WJ-2019 to meet MIL-I-6181D. An immunity to external ac or dc magnetic fields together with a minimal stray magnetic field and low RF radiation, makes the WJ-2019 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator) and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2019 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.


3340

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4.0-8.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 50-120 | 30 Min |
| Power Output Variation | dB | | 7 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1 | 3 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.9 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 6 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 3 | |
| High End (8.0 GHz) | MHz/V | 1.5 | |
| Grid RF Cutoff Voltage | V | -11 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 70 Max |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 70 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 210 | 250 Max |
| Heater Voltage | Vdc | 6.3 | 6.3± 5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current | mA | 9 | 13 Max |
| Helix Voltage Range | V | 302-1805 | 280-1900 Min/Max |
| Helix Current | mA | 1.2 | 3 Max |
| Anode Voltage [1] | V | 120 | 215 Max |
| Anode Current | mA | 0.1 | 2 Max |

[1] Set anode voltage to Final Test Data value furnished with tube.

* Supersedes WJ-2019 Technical Data Sheet Dated June 1967

## MECHANICAL DATA

Weight, 7.5 lbs. Max.
Color Code for 18" Flying Leads

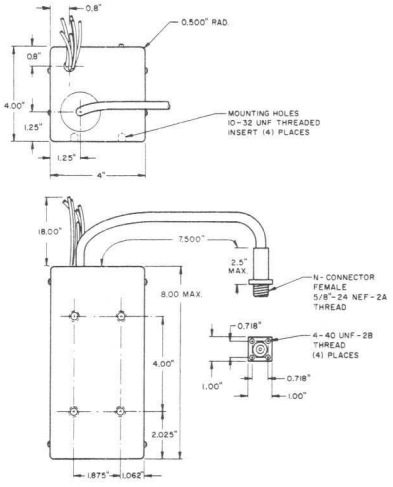
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

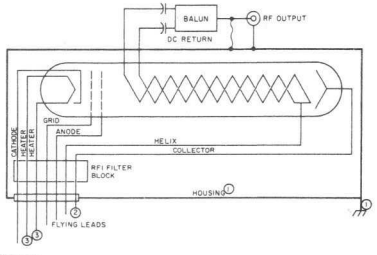
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below $+60^{\circ}$ C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



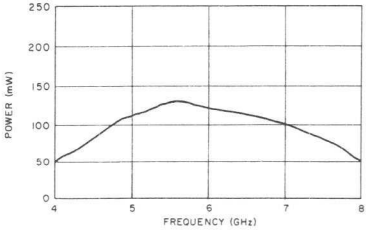

Notes:

(1) For safety, housing should be grounded through mounting screws.

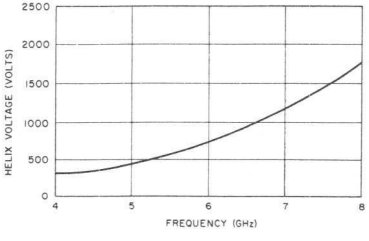
(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

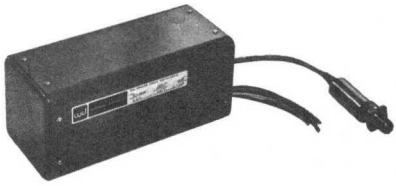
WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR WJ-2019-50

The WJ-2019-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2019-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.



The WJ-2019-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 4.0–8.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50–120 | 30 Min. |
| Power Output Variation | dB | | 7 Max. |
| Fine Grain Variation | dB / 250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.9 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 6 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 3 | |
| High End (8.0 GHz) | MHz/V | 1.5 | |
| Grid RF Cutoff Voltage | V | −11 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 70 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 70 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 210 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 9 | 13 Max. |
| Helix Voltage Range | V | 302-1805 | 280–1900 Min./Max. |
| Helix Current | mA | 1.2 | 3 Max. |
| Anode Voltage | V | 120 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2019-50

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (203 mm) max.
Weight, 8 lbs. (3.63 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

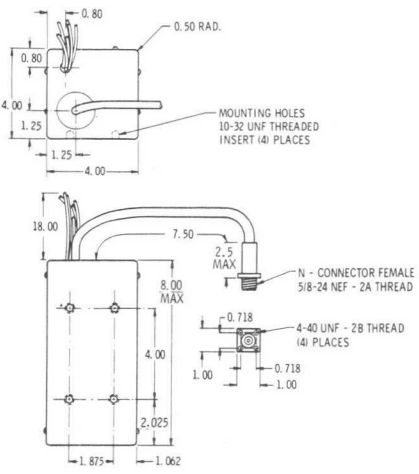
Mounting Position, Any

RF Output Connector, Type N Female on Balun

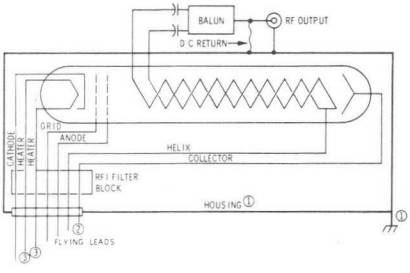
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded
Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING



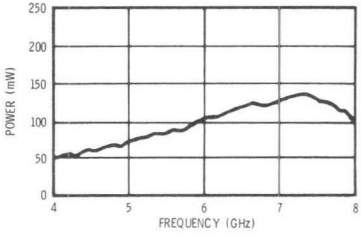

## SCHEMATIC DIAGRAM



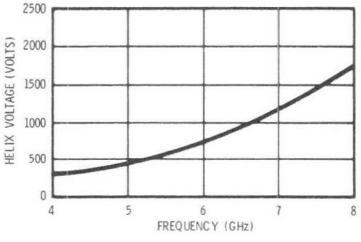

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR WJ-2019-51

The WJ-2019-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2019-51 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2019-51 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 3.7–8.3 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50–120 | 20 Min. |
| Power Output Variation | dB | | 10 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.9 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (3.7 GHz) | MHz/V | 8 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 3 | |
| High End (8.3 GHz) | MHz/V | 0.9 | |
| Grid RF Cutoff Voltage | V | −11 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 70 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 70 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 210 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current * | mA | 9 | 13 Max. |
| Helix Voltage Range | V | 265–2050 | 243–2150 Min./Max. |
| Helix Current | mA | 1.2 | 3 Max. |
| Anode Voltage | V | 120 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2019-51

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 8 lbs. (3.63 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

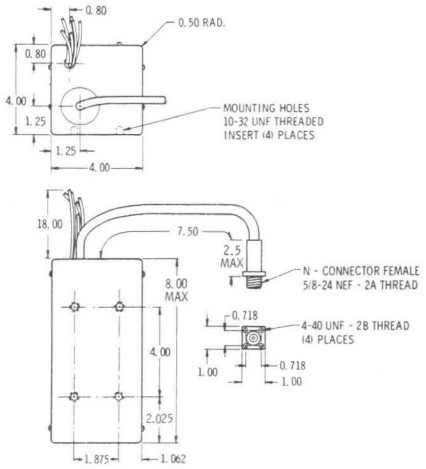
Mounting Position, Any

RF Output Connector, Type N Female on Balun

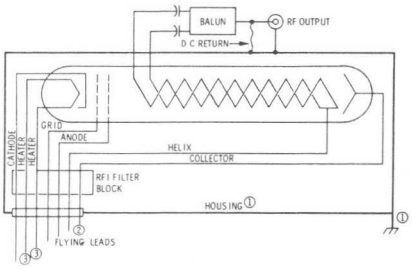
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded
Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



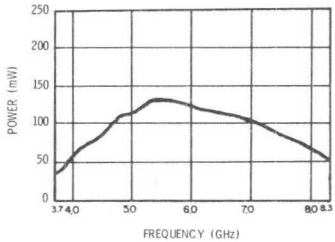

**Notes:**

① For safety, housing should be grounded through mounting screws.

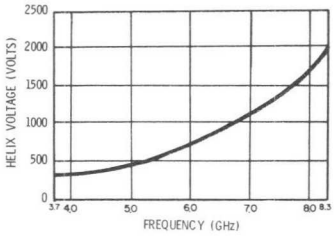
② 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



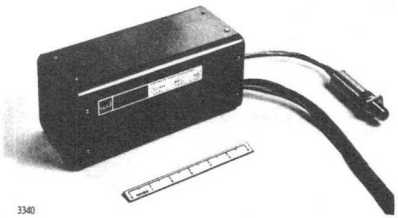
# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-2020

## BACKWARD-WAVE OSCILLATOR

July 1966


3340

The type WJ-2020 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar helix. Unsaturated magnetic shielding reduces the magnetic field strength to less than 5 gauss ½-inch away from any point of the capsule. RFI shielding and filtering enables this tube to meet MIL-I-6181D. Its immunity to external ac or dc magnetic fields, together with minimal stray magnetic field and low RF radiation, makes the WJ-2020 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuts. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## ELECTRICAL CHARACTERISTICS, CW

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| **Nominal Frequency Band** | GHz | 8.0-12.4 | |
| **Power Output into Load with VSWR = 1.25:1** | mW | 60-175 | 50 Min. |
| **Power Output Variation** | dB | | 6 Max. |
| **Fine Grain Variation** | dB/250 MHz | | 3 Max. |
| **Tube VSWR** | | | 2.5:1 Max. |
| **Frequency Pulling Into 2:1 Load (Any Phase)** | MHz | 1.5 | 3 Max. |
| **Ratio of Signal to Noise Power 30 MHz Away** | dB/MHz B.W. | 95 | 85 Min. |
| **Ratio of Signal to 2nd Harmonic Output** | dB | 30 | 20 Min. |
| **Long-term Sensitivity to Heater Voltage** | MHz/V | 3 | 10 Max. |
| **Sensitivity to Anode Voltage** | MHz/V | 0.6 | 1 Max. |
| **Sensitivity to Grid Voltage** | MHz/V | 3 | 5 Max. |
| **Tuning Curve Slope** | | | |
| **Low End (8.0 GHz)** | MHz/V | 7.2 | |
| **Mid-Frequency (10.2 GHz)** | MHz/V | 4.6 | |
| **High End (12.4 GHz)** | MHz/V | 2.7 | |
| **Grid r.f. Cutoff Voltage** | V | —7 | —20 Max. |
| **Capacitance; Grid to all other Electrodes, incl. Heater and Housing** | pf | 45 | 55 Max. |
| **Capacitance; Gride to all other Electrodes, incl. Housing** | pf | 45 | 55 Max. |
| **Capacitance; Helix and Collector to all other Electrodes and Housing** | pf | 230 | 250 Max. |
| **Heater Voltage** | Vdc | 6.3 | 6.3 ±5% |
| **Heater Current** | A | 0.75 | 0.4 to 1.2 Min./Max. |
| **Cathode Current** | mA | 8 | 12 Max. |
| **Helix Voltage Range** | V | 450-1495 | 425-1600 Min./Max. |
| **Anode Voltage*** | V | 150 | 215 Max. |
| **Anode Current** | mA | 0.5 | 2 Max. |

*Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 6 lbs. Max.
Color Code for 18" Flying Leads

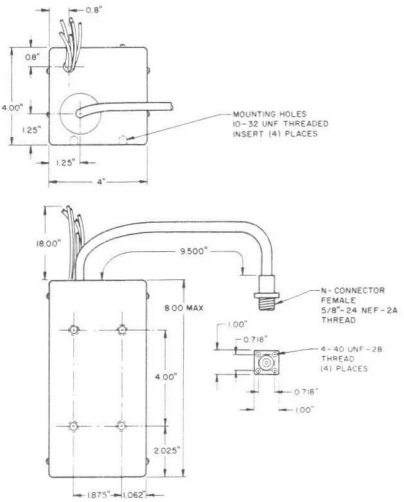
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

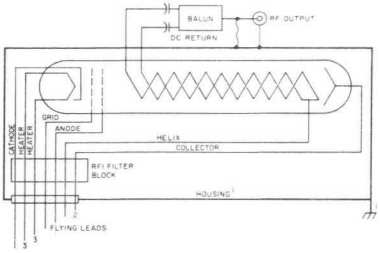
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

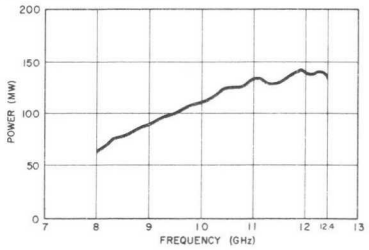



[1] For safety, housing should be grounded through mounting screws.

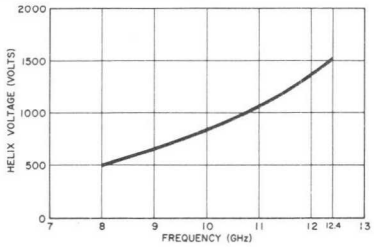
[2] 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

[3] Heater must never be positive with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

JANUARY 1971

## BACKWARD-WAVE OSCILLATOR WJ-2020-50

The WJ-2020-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2020-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2020-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 8.0–12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60–175 | 50 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (7.0 GHz) | MHz/V | 7.2 | |
| Mid-Frequency (9.7 GHz) | MHz/V | 4.6 | |
| High End (12.4 GHz) | MHz/V | 2.7 | |
| Grid RF Cutoff Voltage | V | −7 | −20 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 45 | 55 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 45 | 55 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 230 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min./Max. |
| Cathode Current* | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 450–1495 | 425–1600 Min./Max. |
| Helix Current | mA | | 2.5 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2020-50

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

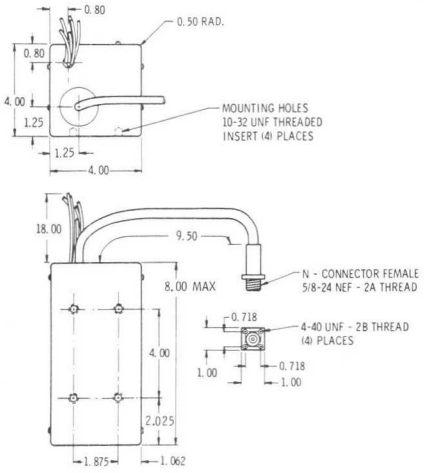
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

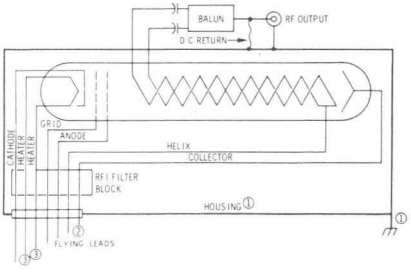
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded
Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

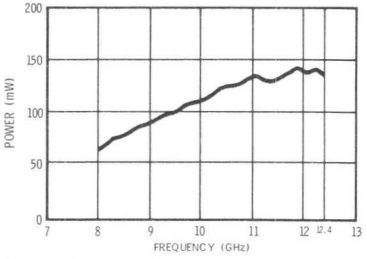
## OUTLINE DRAWING



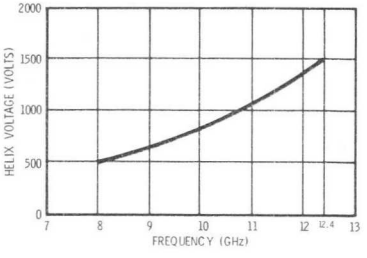

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR WJ-2020-51

The WJ-2020-51 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2020-51 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2020-51 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 7.0–12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 30–175 | 25 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (7.0 GHz) | MHz/V | 8.3 | |
| Mid-Frequency (9.7 GHz) | MHz/V | 4.2 | |
| High End (12.4 GHz) | MHz/V | 2.7 | |
| Grid RF Cutoff Voltage | V | −7 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 45 | 55 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 45 | 55 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 230 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 |
| Cathode Current* | mA | 8 | Min./Max. 12 Max. |
| Helix Voltage Range | V | 330–1495 | 313–1600 Min./Max. |
| Helix Current | mA | | 2.5 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2020-51

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

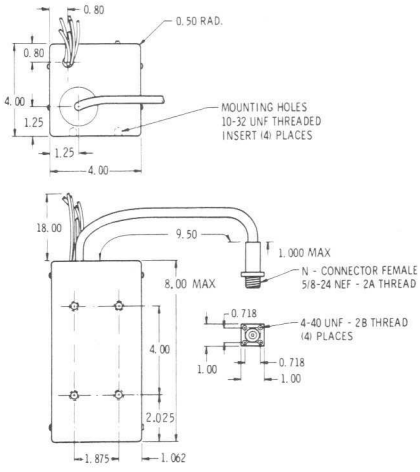
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun
Magnetically Shielded

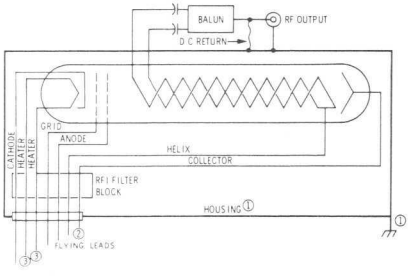
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING



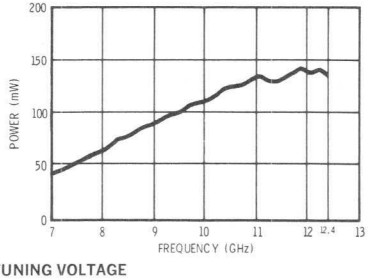

## SCHEMATIC DIAGRAM



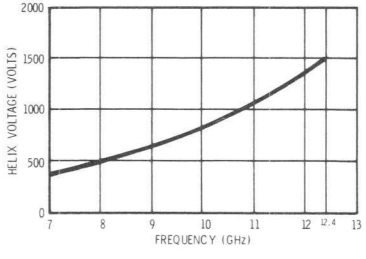

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

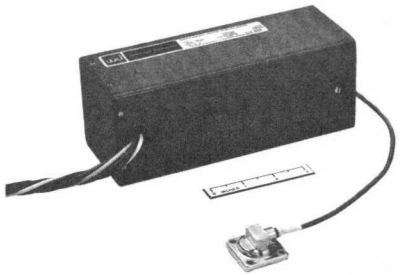
AUGUST 1969 *

## BACKWARD-WAVE OSCILLATOR WJ-2021

The WJ-2021 is a miniature magnetically and RFI shielded, voltage tunable oscillator, utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by the integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation make the WJ-2021 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters and ECM equipment (as master oscillator.).

The fine grain variation of frequency versus voltage is extemely low. The WJ-2021 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 12.4 - 18.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50 - 100 | 40 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 15 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz BW | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 15 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 8 | |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 7.5 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Grid RF Cutoff Voltage | V | —10 | —20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pf | 50 | 90 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pf | 40 | 80 Max. |
| Capitance; Helix and Collector to all other Electrodes and Housing | pf | 130 | 170 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 |
| Cathode Current[1] | mA | 10.0 | 15 Max. |
| Helix Voltage Range | V | 570 - 1930 | 500 - 2100 Min./Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

[1]Set cathode current to Final Test Data value furnished with tube.

*Supersedes WJ-2021 Technical Data Sheet dated April 1969.

# WJ-2021

## MECHANICAL CHARACTERISTICS

Height . . . . . 3 inches (76 mm) max.
Width . . . . . 3 inches (76 mm) max.
Length . . . . . 8 inches (203 mm) max.
Weight . . . . . 6 pounds (2.72 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, Mate with UG 419/U

Separation from Passive Magnetic Materials, None Required

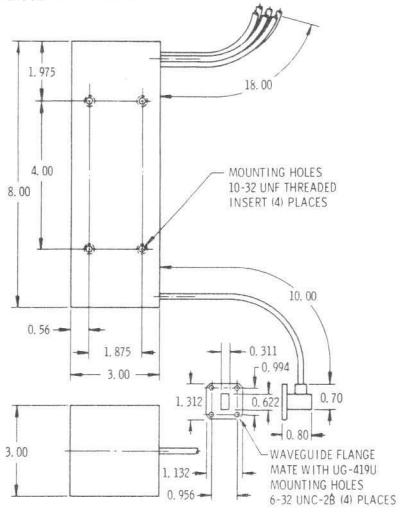
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded

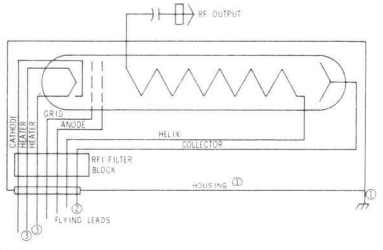
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



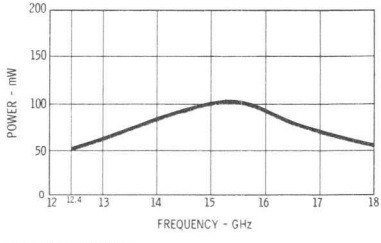

Notes:

(1.) For safety, housing should be grounded through mounting screws.

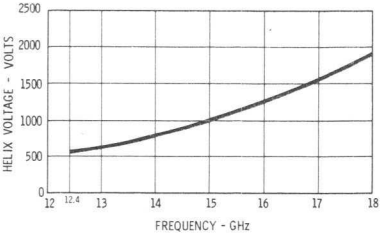
(2.) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969*

## BACKWARD-WAVE OSCILLATOR
## WJ-2022

The WJ-2022 is a magnetically shielded and RFI shielded, voltage tunable oscillator, utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 10 gauss, 1/2 inch from any point of the housing. RFI shielding and filtering allow the WJ-2022 to meet levels of MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2022 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2022 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All

voltages are isolated from the housing for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 18.0 - 26.5 |
| Power Output into Load VSWR = 1.25 | mW | 22 - 70 | 20 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 6 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | dB | 50 | 40 Min. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 90 | 80 Min. |
| Sensitivity to Heater Voltage | MHz/V | 35 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 10 | |
| Tuning Curve Slope | | | |
| Low End (18 MHz) | MHz/V | 12 | |
| Mid-Frequency (22.5 MHz) | MHz/V | 6.5 | |
| High End (26.5 MHz) | MHz/V | 4 | |
| Grid r.f. Cutoff Voltage | V | -10 | -20 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pf | 35 | 50 Max. |
| Capacitance; Grid to all other Electrodes, including Heater and Housing | pf | 35 | 50 Max. |
| Capacitance; Helix & Collector to all other Electrodes including Heater and Housing | pf | 90 | 130 Max. |
| Heater Voltage | V | | 6.3 ± 5% |
| Heater Current | A | 0.67 | 0.4-1.2 |
| Cathode Current[1] | mA | 6 | 10 Max. |
| Helix Voltage Range | V | 530-1820 | 450-2000 |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 115 | 250 Max. |
| Anode Current | mA | 0.2 | 1 Max. |

1. Set Cathode Current to Final Test Data furnished with tube.

* Supersedes WJ-2022 Technical Data Sheet dated February 1968.

## MECHANICAL DATA

Weight, 6.5 lbs. Max.
Color Code for 18" Flying Leads

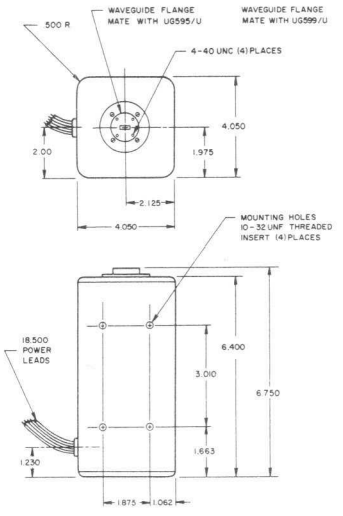
| | |
|---|---|
| Heater | Black (neg) |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, UG-595/U Flange
Magnetically Shielded

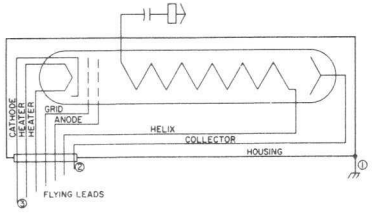
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required, Below + 60° C Ambient
RFI Shielded and Filtered to Meet Levels of MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

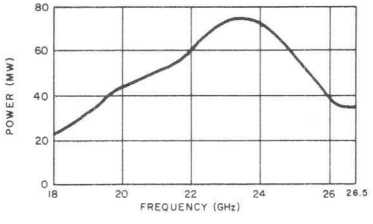



① For safety, housing should be grounded through mounting screws.

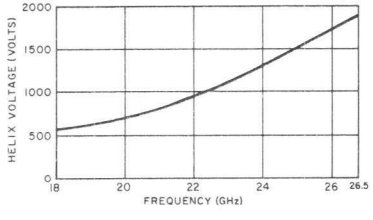
② 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

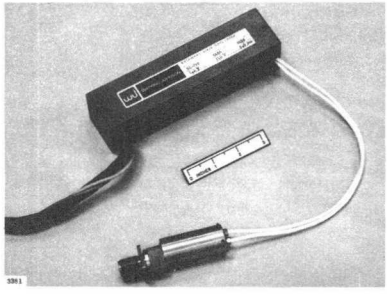
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2024

TECHNICAL DATA • January 1967

The WJ-2024 is a miniature square packaged voltage-tunable oscillator utilizing a bifilar (dual-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2–4 | |
| Power Output into Load with VSWR = 1.25 | mW | 60–250 | 50 Min |
| Power Output Variation | dB | | 8 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 5 Max |
| Spurious Oscillation | | | |
| Ratio of Signal to 2nd Harmonic Output | dB | 25 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 2 | 8 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.25 | 1 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 3.2 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 2.3 | |
| High End (4.0 GHz) | MHz/V | 1.2 | |
| Grid R. F. Cutoff Voltage | V | —8 | —20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 18 | 25 Max |
| Capacitance; Grid to all other Electrodes including Housing | pF | 18 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 150 | 200 Max |
| Heater Voltage | V | | 6.3±5% |
| Heater Current | A | 0.8 | 0.4–1.2 Min/Max |
| Cathode Current | mA | 8 | 15 Max |
| Helix Voltage Range | V | 290–1290 | 270–1350 Min/Max |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 130 | 215 Max |
| Anode Current | mA | 0.6 | 1.5 Max |

## MECHANICAL DATA

Weight, 7.25 lbs. Max

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater | Black |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

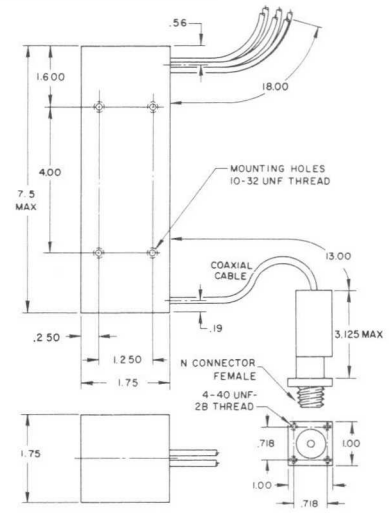
RF Output Connector, Type N
Female on Balun

## ENVIRONMENTAL DATA

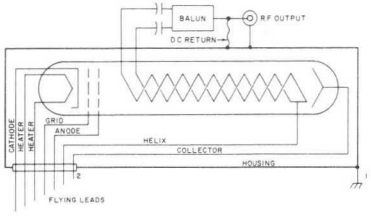
Separation from Passive Magnetic Materials, 4 in. Min

No Forced Air Cooling Required

## OUTLINE DRAWING



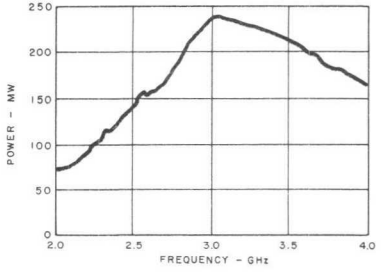

## SCHEMATIC DIAGRAM



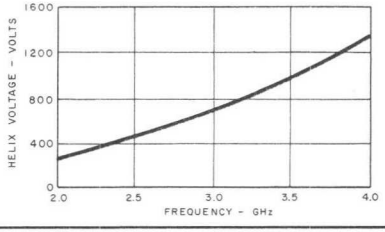

[1] For safety, housing should be grounded through mounting screws.

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

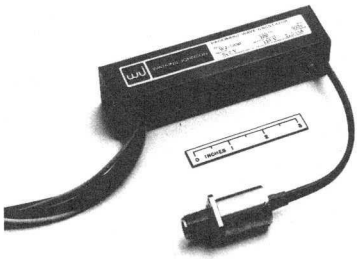
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2025

TECHNICAL DATA • January 1967

The WJ-2025 is a miniature square packaged voltage-tunable oscillator utilizing a bifilar (dual-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



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## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4.0–8.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 30–70 | 20 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.6 | 1.0 |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage at 6 GHz | MHz/V | 3.5 | 6 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.0 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 6.0 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.5 | |
| High End (8.0 GHz) | MHz/V | 1.7 | |
| Grid R. F. Cutoff Voltage | V | −7 | −20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 18 | 25 Max |
| Capacitance; Grid to all other Electrodes including Housing | pF | 18 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 90 | 125 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min/Max |
| Cathode Current | mA | 8.5 | 15 Max |
| Helix Voltage Range | V | 280–1710 | 250–1800 Min Max |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 100 | 200 Max |
| Anode Current | mA | 0.3 | 2 Max |

## MECHANICAL DATA

Weight, 1½ lbs Max

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

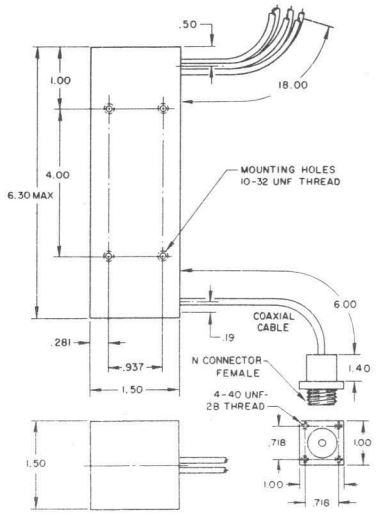
Mounting Position, any
RF Output Connector, Type N female

## ENVIRONMENTAL DATA

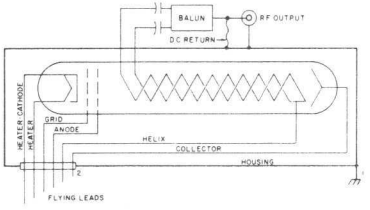
Separation from Passive Magnetic Materials, 2 in. Max

No Forced Air Cooling Required

## OUTLINE DRAWING



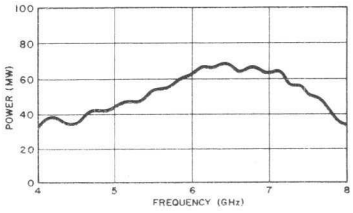

## SCHEMATIC DIAGRAM



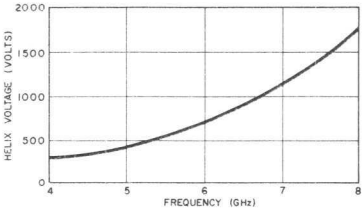

[1] For safety, housing should be grounded through mounting screws.

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

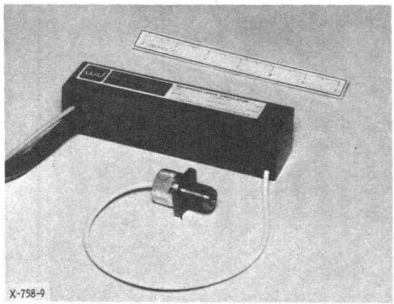
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2026

September 1968 *

The WJ-2026 is a miniature square packaged voltage-tunable oscillator utiiizing a monofilar (single-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.


X-758-9

## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 8.2–12.4 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 25–100 | 20 Min |
| Power Output Variation | dB | | 8 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.8 | 1.5 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5.5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.3 | |
| Sensitivity to Grid Voltage | MHz/V | 2 | |
| Tuning Curve Slope | | | |
| Low End (8.2 GHz) | MHz/V | 6.5 | |
| Mid-Frequency (10.3 GHz) | MHz/V | 3.3 | |
| High End (12.4 GHz) | MHz/V | 1.7 | |
| Grid R. F. Cutoff Voltage | V | −10 | −20 Max |
| Capacitance; Cathode to all other Electrodes Including Heater and Housing | pF | 18 | 25 Max |
| Capacitance; Grid to all other Electrodes Including Housing | pF | 18 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 70 | 100 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 485–1850 | 450–2000 |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 125 | 200 Max |
| Anode Current | mA | 0.3 | 2 Max |

* Supersedes WJ-2026 Technical Data Sheet Dated January 1967

## MECHANICAL DATA

Weight, 1.5 lbs Max
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater-Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

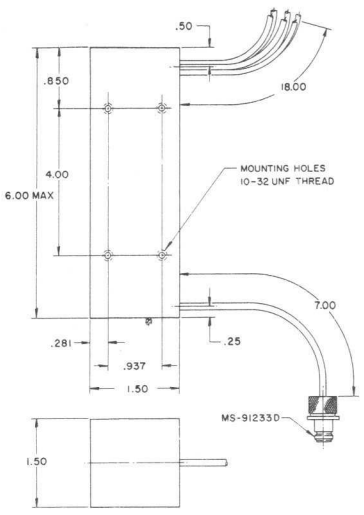
RF Output Connector, Type N Female

## ENVIRONMENTAL DATA

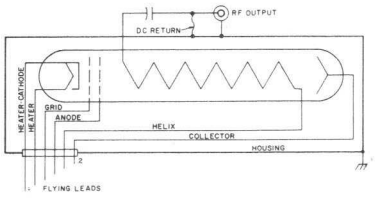
Separation from Passive Magnetic Materials, 2 in. Min

No Forced Air Cooling Required Below +60°C Ambient

## OUTLINE DRAWING



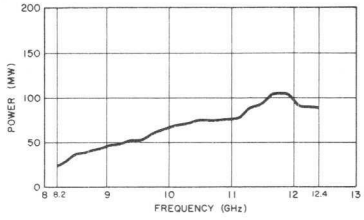

## SCHEMATIC DIAGRAM



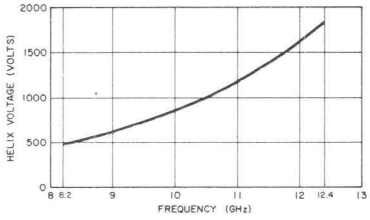

[1] For safety, housing should be grounded through mounting screws

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

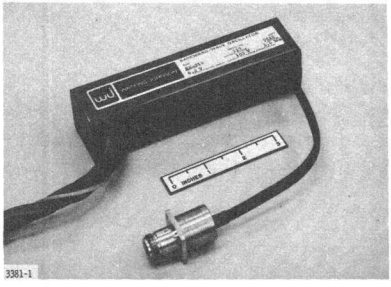
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2027

September 1968 *

The WJ-2027 is a miniature square packaged voltage-tunable oscillator utilizing a bifilar (dual-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



3381-1

## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 8.0–12.4 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 60–175 | 50 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.6 | 1.5 Max |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 7.2 | |
| Mid-Frequency (10.0 GHz) | MHz/V | 4.6 | |
| High End (12.4 GHz) | MHz/V | 2.7 | |
| Grid R. F. Cutoff Voltage | V | —7 | —20 Max |
| Capacitance; Cathode to all other Electrodes, and Housing | pF | 30 | 45 Max |
| Capacitance; Cathode and Grid to all other Electrodes and Housing | pF | 40 | 50 Max |
| Capacitance; Helix to all other Electrodes and Housing | pF | 150 | 175 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 450–1495 | 425–1600 Min Max |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 150 | 200 Max |
| Anode Current | mA | 0.5 | 2 Max |

* Supersedes WJ-2027 Technical Data Sheet Dated January 1967

## MECHANICAL DATA

Weight, 1½ lbs Max

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any

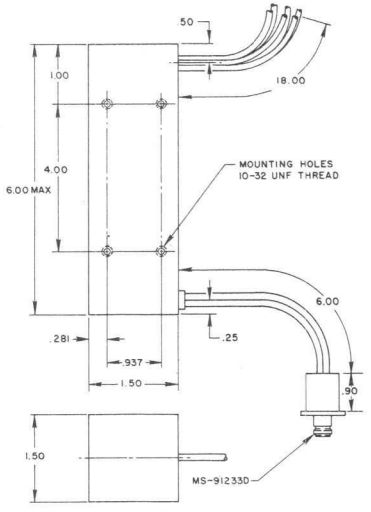
RF Output Connector, Type N Female

## ENVIRONMENTAL DATA

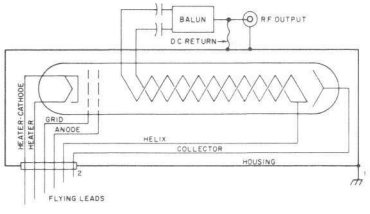
Separation from Passive Magnetic Materials, 2 in. Min

No Forced Air Cooling Required, Below +60°C Ambient

## OUTLINE DRAWING



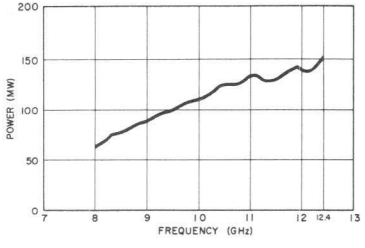

## SCHEMATIC DIAGRAM



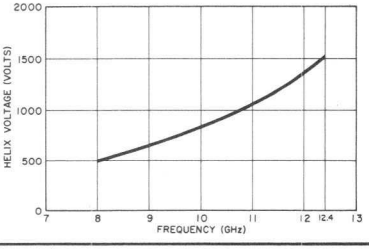

[1] For safety, housing should be grounded through mounting screws.

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

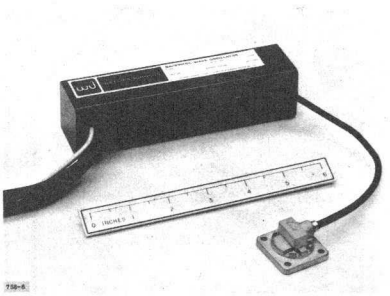
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2028

December 1967 *

The WJ-2028 is a miniature square packaged voltage-tunable oscillator utilizing a monofilar (single-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 12.4–18.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 25–85 | 20 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.0 | 1.5 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.0 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 8.7 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Grid R. F. Cutoff Voltage | V | −10 | −20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 15 | 20 Max |
| Capacitance; Grid to all other Electrodes including Housing | pF | 18 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Case | pF | 80 | 110 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 570–1980 | 500–2100 Min/Max |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 150 | 200 Max |
| Anode Current | mA | 0.5 | 2 Max |

*This Data Sheet supersedes Data Sheet W-J 2028 dated January 1967

## MECHANICAL DATA

Weight, 1.5 lbs Max

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater-Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any

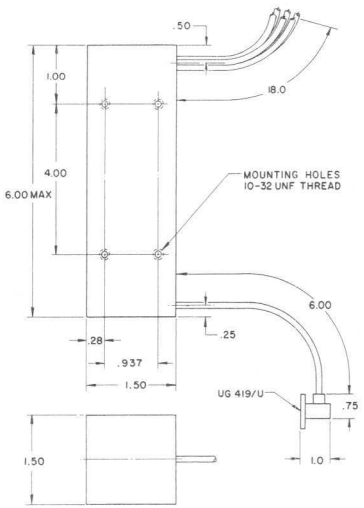
RF Output Connector, UG-419/U Waveguide Flange

## ENVIRONMENTAL DATA

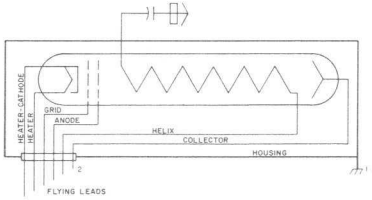
Separation from Passive Magnetic Materials, 2 in. Min

No Forced Air Cooling Required

## OUTLINE DRAWING



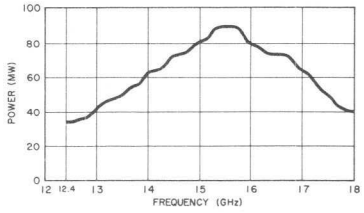

## SCHEMATIC DIAGRAM



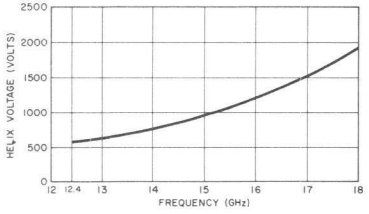

[1] For safety, housing should be grounded through mounting screws

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

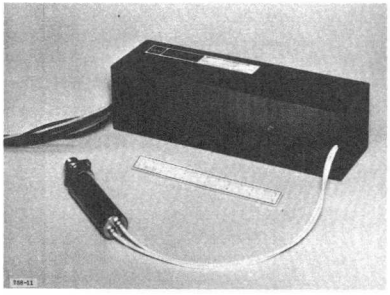
WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2029

TECHNICAL DATA • January 1967

The WJ-2029 is a miniature square packaged voltage-tunable oscillator utilizing a monofilar (single-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 14.0–17.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 15–30 | 10 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | 15–30 | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.9 | 1.5 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | 10 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.5 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 6 Max |
| Tuning Curve Slope | | | |
| Low End (14 GHz) | MHz/V | 10.5 | |
| Mid-Frequency (15.5 GHz) | MHz/V | 8.0 | |
| High End (17 GHz) | MHz/V | 6.0 | |
| Grid R. F. Cutoff Voltage | V | −10 | −20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 15 | 20 Max |
| Capacitance; Grid to all other Electrodes including Housing | pF | 18 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 80 | 110 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min/Max |
| Cathode Current | mA | 7 | 12 Max |
| Helix Voltage Range | V | 405–760 | 375–800 Min/Max |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | 150 | 200 Max |
| Anode Current | mA | 0.5 | 2 Max |

## MECHANICAL DATA

Weight, 1 lb Max

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater-Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, any

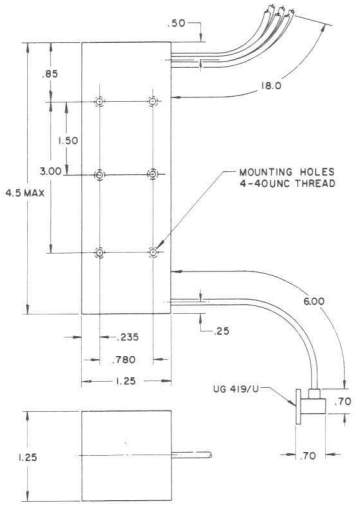
RF Output Connector, UG-419/U Waveguide Flange

## ENVIRONMENTAL DATA

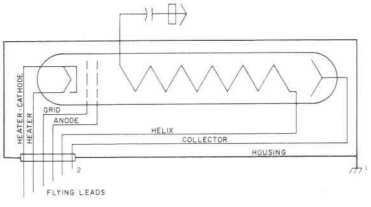
Separation from Passive Magnetic Materials, 2 in. Min

No Forced Air Cooling Required

## OUTLINE DRAWING



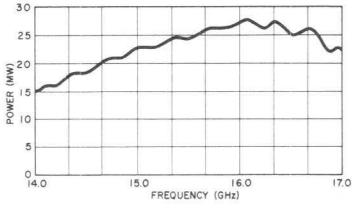

## SCHEMATIC DIAGRAM



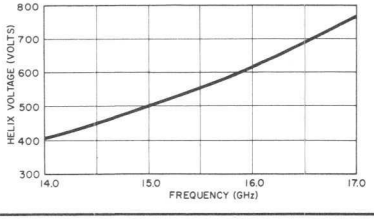

[1] For safety, housing should be grounded through mounting screws

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

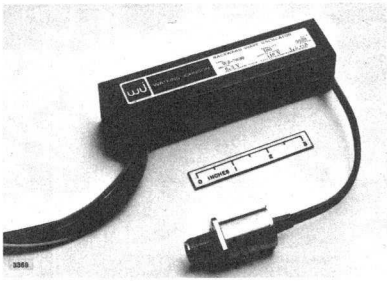
WATKINS-JOHNSON

# WJ-2030

## BACKWARD-WAVE OSCILLATOR

TECHNICAL DATA • January 1967

The WJ-2030 is a miniature square packaged voltage-tunable oscillator utilizing a bifilar (dual-helix) slow-wave structure and a permanent magnet focusing system. The size and weight of this package make it suitable for high density packaging in airborne, shipboard and plug-in sweeper applications. It is used as a local oscillator in swept or FM receivers, master oscillator in transmitters and ECM jammers, signal source in generators and spectrum analyzers. Frequency versus voltage curves are monotonic, making the tubes ideal for linearizing. Power output can be modulated with either grid or anode circuits. All voltages are isolated from the housing for easier packaging.



## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4.0–8.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 60–150 | 50 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 0.6 | 2.0 |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage at 6 GHz | MHz/V | 3.5 | 6 Max |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | 1.0 Max |
| Sensitivity to Grid Voltage | MHz/V | 3 | 5 Max |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 5.4 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.5 | |
| High End (8.0 GHz) | MHz/V | 1.9 | |
| Grid R. F. Cutoff Voltage | V | –7 | –20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 18 | 25 Max |
| Capacitance; Grid to all other Electrodes Including Housing | pF | 18 | 25 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 90 | 125 Max |
| Heater Voltage | Vdc | | 6.3±5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min/Max |
| Cathode Current | mA | 8.5 | 15 Max |
| Helix Voltage Range | V | 345–2085 | 330–2150 |
| Helix Current | mA | 2 | 3 Max |
| Anode Voltage | V | .100 | 200 Max |
| Anode Current | mA | 0.3 | 2 Max |

## MECHANICAL DATA

Weight, 1½ lbs Max

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

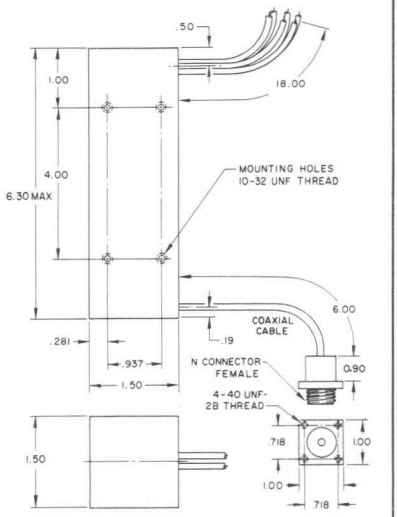
Mounting Position, any
RF Output Connector, Type N female

## ENVIRONMENTAL DATA

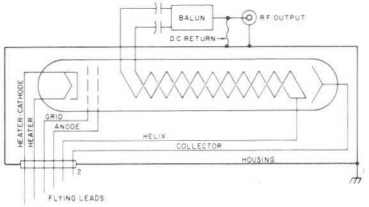
Separation from Passive Magnetic Materials, 2 in. Max

No Forced Air Cooling Required

## OUTLINE DRAWING



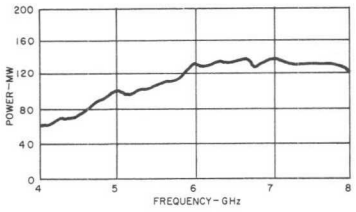

## SCHEMATIC DIAGRAM



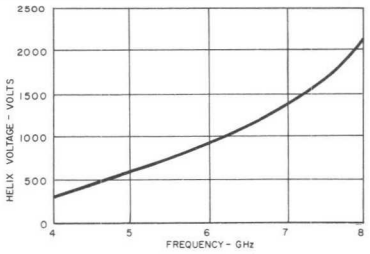

[1] For safety, housing should be grounded through mounting screws.

[2] 24–100 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

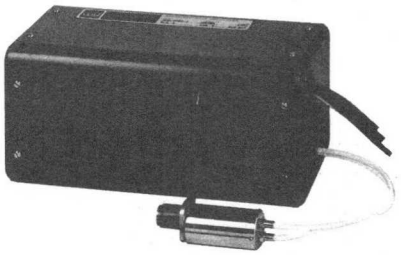
APRIL 1972

## BACKWARD-WAVE OSCILLATOR
## WJ-2032

The WJ-2032 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2032 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2032 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 2.0-6.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 17-180 | 10 Min. |
| Power Output Variation | dB | 10.5 | 12 Max. |
| Fine Grain Variation | dB/250 MHz | 1.0 | 3 Max. |
| Tube VSWR | | 2:1 | 3:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.3 | 4 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 10 | |
| Sensitivity to Anode Voltage | MHz/V | 1.1 | |
| Sensitivity to Grid Voltage | MHz/V | 9 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 6.14 | |
| Mid-Frequency (4.0 GHz) | MHz/V | 2.69 | |
| High End (6.0 GHz) | MHz/V | 1.18 | |
| Grid RF Cutoff Voltage | V | −12 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 45 | 55 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 45 | 55 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 230 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.79 | 0.4—1.2 Min./Max. |
| Cathode Current[1] | mA | 10 | 12.5 Max. |
| Helix Voltage Range | V | 160-1814 | 152-1905 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.2 | 2 Max. |

NOTE 1: Set cathode current to Final Test Data value furnished with tube.

# WJ-2032

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 9 inches (229 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.
Color Code for 18" Flying Leads

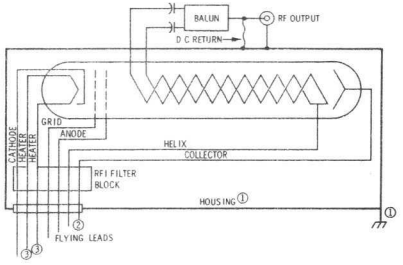
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector mates with Type N Male Connector
Magnetically Shielded

## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

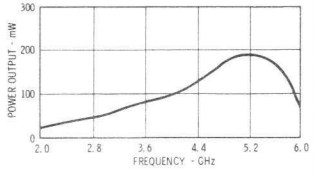
## SCHEMATIC DIAGRAM



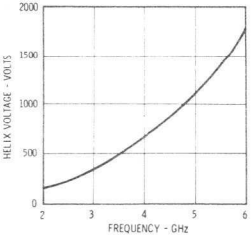

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45—150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

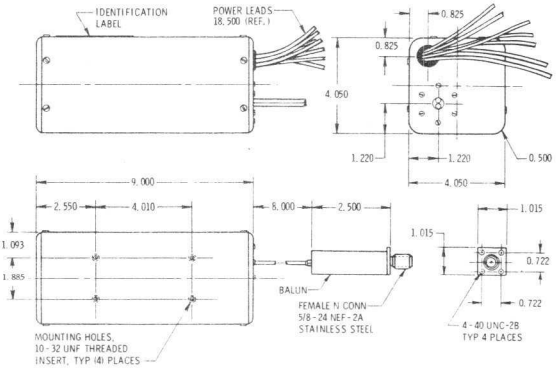
## POWER OUTPUT




## TUNING VOLTAGE




## OUTLINE DRAWING



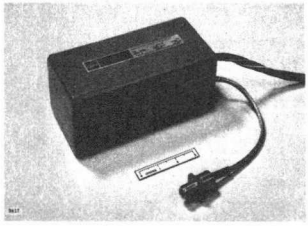
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2033-1

July 1967



The WJ-2033-1 has a minimum power output of 100 milliwatts and is a shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 5 gauss 1/2-inch from any point of the housing. RFI shielding and filtering allow the WJ-2033-1 to meet MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2033-1 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2033-1 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 8.0-12.4 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 125-200 | 100 Min |
| Power Output Variation | dB | | 6 Max |
| Fine Grain Variation | dB/250 MHz | | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1 | 3 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7 | |
| Sensitivity to Anode Voltage | MHz/V | 1.5 | |
| Sensitivity to Grid Voltage | MHz/V | 6 | |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 5 | |
| Mid-Frequency (10.2 GHz) | MHz/V | 3 | |
| High End (12.4 GHz) | MHz/V | 2 | |
| Grid RF Cutoff Voltage | V | -15 | -20 Max |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 75 Max |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 75 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 220 | 250 Max |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5 % |
| Heater Current | A | 0.7 | 0.4 to 1.2 Min/ Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 630-2075 | 600-2150 Min/ Max |
| Helix Current | mA | 1.3 | 3 Max |
| Anode Voltage* | V | 130 | 215 Max |
| Anode Current | mA | 0.05 | 2 Max |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight. 6 lbs. Max.
Color Code for 18" Flying Leads

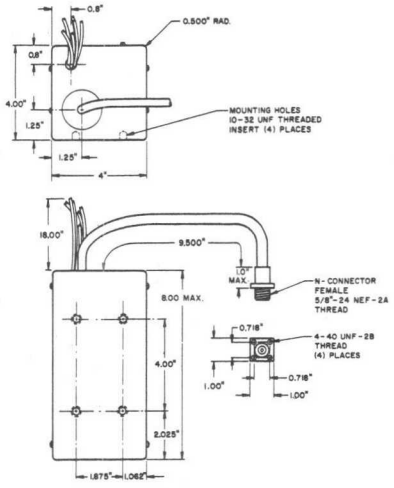
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position. Any
RF Output Connector. Type N Female
Magnetically Shielded

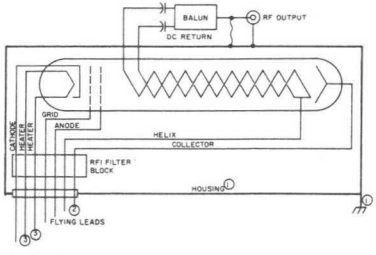
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials. None Required
No Forced Air Cooling Required Below $+60^{\circ}$ C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

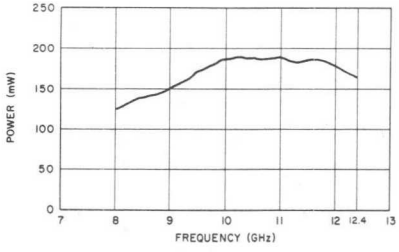



① For safety, housing should be grounded through mounting screws.

