Specification MOA/CV6051 Issue 1, dated 1-7-60 To be read in conjunction with K1006 and the relevent sections of K1001, K1005, where specifically indicated. See note A.	**Security** **Specification**: UNCLASSIFIED **Valve**: UNCLASSIFIED

TYPE OF VALVE Pulse Thyratron, Low Jitter, short recovery time, tetrode, ~~with or~~ with~~out~~ replenisher. (Amdt 1, Amdt 4)

CATHODE Coated Unipotential.

ENVELOPE Glass.

PROTOTYPE VX2511, CX1120.

MARKING

K1001/4

BASE

~~K1001 B4M~~
~~(Super Jumbo)~~
K1006 A4-18 (Amdt 2)

RATINGS (NOTE B)

Not to be used for Inspection purposes

	Symbol	Units	Min	Max	Notes
Heater Voltage	Ef	Vac	5.85	6.75	
Heater Current at EF=6.3 Voc	If	Aac	9.6	11.6	
Cathode warm up time	tk	sec	120		D
Ambient Temperature	TA	°C	-55	90	E
Altitude		ft		10,000	
Grid 1, Peak Forward Voltage	egy1	Volts	300	750	F
Grid 2, Peak Forward Voltage	egy2	Volts	200	750	G
d egy1/dt		v/mus	1		H
d egy2/dt		v/mus	1		H
Grid 1, Peak Inverse Voltage	egx1	V		200	
Grid 2, Peak Inverse Voltage	egx2	V		200	
Grid 1, ~~DC~~ Potential	eg1	V	-10	+5	J
Grid 2, ~~DC~~ Potential	eg2	V	-120	-50	J,K
Grid 1, Drive current	igy1	A	~~0.3~~ 0.1	~~1.0~~ 0.5	
tgd		µs	0.5	3	L
DC anode supply voltage	Ebb	kVdc	2		
Anode Peak Forward Voltage	epy	kv		16	M
Anode Peak Inverse Voltage	epx	kv		5	N
Mean Anode current	Ib	Adc		0.2	P
Peak Anode Current	~~Ib~~ ib	A		325	
dib/dt		A/µs		2,500	Q
Product epy(v)xprr x ib(A)				3.2×10^9	
Recovery Time	tR	µs			C

CONNECTIONS

Pin	Electrode
1	Grid 1
2	Cathode Heater
3	Heater
4	Grid 2
TC	Anode

DIMENSIONS (INCHES)

Dimensions	Min	Max
Length (Overall)	7¾	8¼
Diameter	2	2.9/16

MOUNTING POSITION

Any (Note R)

JOINT SERVICE CATALOGUE NO:

5960 - 99 - 037 - 2231

RATING NOTES

A. Copies of "Inspection Instructions for Electron Tubes", I.I.E.T., referred to in K1006 and in this specification, may be obtained from:-

The Secretary, T.L.5(b),
Ministry of Aviation, Castlewood House, 77/91, New Oxford Street, London.W.C.1.

B. Paragraphs 3.2 and ~~6.5~~ of K1006 ~~apply~~ applies. All limiting ratings are absolute and non simultaneous.

C. See figure 3, and section 1 of the Data Sheet.

D. For instantaneous starting applications where the anode voltage exceeds 12.0 kV, a pre-heating time of 5 minutes must be allowed.

E. TA shall be measured at a point three inches from the tube in the plane through the top of the base cap. If the tube is inclined to the vertical, TA shall be measured at the lowest point consistent with the above. The surroundings of the tube must be such as to permit free convection of air over the bulb. Cooling of the anode lead is permissible, but there shall be no direct air blast on the bulb.

F. The pulse length shall be 1 usec (minimum) at the 300 volt level and shall overlap by 0.25 usec minimum the 200 volt level of the g2 pulse. The impedance of the trigger circuit shall be in the range 300 - 1000 ohms for the duration of the pulse. The D.C. resistance measured between grid and cathode, with no voltage applied, shall not exceed 2 kilohms.

G. The pulse length shall be 0.5 usec (minimum) at the 200 volt level. The impedance of the trigger circuit measured in accordance with note C. shall be within the range 100 - 1000 ohms. The DC resistance calculated from the reduction in the DC voltage, from the bias supply to the grid, measured at the grid, with the valve removed, when a direct current of 5 mA is being drawn, shall not exceed 2 kilohms.

See the Data Section for short recovery and high p.r.f. operation.

H. The instantaneous rates of rise of voltage should not be less than the given values, between the 50V and 300V levels (g1) and between 0 and 200 volts (g2) relative to the cathode. For values less than those specified the performance in respect of tj and Δtad may deteriorate.

J. The limits apply to the potential of the grid during the period between the completion of recovery and the commencement of the succeeding grid pulse.

