VALVE ELECTRONIC **CV6022**

Specification MOA/CV 6022 Issue 1, reprint B, dated **6.12.62.** To be read in conjunction with K1006, MIL-E-1/115D dated 26.1.58	SECURITY Specification: Unclassified Valve: Unclassified

→ denotes a change.

TYPE OF VALVE Thyratron, Hydrogen, with or without reservoir with rugged features, and controlled recovery characteristics	MARKING See K1001/4
CATHODE Coated Unipotential	BASE Super Jumbo, 4 pin with bayonet
PROTOTYPE VX2527, 5C22 with rugged **features and controlled recovery characteristics and improved rating.**	MOUNTING POSITION Any
Relevant documents may be had from TL5(b), M.O.A., 77-91 New Oxford Street, London, W.C.1.	

RATING AND OPERATING CONDITIONS

A.A. The rating is as in MIL-E-1/115D with additions as under:-

Symbol, parameter, units	Ebb, Anode tube over voltage Volts dc.	Ib, mean anode current MA	tk, tube heating time, secs	Pb Heating factor VxAxp.r.f.
Absolute Maximum	----------	250	------	3.8×10^9
Absolute Minimum	1000	----	180	-----

B.B. Additional mechancial ratings: (a) Shock 100g (max)
(b) Continuous Acceleration 12g (max)
(c) Vibrational Acceleration: Not to exceed 0.25g over the range 10-100c/s.

C.C. This note shall be read in conjunction with Note 3. Grid bias, if used must not exceed 200V measured between the grid terminal and cathode, with the grid disconnected. The true bias Ecc must be measured between the low pulse potential end of the grid circuit and cathode with the thyratron connected and running under equipment conditions.

The trigger pulse must be measured at the grid terminal, with the grid disconnected, the true drive pulse egy being the height of the trigger pulse minus the true bias Ecc. The true drive pulse egy must exceed 200 volts and not be greater than 750 volts. If two levels be marked off on the trigger pulse, the lower being Ecc volts above the base line, and the upper being 200 volts above the lower, then the time of rise between these two levels shall not exceed 0.5 /usecs. The width of the pulse at the upper level shall exceed 2 /usecs.

The trigger pulse circuit must be capable of delivering at least 400 m/A of drive current to the grid-cathode of the thyratron. For measurement a non-inductive 0.1 /uf capacitor should be connected between grid and cathode terminals, and the valve removed. The available drive current is the current multiplied by $\frac{\text{egy}}{\text{egy-Ecc}}$, this multiplier always being less than unity when bias is used.

C.C (Cont'd)

The grid to cathode impedance shall not exceed 30,000 ohms during the interpulse period.

In cases where the shortest recovery time is required, the grid-cathode impedance during the recovery period should be as low as possible. This is termed "recovery impedance", and defined as $\frac{eg-Ecc}{ig}$ where eg and ig are the values of grid voltage and current at any instant, and Ecc is the true bias. In fig. 2, the variation in recovery time for various bias and recovery impedance values is shown. The recovery time for a 1kv probe pulse has the symbol TR and is defined as the time after the main pulse when conduction just persists, for a positive 1 kv probe pulse applied to the anode. The recovery time for a probe pulse of height n kv is less than n TR, but little is known about recovery for probe pulses of height less than 1 kv. In this connection the rating:-
5% epy (min) found under epx rating on page 1 is now to be regarded as an empirical factor, and is not mandatory for this thyratron.

TESTS

All the tests in MIL-E-1/115D shall be performed with the addition of the following, **and amended as in notes below:-**

D.D. All valves shall be vibrated in accordance with 4.9.19.2 along axes X,Y only before the holding period. No voltages need be applied. The holding period shall be increased to 144 hours. Prior to the instantaneous start, the valve shall be pre-heated for 24 hours with Ef=6.3 Vac.

E.E. After the Emission test the following test shall be performed at AQL = 0.65% inspection level II, after a holding period of 1 hour.

