VALVE ELECTRONIC **CV6181**

ADMIRALTY SURFACE WEAPONS ESTABLISHMENT

| Specification AD/CV 6181<br>Issue 1 Dated 20th October 1967.<br>To be read in conjunction with K1001, K1005, K1006, MIL-E-IE and MIL-T-5422E. Paragraph numbers in reference column refer to MIL-E-IE unless otherwise stated | SECURITY<br>Specification: Unclassified<br>Valve: Unclassified |
|---|---|

PROTOTYPE: M5317

DESCRIPTION: Travelling Wave signal amplifier for operation from 7.5 to 12 GHz

CATHODE: Indirectly heated

ENVELOPE: Packaged in a periodic permanent magnet focussing system

CONNECTIONS & DIMENSIONS: See Drawing Page 9

WEIGHT: 5.0 lb. max.

NOMINAL R.F. INPUT & OUTPUT IMPEDANCE: 50 ohms

MOUNTING POSITION: Any

COOLING: Free Convection

NATO STOCK NO. 5960-99-037-4623

| Parameter: / Unit: | Ef V | If A | Ec1 Vdc | Ic1 uAdc | Ec2 Vdc | Ic2 uAdc | Ec3 Vdc | Ic3 uAdc | Ec4 Vdc | Ic4 uAdc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ABSOLUTE MAXIMUM RATINGS (Note 1) | | | | | | | | | | | | |
| Maximum: | 6.6 | --- | 0 | 50 | | 150 | 50 | | 500 | 50 | 1000 | 50 |
| Minimum : | 6.0 | --- | -250 | --- | | --- | -- | | --- | -- | ---- | -- |
| TEST CONDITION: | | | | | | | | | | | | |
| (1) | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 |
| (2) | 6.3 | --- | Note 2,3 | -- | Note 2,3 | | -- | Note 2,3 | | -- | Note 2,3 | -- |

| Parameter: / Unit: | Ew Vdc | Iw mAdc | Eb Vdc | Ib mAdc | Ik mAdc | Pi(rf) dBm | Amb.Temp. Deg.C | tk sec | If (surge) A |
|---|---|---|---|---|---|---|---|---|---|
| ABSOLUTE MAXIMUM RATINGS (Note 1) | | | | | | | | | |
| Maximum | 1500 | 1.0 | Ew+ 250 | 1.0 | 1.0 | 30 | 100 | — | 1.5 |
| Minimum | 950 | --- | Ew | --- | --- | --- | -65 | 60 | --- |
| TEST CONDITION: | | | | | | | | | |
| (1) | 0 | 0 | 0 | 0 | 0 | as reqd | --- | 0 | 0 |
| (2) | Note 2,3, 4,5 | -- | Note 2,3,4 | -- | Note 33 | as reqd | --- | Note 33 | --- |

Requirements or tests:

General

Marking - Note 2, 9 and K.1001, Section 4.

Dimensions - Per Outline Drawing

Preparation for Delivery - Note 31.