K. Recovery time will be increased for bias voltages which are more positive.

L. tgd is defined as the time delay of the g2 pulse after the g1 pulse, measured at the 300 and 200 volt levels of the leading edges of the g1 and g2 pulses respectively. The measurement shall be made with respect to cathode at the tube socket with the thyratron removed.

M. To obtain Δtad less than 50 musec, and tad less than 0.25 usec, and tj less than 5 musec, epy should be greater than 6 kV. The maximum permissible epy for instantaneous starting is 13.5 kV and shall not be attained in less than 40 msec.

N. The peak inverse voltage, exclusive of a spike of 1 usec maximum duration and of 16 kV maximum amplitude, shall not exceed 10 kV for the first 5 usec after the anode pulse, and shall not exceed 5 kV thereafter.

P. ib is measured in the anode lead of the thyratron.

Q. dib/dt is defined as the maximum instantaneous value of the rate of rise of ib. The circuit must be such that no tube can have an instantaneous rate of rise exceeding the limit given. The measurement shall be made in the anode lead of the thyratron.

R. The valve should be mounted by the base only. Any cooling of the bulb due to a clamp may have a deleterious effect on operation, due to consequent absorption of hydrogen.

DATA SECTION

The object of this data section is to present additional information to assist the equipmént designer in obtaining the best performance from the valve.

1. RECOVERY

1.1 After a thyratron has passed a pulse of current, a certain time must elapse before the valve will again withstand positive anode voltage. This time, which is a function of the grid bias, grid impedance and peak anode current is known as the recovery time. Thus the time allowed for recovery, in which the anode must be negative, must be greater than the recovery time of the valve. The former is governed largely by the degree of mismatch, charging circuit and the inverse diode system, but other factors such as the magnetising current of the pulse transformer will effect it.

1.2 For a full description of the process of recovery see Refs. 1, 2. Briefly, for the grid to regain control it must reach some critical negative potential (which is a function of time) in the face of an exponentially decaying positive ion current. Thus the bias source must be capable of supplying relatively high peak currents, although as this is in bursts, a large reservoir capacitor will generally provide a low source impedance. To assist circuit design the variation of recovery time with grid resistance is plotted, with grid bias as a parameter. These curves are for a reapplied anode voltage of 1kv, since it has been found that the recovery time for full applied voltage does not differ by more than one or two micro-seconds from that at 100v.

1.3 In general the impedance between the bias supply and the valve grid (known as the recovery impedance) will not be purely resistive and may contain stored energy from the grid pulse. The result of this will be to assist the recovery, but the exact effect would have to be evaluated for each particular case. In many cases trouble may be avoided by taking the recovery resistance as the total resistance between grid and bias source ignoring the effect of shunt inductance and using the recovery time corresponding to this from the graph. This will give a conservative result.

1.4 The formula $ZRg2 = \frac{eg2 - Ecc}{ig2}$ for the recovery impedance at any time expresses the above relationship, where

eg2 is the instantaneous grid 2 potential
ig2 is the instantaneous grid 2 current
Ecc is the on load bias voltage.

In general ZRg2 will not be a constant but the recovery time corresponding to a given resistance will be obtained if ZRg2 is less than or equal to the given Rg2 throughout the period from the end of the grid potential plateau (Ref.2) until the grid reaches its final potential.

The above equation assumes that some point exists which remains at a constant potential of Ecc to provide a measuring point. In a case when this is not so, e.g. when bias is provided by a potential divider from some larger negative rail and the tapping point is not by-passed by a sufficiently large capacity, Ecc is the initial potential of the tapping point and Zg is composed of the grid circuit impedances, plus the effective source resistance of the potential divider. Obviously this is not an economical method quite apart from the effect of feeding back pulses into the negative rail, and it is strongly recommended that a large capacitor such that:-

$$C \cdot ZRg2 \gg tR \times 100$$

be used to stabilise the bias throughout the recovery time. Clearly this may not be fully re-charged before it is next discharged thus Ecc will not be equal to the open circuit source voltage. The necessary source voltage Es may be calculated as follows:-

Mean current drain (if C large)

$$\approx \frac{Ecc}{2Rg2} \cdot tR \times prr$$

$$\text{thus } Es \doteqdot Ecc \left(1 + \frac{Rs}{2Rg2} \cdot tR \times prr \right)$$

where Rs is the source resistance. This slightly over-estimates the correction by assuming that the grid cathode is a short circuit for the duration of the recovery time. In many cases the correction will be small.