Instantaneous starting (2) : epy = 13.5kv, tk = 180, Notes 10,14,15.
Read note 14 to mean the 1 hour holding period for this test.

F.F. After test E.E, include the following test at AQL 0.65% inspection level II: Operation (3), epy = 13.0 kv(min), prr=2500 t = 300 Secs, notes 11,12,16. Limit:- egy = 150 volts (max). For this test the circuit shall be as in figure 4. The recovery resistance R1 + R2 shall be between 4000-4500 ohms. The bias measured across the 2 /uf decoupling capacitor, with the valve running, shall not exceed 50 volts in magnitude. The anode circuit conditions shall be chosen so that at epy = 12.0 kv under resonant charging conditions $\frac{dik}{dt}$ = 1250 amps per microsecond (min), ib = 130 amps(min), tp = 0.5 ± 10%; prr = 2500pps. The grid pulse characteristic shall be:- tp = 2.0/us (max); tR = 0.5/us (min), Impedance of driver = 500 ohms(Min).

G.G. The following modifications to "Measurement Acceptance Tests Part 2" shall be made:-

(a) Increase Inspection Level from L6 to 1A
(b) Delete Vibration and Bump, since these occur elsewhere.
(c) Add new test "Recovery Time (1)", at AQL 6.5%, inspection level 1A. Circuit as in fig. (1), but driven by the arrangement as in fig. 3. Operation (1), but with any convenient p.r.f. below 100c/s e.g. 50c/s, bias 50v, measured across the 2/uf decoupling condenser, with tube running, recovery resistance, Rg = 4000-5000 ohms. The recovery period shall not exceed 35 microseconds.

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TESTS (Cont'd)

G.G. (Cont'd)

(d) Add new test "Recovery Time (2). Conditions as in (c) but with bias values of 0-10-25-50-100 volts, and ten resistance values for each bias over the range 100-30,000 ohms, adjacent values of resistance having ratios between the limits 1:1.5, 1:2. The recovery characteristic so obtained with a 1 kv probe pulse of rise time 3-4/uS shall not be inferior to that shown in fig. 2. This test shall be carried out on two samples per 1000 valves, or on two samples every 6 months whichever is the more frequent.

H.H. A new section "Degradation Rate Acceptance Tests" shall be added as under. In addition note 24 shall be amended to include "Linear Acceleration", "Vibration" and "Bump".

Ref.	Test	Conditions	AQL %	Insp. Level	Limits Min	Limits Max	Units
4.9.20	Degradation Rate Acceptance Tests Note 24.						
4.9.19	Bump	Angle = 20° Note 8	6.5	L6			
4.9.20.5	Shock	Angle = 13° Note 9	6.5	L6			
	Linear Acceleration	Ef = 6.3 Vac Note JJ		L6			
	Resonance Search	Ef = 6.3 Vac Note 10 KK		L6			
	Vibration (3)	Ef = 6.3 Vac Note MM		L6			
	Post Shock Linear Accn. and Vibration (3) End Points:-						
		Operation (1) egy	6.5			150	V
		DC Anode Voltage Ebb	6.5			2500	Vdc
		Time Jitter tj Note LL.	6.5			.005	/uS

Note JJ. The acceleration shall be 12g (min) applied and maintained for one minute at right angles to and in each direction along the major axis of the valve.

Note KK. The vibration shall be applied in two mutually perpendicular directions, one of which shall be parallel to the longitudinal axis of the valve. The frequency shall be swept at a rate not exceeding one octave per minute between 10 cps and 150 cps, with accelerations of $\frac{1}{4}$g (min). All resonances detectable visually or electrically shall be noted for information and also for use as in note MM below.

Note LL. Where the sampling plans give no criterion of acceptance, or give "Accept on zero failures", allow acceptance on one reject, and rejection on two rejects.