| TEST | METHOD OR PARA. | REQUIREMENT OR TEST | CONDITIONS | SYMBOL | LIMITS MIN. | LIMITS MAX. | UNITS |
|---|---|---|---|---|---|---|---|
| | | QUALIFICATION INSPECTION (Qualification Approval) | | | | | |
| 1. | --- | Humidity - Temperature | Test Condition (1) Note 11. | - | - | - | - |
| 2. | --- | Container Drop | Note 6,16. | - | - | - | - |
| 3. | --- | Shock | Test Condition (2) Note 16,17 | - | - | - | - |
| | | Quality Conformance Inspection, part 1 (100%) | After 48 hours Holding Period | | | | |
| 4. | E-50.2 | Post Holding Period Tests | | | | | |
| 4.1 | --- | Grid Current | Test Condition (2) | Ic1 | -10 | +20 | uAdc |
| | | | | Ic2 | -10 | +20 | uAdc |
| | | | | Ic3 | -10 | +20 | uAdc |
| | | | | Ic4 | -10 | +20 | uAdc |
| | | | | Ic5 | -10 | +20 | uAdc |
| 4.2 | --- | Helix Current | Test Condition (2) | Iw | -10 | 200 | uAdc |
| 4.3 | E-1301 | Heater Current | Test Condition (1) Ef = 6.3 | If | 0.19 | 0.26 | A |
| 4.4 | --- | Cathode Current | Test Condition (2) | Ik | 0.4 | 1.0 | mA |
| 4.5 | --- | Collector Current | Test Condition (2) | Ib | 0.3 | 1.0 | mA |
| 4.6 | --- | Noise Figure | Test Condition (2) Note 10,18,20 F1,F4,F5,F6,F7 | | | | |
| | | | 7.5 to 10.75 GHz | | - | 11 | dB |
| | | | >10.75 to 11 GHz | | - | 11.5 | dB |
| | | | >11.0 to 11.5 GHz | | - | 12 | dB |
| | | | >11.5 to 12 GHz | | - | 12.5 | dB |
| 4.7 | --- | Gain | Test Condition (2) Note 10,18,21 | Gss | | | |
| | | | 7.5 to 11 GHz | | 35 | 40 | dB |
| | | | 11 to 12 GHz | | 30 | 40 | dB |
| 4.8 | --- | Frequency Gain Variation | Test Condition (2) Note 19,21 | ΔGss | see below | ~~8~~ see below | dB |
| 4.9 | --- | Saturation Power Output | Test Condition (2) Note 10,18,22. F=F1:F2:F3;F4;F7 | Po | 7 | 18 | dBm |
| 4.10 | --- | Power Gain | Test Condition (2) Note 10,18,23. F=F1;F2;F3;F4;F7 | Gp | Note 24 | - | - |



Tolerance

| | | | |
|---|---|---|---|
| 7.5 to 11 GHz | - | 5 | dB |
| 7.5 to 11.5 GHz | - | 7 | dB |
| 7.5 to 12 GHz | - | 8 | dB |

| TEST | METHOD OR PARA. | REQUIREMENT OR TEST | CONDITIONS | SYMBOL | LIMITS MIN. | LIMITS MAX. | UNITS |
|---|---|---|---|---|---|---|---|
| 4.11 | --- | Input Match | Test Condition (2) Note 26 | VSWR | - | 2.5:1 | ratio |
| 4.12 | --- | Output Match | Test Condition (2) Note 26 | VSWR | - | 2.5:1 | ratio |
| 4.13 | --- | Stability Quality conformance inspection, part 3 | Test Condition (2), No rf input Note 32 | Po | No oscillations | | |
| 5 | --- | Magnetic Shielding | Test Condition (2), Note 7,8. | - | - | - | - |
| 6 | --- | Temperature | Test Condition (2) Note 10,12,13,29 F=F1;F2;F3;F4;F7. | - | - | - | - |
| 7 | --- | Vibration | Test Condition (2) Note 7,14,15,16 | - | - | - | - |
| 8 | --- | Insertion Loss | Test Condition (1) Note 7,25, | L | 55 | - | dB |
| 9 | | Life Test | Test Condition (2) Note 10,27,28,29. F=F1;F2;F3;F4;F7. | t | 1000 | - | hours |
| 10 | | Life Test End Points | Test Condition (2) Note 10. F=F1;F2;F3;F4;F7. | - | Note | 30. | - |

NOTES

Note 1: The absolute maximum ratings define the upper limits of electrical inputs which may be applied to the tube without danger of permanent damage (MIL-E-1, Para. 6.5). The electrical input ratings necessary to provide the required tube performance are specified elsewhere.

Note 2: The tube operating voltages and currents shall be listed on a label affixed to the tube. The voltages shall fall within the following limits:

| Element | Minimum Voltage | Maximum Voltage |
|---|---|---|
| Heater | 6.24 | 6.36 |
| Grid 1 | -50 | 5 |
| Grid 2 | 5 | ~~50~~ 100 |
| Grid 3 | 5 | 250 |
| Grid 4 | 75 | 500 |
| Helix | 1100 | 1300 |
| Collector | Ew+5 | Ew+210 |

All voltages are measured with respect to cathode.