1.5 For economy in bias power, the system has been used of applying between 10 and 20v bias to the thyratron grid via an inductance of a few milli-henries. This is in parallel with the grid trigger, and thus the time constant must be large enough not to seriously differentiate the grid pulse. During the main current pulse the thyratron grid is held at a positive potential, and thus the current in the inductance rises. At the end of the conduction period the grid rests at about cathode potential and the current continues to rise until it is limited by the available positive ion current. Then the voltage across the inductor falls rapidly driving the thyratron grid to about -100v, after which it slowly rises to the applied bias voltage. However, although the circuit may seem attractive, care is needed in design. The locus of grid potential may not cross the locus of the critical grid bias, but move parallel to it, or even worse, cross and re-cross it so that the valve recovers and then relapses. This condition may result in non-repeating charging cycles and consequently (although of use in difficult cases), this system depending as it does on un-controlled valve parameters, is not recommended for general use.

1.6 Attention should be directed to the effect of the charging circuit on recovery. With linear charging reactors the time available for recovery will be a maximum when the inductance is such as to give exactly resonant charging, with any particular value of inverse voltage. Thus for general use resonant charging is preferred. However, if a lower value of inductance is used, with no charging diode, the anode voltage will go increasingly negative for a time before starting to rise positive thereby increasing the time available for recovery without needing a large degree of mismatch. Further if the increases in choke volt-amps and the finite rate of change of pulse forming network voltage at the time of discharge are permissable this system is convenient and simple. (In practice with an inverse diode the negative excursion would tend to be clamped to earth, but the effect is similar).

Recent work done by R.R.E. shows that there are advantages to be gained from the use of non-linear charging reactors, which initially have a very high inductance, then saturate half way through the charging cycle and finally desaturate again to give an almost rectangular rise of P.F.N. voltage. This seems a convenient system for high pulse repetition rates provided that the grid circuit impedance is not so high that the rapid rise of anode voltage triggers the thyratron grid capacitively.

1.7 It has been found that g1 plays little part in recovery, provided the g1 pulse is not excessively long so as to retard recovery and has a reasonably low impedance to cathode to avoid capacitance triggering.

2. TRIGGERING

2.1 The trigger circuit must provide a voltage pulse of sufficient amplitude to create rapid ionisation in the grid cathode region and have sufficient current capacity to maintain this ionisation at an adequate level to give rapid breakdown between the anode and cathode. The rate of rise of voltage should be as high as possible and series inductance should be minimised to prevent limiting the rate of rise of grid current. By these means precise and rapid triggering will be obtained, minimising jitter and drift of anode breakdown time.

2.2 In order to check the capabilities of a grid trigger generator, the amplitude, width, and rise-time are checked at the grid terminals with the valve removed, the limits and points of measurement for width and rate of rise of voltage being as specified in the valve ratings.

In order to assess the ability of the trigger generator to supply peak current it is assumed that the thyratron behaves as an ideal diode between grid and cathode. For measurement purposes a silicon diode type RS27A (CV7024) is used to short circuit the grid and cathode terminal with the valve removed and the resulting current measured. It will be clear that when bias is used the current will be that produced by the portion of the pulse above cathode potential only.

2.3 At the instant of anode breakdown a large positive spike of some thousands of volts and of the order of 10 milli-microseconds wide is fed back from the thyratron into the trigger circuit. This is partly due to the rise of current in the cathode lead inductance and can be reduced by earthing the trigger return directly at the thyratron cathode. The remaining spike is often suppressed by passage through a short length of coaxial cable and integration by stray capacities and series resistance. In cases, however, where damage may result from the voltage spike a silicon carbide non-linear resistor may be connected between cathode and the trigger unit end of the grid resistor. The spike is then substantially removed.

Time jitter is mainly due to the magnetic field of the heater, other than that due to jitter on the trigger pulse or bias supplies. It can be reduced to negligible proportions by attention to triggering, but further improvements will be made by using D.C. for the heater supply.

Drift is a consequence of the warming up of the thyratron. It may be minimised by an adequate cathode warm up time before HT is applied and by an adequate trigger pulse, which will increase the precision of firing and, by reducing anode dissipation, reduce the tendancy to drift. A low D.C. resistance of the bias supply will also help in minimising drift.

2.4 The full advantage of tetrode characteristics will not be obtained unless a suitable priming plasma has been created by the g1 drive pulse prior to the application of the g2 pulse. Therefore, the ratings on g1 drive current and tgd (the time interval between the leading edge of the g1 pulse and the leading edge of the g2 pulse) should be strictly observed.

When particularly precise triggering is necessary and anode delay time is important, variation of g1 current (ig 1) due to amplitude jitter of the drive pulse must be minimised. The values of dtad/digl given in the table below may be used to calculate the expected delay but it should be realised that the value specified is measured with grid pulse of the lowest amplitude and rate of rise permitted by the ratings. Better triggering, in accordance with paragraph 2 will reduce the figure. Similar considerations apply to HT ripple and the value of dtad/depy. The table also gives the maximum change in anode delay time with changes of heater voltage or ambient temperature:

Test	Test Conditions	Limits	Units
tad (Ef)	Ef range 5.8 - 6.8 Vac	30	mus
dtad/digl	ig range 0.3 - 1.0 A	100	mus/A
dtad/depy	epy range 5Kv - 16Kv	5	mus/Kv
tad(TA)	TA range $-55^{o}C$ to $+ 90^{o}C$	30	mus

Parallel operation of tetrode thyratrons is relatively easy due to their precise triggering properties. The preferred method is to use a common g1 pulse fed to each valve via a suitable resistor to prevent interaction and a separate g2 pulse to each valve, slightly variable in time so that all valves may be made to fire simultaneously. Various automatic devices have been used to ensure this, but provided the delay circuits are stable good results can be obtained by manual control.