Note MM. Each valve shall be subjected to vibration for two periods of ten hours. In one period the direction shall be parallel to the longitudinal axis of the valve, and in the other the direction shall be perpendicular to the longitudinal axis of the valve. The acceleration shall be $\frac{1}{4}$g and the frequency shall be that of the strongest resonance detected during the resonant search. If no resonances were detected, then the frequency shall be 150 c/s.

Note NN. Joint Services Catalogue number 5960-99-037-2118

FIG. 2 MAXIMUM RECOVERY CHARACTERISTICS AT 180 AMPS PEAK CURRENT WITH IKV PROBE PULSE.

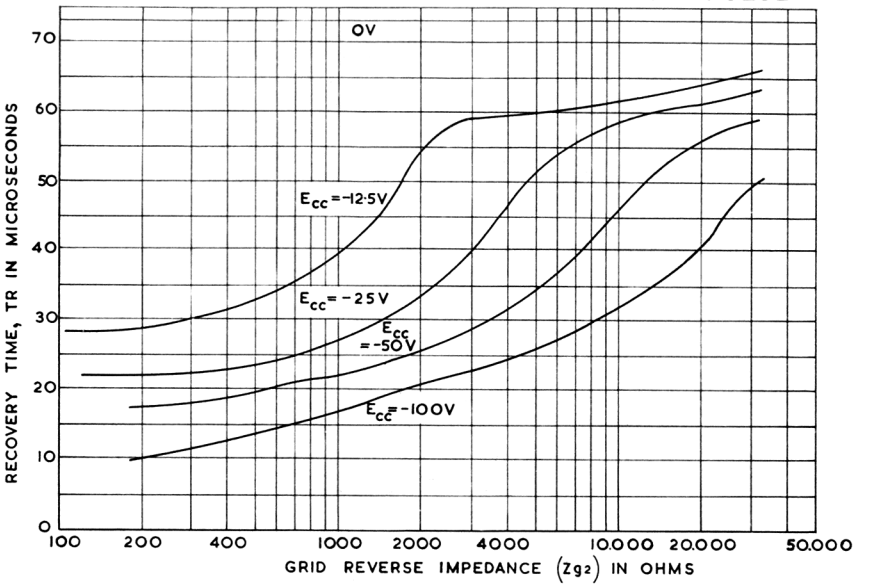


FIG. 3 GRID CIRCUIT USED FOR RECOVERY CHARACTERISTICS

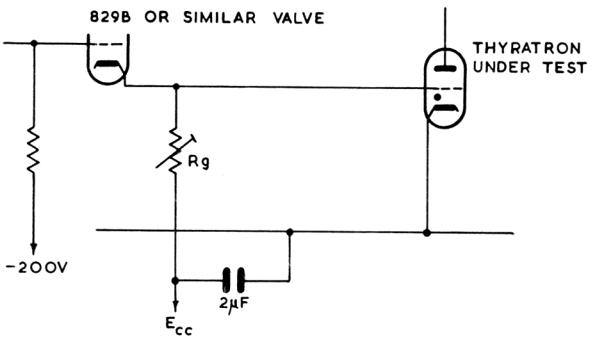
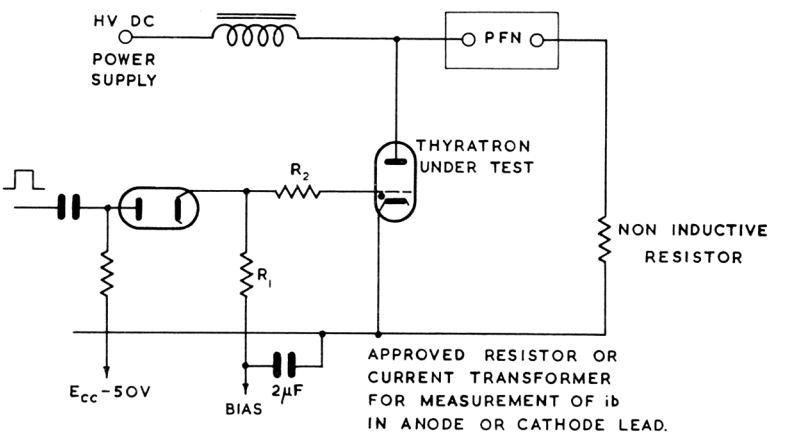