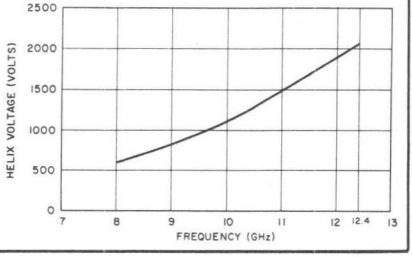
② 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must never be positive with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



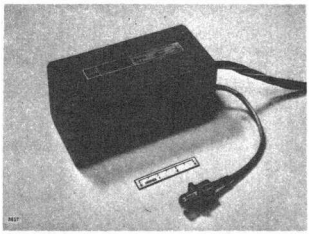
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2034

May 1967



The WJ-2034 is a voltage tunable oscillator utilizing a bifilar helix. Unsaturated magnetic shielding reduces the external magnetic fields strength to less than 5 gauss 1/2-inch from any point of the housing. RFI shielding and filtering allows the WJ-2034 to meet MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2034 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator, and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4.0-8.0 | -- |
| Power Output into Load with VSWR = 1.25:1 | mW | 65-170 | 60 Min |
| Power Output Variation | dB | -- | 7 Max |
| Fine Grain Variation | dB/250 MHz | -- | 3 Max |
| Tube VSWR | -- | -- | 2.5:1 Max |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | -- |
| Sensitivity to Anode Voltage | MHz/V | 5 | -- |
| Sensitivity to Grid Voltage | MHz/V | 3 | -- |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 6 | -- |
| Mid-Frequency (6.0 GHz) | MHz/V | 2.5 | -- |
| High End (8.0 GHz) | MHz/V | 1 | -- |
| Grid r.f. Cutoff Voltage | V | -13 | -20 Max |
| Capacitance; Cathode to all other Electrodes, incl. Heater and Housing | pf | 60 | 80 Max |
| Capacitance; Grid to all other Electrodes, incl. Housing | pf | 50 | 70 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pf | 230 | 260 Max |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.72 | 0.4 to 1.2 Min / Max |
| Cathode Current | mA | 9.5 | 15 Max |
| Helix Voltage Range | V | 350-2100 | 325-2200 Min / Max |
| Anode Voltage * | V | 125 | 215 Max |
| Anode Current | mA | 0.05 | 2 Max |
| Helix Current | mA | 1.2 | 3 Max |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 6.5 lbs. Max.
Color Code for 18" Flying Leads

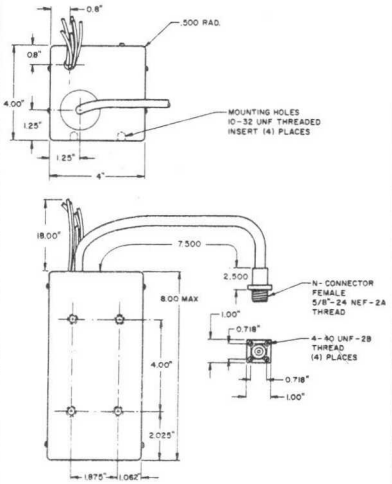
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

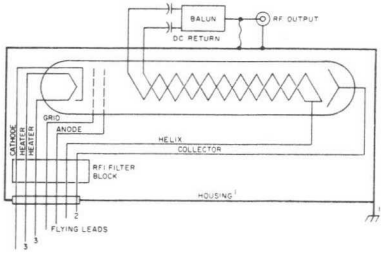
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below $+60^{0}$ C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

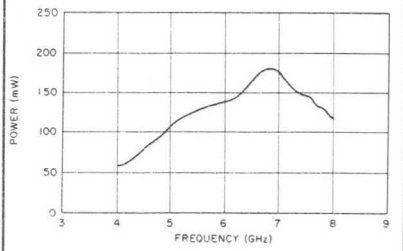



[1] For safety, housing should be grounded through mounting screws.

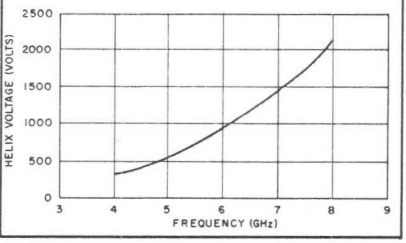
[2] 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

[3] Heater must never be positive with respect to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



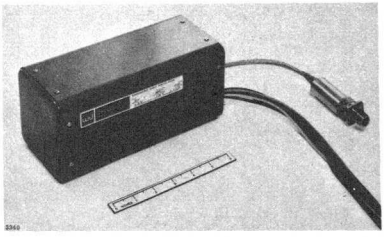
# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-2038

## BACKWARD-WAVE OSCILLATOR

December 1967 *



The WJ-2038 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2038 ideal for use in signal generating and sweeping equipment. The WJ-2038 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2038 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | Units | Typical Values | Absolute Ratings |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2.6-5.2 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 65-230 | 50 Min |
| Power Output Variation | dB | -- | 8 Max |
| Fine Grain Variation | dB/250 MHz | -- | 3 Max |
| Tube VSWR | | | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 3 | 8 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-Term Sensitivity to Heater Voltage @ 4 GHz | MHz/V | 3 | -- |
| Sensitivity to Anode Voltage @ 4 GHz | MHz/V | 0.5 | -- |
| Sensitivity to Grid Voltage @ 4 GHz | MHz/V | 10 | -- |
| Tuning Curve Slope | | | |
| Low End (2.6 GHz) | MHz/V | 3.2 | -- |
| Mid-Frequency (3.9 GHz) | MHz/V | 2 | -- |
| High End (5.2 GHz) | MHz/V | 1 | -- |
| Grid r.f. Cutoff Voltage | V | -10 | -20 Max |
| Capacitance; Cathode to all other Electrodes, incl. Heater and Housing | pF | 55 | 75 Max |
| Capacitance; Grid to all other Electrodes incl. Housing | pF | 55 | 75 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 245 | 290 Max |
| Heater Voltage | Vdc | 6.3 | 6.3±5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min/Max |
| Cathode Current[1] | mA | 10 | 15 Max |
| Helix Voltage Range | V | 365-1830 | 345-1920 Min/Max |
| Helix Current | mA | 1.3 | 3 Max |
| Anode Voltage | V | 110 | 215 Max |
| Anode Current | mA | 0.1 | 2 Max |

[1] Set Cathode Current to Final Test Data value furnished with tube.

*Revision of Technical Data Sheet issued in September 1967.

## MECHANICAL DATA

Weight, 9.7 lbs. Max.
Color Code for 18" Flying Leads

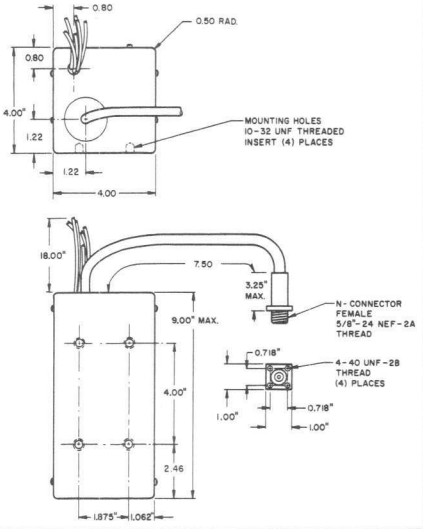
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

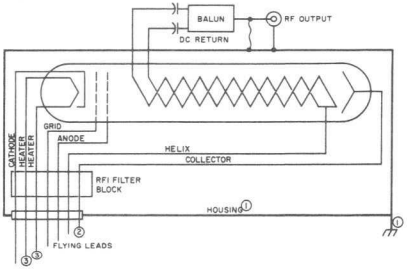
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

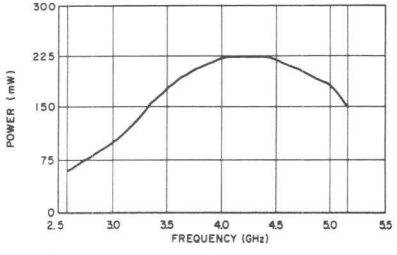



①For safety, housing should be grounded through mounting screws.

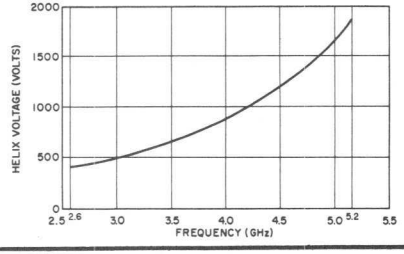
②50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

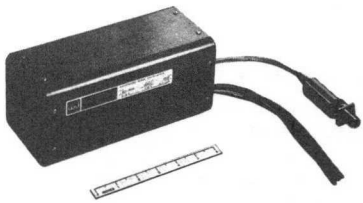
WATKINS-JOHNSON

NOVEMBER 1970

## BACKWARD-WAVE OSCILLATOR WJ-2038-50

The WJ-2038-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2038-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low.

The WJ-2038-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 2.6–5.2 |
| Power Output into Load with VSWR = 1.25:1 | mW | 65–230 | 50 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB / 250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 3 | 8 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 10 | |
| Tuning Curve Slope | | | |
| Low End (2.6 GHz) | MHz/V | 3.2 | |
| Mid-Frequency (3.9 GHz) | MHz/V | 2 | |
| High End (5.2 GHz) | MHz/V | 1 | |
| Grid RF Cutoff Voltage | V | –10 | –25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 245 | 290 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min./Max. |
| Cathode Current* | mA | 10 | 15 Max. |
| Helix Voltage Range | V | 365–1830 | 345–1920 Min./Max. |
| Helix Current | mA | 1.3 | 3 Max. |
| Anode Voltage | V | 110 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2038-50

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 9 inches (229 mm) max.
Weight, 11.3 lbs. (5.13 Kg) max.

Color Code for 18" Flying Leads

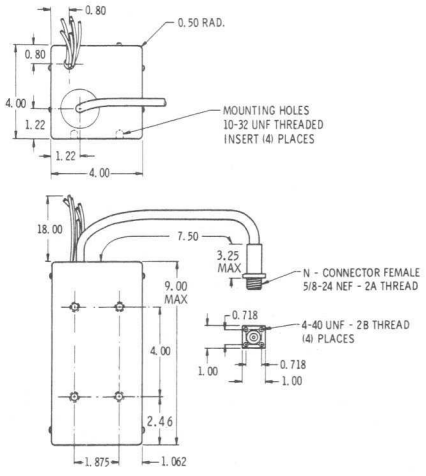
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female on Balun

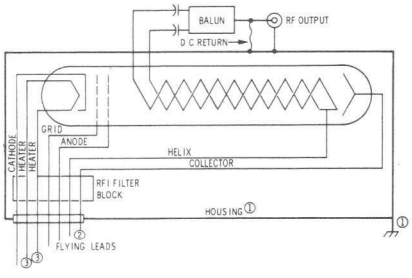
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded
Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

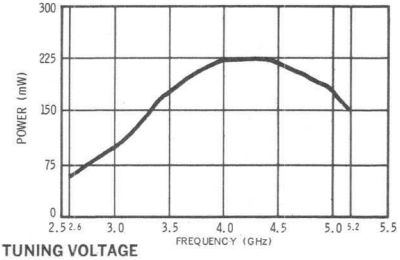
## OUTLINE DRAWING



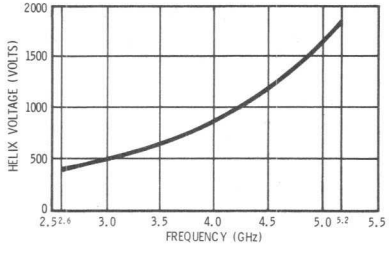

## SCHEMATIC DIAGRAM




## POWER OUTPUT




## TUNING VOLTAGE




**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

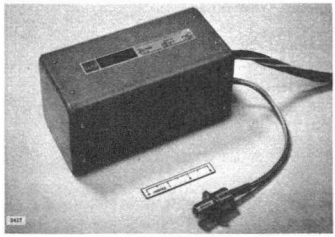
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2039

May 1967



The WJ-2039 is a voltage tunable oscillator with a bifilar helix. An immunity to external ac or dc magnetic fields, plus minimal stray magnetic fields and low RF radiation, makes the WJ-2039 ideal for use in signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Unsaturated magnetic shielding reduces the external magnetic field strength to less than 5 gauss 1/2-inch from any point of the housing. RFI shielding and filtering allows the WJ-2039 to meet the specifications of MIL-I-6181D. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 8.0-12.4 | -- |
| Power Output into Load with VSWR = 1.25:1 | mW | 85 - 135 | 80 Min |
| Power Output Variation | dB | -- | 6 Max |
| Fine Grain Variation | dB/250 MHz | -- | 3 Max |
| Tube VSWR | -- | -- | 2.5:1 Max |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1 | 3 Max |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7 | -- |
| Sensitivity to Anode Voltage | MHz/V | 1.7 | -- |
| Sensitivity to Grid Voltage | MHz/V | 7 | -- |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 5 | -- |
| Mid-Frequency (10.2 GHz) | MHz/V | 3 | -- |
| High End (12.4 GHz) | MHz/V | 2 | -- |
| Grid r.f. Cutoff Voltage | V | -15 | -20 Max |
| Capacitance; Cathode to all other Electrodes, incl. Heater and Housing | pf | 55 | 75 Max |
| Capacitance; Grid to all other Electrodes, incl. Housing | pf | 55 | 75 Max |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pf | 220 | 250 Max |
| Heater Voltage | Vdc | -- | 6.3 ± 5% |
| Heater Current | A | 0.7 | 0.4 to 1.2 Min/Max |
| Cathode Current | mA | 8 | 12 Max |
| Helix Voltage Range | V | 630-2075 | 600-2150 Min/Max |
| Anode Voltage * | V | 120 | 215 Max |
| Anode Current | mA | 0.05 | 2 Max |
| Helix Current | mA | 1.2 | 3 Max |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 6 lbs. Max.
Color Code for 18" Flying Leads

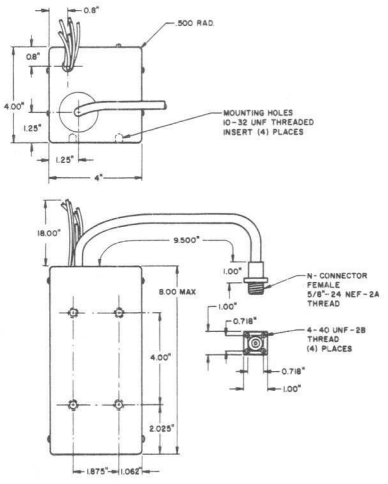
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

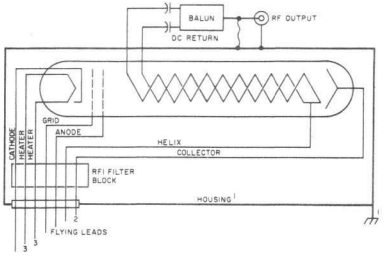
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below $+60^{0}$ C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

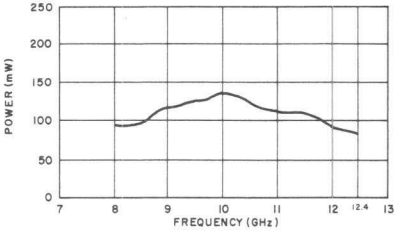



[1] For safety, housing should be grounded through mounting screws.

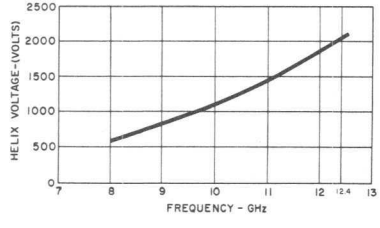
[2] 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

[3] Heater must never be positive with respect to cathode

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

SEPTEMBER 1967

## BACKWARD-WAVE OSCILLATOR
## WJ-2039-1

The WJ-2039-1 is a 7.0 to 12.4 GHz wide band, magnetic and RFI shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 5 gauss ½ inch away from any point in the housing. RFI shielding and filtering allow the WJ-2039-1 to meet MIL-I-6181D. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2039-1 ideal for use in signal generating and sweeping equipment. The WJ-2039-1 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2039-1 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 7.0-12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60-125 | 40 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 3 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B. W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7 | |
| Sensitivity to Anode Voltage | MHz/V | 1.7 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (7.0 GHz) | MHz/V | 7 | |
| Mid-Frequency (9.7 GHz) | MHz/V | 3.5 | |
| High End (12.4 GHz) | MHz/V | 2 | |
| Grid RF Cutoff Voltage | V | −15 | −20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 220 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current* | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 455-2065 | 430-2150 Min/Max |
| Helix Current | mA | 1.2 | 3 Max. |
| Anode Voltage | V | 120 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2039-1

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)

Width, 4 inches (102 mm)

Length, 8 inches (203 mm)

Weight, 6 lbs. (2.72 Kg) Max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, Type N, Female

Magnetically Shielded

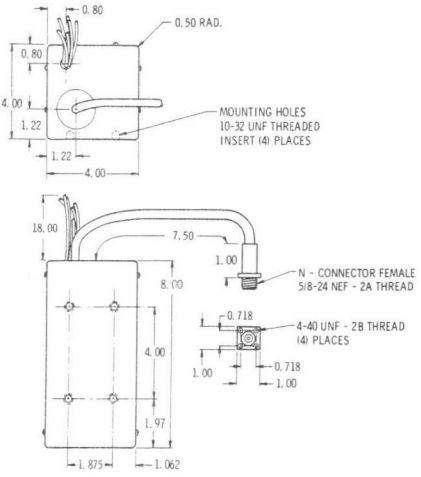
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

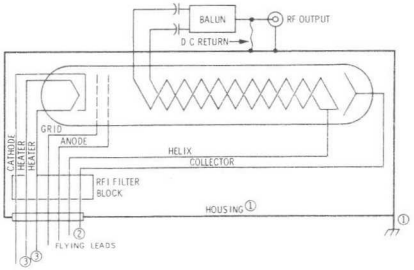
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

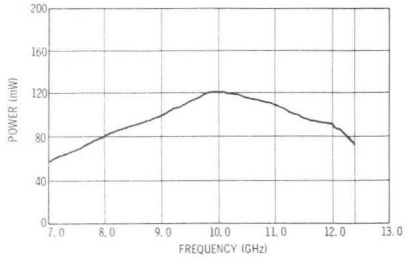



①For safety, housing should be grounded through mounting screws.

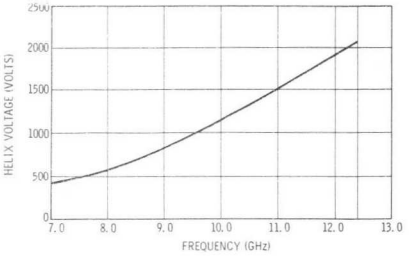
②50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2039-50

The WJ-2039-50 is a 7.0 to 12.4 GHz wide band, magnetic and RFI shielded, voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering allow the WJ-2039-50 to meet MIL-I-6181D. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2039-50 ideal for use in signal generating and sweeping equipment. The WJ-2039-50 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2039-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from the housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 8.0-12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60-125 | 80 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 3 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B. W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7 | |
| Sensitivity to Anode Voltage | MHz/V | 1.7 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 5.7 | |
| Mid-Frequency (10.2 GHz) | MHz/V | 4.1 | |
| High End (12.4 GHz) | MHz/V | 2.4 | |
| Grid RF Cutoff Voltage | V | −15 | −25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 220 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4-1.2 |
| | | | Min/Max |
| Cathode Current* | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 620−2065 | 600-2150 |
| | | | Min/Max |
| Helix Current | mA | 1.2 | 3 Max. |
| Anode Voltage | V | 120 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2039-50

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)

Width, 4 inches (102 mm)

Length, 8 inches (203 mm)

Weight, 9.5 lbs. (4.31 Kg) Max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, Type N, Female

Magnetically Shielded

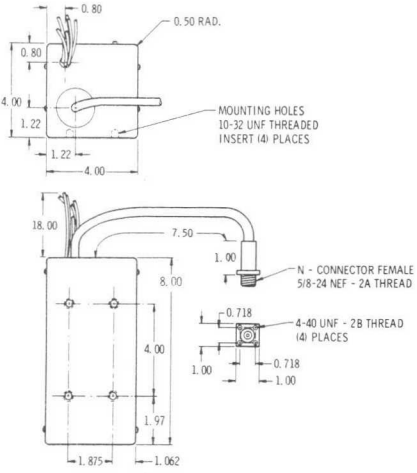
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

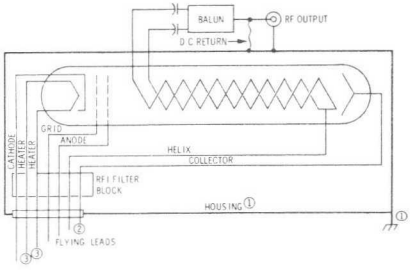
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

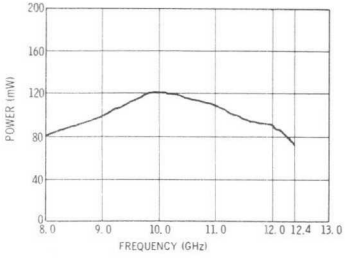



① For safety, housing should be grounded through mounting screws.

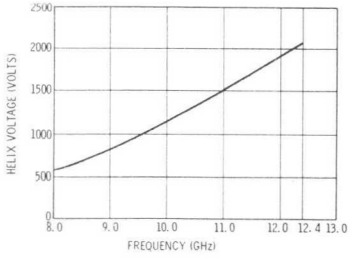
② 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

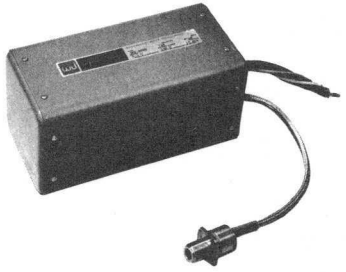
WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2039-51

The WJ-2039-51 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2039-51 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.



The WJ-2039-51 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 7.0-12.4 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60-125 | 40 Min. |
| 8-12.4 GHz | mW | | 70 Min. |
| Power Output Variation | dB | | 9 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 3 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B. W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 7 | |
| Sensitivity to Anode Voltage | MHz/V | 1.7 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (7.0 GHz) | MHz/V | 7 | |
| Mid-Frequency (9.7 GHz) | MHz/V | 3.5 | |
| High End (12.4 GHz) | MHz/V | 2 | |
| Grid RF Cutoff Voltage | V | —15 | —25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 220 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current* | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 455-2065 | 430-2150 Min/Max |
| Helix Current | mA | 1.2 | 3 Max. |
| Anode Voltage | V | 120 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2039-51

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)

Width, 4 inches (102 mm)

Length, 8 inches (203 mm)

Weight, 9.5 lbs. (4.31 Kg) Max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, Type N, Female

Magnetically Shielded

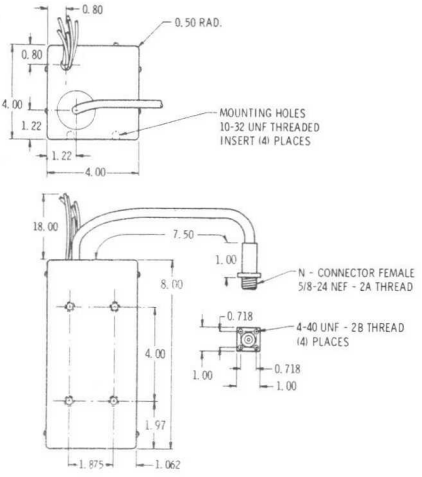
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

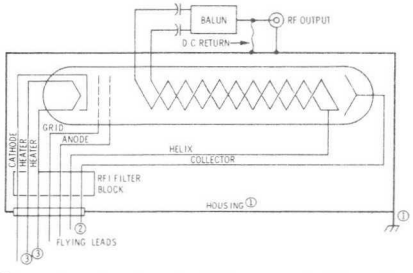
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

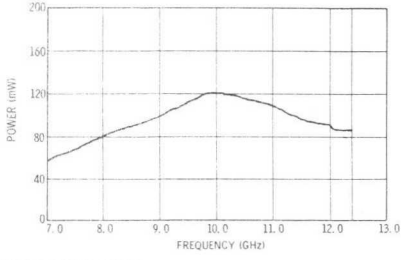



①For safety, housing should be grounded through mounting screws.

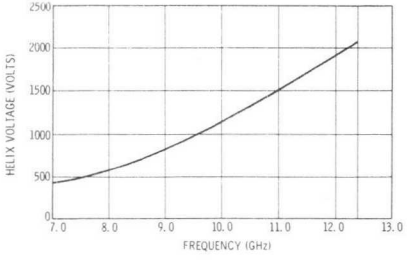
②45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



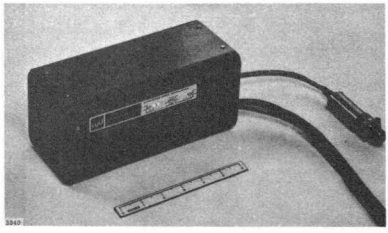
# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-2040

## BACKWARD-WAVE OSCILLATOR

January 1968 *



The WJ-2040 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2040 ideal for use in signal generating and sweeping equipment. The WJ-2040 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2040 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2.0-4.5 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 60 - 350 | 50 Min. |
| Power Output Variation | dB | | 9 Max. |
| Fine Grain Variation | dB/250 MHz | | 4 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 4 | 10 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-Term Sensitivity to Heater Voltage at 3.25 GHz | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 6 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 3.5 | |
| Mid-Frequency (3.25 GHz) | MHz/V | 1.6 | |
| High End (4.5 GHz) | MHz/V | 1 | |
| Grid RF Cutoff Voltage at 3.25 GHz | V | -10 | -20 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 245 | 300 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min/Max |
| Cathode Current[1] | mA | 12.5 | 15 Max. |
| Helix Voltage Range | V | 290-1750 | 275-1800 Min/Max |
| Helix Current | | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

[1] Set Cathode Current to Final Test Data value furnished with tube.

* This is a revised version of Technical Data Sheet issued September 1967.

## MECHANICAL DATA

Weight, 9.7 lbs. Max.
Color Code for 18" Flying Leads

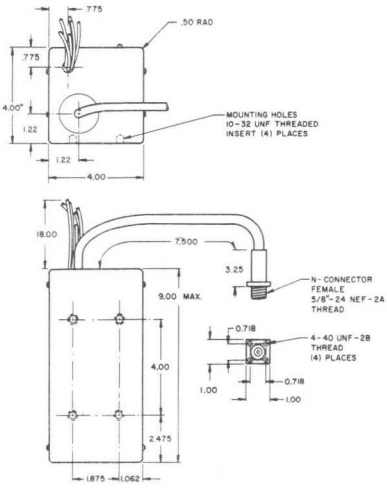
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

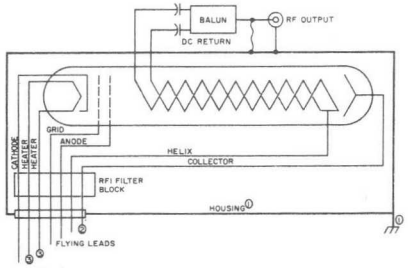
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



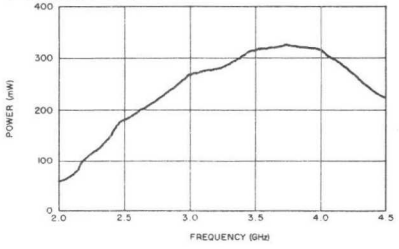

Notes:

① For safety, housing should be grounded through mounting screws.

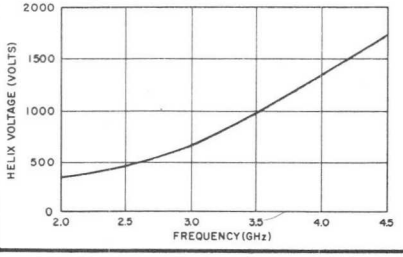
② 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

③ Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



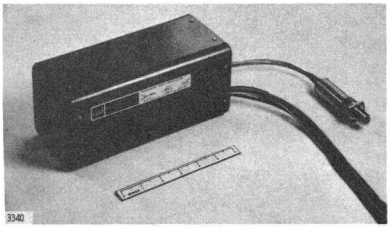
# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

# WJ-2040-2

February 1968




The WJ-2040-2 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2040-2 ideal for use in signal generating and sweeping equipment. The WJ-2040-2 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2040-2 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2.0 - 4.0 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 60-330 | 50 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 4 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 4 | 6 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage at 3GHz | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 6 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 3.5 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 1.6 | |
| High End (4.0 GHz) | MHz/V | 1 | |
| Grid r.f. Cutoff Voltage | V | -8 | -20 Max. |
| Capacitance; Cathode to all other Electrodes incl. Heater and Housing | pf | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes, incl. Housing | pf | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pf | 245 | 300 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min./Max. |
| Cathode Current * | mA | 12.5 | 15 Max. |
| Helix Voltage Range | V | 290-1320 | 275-1400 Min./Max. |
| Helix Current | | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 9.7 lbs. Max.
Color Code for 18" Flying Leads

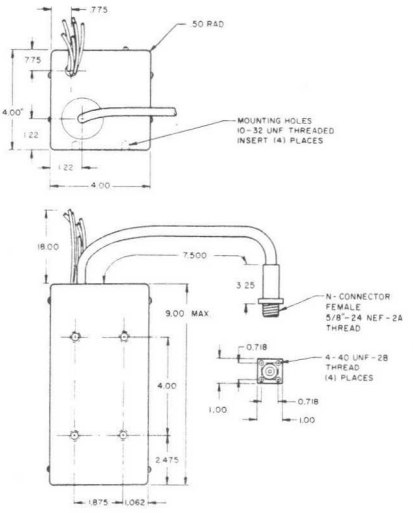
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

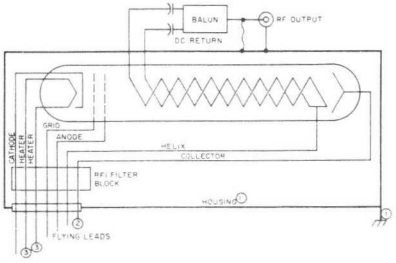
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING



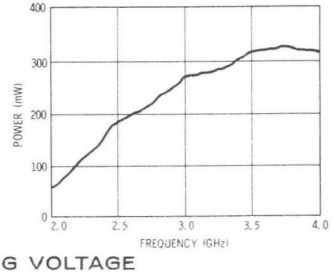

## SCHEMATIC DIAGRAM



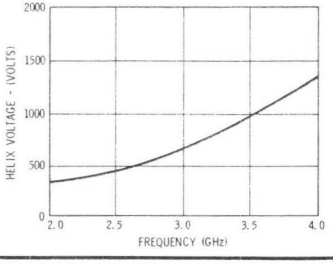

Notes:

1. For safety, housing should be grounded through mounting screws.
2. 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



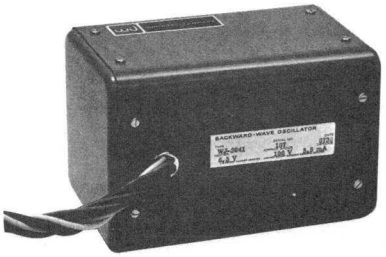
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969 *

## BACKWARD-WAVE OSCILLATOR
## WJ-2041

The WJ-2041 is a magnetically shielded and RFI shielded, voltage tunable oscillator, utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 10 gauss, 1/2 inch from any point of the housing. RFI shielding and filtering allow the WJ-2041 to meet levels of MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2041 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2041 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.




## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 26.5 - 40.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 12 - 35 | 10 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/500 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 6 | 10 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Max. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 30 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 25 | |
| Tuning Curve Slope | | | |
| Low End (26.5 GHz) | MHz/V | 20 | |
| Mid-Frequency (33.25 GHz) | MHz/V | 10 | |
| High End (40 GHz) | MHz/V | 6 | |
| Grid RF Cutoff Voltage | V | -7 | -20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pf | 35 | 50 Max. |
| Capacitance; Grid to all other Electrodes and Housing | pf | 25 | 50 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pf | 60 | 100 Max. |
| Heater Voltage | Vdc | | 6.3 ± 5% |
| Heater Current | A | .65 | 0.4-1.2 |
| Cathode Current[1] | mA | 4 | 5 Max. |
| Helix Voltage Range | V | 520-1940 | 500-2100 |
| Helix Current | mA | 1.0 | 1.5 Max. |
| Anode Voltage | V | 150 | 250 Max. |
| Anode Current | mA | .05 | .5 Max. |

1. Set Cathode Current to Final Test Data value furnished with tube.

* Supersedes WJ-2041 Technical Data Sheet dated February 1968.

## MECHANICAL DATA

Weight, 6.5 lbs. Max.
Color Code for 18" Flying Leads

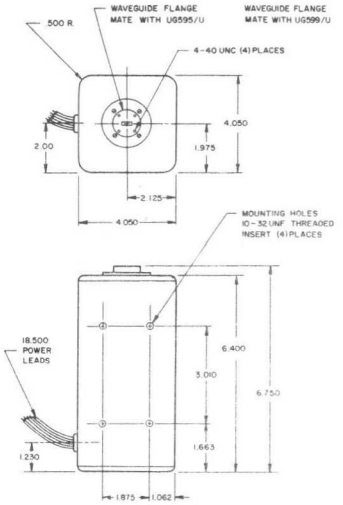
| | |
|---|---|
| Heater | Brown |
| Heater | Black (neg) |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |
| Cathode | Yellow |

Mounting Position, any
RF Output Connector mates to UG599/U Waveguide Flange
Magnetically Shielded

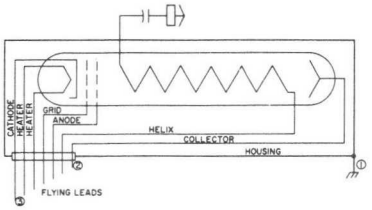
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials - None Required
No Forced Air Cooling Required Below +60° C Ambient
RFI Shielded and Filtered to Meet Levels of MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM

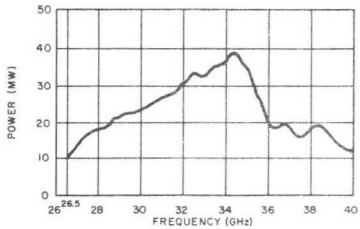



(1) For safety, housing should be grounded through mounting screws.

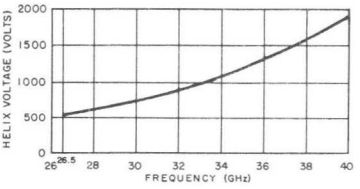
(2) 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-2042

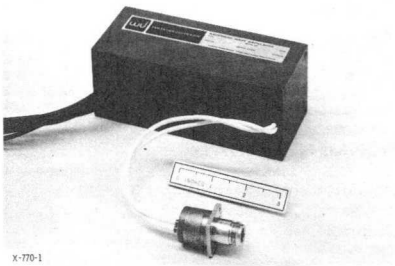
## BACKWARD-WAVE OSCILLATOR

September 1968

The WJ-2042 is a magnetically and RFI shielded voltage tunable oscillator utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Unsaturated magnetic shielding reduces the magnetic field strength at any point, 1/2 inch from the housing, to a value of less than 10 gauss. Interference requirements of MIL-STD-461 are met or exceeded by integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields, and extremely low RF radiation, makes the WJ-2042 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receiver (as local oscillator), frequency diversity transmitters, and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2042 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



X-770-1

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 7.5 - 11.0 |
| Power Output Into Load With VSWR = 1.25 : 1 | mW | 35 - 85 | 30 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5 : 1 Max. |
| Frequency Pulling Into 2 : 1 Load (Any Phase) | MHz | 1.5 | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-Term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (7.5 GHz) | MHz/V | 13.5 | |
| Mid-Frequency (9.25 GHz) | MHz/V | 8.4 | |
| High End (11.0 GHz) | MHz/V | 5.5 | |
| Grid RF Cutoff Voltage | V | -10 | -20 Max. |
| Capacitance; Cathode to All Other Electrodes, Including Heater and Housing | pF | 36 | 50 |
| Capacitance; Grid to All Other Electrodes, Including Housing | pF | 34 | 50 |
| Capacitance; Helix and Collector to All Other Electrodes and Housing | pF | 160 | 185 |
| Heater Voltage | V dc | | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4 Min.<br>1.2 Max. |
| Cathode Current* | mA | 10 | 12 Max. |
| Helix Voltage Range | V | 285 - 720 | 250 Min.<br>800 Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

* Set cathode current to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 4.0 lbs. Max.
Color Code for 18" Flying Leads

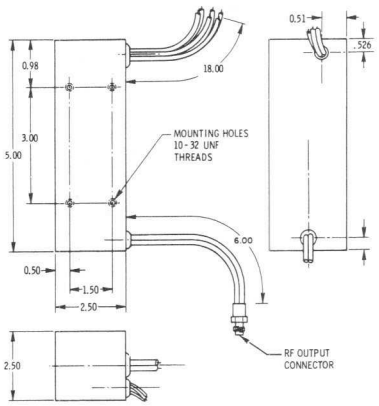
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

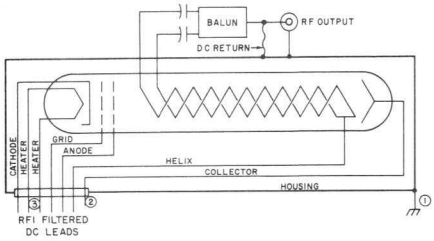
## ENVIRONMENTAL DATA

Separation From Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60° C Ambient
RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



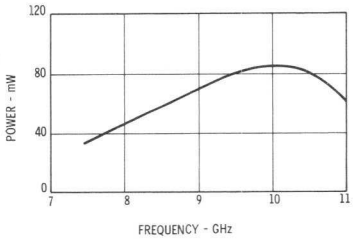

Notes:

(1) For safety, housing should be grounded through mounting screws.

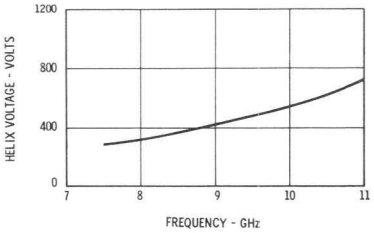
(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

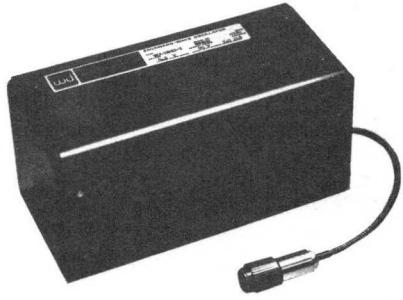
SEPTEMBER 1969 *

## BACKWARD-WAVE OSCILLATOR
## WJ-2043

The WJ-2043 is a magnetically and RFI shielded voltage tunable oscillator utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation, makes the WJ-2043 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), in frequency diversity transmitters and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2043 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 12.4-18.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50-100 | 40 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 15 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz BW | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 15 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 8 | |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 7.5 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Grid RF Cutoff Voltage | V | −10 | −20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 50 | 90 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 40 | 80 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 130 | 170 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min./Max. |
| Cathode Current[1] | mA | 10.0 | 15 Max. |
| Helix Voltage Range | V | 570-1930 | 500-2100 Min./Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

[1]Set cathode current to Final Test Data value furnished with tube.
*Supersedes WJ-2043 Technical Data Sheet dated June 1968.

# WJ-2043

## MECHANICAL CHARACTERISTICS

Height . . . . . 4 inches (102 mm) max.
Width . . . . . 4 inches (102 mm) max.
Length . . . . . 8 inches (203 mm) max.
Weight . . . . . 5.5 pounds (2.49 Kg) max.
Color Code for 18" Flying Leads

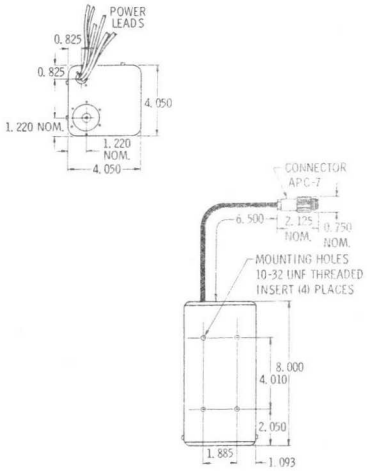
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Coaxial Type APC-7
Magnetically Shielded

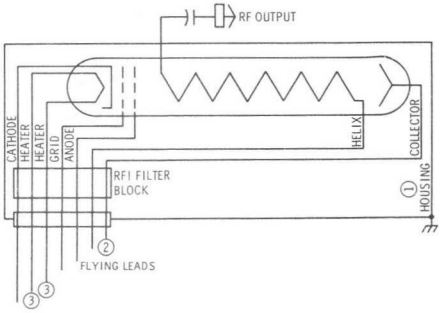
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below —60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING



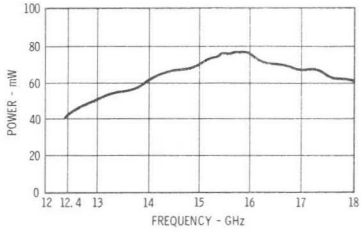

## SCHEMATIC DIAGRAM



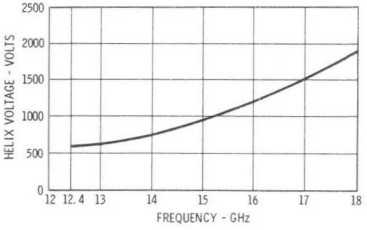

Notes:

1. For safety, housing should be grounded through mounting screws.
2. 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WJ WATKINS-JOHNSON

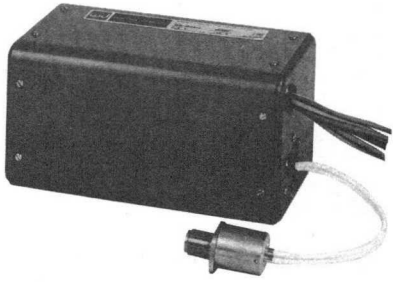
*MARCH 1972

## BACKWARD-WAVE OSCILLATOR
## WJ-2044

The WJ-2044 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2044 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2044 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 4.0-10.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 25—115 | 20 Min. |
| Power Output Variation | dB | 6.0 | 8 Max. |
| Fine Grain Variation | dB / 250 MHz | 1.0 | 3 Max. |
| Tube VSWR | | 2:1 | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 2.0 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 11 | |
| Sensitivity to Anode Voltage | MHz/V | 1.5 | |
| Sensitivity to Grid Voltage | MHz/V | 8 | |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 7.89 | |
| Mid-Frequency (7.0 GHz) | MHz/V | 3.76 | |
| High End (10.0 GHz) | MHz/V | 1.79 | |
| Grid RF Cutoff Voltage | V | —11 | —25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 70 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 70 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 210 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current [1] | mA | 6.5 | 10.5 Max. |
| Helix Voltage Range | V | 226-1974 | 215-2073 Min./Max. |
| Helix Current | mA | 0.8 | 3 Max. |
| Anode Voltage | V | 110 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

NOTE 1: Set cathode current to Final Test Data value furnished with tube.

*Supersedes WJ-2044 Technical Data Sheet dated March 1971.

# WJ-2044

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

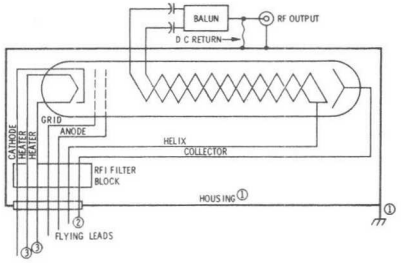
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, mates with Type N Male Connector

## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded
Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

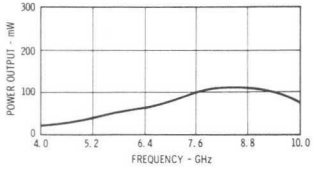
## SCHEMATIC DIAGRAM



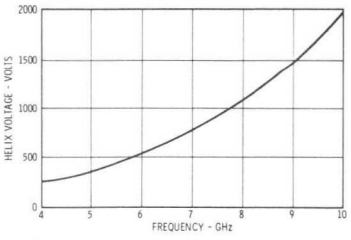

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

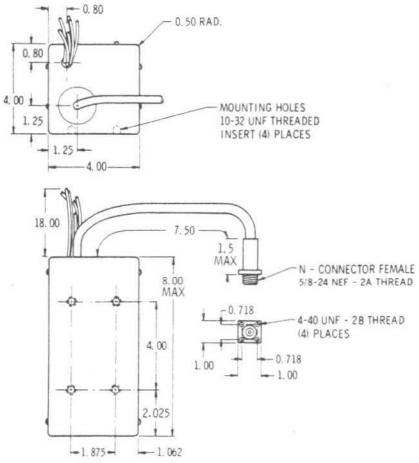
## POWER OUTPUT




## TUNING VOLTAGE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## BACKWARD-WAVE OSCILLATOR WJ-2045

The WJ-2045 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering is provided.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2045 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2045 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 4.0–8.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60–220 | 50 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.9 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 6.2 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 4.2 | |
| High End (8.0 GHz) | MHz/V | 2.3 | |
| Grid RF Cutoff Voltage | V | −11 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 70 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 70 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 210 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current* | mA | 9 | 12 Max. |
| Helix Voltage Range | V | 288-1437 | 270–1500 Min./Max. |
| Helix Current | mA | 1.2 | 4 Max. |
| Anode Voltage | V | 120 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2045

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

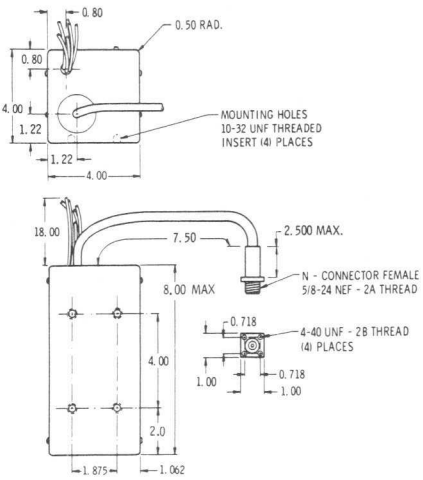
Mounting Position, Any

RF Output Connector, Type N Female on Balun

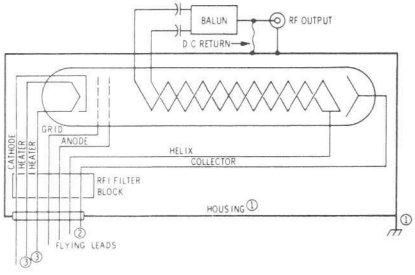
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded
Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING



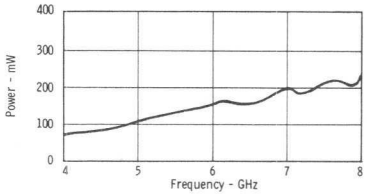

## SCHEMATIC DIAGRAM



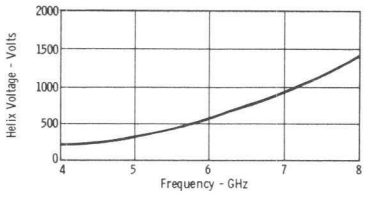

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

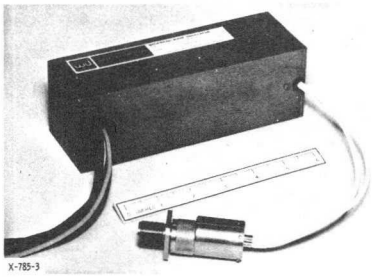
WATKINS-JOHNSON

# WJ-2047

November 1968

## BACKWARD-WAVE OSCILLATOR

The type WJ-2047 is a bifilar (dual-helix), voltage tunable oscillator utilizing permanent magnet focusing. This wide band oscillator is well suited for use as a swept signal source in highly stable signal generators. Other applications include local oscillators in ECM receivers, master oscillators in frequency diversity transmitters, and electronic test sets. The WJ-2047 delivers smooth power output over the band with low operating cathode current. Power output can be modulated with either the grid or the anode circuits. All voltages are isolated from the tube housing for maximum flexibility in circuit applications.



X-785-3

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 4.0 - 8.0 |
| Power Output Into Load With VSWR = 1.25 : 1 | mW | 60 - 125 | 40 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5 : 1 Max. |
| Frequency Pulling Into 2 : 1 Load (Any Phase) | MHz | 1 | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Min. |
| Long-Term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 5 | |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 7.5 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 3.7 | |
| High End (8.0 GHz) | MHz/V | 2.3 | |
| Grid RF Cutoff Voltage | V | -8 | -20 Max. |
| Capacitance; Cathode to All Other Electrodes, Including Heater and Housing | pF | 22 | 50 Max. |
| Capacitance; Grid to All Other Electrodes, Including Housing | pF | 20 | 50 Max. |
| Capacitance; Helix and Collector to All Other Electrodes and Housing | pF | 230 | 300 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4 Min.<br>1.2 Max. |
| Cathode Current | mA | 10 | 15 Max. |
| Helix Voltage Range | V | 290 - 1430 | 270 Min.<br>1500 Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage* | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 6.0 lbs. Max.
Color Code for 18" Flying Leads

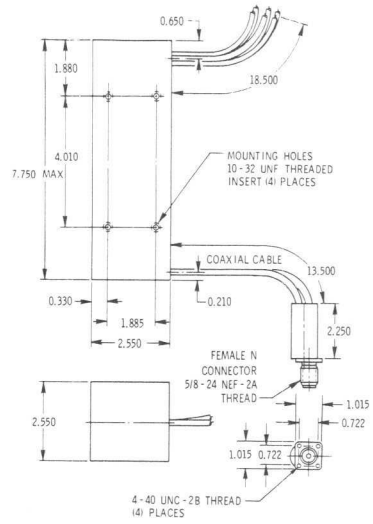
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female

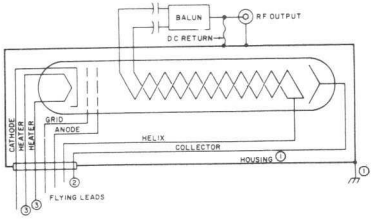
## ENVIRONMENTAL DATA

Separation From Passive Magnetic Materials, 2 in. Min.
No Forced Air Cooling Required Below +60° C Ambient

## OUTLINE DRAWING



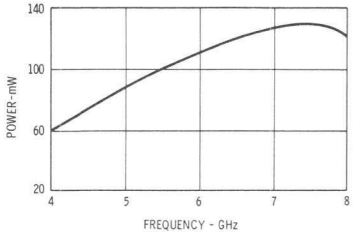

## SCHEMATIC DIAGRAM



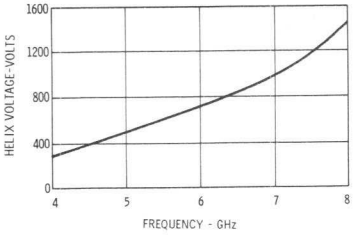

Notes:

1. For safety, housing should be grounded through mounting screws.
2. 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

JUNE 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2049

The WJ-2049 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2049 ideal for use in signal generating and sweeping equipment. The WJ-2049 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2049 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 3.5-6.75 | |
| Power Output into Load with VSWR = 1.25:1 | mW | 50-120 | |
| Power Output Variation | dB | | 40 Min. |
| Fine Grain Variation | dB/250 MHz | | 8 Max. |
| Tube VSWR | | | 3 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 2.5:1 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B. W. | 95 | 3 Max. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | 20 Min. |
| Sensitivity to Anode Voltage | MHz/V | 0.9 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (3.500 GHz) | MHz/V | 4.7 | |
| Mid-Frequency (5.125 GHz) | MHz/V | 2.2 | |
| High End (6.750 GHz) | MHz/V | 1.1 | |
| Grid RF Cutoff Voltage | V | −11 | −20 Max. |
| Capacitance; Cathode to all other Electrodes, including heater and housing | pF | 55 | 70 Max. |
| Capacitance; Grid to all other Electrodes; including Housing | pF | 55 | 70 Max. |
| Capacitance; Helix and collector to all other Electrodes and Housing | pF | 210 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4-1.2 Min./Max. |
| Cathode Current | mA | 9 | 13 Max. |
| Helix Voltage Range | V | | 380-2050 Min./Max. |
| Helix Current | mA | 1.2 | 3 Max. |
| Anode Voltage* | V | 120 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

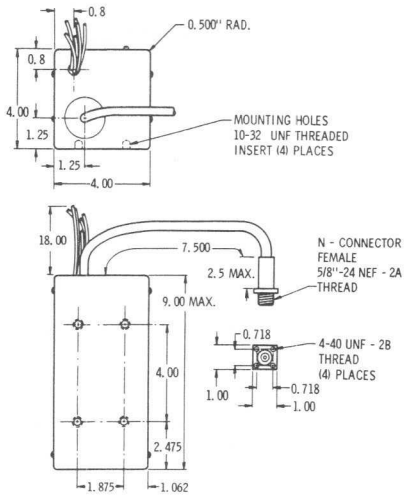
*Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL CHARACTERISTICS

Weight, 9.7 lbs. Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

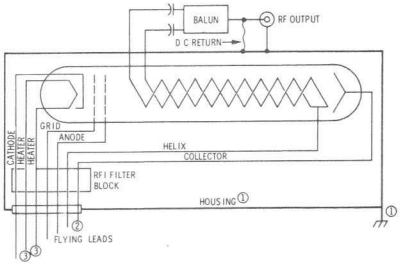
Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded




## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials.
None Required
No Forced Air Cooling Required Below
+60°C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

## SCHEMATIC DIAGRAM



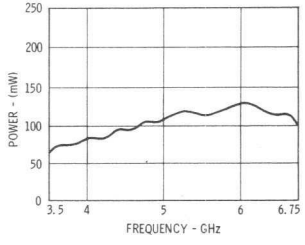

**Notes:**

(1.) For safety, housing should be grounded through mounting screws.