3. ANODE CIRCUIT

3.1 In order to prevent excessive anode dissipation and consequent rapid clean up of gas, limits are placed on the peak and mean rates of rise of anode current. It is normal practice to include an inductor at the anode to limit the rate of rise. However, although this does prevent the rapid discharge of stray capacities through the valve the current due to these strays will still produce a reaction on the load current due to the anode inductor being common to both circuits. It is desirable additionally to connect all sources of stray capacity, charging circuit, inverse circuit etc., to one end of the PFN coil and to connect the thyratron anode to the other. This has the effect of delaying the discharge of stray capacities until the middle of the pulse, so preserving a good pulse rise at the load. This also improves the efficiency of the overswing circuit Ref.(3).

4. LIFE

4.1 The best life will be obtained if the valve is operated well within its ratings particularly with respect to rate of rise of anode current and grid pulse voltage.

References

1. Malter & Johnson — R.C.A.Review June 1950

2. Armstrong — R.R.E. Technical Memo 604

3. Watrous & McArtney — Fifth Symposium on Hydrogen Thyratrons and Modulators. 1958.

<u>TESTS</u> Notes 12.32

To be carried out in addition to those applicable in K1006. All limits are absolute.

<u>Conditions for operating tests</u> (except where otherwise stated for individual tests).

(Note 1). The test conditions shall be at the discretion of the manufacturer provided they satisfy the limit below.

FEATURE	Symbol	Op1 Limits Min	Op1 Limits Max	Op2 Limits Min	Op2 Limits Max	Op3 Limits Min	Op3 Limits Max	Units	Notes
<u>Heater Supply</u>	Ef	-	-	-	-	-	-	Vac	2
	tk	-	180	-	120	-	180	Sec	-
<u>Grid 1 Circuit</u>	egy1	-	300		300	-	-	V	3
	degy1/dt	-	1.0	-	1.0	-	1.0	kV/us	4
	Zg1	1.0	-	1.0	-	1.0	-	kohms	5.3
	tp	-	1.5	-	1.5	-	-	us	6
Amdt 1 Ecc1	Eg1	-5	0	-5	0	-5	0	V	7
<u>Grid 2 Circuit</u>	egy2	-	200	-	200	-	-	V	3
	degy2/dt	-	1.0	-	1.0	-	-	kv/us	4
	Zg2	1.0	-	1.0	-	1.0	-	kohms	5.3
	tp	-	1.0	-	1.0	-	-	us	8
Amdt 1 Ecc2	Eg2	-110	-90	-110	-90	-	-	V	7
	tgd	0.5	0.9	0.5	0.9	-	-	us	9
<u>Anode Circuit</u>	epy	16	-	5	6	5	-	kv	
	ib	170	-	100	-	170	200	A	
	dib/dt	2500	-	2500	-	-	2500	Aus	10
	tp	0.9	1.1	0.27	0.33	0.25	2.5	us	
	Prr	1000	-	6400	-	-	100	pps	
<u>Mounting Position</u>		Any		Any		Any			
<u>Ambient Temp</u>	Ta	10	40	10	40	10	40	°C	17

K1006	TEST	TEST CONDITIONS	SYMBOL	LIMITS Min.	LIMITS Max.	UNITS	NOTES
	GROUP A	100% Inspection					
	a. Instantaneous Start (1)	Vh = 5.85V Op1, epy = 13.5 kv tk = 300 secs, max					18 13
	b. Operation (1)	Op1 for 10 minutes					14
	c. Anode Delay Time (1)	Op1 Vh = 6.75V	tad	-0.1	~~0.2~~ 0.3	us	19, 20, 33, 34
	d. Anode Delay Time Drift	Op1 Vh = 6.75V	Δtad		50	mus	21
	e. Jitter	Op1 Vh = 6.3V	tj		5	mus	24
	f. Short Circuit	Op1 Vh = 6.3V					22
	g. Grid 2 Current	Op1 Vh = 6.3V	Ic2		3	mA	15
	h. Grid 2 Hold Off	Op1 Vh = 6.3V					16
4.10.17.2	j. DC Anode Voltage	Op1 Vh = 6.3V	Ebb		1.0	kv	11
4.10.8	k. Heater Current	Ef = 6.3 Vac tk = 300 secs (min)	If	9.6	11.6	Aac	
	GROUP B	NO TESTS					
	GROUP C						12
	l. Recovery (1)	Op3, Ecc2 = -100V	tR		23	us	25
	GROUP D						12
	m. Recovery (2)	Op3					26
	n. Operation (2)	Op2 for 10 minutes					14
	p. Anode Delay Time (2)	Op2	tad	-0.1	~~0.2~~ 0.3	us	19, 20, 33, 34
	q. Anode Delay Time Drift (2)	Op2	Δtad		50	mus	21
	r. Jitter (2)	Op2	tj		5	mus	24
4.10.17.2	s. DC Anode Voltage	Op2	Ebb		2.0	kv	11
	t. Instantaneous Start (2)	Op1, epy = 12 kv tk = 120 secs					13, 18