NOTES (Cont'd)

Note 3: In order to maintain the specified performance over the specified temperature range, the following power supply requirements must be met:

| Element | Installation Accuracy (±%) | Stability (±%) (Long term variation) | Ripple (volts pk. to pk) (Short term variation) |
|---|---|---|---|
| Heater | 1.0 | 1.0 | |
| Grid 1 | 0.15 | 1.0 | 0.020 |
| Grid 2 | - | 1.0 | 0.020 |
| Grid 3 | 0.15 | 1.0 | 0.020 |
| Grid 4 | 0.15 | 1.0 | 0.050 |
| Grid 5 | 0.15 | 1.0 | 0.050 |
| Helix | 0.15 | 0.25 | 0.050 |
| Collector | 0.15 | 5.0 | 10.0 |

(a) Installation accuracy is set on accuracy at 20°C.

(b) Stability includes power supply variations from all causes including temperature.

Note 4: Tube may be operated with any one of the following elements at capsule potential:

Cathode
Helix
Collector

Note 5: The symbols and abbreviations used are defined in MIL-E-IE, except as follows:

| | |
|---|---|
| Iw | Helix Current |
| Ew | Helix Voltage |
| GHz | $10^9$ Hz |
| Gss | Small Signal Gain |
| Gp | Power Gain |
| L | Insertion Loss |
| dBm | DB relative to 1 milliwatt |

Note 6: The tube shall be packed in its regular shipping container and the packaged tube subjected to the drop tests specified in K.1005. There shall be no mechanical damage following the drop tests.

Note 7: These tests shall be performed on one tube every 6 months when the tube is in continuous production or one tube per 100 tubes, whichever comes sooner. In the event of a failure, corrective action shall be taken by the manufacturer and the Approval Authority informed.

Note 8: The tube under test shall be mounted parallel with, and at a distance not greater than 3" between centres from another CV6181, on a steel plate which is 18" square by ½" thick. The tube under test shall operate within the limits specified for each test listed under Quality Conformance Inspection Part 1. (Tests 4.1 through 4.13)

NOTES (Cont'd)

Note 9: A label shall be fixed to the body of each tube. The label shall be indelibly marked "Magnetized Materials".

Note 10: The test frequencies Fn are defined as follows:

| Designation | Frequency (GHz) |
|---|---|
| F1 | 7.5 |
| F2 | 8.25 |
| F3 | 9.5 |
| F4 | 10.75 |
| F5 | 11.0 |
| F6 | 11.5 |
| F7 | 12.0 |

Note 11: Follow procedure of MIL-T-5422E

Note 12: The results of all performance measurements shall be recorded. These measurements shall be of the Grid and Helix currents, Gain, Saturation Power Output and Noise figure as specified in Quality Conformance Part 1.

The Temperature test shall be performed as follows:

Affix a temperature indicating device to the capsule outside diameter at a point approximately bisecting the tube length.

| Step | Condition | Time at Indicated Capsule Temperature Prior to Measurements | Measurements |
|---|---|---|---|
| 1 | Room ambient temp. Normal test rig outside chamber | - | Required record ambient temp. |
| 2 | Room temp. as in Step 1 but with tube in chamber | - | Required |
| 3 | Adjust chamber to -10°C | 40 Minutes | Required |
| 4 | " " -62°C | 1 hour | Not required |
| 5 | " " 45°C | 2 hours 10 Min | Required |
| 6 | " " 70°C | 30 Minutes | Required |
| 7 | " " 90°C | 25 Minutes | Required |
| 8 | Room ambient temp. Normal test rig outside chamber. | 1 hour 25 Min. | Required Record ambient temp. |

Note 13: Where measured, the performance at the operating temperatures shall be compared with the performance at Step 2 (Note 12) and the differences shall not exceed the following limits:

| Performance | Limits |
|---|---|
| Gain | ± 3 dB |
| Saturation Power Output | ± 1.5 dB |
| Noise Figure | ± 2 dB |

NOTES (Cont'd)

The grid and helix currents shall not exceed the following limits:

| | |
|---|---|
| Grid Currents | As specified in test 4.1 |
| Max Helix Current | 150 uA d.c. for steps 3 and 5 in Note 12 |
| | 350 uA d.c. for steps 6 and 7 in Note 12 |

There shall be no change greater than Measurement Error (Note 34) in performance between Steps 1 and 8 (Note 12). In the event of a failure the Approval Authority shall be informed immediately.