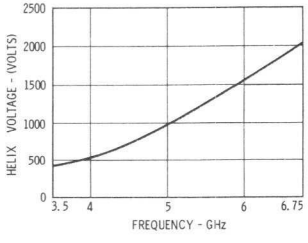
(2.) 50-150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3.) Heater must always be negative with respect to cathode. Positive heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



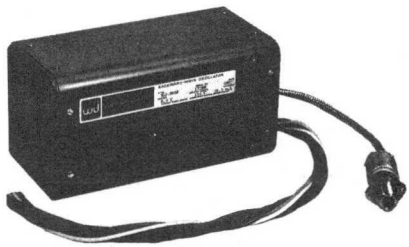
# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2049-50

The WJ-2049-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2049-50 ideal for use in signal generating and sweeping equipment. The WJ-2049-50 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2049-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 3.5-6.75 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50-130 | 40 Min. |
| Power Output Variation | dB | | 7 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B. W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 0.5 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (3.500 GHz) | MHz/V | 3.5 | |
| Mid-Frequency (5.125 GHz) | MHz/V | 2.5 | |
| High End (6.750 GHz) | MHz/V | 1.1 | |
| Grid RF Cutoff Voltage | V | −7 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including heater and housing | pF | 30 | 45 Max. |
| Capacitance; Grid to all other Electrodes; including Housing | pF | 30 | 45 Max. |
| Capacitance; Helix and collector to all other Electrodes and Housing | pF | 100 | 150 Max. |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | 0.85 | 0.4-1.2 Min./Max. |
| Cathode Current* | mA | 8 | 12 Max. |
| Helix Voltage Range | V | 400-2040 | 350-2100 Min./Max. |
| Helix Current | mA | 2 | 3 Max. |
| Anode Voltage | V | 175 | 215 Max. |
| Anode Current | mA | 0.5 | 2.0 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2049-50

## MECHANICAL CHARACTERISTICS

Height . . . . . 4 inches (102 mm)
Width . . . . . 4 inches (102 mm)
Length . . . . . 9 inches (229 mm)
Weight . . . . . 11.3 pounds (5.13 Kg) Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black (neg) |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, Type N Female

Magnetically Shielded

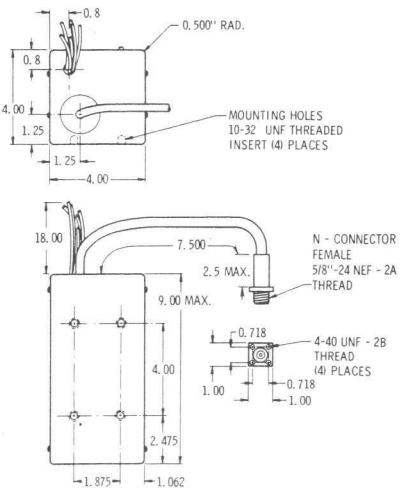
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

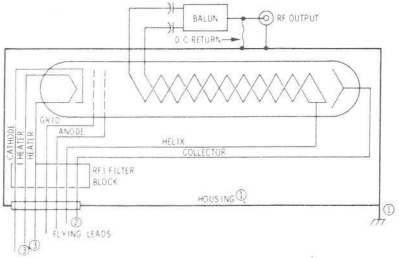
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



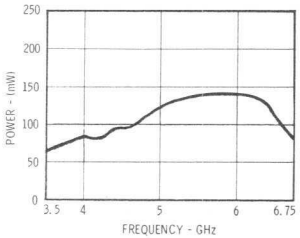

Notes:

(1) For safety, housing should be grounded through mounting screws.

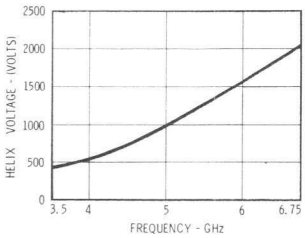
(2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

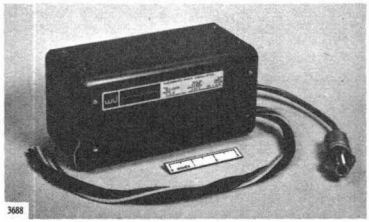
WATKINS-JOHNSON

# WJ-2050

## BACKWARD-WAVE OSCILLATOR

APRIL 1969

The WJ-2050 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2050 ideal for use in signal generating and sweeping equipment. The WJ-2050 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2050 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.




## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 4.0 - 8.0 | |
| Power Output into Load with VSWR = 1.25 : 1 | mW | 40 - 100 | 30 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/200 MHz | | 3 Max. |
| Tube VSWR | | | 2.5 : 1 Max. |
| Frequency Pulling into 2 : 1 Load (Any Phase) | MHz | 2 | 4 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz BW | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.9 | |
| Sensitivity to Grid Voltage | MHz/V | 7 | |
| Tuning Curve Slope | | | |
| Low End (4.0 GHz) | MHz/V | 6 | |
| Mid-Frequency (6.0 GHz) | MHz/V | 3 | |
| High End (8.0 GHz) | MHz/V | 1.5 | |
| Grid RF Cutoff Voltage | V | -11 | -20 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 70 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 70 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 210 | 250 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4 - 1.2 Min./Max. |
| Cathode Current | mA | 6 | 10 Max. |
| Helix Voltage Range | V | 302 - 1805 | 275 - 1900 Min./Max. |
| Helix Current | mA | 1.2 | 3 Max. |
| Anode Voltage* | V | 110 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 9.5 lbs. Max.
Color Code for 18" Flying Leads

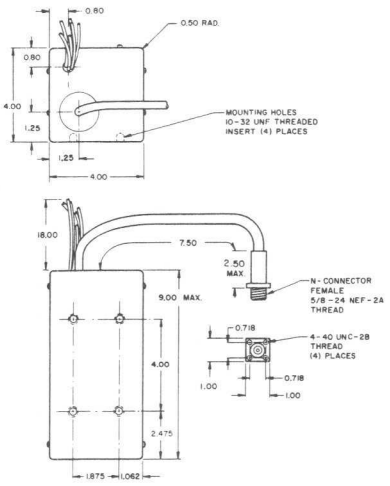
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

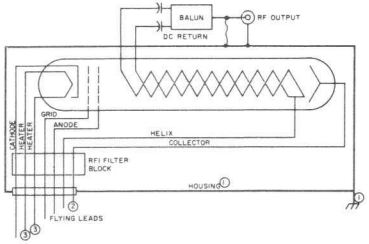
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below $+60^{\circ}$ C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



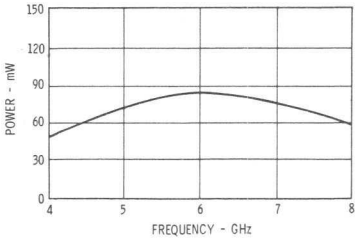

Notes:

(1) For safety, housing should be grounded through mounting screws.

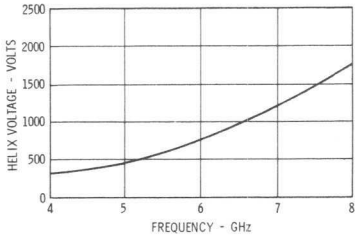
(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

## BACKWARD-WAVE OSCILLATOR

WJ-2051

APRIL 1969

The WJ-2051 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual) helix and a permanent-magnet focusing system. Minimal stray magnetic field, low RF radiation, and an immunity to external ac or dc magnetic fields make the WJ-2051 ideal for use in signal generating and sweeping equipment. The WJ-2051 is also well suited for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2051 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuit. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.


## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | 2.0 - 4.0 | |
| Power Output into Load with VSWR = 1.25 : 1 | mW | 40 - 100 | 30 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/100 MHz | | 3 Max. |
| Tube VSWR | | | 2.5 : 1 Max. |
| Frequency Pulling into 2 : 1 Load (Any Phase) | MHz | 3 | 6 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz BW | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 1.0 | |
| Sensitivity to Grid Voltage | MHz/V | 6 | |
| Tuning Curve Slope | | | |
| Low End (2.0 GHz) | MHz/V | 3.5 | |
| Mid-Frequency (3.0 GHz) | MHz/V | 2.2 | |
| High End (4.0 GHz) | MHz/V | 1.3 | |
| Grid RF Cutoff Voltage | V | -7 | -20 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 55 | 75 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 55 | 75 Max. |
| Capacitance; Helix and Collector to all other Electrodes and Housing | pF | 245 | 275 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4 - 1.2 Min./Max. |
| Cathode Current | mA | 8 | 10 Max. |
| Helix Voltage Range | V | 285 - 1310 | 250 - 1500 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage* | V | 110 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

* Set anode voltage to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 11.0 lbs. Max.
Color Code for 18" Flying Leads

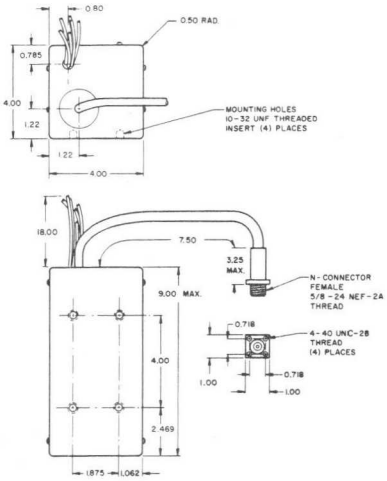
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Type N Female
Magnetically Shielded

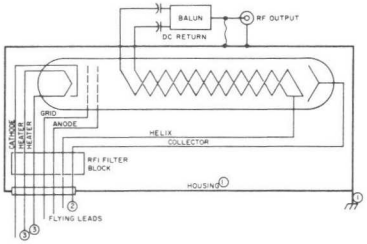
## ENVIRONMENTAL DATA

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below $+60^{0}$ C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



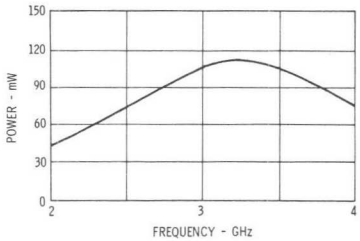

Notes:

(1) For safety, housing should be grounded through mounting screws.

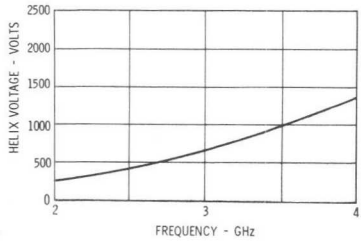
(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

# WJ-2052

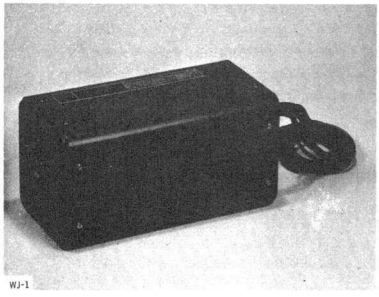
## BACKWARD-WAVE OSCILLATOR

November 1968

The WJ-2052 is a magnetically and RFI shielded voltage tunable oscillator utilizing a single helix and permanent magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Unsaturated magnetic shielding reduces the magnetic field strength at any point, 1/2 inch from the housing, to a value of less than 10 gauss. Interference requirements of MIL-STD-461 are met or exceeded by integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields, and extremely low RF radiation, makes the WJ-2052 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters, and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2052 delivers smooth power output over the band with low operating cathode current and low electrode voltages. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



WJ-1

## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 12.4 - 18.0 |
| Power Output Into Load With VSWR = 1.25 : 1 | mW | 40 - 100 | 20 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/500 MHz | | 3 Max. |
| Tube VSWR | | | 2.5 : 1 Max. |
| Frequency Pulling Into 2 : 1 Load (Any Phase) | MHz | 1 | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Max. |
| Long-Term Sensitivity to Heater Voltage | MHz/V | 5 | |
| Sensitivity to Anode Voltage | MHz/V | 3.5 | |
| Sensitivity to Grid Voltage | MHz/V | 4.4 | |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 10.0 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 5.9 | |
| High End (18.0 GHz) | MHz/V | 3.5 | |
| Grid RF Cutoff Voltage | V | -10 | -20 Max. |
| Capacitance; Cathode to All Other Electrodes Including Heater and Housing | pF | 40 | 75 Max. |
| Capacitance; Grid to All Other Electrodes and Housing | pF | 40 | 75 Max. |
| Capacitance; Helix and Collector to All Other Electrodes and Housing | pF | 130 | 170 Max. |
| Heater Voltage | V dc | | 6.3 ± 5% |
| Heater Current | A | 0.67 | 0.4 Min.<br>1.2 Max. |
| Cathode Current* | mA | 10 | 15 Max. |
| Helix Voltage Range | V | 418 - 1417 | 350 Min.<br>1500 Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

* Set cathode current to Final Test Data value furnished with tube.

## MECHANICAL DATA

Weight, 6.5 lbs. Max.
Color Code for 18" Flying Leads

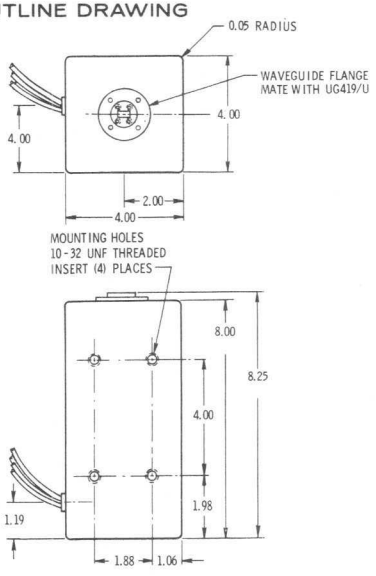
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, Mate With UG 419/U Waveguide Flange
Magnetically Shielded

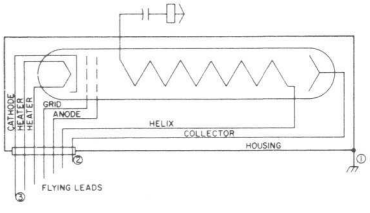
## ENVIRONMENTAL DATA

Separation From Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60° C Ambient
RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



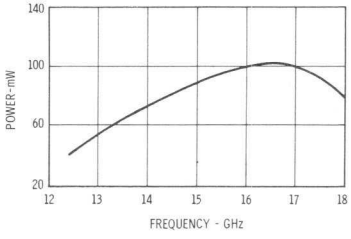

Notes:

(1) For safety, housing should be grounded through mounting screws.

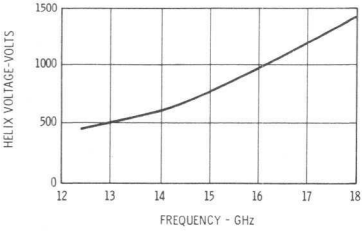
(2) 50 - 150 V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

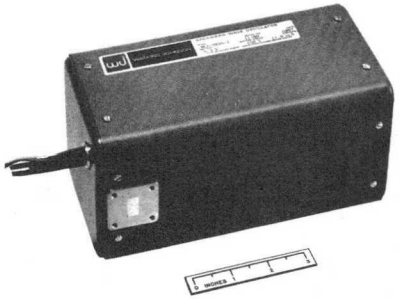
APRIL 1969

## BACKWARD-WAVE OSCILLATOR WJ-2056

The WJ-2056 is a magnetically and RFI shielded, voltage-tunable oscillator, utilizing a single helix and permanent-magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by the integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation make the WJ-2056 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters and ECM equipment (as master oscillator.).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2056 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 12.4 - 18.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50 - 100 | 40 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 15 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz BW | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 15 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 8 | |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 7.5 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Grid RF Cutoff Voltage | V | —10 | —20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 50 | 90 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 40 | 80 Max. |
| Capitance; Helix and Collector to all other Electrodes and Housing | pF | 130 | 170 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min./Max. |
| Cathode Current* | mA | 10.0 | 15 Max. |
| Helix Voltage Range | V | 570 - 1930 | 500 - 2100 Min./Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2056

## MECHANICAL CHARACTERISTICS

Height . . . . . 4 inches (102 mm)
Width . . . . . 4 inches (102 mm)
Length . . . . . 8 inches (203 mm)
Weight . . . . . 9 pounds (4.08 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, Mate with UG 419/U

Separation from Passive Magnetic Materials, None Required

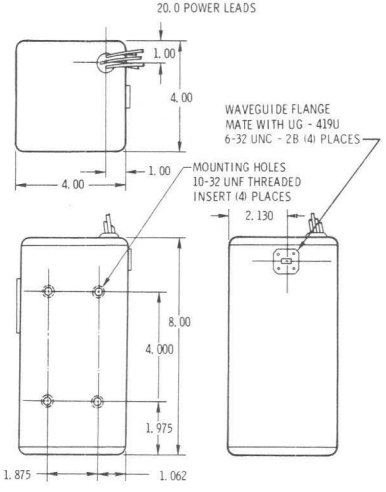
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded

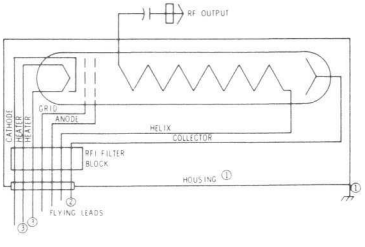
No Forced-Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



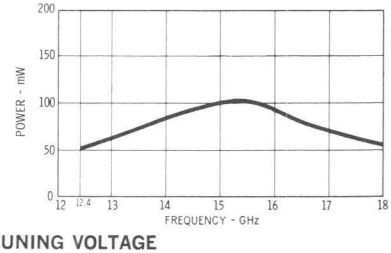

Notes:

(1.) For safety, housing should be grounded through mounting screws.

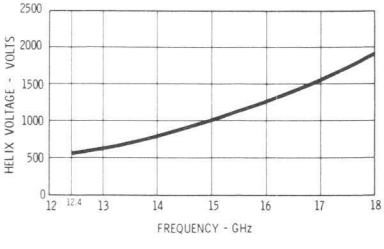
(2.) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

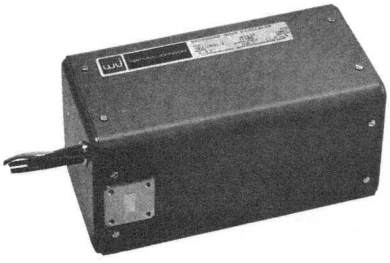
DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2056-50

The WJ-2056-50 is a magnetically and RFI shielded, voltage-tunable oscillator, utilizing a single helix and permanent-magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by the integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation make the WJ-2056-50 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2056-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 12.4 - 18.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50 - 100 | 50 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 15 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz BW | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 15 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 8 | |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 7.5 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Grid RF Cutoff Voltage | V | —10 | —25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 50 | 90 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 40 | 80 Max. |
| Capitance; Helix and Collector to all other Electrodes and Housing | pF | 130 | 170 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min./Max. |
| Cathode Current* | mA | 10.0 | 15 Max. |
| Helix Voltage Range | V | 570 - 1930 | 500 - 2100 Min./Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2056-50

## MECHANICAL CHARACTERISTICS

Height . . . . . 4 inches (102 mm)
Width . . . . . 4 inches (102 mm)
Length . . . . . 8 inches (203 mm)
Weight . . . . . 9 pounds (4.08 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, Mate with UG 419/U

Separation from Passive Magnetic Materials, None Required

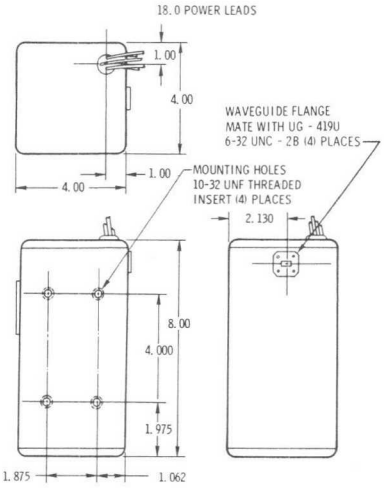
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded

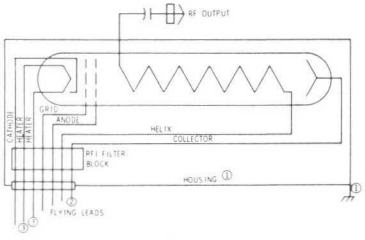
No Forced-Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



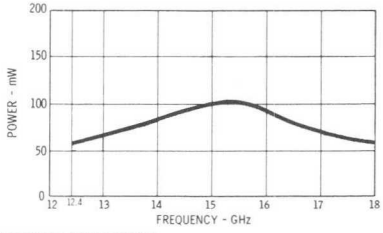

Notes:

(1.) For safety, housing should be grounded through mounting screws.

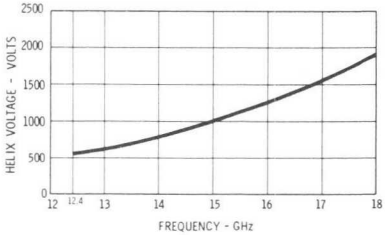
(2.) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



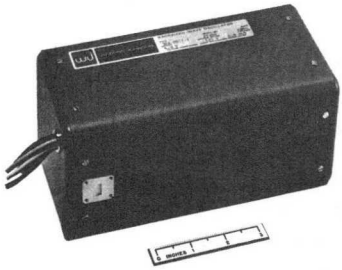
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969

## BACKWARD-WAVE OSCILLATOR WJ-2057

The WJ-2057 is a magnetically shielded and RFI shielded, voltage tunable oscillator, utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 10 gauss, ½ inch from any point of the housing. RFI shielding and filtering allow the WJ-2057 to meet levels of MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2057 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2057 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 18.0 - 26.5 |
| Power Output into Load with VSWR = 1.25 | mW | 22 - 70 | 20 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 6 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | dB | 50 | 40 Min. |
| Ratio or Signal to Noise Power 30 MHz away | dB/MHz | 90 | 80 Min. |
| Sensitivity to Heater Voltage | MHz/V | 35 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 10 | |
| Tuning Curve Slope | | | |
| Low End (18 MHz) | MHz/V | 12 | |
| Mid-Frequency (22.5 MHz) | MHz/V | 6.5 | |
| High End (26.5 MHz) | MHz/V | 4 | |
| Grid r.f. Cutoff Voltage | V | —10 | —20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 35 | 50 Max. |
| Capacitance; Grid to all other Electrodes including Heater and Housing | pF | 35 | 50 Max. |
| Capitance; Helix and Collector to all other Electrodes including Heater and Housing | pF | 90 | 130 Max. |
| Heater Voltage | V | | 6.3 ±5% |
| Heater Current | A | 0.67 | 0.4 - 1.2 Min./Max. |
| Cathode Current* | mA | 6 | 10 Max. |
| Helix Voltage Range | V | 530 - 1820 | 450 - 2000 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 115 | 250 Max. |
| Anode Current | mA | 0.2 | 1 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2057

## MECHANICAL CHARACTERISTICS

Height . . . . . 4 inches (102 mm)
Width . . . . . 4 inches (102 mm)
Length . . . . . 8 inches (203 mm)
Weight . . . . . 6.5 pounds (2.95 Kg) max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black (neg) |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, UG-595/U Flange

Magnetically Shielded

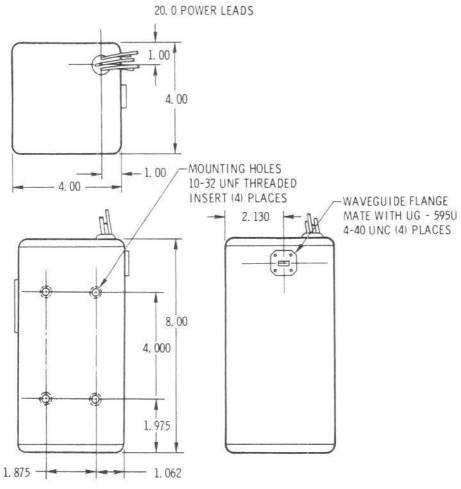
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

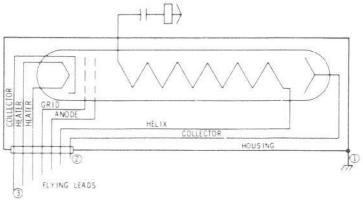
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet Levels of MIL-I-6181D

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



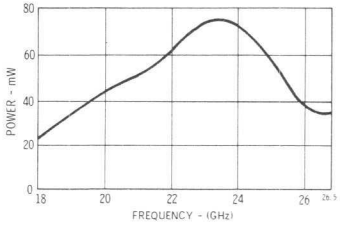

Notes:

(1.) For safety, housing should be grounded through mounting screws.

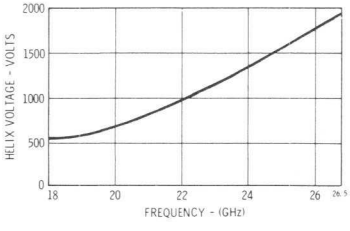
(2.) 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3.) Heater must always be negative with respect to cathode One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2057-50

The WJ-2057-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2057-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2057-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 18.0 - 26.5 |
| Power Output into Load with VSWR = 1.25:1 | mW | 22 - 70 | 20 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 2 | 6 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | dB | 50 | 40 Min. |
| Ratio or Signal to Noise Power 30 MHz away | dB/MHz | 90 | 80 Min. |
| Sensitivity to Heater Voltage | MHz/V | 35 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 10 | |
| Tuning Curve Slope | | | |
| Low End (18 MHz) | MHz/V | 12 | |
| Mid-Frequency (22.5 MHz) | MHz/V | 6.5 | |
| High End (26.5 MHz) | MHz/V | 4 | |
| Grid r.f. Cutoff Voltage | V | −10 | −25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 35 | 50 Max. |
| Capacitance; Grid to all other Electrodes including Heater and Housing | pF | 35 | 50 Max. |
| Capitance; Helix and Collector to all other Electrodes including Heater and Housing | pF | 90 | 130 Max. |
| Heater Voltage | V | | 6.3 ±5% |
| Heater Current | A | 0.67 | 0.4 - 1.2 Min./Max. |
| Cathode Current* | mA | 6 | 10 Max. |
| Helix Voltage Range | V | 520 − 1800 | 480-2050 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 115 | 215 Max. |
| Anode Current | mA | 0.2 | 1 Max. |

* Set Cathode current to Final Test Data value furnished with tube.

# WJ-2057-50

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm)
Weight, 8.0 lbs. (3.63 Kg) Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black (neg) |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, UG-595/U Flange

Magnetically Shielded

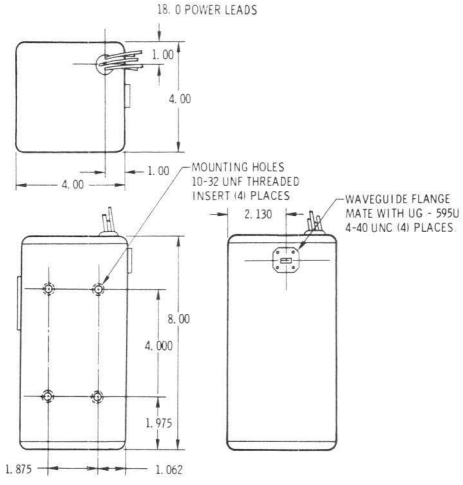
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

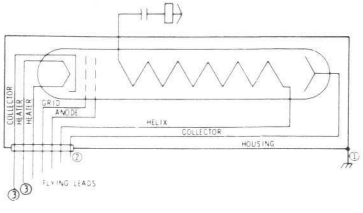
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



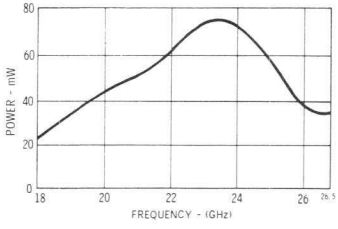

Notes:

(1) For safety, housing should be grounded through mounting screws.

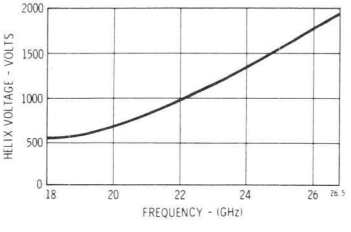
(2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



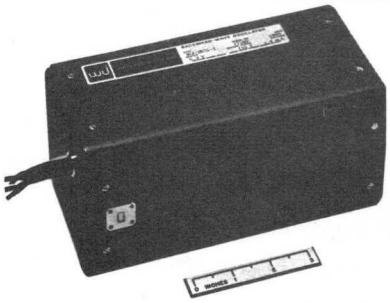
# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969

## BACKWARD-WAVE OSCILLATOR WJ-2058

The WJ-2058 is a magnetically shielded and RFI shielded, voltage tunable oscillator, utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength to less than 10 gauss, ½ inch from any point of the housing. RFI shielding and filtering allow the WJ-2058 to meet levels of MIL-I-6181D. An immunity to external ac or dc magnetic fields, together with minimal stray magnetic fields and low RF radiation, makes the WJ-2058 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. The WJ-2058 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



## SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Nominal Frequency Band | GHz | | 26.5 - 40.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 12-35 | 10 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/500 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 6 | 10 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Max. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 30 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 25 | |
| Tuning Curve Slope | | | |
| Low End (26.5 GHz) | MHz/V | 20 | |
| Mid-Frequency (33.25 GHz) | MHz/V | 10 | |
| High End (40 GHz) | MHz/V | 6 | |
| Grid RF Cutoff Voltage | V | −7 | −20 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | .35 | 50 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | .25 | 50 Max. |
| Capitance; Helix and Collector to all other Electrodes and Housing | pF | .60 | 100 Max. |
| Heater Voltage | V dc | | 6.3 ±5% |
| Heater Current | A | .65 | 0.4 to 1.2 Min./Max. |
| Cathode Current* | mA | 4 | 5 Max. |
| Helix Voltage Range | V | 520-1940 | 500-2100 Min./Max. |
| Helix Current | mA | 1.0 | 1.5 Max. |
| Anode Voltage | V | 150 | 250 Max. |
| Anode Current | mA | .05 | .5 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2058

## MECHANICAL CHARACTERISTICS

Weight, 6.5 lbs. Max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Brown |
| Heater | Black (neg) |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |
| Cathode | Yellow |

Mounting Position, Any

RF Output Connector mates to UG599/U Waveguide Flange

Magnetically Shielded

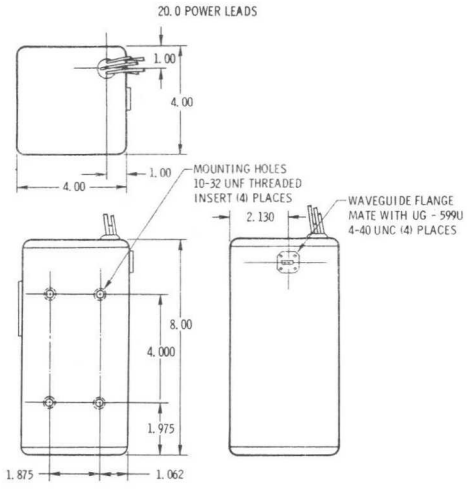
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

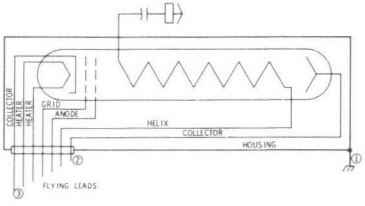
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet Levels of MIL-I-6181D

## OUTLINE DRAWING



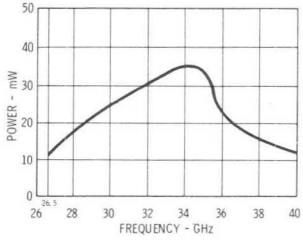

## SCHEMATIC DIAGRAM



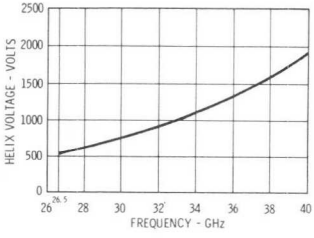

Notes:

1. For safety, housing should be grounded through mounting screws.
2. 50-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode One heater lead may be tied to cathode.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2058-50

The WJ-2058-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2058-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2058-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 26.5 - 40.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 12-35 | 7 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/500 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 6 | 10 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Max. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 30 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 25 | |
| Tuning Curve Slope | | | |
| Low End (26.5 GHz) | MHz/V | 20 | |
| Mid-Frequency (33.25 GHz) | MHz/V | 10 | |
| High End (40 GHz) | MHz/V | 6 | |
| Grid RF Cutoff Voltage | V | —7 | —25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | .35 | 50 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | .25 | 50 Max. |
| Capitance; Helix and Collector to all other Electrodes and Housing | pF | .60 | 100 Max. |
| Heater Voltage | V dc | | 6.3 ±5% |
| Heater Current | A | .65 | 0.4 to 1.2 Min./Max. |
| Cathode Current* | mA | 4 | 5 Max. |
| Helix Voltage Range | V | 520-1940 | 480-2050 Min./Max. |
| Helix Current | mA | 1.0 | 1.5 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | .05 | .5 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2058-50

## MECHANICAL CHARACTERISTICS

Height . . . . . 4 inches (102 mm)
Width . . . . . 4 inches (102 mm)
Length . . . . . 8 inches (204 mm)
Weight . . . . . 8.0 lbs. (3.63 Kg) Max.
Color Code for 18" Flying Leads

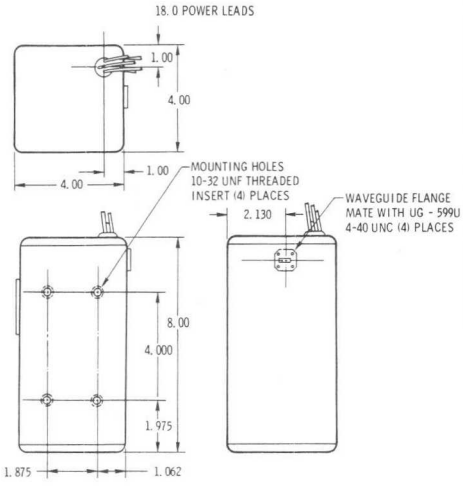
| | |
|---|---|
| Heater | Black (neg) |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector mates to UG599/U Waveguide Flange
Magnetically Shielded

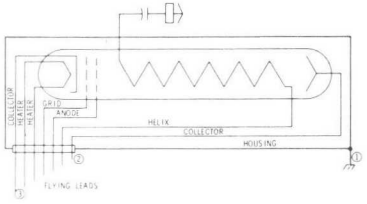
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



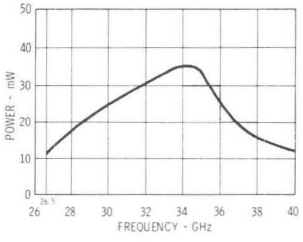

Notes:

(1) For safety, housing should be grounded through mounting screws.

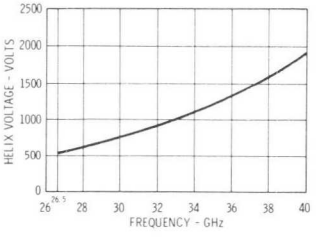
(2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

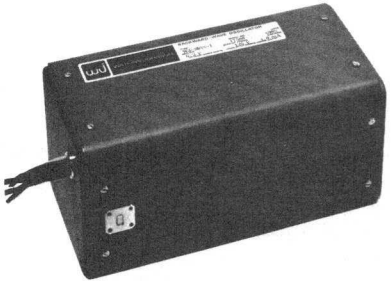
DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR WJ-2060-50

The WJ-2060-50 is a magnetically and RFI shielded, voltage-tunable oscillator, utilizing a single helix and permanent-magnet focusing system to cover the frequency range from 12.4 to 18.0 GHz. Interference requirements of MIL-STD-461 are met or exceeded by the integral RFI shielding and filtering.

The combination of immunity to external ac or dc magnetic fields, minimal stray generated magnetic fields and very low RF radiation make the WJ-2060-50 ideal for a number of applications, including the following: signal generating and sweeping equipment, radar receivers (as local oscillator), frequency diversity transmitters and ECM equipment (as master oscillator).

The fine grain variation of frequency versus voltage is extremely low. The WJ-2060-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from the housing for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 12.4 - 18.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 50 - 100 | 50 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 1 | 15 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz BW | 95 | 85 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 15 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 8 | |
| Tuning Curve Slope | | | |
| Low End (12.4 GHz) | MHz/V | 7.5 | |
| Mid-Frequency (15.2 GHz) | MHz/V | 4.4 | |
| High End (18.0 GHz) | MHz/V | 2.2 | |
| Grid RF Cutoff Voltage | V | —10 | —25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 50 | 90 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 40 | 80 Max. |
| Capitance; Helix and Collector to all other Electrodes and Housing | pF | 130 | 170 Max. |
| Heater Voltage | V dc | 6.3 | 6.3 ±5% |
| Heater Current | A | 0.75 | 0.4 to 1.2 Min./Max. |
| Cathode Current* | mA | 10.0 | 15 Max. |
| Helix Voltage Range | V | 570 - 1930 | 500 - 2100 Min./Max. |
| Helix Current | mA | 1.8 | 3 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.1 | 1 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2060-50

## MECHANICAL CHARACTERISTICS

Height . . . . . 4 inches (102 mm)
Width . . . . . 4 inches (102 mm)
Length . . . . . 8 inches (203 mm)
Weight . . . . . 9 pounds (4.08 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, Mate with UG 419/U

Separation from Passive Magnetic Materials, None Required

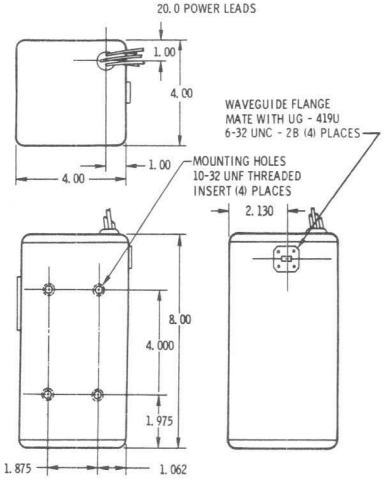
## ENVIRONMENTAL CHARACTERISTICS

Magnetically Shielded

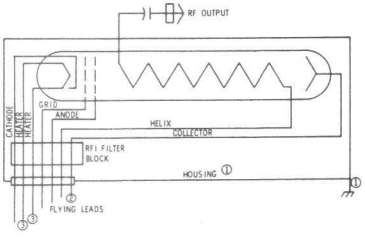
No Forced-Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet or Exceed MIL-STD-461

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



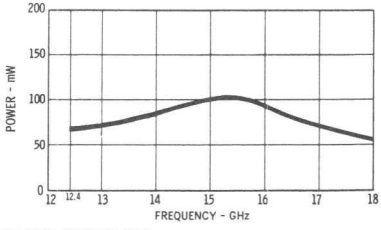

**Notes:**

(1.) For safety, housing should be grounded through mounting screws.

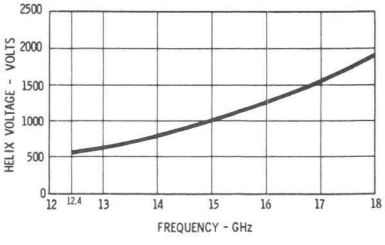
(2.) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3.) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR WJ-2061-50

The WJ-2061-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a single-helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2061-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2061-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 18.0–26.5 |
| Power Output into Load with VSWR = 1.25 | mW | 22–70 | 25 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 2 | 6 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Total Spurious Output | dB | 50 | 40 Min. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 90 | 80 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 35 | |
| Sensitivity to Anode Voltage | MHz/V | 1 | |
| Sensitivity to Grid Voltage | MHz/V | 10 | |
| Tuning Curve Slope | | | |
| Low End (18 MHz) | MHz/V | 12 | |
| Mid-Frequency (22.5 MHz) | MHz/V | 6.5 | |
| High End (26.5 MHz) | MHz/V | 4 | |
| Grid RF Cutoff Voltage | V | −10 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 35 | 50 Max. |
| Capacitance; Grid to all other Electrodes, including Heater and Housing | pF | 35 | 50 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Heater and Housing | pF | 90 | 130 Max. |
| Heater Voltage | Vdc | | 6.3 ±5% |
| Heater Current | A | 0.67 | 0.4–1.2 Min./Max. |
| Cathode Current* | mA | 6 | 10 Max. |
| Helix Voltage Range | V | 560–1950 | 480–2050 Min./Max. |
| Helix Current | mA | 1.5 | 3 Max. |
| Anode Voltage | V | 115 | 215 Max |
| Anode Current | mA | 0.2 | 1 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2061-50

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 8 lbs. (3.63 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

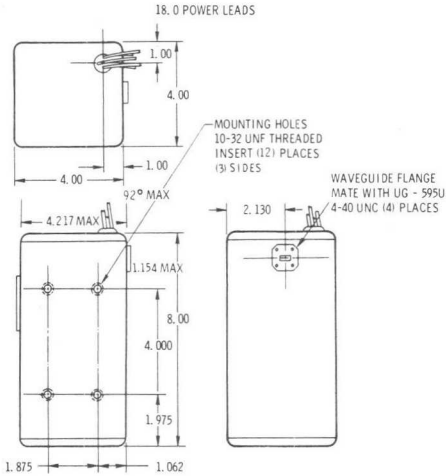
RF Output Connector, UG-595/U Flange

Magnetically Shielded

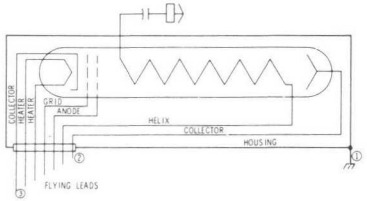
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

## OUTLINE DRAWING



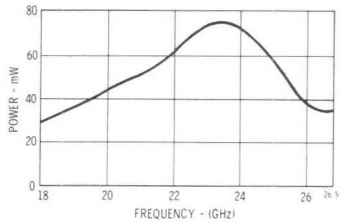

## SCHEMATIC DIAGRAM



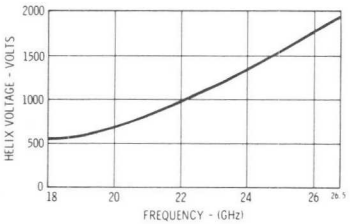

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE



# TECHNICAL DATA

WATKINS-JOHNSON

DECEMBER 1970

## BACKWARD-WAVE OSCILLATOR
## WJ-2062-50

The WJ-2062-50 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2062-50 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2062-50 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 26.5 - 40.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 12-35 | 10 Min. |
| Power Output Variation | dB | | 8 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling into 2:1 Load (Any Phase) | MHz | 6 | 10 Max. |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz | 95 | 85 Max. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 30 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 25 | |
| Tuning Curve Slope | | | |
| Low End (26.5 GHz) | MHz/V | 20 | |
| Mid-Frequency (33.25 GHz) | MHz/V | 10 | |
| High End (40 GHz) | MHz/V | 6 | |
| Grid RF Cutoff Voltage | V | −7 | −25 Max. |
| Capacitance; Cathode to all other Electrodes including Heater and Housing | pF | 35 | 50 Max. |
| Capacitance; Grid to all other Electrodes including Housing | pF | 25 | 50 Max. |
| Capitance; Helix and Collector to all other Electrodes and Housing | pF | 60 | 100 Max. |
| Heater Voltage | V dc | | 6.3 ±5% |
| Heater Current | A | .65 | 0.4 to 1.2 Min./Max. |
| Cathode Current* | mA | 4 | 5 Max. |
| Helix Voltage Range | V | 520-1940 | 480-2050 Min./Max. |
| Helix Current | mA | 1.0 | 1.5 Max. |
| Anode Voltage | V | 150 | 215 Max. |
| Anode Current | mA | .05 | .5 Max. |

*Set cathode current to Final Test Data value furnished with tube.

# WJ-2062-50

## MECHANICAL CHARACTERISTICS

Height . . . . . 4 inches (102 mm)
Width . . . . . 4 inches (102 mm)
Length . . . . . 8 inches (204 mm)
Weight . . . . . 8.0 lbs. (3.63 Kg) Max.
Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black (neg) |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector mates to UG599/U Waveguide Flange

Magnetically Shielded

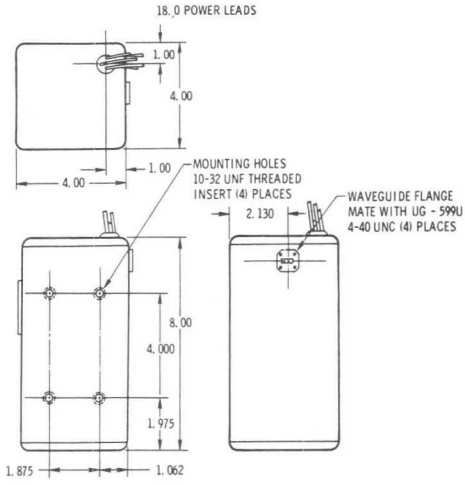
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

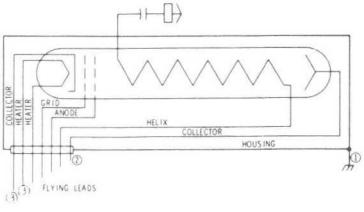
No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered

## OUTLINE DRAWING




## SCHEMATIC DIAGRAM



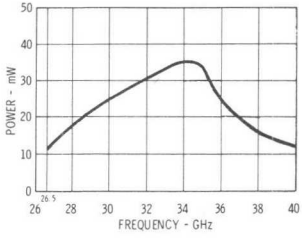

Notes:

(1) For safety, housing should be grounded through mounting screws.

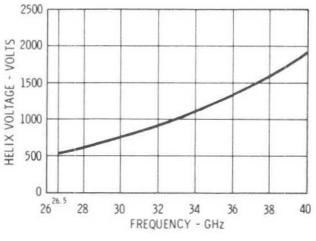
(2) 45-150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.

(3) Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING VOLTAGE

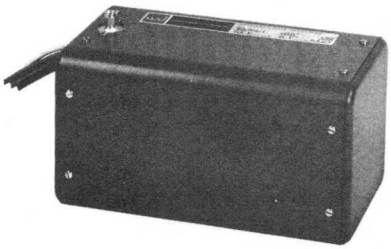


# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1972

## BACKWARD-WAVE OSCILLATOR WJ-2065



The WJ-2065 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a single helix and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering are utilized on this tube.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2065 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2065 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 10.0-20.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 6.5-48 | 5 Min. |
| Power Output Variation | dB | 8.5 | 12 Max. |
| Fine Grain Variation | dB/250 MHz | 1.0 | 3 Max. |
| Tube VSWR | | 2.5:1 | 3.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 0.4 | 4 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 14 | |
| Sensitivity to Anode Voltage | MHz/V | 2.1 | |
| Sensitivity to Grid Voltage | MHz/V | 9 | |
| Tuning Curve Slope | | | |
| Low End (10.0 GHz) | MHz/V | 16.9 | |
| Mid-Frequency (15.0 GHz) | MHz/V | 6.11 | |
| High End (20.0 GHz) | MHz/V | 2.21 | |
| Grid RF Cutoff Voltage | V | —12 | —25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 45 | 55 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 45 | 55 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 230 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.70 | 0.4—1.2 Min./Max. |
| Cathode Current[1] | mA | 6.5 | 12.5 Max. |
| Helix Voltage Range | V | 230-2135 | 218-2242 Min./Max. |
| Helix Current | mA | 1.5 | 3.0 Max. |
| Anode Voltage | V | 100 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

NOTE 1: Set cathode current to Final Test Data value furnished with tube.

# WJ-2065

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.
Color Code for 18" Flying Leads

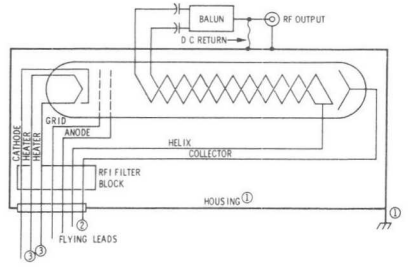
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, mates with SMA 3mm Jack (Female)
Magnetically Shielded

## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered to Meet MIL-I-6181D

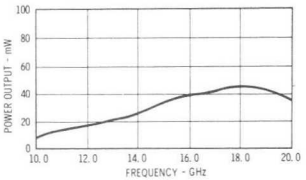
## SCHEMATIC DIAGRAM



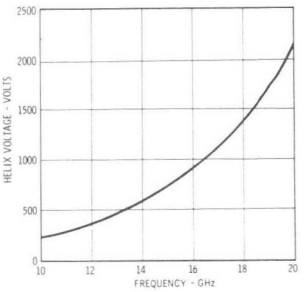

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45—150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

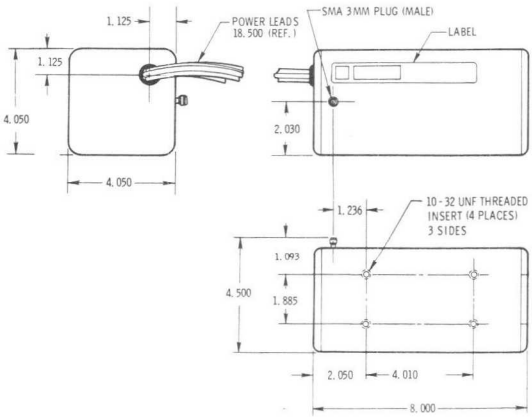
## POWER OUTPUT




## TUNING VOLTAGE




## OUTLINE DRIVING



# TECHNICAL DATA

WATKINS-JOHNSON

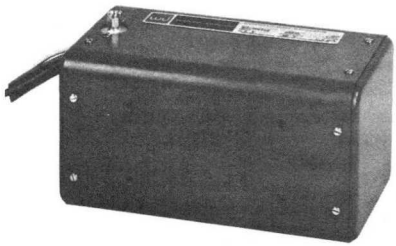
* MARCH 1972

## BACKWARD-WAVE OSCILLATOR
## WJ-2067

The WJ-2067 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2067 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2067 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.



### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 7.0-16.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 18-70 | 15 Min. |
| Power Output Variation | dB | 4 | 10 Max. |
| Fine Grain Variation | dB/250 MHz | 1 | 3 Max. |
| Tube VSWR | | 2:1 | 3:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 0.8 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 15 | |
| Sensitivity to Anode Voltage | MHz/V | 1.8 | |
| Sensitivity to Grid Voltage | MHz/V | 8 | |
| Tuning Curve Slope | | | |
| Low End (7.0 GHz) | MHz/V | 14.4 | |
| Mid-Frequency (11.5 GHz) | MHz/V | 5.52 | |
| High End (16.0 GHz) | MHz/V | 2.15 | |
| Grid RF Cutoff Voltage | V | −12 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 45 | 55 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 45 | 55 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 230 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 |
| | | | Min./Max. |
| Cathode Current [1] | mA | 8 | 12.5 Max. |
| Helix Voltage Range | V | 210-2095 | 200-2200 |
| | | | Min./Max. |
| Helix Current | mA | 1.5 | 3.0 Max. |
| Anode Voltage | V | 100 | 215 Max. |
| Anode Current | mA | 0.1 | 2 Max. |

NOTE 1: Set cathode current to Final Test Data value furnished with tube.

*Supersedes WJ-2067 Technical Data Sheet dated January 1972.

# WJ-2067

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, mates with SMA 3mm Jack (Female)

Magnetically Shielded

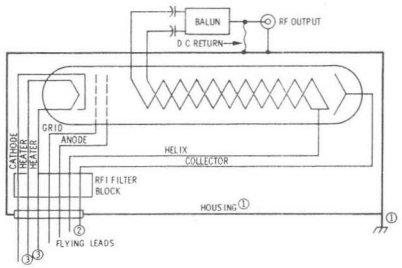
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet MIL-I-6181D

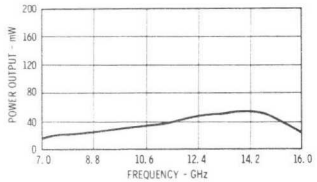
## SCHEMATIC DIAGRAM



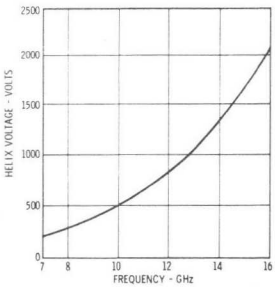

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45—150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

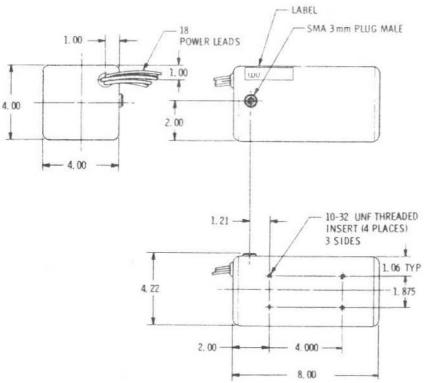
## POWER OUTPUT




## TUNING VOLTAGE




## OUTLINE DRAWING

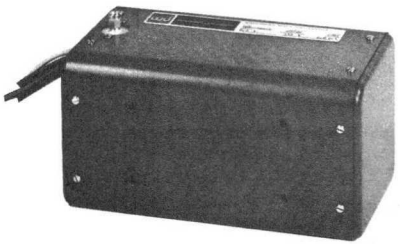


# TECHNICAL DATA

WATKINS-JOHNSON

* MARCH 1972

## BACKWARD-WAVE OSCILLATOR
## WJ-2068



The WJ-2068 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering enables this tube to meet MIL-I-6181D.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2068 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.

The WJ-2068 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 8.0-18.0 |
| Power Output into Load with VSWR = 1.25:1 | mW | 13-75 | 10 Min. |
| Power Output Variation | dB | 8.0 | 12 Max. |
| Fine Grain Variation | dB/250 MHz | 1.5 | 3 Max. |
| Tube VSWR | | 2.5:1 | 3:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 0.5 | 4 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB/MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 14 | |
| Sensitivity to Anode Voltage | MHz/V | 2 | |
| Sensitivity to Grid Voltage | MHz/V | 10 | |
| Tuning Curve Slope | | | |
| Low End (8.0 GHz) | MHz/V | 16.3 | |
| Mid-Frequency (13.0 GHz) | MHz/V | 5.88 | |
| High End (18.0 GHz) | MHz/V | 2.14 | |
| Grid RF Cutoff Voltage | V | −8 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 45 | 55 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 45 | 55 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 230 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current[1] | mA | 8 | 12.5 Max. |
| Helix Voltage Range | V | 206-2215 | 196-2326 Min./Max. |
| Helix Current | mA | 1.0 | 3.0 Max. |
| Anode Voltage | V | 115 | 215 Max. |
| Anode Current | mA | 0.15 | 2 Max. |

NOTE 1: Set cathode current to Final Test Data value furnished with tube.