Amdt 4

Amdt 4

K1006	TEST	TEST CONDITIONS	SYMBOL	LIMITS Min.	LIMITS Max.	UNITS	NOTES
	<u>GROUP E</u>						12
	u. Resonance Search	Op2 50-200 cps at 2g 200-500 cps at 0.5g					28
	v. Microphony	Op2, 50-200 cps at 2g 200-500 cps at 0.5g	tj		1	mus	28
	w. Fatique	Ef = 6.3 Vac, No other voltages					29
4.9.19.3	x. Bump	Angle 20°					
4.9.20.5	y. Shock	Angle 13°					
K.1005	z. Container Drop	Valve to have holding period of 24 HRs min after drop and before electrical test end point tests.					
	aa. Test End Points for tests:- w.x.y.z.	Repeat tests a,b,e,h, same limits.					
Amdt 4		Repeat tests c,d,g, with limits as under:-					
		c	tad	-0.1	~~0.25~~ 0.35	us	
		d	Δtad		75	mus	
		g			5	mA	
		Combined AQL = 6.5% for the repeated tests, separately applicable to each test,w,x,y,z.					

Ref.	TEST	TEST CONDITIONS	Insp. Level	LIMITS		UNITS	NOTES
				Min.	Max.		
	GROUP F						12
4.11.5	bb. Life	Op1 Intermittant tk = 300 secs max.	Group D	500		hrs	30.23
	cc. Life Information	As for test bb.		1000		hrs	23.30
	dd. Stand by Life	Ef = 6.3 Vac. No other voltages	Group D	500		hrs	23.31
	ee. Stand by Life Information(1)	As for test dd		1000		hrs	23.31
	ff. Standby Life Information(2)	As for test dd		2000		hrs	23.31
	gg. Shelf Life	No voltages	Group D	2000		hrs	
4.11.4	hh. Test end Points for Tests bb,cc,dd,ee,ff, gg.	As for test aa					
	GROUP G						
	jj. Electrical Re-test after 28 days holding period.	Repeat tests a,b, c,d, same limits.					12

NOTES

1. These operating conditions define the test circuits which have the general form as in fig (1). Where one of these operation conditions is specified with one or more of the parameters changed, the limits applying to all independent parameters shall be unchanged, but proportional changes shall be made to the limits applying to those parameters subject to consequential variation. Measurement of all grid parameters shall be made at the socket with the valve removed.

2. The heater voltage shall be 6.3 volts ~~for all tests~~. unless otherwise specified

3. Measured in accordance with paragraph 5.13.2 of I.I.E.T. appended to K1006.
The voltages are measured with respect to cathode potential.

Amdt. 1

4. The instantaneous value of the rate of rise of voltage shall not exceed the value stated.

5. The D.C. resistance shall not be less than 2 kohms. The impedance during the post pulse period defined as $\frac{eg - Ecc}{ig}$ shall not be less than the value given for Zg, where eg and ig are the values of grid voltage and current at any instant, and Ecc is the value of the bias supply voltage.

6. Measured at the 150 volt level.

7. The limits apply to the potential of the grid during the period between completion of recovery and commencement of the succeeding grid pulse.

Amdt 1 8. ~~Measured at the 50 volt level.~~ To be measured at the 70.7% level

9. tgd is defined as the time delay of the g2 pulse after the g1 pulse measured at the 150 and 50 volt levels of the leading edges of the g1 and g2 pulses respectively.

10. dib/dt is defined as the maximum instantaneous value of the rate of rise of ib.

11. This test is to be carried out within 60 seconds after the relevent operation test.

12. The sampling inspection shall be carried out as follows:-

<u>Group C</u>	2% of the production shall be inspected. If any failures a further 2% shall be inspected, and if any further failures, shipment shall cease pending negotiations with the Approving Authority.
<u>Group D</u>	2 valves per every 1000 of the production or every six months, which ever is the greater rate, shall be tested. If any failures, shipment shall cease and the Approving Authority shall be notified.
<u>Group E</u>	tests u,v,w, as Group D, remainder of tests, each at inspection level L6. AQL 6.5% Amdt 1
<u>Group F</u>	As specified.
<u>Group G</u>	100% testing required. Rejects shall not be shipped.