Note 14: Measure gain using a swept frequency technique. Gain variation due to resonances during the test shall be less than 0.5 dB at any frequency between 7.5 and 12 GHz.

Note 15: The tube shall be vibrated in three mutually perpendicular directions successively, one of which shall be the major axis.

(a) Resonance search: 5 to 55 Hz at ± 0.010" amplitude, 1 Hz steps, 15 secs each. Record resonant frequencies.

(b) 5 to 15 Hz at ± 0.030" amplitude, 1 Hz steps, 2 minutes/step.
16 to 25 Hz at ± 0.020" amplitude, 1 Hz steps, 2 minutes/step.
26 to 55 Hz at ± 0.010" amplitude, 1 Hz steps, 2 minutes/step.
Record resonant frequencies.

(c) 2 hours at resonances.

Note 16: Before and after this test, perform Quality Conformance Inspection tests 4.6; 4.7 and 4.9. There shall be no change greater than the limits of Measurement Error (Note 34).

Note 17: Following the procedure of MIL-T-5422E subject the operating tube, with no rf input and at the prevailing room temperature, to 18 impact shocks of 30G and a time duration of 11 ± 1 ms. Three impact shocks shall be applied in each direction to the tube in each of three mutually perpendicular axes.

Note 18: At the discretion of the manufacturer, a swept frequency signal source may be employed and the performance recorded continuously over the frequency band.

Note 19: Frequency Gain Variation shall be measured using a swept frequency source over the operating band.

Note 20: Noise mounts of A.I.L. manufacture having part nos. 07051 and 07052 shall be assumed to have a relative excess noise temperature of 15.3 dB.

Note 21: Gain tests shall be performed with input power adjusted to give an output power level of 1 milliwatt.

Note 22: The Saturation Power Output test shall be performed as follows: At each frequency, increase the power input until the first power output peak is reached, measure the power output at this value of power input.

NOTES (Cont'd)

Note 23: Power Gain is defined as the gain measured with the input power adjusted to give the power output obtained using the setting procedure specified in Note 22.

Note 24: Power Gain shall be not less than the value of Gss - 8 dB.

Note 25: The Insertion Loss shall be measured across the frequency band using a swept frequency technique.

Note 26: The VSWR at the relevant connector shall be measured across the frequency band using a swept frequency technique, the other connector being terminated in a matched load.

Note 27: The tube selected for this test shall have passed the acceptance tests (Quality Conformance Inspection, Part 1), or have the approval of the Inspecting Officer.

Note 28: Before the life tests and at 50, 100, 200, 500 and 1000 hours, the electrode currents, the gain, saturated power output and noise figure shall be measured.

Note 29: This test shall be one tube per lot where lot size shall consist of 25 tubes or 1 month's production, whichever is the greater.

Note 30: The End of Life is defined as the time at which any of the following changes occur :-

Helix current exceeds the specified limits.
Grid current exceeds the specified limits.
Gain changes by more than 2 dB.
Sat Power Output changes by more than 2 dB.
Noise Figure changes by more than 1 dB.

In the event of a failure the Approval Authority shall be informed.

Note 31: Preservation, packaging and packing. Unless otherwise specified in the contract or order, preservation, packaging and packing shall be according to J.S.Specification K1005.