*Supersedes WJ-2068 Technical Data Sheet dated January 1972.

# WJ-2068

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any

RF Output Connector, mates with SMA 3mm Jack (Female)

Magnetically Shielded

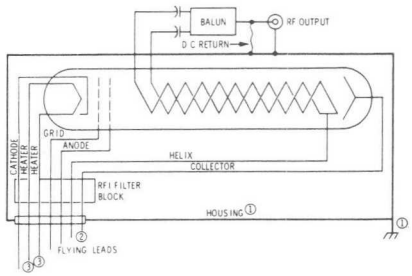
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required

No Forced Air Cooling Required Below +60°C Ambient

RFI Shielded and Filtered to Meet MIL-I-6181D

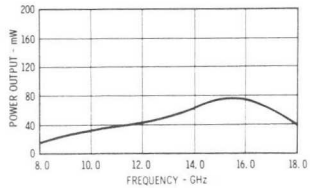
## SCHEMATIC DIAGRAM



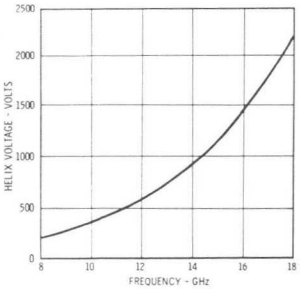

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

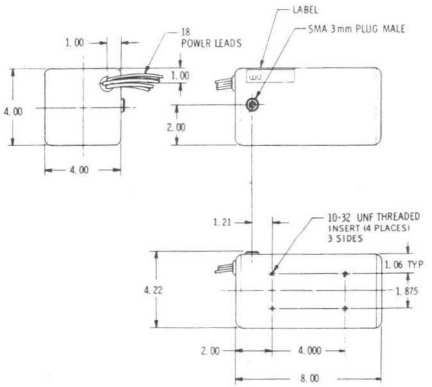
## POWER OUTPUT




## TUNING VOLTAGE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

JUNE 1971

## BACKWARD-WAVE OSCILLATOR WJ-2069

The WJ-2069 is a magnetically shielded and RFI shielded voltage tunable oscillator utilizing a bifilar (dual helix) and a permanent-magnet focusing system. Unsaturated magnetic shielding reduces the magnetic field strength along the outside of the housing. RFI shielding and filtering are provided.

An immunity to external ac or dc magnetic fields, together with a minimal stray magnetic field and low RF radiation, makes the WJ-2069 ideal for signal generating and sweeping equipment, for use in radar receivers (as local oscillator), in frequency diversity transmitters (as master oscillator), and in ECM equipment. Fine grain variation of frequency versus voltage is extremely low. Power output and tuning curves are uniform and highly reproducible.
The WJ-2069 delivers smooth power output over the band with low operating cathode current. Power can be modulated and leveled with either grid or anode circuits. All voltages are isolated from housing and RF output connector for maximum flexibility in circuit applications.

### SPECIFICATIONS

| | UNITS | TYPICAL VALUES | ABSOLUTE RATINGS |
|---|---|---|---|
| Frequency Band | GHz | | 10.0–15.5 |
| Power Output into Load with VSWR = 1.25:1 | mW | 60–110 | 50 Min. |
| Power Output Variation | dB | | 6 Max. |
| Fine Grain Variation | dB/250 MHz | | 3 Max. |
| Tube VSWR | | | 2.5:1 Max. |
| Frequency Pulling Into 2:1 Load (Any Phase) | MHz | 1.5 | 3 Max. |
| Spurious Oscillation | | | |
| Ratio of Signal to Noise Power 30 MHz Away | dB / MHz B.W. | 95 | 85 Min. |
| Ratio of Signal to 2nd Harmonic Output | dB | 30 | 20 Min. |
| Long-term Sensitivity to Heater Voltage | MHz/V | 3 | |
| Sensitivity to Anode Voltage | MHz/V | 0.6 | |
| Sensitivity to Grid Voltage | MHz/V | 3 | |
| Tuning Curve Slope | | | |
| Low End (10.0 GHz) | MHz/V | 8.0 | |
| Mid-Frequency (12.75 GHz) | MHz/V | 4.2 | |
| High End (15.5 GHz) | MHz/V | 2.5 | |
| Grid RF Cutoff Voltage | V | −7 | −25 Max. |
| Capacitance; Cathode to all other Electrodes, including Heater and Housing | pF | 45 | 55 Max. |
| Capacitance; Grid to all other Electrodes, including Housing | pF | 45 | 55 Max. |
| Capacitance; Helix and Collector to all other Electrodes including Housing | pF | 230 | 250 Max. |
| Heater Voltage | Vdc | 6.3 | 6.3 ± 5% |
| Heater Current | A | 0.75 | 0.4–1.2 Min./Max. |
| Cathode Current* | mA | 9.5 | 14 Max. |
| Helix Voltage Range | V | 505–1880 | 480–1975 Min./Max. |
| Helix Current | mA | 1.0 | 2.5 Max. |
| Anode Voltage | V | 130 | 215 Max. |
| Anode Current | mA | 0.5 | 2 Max. |

* Set cathode current to Final Test Data value furnished with tube.

# WJ-2069

## MECHANICAL CHARACTERISTICS

Height, 4 inches (102 mm)
Width, 4 inches (102 mm)
Length, 8 inches (204 mm) max.
Weight, 9.5 lbs. (4.31 Kg) max.

Color Code for 18" Flying Leads

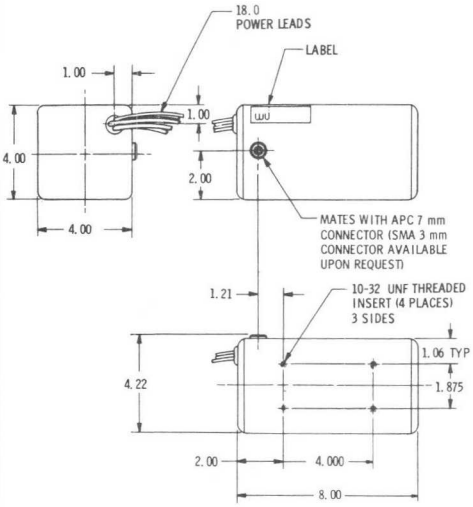
| | |
|---|---|
| Heater | Black |
| Heater | Brown |
| Cathode | Yellow |
| Grid | Green |
| Anode | Blue |
| Helix | Red |
| Collector | Orange |

Mounting Position, Any
RF Output Connector, mates with APC-7 (SMA 3 mm Male Connector Available Upon Request)
Magnetically Shielded

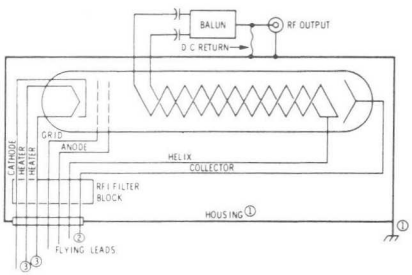
## ENVIRONMENTAL CHARACTERISTICS

Separation from Passive Magnetic Materials, None Required
No Forced Air Cooling Required Below +60°C Ambient
RFI Shielded and Filtered

## OUTLINE DRAWING



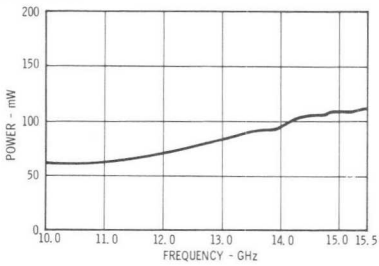

## SCHEMATIC DIAGRAM



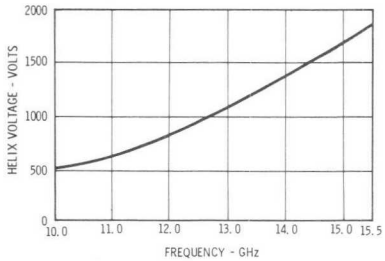

**Notes:**

1. For safety, housing should be grounded through mounting screws.
2. 45–150V positive collector bias recommended. Tube will operate with collector at helix potential at somewhat reduced performance.
3. Heater must always be negative with respect to cathode. If cathode is to be tied to one side of heater when using dc heater supply, connect cathode to positive (+) side of heater supply.

## POWER OUTPUT




## TUNING CURVE



# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969

## 0.5 TO 1.0 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR
## WJ-2800


- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2800 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 0.5 to 1.0 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Since it is a fundamental oscillator, no in-band harmonics are exhibited.

WJ-2800 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

### SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 0.47 to 1.03 GHz | 0.5 to 1.0 GHz |
| Power Output (50Ω load) | 125 mW | 100 mW min. |
| Power Output (1.5:1 load VSWR) | 125 mW | 100 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±0.5% | ±1% max. |
| Frequency Pulling (1.5:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 1 kHz | 5 kHz max. |
| Harmonic Rejection[1] | 30 dB | 15 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | 100 ppm/°C | 300 ppm/°C max. |

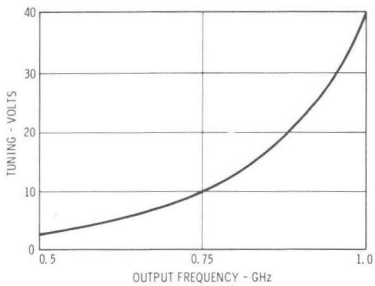
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | +24 V dc at 200 mA max. |
| Tuning Voltage at 0.5 GHz | +1.5 V dc min. at −3 mA max. |
| Tuning Voltage at 1.0 GHz | +60 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | 6 oz. (170 g) max. |
| Connector, RF | miniature coaxial jack |
| Connectors, dc | solder lugs |

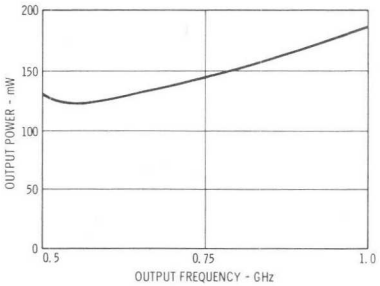
NOTES:
[1]The WJ-2800 is a fundamental oscillator and has no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

# WJ-2800

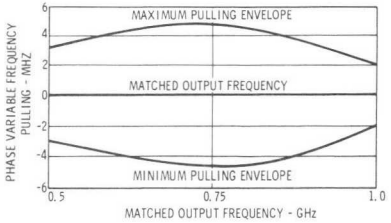
## TUNING CHARACTERISTICS (TYPICAL)



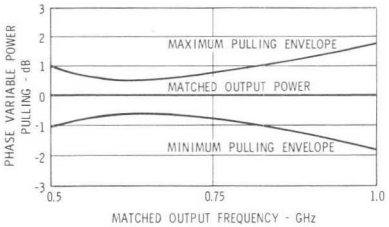

## OUTPUT POWER (TYPICAL)



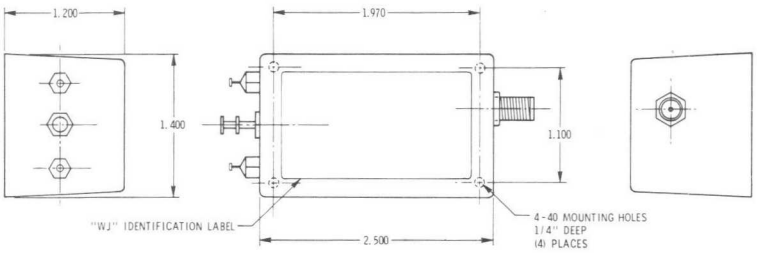

## FREQUENCY PULLING — 1.5:1 LOAD VSWR (TYPICAL)




## POWER PULLING — 1.5:1 LOAD VSWR (TYPICAL)



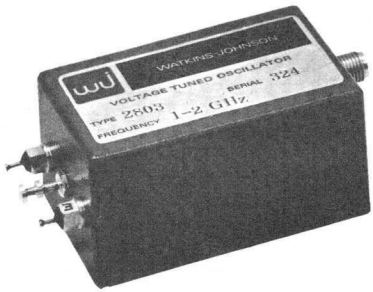

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969*




## 1 TO 2 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR

## WJ-2803

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2803 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 1 to 2 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no in-band harmonics are exhibited.

WJ-2803 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 0.97 to 2.03 GHz | 1.0 to 2.0 GHz |
| Power Output (50Ω load) | 150 mW | 100 mW min. |
| Power Output (1.5:1 load VSWR) | 150 mW | 100 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±0.5% | ±1% max. |
| Frequency Pulling (1.5:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 1 kHz | 5 kHz max. |
| Harmonic Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | 100 ppm/°C | 300 ppm/°C max. |

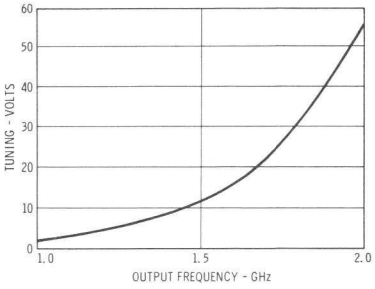
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | +15 V dc at 250 mA max. |
| Tuning Voltage at 1.0 GHz | +1.5 V dc min. at −3 mA max. |
| Tuning Voltage at 2.0 GHz | +60 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | 6 oz. (170 g) max. |
| Connector, RF | miniature coaxial jack |
| Connectors, dc | solder lugs |

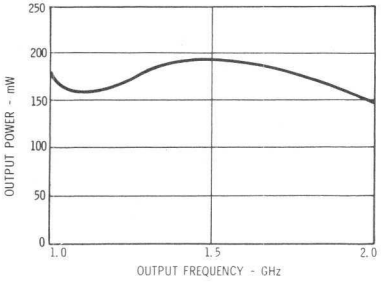
NOTES:
[1]The WJ-2803 is a fundamental oscillator and has no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.
*Supersedes WJ-2803 Technical Data Sheet dated November 1968.

# WJ-2803

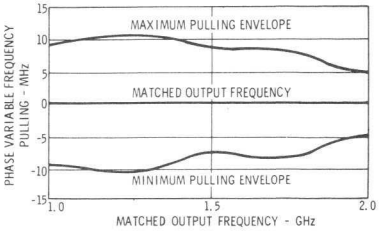
## TUNING CHARACTERISTICS (TYPICAL)



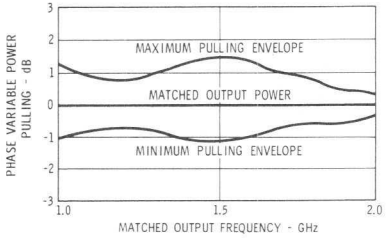

## OUTPUT POWER (TYPICAL)



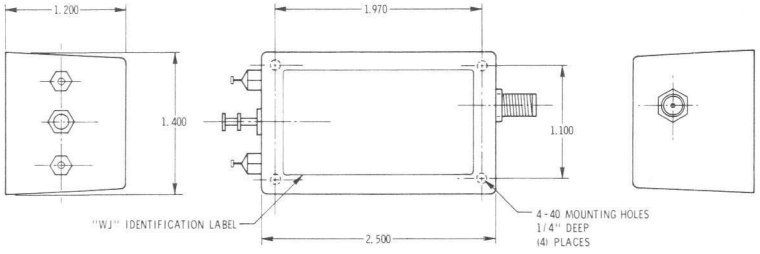

## FREQUENCY PULLING — 1.5:1 LOAD VSWR (TYPICAL)




## POWER PULLING — 1.5:1 LOAD VSWR (TYPICAL)



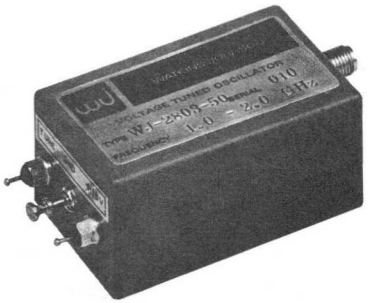

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1971



## 1 TO 2 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2803-50

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2803-50 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 1 to 2 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no in-band harmonics are exhibited.

WJ-2803-50 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

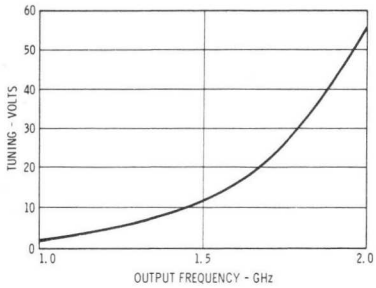
## SPECIFICATIONS

| | Typical | Guaranteed |
|---|---|---|
| **OUTPUT CHARACTERISTICS** | | |
| Frequency Range | 0.97 to 2.03 GHz | 1.0 to 2.0 GHz |
| Power Output (50Ω load) | 75 mW | 50 mW min. |
| Power Output (1.5:1 load VSWR) | 75 mW | 50 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±0.5% | ±1% max. |
| Frequency Pulling (1.5:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 1 kHz | 5 kHz max. |
| Harmonic Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ± 100 ppm/°C | ± 300 ppm/°C max. |
| **INPUT REQUIREMENTS** | | |
| Transistor Supply Voltage | | +15 V dc at 250 mA max. |
| Tuning Voltage at 1.0 GHz | | +1.5 V dc min. at −3 mA max. |
| Tuning Voltage at 2.0 GHz | | +60 V dc max. at 1 mA max. |
| **MECHANICAL CHARACTERISTICS** | | |
| Dimensions | | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | | 6 oz. (170 g) max. |
| Connector, RF | | miniature coaxial jack |
| Connectors, dc | | solder lugs |

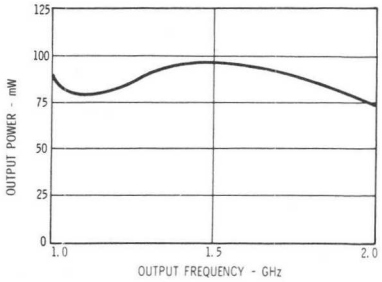
NOTES:
[1]The WJ-2803-50 is a fundamental oscillator and has no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

## WJ-2803-50

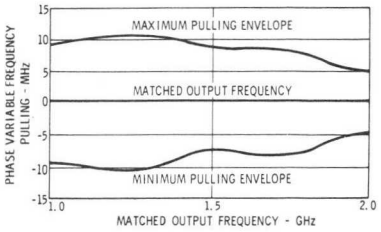
### TUNING CHARACTERISTICS (TYPICAL)



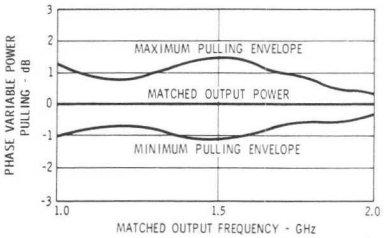

### OUTPUT POWER (TYPICAL)



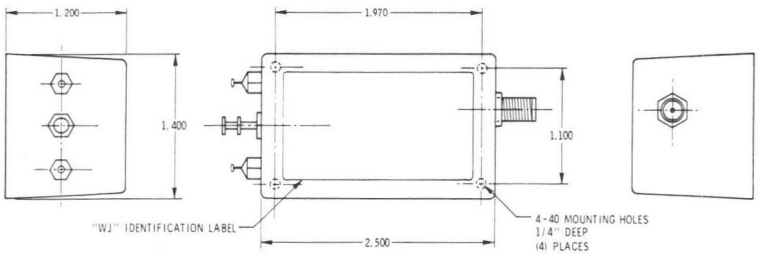

### FREQUENCY PULLING — 1.5:1 LOAD VSWR (TYPICAL)




### POWER PULLING — 1.5:1 LOAD VSWR (TYPICAL)




### OUTLINE DRAWING



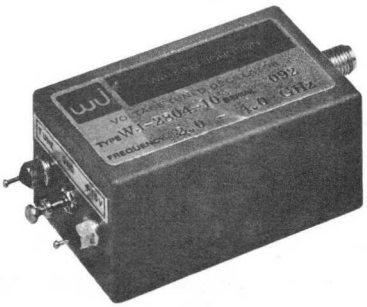
# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1971

## 2 TO 4 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR

## WJ-2804-10



- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2804-10 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 2 to 4 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no in-band harmonics are exhibited.

WJ-2804-10 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 1.95 to 4.05 GHz | 2.0 to 4.0 GHz |
| Power Output (50Ω load) | 20 mW | 10 mW min. |
| Power Output (1.25:1 load VSWR) | 20 mW | 10 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 1 kHz | 10 kHz max. |
| Harmonic Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |

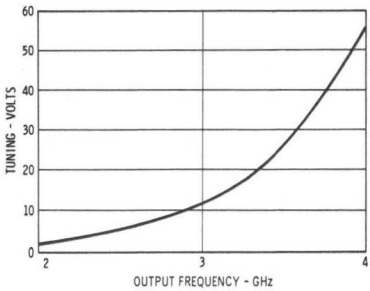
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | +15 V dc at 200 mA max. |
| Tuning Voltage at 2.0 GHz | +1.5 V dc min. at −3 mA max. |
| Tuning Voltage at 4.0 GHz | +60 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | 6 oz. (170 g) max. |
| Connector, RF | miniature coaxial jack |
| Connectors, dc | solder lugs |

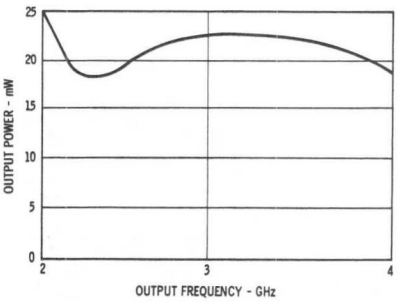
NOTES:
[1]The WJ-2804-10 is a fundamental oscillator and has no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

# WJ-2804-10

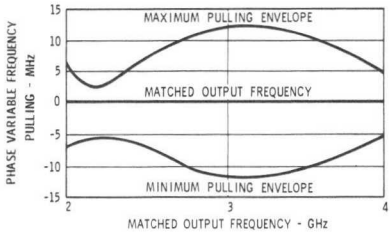
## TUNING CHARACTERISTICS (TYPICAL)



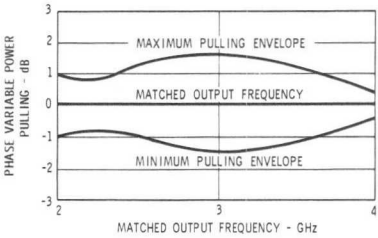

## OUTPUT POWER (TYPICAL)



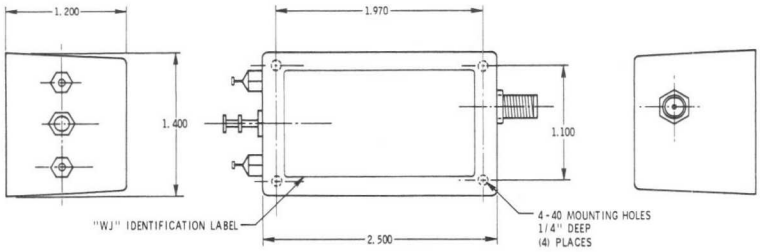

## FREQUENCY PULLING — 1.25:1 LOAD VSWR (TYPICAL)




## POWER PULLING — 1.25:1 LOAD VSWR (TYPICAL)



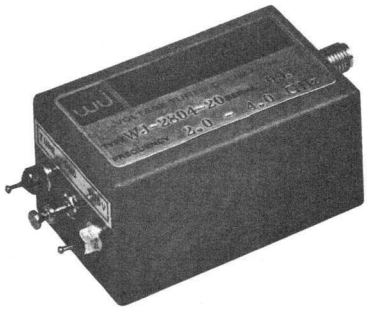

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1971



## 2 TO 4 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR

## WJ-2804-20

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2804-20 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 2 to 4 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no in-band harmonics are exhibited.

WJ-2804-20 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 1.95 to 4.05 GHz | 2.0 to 4.0 GHz |
| Power Output (50Ω load) | 25 mW | 20 mW min. |
| Power Output (1.25:1 load VSWR) | 25 mW | 20 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 1 kHz | 10 kHz max. |
| Harmonic Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |

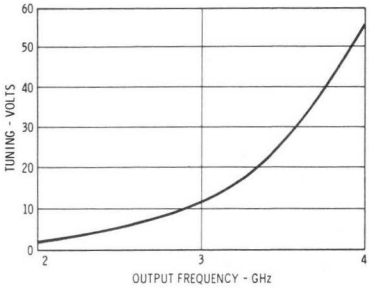
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | +15 V dc at 200 mA max. |
| Tuning Voltage at 2.0 GHz | +1.5 V dc min. at −3 mA max. |
| Tuning Voltage at 4.0 GHz | +60 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | 6 oz. (170 g) max. |
| Connector, RF | miniature coaxial jack |
| Connectors, dc | solder lugs |

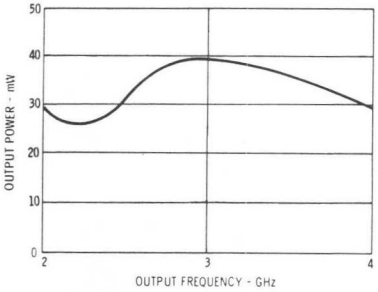
NOTES:
[1]The WJ-2804-20 is a fundamental oscillator and has no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

# WJ-2804-20

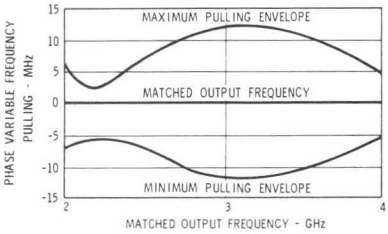
## TUNING CHARACTERISTICS (TYPICAL)



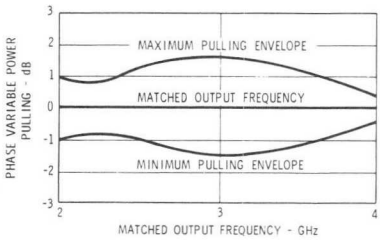

## OUTPUT POWER (TYPICAL)



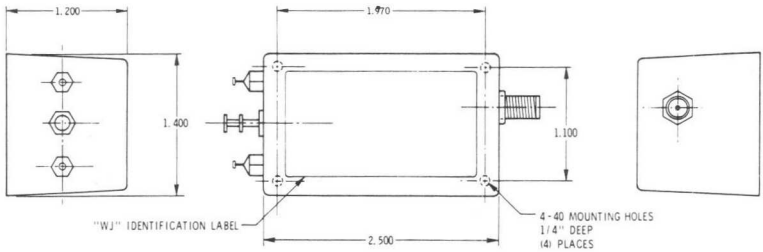

## FREQUENCY PULLING — 1.25:1 LOAD VSWR (TYPICAL)




## POWER PULLING — 1.25:1 LOAD VSWR (TYPICAL)



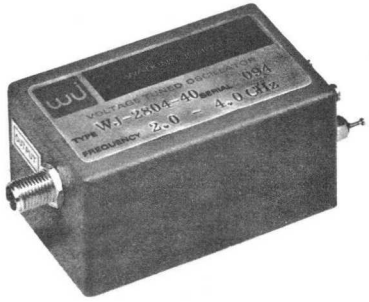

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1971



## 2 TO 4 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2804-40

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2804-40 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 2 to 4 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide superior out-of-band harmonics rejection. Since the device is a fundamental oscillator, no in-band harmonics are exhibited.

WJ-2804-40 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 1.95 to 4.05 GHz | 2.0 to 4.0 GHz |
| Power Output (50Ω load) | 50 mW | 40 mW min. |
| Power Output (1.25:1 load VSWR) | 50 mW | 40 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 1 kHz | 10 kHz max. |
| Harmonic Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |

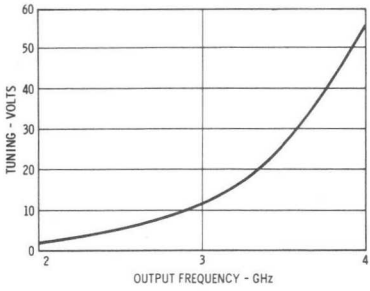
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | +15 V dc at 200 mA max. |
| Tuning Voltage at 2.0 GHz | +1.5 V dc min. at −3 mA max. |
| Tuning Voltage at 4.0 GHz | +60 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | 6 oz. (170 g) max. |
| Connector, RF | miniature coaxial jack |
| Connectors, dc | solder lugs |

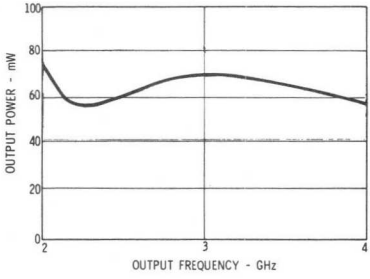
NOTES:
[1]The WJ-2804-40 is a fundamental oscillator and has no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

## WJ-2804-40

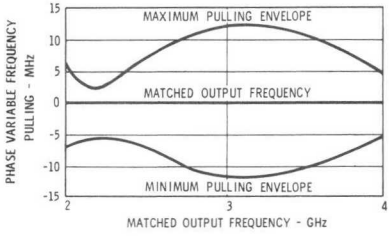
### TUNING CHARACTERISTICS (TYPICAL)



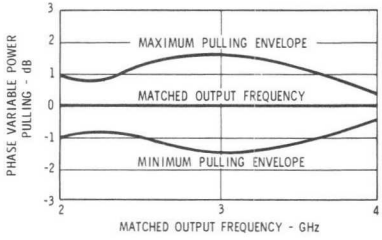

### OUTPUT POWER (TYPICAL)



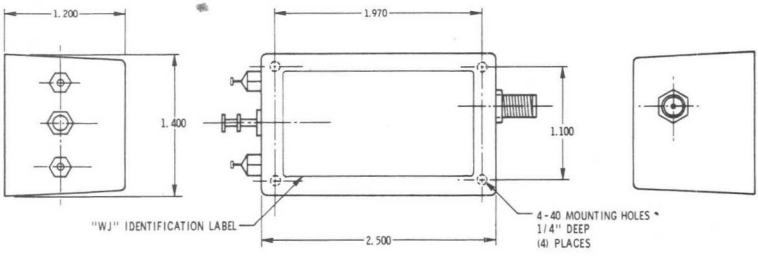

### FREQUENCY PULLING — 1.25:1 LOAD VSWR (TYPICAL)




### POWER PULLING — 1.25:1 LOAD VSWR (TYPICAL)



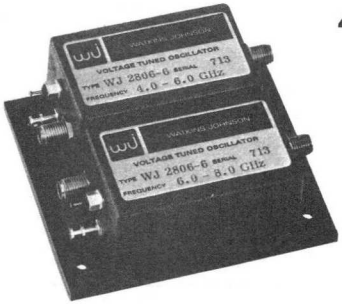

### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971




## 4 TO 8 GHz DUAL-BAND VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2806-6

- VOLTAGE-TUNABLE, FULL OCTAVE COVERAGE IN TWO BANDS
- SUPERIOR PULLING CHARACTERISTICS
- LOW INPUT POWER REQUIREMENTS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVES

WJ-2806-6 is a pair of varactor-tuned transistor oscillators designed to provide microwave power over the 4 to 8 GHz frequency range in two bands: 4 to 6 GHz and 6 to 8 GHz. Varactor tuning ensures a high tuning input impedance characteristic for each device. Two transistors in a push-pull configuration provide output power at the second harmonic of the fundamental oscillator frequency. Circuit balancing provides rejection of the fundamental and unwanted harmonics.

WJ-2806-6 is capable of supplying considerably more than its rated output power, but decoupling is employed to reduce the pulling effects of load mismatches. The tuning voltage vs. frequency curves are roughly exponential and therefore monotonic, allowing easy linearization. The device is well suited for applications where small size, low power requirements and high reliability are essential.

## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range (both bands) | 3.96 to 8.05 GHz | 4.0 to 8.0 GHz |
| Frequency Range (band 1) | 3.96 to 6.04 GHz | 4.0 to 6.0 GHz |
| Frequency Range (band 2) | 5.95 to 8.05 GHz | 6.0 to 8.0 GHz |
| Power Output (50Ω load) | 30 mW | 20 mW min. |
| Power Output (1.25:1 load VSWR) | 30 mW | 20 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 5 kHz | 10 kHz max. |
| Harmonically Related Spurious Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |

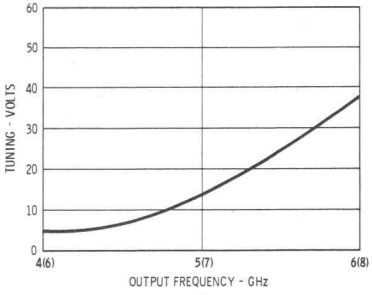
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage (each band) | +15 V dc at 250 mA max. |
| Tuning Voltage at 4.0 GHz (6.0 GHz) | +2 V dc min. at −3 mA max. |
| Tuning Voltage at 6.0 GHz (8.0 GHz) | +45 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.25 x 2.87 x 3.25 inches (32 x 73 x 83 mm) max. |
| Weight | 12 oz. (340 g) max. |
| Connectors, RF | miniature coaxial jacks |
| Connectors, dc | solder lugs |

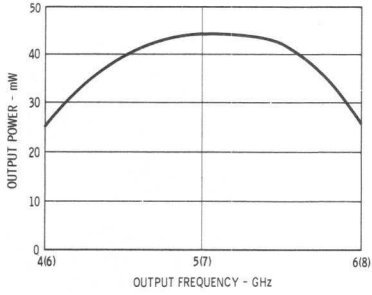
NOTES:
[1]The WJ-2806-6 is a doubling oscillator and has one sub-harmonic spurious.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

# WJ-2806-6

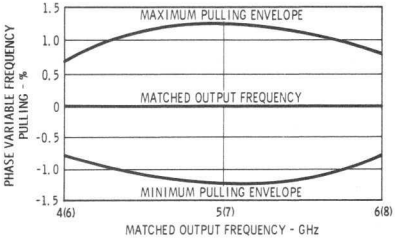
## TUNING CHARACTERISTICS (TYPICAL)



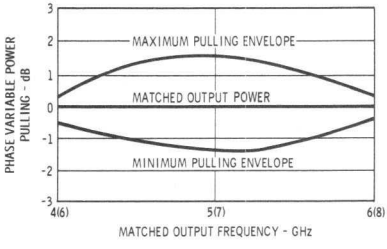

## OUTPUT POWER (TYPICAL)



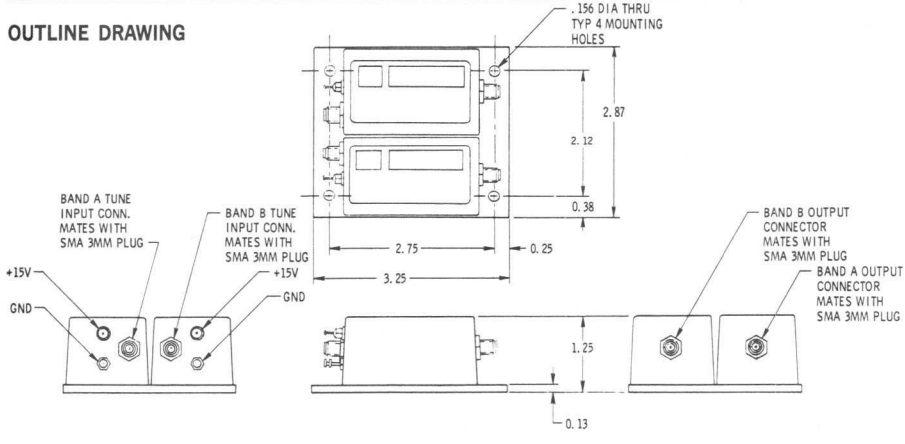

## FREQUENCY PULLING – 1.25:1 LOAD VSWR (TYPICAL)




## POWER PULLING – 1.25:1 LOAD VSWR (TYPICAL)




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 8.5 TO 9.6 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2807-3


- VOLTAGE-TUNABLE OVER FULL RANGE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVES

WJ-2807-3 is a voltage-tuned transistor oscillator designed to provide microwave power over the 8.5 to 9.6 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide output power at the second harmonic of the fundamental oscillator frequency. Circuit balancing provides rejection of the fundamental and unwanted harmonics.

WJ-2807-3 is capable of supplying considerably more than its rated output power, but decoupling is employed to reduce the pulling effects of load mismatches. The tuning voltage vs. frequency curves are roughly exponential and therefore monotonic, allowing easy linearization. The device is well suited for applications where small size, low power requirements and high reliability are essential.

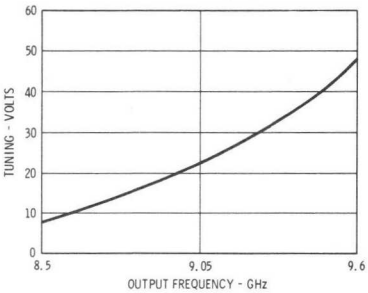
### SPECIFICATIONS

| | Typical | Guaranteed |
|---|---|---|
| **OUTPUT CHARACTERISTICS** | | |
| Frequency Range | 8.45 to 9.65 GHz | 8.5 to 9.6 GHz |
| Power Output (50Ω load) | 20 mW | 10 mW min. |
| Power Output (1.25:1 load VSWR) | 20 mW | 10 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 10 kHz | 20 kHz max. |
| Harmonically Related Spurious Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |
| **INPUT REQUIREMENTS** | | |
| Transistor Supply Voltage | | +15 V dc at 250 mA max. |
| Tuning Voltage at 8.5 GHz | | +5 V dc min. at −3 mA max. |
| Tuning Voltage at 9.6 GHz | | +50 V dc max. at 1 mA max. |
| **MECHANICAL CHARACTERISTICS** | | |
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. | |
| Weight | 6 oz. (170 g) max. | |
| Connector, RF | miniature coaxial jack | |
| Connectors, dc | solder lugs | |

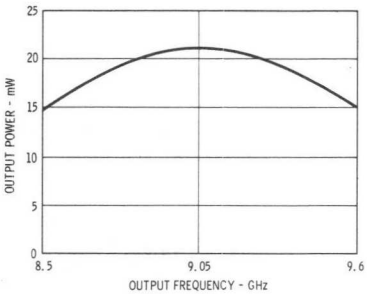
NOTES:
[1]The WJ-2807-3 is a doubling oscillator and has one sub-harmonic spurious but no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

## WJ-2807-3

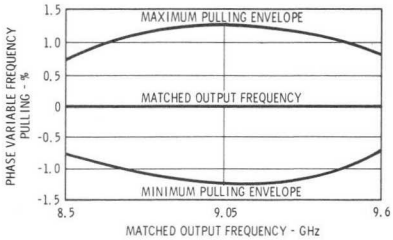
### TUNING CHARACTERISTICS (TYPICAL)



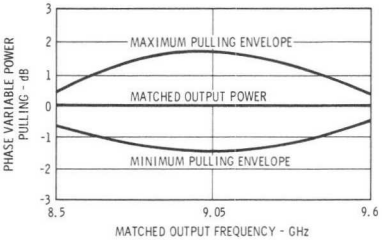

### OUTPUT POWER (TYPICAL)



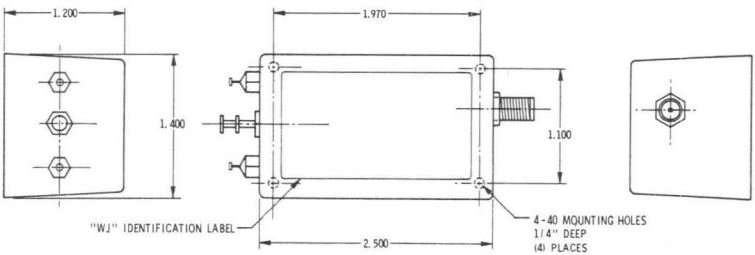

### FREQUENCY PULLING – 1.25:1 LOAD VSWR (TYPICAL)




### POWER PULLING – 1.25:1 LOAD VSWR (TYPICAL)




### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1970

## 1.4 TO 2.4 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2810

- **VOLTAGE-TUNABLE OVER FULL RANGE**
- **SUPERIOR PULLING CHARACTERISTICS**
- **NO IN-BAND HARMONICS**
- **LOW OUT-OF-BAND HARMONICS**
- **MONOTONIC TUNING CURVE**


WJ-2810 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 1.4 to 2.4 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Since it is a fundamental oscillator, no in-band harmonics are exhibited.

WJ-2810 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

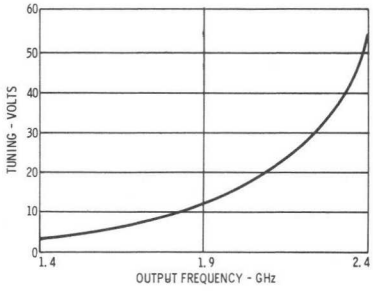
## SPECIFICATIONS

| | Typical | Guaranteed |
|---|---|---|
| **OUTPUT CHARACTERISTICS** | | |
| Frequency Range | 1.38 to 2.42 GHz | 1.4 to 2.4 GHz |
| Power Output (50Ω load) | 60 mW | 50 mW min. |
| Power Output (1.5:1 load VSWR) | 60 mW | 50 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±0.5% | ±1% max. |
| Frequency Pulling (1.5:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 1 kHz | 10 kHz max. |
| Harmonic Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | 100 ppm/°C | 300 ppm/°C max. |
| **INPUT REQUIREMENTS** | | |
| Transistor Supply Voltage | | +15 V dc at 250 mA max. |
| Tuning Voltage at 1.0 GHz | | +1.5 V dc min. at −3 mA max. |
| Tuning Voltage at 2.0 GHz | | +60 V dc max. at 1 mA max. |
| **MECHANICAL CHARACTERISTICS** | | |
| Dimensions | | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | | 6 oz. (170 g) max. |
| Connector, RF | | miniature coaxial jack |
| Connectors, dc | | solder lugs |

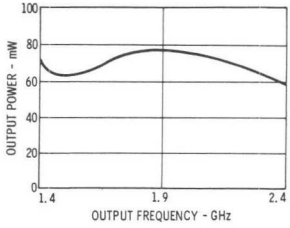
1. The WJ-2810 is a fundamental oscillator and has no in-band harmonics.
2. Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

## WJ-2810

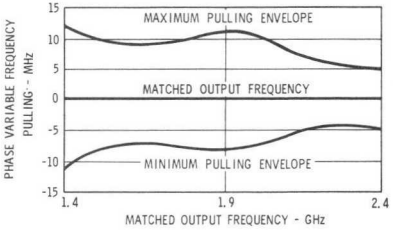
### TUNING CHARACTERISTICS (TYPICAL)



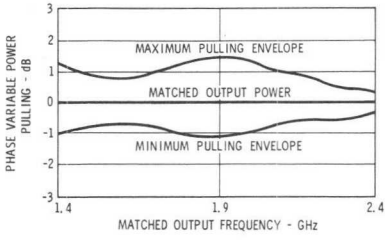

### OUTPUT POWER (TYPICAL)



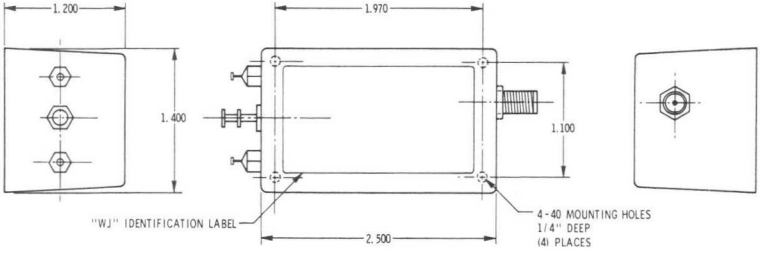

### FREQUENCY PULLING — 1.5:1 LOAD VSWR (TYPICAL)




### POWER PULLING — 1.5:1 LOAD VSWR (TYPICAL)




### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

APRIL 1969

## 0.25 TO 0.5 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2811


- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE

WJ-2811 is a voltage-tuned transistor oscillator designed to provide fundamental microwave power over the 0.25 to 0.5 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Since it is a fundamental oscillator, no in-band harmonics are exhibited.

WJ-2811 is capable of supplying considerably more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

### SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 0.23 to 0.53 GHz | 0.25 to 0.5 GHz |
| Power Output (50Ω load) | 125 mW | 100 mW min. |
| Power Output (1.5:1 load VSWR) | 125 mW | 100 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±0.5% | ±1% max. |
| Frequency Pulling (1.5:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 1 kHz | 5 kHz max. |
| Harmonic Rejection[1] | 30 dB | 15 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | 100 ppm/°C | 300 ppm/°C max. |

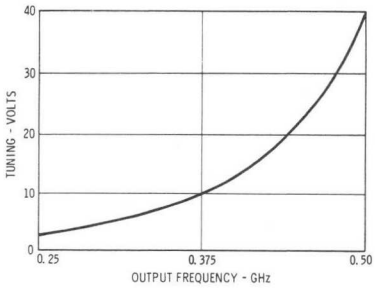
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | +24 V dc at 200 mA max. |
| Tuning Voltage at 0.25 GHz | +1.5 V dc min. at −3 mA max. |
| Tuning Voltage at 0.5 GHz | +60 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | 6 oz. (170 g) max. |
| Connector, RF | miniature coaxial jack |
| Connectors, dc | solder lugs |

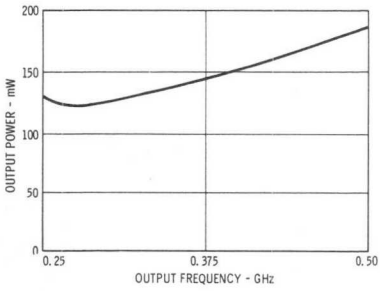
NOTES:
[1]The WJ-2811 is a fundamental oscillator and has no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

# WJ-2811

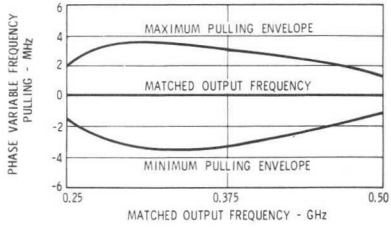
## TUNING CHARACTERISTICS (TYPICAL)



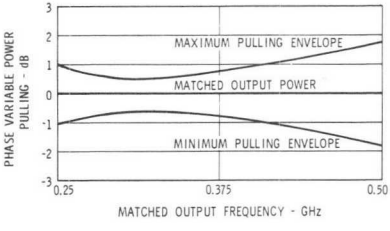

## OUTPUT POWER (TYPICAL)



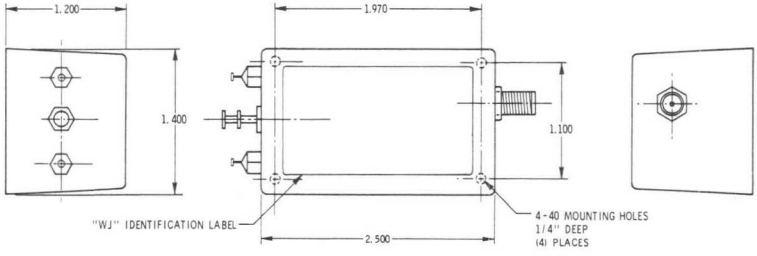

## FREQUENCY PULLING — 1.5:1 LOAD VSWR (TYPICAL)




## POWER PULLING — 1.5:1 LOAD VSWR (TYPICAL)




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

## 4 TO 8 GHz VOLTAGE-CONTROLLED SOLID STATE OSCILLATOR WJ-2812

- VOLTAGE-TUNABLE OVER FULL OCTAVE
- SUPERIOR PULLING CHARACTERISTICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVE
- INTEGRAL ISOLATOR AND FILTER

WJ-2812 is a varactor-tuned transistor oscillator designed to provide microwave power over the 4 to 8 GHz range. Varactor tuning ensures a high tuning input impedance characteristic and a high-speed tuning capability for the device. The integral isolator supplied with the unit permits operation into a 3:1 VSWR while maintaining excellent frequency and power pulling characteristics. The integral filter provides increased harmonic rejection.

WJ-2812 is capable of supplying more than its rated output power in some applications. Its tuning voltage vs. frequency curve is approximately exponential and monotonic, allowing easy linearization. The device is well suited for applications where small size, low input requirements and high reliability are essential.

## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 3.97 to 8.03 GHz | 4 to 8 GHz |
| Power Output (50Ω load) | 25 mW | 20 mW min. |
| Power Output (3:1 load VSWR) | 25 mW | 20 mW min. |
| Frequency Pulling (3:1 load VSWR) | ±0.2% | ±0.5% max. |
| Residual FM (peak) | 10 kHz | 20 kHz max. |
| Harmonic Rejection | 22 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[1] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±300 ppm/°C | ±400 ppm/°C max. |
| Power Output Variation | 7 dB | 10 dB |

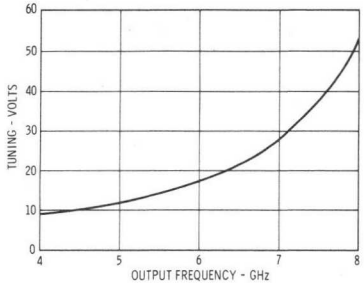
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | −15 V dc at 200 mA max. |
| Tuning Voltage at 4 GHz | −9 V dc min. at 5 mA max. |
| Tuning Voltage at 8 GHz | −70 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.7 x 2.6 x 3.0 inches (44 x 66 x 77 mm) max. |
| Weight | 16 oz. (454 g) max. |
| Connector, RF | SMA miniature coaxial jack |
| Connectors, dc | solder lugs |

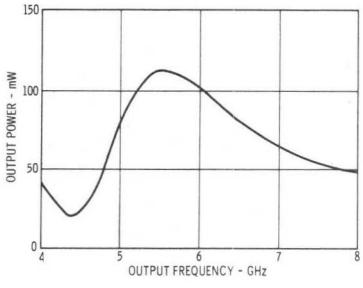
NOTE:
[1]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

## WJ-2812

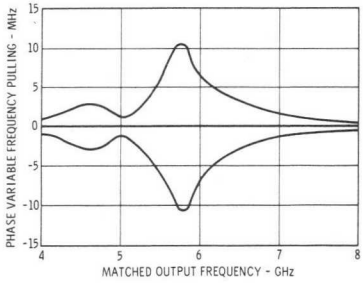
### TUNING CHARACTERISTICS (TYPICAL)



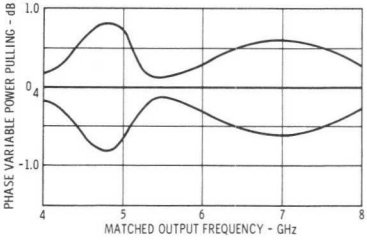

### OUTPUT POWER (TYPICAL)



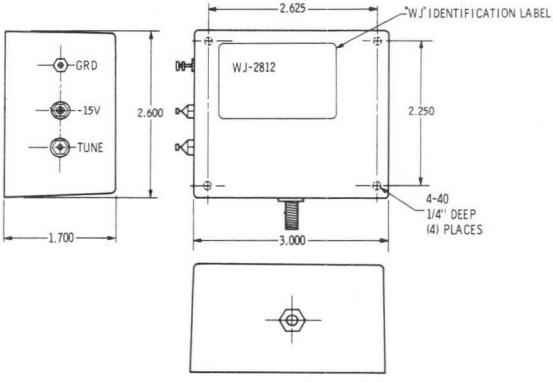

### FREQUENCY PULLING — 3:1 LOAD VSWR (TYPICAL)




### POWER PULLING — 3:1 LOAD VSWR (TYPICAL)




### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 4 TO 5.6 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2817


- VOLTAGE-TUNABLE OVER FULL RANGE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVES

WJ-2817 is a voltage-tuned transistor oscillator designed to provide microwave power over the 4 to 5.6 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide output power at the second harmonic of the fundamental oscillator frequency. Circuit balancing provides rejection of the fundamental and unwanted harmonics.

WJ-2817 is capable of supplying considerably more than its rated output power, but decoupling is employed to reduce the pulling effects of load mismatches. The tuning voltage vs. frequency curves are roughly exponential and therefore monotonic, allowing easy linearization. The device is well suited for applications where small size, low power requirements and high reliability are essential.