The following tests are destructive:- Fatigue(W), Shock(Y), All life(bb - gg inclusive) and valves subjected to them shall not be delivered.

13. Grid-cathode breakdown must occur within the period before the application of Anode voltage. The valve shall operate satisfactorily on push-button starting when the anode voltage is applied to the valve, under test in such a manner as to rise from 0 to 13.5 kV within 0.03 seconds. The filter in the rectifier shall be designed so that the anode voltage reached 7 kV (min) within 0.015 seconds. The intervals between successive attempts to instantaneously start the valve shall not be less than 10 seconds, nor greater than 30 seconds. Any valve failing to start within three attempts will be considered a failure.

14. There shall be no evidence of arc back or anode heating.

15. At the end of operation 1 test, the total g2 current shall not exceed the value specified.

16. At the end of the operation 1 test, the bias on grid 2, ~~Eg2~~ Ecc2, shall be reduced to -50V, and the valve shall continue to operate, controlled and triggered by the grid 2 pulse. Amdt 1

17. TA shall be measured at a point three inches from the tube in the plane through the top of the base cap. If the tube is inclined to the vertical, TA shall be measured at the lowest point consistent with the above. The surroundings of the tube must be such as to permit free convection of air over the bulb. Cooling of the anode lead is permissible, but there shall be no direct air blast on the bulb.

18. This test shall be carried out immediately after a 24 hour holding period.

19. Measured in accordance with paragraph 5.13.4.1 of I.I.E.T. appended to K1001.

20. tad is measured 10 seconds (maximum), after the application of the epy required by the test.

21. 590 seconds after the first tad readings, a second tad reading shall be taken. The difference between these readings (Δtad) is the anode delay time drift.

22. During the operation 1 test, the dummy load shall be short circuited for three periods of 1 second each (min), 2 seconds (max), separated by at least 10 seconds. The charging circuit shall be such that epy, with the load short circuited, is not less than the value specified for normal operation. The modulator shall not trip out more than once.

23. One valve in every four shall be run to 1000 hours. In addition, for standby life, one valve in every eight shall be run to 2000 hours.

24. Measured at the end of the operation 1 or 2 test as appropriate, by observing the waveshape of one of the following:-

(1) Current pulse, (2) Rate of fall of anode voltage, (3) dib/dt,

(4) Grid voltage.

25. For the test the circuit shall be as described in note 27. The recovery impedance shall be between 900 - 1100 ohms, and the bias, measured across the decoupling condenser with the valve running, shall be 100 volts.

26. For this test, the circuit shall as described in note 27. The recovery time shall be measured for the discrete bias levels and recovery impedances indicated below. The bias shall be applied to grid 2 and shall be measured across the grid circuit decoupling capacitor, with the valve running and shall have the values:- -0, -12.5, -25, -50, -100 volts. The recovery impedance shall have ten values over the range 100-30,000 ohms for each bias, adjacent values of resistance having ratios between the limits 1/1.5, 1/1.2. The recovery characteristics so obtained shall not be inferior to those shown in figure 3.

Amdt 1

27. The circuit for recovery time testing is shown in Fig.2.

A 1kv (min.) probe pulse of rise time 3 - 4 μ sec. is applied after a suitable delay via D_3 to the anode of the valve under test. The recovery time is the interval between the instant when the cathode current falls to zero, and the point where the valve just re-strikes.

The isolating circuit allows the re-charging of the P.F.N. without application of voltage to the anode of the valve for the duration of the recovery period.

D_2 serves to remove any inverse voltage from the anode of the valve under test.

The grid 2 circuit ensures that R_2 is not shunted by the driver circuit in the recovery period, thus the recovery impedance is exactly fixed by $R_1 + R_2$.

28. The vibration shall be applied successively in three mutually perpendicular directions one of which shall be the axis of the anode lead. The valve shall be mounted either with the axis of anode lead vertical in a suitable valve holder clamped to a rigid plate, or with the axis of the anode lead horizontal, and the valve screwed to a rigid plate by means of a clamp around the bulb. The frequency shall be swept at a rate not exceeding one octave per minute up to 200 cps and at a rate not exceeding 100 cps per minute above this. All resonances detectable visually or electrically shall be noted, for information only, and for use in the fatigue test below. The additional jitter, tj, due to vibration, shall not exceed the limit stated. The valve shall continue to function whilst undergoing the tests.