FIG. 4 OPERATION CIRCUIT WITH BIAS



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MIL-E-1/115D
28 January 1958
SUPERSEDING
MIL-E-1/115C
23 August 1955

INDIVIDUAL MILITARY SPECIFICATION SHEET

ELECTRON TUBE, THYRATRON, HYDROGEN, WITH OR WITHOUT HYDROGEN RESERVOIR

JAN-5C22/HT-415

This specification sheet forms a part of the latest issue of Military Specification MIL-E-1.

Ratings	:	Ef	epy	epx	Ebb	Ecc	egx	egy	ib	tk	dik dt	Ib	Pb	TA	Cooling	prr	Alt
Absolute	:	V	kv	kv	Vdc	Vdc	v	v	a	sec	a/us	mAdc	---	°C	---		ft
Maximum:		6.3±7.5%	16.0 Note 1	16.0 Note 2	---	---	200	---	325	---	1500	200	$3.2X10^9$	190	Note 4	---	10,000
Minimum:		---	---	5% epy	4500	---	---	Note 3	---	300	---	---	---	-50	---	---	---
Test Cond	:	---	16.0	---	---	0	---	150	---	---	---	---	---	---	---	1000	---

Cathode: Coated Unipotential
Base: Super Jumbo 4-Pin with bayonet, A4-18 with ceramic insert

Height: 8-1/4 in. min; 8-3/4 in. max.
Diameter: 2 in. min; 2-9/16 in. max.

Mounting Position: Any

Cap: Diameter: .566±.007 in.
Length: 3/8 in. min. straight side

Pin No.:	1	2	3	4	Cap
Element:	g	h k	h	k	p Note 6

Clamping: Note 5
Envelope: T-20

The following tests shall be performed:
For miscellaneous requirements, see Paragraph 3.3, Inspection Instructions for Electron Tubes.

Ref.	Test	Conditions	AQL(%)	Insp. Level or Code	Sym.	LIMITS Min.	LAL	Bogie	UAL	Max.	ALD	Units
	Qualification Approval Tests											
3.1	Qualification Approval:	Required for JAN Marking	---	---								
---	Cathode:	Coated Unipotential	---	---								
3.4.3	Base Connections:		---	---								
4.9.20.3	Vibration (2):	No Voltages; Notes 7, 8	---	---								
4.9.20.5	Shock:	Angle =13°; Note 9, 24	---	---								
---	Post Shock Test -	Operation (1)	---	---	egy:	---	---	---	---	150	---	v
	End Points:	DC Anode Voltage	---	---	Ebb:	---	---	---	---	2500	---	V
		Time Jitter	---	---	tj:	---	---	---	---	0.005	---	us
---	Operation (2):	TA=90°C;t=5.0 hours; Ef=6.30±0.50Vac; Notes 10, 11, 12	---	---	egy:	---	---	---	---	150	---	v
	Measurements Acceptance Tests, Part 1; Note 13											
4.5	Holding Period:	t=96 hours			---:	---	---	---	---	---	---	
4.10.8	Heater Current:	Ef=6.30Vac	0.65	II	If:	9.60	---	---	---	11.60	---	Aac
---	†Instantaneous Starting:	epy=13.5kv min; tk=300; Notes 10, 14, 15	.65	II	---:	---	---	---	---	---	---	
---	†Operation (1):	epy=18.0kv min; prr=800; t=300; Notes 10, 11, 12, 16	.65	II	egy:	---	---	---	---	150	---	v
4.10.17.2	D.C. Anode Voltage:	Notes 10, 16, 17	.65	II	Ebb:	---	---	---	---	2500	---	Vdc
---	Emission:	Ef=6.30Vac;ik=325a minimum; prr=60 ±10%; tp=5us±10%; tr=0.5us maximum; Note 18	.65	II	egk:	---	---	---	---	175	---	v
4.9.1	Mechanical:	Envelope										