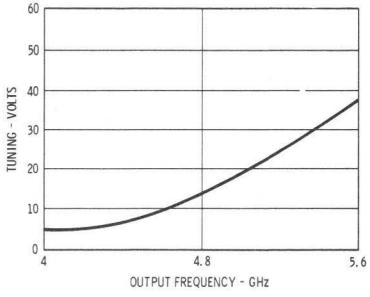
### SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 3.95 to 5.65 GHz | 4.0 to 5.6 GHz |
| Power Output (50Ω load) | 30 mW | 20 mW min. |
| Power Output (1.25:1 load VSWR) | 30 mW | 20 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 5 kHz | 10 kHz max. |
| Harmonically Related Spurious Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |
| **INPUT REQUIREMENTS** | | |
| Transistor Supply Voltage | | +15 V dc at 250 mA max. |
| Tuning Voltage at 4.0 GHz | | +2 V dc min. at −3 mA max. |
| Tuning Voltage at 5.6 GHz | | +45 V dc max. at 1 mA max. |
| **MECHANICAL CHARACTERISTICS** | | |
| Dimensions | | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | | 6 oz. (170 g) max. |
| Connector, RF | | miniature coaxial jack |
| Connectors, dc | | solder lugs |

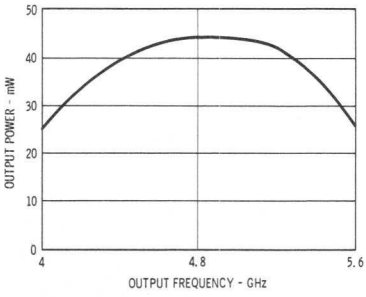
NOTES:
[1]The WJ-2817 is a doubling oscillator and has one sub-harmonic spurious but no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

## WJ-2817

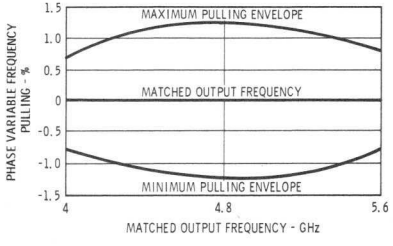
### TUNING CHARACTERISTICS (TYPICAL)



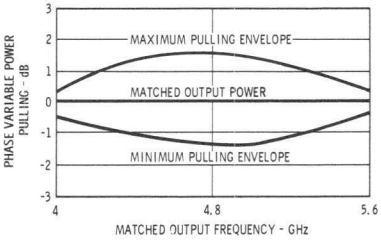

### OUTPUT POWER (TYPICAL)



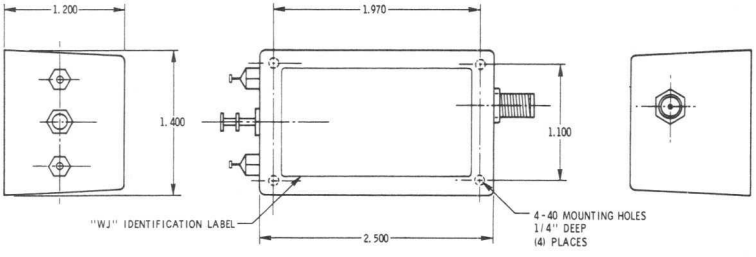

### FREQUENCY PULLING – 1.25:1 LOAD VSWR (TYPICAL)




### POWER PULLING – 1.25:1 LOAD VSWR (TYPICAL)



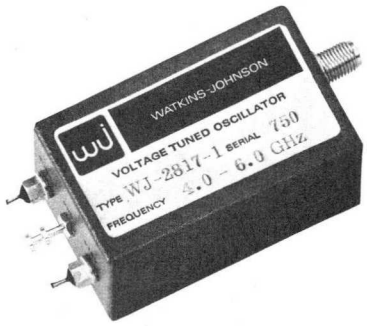

### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971




## 4 TO 6 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR
## WJ-2817-1

- **VOLTAGE-TUNABLE OVER FULL RANGE**
- **SUPERIOR PULLING CHARACTERISTICS**
- **LOW INPUT POWER REQUIREMENTS**
- **LOW OUT-OF-BAND HARMONICS**
- **MONOTONIC TUNING CURVES**

WJ-2817-1 is a voltage-tuned transistor oscillator designed to provide microwave power over the 4 to 6 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide output power at the second harmonic of the fundamental oscillator frequency. Circuit balancing provides rejection of the fundamental and unwanted harmonics.

WJ-2817-1 is capable of supplying considerably more than its rated output power, but decoupling is employed to reduce the pulling effects of load mismatches. The tuning voltage vs. frequency curves are roughly exponential and therefore monotonic, allowing easy linearization. The device is well suited for applications where small size, low power requirements and high reliability are essential.

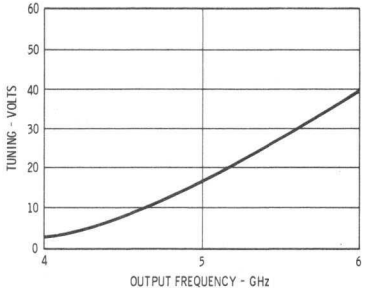
## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 3.95 to 6.05 GHz | 4.0 to 6.0 GHz |
| Power Output (50Ω load) | 30 mW | 20 mW min. |
| Power Output (1.25:1 load VSWR) | 30 mW | 20 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 5 kHz | 10 kHz max. |
| Harmonically Related Spurious Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |
| **INPUT REQUIREMENTS** | | |
| Transistor Supply Voltage | | +15 V dc at 250 mA max. |
| Tuning Voltage at 4.0 GHz | | +2 V dc min. at −3 mA max. |
| Tuning Voltage at 6.0 GHz | | +45 V dc max. at 1 mA max. |
| **MECHANICAL CHARACTERISTICS** | | |
| Dimensions | | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | | 6 oz. (170 g) max. |
| Connector, RF | | miniature coaxial jack |
| Connectors, dc | | solder lugs |

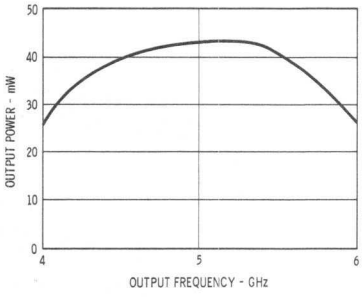
NOTES:
[1]The WJ-2817-1 is a doubling oscillator and has one sub-harmonic spurious.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

## WJ-2817-1

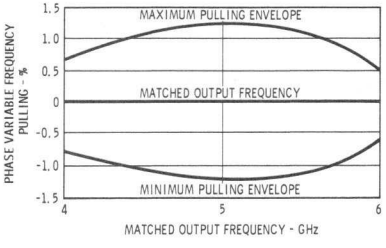
### TUNING CHARACTERISTICS (TYPICAL)



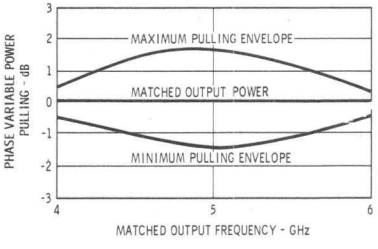

### OUTPUT POWER (TYPICAL)



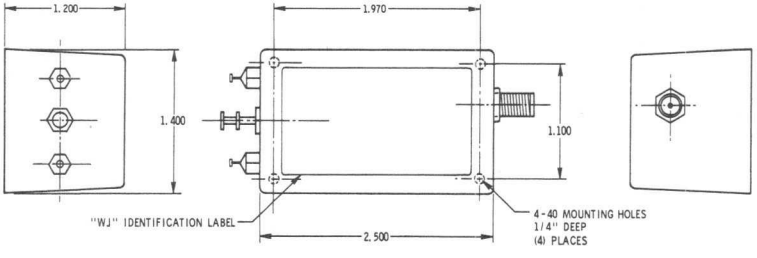

### FREQUENCY PULLING – 1.25:1 LOAD VSWR (TYPICAL)




### POWER PULLING – 1.25:1 LOAD VSWR (TYPICAL)




### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 5.6 TO 8 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2818


- VOLTAGE-TUNABLE OVER FULL RANGE
- SUPERIOR PULLING CHARACTERISTICS
- NO IN-BAND HARMONICS
- LOW OUT-OF-BAND HARMONICS
- MONOTONIC TUNING CURVES

WJ-2818 is a voltage-tuned transistor oscillator designed to provide microwave power over the 5.6 to 8 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide output power at the second harmonic of the fundamental oscillator frequency. Circuit balancing provides rejection of the fundamental and unwanted harmonics.

WJ-2818 is capable of supplying considerably more than its rated output power, but decoupling is employed to reduce the pulling effects of load mismatches. The tuning voltage vs. frequency curves are roughly exponential and therefore monotonic, allowing easy linearization. The device is well suited for applications where small size, low power requirements and high reliability are essential.

## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 5.55 to 8.05 GHz | 5.6 to 8.0 GHz |
| Power Output (50Ω load) | 30 mW | 20 mW min. |
| Power Output (1.25:1 load VSWR) | 30 mW | 20 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 5 kHz | 10 kHz max |
| Harmonically Related Spurious Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |

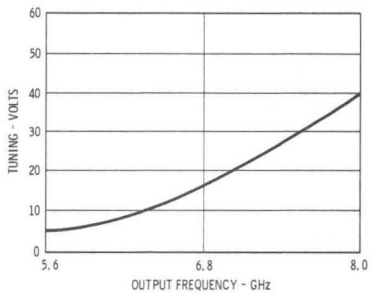
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | +15 V dc at 250 mA max. |
| Tuning Voltage at 5.6 GHz | +2 V dc min. at −3 mA max. |
| Tuning Voltage at 8.0 GHz | +45 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | 6 oz. (170 g) max. |
| Connector, RF | miniature coaxial jack |
| Connectors, dc | solder lugs |

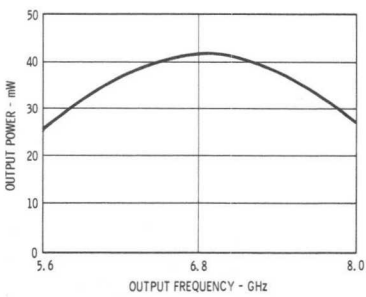
NOTES:
[1]The WJ-2818 is a doubling oscillator and has one sub-harmonic spurious but no in-band harmonics.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

## WJ-2818

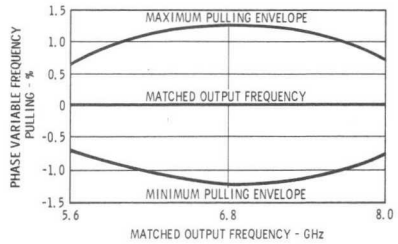
### TUNING CHARACTERISTICS (TYPICAL)



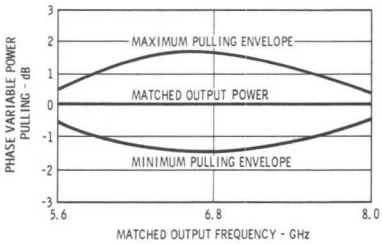

### OUTPUT POWER (TYPICAL)



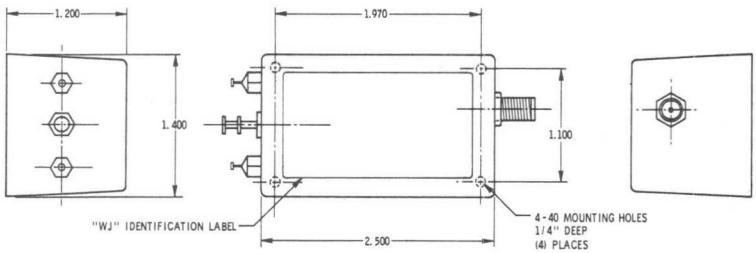

### FREQUENCY PULLING – 1.25:1 LOAD VSWR (TYPICAL)




### POWER PULLING – 1.25:1 LOAD VSWR (TYPICAL)




### OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 6 TO 8 GHz VOLTAGE-TUNED SOLID STATE OSCILLATOR WJ-2818-1


- **VOLTAGE-TUNABLE OVER FULL RANGE**
- **SUPERIOR PULLING CHARACTERISTICS**
- **LOW INPUT POWER REQUIREMENTS**
- **LOW OUT-OF-BAND HARMONICS**
- **MONOTONIC TUNING CURVES**

WJ-2818-1 is a voltage-tuned transistor oscillator designed to provide microwave power over the 6 to 8 GHz range. Varactor tuning ensures a high tuning input impedance characteristic for the device. Two transistors in a push-pull configuration provide output power at the second harmonic of the fundamental oscillator frequency. Circuit balancing provides rejection of the fundamental and unwanted harmonics.

WJ-2818-1 is capable of supplying considerably more than its rated output power, but decoupling is employed to reduce the pulling effects of load mismatches. The tuning voltage vs. frequency curves are roughly exponential and therefore monotonic, allowing easy linearization. The device is well suited for applications where small size, low power requirements and high reliability are essential.

## SPECIFICATIONS

| OUTPUT CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 5.95 to 8.05 GHz | 6.0 to 8.0 GHz |
| Power Output (50Ω load) | 30 mW | 20 mW min. |
| Power Output (1.25:1 load VSWR) | 30 mW | 20 mW min. |
| Frequency Pulling (1.25:1 load VSWR) | ±1% | ±2% max. |
| Residual FM (peak) | 5 kHz | 10 kHz max. |
| Harmonically Related Spurious Rejection[1] | 30 dB | 20 dB min. |
| Non-Harmonic Spurious Rejection[2] | | 60 dB min. |
| Frequency Pushing (supply variations) | ±1% per volt | ±2% per volt max. |
| Operating Temperature Range (heat sink temperature) | | 0 to 55°C |
| Frequency Drift with Temperature | ±100 ppm/°C | ±300 ppm/°C max. |

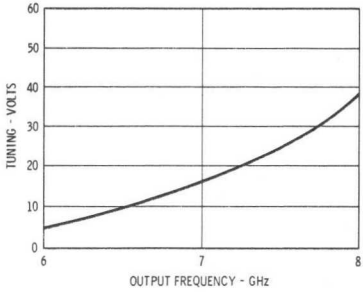
| INPUT REQUIREMENTS | |
|---|---|
| Transistor Supply Voltage | +15 V dc at 250 mA max. |
| Tuning Voltage at 6.0 GHz | +2 V dc min. at −3 mA max. |
| Tuning Voltage at 8.0 GHz | +45 V dc max. at 1 mA max. |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions | 1.2 x 1.4 x 2.5 inches (30 x 36 x 64 mm) max. |
| Weight | 6 oz. (170 g) max. |
| Connector, RF | miniature coaxial jack |
| Connectors, dc | solder lugs |

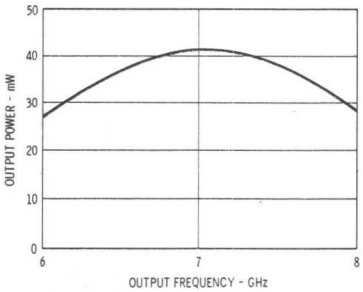
NOTES:
[1]The WJ-2818-1 is a doubling oscillator and has one sub-harmonic spurious.
[2]Measured on a spectrum analyzer with approximately 60 dB dynamic range. Only signals greater than 10 kHz from the main signal are specified.

# WJ-2818-1

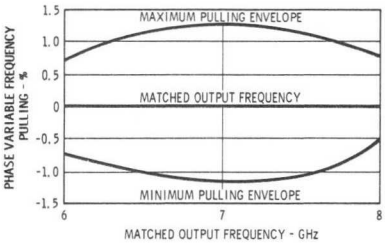
## TUNING CHARACTERISTICS (TYPICAL)



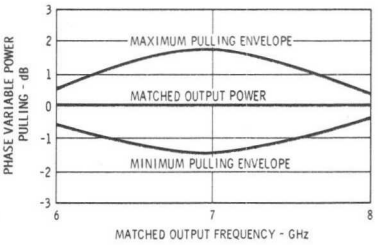

## OUTPUT POWER (TYPICAL)



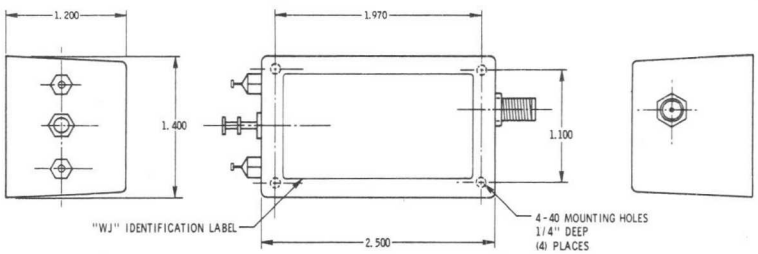

## FREQUENCY PULLING – 1.25:1 LOAD VSWR (TYPICAL)




## POWER PULLING – 1.25:1 LOAD VSWR (TYPICAL)




## OUTLINE DRAWING



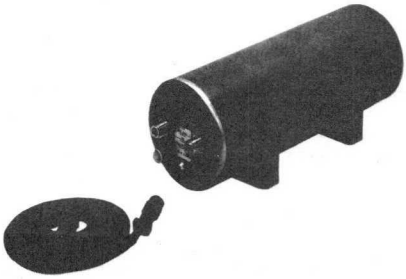
# TECHNICAL DATA

WATKINS-JOHNSON

AUGUST 1969

## 2 TO 4 GHz, 100 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-3003

- **POWER OUTPUT 100 mW MINIMUM**
- **NOISE FIGURE 10 dB MAXIMUM**
- **"JUST PLUG IT IN"**
- **PROVEN RELIABILITY**
- **NO ADJUSTMENTS REQUIRED**
- **MEETS MIL-E-5400, CLASS 2 SPECIFICATION**



WJ-3003 is an S-band amplifier that provides 100 mW power output for applications where increased dynamic range is desired. The amplifier is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz). In addition, it may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. The environmental characteristics of the WJ-3003 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 2 to 4 GHz |
| Noise figure, terminal | 9 dB | 10 dB, max. |
| Gain, small signal | 35 dB | 30 dB, min. |
| VSWR, input and output | 1.5:1 | 2:1, max. |
| Power Output | 21 dBm | 20 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 V ac | 115 ±10 V ac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 20 W | |

# WJ-3003

## ENVIRONMENTAL CHARACTERISTICS[2]

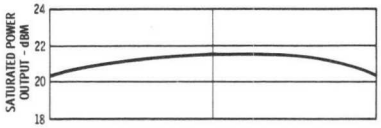
Temperature ..... −54°C to +71°C
Vibration
a) 0.10 Inch, Double Amplitude ..... 5 to 30 Hz
b) 5 g, Single Amplitude ..... 30 to 500 Hz
Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

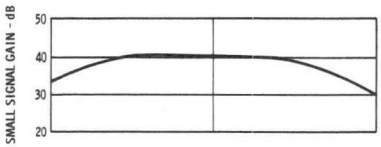
Height ..... 4.75 inches (121 mm) max.
Width ..... 4.75 inches (121 mm) max.
Length (excluding connectors) ..... 12 inches (305 mm) max.
Weight ..... 18 pounds (8.16 Kg) max.
Primary Power Connection ..... Bendix Receptacle PT 07C-8-3P
RF Connectors ..... Type N, Jack
Reference Drawing Number ..... 290029

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

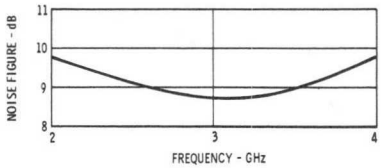
## POWER



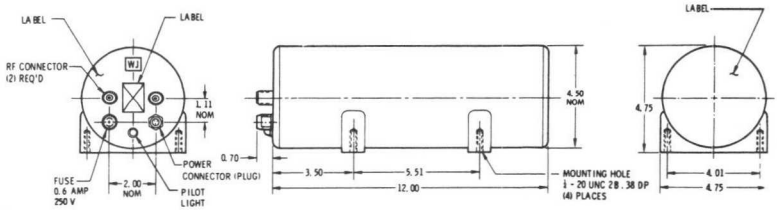

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT 07C-8-3P (PLUG) MS 3116 E-8-3S (SR) (SOC) | | |
| P.I.N | CONNECTION | |
| A | AC | 105-125 VAC |
| B | GROUND | 48-420 CPS |
| C | AC (HOT) | SINGLE PHASE |

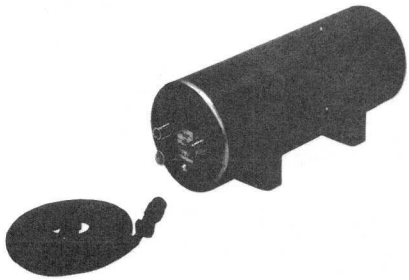
# TECHNICAL DATA

WATKINS-JOHNSON

AUGUST 1969

## 4 TO 8 GHz, 100 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-3004

- **POWER OUTPUT 100 mW MINIMUM**
- **NOISE FIGURE 10 dB MAXIMUM**
- **"JUST PLUG IT IN"**
- **PROVEN RELIABILITY**
- **NO ADJUSTMENTS REQUIRED**
- **MEETS MIL-E-5400, CLASS 2 SPECIFICATION**



WJ-3004 is a C-band amplifier that provides 100 mW power ouput for applications where increased dynamic range is desired. The amplifier is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz). In addition, it may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. The environmental characteristics of the WJ-3004 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 4 to 8 GHz |
| Noise figure, terminal | 9 dB | 10 dB, max. |
| Gain, small signal | 35 dB | 30 dB, min. |
| VSWR, input and output | 1.5:1 | 2:1, max. |
| Power Output | 21 dBm | 20 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 V ac | 115 ±10 V ac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 20 W | |

# WJ-3004

## ENVIRONMENTAL CHARACTERISTICS[2]

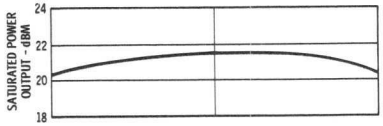
Temperature ..... −54°C to +71°C
Vibration
a) 0.10 Inch, Double Amplitude ..... 5 to 30 Hz
b) 5 g, Single Amplitude ..... 30 to 500 Hz
Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

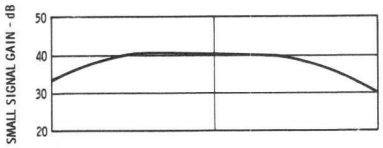
Height ..... 4.75 inches (121 mm) max.
Width ..... 4.75 inches (121 mm) max.
Length (excluding connectors) ..... 12 inches (305 mm) max.
Weight ..... 18 pounds (8.16 Kg) max.
Primary Power Connection ..... Bendix Receptacle PT 07C-8-3P
RF Connectors ..... Type N, Jack
Reference Drawing Number ..... 290029

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

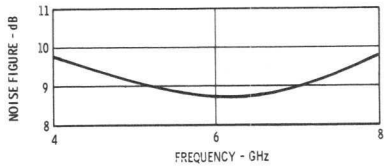
## POWER



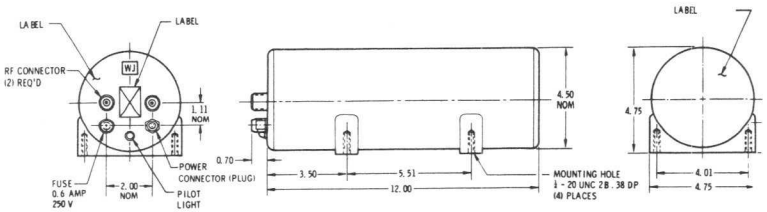

## GAIN




## NOISE




## OUTLINE DRAWING




| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT 07C-8-3P (PLUG) MS 3116 E-8-35 (SR) (SOC) | | |
| PIN | CONNECTION | |
| A | AC | 105-125 VAC |
| B | GROUND | 48-420 CPS |
| C | AC (HOT) | SINGLE PHASE |

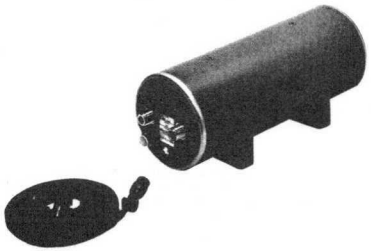
# TECHNICAL DATA

WATKINS-JOHNSON

* DECEMBER 1970

## 8 TO 12 GHz, 100 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-3005

- **POWER OUTPUT 100 mW MINIMUM**
- **NOISE FIGURE 10 dB MAXIMUM**
- **"JUST PLUG IT IN"**
- **PROVEN RELIABILITY**
- **NO ADJUSTMENTS REQUIRED**
- **MEETS MIL-E-5400, CLASS 2 SPECIFICATION**



WJ-3005 is an X-band amplifier that provides 100 mW power output for applications where increased dynamic range is desired. The amplifier is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz). In addition, it may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. The environmental characteristics of the WJ-3005 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 8 to 12 GHz |
| Noise figure, terminal | 9 dB | 10 dB, max. |
| Gain, small signal | 35 dB | 30 dB, min. |
| VSWR, input and output | 1.5:1 | 2:1, max. |
| Power Output | 21 dBm | 20 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 V ac | 115 ±10 V ac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 20 W | |

*Supersedes WJ-3005 Data Sheet dated August 1970

# WJ-3005

## ENVIRONMENTAL CHARACTERISTICS[2]

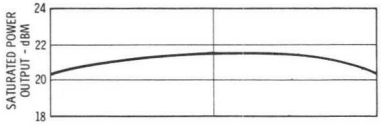
Temperature ..... −54°C to +71°C
Vibration
a) 0.10 Inch, Double Amplitude ..... 5 to 30 Hz
b) 5 g, Single Amplitude ..... 30 to 500 Hz
Shock ..... 15 g, 11 ms

## MECHANICAL CHARACTERISTICS

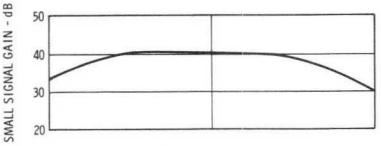
Height ..... 4.75 inches (121 mm) max.
Width ..... 4.75 inches (121 mm) max.
Length (excluding connectors) ..... 13 inches (330 mm) max.
Weight ..... 20 pounds (9.06 Kg) max.
Primary Power Connection ..... Bendix Receptacle PT 07C-8-3P
RF Connectors ..... Type N, Jack
Reference Drawing Number ..... 290299

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

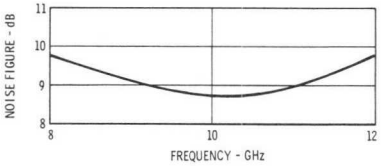
## POWER



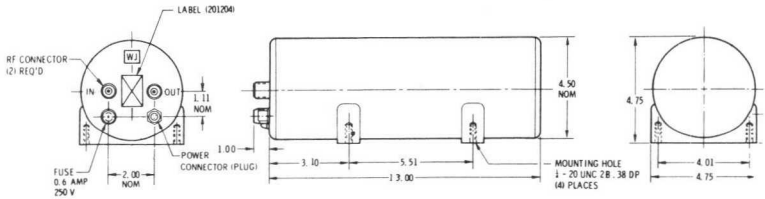

## GAIN




## NOISE




## OUTLINE DRAWING



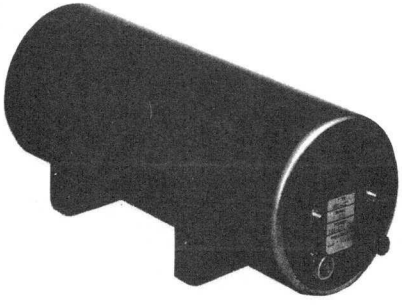

| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT 07C - 8 - 3P (PLUG) MS 3116 E - 8 - 3S (SR) (SOC) | | |
| PIN | CONNECTION | |
| A | AC | 105 - 125 VAC |
| B | GROUND | 48 - 420 CPS |
| C | AC (HOT) | SINGLE PHASE |

# TECHNICAL DATA

WATKINS-JOHNSON

## 12 TO 18 GHz, 100 MILLIWATT LOW-NOISE TRAVELING-WAVE AMPLIFIER WITH INTEGRAL POWER SUPPLY

## WJ-3006



- **POWER OUTPUT 100 mW MINIMUM**
- **NOISE FIGURE 13 dB MAXIMUM**
- **"JUST PLUG IT IN"**
- **PROVEN RELIABILITY**
- **NO ADJUSTMENTS REQUIRED**
- **MEETS TEMPERATURE, VIBRATION AND SHOCK REQUIREMENTS OF MIL-E-5400, CLASS 2**

WJ-3006 is a 12 to 18 GHz amplifier that provides 100 mW power output for applications where increased dynamic range is desired. The amplifier is completely self-contained, adjustment-free, and requires only a 115-volt ac line voltage input (48 to 420 Hz). In addition, it may be operated in any orientation, in stacked arrays, or adjacent to ferromagnetic materials without degradation of performance.

Rugged construction of the tube, magnet, and power supply assembly assures reliable operation under vibrational forces of 5 g, at frequencies up to 500 Hz. Full specifications are met over the operating temperature range of −54° to +71°C. The environmental characteristics of the WJ-3006 meet or exceed the corresponding requirements of MIL-E-5400, Class 2.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 12 to 18 GHz |
| Noise figure, terminal | 12 dB | 13 dB, max. |
| Gain, small signal | 35 dB | 30 dB, min. |
| VSWR, input and output | 1.5:1 | 2:1, max. |
| Power Output | 21 dBm | 20 dBm |

| ELECTRICAL REQUIREMENTS | Typical | Range[1] |
|---|---|---|
| Primary voltage | 115 V ac | 115 ±10 V ac |
| Primary frequency | 60 Hz | 48 to 420 Hz |
| Primary power | 20 W | |

* Supersedes WJ-3006 Technical Data Sheet dated December 1970.

# WJ-3006

## ENVIRONMENTAL CHARACTERISTICS[2]

Temperature ..... −54°C to +71°C
Vibration
a) 0.10 Inch; Double Amplitude ..... 5 to 30 Hz
b) 5 g, Single Amplitude ..... 30 to 500 Hz
Shock ..... 15 g, 11 ms

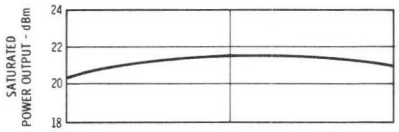
## MECHANICAL CHARACTERISTICS

Height ..... 4.75 inches (121 mm) max.
Width ..... 4.75 inches (121 mm) max.
Length (excluding connectors) ..... 13 inches (330 mm) max.
Weight ..... 18.5 pounds (8.35 Kg) max.
Primary Power Connection ..... Bendix Receptacle PT 07C-8-3P
RF Connectors ..... SMA Female
Reference Drawing Number ..... 290371

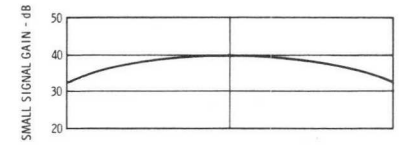
NOTES:

1. Every tube will meet the guaranteed performance specifications for any voltage and frequency within these ranges.
2. These environmental characteristics meet or exceed the respective requirements of MIL-E-5400K (dated 24 May 1968), Class 2.

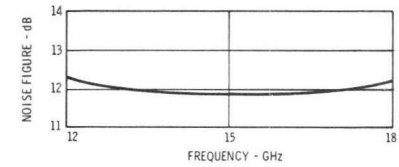
## POWER



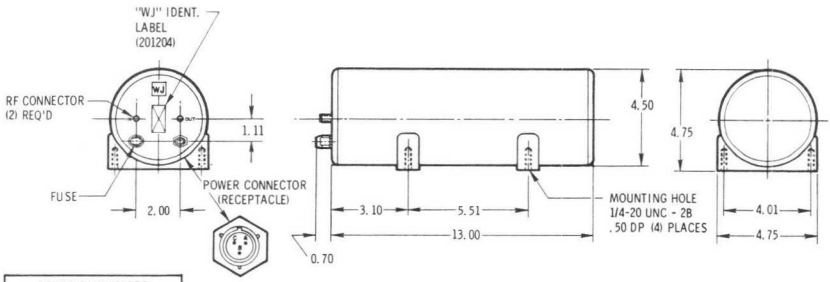

## GAIN




## NOISE




## OUTLINE DRAWING



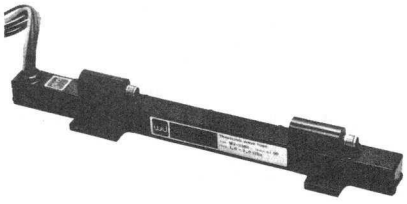

| POWER CONNECTORS | | |
|---|---|---|
| BENDIX: PT 07C-8-3P (RECP) MS 3116 E-8-3S (SR) (PLUG) | | |
| PIN | CONNECTION | |
| C | AC (HOT) | 105 - 125 VAC |
| B | GROUND | 48 - 420 Hz |
| A | AC | SINGLE PHASE |

| RF CONNECTORS |
|---|
| INPUT: TYPE OSM JACK |
| OUTPUT: TYPE OSM JACK |

# TECHNICAL DATA

WATKINS-JOHNSON

## 1 TO 2 GHz 1-WATT TRAVELING-WAVE TUBE WJ-3500



- **OUTPUT POWER 1 WATT MINIMUM**
- **SMALL SIGNAL GAIN 30 dB MINIMUM**
- **PPM FOCUSING**

WJ-3500 is the 1 to 2 GHz unit in a series of medium-power traveling-wave tubes developed by Watkins-Johnson for commercial application. It is intended for new or replacement use in one-watt amplifiers for laboratory work and driver applications.

A new low profile and light weight are mechanical advantages that supplement the excellent performance and high reliability. All voltages are isolated from housing and connectors for maximum flexibility in power supply configurations.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 1 to 2 GHz | 1to 2 GHz |
| Saturated Power Output | +32 dBm | +30 dBm min. |
| Small Signal Gain | 32 to 38 dB | 30 dB min. |
| Total Gain Variation | 6 dB | 10 dB |
| Noise Figure | 20 dB | 30 dB max. |

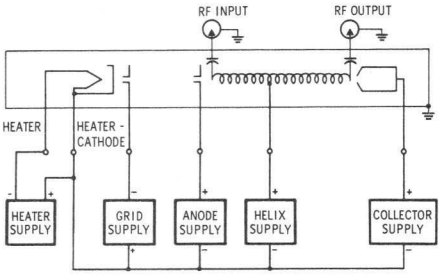
| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.2 to 6.4 volts |
| Heater Current | 0.7 A | 0.4 to 1.2 A |
| Cathode Voltage | 0v | |
| Cathode Current | 20 mA | 25 mA max. |
| Anode Voltage | 200 volts | 150 to 350 volts |
| Helix Voltage | 800 volts | 700 to 900 volts |
| Helix Current | 0.5 mA | 3 mA max. |
| Grid Voltage | 0 volts | —0 to —70 volts |
| Collector Voltage | 800 volts | 700 to 900 volts |
| Collector Current | 20 mA | 25 mA max. |

# WJ-3500

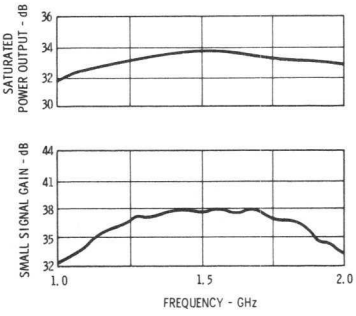
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height | 1.625 inches (41 mm max.) |
| Width | 2.21 inches (56 mm) max. |
| Length | 12.6 inches (320 mm) max. |
| Weight | 1.75 pounds (0.79 Kg) max. |
| DC Connectors | Flying Leads |
| RF Connectors | Type "TNC" Female |
| Cooling | Heat sink or air cooled |
| Focusing | PPM |
| Outline Drawing | 290490 |

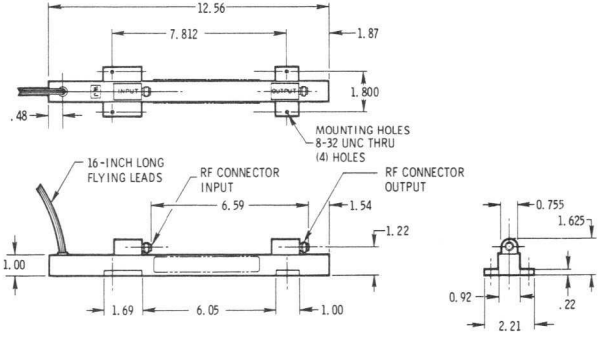
## SCHEMATIC DIAGRAM




## RF ELECTRICAL PERFORMANCE CHARACTERISTICS




## OUTLINE DRAWING




| TWT RF CONNECTORS | |
|---|---|
| INPUT: | TYPE TNC FEMALE |
| OUTPUT: | TYPE TNC FEMALE |

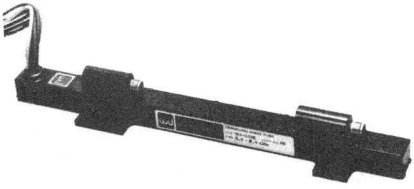
| FLYING LEADS | |
|---|---|
| COLOR | CONNECTION |
| BLACK | CAPSULE |
| BROWN | HEATER |
| GREEN | GRID |
| YELLOW | HEATER-CATHODE |
| BLUE | ANODE |
| ORANGE | HELIX |
| RED | COLLECTOR |

NOTE: VARIOUS MOUNTING CONFIGURATIONS AVAILABLE TO MEET CUSTOMER REQUIREMENTS.

# TECHNICAL DATA

WATKINS-JOHNSON

## 2 TO 4 GHz 1-WATT TRAVELING-WAVE TUBE WJ-3501



- **OUTPUT POWER 1 WATT MINIMUM**
- **SMALL SIGNAL GAIN 30 dB MINIMUM**
- **PPM FOCUSING**

WJ-3501 is the 2 to 4 GHz unit in a series of medium-power traveling-wave tubes developed by Watkins-Johnson for commercial application. It is intended for new or replacement use in one-watt amplifiers for laboratory work and driver applications.

A new low profile and light weight are mechanical advantages that supplement the excellent performance and high reliability. All voltages are isolated from housing and connectors for maximum flexibility in power supply configurations.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2 to 4 GHz | 2 to 4 GHz |
| Saturated Power Output | +32 dBm | +30 dBm min. |
| Small Signal Gain | 32 to 38 dB | 30 dB min. |
| Total Gain Variation | 6 dB | 10 dB |
| Noise Figure | 25 dB | 30 dB max. |

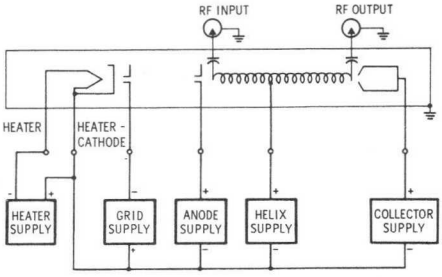
| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6. 2 to 6.4 volts |
| Heater Current | 0.7 A | 0.4 to 1.2 A |
| Cathode Voltage | 0v | |
| Cathode Current | 15 mA | 25 mA max. |
| Anode Voltage | 200 volts | 150 to 450 volts |
| Helix Voltage | 950 volts | 850 to 1050 volts |
| Helix Current | 0.5 mA | 3 mA max. |
| Grid Voltage | —0 volts | —0 to —70 volts |
| Collector Voltage | 950 volts | 850 to 1050 volts |
| Collector Current | 15 mA | 25 mA max. |

# WJ-3501

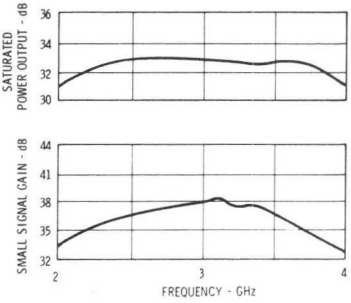
## MECHANICAL CHARACTERISTICS

Height ..... 1.625 inches (41 mm) max.
Width ..... 2.21 inches (56 mm) max.
Length ..... 12.56 inches (319 mm) max.
Weight .....1.75 pounds (0.79 Kg) max.
DC Connectors ..... Flying Leads
RF Connectors ..... Type "TNC" Female
Cooling ..... Air Cooled
Focusing ..... PPM
Outline Drawing ..... 290490

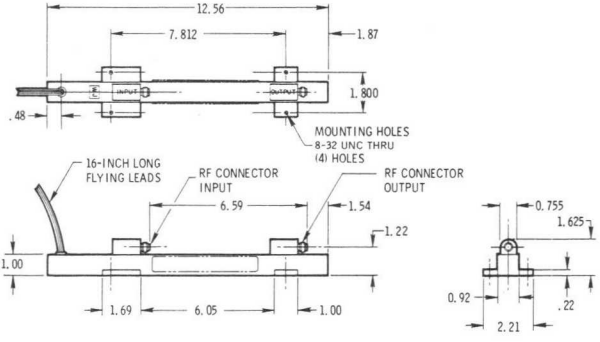
## SCHEMATIC DIAGRAM




## RF ELECTRICAL PERFORMANCE CHARACTERISTICS




## OUTLINE DRAWING




| TWT RF CONNECTORS | |
|---|---|
| INPUT: | TYPE TNC FEMALE |
| OUTPUT: | TYPE TNC FEMALE |

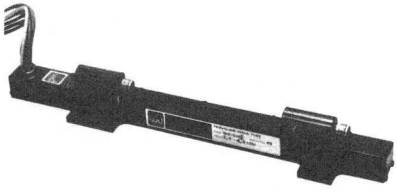
| FLYING LEADS | |
|---|---|
| COLOR | CONNECTION |
| BLACK | CAPSULE |
| BROWN | HEATER |
| GREEN | GRID |
| YELLOW | HEATER-CATHODE |
| BLUE | ANODE |
| ORANGE | HELIX |
| RED | COLLECTOR |

NOTE: VARIOUS MOUNTING CONFIGURATIONS AVAILABLE TO MEET CUSTOMER REQUIREMENTS.

# TECHNICAL DATA

WATKINS-JOHNSON

## 4 TO 8 GHz 1-WATT TRAVELING-WAVE TUBE WJ-3502



- **OUTPUT POWER 1 WATT MINIMUM**
- **SMALL SIGNAL GAIN 30 dB MINIMUM**
- **PPM FOCUSING**

WJ-3502 is the 4 to 8 GHz unit in a series of medium-power traveling-wave tubes developed by Watkins-Johnson for commercial application. It is intended for new or replacement use in one-watt amplifiers for laboratory work and driver applications.

A new low profile and light weight are mechanical advantages that supplement the excellent performance and high reliability. All voltages are isolated from housing and connectors for maximum flexibility in power supply configurations.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4 to 8 GHz | 4 to 8 GHz |
| Saturated Power Output | +32 dBm | +30 dBm min. |
| Small Signal Gain | 33 to 37 dB | 30 dB min. |
| Total Gain Variation | 4 dB | 7 dB |
| Noise Figure | 25 dB | 30 dB max. |

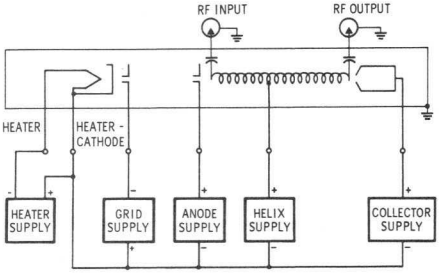
| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6. 2 to 6.4 volts |
| Heater Current | 0.7 A | 0.4 to 1.2 A |
| Cathode Voltage | 0v | |
| Cathode Current | 12 mA | 17 mA max. |
| Anode Voltage | 600 volts | 300 to 800 volts |
| Helix Voltage | 2000 volts | 1900 to 2400 volts |
| Helix Current | 0.5 mA | 3 mA max. |
| Grid Voltage | 0 volts | —0 to —70 volts |
| Collector Voltage | 2000 volts | 1900 to 2400 volts |
| Collector Current | 12 mA | 17 mA max. |

# WJ-3502

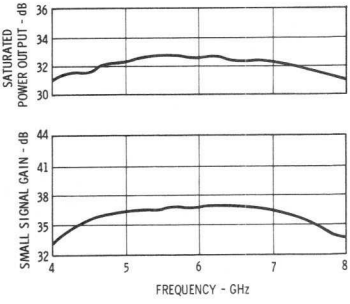
## MECHANICAL CHARACTERISTICS

Height . . . . . 1.625 inches (41 mm max.)
Width . . . . . 2.21 inches (56 mm) max.
Length . . . . . 12.6 inches (320 mm) max.
Weight . . . . . 1.75 pounds (0.79 Kg) max.
DC Connectors . . . . . Flying Leads
RF Connectors . . . . . SMA Female
Cooling . . . . . Heat sink or air cooled
Focusing . . . . . PPM
Outline Drawing . . . . . 290491

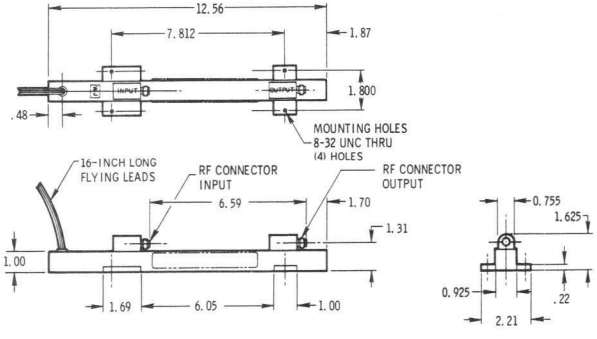
## SCHEMATIC DIAGRAM




## RF ELECTRICAL PERFORMANCE CHARACTERISTICS




## OUTLINE DRAWING




| TWT RF CONNECTORS | |
|---|---|
| INPUT: | TYPE SMA FEMALE |
| OUTPUT: | TYPE SMA FEMALE |

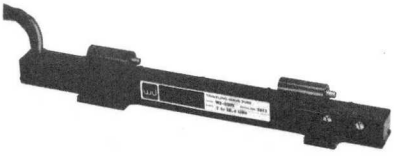
| FLYING LEADS | |
|---|---|
| COLOR | CONNECTION |
| BLACK | CAPSULE |
| BROWN | HEATER |
| GREEN | GRID |
| YELLOW | HEATER-CATHODE |
| BLUE | ANODE |
| ORANGE | HELIX |
| RED | COLLECTOR |

NOTE: VARIOUS MOUNTING CONFIGURATIONS AVAILABLE TO MEET CUSTOMER REQUIREMENTS.

# TECHNICAL DATA

WATKINS-JOHNSON

## 7 TO 12.4 GHz 1-WATT TRAVELING-WAVE TUBE WJ-3503



- **OUTPUT POWER 1 WATT MINIMUM**
- **SMALL SIGNAL GAIN 30 dB MINIMUM**
- **PPM FOCUSING**

WJ-3503 is the 7 to 12.4 GHz unit in a series of medium power traveling-wave tubes developed by Watkins-Johnson for commercial applications. It is intended for new or replacement use in one-watt amplifiers for laboratory work or driver applications.

A new low profile and light weight are mechanical advantages that supplement the excellent performance and high reliability. All voltages are isolated from housing and connectors for maximum flexibility in power supply configurations.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 7 to 12.4 GHz | 7.0 to 12.4 GHz |
| Saturated Power Output | +32 dBm | +30 dBm min. |
| Small Signal Gain | 35 to 40 dB | 30 dB min. |
| Total Gain Variation | 5 dB | 7 dB |
| Noise Figure | 23 dB | 30 dB max. |

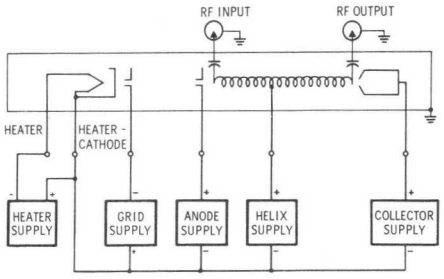
| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.2 to 6.4 volts |
| Heater Current | 0.7 A | 0.4 to 1.2 A |
| Cathode Voltage | 0v | |
| Cathode Current | 10 mA | 17 mA max. |
| Anode Voltage | 250 volts | 200 to 700 volts |
| Helix Voltage | 2500 volts | 2200 to 2700 volts |
| Helix Current | 0.5 mA | 3 mA max. |
| Grid Voltage | 0 volts | —0 to —70 volts |
| Collector Voltage | 2500 volts | 2200 to 2700 volts |
| Collector Current | 10 mA | 17 mA max. |

# WJ-3503

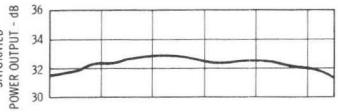
## MECHANICAL CHARACTERISTICS

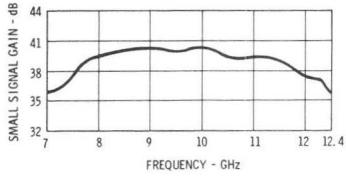
Height . . . . . 1.625 inches (41 mm max.)
Width . . . . . 2.21 inches (56 mm) max.
Length . . . . . 12.6 inches (320 mm) max.
Weight . . . . . 1.75 pounds (0.79 Kg) max.
DC Connectors . . . . . Flying Leads
RF Connectors . . . . . SMA Female
Cooling . . . . . Heat sink or air cooled
Focusing . . . . . PPM
Outline Drawing . . . . . 290491

## SCHEMATIC DIAGRAM

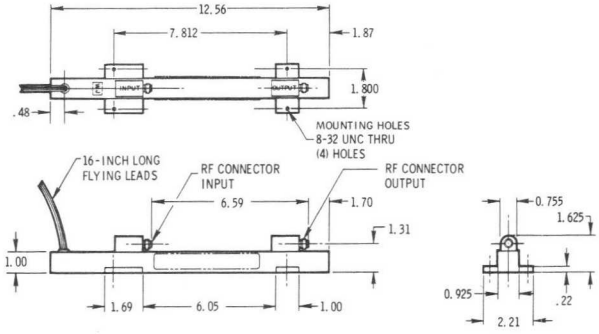



## RF ELECTRICAL PERFORMANCE




## OUTLINE DRAWING




| TWT RF CONNECTORS | |
|---|---|
| INPUT: | TYPE SMA FEMALE |
| OUTPUT: | TYPE SMA FEMALE |

| FLYING LEADS | |
|---|---|
| COLOR | CONNECTION |
| BLACK | CAPSULE |
| BROWN | HEATER |
| GREEN | GRID |
| YELLOW | HEATER-CATHODE |
| BLUE | ANODE |
| ORANGE | HELIX |
| RED | COLLECTOR |

NOTE: VARIOUS MOUNTING CONFIGURATIONS AVAILABLE TO MEET CUSTOMER REQUIREMENTS.

# TECHNICAL DATA

WATKINS-JOHNSON

## 4 TO 8 GHz 200-WATT CW CONDUCTION-COOLED TRAVELING-WAVE TUBE WJ-3641

WJ-3641 is one of a series of TWT amplifiers designed by Watkins-Johnson for ECM, airborne and missile applications. It joins a select group of PPM-focused amplifiers that have successfully operated at power levels as high as 400 watts CW over the frequency range of 5.2 to 10.4 GHz.

A unique cooling system allows the WJ-3641 to be operated at high power levels with increased reliability and longer life. Radial copper bus bars promote thermal conduction between the helix interaction surface and the baseplate, thus providing a cooler operating RF circuit.

### SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 4.0-8.0 GHz | 4.0 -8.0 GHz |
| Saturation Power Output | 225 watts | 200 watts min. |
| Saturation Gain | 40 dB | 35 dB min. |
| Overall Efficiency, Including Heater[1] | 20 percent | 15 percent min. |
| **ELECTRICAL REQUIREMENTS** | | |
| Heater Voltage | 6.3 volts | 6.0-6.5 volts |
| Heater Current | 2.5 A | 2.6 A max. |
| Anode Voltage[2] | 6000 volts | 5800-6300 volts |
| Anode Current | 0.5 mA | 1.0 mA max. |
| Helix Voltage[2] | 5700 volts | 5700-6200 volts |
| Helix Current | 10 mA | 15 mA max. |
| Collector Voltage[2] | 3700 volts | 3500-4000 volts |
| Collector Current | 350 mA | 375 mA max. |

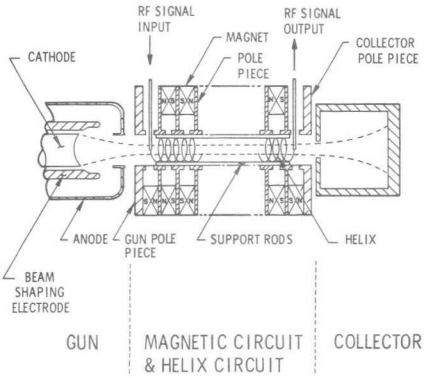
NOTES:
1. Overall efficiency is defined as the RF output power divided by the total dc input power, including heater power.
2. These voltages are referenced to the cathode. Helix is operated at ground potential.

# WJ-3641

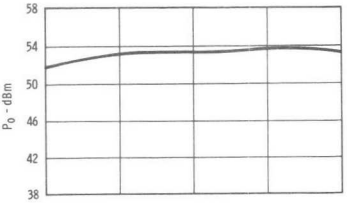
## MECHANICAL CHARACTERISTICS

Tube Length . . . . . 16.25 inches (413 mm) max.
Tube Height, Excluding
Connectors . . . . . 2.25 inches (57 mm) max.
Tube Width . . . . . 3.03 inches (76 mm) max.
Tube Weight . . . . . 9.0 pounds (4.08 kg) max.
DC Connectors . . . . . High voltage connectors
RF Connectors . . . . . Input: SMA (female)
Output: type N (female)
Cooling . . . . . Conduction from bottom surface
Focusing . . . . . PPM

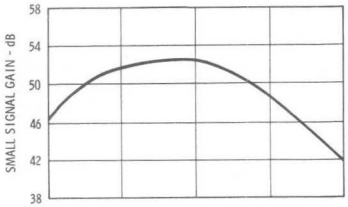
## CROSS SECTION



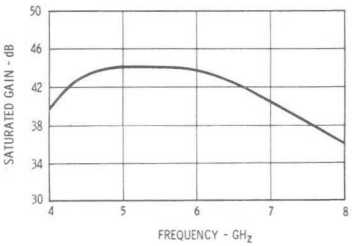

## SATURATED POWER OUTPUT



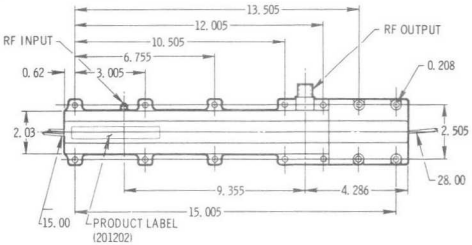

## SMALL SIGNAL GAIN

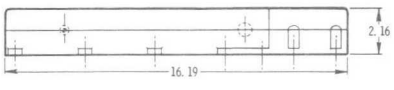


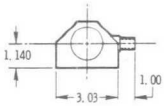

## SATURATED GAIN




## OUTLINE DRAWING




| POWER CONNECTION FLYING LEADS | |
|---|---|
| COLOR | DESIGNATION |
| BROWN | HEATER |
| YELLOW | HEATER-CATHODE |
| GREEN | ANODE OR GRID |
| RED | COLLECTOR |
| ORANGE | HELIX (GRND) |

| RF CONNECTORS | |
|---|---|
| INPUT: | TYPE SMA FEMALE |
| OUTPUT: | TYPE "N" FEMALE |

# TECHNICAL DATA

WATKINS-JOHNSON

## 8 TO 12 GHz 175-WATT CW CONDUCTION-COOLED TRAVELING-WAVE TUBE WJ-3642

WJ-3642 is one of a series of TWT amplifiers designed by Watkins-Johnson for ECM, airborne and missile applications. It joins a select group of PPM-focused amplifiers that have successfully operated at power levels as high as 400 watts CW over the frequency range of 5.2 to 10.4 GHz.

A unique cooling system allows the WJ-3642 to be operated at high power levels with increased reliability and longer life. Radial copper bus bars promote thermal conduction between the helix interaction surface and the baseplate, thus providing a cooler operating RF circuit.

### SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Frequency Range | 8-12 GHz | 8-12 GHz |
| Saturation Power Output | 200 watts | 175 watts min. |
| Saturation Gain | 40 dB | 35 dB min. |
| Overall Efficiency, Including Heater[1] | 20 percent | 15 percent min. |
| **ELECTRICAL REQUIREMENTS** | | |
| Heater Voltage | 6.3 volts | 6.0-6.5 volts |
| Heater Current | 2.5 A | 2.6 A max. |
| Anode Voltage[2] | 7000 volts | 7000-7300 volts |
| Anode Current | 0.5 mA | 1.0 mA max. |
| Helix Voltage[2] | 6800 volts | 6800-7200 volts |
| Helix Current | 10 mA | 15 mA max. |
| Collector Voltage[2] | 4100 volts | 4300-5000 volts |
| Collector Current | 300 mA | 325 mA max. |

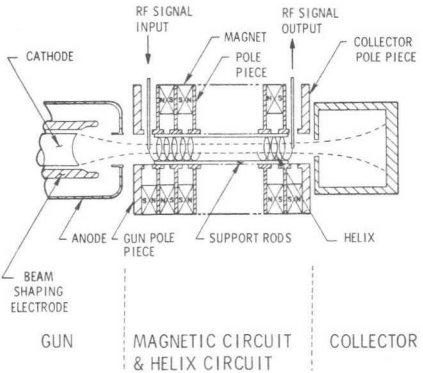
NOTES:
1. Overall efficiency is defined as the RF output power divided by the total dc input power, including heater power.
2. These voltages are referenced to the cathode. Helix is operated at ground potential.

# WJ-3642

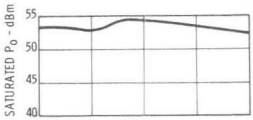
## MECHANICAL CHARACTERISTICS

Tube Length ..... 16.25 inches (413 mm) max.
Tube Height, Excluding
Connectors ..... 2.25 inches (57 mm) max.
Tube Width ..... 3.03 inches (76 mm) max.
Tube Weight ..... 9.0 pounds (4.08 kg) max.
DC Connectors ..... Flying leads high voltage connectors
RF Connectors ..... Input: SMA (female)
Output: type N (female)
Cooling ..... Conduction from bottom surface
Focusing ..... PPM

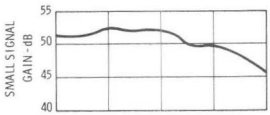
## CROSS SECTION



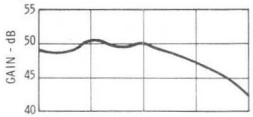

## SATURATED POWER OUTPUT



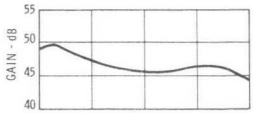

## SMALL SIGNAL GAIN



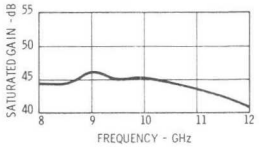

## GAIN AT RATED $P_0$



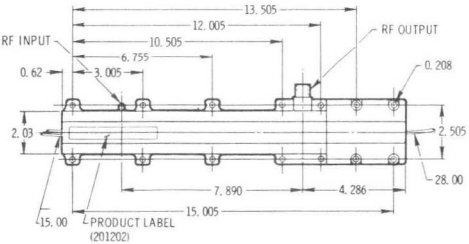

## GAIN WITH EQUALIZER

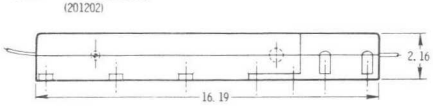


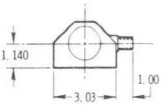

## SATURATED GAIN




## OUTLINE DRAWING



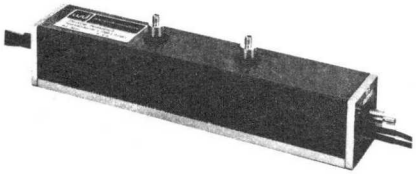

| POWER CONNECTION | |
|---|---|
| FLYING LEADS | |
| COLOR | DESIGNATION |
| BROWN | HEATER |
| YELLOW | HEATER-CATHODE |
| GREEN | ANODE OR GRID |
| RED | COLLECTOR |
| ORANGE | HELIX (GRND) |

| RF CONNECTORS | |
|---|---|
| INPUT: | TYPE SMA FEMALE |
| OUTPUT: | TYPE "N" FEMALE |

# TECHNICAL DATA

WATKINS-JOHNSON

## ELECTRON BOMBARDED SEMICONDUCTOR (EBS) RF AND VIDEO PULSE AMPLIFIER WJ-3650



- **PULSE OUTPUT VOLTAGE 250 VOLTS (DUAL-POLARITY)**
- **PULSE RISETIME LESS THAN 2 NANOSECONDS**
- **PEAK POWER OUTPUT 125 WATTS AT 27 dB GAIN**

The WJ-3650 is one of a new series of Watkins-Johnson Electron Bombarded Semiconductor (EBS) components. This device amplifies pulses of either polarity and delivers an amplified voltage output pulse with nanosecond risetimes. Alternatively, it can be used as an RF amplifier to produce a peak power output greater than 125 watts (50 ohm load) and wide instantaneous bandwidth.

The WJ-3650 utilizes an electron beam that passes through a wideband deflection system. An input signal deflects the electron beam between two silicon semiconductor diode targets. Since the pair creation energy of a silicon semiconductor lattice is 3.6 eV, each 10 keV incident beam electron produces thousands of carrier pairs, resulting in a current gain of about 2000. In the absence of an input signal, no beam current is intercepted by the diodes and thus no output signal results.

For maximum efficiency, a voltage swing across the diode from zero to the maximum output voltage is desirable. This will result in the positive half of the sine wave being completely intercepted by one target and the negative half of the sine wave intercepted by the other target. Efficiencies as high as 50% have been measured.

The basic frequency response of the WJ-3650 is that of a broadband low pass amplifier. This response is largely limited by the capacitance of the diode and the load impedance. The transit time of the carrier pairs through the diode also has an effect. Pulse risetimes of 1.0 nanosecond are attained into a 25 ohm load.

### SPECIFICATIONS

| PERFORMANCE CHARACTERISTICS | Fast Rise Mode (Load Impedance: 25 ohms) | High Voltage Mode (Load Impedance: 50 ohms) |
|---|---|---|
| **Time Domain** | | |
| Video output voltage | 190 volts | 250 volts |
| Pulse risetime | 1 nanosecond | 2 nanoseconds |
| Video input voltage | 10 volts | 10 volts |
| Pulse polarity | Dual polarity[1] | Dual polarity[1] |
| Duty factor | 4 percent | 4 percent |
| **Frequency Domain** | | |
| RF output power | 175 watts | 125 watts |
| Frequency response (3 dB) | DC —320 MHz | DC —160 MHz |
| RF input power | 0.25 watts | 0.25 watts |
| Power gain | 28.5 dB | 27 dB |
| Duty factor | 2 percent | 2 percent |

# WJ-3650

## SPECIFICATIONS (Cont'd)

### ELECTRICAL REQUIREMENTS

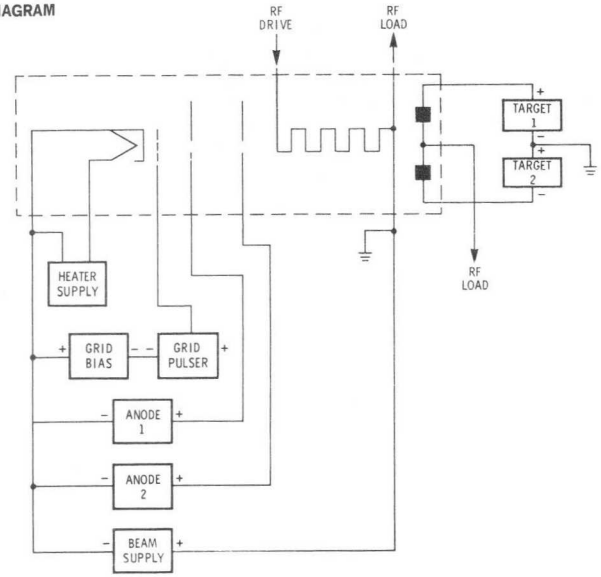
| | | |
|---|---|---|
| Heater voltage ac | 5.0 volts | 5.0 to 6.0 Vac |
| Heater current | 0.8 A | 0.6 to 1.0 A |
| Cathode voltage[4] | −15 kV | −12 to −15 kV |
| Cathode current | 5 mA | 2 to 5 mA |
| Grid bias voltage[2] | −150 volts | −140 to −180 V |
| Grid pulse voltage[3] (peak) | 135 volts | 130 to 180 V |
| Grid current | less than 5 μA | 0 to 5 μA |
| Anode 1 voltage[2] | 550 volts | 500 to 700 V |
| Anode 1 current | less than 5 μA | 0 to 5 μA |
| Anode 2 voltage[2] | 1500 volts | 1400 to 2000 V |
| Anode 2 current | less than 5 μA | 0 to 5 μA |
| Target 1 voltage[4] | +200 volts | 150 to 250 V |
| Target 2 voltage[4] | −200 volts | −150 to −250 V |
| Targets 1 and 2 current (peak) | 7.5 A | 5 to 9 A |

### MECHANICAL CHARACTERISTICS

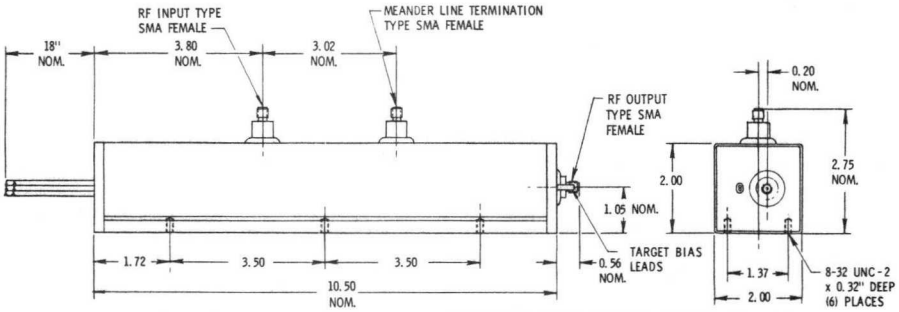
| | |
|---|---|
| Length | 10.75 inches (273 mm) max. (excluding connectors) |
| Cross section | 2 x 2 inches (51 x 51 mm) (excluding connectors) |
| Weight | 3 lbs. (1.36 kg) |
| Connectors | SMA, Jack |
| Cooling | Conduction through baseplate |

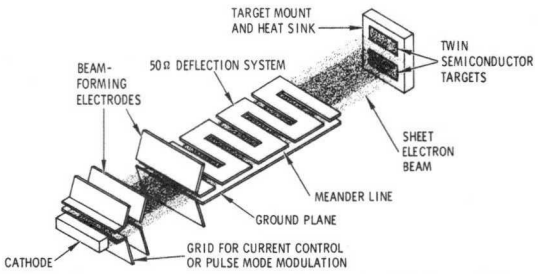
NOTES:
1. Both plus or minus output voltage can be obtained.
2. Indicated voltages are with respect to cathode. Body is at ground potential.
3. Indicated voltages are with respect to the grid bias voltage.
4. Indicated voltages are with respect to ground potential.

### SCHEMATIC DIAGRAM

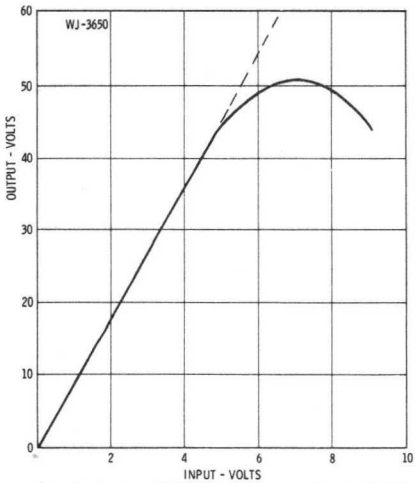


## OUTLINE DRAWING

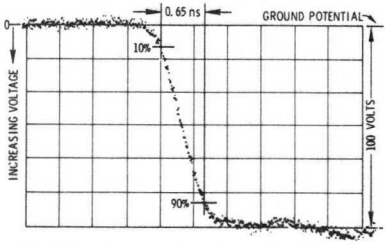



**Schematic of the balanced twin-target EBS amplifier using deflection modulation.**

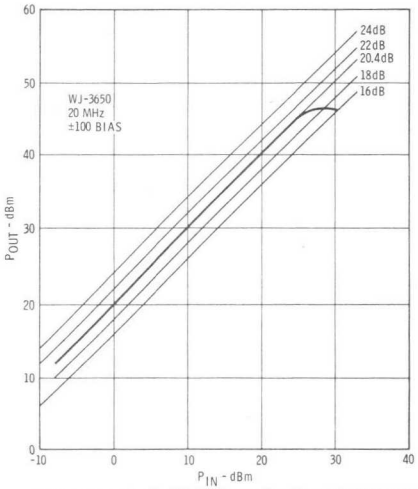



**Output voltage of WJ-3650 as a function of input voltage. Note linearity up to saturation point.**

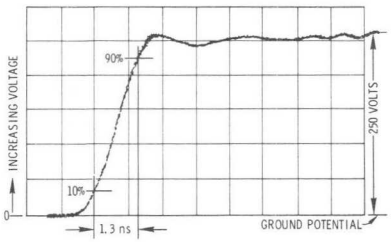



**Actual data of response to an input pulse of 6.0 volts, with a single diode target. Output risetime is 0.65 nsec., since only one-half the dual target capacitance is present.**

# WJ-3650




Output power for the WJ-3650 as a function of input power. Note linearity.




Actual data of response to 10 volt input pulse; 1 nsec risetime. Output risetime is 1.3 nsec.

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TABLE OF WATKINS-JOHNSON ELECTRON-BOMBARDED SEMICONDUCTOR APPLICATION NOTES:

Device Delivers kW Output in Picoseconds — No. 100273

The Capabilities of Electron-Beam Semiconductor Active Devices — No. 100274

A Comparison of Electron-Beam Semiconductor Devices Employing Grid Modulation and Beam Deflection — No. 100275B

The Capabilities of Simple Electron-Beam Semiconductor Linear-Switching Devices — No. 100276A

A Picosecond-Risetime Real Time Sampling Element Based on the EBS interaction — No. 100280A

Characteristics of an EBS RF Amplifier — No. 100336

A Kilowatt-Pulsed RF Electron-Beam Semiconductor Amplifier — No. 100352

Design and Performance of Deflected Beam, EBS Amplifiers — No. 100353D

New Solid State Devices Evolve 100365

EBS Amplifiers Debut 100368

Recent Improvements to Semiconductor Targets Reliability and Performance of the WJ-3650 EBS Video Pulsed Amplifier — 100398

Character of WJ-3652 High Speed EBS Switch for Modulation of Injection Lasers — 100421

EBS Devices — 100423

# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 4 TO 8 GHz MEDIUM-POWER LOW-NOISE TRAVELING-WAVE TUBE WJ-3802

- **OUTPUT POWER 4 WATTS MINIMUM**
- **PPM FOCUSING**
- **ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION**
- **EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION**

WJ-3802 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where gain variation and phase linearity are important (the tube provides fine structure gain variation of ±0.5 dB). A unique feature of the tube is its low cathode current density: a W-J innovation in low-noise electron gun design allows cathode loading of only 1.0 A/cm². This feature ensures the user of extremely long tube life.

The use of Periodic-Permanent-Magnet (PPM) focusing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variation over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-3802 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 4.0 to 8.0 GHz |
| Saturated Power Output | 5 watts | 4 watts, min. |
| Small Signal Gain | 42 dB | 40 dB, min. |
| Small Signal Gain Variation | ±2.5 dB | ±3 dB, max. |
| Gross Fine Structure Small Signal Gain Variation | ±0.2 dB | ±0.5 dB |
| Noise Figure | 20 dB | 22 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.0 to 6.6 volts |
| Grid Voltage[1] | —20 volts | —18 to —22 volts |
| Helix Voltage[1] | 2800 volts | 2600 to 3000 volts |
| Collector Voltage[1] | 1500 volts | 1400 to 1800 volts |
| Cathode Current | 35 mA | 30 to 40 mA |
| Helix Current | 1.0 mA | 0.2 to 3 mA |
| Heater Current | 0.4 A | 0.3 to 0.5 A |

NOTE 1. Voltage with respect to cathode.
2. Helix is grounded to tube capsule.

# WJ-3802

## SPECIFICATIONS (Cont'd)

### MECHANICAL CHARACTERISTICS

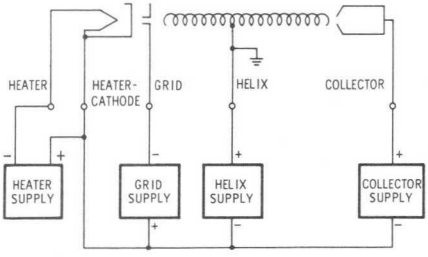
| | |
|---|---|
| Cooling | Conduction through baseplate[3] |
| Length | 14.0 inches, (356 mm) max. |
| Height (excluding connectors) | 1.40 inch, (36 mm) max. |
| Width | 1.70 inch, (43 mm) max. |
| Weight | 2.5 lbs., 1.13 kg) max. |
| Connectors | OSM, Jack |
| Focusing | PPM |

### ENVIRONMENTAL CAPABILITY

| | |
|---|---|
| Temperature | –54°C to 85°C (baseplate) |
| Vibration (120-2000 cycles) | 5 Grms |
| Shock | 20 G |
| Altitude | Any |

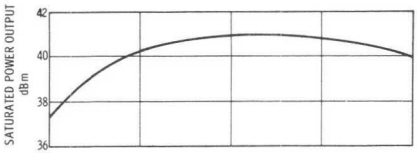
[3]Air cooling available upon request.

## SCHEMATIC DIAGRAM

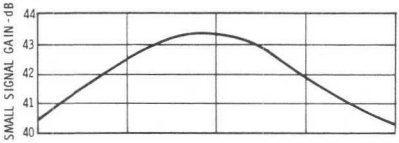



## RF ELECTRICAL PERFORMANCE CHARACTERISTICS

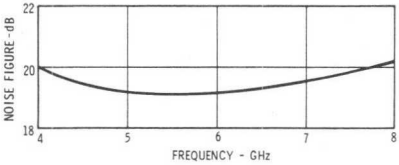
### POWER



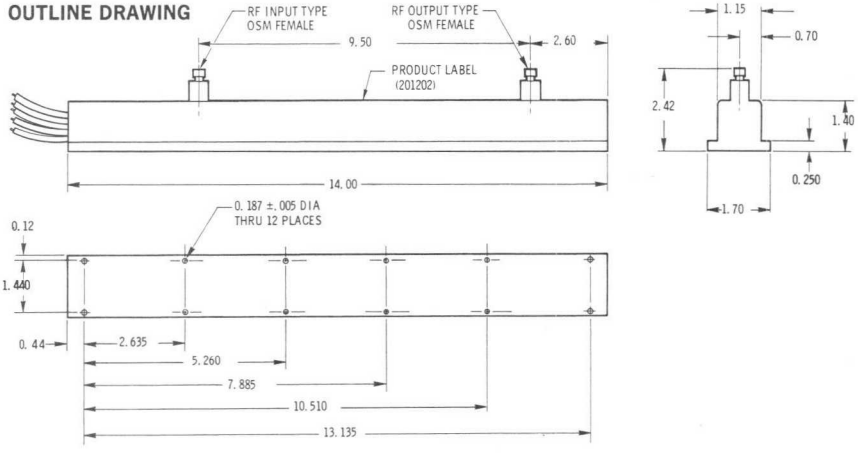

### GAIN




### NOISE




## OUTLINE DRAWING

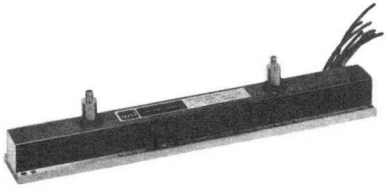


# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 7 TO 11 GHz MEDIUM-POWER LOW-NOISE TRAVELING-WAVE TUBE
## WJ-3804



- **OUTPUT POWER 3 WATTS MINIMUM**
- **PPM FOCUSING**
- **ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION**
- **EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION**

WJ-3804 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where gain variation and phase linearity are important (the tube provides fine structure gain variation of ±0.5 dB). A unique feature of the tube is its low cathode current density: a W-J innovation in low-noise electron gun design allows cathode loading of only 0.8 A/cm². This feature ensures the user of extremely long tube life.

The use of Periodic-Permanent-Magnet (PPM) focusing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variations over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-3804 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 7.0 to 11.0 GHz |
| Saturated Power Output | 4 watts | 3 watts, min. |
| Small Signal Gain | 45 dB | 43 dB, min. |
| Small Signal Gain Variation | ±1.5 dB | ±2 dB, max. |
| Gross Fine Structure Small Signal Gain Variation | ±0.2 dB | ±0.5 dB |
| Noise Figure | 20 dB | 22 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.0 to 6.6 volts |
| Grid Voltage[1] | −20 volts | 19.5 to −20.5 volts |
| Helix Voltage[1] | 3100 volts | 2900 to 3200 volts |
| Collector Voltage[1] | 1800 volts | 1700 to 1900 volts |
| Cathode Current | 26 mA | 23 to 30 mA |
| Helix Current | 0.5 mA | 0.2 to 3 mA |
| Heater Current | 0.4 A | 0.3 to 0.5 A |

NOTE 1. Voltage with respect to cathode.
2. Helix is grounded to tube capsule.

# WJ-3804

## MECHANICAL CHARACTERISTICS

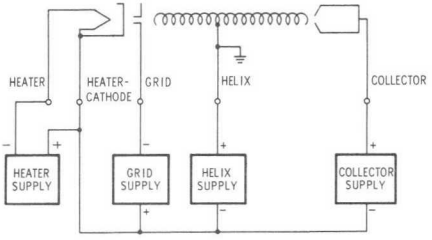
| | |
|---|---|
| Cooling | Conduction through baseplate[3] |
| Length | 12 inches, (305mm) max. |
| Height | 1.40 inch, (36mm) max. |
| Width | 1.70 inch, (43 mm) max. |
| Weight | 2.0 lbs. (0.91 Kg) max. |
| Connectors | OSM, Jack |
| Focusing | PPM |

## ENVIRONMENTAL CAPABILITY

| | |
|---|---|
| Temperature | −54°C to 85°C (baseplate) |
| Vibration (120-2000 cycles) | 5 Grms |
| Shock | 20 G |
| Altitude | Any |

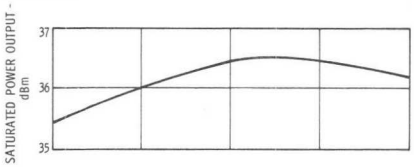
[3]Air cooling available upon request.

## SCHEMATIC DIAGRAM

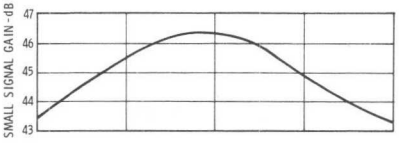



## RF ELECTRICAL PERFORMANCE CHARACTERISTICS

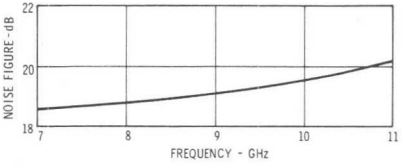
### POWER



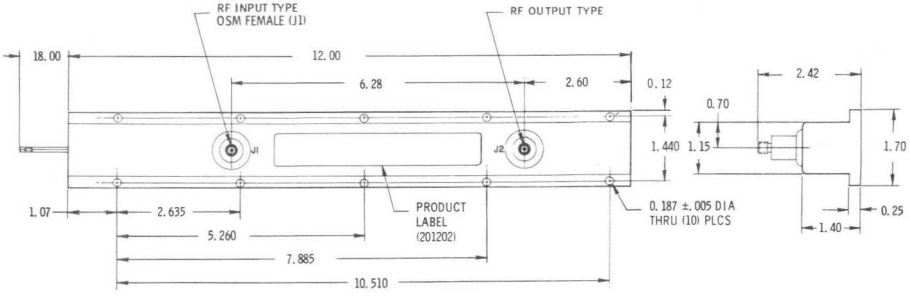

### GAIN




### NOISE




## OUTLINE DRAWING

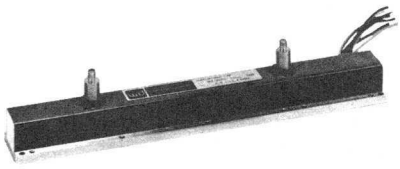


# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 8 TO 12.4 GHz MEDIUM-POWER LOW-NOISE TRAVELING-WAVE TUBE WJ-3805



- OUTPUT POWER 3 WATTS MINIMUM
- PPM FOCUSING
- ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION
- EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION

WJ-3805 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where gain variation and phase linearity are important (the tube provides fine structure gain variation of ±0.5 dB). A unique feature of the tube is its low cathode current density: a W-J innovation in low-noise electron gun design allows cathode loading of only 0.8 A/cm². This feature ensures the user of extremely long tube life.

The use of Periodic-Permanent-Magnet (PPM) focusing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variations over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-3805 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 8.0 to 12.4 GHz |
| Saturated Power Output | 4 watts | 3 watts, min. |
| Small Signal Gain | 45 dB | 42 dB, min. |
| Small Signal Gain Variation | ±1.5 dB | ±2 dB, max. |
| Gross Fine Structure Small Signal Gain Variation | ±0.2 dB | ±0.5 dB |
| Noise Figure | 20 dB | 22 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.0 to 6.6 volts |
| Grid Voltage[1] | −20 volts | −19.5 to −20.5 volts |
| Helix Voltage[1] | 3100 volts | 2900 to 3200 volts |
| Collector Voltage[1] | 1800 volts | 1700 to 1900 volts |
| Cathode Current | 26 mA | 23 to 30 mA |
| Helix Current | 0.5 mA | 0.2 to 3 mA |
| Heater Current | 0.4 A | 0.3 to 0.5 A |

NOTE 1. Voltage with respect to cathode.
2. Helix is grounded to tube capsule.

# WJ-3805

## MECHANICAL CHARACTERISTICS

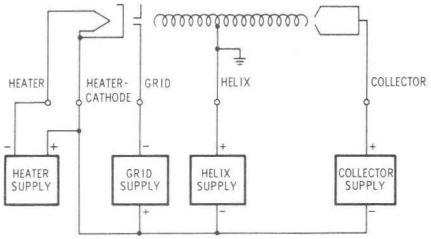
| | |
|---|---|
| Cooling | Conduction through baseplate[3] |
| Length | 12 inches, (305 mm) max. |
| Height | 1.40 inch, (36 mm) max. |
| Width | 1.70 inch, (43 mm) max. |
| Weight | 2.0 lbs. (0.91 Kg) max. |
| Connectors | OSM, Jack |
| Focusing | PPM |

## ENVIRONMENTAL CAPABILITY

| | |
|---|---|
| Temperature | −54°C to 85°C (baseplate) |
| Vibration (120-2000 cycles) | 5 Grms |
| Shock | 20 G |
| Altitude | Any |

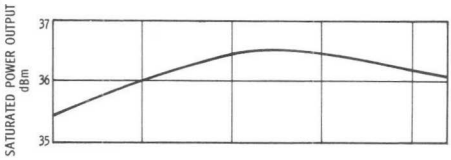
[3]Air cooling available upon request.

## SCHEMATIC DIAGRAM

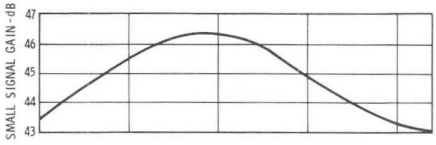



## RF ELECTRICAL PERFORMANCE CHARACTERISTICS

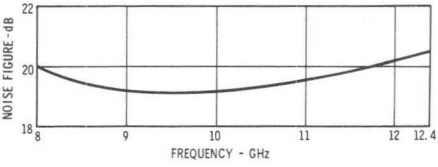
### POWER



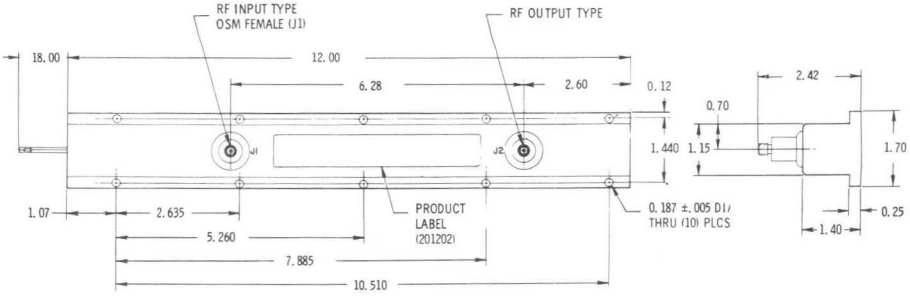

### GAIN




### NOISE




## OUTLINE DRAWING

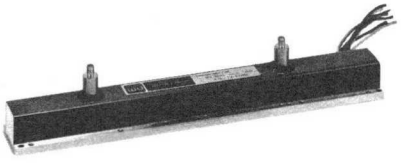


# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 8 TO 12.4 GHz HIGH-GAIN MEDIUM-POWER LOW-NOISE TRAVELING-WAVE TUBE WJ-3805-1



- **SMALL SIGNAL GAIN 60 dB MINIMUM**
- **OUTPUT POWER 5 WATTS MINIMUM**
- **PPM FOCUSING**
- **ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION**

WJ-3805-1 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where high gain and low noise are important. A unique feature of the tube is its low cathode current density: a W-J innovation in low-noise electron gun design allows cathode loading of only 1.5 A/cm². This feature ensures the user of long tube life.

The use of Periodic-Permanent-Magnet (PPM) focusing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variations over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-3805-1 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 8.0 to 12.4 GHz |
| Saturated Power Output | 6 watts | 5 watts, min. |
| Small Signal Gain | 62 dB | 60 dB, min. |
| Small Signal Gain Variation | ±2.0 dB | ±3.0 dB, max. |
| Gross Fine Structure Small Signal Gain Variation | ±1.0 dB | ±1.5 dB |
| Noise Figure | 20 dB | 22 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.0 to 6.6 volts |
| Grid Voltage[1] | —20 volts | —19.5 to —20.5 volts |
| Helix Voltage[1] | 3100 volts | 2800 to 3200 volts |
| Collector Voltage[1] | 1800 volts | 1700 to 3200 volts |
| Cathode Current | 37 mA | 35 to 40 mA |
| Helix Current | 0.5 mA | 0.2 to 4.0 mA |
| Heater Current | 0.4 A | 0.3 to 0.5 A |

NOTE 1. Voltage with respect to cathode.
2. Helix is at ground potential.

# WJ-3805-1

## MECHANICAL CHARACTERISTICS

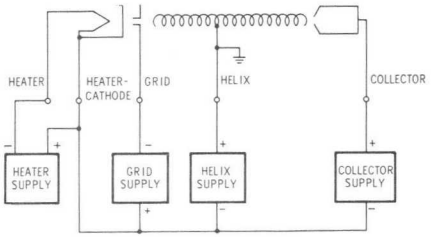
| | |
|---|---|
| Cooling | Conduction through baseplate[3] |
| Height | 1.40 inches (36 mm) max. |
| Width (excluding connectors) | 1.70 inches (43 mm) max. |
| Length | 12 inches (305 mm) max. |
| Weight | 2 pounds (0.91 Kg) max. |
| Connectors | OSM, Jack |
| Focusing | PPM |

## ENVIRONMENTAL CAPABILITY

| | |
|---|---|
| Temperature | −54°C to 85°C (baseplate) |
| Vibration (120-2000 cycles) | 5 Grms |
| Shock | 20 G |
| Altitude | Any |

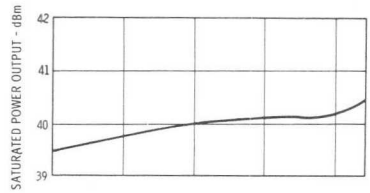
[3]Air cooling available upon request.

## SCHEMATIC DIAGRAM

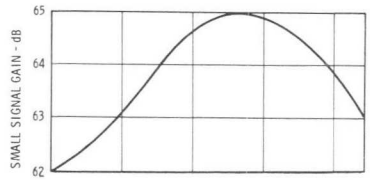



## RF ELECTRICAL PERFORMANCE CHARACTERISTICS

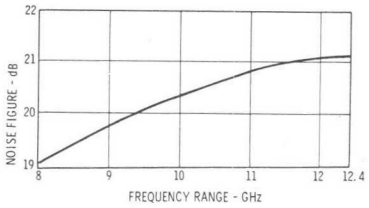
### POWER



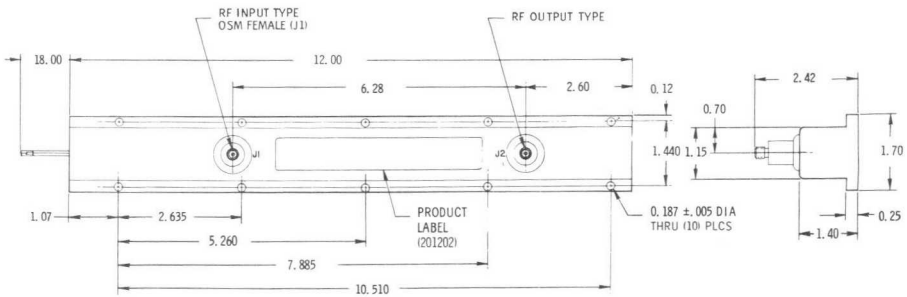

### GAIN




### NOISE




## OUTLINE DRAWING

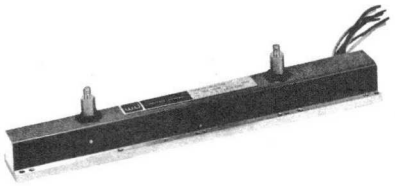


# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 8 TO 16 GHz MEDIUM-POWER LOW-NOISE TRAVELING-WAVE TUBE
## WJ-3806



- **OUTPUT POWER 3 WATTS MINIMUM**
- **PPM FOCUSING**
- **ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION**
- **EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION**

WJ-3806 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where gain variation and phase linearity are important (the tube provides fine structure gain variation of ±0.5 dB). A unique feature of the tube is its low cathode current density: a W-J innovation in low-noise electron gun design allows cathode loading of only 0.8 A/cm². This feature ensures the user of extremely long tube life.

The use of Periodic-Permanent-Magnet (PPM) focusing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variations over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-3806 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 8.0 to 16.0 GHz |
| Saturated Power Output | 4 watts | 3 watts, min. |
| Small Signal Gain | 40 dB | 38 dB, min. |
| Small Signal Gain Variation | ±2.5 dB | ±3.0 dB, max. |
| Gross Fine Structure Small Signal Gain Variation | ±0.2 dB | ±0.5 dB |
| Noise Figure | 22 dB | 24 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.0 to 6.6 volts |
| Grid Voltage[1] | -20 volts | -19.5 to -20.5 volts |
| Helix Voltage[1] | 3000 volts | 2800 to 3100 volts |
| Collector Voltage[1] | 1800 volts | 1700 to 1900 volts |
| Cathode Current | 26 mA | 23 to 30 mA |
| Helix Current | 0.5 mA | 0.2 to 3 mA |
| Heater Current | 0.4 A | 0.3 to 0.5 A |

NOTE 1. Voltage with respect to cathode.
2. Helix is grounded to tube capsule.

# WJ-3806

## MECHANICAL CHARACTERISTICS

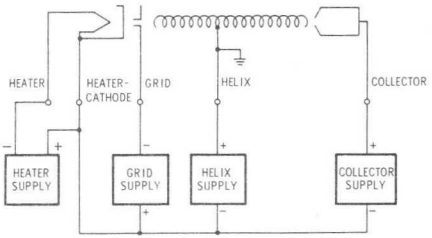
| | |
|---|---|
| Cooling | Conduction through baseplate[3] |
| Length | 12 inches, (305 mm) max. |
| Height | 1.40 inch, (36 mm) max. |
| Width | 1.70 inch, (43 mm) max. |
| Weight | 2.0 lbs. (0.91 Kg) max. |
| Connectors | OSM, Jack |
| Focusing | PPM |

## ENVIRONMENTAL CAPABILITY

| | |
|---|---|
| Temperature | −54°C to 85°C (baseplate) |
| Vibration (120-2000 cycles) | 5 Grms |
| Shock | 20 G |
| Altitude | Any |

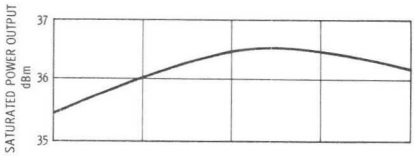
[3]Air cooling available upon request.

## SCHEMATIC DIAGRAM

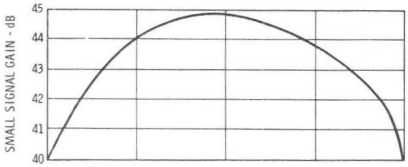



## RF ELECTRICAL PERFORMANCE CHARACTERISTICS

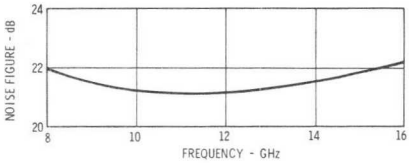
### POWER



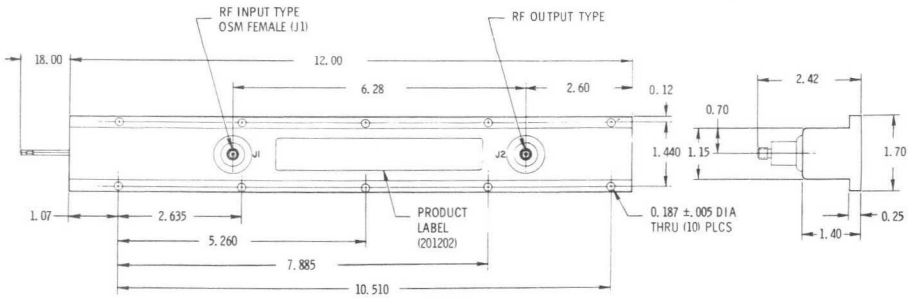

### GAIN




### NOISE




## OUTLINE DRAWING



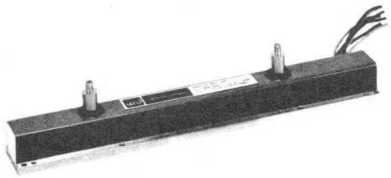
# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1971

## 12 TO 18 GHz MEDIUM-POWER LOW-NOISE TRAVELING-WAVE TUBE

## WJ-3807



- **OUTPUT POWER 2 WATTS MINIMUM**
- **PPM FOCUSING**
- **ESPECIALLY SUITABLE FOR AIRBORNE/SPACE APPLICATION**
- **EXTREMELY LOW FINE-STRUCTURE GAIN VARIATION**

WJ-3807 is a medium-power low-noise traveling-wave tube designed for use in airborne and space applications. It is particularly suitable for applications where gain variation and phase linearity are important (the tube provides fine structure gain variation of ±0.5 dB). A unique feature of the tube is its low cathode current density: a W-J innovation in low-noise electron gun design allows cathode loading of only 0.8 A/cm². This feature ensures the user of extremely long tube life.

The use of Periodic-Permanent-Magnet (PPM) focusing and metal-ceramic construction results in a compact, lightweight configuration. Alnico-8 magnets are used in the PPM-focusing system, making it insensitive to temperature variations over the operating range. Cooling of the tube is by conduction through the baseplate of the capsule.

Operating efficiency of the WJ-3807 can be improved by depressing the collector voltage below the helix voltage. The tube may also be supplied with an integral power supply, resulting in a fully integrated TWT amplifier.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 12.0 to 18.0 GHz |
| Saturated Power Output | 3 watts | 2 watts, min. |
| Small Signal Gain | 41 dB | 38 dB, min. |
| Small Signal Gain Variation | ±1.5 dB | ±2 dB, max. |
| Gross Fine Structure Small Signal Gain Variation | ±0.2 dB | ±0.5 dB |
| Noise Figure | 23 dB | 25 dB, max. |

| ELECTRICAL REQUIREMENTS | Typical | Range |
|---|---|---|
| Heater Voltage | 6.3 volts | 6.0 to 6.6 volts |
| Grid Voltage[1] | −20 volts | −19.5 to −20.5 volts |
| Helix Voltage[1] | 2800 volts | 2700 to 3000 volts |
| Collector Voltage[1] | 1800 volts | 1700 to 1900 volts |
| Cathode Current | 26 mA | 23 to 30 mA |
| Helix Current | 0.5 mA | 0.2 to 5.0 mA |
| Heater Current | 0.4 A | 0.3 to 0.5 A |

NOTE 1. Voltage with respect to cathode.
2. Helix is grounded to tube capsule.

# WJ-3807

## MECHANICAL CHARACTERISTICS

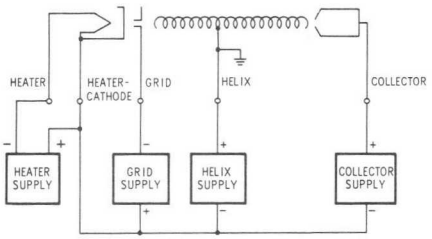
| | |
|---|---|
| Cooling | Conduction through baseplate[3] |
| Length | 12 inches, (305mm) max. |
| Height | 1.40 inch, (36 mm) max. |
| Width | 1.70 inch, (43mm) max. |
| Weight | 2.0 lbs. (0.91 Kg) max. |
| Connectors | OSM, Jack |
| Focusing | PPM |

## ENVIRONMENTAL CAPABILITY

| | |
|---|---|
| Temperature | −54°C to 85°C (baseplate) |
| Vibration (120-2000 cycles) | 5 Grms |
| Shock | 20 G |
| Altitude | Any |

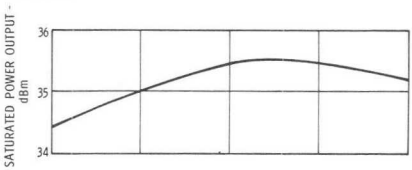
[3]Air cooling available upon request.

## SCHEMATIC DIAGRAM

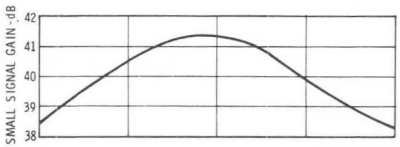



## RF ELECTRICAL PERFORMANCE CHARACTERISTICS

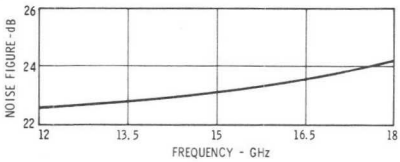
### POWER



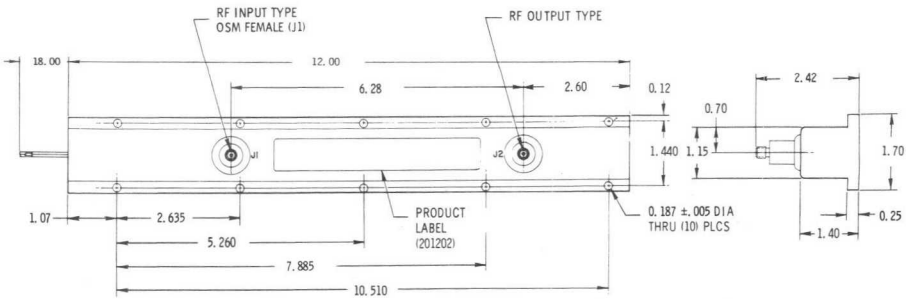

### GAIN




### NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

September 1971

## 2 to 4 GHz 25 WATT CW GRIDDED TRAVELING-WAVE TUBE
## WJ-3850

The WJ-3850 is a PPM-focused, helix-type, traveling-wave tube designed to operate to 100% duty cycle with 25 watts output power and 100 mW RF drive power. It can, however, be used over a wide range of power levels, pulse lengths, and duty cycles.

The high-mu gridded gun, wide-band helix interaction structure, and high average power capability of the WJ-3850 allow several different applications. It may, for example, be used as a driver for high-power radar transmitters, as a driver or transmitter for ECM equipment, or as a radar transponder transmitter. In addition, it has been qualified for severe airborne environmental applications.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0–4.0 GHz | 2.0–4.0 GHz |
| Power Output | 30 W | 25 W, min. |
| Gain at Rated Output Power | 28 dB | 25 dB, min. |
| Duty Cycle | | 0 to 100% |

| ELECTRICAL REQUIREMENTS | Typical | Range[3] or Maximum |
|---|---|---|
| Cathode Voltage[1] | −3500 V | −3400 to −3800 V |
| Beam Current | 150 mA | 190 mA |
| Grid Bias Voltage[2] | −100 V | −75 to −100 V |
| Grid Voltage[2] | +40 V | +25 to +80 V |
| Grid Current | 30 mA | 50 mA, max. |
| Helix Voltage | Ground | Ground |
| Helix Current | 8 mA | 10 mA, max. |
| Collector Voltage[2] | +3000 V | +2800 to +3000 V |
| Heater Voltage | 5.6 V | 5.3 to 5.8 V |
| Heater Current | 1.2 A | 1.4 A max. |

**NOTES:**
[1]Relative to ground.
[2]Relative to cathode.
[3]Every tube will meet the guaranteed performance specifications for a voltage and current lying in this range.

# WJ-3850

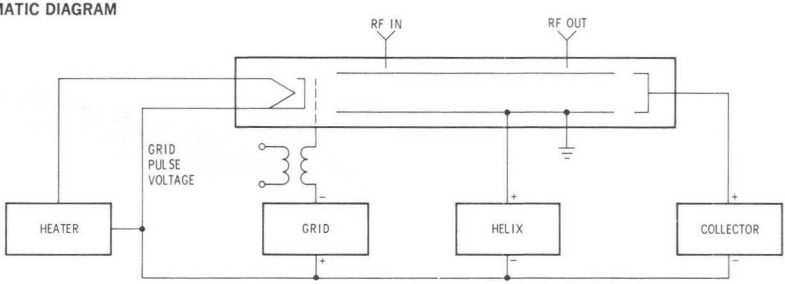
## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature | −55°C to +85°C |
| Altitude | 0 to 70,000 feet |
| Shock | 10 g, 11 ms |
| Vibration | |
| a. 0.3 inch, double amplitude | 5 to 23 Hz |
| b. 0.06 inch, double amplitude | 23 to 55 Hz |
| c. 6 g | 55 to 200 Hz |
| d. 3 g | 200 to 1500 Hz |

## MECHANICAL CHARACTERISTICS

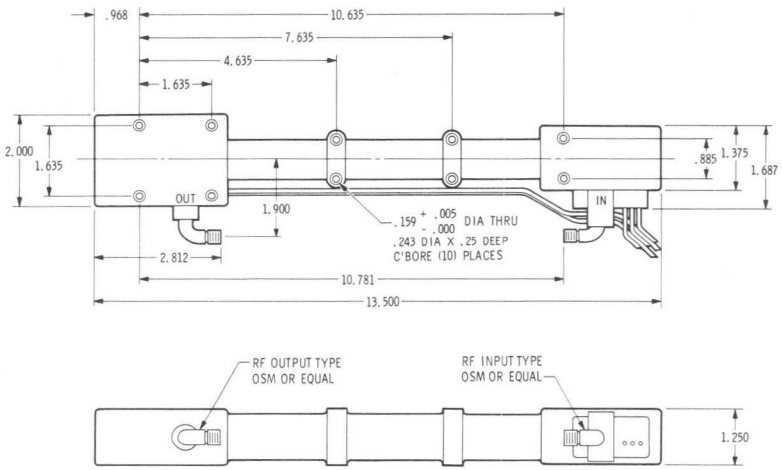
| | |
|---|---|
| Length | 13.5 inches (343 mm), max. |
| Cross Section (excluding connectors) | 1.25 x 2.0 inches (32 x 51 mm), max. |
| Weight | 2.5 lbs. (1.13 kg), max. |
| RF Connectors | OSM |
| Power Connections | Flying Leads |
| Cooling | Heat Sink |
| Focusing | PPM |

## SCHEMATIC DIAGRAM




Preferred Power Supply Configuration for WJ-3850

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

September 1971

## 2 to 4 GHz 50 WATT CW GRIDDED TRAVELING WAVE TUBE
## WJ-3851

The WJ-3851 is a PPM-focused, helix-type, traveling-wave tube designed to operate to 100% duty cycle with 50 watts output power and 50 mW RF drive power. It can, however, be used over a wide range of power levels, pulse lengths, and duty cycles.

The high-mu gridded gun, wide-band helix interaction structure, and high average power capability of the WJ-3851 allow several different applications. It may, for example, be used as a driver for high-power radar transmitters, as a driver or transmitter for ECM equipment, or as a radar transponder transmitter. In addition, it has been qualified for severe airborne environmental applications.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0–4.0 GHz | 2.0–4.0 GHz |
| Power Output | 60 W | 50 W, min. |
| Gain at Rated Output Power | 33 dB | 30 dB, min. |
| Duty Cycle | | 0 to 100% |

| ELECTRICAL REQUIREMENTS | Typical | Range[3] or Maximum |
|---|---|---|
| Cathode Voltage[1] | −3500 V | −3400 to −3800 V |
| Beam Current | 165 mA | 195 mA |
| Grid Bias Voltage[2] | −100 V | −75 to −100 V |
| Grid Voltage[2] | +70 V | +40 to +100 V |
| Grid Current | 30 mA | 50 mA, max. |
| Helix Voltage | Ground | Ground |
| Helix Current | 10 mA | 15 mA, max. |
| Collector Voltage[2] | +3000 V | +2600 to +3000 V |
| Heater Voltage | 5.6 V | 5.3 to 5.8 V |
| Heater Current | 1.2 A | 1.4 A max. |

**NOTES:**
[1]Relative to ground.
[2]Relative to cathode.
[3]Every tube will meet the guaranteed performance specifications for a voltage and current lying in this range.

# WJ-3851

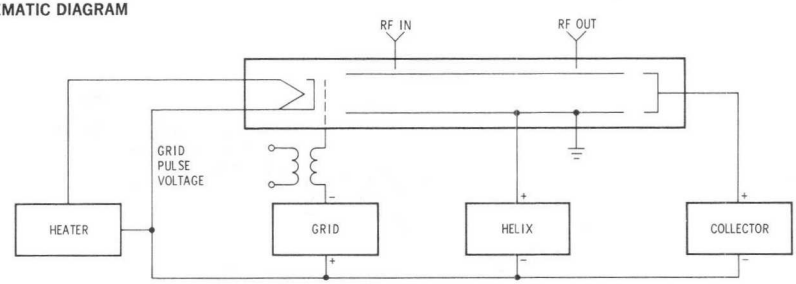
## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature | −55°C to +85°C |
| Altitude | 0 to 70,000 feet |
| Shock | 10 g, 11 ms |
| Vibration | |
| a. 0.3 inch, double amplitude | 5 to 23 Hz |
| b. 0.06 inch, double amplitude | 23 to 55 Hz |
| c. 6 g | 55 to 200 Hz |
| d. 3 g | 200 to 1500 Hz |

## MECHANICAL CHARACTERISTICS

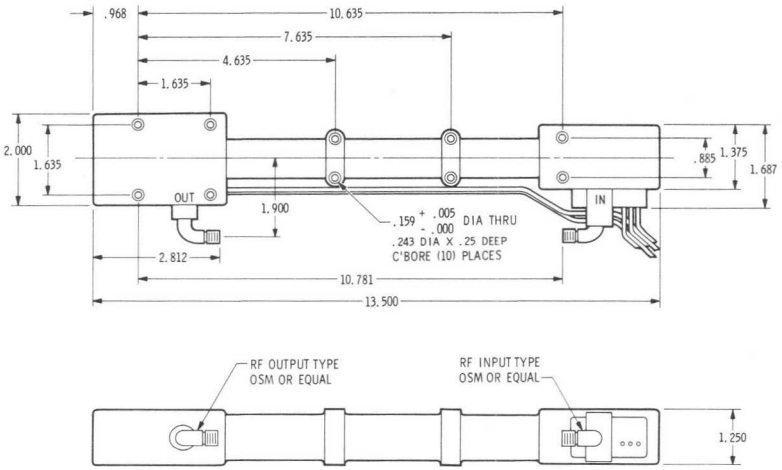
| | |
|---|---|
| Length | 13.5 inches (343 mm), max. |
| Cross Section (excluding connectors) | 1.25 x 2.0 inches (32 x 51 mm), max. |
| Weight | 2.5 lbs. (1.13 kg), max. |
| RF Connectors | OSM |
| Power Connections | Flying Leads |
| Cooling | Heat Sink |
| Focusing | PPM |

## SCHEMATIC DIAGRAM




Preferred Power Supply Configuration for WJ-3851

## OUTLINE DRAWING



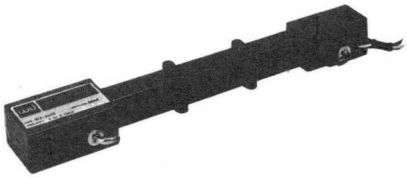
# TECHNICAL DATA

WATKINS-JOHNSON

September 1971

## 4 to 8 GHz 25 WATT CW GRIDDED TRAVELING-WAVE TUBE
## WJ-3860

The WJ-3860 is a PPM-focused, helix type, traveling-wave tube produced by Watkins-Johnson Company for use over a wide range of power levels, pulse lengths, frequencies, and duty cycles. It is designed to operate to 100% duty cycle with 25 watts output power and 100 mW RF drive power. Various other performance levels can be achieved by varying the specified voltages and currents. At low duty, for example, 100 watts output power can be achieved from 4.0 to 8.0 GHz with greater than 30 dB gain.