29. (a) Each valve shall be subjected to vibration for two periods of ten hours. In one period the direction shall be parallel to the anode lead, and in the other the direction shall be perpendicular to this. The valve shall be mounted as for the resonance search test. The frequency shall be that of the strongest test resonance detected during the resonant search, and of acceleration 2g if within the range 50-200 cps, and 0.5g if in the range 200-500 cps. If no resonances have been detected then the frequency of vibration for this test shall be 150 cps at 2g acceleration.

(b) At the discretion of the manufacturer a swept fatigue test may be used instead of the test in (a) above. In this case the resonance search, but not the microphony test shall be waived. The valve shall be maintained as for the resonance search test and swept frequencies shall be applied for 150 hours each, in the direction of the anode lead, and along one direction perpendicular to the anode lead. The rate of sweep shall not exceed one octave per minute up to 200 cps, and 100 cps per minute above this. The transition from 2g to 0.5g may, at the discretion of the manufacturer, occupy the frequency range 190-210 cps for this swept fatigue test only. Again, at the discretion of the manufacturer the 150 hours may be split into a period of 60 hours with swept frequencies between 50-200 cps at 2g applied at a rate not exceeding one octave per minute, and a period of 90 hours with swept frequencies between 200-500 cps at 0.5g applied at a rate not exceeding 100 cps per minute.

30. The valve shall be subjected to the following cycle, circuit conditions being as for operation 1 :-

(a) 5 minutes heaters and grid drive only.
(b) 20 minutes operation at, epy = 16 kv, prf = 1000 pps.
(c) 5 minutes, no voltages.

The duration of the test shall be the total time, i.e. 2/3 of this time will be with HT ON.

31. The valve shall be operated with Ef = 6.3 volts and with no other voltages. The valve may be operated for a maximum of five minutes each day under Op1 or Op2 conditions at the discretion of the manufacturer. For operation the valve may be transferred from a preheater unit, to a modulator provided not more than 60 seconds elapse.

32. For Type Approval the requirements of K1001/15 apply, ignoring para.15.2.

Amdt 4 33. Definition of 'tad'
The time interval between the instant when the open circuit g2 voltage passes cathode potential and the instant when anode conduction takes place.

Amdt 4 34. Where in MIL test methods the pulse measuring points are specified as '26%' and '70.7%' practical values of '25%' and '75%' may be substituted.

CV6051

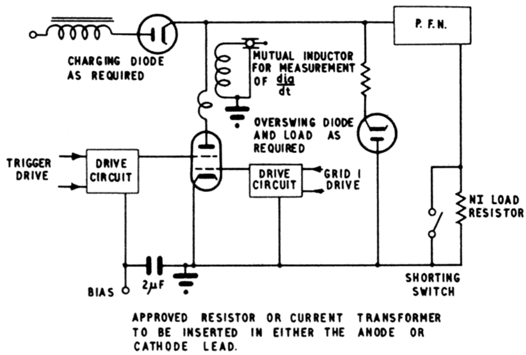

FIG. I. GENERAL OPERATION TEST CIRCUIT.

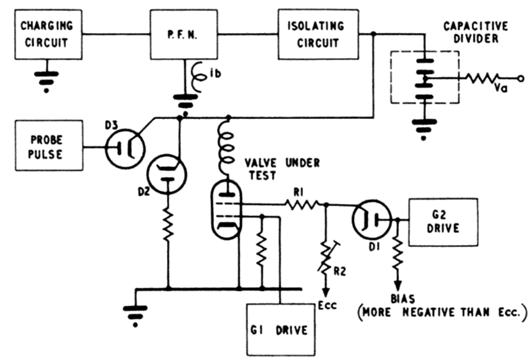

FIG. 2. CIRCUIT FOR RECOVERY TIME TEST

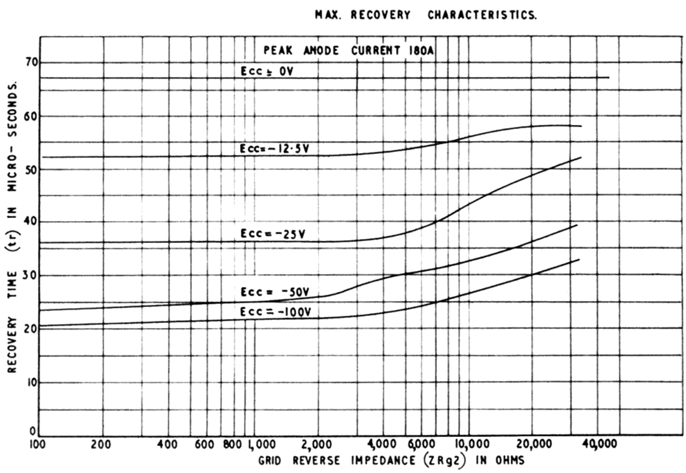

FIG. 3. MAXIMUM RECOVERY CHARACTERISTICS AT 180 AMPS. FOR 1KV PROBE PULSE.