Note 32: With the tube input and output separately terminated in a short, the phase of the mismatch shall be varied by 360 electrical degrees and helix voltage swept plus and minus 2 per cent from its optimum value at a 50 to 400 cycle rate. The detected tube output shall be viewed as the vertical deflection on an oscilloscope and the helix voltage as the horizontal deflection. The sensitivity of the test circuit shall be that necessary to indicate the tube noise output. The onset of oscillation is observed as a discontinuity in the oscilloscope trace.

Note 33: Installation and alignment shall be as follows:-

(a) Connect power supply and rf lines to the TWT

(b) Apply rated heater voltage for a period of two minutes. The full rated heater voltage may be applied instantaneously.

(c) Set grid 2 to zero volts, and set all other elements to voltages shown on the tube label.

(d) Turn up the voltage on grid 2 until the collector current reaches the value shown on the tube label. Grid 2 voltage shall then be approximately that shown on the label. Collector current shall be set to an accuracy of 1%.

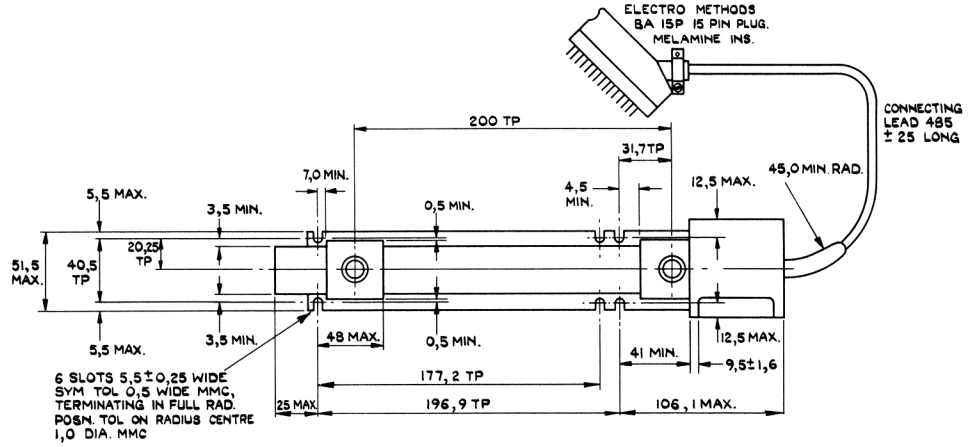
(e) After initial installation and setting of voltages, subsequent turn-on procedure may be as follows:-

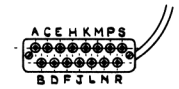
1. Same as (b).

2. All other voltages may then be immediately turned on to the preset values with the proviso that the grid 2 voltage is not achieved before the helix voltage.

Note 34. Measurement Error shall be defined as :-

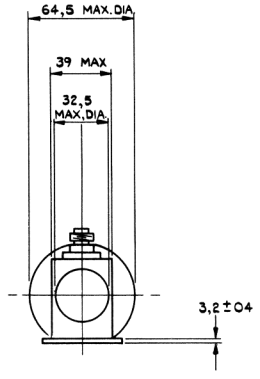
| | |
|---|---|
| Gain: | ± 1 dB |
| Sat.Power O/P : | ± 1 dB |
| Noise: | ± 0.5 dB |