The high-mu gridded gun, wide-band helix interaction structure, and high average power capability of the WJ-3860 allow several different applications. It may, for example, be used as a driver for high-power radar transmitters, as a driver or transmitter for ECM equipment, or as a radar transponder transmitter. In addition, it has been qualified for severe airborne environmental applications.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0–8.0 GHz | 4.0–8.0 GHz |
| Power Output | 30 W | 25 W, min. |
| Gain at Rated Output Power | 28 dB | 25 dB, min. |
| Duty Cycle | | 0 to 100% |

| ELECTRICAL REQUIREMENTS | Typical | Range[3] or Maximum |
|---|---|---|
| Cathode Voltage[1] | −4500 V | −4400 to −4700 V |
| Beam Current | 130 mA | 150 mA max. |
| Grid Bias Voltage[2] | −100 V | −75 to −100 V |
| Grid Voltage[2] | +40 V | +60 to +80 V |
| Grid Current | 20 mA | 35 mA, max. |
| Helix Voltage | Ground | Ground |
| Helix Current | 10 mA | 15 mA, max. |
| Collector Voltage[2] | +3000 V | +2600 to +3000 V |
| Heater Voltage | 5.6 V | 5.3 to 5.8 V |
| Heater Current | 1.2 A | 1.4 A max. |

**NOTES:**
[1]Relative to ground.
[2]Relative to cathode.
[3]Every tube will meet the guaranteed performance specifications for a voltage and current lying in this range.

# WJ-3860

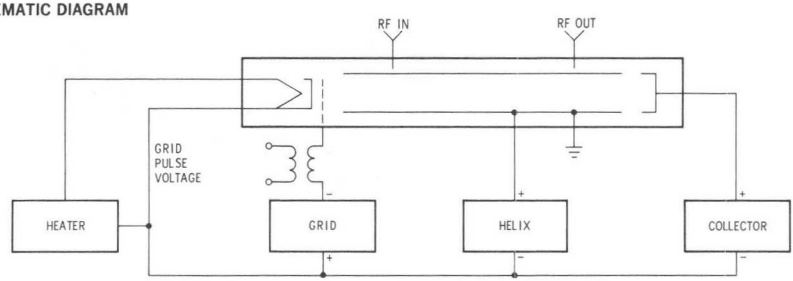
## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature | −55°C to +85°C |
| Altitude | 0 to 70,000 feet |
| Shock | 10 g, 11 ms |
| Vibration | |
| a. 0.3 inch, double amplitude | 5 to 23 Hz |
| b. 0.06 inch, double amplitude | 23 to 55 Hz |
| c. 6 g | 55 to 200 Hz |
| d. 3 g | 200 to 1500 Hz |

## MECHANICAL CHARACTERISTICS

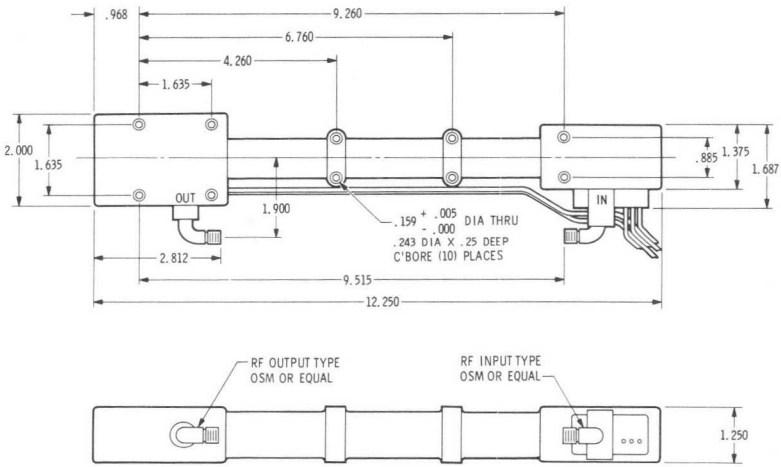
| | |
|---|---|
| Length | 12.25 inches (311 mm), max. |
| Cross Section (excluding connectors) | 1.25 x 2.0 inches (32 x 51 mm), max. |
| Weight | 2.2 lbs. (0.99kg), max. |
| RF Connectors | OSM |
| Power Connections | Flying Leads |
| Cooling | Heat Sink |
| Focusing | PPM |

## SCHEMATIC DIAGRAM




Preferred Power Supply Configuration for WJ-3860

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

September 1971

## 4 to 8 GHz 50 WATT CW GRIDDED TRAVELING-WAVE TUBE
## WJ-3861

The WJ-3861 is a PPM-focused, helix type, traveling-wave tube produced by Watkins-Johnson Company for use over a wide range of power levels, pulse lengths, frequencies, and duty cycles. It is designed to operate to 100% duty cycle with 50 watts output power and 50 mW RF drive power. Various other performance levels can be achieved by varying the specified voltages and currents. At low duty, for example, 100 watts output power can be achieved from 4.0 to 8.0 GHz with greater than 30 dB gain.

The high-mu gridded gun, wide-band helix interaction structure, and high average power capability of the WJ-3861 allow several different applications. It may, for example, be used as a driver for high-power radar transmitters, as a driver or transmitter for ECM equipment, or as a radar transponder transmitter. In addition, it has been qualified for severe airborne environmental applications.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 4.0–8.0 GHz | 4.0–8.0 GHz |
| Power Output | 60 W | 50 W, min. |
| Gain at Rated Output Power | 33 dB | 30 dB, min. |
| Duty Cycle | | 0 to 100% |

| ELECTRICAL REQUIREMENTS | Typical | Range[3] or Maximum |
|---|---|---|
| Cathode Voltage[1] | −4500 V | −4400 to −4700 V |
| Beam Current | 190 mA | 210 mA max. |
| Grid Bias Voltage[2] | −100 V | −75 to −100 V |
| Grid Voltage[2] | +70 V | +60 to +100 V |
| Grid Current | 20 mA | 35 mA, max. |
| Helix Voltage | Ground | Ground |
| Helix Current | 10 mA | 15 mA, max. |
| Collector Voltage[2] | +3000 V | +2600 to +3000 V |
| Heater Voltage | 5.6 V | 5.3 to 5.8 V |
| Heater Current | 1.2 A | 1.4 A max. |

**NOTES:**
[1]Relative to ground.
[2]Relative to cathode.
[3]Every tube will meet the guaranteed performance specifications for a voltage and current lying in this range.

# WJ-3861

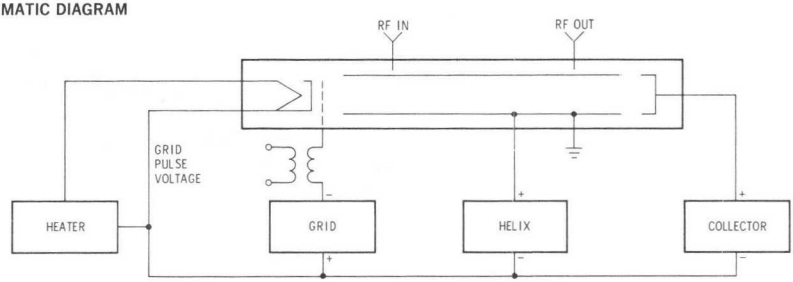
## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature | −55°C to +85°C |
| Altitude | 0 to 70,000 feet |
| Shock | 10 g, 11 ms |
| Vibration | |
| a. 0.3 inch, double amplitude | 5 to 23 Hz |
| b. 0.06 inch, double amplitude | 23 to 55 Hz |
| c. 6 g | 55 to 200 Hz |
| d. 3 g | 200 to 1500 Hz |

## MECHANICAL CHARACTERISTICS

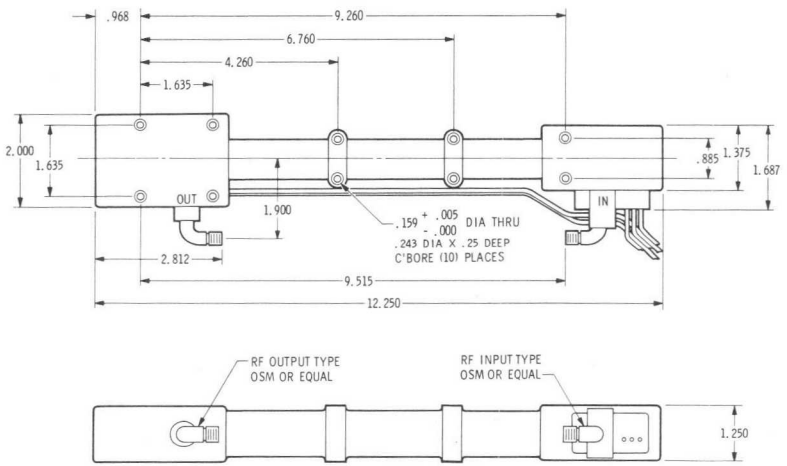
| | |
|---|---|
| Length | 12.25 inches (311 mm), max. |
| Cross Section (excluding connectors) | 1.25 x 2.0 inches (32 x 51 mm), max. |
| Weight | 2.2 lbs. (0.99kg), max. |
| RF Connectors | OSM |
| Power Connections | Flying Leads |
| Cooling | Heat Sink |
| Focusing | PPM |

## SCHEMATIC DIAGRAM




Preferred Power Supply Configuration for WJ-3861

## OUTLINE DRAWING



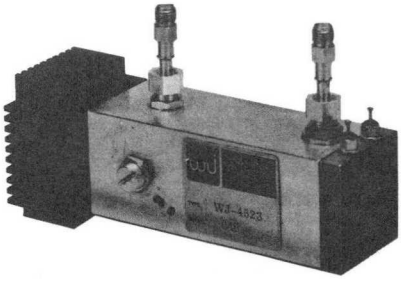
# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1970

## 2200 TO 2300 MHz 20-WATT CW CAVITY AMPLIFIER WJ-4523

The WJ-4523 cavity amplifier is a compact modular amplifier readily adaptable to airborne or ground support telemetry and communications systems. It is an optimum combination of the tube configuration with the associated rf circuit. Maximum efficiency and rf output from a very small package are outstanding features offered by this amplifier. Tuning can be accomplished with a minimum of test equipment.



### SPECIFICATIONS

**ELECTRICAL**

| | |
|---|---|
| Tuning Range | 2200 to 2300 MHz |
| Tube Type | Type A-0897 P/N 126066 |
| Power Supply Requirements: | |
| Anode Voltage | 800 V |
| Anode Current | 125 mA |
| Heater Voltage | 6.0 V |
| Heater Current | 1.0 A |
| Operating Characteristics: | |
| Power Input (Nominal) | 2.0 W |
| Power Output, Minimum | 22 W |
| Modulation | CW/FM |
| Bandwidth, 3 dB points | 5 MHz |
| Frequency Stability | 20 PPM/°C |
| Load Impedance | 50 Ohms Nominal |
| Load VSWR | 1.5:1 Any Constant Phase |

**MECHANICAL**

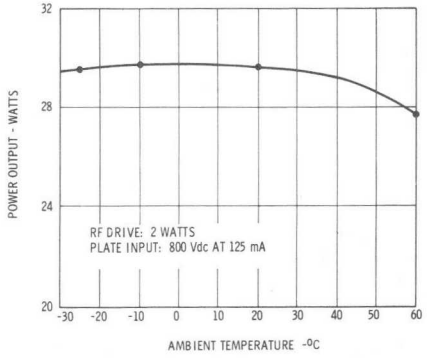
| | |
|---|---|
| Connectors | Type OSM |
| Cooling | Conduction to Heat Sink |
| Maximum Overall Dimensions | 1.25 x 1.25 x 4.38 inches (32 x 32 x 111 mm.) |
| Net Weight | 1.6 lbs. (725 g) |

**ENVIRONMENTAL**

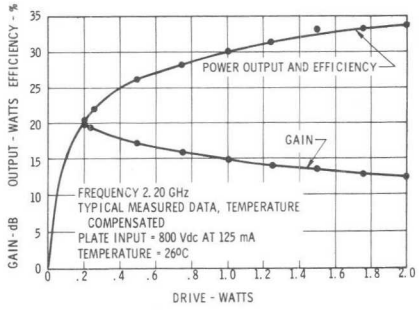
| | |
|---|---|
| Mounting Surface Temperature | −40° to +85°C |
| Vibration | 10g, 5-500 cycles, 15 minutes in 3 mutually perpendicular planes |
| Shock | 15g for 11 milliseconds in 3 mutually perpendicular planes |

# WJ-4523

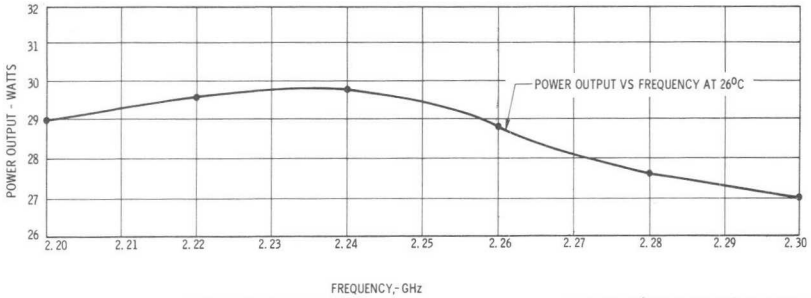
## POWER OUTPUT vs. AMBIENT TEMPERATURE



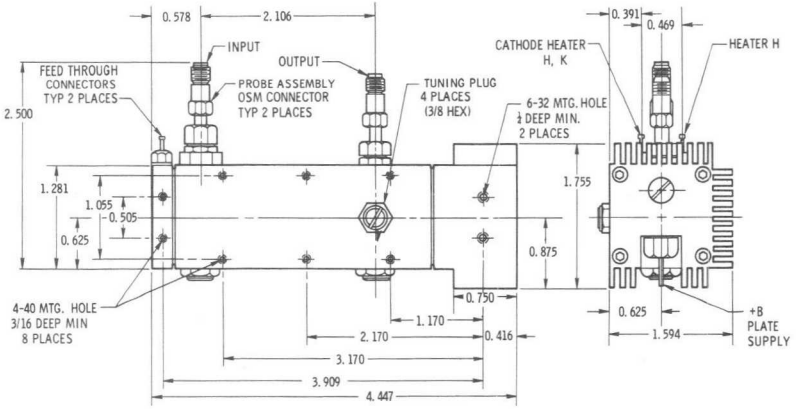

## PERFORMANCE vs. DRIVE POWER




## POWER OUTPUT vs. FREQUENCY




## OUTLINE DRAWING

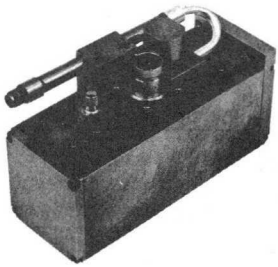


# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1969

## 1420 TO 1600 MHz CAVITY AMPLIFIER WJ-4539



WJ-4539 is a miniaturized, 20-watt cavity amplifier incorporating a ceramic-metal planar triode. It is intended for use in aerospace telemetry transmitters and special aerospace transmitters.

A recommended DC-DC converter for use with this amplifier is WJ-4590.

### SPECIFICATIONS

**PERFORMANCE**

| | |
|---|---|
| Frequency,[1] continuously tunable | 1420-1600 MHz |
| Rf power[2] output (with 2 watts drive) | |
| at 1420-1435 MHz | 15 watts, CW |
| at 1435-1535 MHz | 20 watts, CW |
| at 1535-1600 MHz | 15 watts, CW |
| Input Signals | All standard FM telemetry signal formats, per IRIG 106-66 |
| Bandwidth, Minimum, 3 dB points | 10 MHz |
| Gain, Minimum, 1435-1535 MHz | 10 dB |
| Load Impedance, nominal | 50 ohms |
| VSWR, Maximum, | |
| for full rated output | 1.5:1 |
| without damage | 3:1 |
| Efficiency,[2] Overall, Minimum | 25% |
| Phase jitter, Maximum, between input and output | 5° peak |
| Power Supply Requirements[3] | |
| Anode Voltage | 600 Volts |
| Current | 125 mA |
| Heater Voltage | 6.0 Volts |
| Current | 1.0 Amperes |
| Harmonic Suppression (2nd, 3rd and 4th of 1435-1535 MHz) | 60 dB |
| Warm-up Time | 3 Minutes |

1. Also available with similar performance characteristics for other frequencies in the 900-2500 MHz range.
2. Under worst combination of specified environmental conditions. Output and efficiency are higher under optimum conditions. See curves for typical output and efficiency with other drive levels.
3. A separate DC-DC converter package, WJ-4590, operating from 28 +8/−4 Vdc, is available from Watkins-Johnson. Power supplies for operation from other primary sources are available on special order.

# WJ-4539

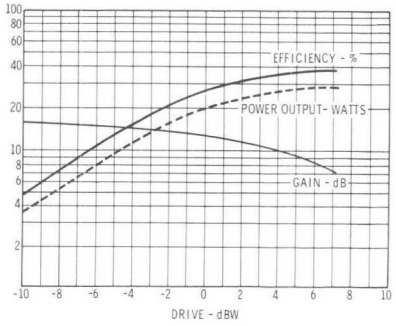
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Size, Overall (including protrusions) | 4" x 2½" x 1½" |
| Weight | 1.1 pounds |
| Mounting | To Heat Sink (not included) |
| Tuning Controls | Three (all on same surface) |
| Cooling | Conduction to Heat Sink at −54°C to +95°C |
| Connectors: rf input | OSM |
| rf ouput | OSM |
| Power | Deutsch #DM 5300-3P-643 |

## ENVIRONMENTAL CHARACTERISTICS

| | |
|---|---|
| Temperature, heat sink, for continuous operation | −54°C to +95°C |
| Altitude | Any |
| Vibration | 20g, 20-2000 cps, 3 major axes |
| Other | Per MIL-E-5400 |

**FIG. 1 TYPICAL DATA FOR EFFICIENCY, POWER OUTPUT AND GAIN OF WJ-4539 OPERATING AT 1485 MHz**




## OUTLINE DRAWING

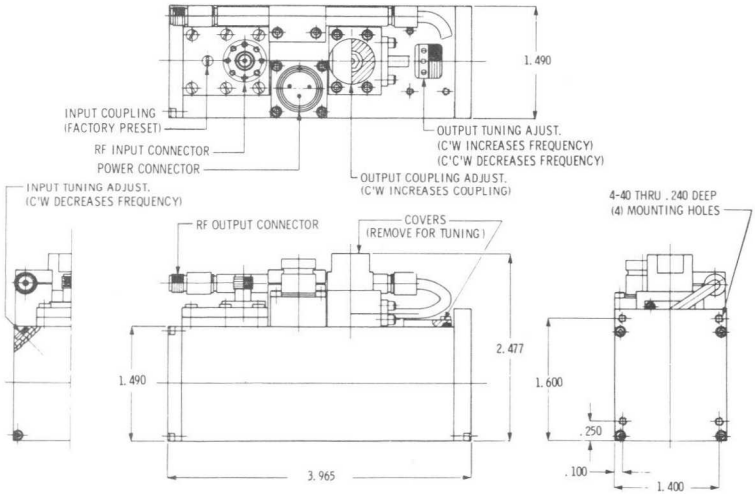


**FIG. 2 TUNING RANGE OF WJ-4539 WITH 2 WATTS DRIVE**

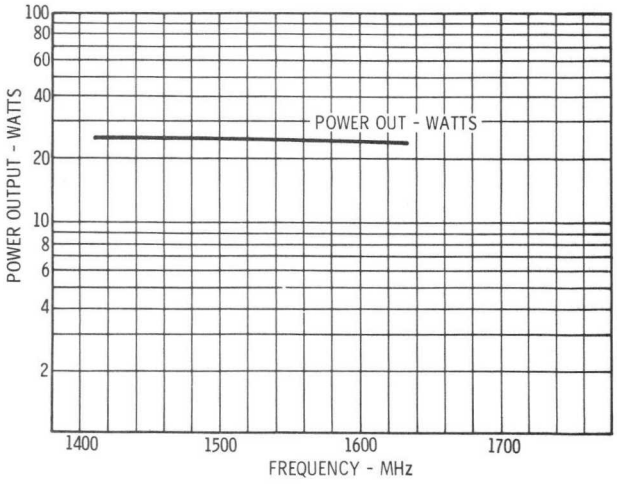
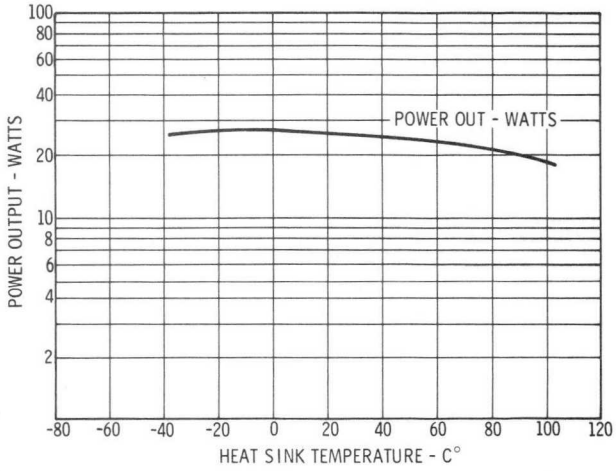



**FIG. 3 TEMPERATURE EFFECT OF WJ-4539 WITH 8 WATTS DRIVE AT 1482 MHz**



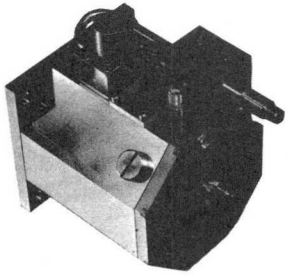
# TECHNICAL DATA

WATKINS-JOHNSON

MAY 1969

## 1435-1540 MHz CAVITY AMPLIFIER WJ-4540A

WJ-4540A is a grounded-grid cavity amplifier incorporating a stable-anode planar triode. Recommended for use in missile and aircraft telemetry transmitters, its small size, light weight and sturdy construction make it ideal for airborne systems.



### SPECIFICATIONS

**ELECTRICAL**

| | |
|---|---|
| Frequency, tunable | 1435-1540 MHz |
| Power Output, Minimum, with 10 W drive | 100 Watts |
| with 5 W drive | 75 Watts |
| with 3 W drive | 65 Watts |
| Bandwidth, Minimum (3 dB), with 10 W drive | 15 MHz |
| VSWR, Maximum, for full rated output | 1.5:1 |
| Efficiency, overall, minimum (at 100W) | 30% |
| Harmonic suppression (2nd, 3rd & 4th) | 60 dB |
| Warm-up Time | 2 Minutes |
| Power Supply Requirements: Anode: | 1200 V @ 250 mA |
| Heater: | 5.5 V @ 1.2 A |

**MECHANICAL**

| | |
|---|---|
| Size, overall (including connectors) | 2.5 x 3.5 x 3.75 Inches |
| Weight | 2.25 Pounds |
| Cooling | Conduction to Heat Sink (not included) |
| Connectors: RF Input and Output | OSM Female |
| High Voltage | Special (Mating connector included) |

**ENVIRONMENT**

| | |
|---|---|
| Temperature, heat sink, continuous operation | −54°C to +95°C |
| Altitude | Any |
| Vibration, sinusoidal | 20g, 20-2000 Hz |
| Other | Per MIL-E-5400 |

Recommended power supply (DC-DC converter) is WJ-4541. AC supplies also available.

# TECHNICAL DATA

WATKINS-JOHNSON

FEBRUARY 1970*

## 2.0 TO 4.0 GHz
## LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER
## WITH INTEGRAL POWER SUPPLY
## WJ-5004-4


- **SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES**
- **GUARANTEED 7.0 dB NOISE FIGURE**
- **GUARANTEED +5 dBm POWER OUTPUT**
- **MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT**
- **"JUST PLUG IT IN"**

The WJ-5004-4 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 7.0 dB and +5 dBm power output.[1] This high-performance S-band amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5004-4 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise Figure | 6.0 dB | 7.0 dB max. |
| Gain, Small Signal | 27 dB | 25 dB min. |
| VSWR, Input and Output | 1.7:1 | 2.0:1 max. |
| Power Output[1] | +7 dBm | +5 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for 3rd Order IM | +15 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | 115 ±10 volt ac |
| Primary Power | 3.0 watts max. |
| Primary Frequency | 48 to 420 Hz |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

[1] For 1 dB gain compression.

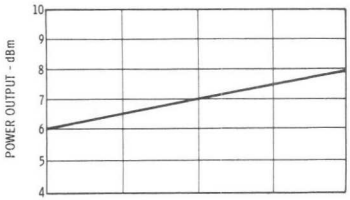
*Supersedes WJ-5004-4 Technical Data Sheet dated October 1969.

## WJ-5004-4

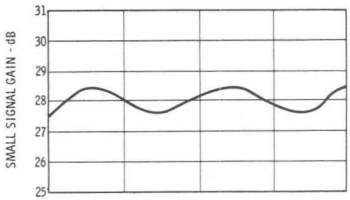
### MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height | 2.3 inches (58 mm) |
| Width | 1.3 inches (33 mm) |
| Length | 2.9 inches (74 mm) (less connectors) |
| Weight | 6.0 ounces (170 g) |
| RF Connectors | OSM Jack |

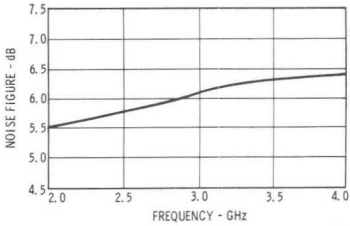
### POWER



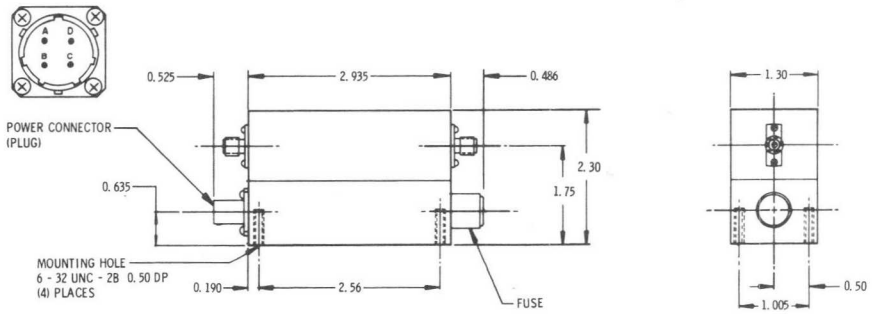

### GAIN




### NOISE




### OUTLINE DRAWING

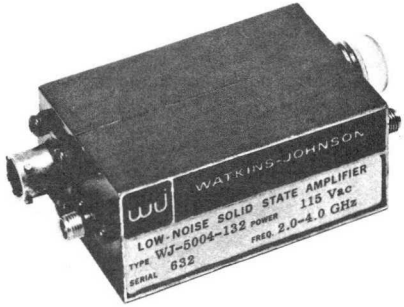


# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1972

## 2.0 TO 4.0 GHz
## LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY
## WJ-5004-132




- **SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES**
- **GUARANTEED 5.5 dB NOISE FIGURE**
- **GUARANTEED +5 dBm POWER OUTPUT**
- **MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT**
- **"JUST PLUG IT IN"**

The WJ-5004-132 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 5.5 dB and +5 dBm power output.[1] This high-performance amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5004-132 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise Figure | 5.0 dB | 5.5 dB max. |
| Gain, Small Signal | 27 dB | 25 dB min. |
| VSWR, Input and Output | 1.7:1 | 2.0:1 max. |
| Power Output[1] | +7 dBm | +5 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for 3rd Order IM | +15 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | 115 ±10 volt ac |
| Primary Power | 3.0 watts max. |
| Primary Frequency | 48 to 420 Hz |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May, 1968, and MIL-E-5400K, class 2.

[1] For 1 dB gain compression.

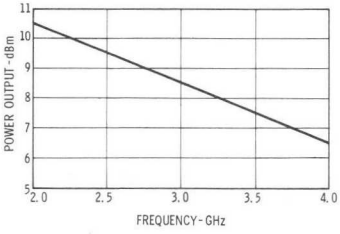
# WJ-5004-132

**SPECIFICATIONS (Cont'd)**

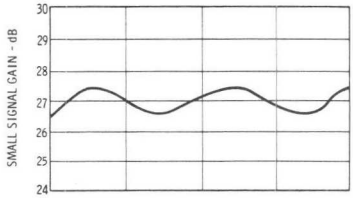
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height | 2.3 inches (58 mm) |
| Width | 1.3 inches (33 mm) |
| Length | 2.9 inches (74 mm) (less connectors) |
| Weight | 6.0 ounces (170 g) |
| RF Connectors | OSM Jack |

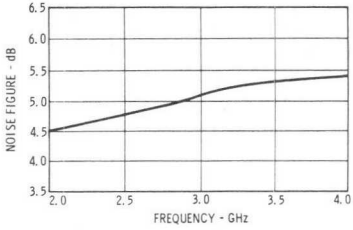
**POWER**



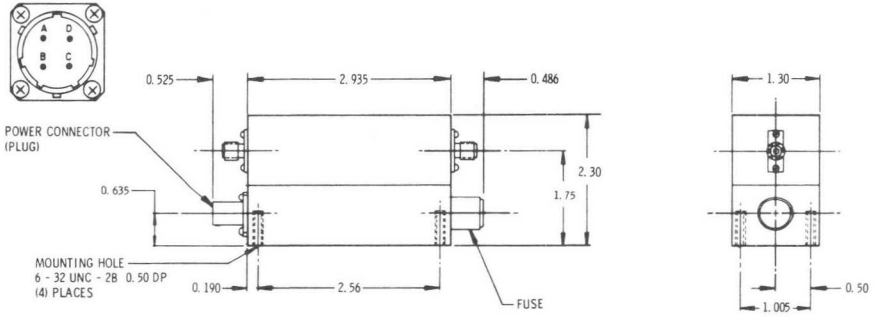

**GAIN**




**NOISE**




## OUTLINE DRAWING

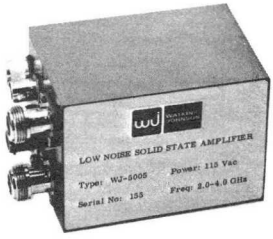


# TECHNICAL DATA

WATKINS-JOHNSON

AUGUST 1971

## 2.0 TO 4.0 GHz
## LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER
## WITH INTEGRAL POWER SUPPLY
## WJ-5005




- **SMALL SIZE: 2.5 X 2.5 X 3.5 INCHES**
- **GUARANTEED 8.0 dB NOISE FIGURE**
- **GUARANTEED +10 dBm POWER OUTPUT AT THE 1 dB COMPRESSION LEVEL**
- **QUALIFIED TO MIL-E-16400 CLASS II ENVIRONMENT**
- **"JUST PLUG IT IN"**

The WJ-5005 is a fully qualified low-noise microwave transistor amplifier developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 8.0 dB and +10 dBm power output.[1] This high-performance amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlet for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5005 is consistent with the general requirements of MIL-E-16400 class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise Figure | 6.5 dB | 8.0 dB max. |
| Gain, Small Signal | 38 dB | 42 dB max., 36 dB min. |
| Gain Flatness | ±1 dB | ±2 dB |
| VSWR, Input and Output | 1.7:1 | 2.5:1 max. |
| Power Output[1] | +12 dBm | +10 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for 3rd Order IM | +22 dBm | 20 dBm[2] |
| **PRIMARY ELECTRICAL REQUIREMENTS** | | |
| Primary Voltage | 115 ±10 volt ac | |
| Primary Power | 4.0 watts | 10 W, max. |
| Primary Frequency | 48 to 420 Hz | |
| **ENVIRONMENTAL CHARACTERISTICS** | | |
| Qualified to MIL-E-16400, class 2. | | |

[1] For 1 dB gain compression. [2] This measurement will be made for design verification only.

# WJ-5005

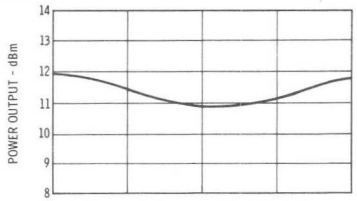
## MECHANICAL CHARACTERISTICS

| | |
|---|---|
| Height | 2.5 inches (64 mm) |
| Width | 2.5 inches (64 mm) |
| Length | 3.5 inches (89 mm) (less connectors) |
| Weight | 26 ounces max. (740 g) |
| RF Connectors | Type N Female |
| Power Connector | MS 3112E-8-3P |
| Blanking Connector | BNC |
| Outline Drawing No. | 295117 |

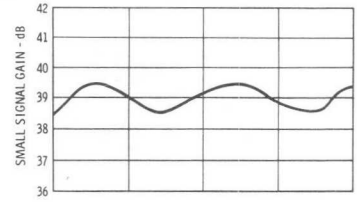
NOTES:

2. Amplifier will not oscillate with input and output open or short circuited.
3. Maximum safe input RF power is +20 dBm CW.
4. Blanking will be provided through the application of −2 to −20 volts from a 125 ohm source. Attack and release is 50 nsec (10 to 90%).

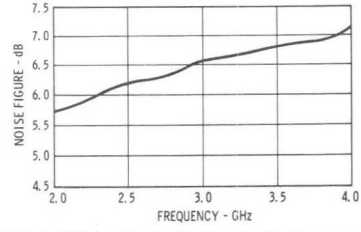
## POWER



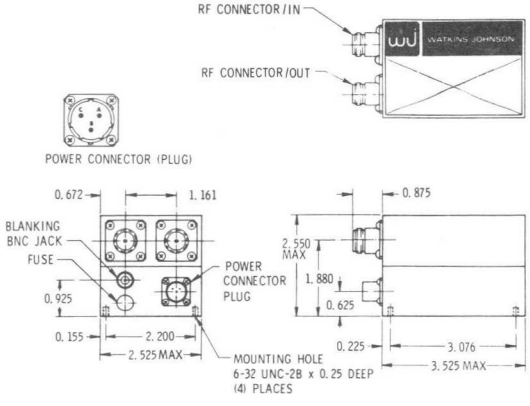

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

* NOVEMBER 1971

## YIG-TUNED BULK GaAs OSCILLATOR
## WJ-5008

WJ-5008 is one of a family of lightweight, electronically-tuned solid state oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full microwave band for this microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The dc bias terminal for this oscillator is isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Frequency tuning of the WJ-5008 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-5008 is magnetically self-shielding, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments. A secondary tuning coil permits rapid, narrow-range frequency dither about the operating point for FM or closed loop phase locking requirements.


YIG-tuned oscillators with wider bandwith, higher outputs, lower power variation, lower frequency drift, and different tuning sensitivity can be made to order.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Nominal Frequency Band | | 8 to 12.4 GHz |
| Power Output into Load VSWR = 1.25:1 (50 ohm) | 15 mW | 10 mW min. |
| Power Output Variation (matched load) | 5 dB | 8 dB max. |
| Spurious Oscillation | | |
| Ratio of Signal to 2nd Harmonic Output | 25 dB | 20 dB min. |
| Ratio of Signal to all Other Spurious Outputs in the Nominal Frequency Band | 60 dB | 50 dB min. |
| Sensitivity to Supply Voltage | 5 MHz/V | 10 MHz/V max. |
| Frequency Drift, 10° to 60°C | 100 ppm/°C | 250 ppm/°C max. |
| Pulling Figure, VSWR 2:1 at any phase | 10 MHz | 25 MHz max. |
| Residual FM, Peak to Peak | 10 kHz | |

| TUNING CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| **Primary Input** | | |
| Sweep Rate (Sawtooth) | 100 Hz | |
| Tuning Linearity | ±10 MHz | ±20 MHz max. |
| Hysteresis | 10 MHz | 20 MHz max. |
| Tuning Sensitivity | 17 MHz/mA | |
| Tuning Coil Resistance | 5 Ohms | |
| Tuning Coil Inductance | 85 mH | |
| **Secondary Input** | | |
| Tuning Sensitivity | 120 KHz/mA | |
| Bandwidth (3 dB) | 200 KHz | |
| Deviation (continuous) | ±60 MHz | |

*Supersedes WJ-5008 Technical Data Sheet dated November 1970.

## ELECTRICAL REQUIREMENTS

| | Typical |
|---|---|
| *Oscillator Bias Voltage, (typical) | −16 Vdc |
| Oscillator Current (typical) | 400 mA |

*Positive side ground. Exact bias varies and is specified for each unit on the final data sheet provided.

## MECHANICAL CHARACTERISTICS

Size excluding RF Connector and Solder Terminals (width x length x height) . . . . . 2 x 2 x 2.2 inches (51 x 51 x 56 mm)

Weight, including Magnetic Shielding . . . . . 34 ounces (965 g) max.

RF Output Connection . . . . . SMA Jack

†DC Input Connections . . . . . Solder Terminals

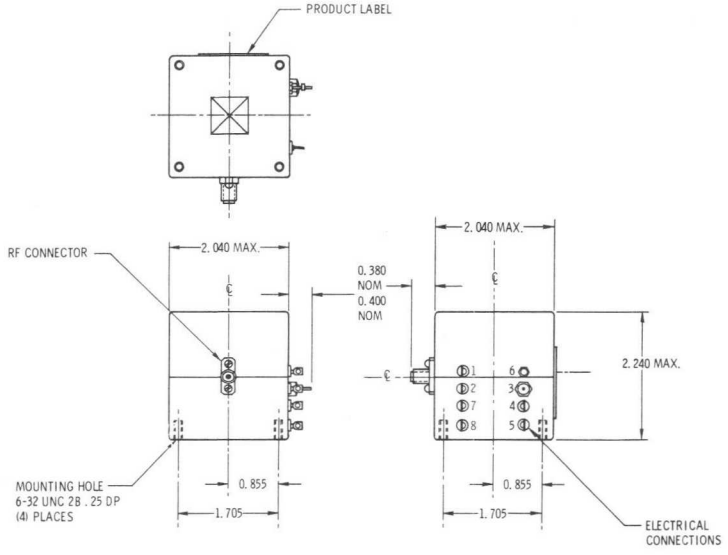
## ENVIRONMENTAL CHARACTERISTICS

Temperature, operating . . . . . 10° to 60°C

Temperature, non-operating . . . . −55°C to +85°C

†GaAs Oscillator Diode Bias Solder Terminal has RFI shielding.

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1971

## YIG-TUNED BULK GaAs OSCILLATOR
## WJ-5008-1

WJ-5008-1 is one of a family of lightweight, electronically-tuned solid state oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full microwave band for this microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The dc bias terminal for this oscillator is isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Frequency tuning of the WJ-5008-1 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-5008-1 is magnetically self-shielding, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments. A secondary tuning coil permits rapid, narrow-range frequency dither about the operating point for FM or closed loop phase locking requirements.


YIG-tuned oscillators with wider bandwith, higher outputs, lower power variation, lower frequency drift, and different tuning sensitivity can be made to order.

### SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Nominal Frequency Band | | 8 to 12.4 GHz |
| Power Output into Load VSWR = 1.25:1 (50 ohm) | 15 mW | 10 mW min. |
| Power Output Variation (matched load) | 5 dB | 8 dB max. |
| Spurious Oscillation | | |
| Ratio of Signal to 2nd Harmonic Output | 25 dB | 20 dB min. |
| Ratio of Signal to all Other Spurious Outputs in the Nominal Frequency Band | 60 dB | 50 dB min. |
| Sensitivity to Supply Voltage | 5 MHz/V | 10 MHz/V max. |
| Frequency Drift, 10° to 60°C | 25 ppm/°C | 50 ppm/°C max. |
| Pulling Figure, VSWR 2:1 at any phase | 10 MHz | 25 MHz max. |
| Residual FM, Peak to Peak | 10 kHz | |

| TUNING CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| **Primary Input** | | |
| Sweep Rate (Sawtooth) | 100 Hz | |
| Tuning Linearity | ±10 MHz | ±20 MHz max. |
| Hysteresis | 10 MHz | 20 MHz max. |
| Tuning Sensitivity | 16 MHz/mA | |
| Tuning Coil Resistance | 5 Ohms | |
| Tuning Coil Inductance | 85 mH | |
| **Secondary Input** | | |
| Tuning Sensitivity | 120 KHz/mA | |
| Bandwidth (3 dB) | 200 KHz | |
| Deviation (continuous) | ±60 MHz | |

| ELECTRICAL REQUIREMENTS | Typical |
|---|---|
| *Oscillator Bias Voltage (typical) | −16 Vdc |
| Oscillator Current (typical) | 400 mA |

*Positive side ground. Exact bias varies and is specified for each unit on the final data sheet provided.

**MECHANICAL CHARACTERISTICS**

Size excluding RF Connector and Solder Terminals (width x length x height) ..... 2 x 2 x 2.2 inches (51 x 51 x 56 mm)

Weight, including Magnetic Shielding ..... 34 ounces (965 g) max.

RF Output Connection ..... SMA Jack

†DC Input Connections ..... Solder Terminals

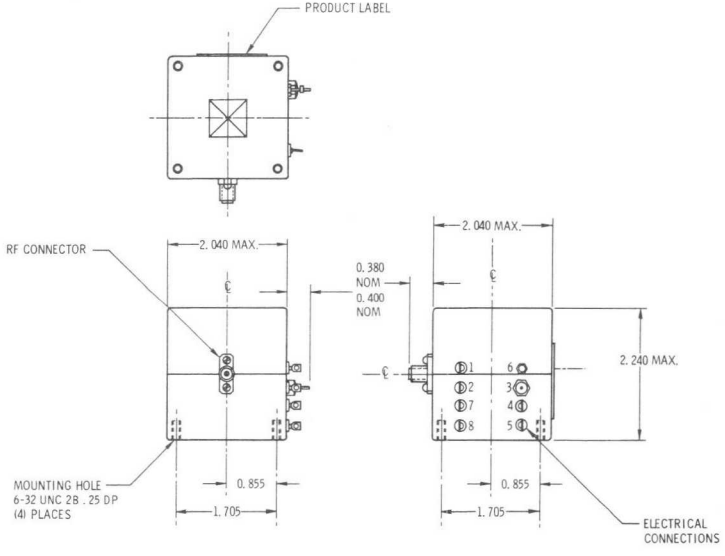
**ENVIRONMENTAL CHARACTERISTICS**

Temperature, operating ..... 10° to 60°C

Temperature, non-operating .... −55°C to +85°C

†GaAs Oscillator Diode Bias Solder Terminal has RFI shielding.

**OUTLINE DRAWING**

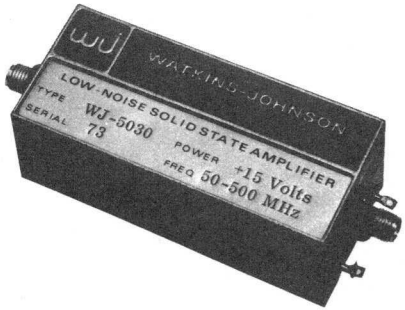


# TECHNICAL DATA

WATKINS-JOHNSON

## 50 TO 500 MHz LOW-NOISE VHF/UHF TRANSISTOR AMPLIFIER WJ-5030

- **SMALL SIZE: 1.0 x 1.3 x 2.9 INCHES**
- **GUARANTEED 3.5 dB NOISE FIGURE**
- **GUARANTEED -3 dBm POWER OUTPUT***
- **MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT DESIGN**
- **NO ADJUSTMENTS REQUIRED**




The WJ-5030 is one of a new series of low-noise VHF/UHF transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise microwave amplifiers. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 3.5 dB and —3 dBm power* output over a full decade frequency band.

This high-performance amplifier offers a power output/noise figure/size combination that is intended to satisfy most design requirements.

Modular construction ensures high reliablility under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5030 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 50 to 500 MHz | 50 to 500 MHz |
| Noise Figure | 2.3 dB | 3.5 dB max. |
| Gain, Small Signal | 35 dB | 32 dB min. |
| Gain Variation | ±0.7 dB | ±1.0 dB max. |
| VSWR, Input and Output | 2.0:1/1.5:1 | 2.5:1/2.0:1 max. |
| Power Output* | +1dBm | —3 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for 3rd Order IM | +5 dBm | |

### PRIMARY ELECTRICAL REQUIREMENTS

| | |
|---|---|
| Primary Voltage | +15 V dc |
| Primary Power | 1 watt max. |

### ENVIRONMENTAL CHARACTERISTICS

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

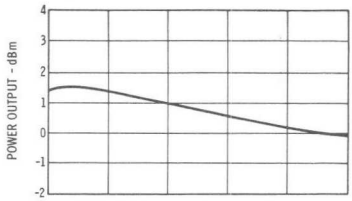
*For 1 dB gain compression.

# WJ-5030

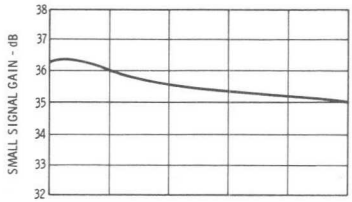
## MECHANICAL CHARACTERISTICS

Height ..... 1.0 inch (25 mm)
Width ..... 1.3 inches (33 mm)
Length ... 2.9 inches (74 mm) (less connectors)
Weight ..... 3.0 ounces (85 g)
RF Connectors ..... OSM Jack

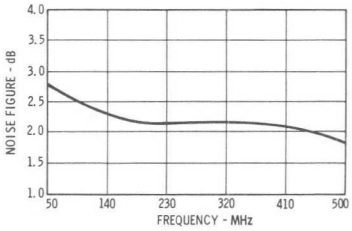
## POWER



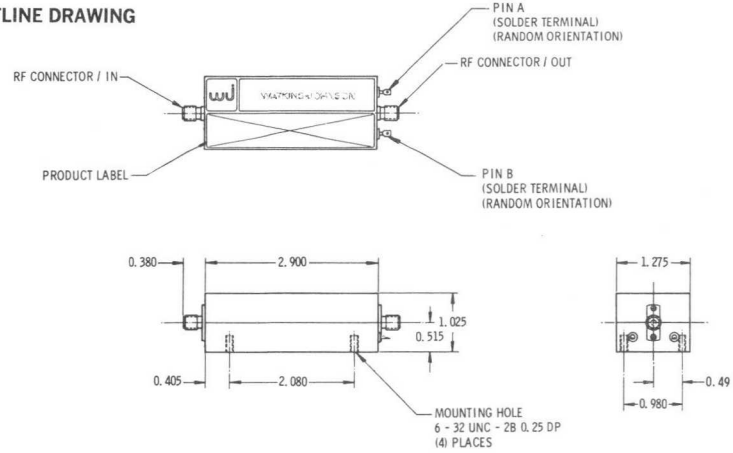

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

• NOVEMBER 1971

## YIG-TUNED BULK GaAs OSCILLATOR
## WJ-5041

WJ-5041 is one of a family of lightweight, electronically tuned solid state oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full microwave band for this microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The dc bias terminal for this oscillator is isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Frequency tuning of the WJ-5041 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-5041 is magnetically self-shielding, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments. A secondary tuning coil permits rapid, narrow-range frequency dither about the operating point for FM or closed loop phase locking requirements.


YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, lower frequency drift and different tuning sensitivity can be made to order.

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Nominal Frequency Band | | 12.4 to 18 GHz |
| Power Output into Load VSWR = 1.25:1 (50 ohm) | 10 mW | 6 mW min. |
| Power Output Variation (matched load) | 5 dB | 8 dB max. |
| Spurious Oscillation | | |
| Ratio of Signal to 2nd Harmonic Output | 25 dB | 20 dB min. |
| Ratio of Signal to all Other Spurious Outputs in the Nominal Frequency Band | 60 dB | 50 dB min. |
| Sensitivity to Supply Voltage | 5 MHz/V | 10 MHz/V max. |
| Frequency Drift, 10° to 60°C | 100 ppm/°C | 250 ppm/°C max. |
| Pulling Figure, VSWR 2:1 at any phase | 10 MHz | 25 MHz max. |
| Residual FM, Peak to Peak | 10 kHz | |
| **TUNING CHARACTERISTICS** | | |
| **Primary Input** | | |
| Sweep Rate (Sawtooth) | 100 Hz | |
| Tuning Linearity | ±10 MHz | ±20 MHz max. |
| Hysteresis | 15 MHz | 25 MHz max. |
| Tuning Sensitivity | 17 MHz/mA | |
| Tuning Coil Resistance | 5 Ohms | |
| Tuning Coil Inductance | 85 mH | |
| **Secondary Input** | | |
| Tuning Sensitivity | 120 KHz/mA | |
| Bandwidth (3 dB) | 200 KHz | |
| Deviation (continuous) | ±60 MHz | |

*Supersedes WJ-5041 Technical Data Sheet dated November 1970.

## ELECTRICAL REQUIREMENTS

*Oscillator Bias Voltage (typical) ..... −10 Vdc
Oscillator Current (typical) ..... 500 mA

*Positive side ground. Exact bias varies and is specified for each unit on the final data sheet provided.

## MECHANICAL CHARACTERISTICS

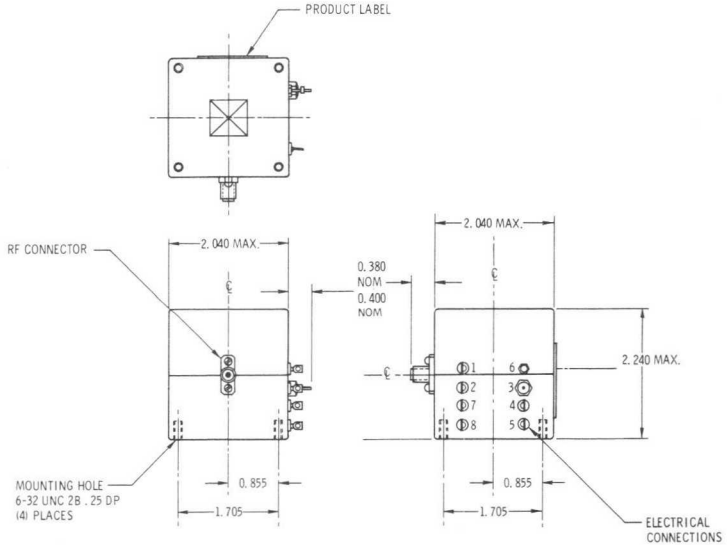
Size excluding RF Connector and Solder Terminals (width x length x height) ..... 2 x 2 x 2.2 inches (51 x 51 x 56 mm)
Weight, including Magnetic Shielding ..... 34 ounces (965 g) max.
RF Output Connection ..... SMA Jack
†DC Input Connections ..... Solder Terminals

## ENVIRONMENTAL CHARACTERISTICS

Temperature, operating ..... 10° to 60°C
Temperature, non-operating .... −55°C to +85°C

†GaAs Oscillator Diode Bias Solder Terminal has RFI shielding.

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1971

## YIG-TUNED BULK GaAs OSCILLATOR
## WJ-5041-1

WJ-5041-1 is one of a family of lightweight, electronically tuned solid state oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full microwave band for this microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The dc bias terminal for this oscillator is isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Frequency tuning of the WJ-5041-1 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-5041-1 is magnetically self-shielding, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments. A secondary tuning coil permits rapid, narrow-range frequency dither about the operating point for FM or closed loop phase locking requirements.


YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, lower frequency drift and different tuning sensitivity can be made to order.

### SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Nominal Frequency Band | | 12.4 to 18 GHz |
| Power Output into Load VSWR = 1.25:1 (50 ohm) | 10 mW | 6 mW min. |
| Power Output Variation (matched load) | 5 dB | 8 dB max. |
| Spurious Oscillation | | |
| Ratio of Signal to 2nd Harmonic Output | 25 dB | 20 dB min. |
| Ratio of Signal to all Other Spurious Outputs in the Nominal Frequency Band | 60 dB | 50 dB min. |
| Sensitivity to Supply Voltage | 5 MHz/V | 10 MHz/V max. |
| Frequency Drift, 10° to 60°C | 25 ppm/°C | 50 ppm/°C max. |
| Pulling Figure, VSWR 2:1 at any phase | 10 MHz | 25 MHz max. |
| Residual FM, Peak to Peak | 10 kHz | |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| **Primary Input** | | |
| Sweep Rate (Sawtooth) | 100 Hz | |
| Tuning Linearity | ±10 MHz | ±20 MHz max. |
| Hysteresis | 15 MHz | 25 MHz max. |
| Tuning Sensitivity | 16 MHz/mA | |
| Tuning Coil Resistance | 5 Ohms | |
| Tuning Coil Inductance | 85 mH | |
| **Secondary Input** | | |
| Tuning Sensitivity | 120 KHz/mA | |
| Bandwidth (3 dB) | 200 KHz | |
| Deviation (continuous) | ±60 MHz | |

## ELECTRICAL REQUIREMENTS

*Oscillator Bias Voltage (typical) ..... −10 Vdc
Oscillator Current (typical) ..... 500 mA

*Positive side ground. Exact bias varies and is specified for each unit on the final data sheet provided.

## MECHANICAL CHARACTERISTICS

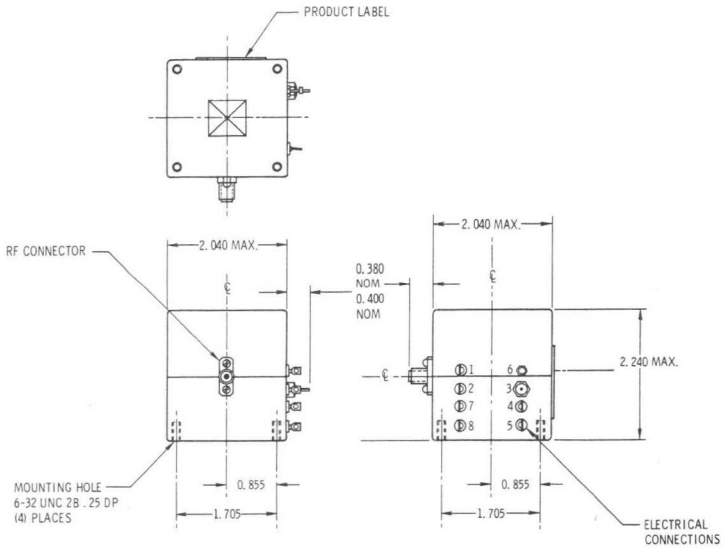
Size excluding RF Connector and Solder Terminals (width x length x height) ..... 2 x 2 x 2.2 inches (51 x 51 x 56 mm)
Weight, including Magnetic Shielding ..... 34 ounces (965 g) max.
RF Output Connection ..... SMA Jack
†DC Input Connections ..... Solder Terminals

## ENVIRONMENTAL CHARACTERISTICS

Temperature, operating ..... 10° to 60°C
Temperature, non-operating .... −55°C to +85°C

†GaAs Oscillator Diode Bias Solder Terminal has RFI shielding.