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Ref.	Test	Conditions	AQL(%)	Insp. Level or Code	Sym.	LIMITS Min.	LAL	Bogie	UAL	Max.	ALD	Units
	Measurements Acceptance Tests, Part 2											
4.9.19.2	Vibration (1):	No Voltages; Note 8	6.5	L6	---:	---	---	---	---	---	---	
4.9.19.3	Bump:	Angle=20°; Note 8	6.5	L6	---:	---	---	---	---	---	---	
---	Operation (1A):	Operation (1); Ef=6.80 Vac; Note 19	6.5	L6	egy:	---	---	---	---	150	---	v
---	Anode Delay Time:	Operation (1); t=120; egy=150v; Note 20, 21	6.5	L6	tad:	---	---	---	---	0.65	---	us
---	Anode Delay Time Drift:	Anode Delay Time; Note 22	6.5	L6	Δtad:	---	---	---	---	0.10	---	ua
---	Time Jitter:	Ef=6.30Vac; epy=5.0kv maximum; Notes 10, 23	6.5	L6	tj:	---	---	---	---	0.005	---	us
	Acceptance Life Tests											
4.11	Life Test:	Group C; Ef=6.30Vac; Notes 10, 12, 25			t:	500	---	---	---	---	---	hours
4.11.4	Life Test End Points:	Operation (1), and Operation (1A) Note 26			egy:	---	---	---	---	160	---	v
		DC Anode Voltage;egy=160v			Ebb:	---	---	---	---	4000	---	Vdc
		Time Jitter; egy=160v			tj:	---	---	---	---	0.010	---	us
		Anode Delay Time;egy=160v			tad:	---	---	---	---	0.70	---	us
		Anode Delay Time drift; egy=160v			Δtad:	---	---	---	---	0.10	---	us
	Packaging Requirements											
4.9.18.1.6	Container Drop:	(d) Package Group 1; Container Size T										

Note 1: For instantaneous starting applications where plate voltage is applied instantaneously, the maximum permissible epy is 13.5kv and shall not be attained in less than 0.04 seconds.

Note 2: In pulsed operation, the peak inverse voltage, exclusive of a spike of 0.05 us maximum duration, shall not exceed 5.0kv during the first 25us after the pulse.

Note 3: Driver pulse measured at tube socket with thyratron grid disconnected; egy=200v(minimum), time of rise=0.5us(maximum); grid pulse duration=2us(minimum); impedance of driver circuit=500 ohms(maximum).

Note 4: Cooling of the anode lead is permissible, but there shall be no air blast directly on the bulb.

Note 5: Clamping is permissible by the base, by the bulb, or both in the area up to 4-1/4 inches above the top of the base only.

Note 6: Where equipment is designed to withstand shock and vibration, it is recommended that the anode connector be of the spring clip type. (National Co. type 12 or equivalent).

Note 7: There shall be no pronounced resonance in the specified range.

Note 8: There shall be no evidence of shorts of any kind resulting from this test.

Note 9: Use clamp as per 243-JAN drawing.

Note 10: The circuit used for this test is shown in the attached drawing (Fig. 1). The anode circuit constants shall be chosen so that at epy=16.0kv under resonant charging conditions, dik/dt=1500a/us (minimum); ib=175a; tp=1.0us±10%; prr=1000.

Warning: These conditions are specified only for the purpose of determining circuit constants. The actual operating voltage and repetition rates for each test is specified in the conventional manner under the particular conditions or under the general test conditions, as the case may be. Tests performed at repetition rates less than the resonant repetition rate shall be made with a hold-off diode in the charging circuit.

The grid pulse characteristic shall be tp=2.0us(maximum); tr=0.5us(minimum). Internal impedance of driver=500 ohms (minimum).