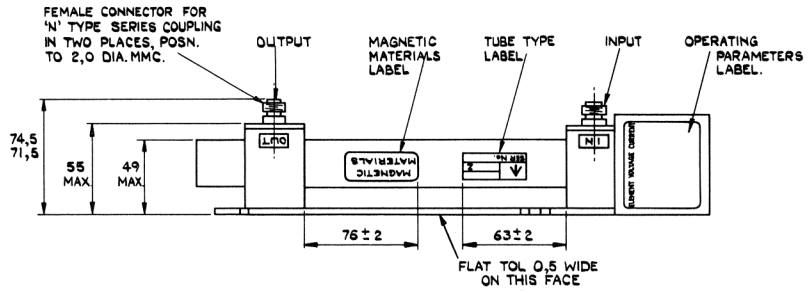


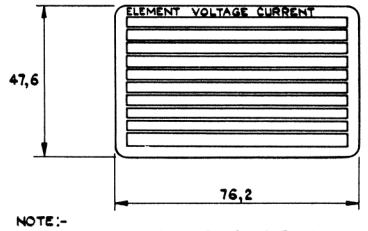




| PIN | CONNECTION | COLOUR |
|---|---|---|
| A | N.C. | — |
| B | N.C. | — |
| C | GRID 1 | GREEN |
| D | HELIX | ORANGE |
| E | COLLECTOR | RED |
| F | GRID 4 | WHITE |
| H | GRID 3 | GREY |
| J | GRID 2 | BLUE |
| K | N.C. | — |
| L | CATHODE | YELLOW |
| M | HEATER | BROWN |
| N | HEATER CATHODE | YELLOW |
| P | CAPSULE GRD | BLACK |
| R | N.C. | — |
| S | N.C. | — |

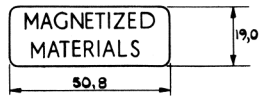
NOTE: NO CONNECTION IS TO BE MADE TO PINS A, B, K, R & S



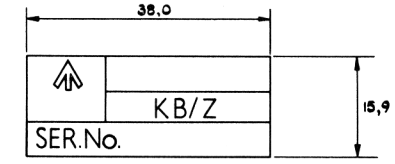




NOTE:-
LETTERS 1,5 HIGH, AND BOXES TO BE ALUMINIUM ON ANODISED MATT BLUE GROUND.




NOTE:-
BLACK LETTERS 5,5 HIGH ON CANARY YELLOW GROUND.
THE WORDS 'MAGNETIZED MATERIALS' TO BE CENTRALLY LOCATED.
FINISH:- FERROUS COMPONENTS BLACKENED AND PRIMED WITH PAINT TO CS 2307A IN ACCORDANCE WITH DEF 5000 PART 7, SECTION 5, PARA 2b.
TOP COAT LIGHT GREY EGGSHELL PAINT TO CS 2308A IN ACCORDANCE WITH DEF 5000 PART 7.
R.F. CONNECTORS BRIGHT SILVER PLATED.




NOTES:-
1. BROAD ARROW 4,8 HIGH. CHARACTERS TO BE 2,5 HIGH.
2. COLOUR:- WHITE CHARACTERS ON BLACK BACKGROUND.

# OUTLINE DRAWING OF TUBE

DIMENSIONS IN mm

CV6181/1/9

ELECTRONIC VALVE SPECIFICATION
SPECIFICATION AD/CV6181 DATED 20TH OCTOBER 1967

AMENDMENT No. 1

Page 2

Test 4.8 Frequency Gain Variation

Delete existing test and substitute the following:-

| TEST | METHOD OF PARA. | REQUIREMENT OR TEST | CONDITIONS | SYMBOL | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN. | MAX. | |
| 4.8 | - | Frequency Gain Variation | Test Condition (2)<br>Note 19, 21 | $\Delta G_{ss}$ | | | |
| | | | 7.5 to 11 GHz | | - | 5 | dB |
| | | | 7.5 to 11.5 GHz | | - | 7 | dB |
| | | | 7.5 to 12 GHz | | - | 8 | dB |

Page 3

Test 4.11 Input Match

Under "Limits" "Max"

Insert 2.5:1

Page 3

Test 4.12 Output Match

Under "Limits" "Max."

Insert 2.5:1

Page 3 NOTE 2 Maximum Voltage

Grid 2 Delete 50
Insert 100

TVC for ASWE

March 1968
NM.530312T

28/8/68

ELECTRONIC VALVE SPECIFICATION

SPECIFICATION AD/CV 6181
ISSUE 1 DATED 20 OCTOBER 1967

AMENDMENT NO 3

OUTLINE DRAWING OF TUBE

FINISH - FIRST SENTENCE, AFTER "..... Section 5, Paragraph 2b".

ADD - , or commercial equivalent.

FINISH - SECOND SENTENCE, AFTER "..... DEF 5000, PART 7".

ADD - , or commercial equivalent.

SLR 23 FOR PSV2/P14481/76

October 1976