ELECTRONIC VALVE SPECIFICATIONS

SPECIFICATION MOA/CV6051

ISSUE 1, DATED 1.7.60

AMENDMENT No. 1

Page 1 TYPE OF VALVE Delete the whole sentence and replace with:- "Pulse Thyratron, Low Jitter, short recovery time, tetrode, without replenisher".

RATINGS Grid 1, DC Potential. Delete "DC"
Grid 2, DC Potential. Delete "DC"
Peak Anode Current Delete "Ib", replace with "ib".

Note B. Delete the whole sentence and replace with:- "Paragraph 3.2 of K1006 applies. All limiting ratings are absolute and non-simultaneous".

Page 2 Note P. Delete "ib", replace with "Ib".

Page 4 the second equation. Rewrite as:-

$$Es \doteq Ecc \left(1 + \frac{Rs}{ZRg2} \cdot tr \times prr\right)$$

/Page 7

Page 7 Symbols column: Delete "Eg1", replace with "Ecc1",
Delete "Eg2", replace with "Ecc2".

Page 11 Note 3. Add "The voltages are measured with respect to cathode potential.

Note 8. Delete the whole of the sentence, and replace with:- "To be measured at the 70.7% level".

Note 12. Group E. Add "AQL 6.5%".

Page 12 Note 16. Delete "Eg2", replace with "Ecc2".

Note 26. 7th line. Delete 1;1.5, 1;2, and replace with 1/1.5, 1/1.2.

December, 1960 R.R.E.

N. 46655/D

✓AAS 9/3/61

ELECTRONIC VALVE SPECIFICATIONS

SPECIFICATION MOA/CV 6051 ISSUE 1 DATED 1.7.60

AMENDMENT No.2.

Page 1. Box headed "Base"

Delete K1001. B4M (Super Jumbo) and substitute K1006. A4-18.

T.V.C. for
R.R.E.

September, 1962.

(40841)

JAM

ELECTRONIC VALVE SPECIFICATIONS

SPECIFICATION MOA/CV6051, ISSUE 1, DATED 1. 7. 60

AMENDMENT NO. 3.

Page 1 RATINGS

Against "Grid 1 Drive current" Delete in the 'Min' column "0.3" and 'Max' column "1.0" and Substitute "0.1" and "0.5" respectively.

T.V.C. for R.R.E.

August, 1964.

VAAB 30/10/64

ELECTRONIC VALVE SPECIFICATION

SPECIFICATION MOA/CV6051, ISSUE 1, DATED 1.7.60

AMENDMENT NO 4

Insert the following changes:-

i PAGE 1 TYPE OF VALVE

Amend to read: Pulse thyratron, low jitter, short recovery time, tetrode with replenisher. (Amendment No 1 first item to be deleted as this states 'without replenisher').

ii PAGE 8 GROUP A TESTS

The tests shall be conducted with the following heater voltages applied:-

a	Instantaneous Start 1	Vh = 5.85 V
b	Operation 1	
c	Anode Delay Time 1	Vh = 6.75
d	Anode Delay Time Drift	
e	Jitter	Vh = 6.3 V
f	Short Circuit	
g	Grid 2 Current	
h	Grid 2 Hold Off	
j	DC Anode Voltage	

iii PAGE 8 ANODE DELAY TIME 1 (GROUP A) ANODE DELAY TIME 2 (GROUP B)

In column headed "Limits Max" Delete "0.2" and Insert "0.3" and in 'Notes' column Add "33, 34".

iv PAGE 9 TEST aa

In column headed "Limits Max" Delete "0.25" and Insert "0.35".

v PAGE 11 NOTE 2

Amend to read "The heater voltage shall be 6.3 V, unless otherwise specified".

vi PAGE 13 INSERT NEW NOTE 33 AND 34

33 DEFINITION OF 'tad'

The time interval between the instant when the open circuit g2 voltage passes cathode potential and the instant when anode conduction takes place.

34 Where in MIL test methods the pulse measuring points are specified as "26%" and "70.7%" practical values of "25%" and "75%" may be substituted.

JAB
29/4/72

PROCUREMENT EXECUTIVE, MINISTRY OF DEFENCE
ROOM 678
ST GILES COURT
1-13 ST GILES HIGH STREET
LONDON, WC2H 8LD

CHANGE SHEET

FOR HOLDERS OF THE PREFERRED VALVE SPECIFICATION BOOK(S) (PS OF EVS)

It should be noted that Amendment No 4 to MOA/CV 6051 dated January 1972 for inclusion in the Preferred Book held by you which was previously cancelled should now be reinstated.

Please amend your numerical list accordingly.

March 1972

Enquiries relating to this amendment should be referred to:-

Procurement Executive, Ministry of Defence, LT/P23d
Attention of Mr A J Hawtin, Ext 1546/1457

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