Note 11: The tube shall operate continuously without evidence of arc-back.

Note 12: There shall be no evidence of anode heating during the test.

Note 13: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding Mechanical, shall be one percent. A tube having one or more defects shall be counted as one defective. MIL-STD-105, Inspection Level II, shall apply.

Note 14: This shall be the first test after the holding period. "The tube shall not be subjected to any voltage except filament and Grid #drive voltage, and the test shall be performed immediately after the cathode-heating time (tk). The grid-drive voltage shall be applied within 10 seconds before applications of Anode Voltage." The tube shall operate satisfactorily on push-button starting within 3 attempts when the anode voltage (epy) is applied to the tube under test in such a manner as to rise from 0 to 13.5kv within 0.03 sec. (The filter in the rectifier shall be designed so that the epy reaches at least 7 kv within 0.015 sec.) The intervals between successive attempts to instantaneously start the tube shall not be less than 10 seconds nor more than 30 seconds. Any tube failing to start within 3 attempts will be considered a failure.

Note 15: For tubes WITH hydrogen reservoirs, this test shall be performed at Ef=6.80Vac. For tubes WITHOUT hydrogen reservoirs, this test shall be performed at Ef=6.30Vac.

Note 16: For tubes WITH hydrogen reservoirs, this test shall be performed at Ef=5.80Vac. For tubes WITHOUT hydrogen reservoirs, this test shall be performed at Ef=6.30Vac.

Note 17: This test shall be conducted within 60 sec. after the Operation (1) test. ←

Note 18: The positive pulse shall be applied to the grid of the tube. Measure the voltage between grid and cathode 2.5us (maximum) after the beginning of the current pulse. The average voltage shall not rise during the last four microseconds. Plate floating.

Note 19: This test shall NOT be performed on tubes WITHOUT Hydrogen reservoirs.

Note 20: "On tubes without hydrogen reservoirs this test shall be performed at Ef=6.30Vac; and on tubes with hydrogen reservoirs at Ef=5.80Vac or 6.30Vac."

Note 21: Anode Delay Time (tad) = a time interval between the point on the rising portion of the grid pulse which is 26% of the maximum unloaded pulse amplitude and the point where anode conduction takes place.

Note 22: During the interval between 2 minutes and 7 minutes of the Anode Delay Time test, the change in anode delay time (Δtad) relative to the tad value observed on the Anode Delay Time test shall not exceed the specified value.

Note 23: The variation in firing time (tj) shall be measured at 50% of pulse amplitude and shall not be greater than the amount specified.

Note 24: Destructive Test.

Tubes subjected to the folllowing destructive test are not to be accepted under this specification:

4.9.20.5 Shock

Note 25: Life test shall be run with the tube in a horizontal position and shall be shut down every ninety-six (96) hours for a sixty (60) minute interval.

Note 26: For tubes WITH hydrogen reservoirs, anode heating shall NOT be cause for rejection on Operation (1) and Operation (1A) performed during periodic life test end point tests.

Note 27: Reference specification shall be of the issue in effect on the date of invitation for bids.

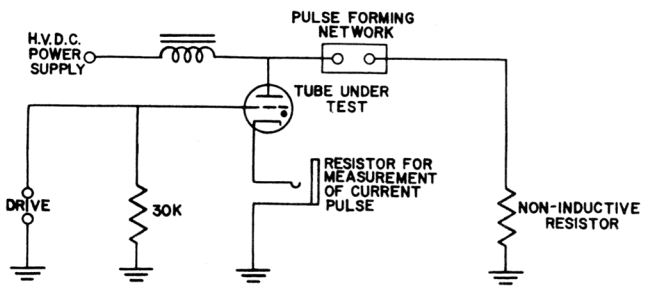

Figure 1

NOTE

Specification CV.6022 Issue 1. Reprint B consists of Sheets A, B, C and D enclosed herewith together with Pages 1, 2 and 3 of Reprint A which must be retained.

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