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

NOVEMBER 1971

## YIG-TUNED BULK GaAs OSCILLATOR
## WJ-5041-3

WJ-5041-3 is one of a family of lightweight, electronically tuned solid state oscillators produced by Watkins-Johnson Company. YIG tuning provides excellent linearity over the full microwave band for this microwave signal source. The use of high "Q" YIG spheres for frequency control ensures an extremely clean output spectrum.

The dc bias terminal for this oscillator is isolated by low pass filters to prevent RFI. The RF circuit is isolated from the dc circuit, thus enabling the input voltages to be common to other circuit voltages if desired.

Frequency tuning of the WJ-5041-3 is accomplished by changing the current which flows through the tuning coils, producing a magnetic bias for the YIG resonator. Since the WJ-5041-3 is magnetically self-shielding, it produces negligible stray magnetic fields and remains unaffected by moderate magnetic environments. A secondary tuning coil permits rapid, narrow-range frequency dither about the operating point for FM or closed loop phase locking requirements.


YIG-tuned oscillators with wider bandwidth, higher outputs, lower power variation, lower frequency drift and different tuning sensitivity can be made to order.

## SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Nominal Frequency Band | | 10 to 16 GHz |
| Power Output into Load VSWR = 1.25:1 (50 ohm) | 10 mW | 6 mW min. |
| Power Output Variation (matched load) | 5 dB | 8 dB max. |
| Spurious Oscillation | | |
| Ratio of Signal to 2nd Harmonic Output | 25 dB | 20 dB min. |
| Ratio of Signal to all Other Spurious Outputs in the Nominal Frequency Band | 60 dB | 50 dB min. |
| Sensitivity to Supply Voltage | 5 MHz/V | 10 MHz/V max. |
| Frequency Drift, 10° to 60°C | 100 ppm/°C | 250 ppm/°C max. |
| Pulling Figure, VSWR 2:1 at any phase | 10 MHz | 25 MHz max. |
| Residual FM, Peak to Peak | 10 kHz | |

| TUNING CHARACTERISTICS | | |
|---|---|---|
| **Primary Input** | | |
| Sweep Rate (Sawtooth) | 100 Hz | |
| Tuning Linearity | ±10 MHz | ±20 MHz max. |
| Hysteresis | 15 MHz | 25 MHz max. |
| Tuning Sensitivity | 17 MHz/mA | |
| Tuning Coil Resistance | 5 Ohms | |
| Tuning Coil Inductance | 85 mH | |
| **Secondary Input** | | |
| Tuning Sensitivity | 120 KHz/mA | |
| Bandwidth (3 dB) | 200 KHz | |
| Deviation (continuous) | ±60 MHz | |

## ELECTRICAL REQUIREMENTS

*Oscillator Bias Voltage (typical) ..... −12 Vdc
Oscillator Current (typical) ..... 500 mA

*Positive side ground. Exact bias varies and is specified for each unit on the final data sheet provided.

## MECHANICAL CHARACTERISTICS

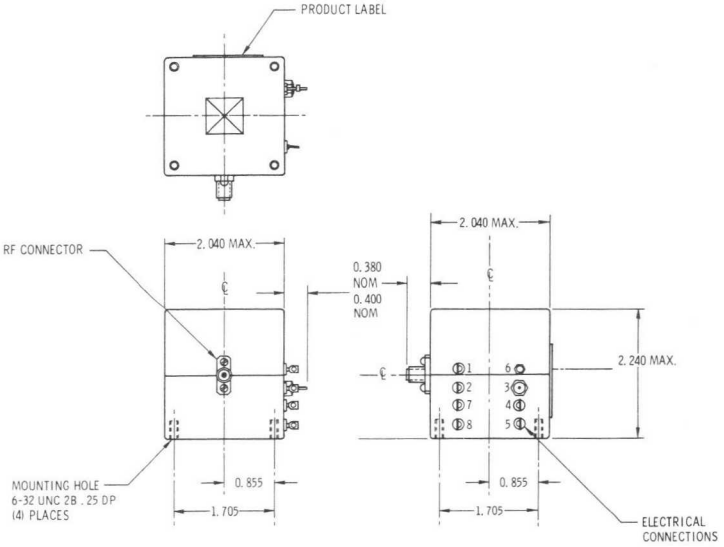
Size excluding RF Connector and Solder Terminals (width x length x height) ..... 2 x 2 x 2.2 inches (51 x 51 x 56 mm)
Weight, including Magnetic Shielding ..... 34 ounces (965 g) max.
RF Output Connection ..... SMA Jack
†DC Input Connections ..... Solder Terminals

## ENVIRONMENTAL CHARACTERISTICS

Temperature, operating ..... 10° to 60°C
Temperature, non-operating .... −55°C to +85°C

†GaAs Oscillator Diode Bias Solder Terminal has RFI shielding.

## OUTLINE DRAWING

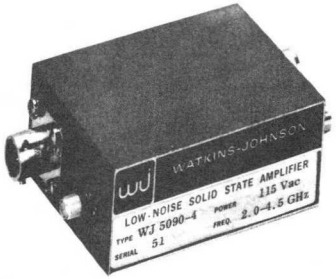


# TECHNICAL DATA

WATKINS-JOHNSON

* SEPTEMBER 1971

# 2.0 TO 4.5 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-5090-4




- **SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES**
- **GUARANTEED 8.0 dB NOISE FIGURE**
- **GUARANTEED +5 dBm POWER OUTPUT**
- **DESIGNED TO MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT**
- **"JUST PLUG IT IN"**

The WJ-5090-4 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 8.0 dB and +5 dBm power output.[1] This high-performance S-band amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5090-4 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 2.0 to 4.5 GHz |
| Noise Figure | 7.0 dB | 8.0 dB max. |
| Gain, Small Signal | 25 dB | 23 dB min. |
| VSWR, Input and Output | 1.7:1 | 2.5:1 max. |
| Power Output (For 1 dB gain compression.) | +7 dBm | +5 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for 3rd Order IM | +17 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | 115 ± 10 volt ac |
| Primary Power | 3.0 watts max. |
| Primary Frequency | 48 to 420 Hz |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

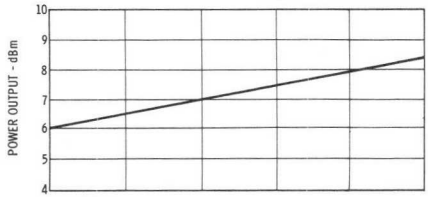
* Supersedes WJ-5090-4 Technical Data Sheet dated January 1971.

# WJ-5090-4

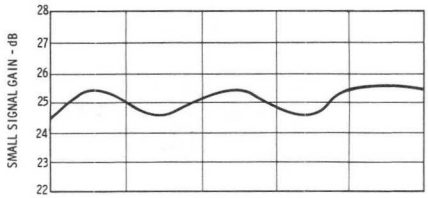
## MECHANICAL CHARACTERISTICS

Height . . . . . 2.3 inches (58 mm)
Width. . . . . 1.3 inches (33 mm)
Length . . . . 2.9 inches (74 mm) (less connectors)
Weight . . . . . 6.0 ounces (170 g)
RF Connectors . . . . . OSM Jack

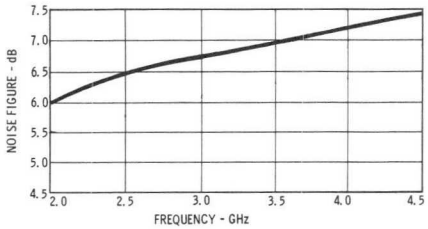
## POWER



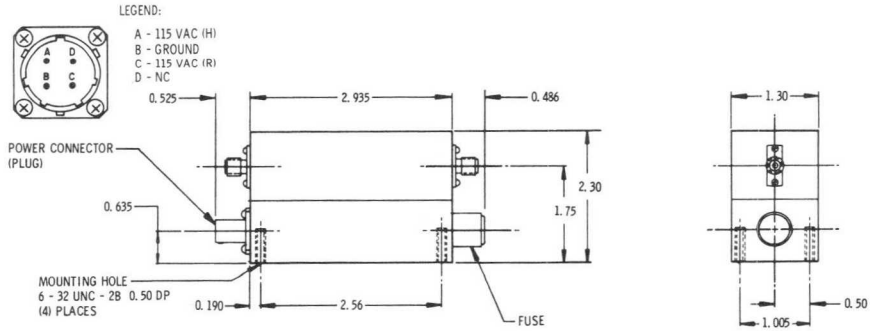

## GAIN




## NOISE



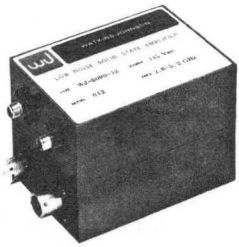

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

## 2.6 TO 5.2 GHz
## LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER
## WITH INTEGRAL POWER SUPPLY
## WJ-5090-13



- **SMALL SIZE: 2.5 x 2.5 x 3.5 INCHES**
- **GUARANTEED 8.0 dB NOISE FIGURE**
- **GUARANTEED +5 dBm POWER OUTPUT**
- **DESIGNED TO MIL-E-16400 AND MIL-E-5400 CLASS 2 ENVIRONMENT**
- **"JUST PLUG IT IN"**

The WJ-5090-13 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 8.0 dB and +5 dBm power output. This high-performance amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5090-13 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class 2. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

### SPECIFICATIONS

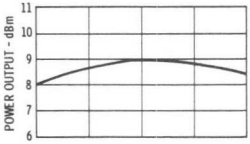
| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 2.6-5.2 GHz |
| Noise Figure | 7.0 dB | 8.0 dB |
| Gain, Small Signal, min. | 27 dB | 25 dB |
| VSWR, Input and Output, max. | 1.8:1 | 2.5:1 |
| Power Output, min. Note 1 | +8 dBm | +5 dBm |
| Impedance, Input and Output | 50 ohms | |
| Gain Flatness, max. | ±1.0 dB | ±1.5 dB |
| Reverse Isolation, | 50 dB | |
| Intercept Point for IM | +15 dBm | |
| **PRIMARY ELECTRICAL REQUIREMENTS** | | |
| Primary Voltage | | 115 Vac ±10% |
| Primary Frequency | | 48-420 Hz |
| Primary Power, max. | | 3 watts |

# WJ-5090-13

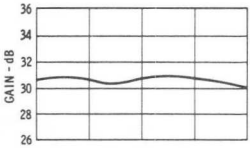
## MECHANICAL CHARACTERISTICS

Dimensions . . 2.5 x 2.5 x 3.5 inches (64 x 64 x 89 mm)
Weight . . . . . 12 ounces (340 g)
RF Connector . . . . . SMA , Jack
Outline Drawing Number . . . . . 295091

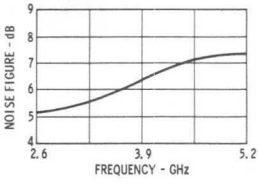
## POWER



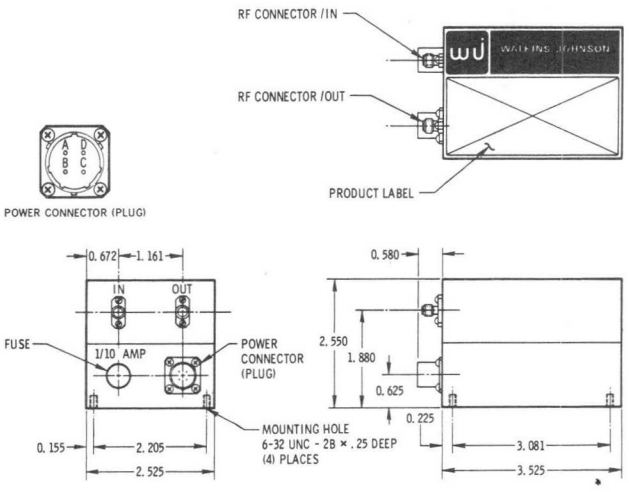

## GAIN




## NOISE




## OUTLINE DRAWING




| RF CONNECTORS |
|---|
| INPUT: TYPE SMA JACK |
| OUTPUT: TYPE SMA JACK |

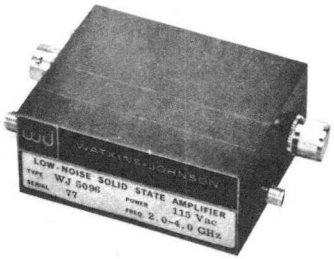
| POWER CONNECTORS | | |
|---|---|---|
| BENDIX ( OR EQUIVALENT )<br>PT02 - H - 8 - 4P (PLUG)<br>MS3116 - H - 8 - 4S (SOCKET) | | |
| PIN | CONNECTION | |
| A | AC(HOT) | 115 ± 10 VAC |
| B | GROUND | 48-420 Hz |
| C | AC | SINGLE PHASE |
| D | NONE | |

# TECHNICAL DATA

WATKINS-JOHNSON

JULY 1970

## 2.0 TO 4.0 GHz
## LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY
## WJ-5096




- **SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES**
- **GUARANTEED 8.5 dB NOISE FIGURE**
- **GUARANTEED +5 dBm POWER OUTPUT**
- **MEETS MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT**
- **"JUST PLUG IT IN"**

The WJ-5096 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 8.5 dB and +5 dBm power output.[1] This high-performance S-band amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5096 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

### SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | 2.0 to 4.0 GHz | 2.0 to 4.0 GHz |
| Noise Figure | 8.0 dB | 8.5 dB max. |
| Gain, Small Signal | 27 dB | 25 dB min. |
| VSWR, Input and Output | 1.7:1 | 2.5:1 max. |
| Power Output [1] | +7 dBm | +5 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Gain Flatness | ± 1.0 dB | |
| Reverse Isolation | 50 dB | |
| Intercept Point for 3rd Order IM | +12 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | 115 ± 10 volt ac |
| Primary Power | 3.0 watts max. |
| Primary Frequency | 48 to 420 Hz |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

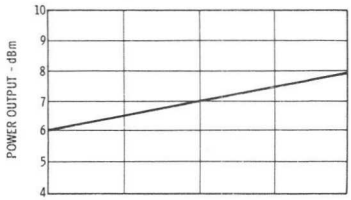
[1] For 1 dB gain compression.

# WJ-5096

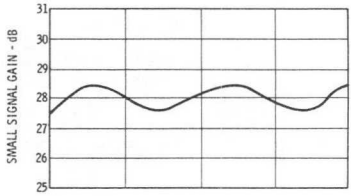
## MECHANICAL CHARACTERISTICS

Height . . . . . 2.3 inches (58 mm)
Width . . . . . 1.3 inches (33 mm)
Length . . . . 2.9 inches (74 mm) (less connectors)
Weight . . . . . 6.0 ounces (170 g)
RF Connectors . . . . . OSM Jack

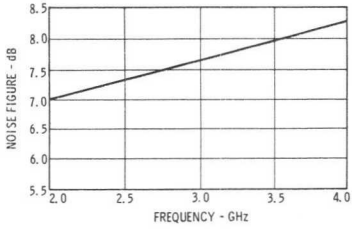
## POWER



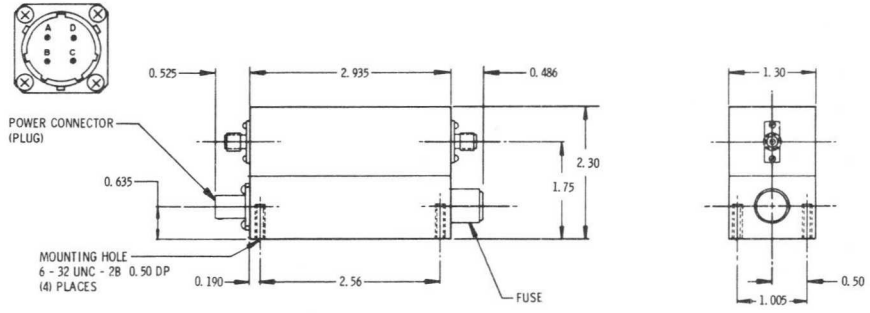

## GAIN




## NOISE




## OUTLINE DRAWING

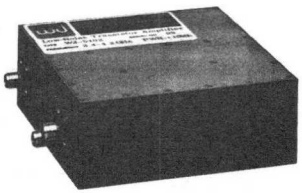


# TECHNICAL DATA

WATKINS-JOHNSON

JULY 1971

## 3.4 TO 4.2 GHz SOLID STATE TRANSISTOR AMPLIFIERS
## WJ-5102 SERIES



- **7.5 dB max. NOISE FIGURE**
- **±0.5 dB max. GAIN FLATNESS**
- **+23 dBm INTERCEPT POINT**
- **MEETS MIL-E-16400 AND MIL-E-5400, CLASS 2.**

Watkins-Johnson has developed a new series of solid state amplifiers with outstanding performance characteristics in the 3.4 to 4.2 GHz range. Featuring low noise figure, extremely flat gain, minimal time delay distortion, high intercept point, low VSWR and adjustment-free operation, these amplifiers are ideal for use in microwave communication systems.

Modular construction of each amplifier ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5102 series is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class 2.

### SPECIFICATIONS

| RF PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency Range | | 3.4 to 4.2 GHz |
| Noise Figure, Terminal | 7.0 dB, max. | 7.5 dB, max. |
| Gain, Small Signal | | 25 dB, min. |
| VSWR, Input and Output | | 1.3:1 max. |
| Power Output[1] | | +12 dBm, min. |
| Impedance, Input and Output[2] | 50 ohms, nominal | |
| Delay Distortion, Total[2, 3] | 0.025 NS/40 MHz | 0.25 NS/40 MHz |
| Group Delay:[2, 3] | | |
| Linear | 0.001 NS/MHz | 0.050 NS/MHz, max. |
| Parabolic | 0.0001 NS/MHz$^2$ | 0.015 NS/MHz$^2$, max. |
| Gain Flatness | | ±.5 dB, max. |
| Gain Stability | | 0.8 dB/wk/0 to 50°C |
| Gain Slope | | 0.01 dB/MHz, max. |
| Reverse Isolation[2] | | 50 dB, min. |
| Intercept Point for IM[2, 4] | +23 dBm | |

| ELECTRICAL REQUIREMENTS | |
|---|---|
| Primary Voltage | +15V dc |
| Primary Power | 3.5 watts, max. |

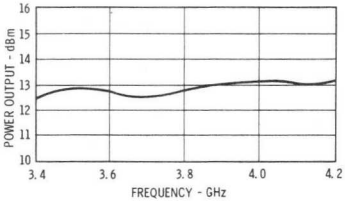
| MECHANICAL CHARACTERISTICS | |
|---|---|
| Dimensions max. | 1.3 x 3.55 x 3.55 inches (33 x 89 x 89 mm) |
| Weight max. | 13.5 ounces (380g) |
| RF Connectors | SMA Jack |

**NOTES**

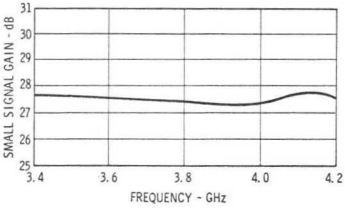
[1]Nominal 1 dB gain compression point.
[2]Design certification only.
[3]Specification limited by measurement accuracy.
[4]Third order intermodulation products will down 40 dB min. for +3 dBm output signals.

# WJ-5102 SERIES

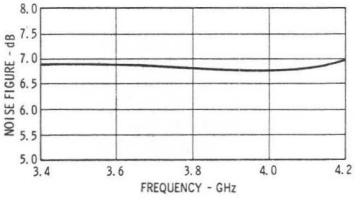
## POWER



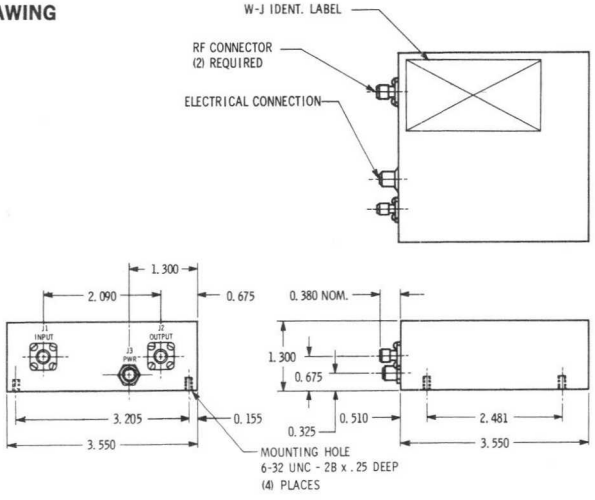

## GAIN




## NOISE




## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

JUNE 1971

## 2.9 TO 3.1 GHz
## LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIERS
## WJ-5108 SERIES


- **SMALL SIZE: 1.25 x 2.75 x 4.0 INCHES**
- **GUARANTEED 4.5 dB NOISE FIGURE AT 50°C**
- **GUARANTEED +15 dBm INTERCEPT POINT POWER OUTPUT**
- **DESIGNED TO MEET MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT**

The WJ-5108 series (consisting of WJ-5108-3, WJ-5108-4 and WJ-5108-5) features guaranteed noise figures as much as 2 dB lower than those offered by other solid state amplifiers. The key to this performance is the use of thermo-electric coolers on the first stage. As ambient temperatures rise to +50°C, the transistor remains cool to provide room temperature noise figure values. Size of each amplifier is a minimal 1.25 x 2.75 x 4.0 inches, making them ideal for front-end requirement in modern receiver designs.

Modular construction of each amplifier ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-5108 series is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class 2. Since each amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

## SPECIFICATIONS

| PERFORMANCE | WJ-5108-3 | WJ-5108-4 | WJ-5108-5 |
|---|---|---|---|
| Frequency | 2.9-3.1 GHz | 2.9-3.1 GHz | 2.9-3.1 GHz |
| Noise Figure, max. | 4.5 dB | 5.0 dB | 5.4 dB |
| Small Signal Gain, min. | 30 dB | 30 dB | 30 dB |
| Gain Flatness, max. | ±0.5 dB | ±0.5 dB | ±0.5 dB |
| VSWR Input | — | — | 1.3:1 |
| VSWR Output | 2.0:1 | 2.0:1 | 2.0:1 |
| Power Output, min.[1] | +5 dBm | +5 dBm | +5 dBm |
| Impedance, Input and Output | 50 ohms | 50 ohms | 50 ohms |
| Intercept Point for third Order Intermodulation | +15 dBm | +15 dBm | +15 dBm |

**PRIMARY ELECTRICAL REQUIREMENTS**

Primary Voltage ..... +15 Vdc @ 50 mA max. and +1.8 Vdc @ 4.8A max.

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

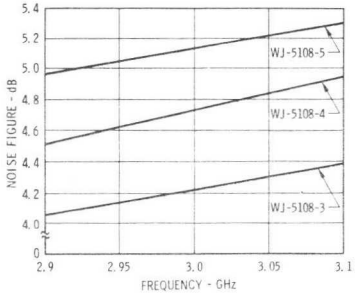
[1] For 1 dB gain compression.

# WJ-5108 SERIES

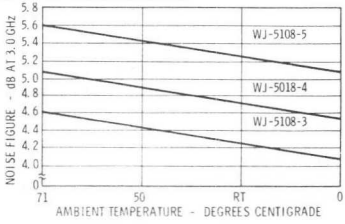
**MECHANICAL CHARACTERISTICS:**

Height . . . . . 1.25 inches (32 mm)
Width . . . . . 2.75 inches (70 mm)
Length (excluding connectors) . . . . . 4.0 inches(102 mm)
Weight (WJ-5108-3, 5108-4) . . . 12 ounces (340 g)
Weight (WJ-5108-5) . . . . . 14 ounces (400 g)

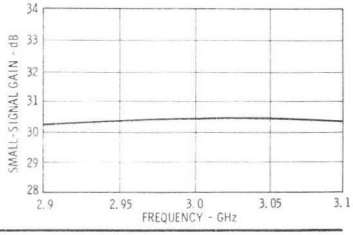
## NOISE FIGURES



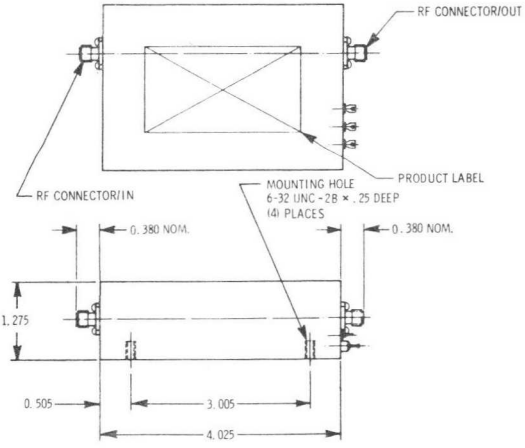

## NOISE FIGURE VARIATIONS

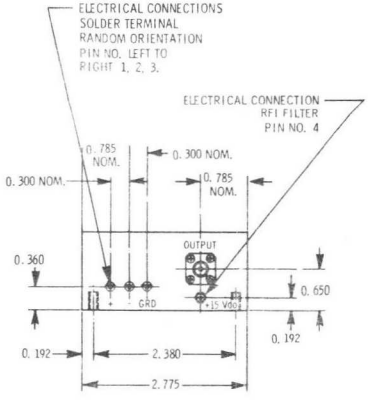



## GAIN




## OUTLINE DRAWING

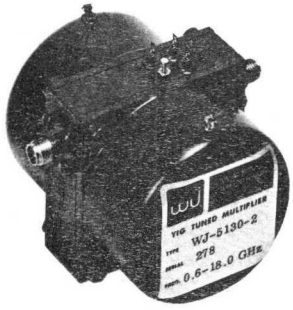


# TECHNICAL DATA

WATKINS-JOHNSON

## YIG-TUNED MULTIOCTAVE MULTIPLIER
## WJ-5130-2




WJ-5130-2 is one of a series of YIG-tuned multioctave multipliers designed for use in microwave counters, frequency synthesizers and marker systems. It accepts a 200 MHz input and yields useful power at all harmonically related frequencies from 600 MHz to 18 GHz. Other models in the series provide the same outputs upon receipt of selected inputs in the 100 MHz to 2 GHz range.

Mutipliers in this series basically consist of an input matching circuit and a step recovery diode circuit integrated into a multi-stage YIG filter. They are approximately 5 to 7 dB more efficient than standard comb generators, and their output power can be leveled within a 10 dB range by controlling the input power and bias voltage. These rugged devices measure a compact 2 x 2 x 2.8 inches and weigh 48 ounces.

### SPECIFICATIONS

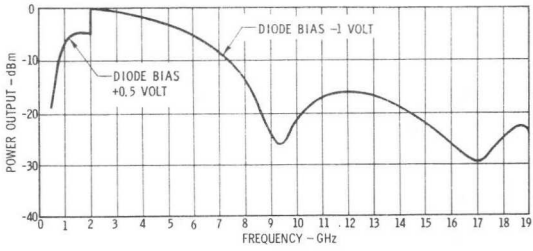
| ELECTRICAL CHARACTERISTICS | Typical | Guaranteed |
|---|---|---|
| Input frequency | | 200 MHz |
| Input power level | 0.8 to 1.3 Watt | 1.0 Watt |
| Input impedance (at 0.8 W) | 50 Ohms (max. VSWR 2:1) | |
| Output (0.2 GHz steps) | 0.6-19 GHz | 0.6-18 GHz |
| Output power level, Note 1 | +10 dBm, max. | +15 dBm max. to −30 dBm min. from 0.6 to 12.4 GHz; −40 dBm, min. from 12.6 to 18 GHz |
| Adjacent harmonic rejection and unwanted signal rejection other than harmonics | 45 dB | 30 dB at 0.6, 0.8 and 12.6 to 18 GHz; 40 dB min., from 1.0 to 12.4 GHz |
| 200 MHz direct feedthrough | −60 dBm | −50 dBm, max. level |
| Maximum frequency drift (10 to 65°C) (All measurements into 50 ohm load) | 20 MHz | 40 MHz |
| Linearity error | ±15 MHz | ±30 MHz, max., Note 2 |
| Tuning sensitivity | 20 MHz, min. per milliampere | |
| Tuning coil resistance | 10 ohm, max. | |
| Tuning coil inductance | 100 mH, max. | |
| Repeatability (up from zero current) | 0.05% | 0.1% max. |
| Heater current | 500 mA max. for 30 sec. min., 200 mA, max. continuous | |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Temperature range | 10° to 65°C |
| Size (excluding connectors) | 2 x 2 x 2.8 inches |
| Weight | 48 ounces |
| RF connectors | SMA Jack |
| Heater and bias connectors | Solder terminals |
| Outline drawing number | 295204 |

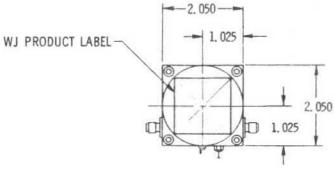
NOTES:
1. Multiplier diode bias switch points required for specified performance. Location of switch points to be the same from unit to unit.
2. Linearization is required in 12 to 18 GHz region. Location of a linearizing breakpoint to be the same from unit to unit.

# WJ-5130-2

**WJ-5130-2**
**Typical Unleveled Power Output Envelope**
**With 200 MHz Input**

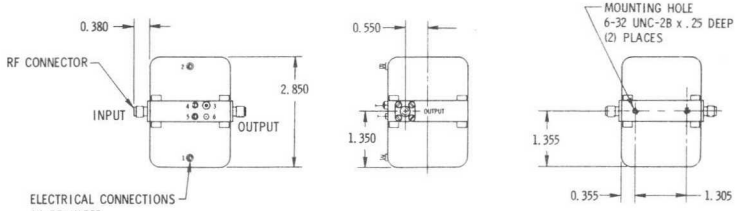



## OUTLINE DRAWING




| RF CONNECTORS |
|---|
| INPUT: TYPE SMA JACK |
| OUTPUT: TYPE SMA JACK |

| ELECTRICAL CONNECTORS | |
|---|---|
| PIN | CONNECTION |
| 1 | TUNING CURRENT + |
| 2 | TUNING CURRENT – |
| 3 | DC BIAS VOLTAGE |
| 4 | YIG HEATER +28 VDC |
| 5 | YIG HEATER RETURN |
| 6 | DC BIAS RETURN/GND |



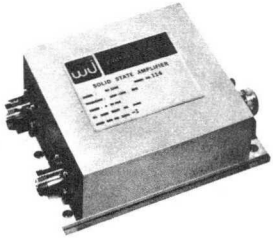
# TECHNICAL DATA

WATKINS-JOHNSON

MARCH 1971

## 1.25 TO 1.35 GHz
## 1-WATT SOLID STATE AMPLIFIER
## WJ-5200

- **1-WATT POWER OUTPUT**
- **10 dB NOISE FIGURE**
- **COMPACT SIZE: 2 x 4 x 5 INCHES**
- **HERMETICALLY SEALED**
- **RUGGEDIZED DESIGN FOR DRONE ENVIRONMENT**



WJ-5200 is one of a new series of medium power solid-state amplifiers developed by Watkins-Johnson. Featuring all solid state construction, the WJ-5200 has a guaranteed saturation power output of +30 dBm. The unit is mechanically designed for extreme airborne applications and will survive water submersion.

The overall design of the WJ-5200 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class 2. The micro stripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

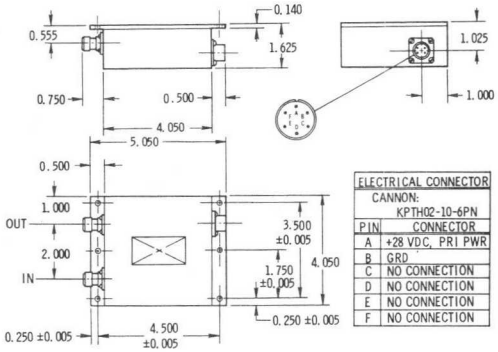
### SPECIFICATIONS

| | Typical | Guaranteed |
|---|---|---|
| **RF PERFORMANCE** | | |
| Frequency Range | | 1.250-1.350 GHz |
| Noise Figure (terminal) | 10 dB | |
| Gain, small signal, | | (Note 1) 40 dB min., 46 dB max. |
| Power Output, min. | +33 dBm | +30 dBm |
| VSWR, Input and Output, max. | 1.6:1 | 2:1 |
| Impedance, Input and Output | 50 ohms | |
| Gain Flatness, max. | ±1.0 dB | |
| **PRIMARY ELECTRICAL REQUIREMENTS** | | |
| Primary Voltage | | (Note 2) +28 ±0.5 volts |
| Primary Power | | 28 watts |
| **MECHANICAL CHARACTERISTICS** | | |
| Dimensions (excluding connectors) | | 2 x 4 x 5 inches (51 x 102 x 127 mm) |
| Weight, max. | | 3 pounds (1.36 kg) |
| RF Connector | | TNC JACK |
| Outline Drawing Number | | 295132 |
| Power Connector | | Cannon KPTM06E10-10P |
| **ENVIRONMENTAL CHARACTERISTICS** | | |
| Altitude | | 100,000 feet |
| Temperature | | −54°C to +71°C |
| Vibration | | 5 G, 10 to 2000 Hz |
| Shock | | 15 G, 11 ms, 3 axis |
| Acceleration | | 20 G, 3 axis |
| Salt-Fog | | 50 hours |
| Salt Water Immersion | | 3 hours |

(NOTE 1) Higher or lower gain versions available (NOTE 2) 28 or 24V ±10% versions available

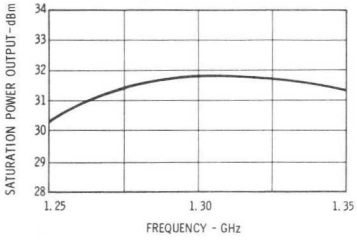
# WJ-5200

## OUTLINE DRAWING

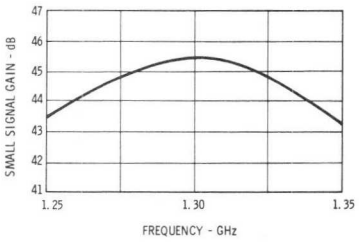



| ELECTRICAL CONNECTOR | |
|---|---|
| CANNON: | KPTH02-10-6PN |
| PIN | CONNECTOR |
| A | +28 VDC, PRI PWR |
| B | GRD |
| C | NO CONNECTION |
| D | NO CONNECTION |
| E | NO CONNECTION |
| F | NO CONNECTION |

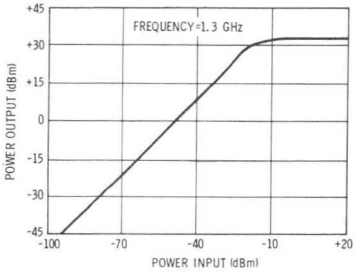
## POWER OUTPUT




## GAIN



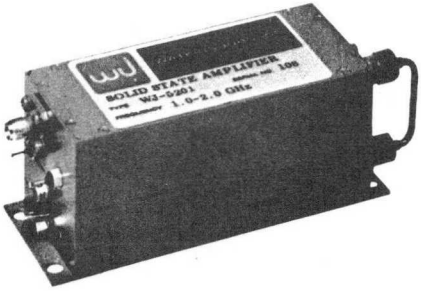

## OVERDRIVE



# TECHNICAL DATA

WATKINS-JOHNSON

## 1.0 TO 2.0 GHz
## 1-WATT THIN-FILM SOLID STATE AMPLIFIER
## WJ-5201 SERIES




- **1 WATT POWER OUTPUT**
- **COMPACT SIZE: 1.5 x 3.5 x 1.65 INCHES**
- **RUGGEDIZED DESIGN FOR MILITARY ENVIRONMENT**

Featuring all solid state, thin-film construction, the amplifiers in the WJ-5201 series deliver a guaranteed saturation power output of +30 dBm. Each unit is mechanically designed for use in adverse environments such as those encountered in military applications. The entire series has been qualified to MIL-E-5400, class 3, with an elevated 110°C temperature.

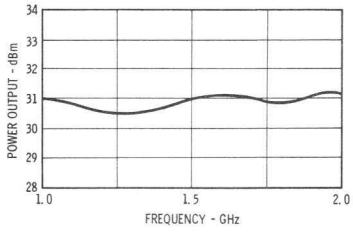
The microstripline circuit configuration is deposited in thin-film form on high dielectric constant ceramic substrates to provide minimum size and weight. The silicon semiconductors used are individually hermetically sealed in ceramic/metal packages for reliability. Active bias circuits are employed to maintain performance over wide temperature ranges.

### SPECIFICATIONS

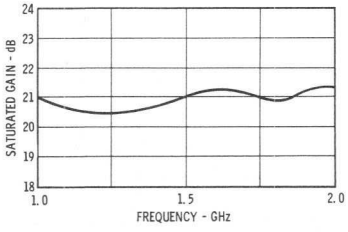
| | Guaranteed |
|---|---|
| **RF PERFORMANCE** | |
| Frequency Range | 1.0-2.0 GHz |
| Saturated Power Output | +30 dBm min. |
| Saturated Gain[1] | 20 dB min. |
| VSWR, Input and Output | 1.5:1/2.0:1 max. |
| Saturated Gain Flatness | ±1.5 dB max. |
| **PRIMARY ELECTRICAL REQUIREMENTS** | |
| Primary Voltage | +24 Vdc at 300 mA<br>+17 Vdc at 375 mA<br>−5 Vdc at 375 mA |
| **MECHANICAL CHARACTERISTICS** | |
| Dimensions, excluding Connectors | 1.5 x 3.5 x 1.65 inches max. |
| Weight | 8 ounces max. |
| RF Connector | SMA, Jack |
| Power Connector | Solder Terminals |
| Outline Drawing No. | 295205 |

**NOTES:**
**1. Higher gain versions are available.**

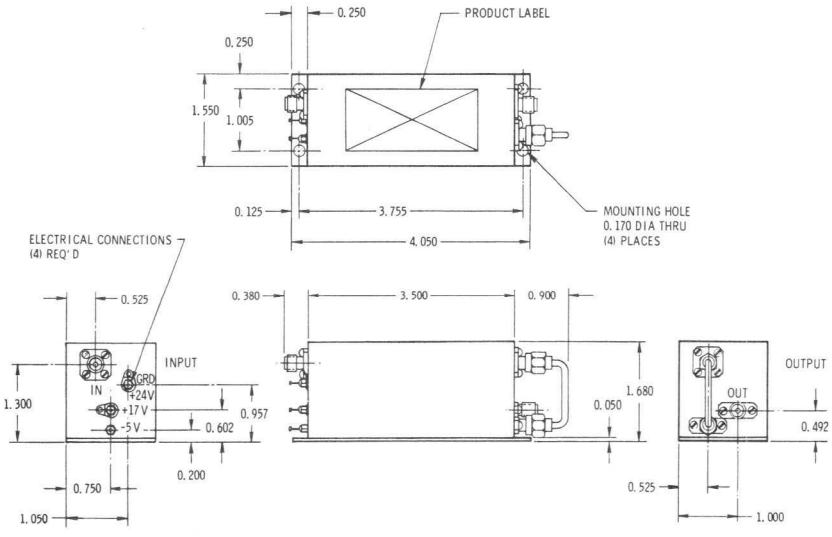
**POWER OUTPUT**




**GAIN**




**OUTLINE DRAWING**



# TECHNICAL DATA

WATKINS-JOHNSON

## 2 TO 4 GHz
## 100 MILLIWATT SOLID STATE AMPLIFIER
## WJ-5202-4

- **100 MILLIWATT POWER OUTPUT**
- **10 dB NOISE FIGURE**
- **COMPACT SIZE: 1.25 x 3.5 x 3.5 INCHES**
- **RUGGEDIZED DESIGN**

WJ-5202-4 is one of a series of medium-power solid state amplifiers developed by Watkins-Johnson for use in adverse environments. Featuring all solid state construction, the WJ-5202-4 has a guaranteed saturated power output of +20 dBm. Outstanding performance coupled with small size makes this amplifier especially suitable for TWT replacement applications.

The overall design of the WJ-5202-4 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class 2. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The amplifier is tested and set for operation prior to shipment; no adjustments are necessary by the user.

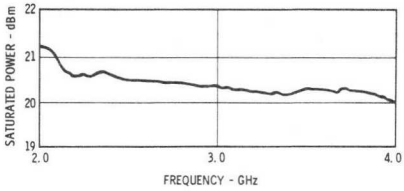
### SPECIFICATIONS

| | Guaranteed |
|---|---|
| **RF PERFORMANCE** | |
| Frequency Range | 2 to 4 GHz |
| Noise Figure (terminal) | 10 dB |
| Small Signal Gain[1] | 30 dB min. |
| Saturated Power Output | +20 dBm min. |
| Power Output at 1 dB Gain Compression | +17 dBm min. |
| VSWR, Input and Output | 2:1 max. |
| Impedance, Input and Output | 50 ohms |
| **PRIMARY ELECTRICAL REQUIREMENTS** | |
| Primary Voltage | +24 ±0.1 volts |
| Primary Power | 6 watts |
| **MECHANICAL CHARACTERISTICS** | |
| Dimensions, excluding connectors | 1.25 x 3.5 x 3.5 inches (32 x 89 x 89 mm) |
| Weight | 18 ounces (510 g) max. |
| RF Connector | SMA Jack |
| Outline Drawing No. | 295184 |
| Power Connector | SMA Jack |
| **ENVIRONMENTAL CHARACTERISTICS** | |
| Altitude | 100,000 feet |
| Temperature | −54°C to +71°C |
| Vibration | 5 G, 10 to 2000 Hz |
| Shock | 15 G, 11 ms, 3 axis |

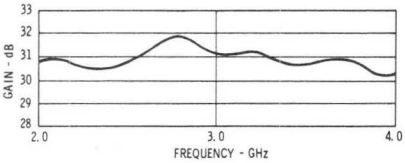
**NOTES:**
**1. Higher gain versions are available.**

# WJ-5202-4

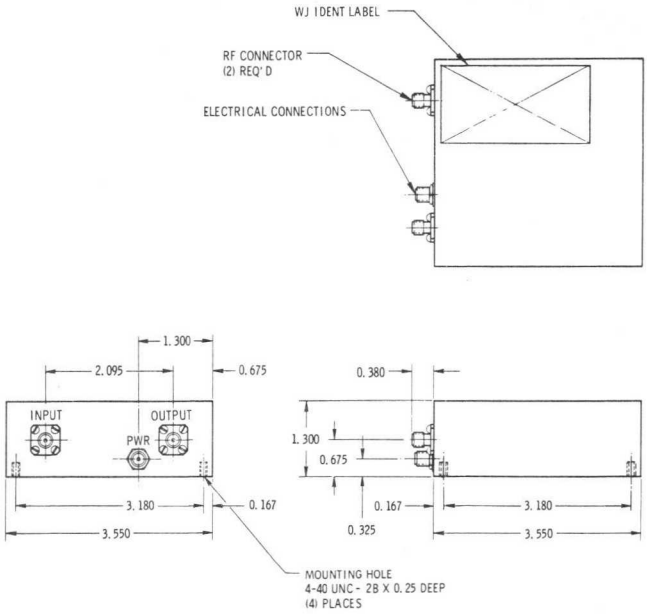
## POWER




## GAIN



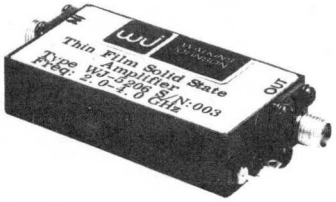

## OUTLINE DRAWING



# TECHNICAL DATA

WATKINS-JOHNSON

## 2 TO 4 GHz
## LOW-NOISE THIN-FILM SOLID STATE AMPLIFIER
## WJ-5206




- **MINIATURE SIZE: 0.5 x 1.1 x 2.1 INCHES**
- **GUARANTEED 8 dB NOISE FIGURE**
- **GUARANTEED +7 dBm POWER OUTPUT**
- **RUGGEDIZED DESIGN FOR MILITARY ENVIRONMENT**

Featuring all solid state, thin-film construction, the WJ-5206 Series amplifiers deliver the highest RF performance in the most compact size. Offering a noise figure of 8 dB and +7 dBm power output, the miniaturized WJ-5206 amplifier is mechanically designed for use in adverse environments such as those encountered in military applications. The entire series has been designed to MIL-E-5400, class 3, with an elevated 110°C temperature.

The microstripline circuit configuration is deposited in thin-film form on high dielectric constant ceramic substrates to provide minimum size and weight. The silicon semiconductors used are individually hermetically sealed in ceramic/metal packages for reliability. Active bias circuits are employed to maintain performance over wide temperature ranges.

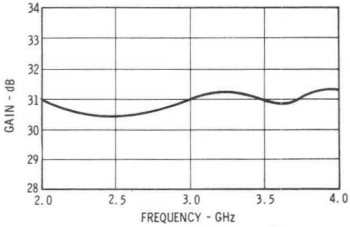
### SPECIFICATIONS

| | Typical | Guaranteed |
|---|---|---|
| **RF PERFORMANCE** | | |
| Frequency Range | | 2 to 4 GHz |
| Power Output[1] | +10 dBm | +7 dBm min. |
| Gain[2] | 31 dB | 28 dB min. |
| VSWR, Input and Output | 1.3:1/1.3:1 | 1.5:1/1.5:1 max. |
| Gain Flatness | ±0.75 dB | ±1.0 dB max. |
| Noise Figure[3] | 6.5 dB | 8.0 dB max. |
| **PRIMARY ELECTRICAL REQUIREMENTS** | | |
| Primary Voltage | | +15 Vdc at 120 mA |
| **MECHANICAL CHARACTERISTICS** | | |
| Dimensions, excluding Connectors | 0.5 x 1.1 x 2.1 inches (13 x 28 x 53 mm) | |
| Weight | | 2 ounce max. |
| RF Connector | | SMA, Jack |
| Power Connector | | Solder Terminals |
| Outline Drawing No. | | 295254 (without mounting flange)<br>295255 (with mounting flange) |

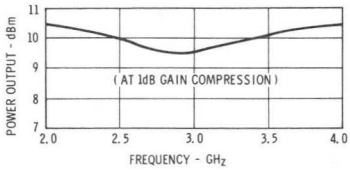
NOTES:
1. For 1 dB gain compression. Higher power versions available.
2. Higher and lower gain versions are available.
3. Lower noise figure versions available.

# WJ-5206

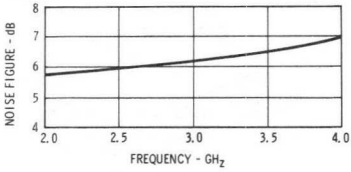
## GAIN



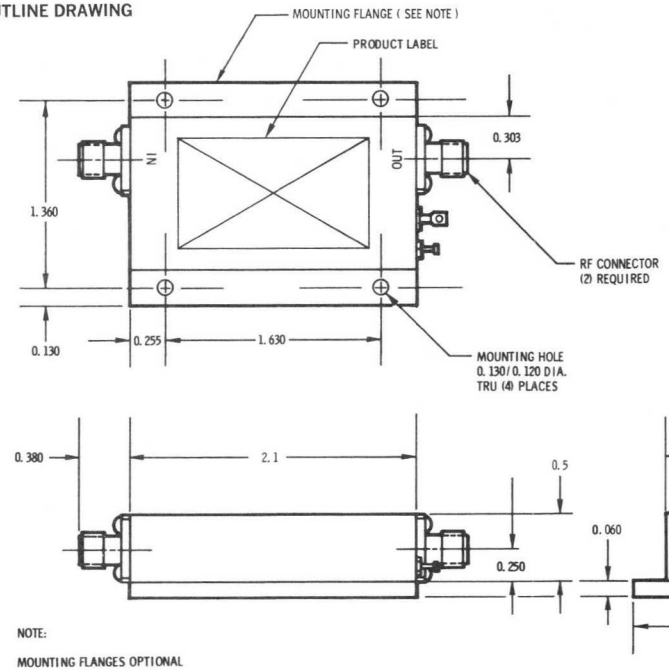

## POWER OUTPUT




## NOISE FIGURE




## OUTLINE DRAWING




NOTE:

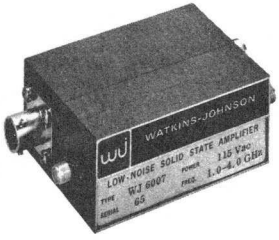
MOUNTING FLANGES OPTIONAL

# TECHNICAL DATA

WATKINS-JOHNSON

*OCTOBER 1971

# 1.0 TO 4.0 GHz LOW-NOISE MICROWAVE TRANSISTOR AMPLIFIER WITH INTEGRAL POWER SUPPLY WJ-6007




- **SMALL SIZE: 1.3 x 2.3 x 2.9 INCHES**
- **GUARANTEED 7.5 dB NOISE FIGURE**
- **GUARANTEED +5 dBm POWER OUTPUT**
- **DESIGNED TO MIL-E-16400 AND MIL-E-5400 CLASS II ENVIRONMENT**
- **"JUST PLUG IT IN"**

The WJ-6007 is one of a new series of low-noise microwave transistor amplifiers developed by Watkins-Johnson Company to complement an existing line of ultra-low-noise TWAs. Featuring all solid state components, this miniaturized amplifier offers a guaranteed noise figure of 7.5 dB and +5 dBm power output. This high-performance double-octave amplifier (with integral power supply) offers a power output/noise figure/size combination that is intended to satisfy most design requirements. Plug it into 115 volt ac power outlets for operation.

Modular construction ensures high reliability under adverse operating conditions. The microstripline circuit configuration employs integrated circuit biasing and bypass modules for consistently high performance. The overall design of the WJ-6007 is consistent with the general requirements of MIL-E-16400 and MIL-E-5400, class II. Since the amplifier is tested and set for operation prior to shipment, no adjustments are necessary by the user.

## SPECIFICATIONS

| PERFORMANCE | Typical | Guaranteed |
|---|---|---|
| Frequency | | 1.0 to 4.0 GHz |
| Noise Figure | 6.0 dB | 7.5 dB max. |
| Gain, Small Signal | 28 dB | 25 dB min. |
| VSWR, Input and Output | 1.7:1 | 2.5:1 max. |
| Power Output (For 1 dB gain compression.) | +7 dBm | +5 dBm min. |
| Impedance, Input and Output | 50 ohms | 50 ohms |
| Intercept Point for 3rd Order IM | +17 dBm | |

**PRIMARY ELECTRICAL REQUIREMENTS**

| | |
|---|---|
| Primary Voltage | 115 ± 10 volt ac |
| Primary Power | 3.0 watts max. |
| Primary Frequency | 48 to 420 Hz |

**ENVIRONMENTAL CHARACTERISTICS**

Designed to meet the respective requirements of MIL-E-16400 F, including Amendment 4 dated 15 May 1968, and MIL-E-5400K, class 2.

NOTE 1. For 1 dB gain compression.

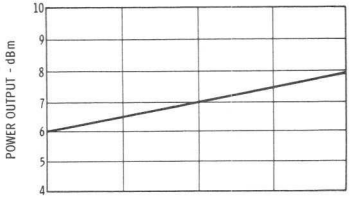
*Supersedes WJ-6007 Technical Data Sheet dated January 1971.

# WJ-6007

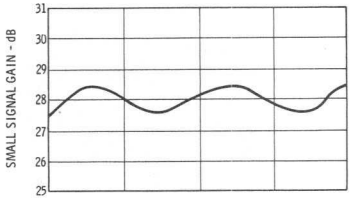
## MECHANICAL CHARACTERISTICS

Height . . . . . 2.3 inches (58 mm)
Width . . . . . 1.3 inches (33 mm)
Length . . . . 2.9 inches (74 mm) (less connectors)
Weight . . . . . 6.0 ounces (170 g)
RF Connectors . . . . . OSM Jack

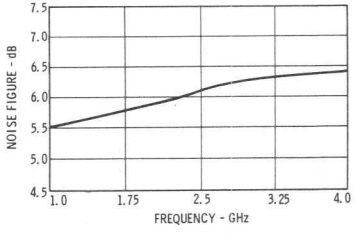
## POWER



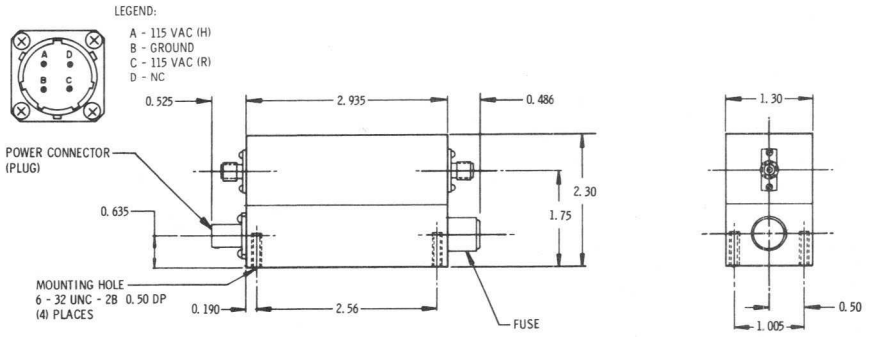

## GAIN




## NOISE




## OUTLINE DRAWING



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