Mullard Valves

for

industry and communications

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for Transmitting & Industrial Dept.

MULLARD ELECTRONIC PRODUCTS LIMITED

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foreword

This publication, which is Part I of a series, lists only those Mullard Valves in current production which can be supplied for incorporation in new industrial electronic and tele-communication equipment. Certain types listed herein are in limited production only, and are therefore not recommended for use in domestic receivers or television sets. A separate series of publications—the "Century Series"—lists valves available for these purposes.

Part 2 of "Mullard Valves for Industry and Communications", deals with Power Valves for Industrial and Transmitting Equipment. New editions of each volume will be issued from time to time to include data on new types or revised data on existing valves.

A complete loose leaf manual of data sheets covering all Mullard current and obsolescent valves in three volumes is available on a subscription basis. Details of this service can be obtained on application to Technical Publications Department, Century House.

index to valve types

classified index

Classification	Battery Operated 1.4V Filament		A.C. Mains Operated 6.3V Heater		
	Octal Base — Section	Miniature — Section	Octal Base — Section	All-Glass B.7G Base — Section	Miniature — Section
Single diodes ...					EA50 4
Double diodes ...			EB34 4		EB91 4
Diode triodes ...	DAC 32 2				EAC91 2
Double diode triodes			EBC33 2		
Diode H.F. pentodes		DAF91 1			
Double diode output pentodes			EBL31 5		
Triodes			EBC33 2	EC52 2 EC53 2	EC91 2
Double triodes ...			ECC32 2 ECC35 2		ECC91 2
H.F. pentodes ...		DAF91 1	EF36 1 EF37 1	EF50 1 EF54 1 EF55 1	EF91 1
Variable-mu H.F. pentodes	DF33 1	DF91 1	EF39 1		EF92 1
Output pentodes ...	DL33 5 DL35 5	DL92 5	EL32 5 EL33 5 EL37 5 EBL31 5		EL91 5
Triode hexodes ...			ECH35 3		
Heptodes	DK32 3	DK91 3			
Half-wave rectifiers				EY51 6	EY91 6
Full-wave rectifiers			EZ35 6		
Cathode ray tubes ...					
Electron beam indicators			EM34 8		
Gas-filled triodes ...			EN31 8		
Stabilising tubes ...					
Flash tubes					
Accelerometer double diodes					

classified index

D.C./A.C. Mains Operated. 0.2A Heater Octal Base	Section	Rectifiers. Cathode R.M. Tubes and Miscellaneous	Section	Remarks	Classification
					Single diodes.
					Double diodes.
					Diode triodes.
EBC33	2				Double Diode Triodes
					Diode H.F. pentodes.
CBL31	5				Double diode output pentodes.
EBC33	2				Triodes.
					Double triodes.
EF37	1				H.F. pentodes.
EF39	1				Variable-mu H.F. pentodes.
CL33 EL32 CBL31	5 5 5				Output pentodes.
CCH35	3				Triode hexodes.
					Heptodes.
CY31	6	HVR 2	6	High voltage. Indirectly heated. 4V heater.	Half-wave rectifiers.
		AZ 31 FW 4-500 FW 4-800 IW 4-500	6 6 6 6	Directly heated. 4V. filament. Directly heated. 4V. filament. Directly heated. 4V. filament. Indirectly heated. 4V. heater.	Full-wave rectifiers.
		ECR 30 ECR 35 ECR 35P ECR 60	7 7 7 7		Cathode ray tubes.
					Electron beam indicators.
					Gas-filled triodes.
		4687 7475 13201A	8 8 8		Stabilising tubes.
		LSD 2	8		Flash tubes.
		DDR 100	8		Accelerometer double diodes.

list of symbols

1. SYMBOLS FOR ELECTRODES.

Anode	a	Fluorescent Screen or Target	t
Cathode	k	External Metallisation ...	M
Grid	g	Internal Metallisation ...	m
Heater	h	Deflector Electrodes ...	x or y
Filament	f	Internal Shield	s
Beam Plates	bp		

NOTE 1. In valves having more than one grid, the grids are distinguished by numbers—g1, g2, etc., g1 being the grid nearest the cathode.

NOTE 2. In multiple valves, electrodes of the different sections may be distinguished by adding one of the following letters :

Diode	d	Hexode	h
Triode	t	Heptode ...	h
Tetrode	q	Octode	h
Pentode	p	Rectifier	r

Thus, the grid of the triode section of a triode-hexode is denoted by gt.

NOTE 3. Two or more similar electrodes which cannot be distinguished by any of the above means may be denoted by adding one or more apostrophes to indicate to which electrode system the electrode forms a part.
Thus, the anode of the first diode in a double diode valve is denoted a'.

2. SYMBOLS FOR ELECTRIC MAGNITUDES.

Voltages		Current	
Direct Voltage	V	Direct Current	I
Alternating Voltage (rms)	V_{rms}	Alternating Current (rms)	I_{rms}
Alternating Voltage (mean)	V_{av}	Alternating Current (mean)	I_{av}
Alternating Voltage (peak)	V_{pk}	Alternating Current (peak)	I_{pk}
Peak Inverse Voltage	P.I.V.		

list of symbols

Frequency	f
Amplification Factor	μ
Mutual Conductance	g_m
Conversion Conductance	g_c
Distortion	D
Anode efficiency	η

	Inside Valve.	Outside Valve.
Resistance	r	R
Reactance	x	X
Impedance	z	Z
Admittance	y	Y
Mutual Inductance	m	M
Capacitance	c	C
Capacitance at Working Temperature	cw	
Power	p	P

3. AUXILIARY SYMBOLS.

Battery or other source of supply	b
Inverse (Voltage or Current)	inv
Ignition (Voltage)	ign
Extinction (Voltage)	ext
No signal	o
Input	in
Output	out
Total	tot
Centre Tap	ct

4. COMPLEX SYMBOLS.

Symbols in Section 1 and 3 above may be used as subscripts to symbols in Section 2, to denote such magnitudes as Anode Current, Grid Volts, etc., e.g. :—

Anode Voltage	V_a	Anode Current (D.C.)	I_a
Control Grid Voltage	V_{g1}	Anode Current (A.C. rms)	$I_{a(rms)}$
Anode Supply Voltage	$V_{a(b)}$	No signal Anode Current	$I_{a(o)}$

list of symbols

Filament Voltage ...	V_f	Control Grid Current ...	I_{g1}
Heater Voltage ...	V_h	Total Distortion ...	D_{tot}
Anode Dissipation ...	p_a	3rd Harmonic Distortion	D_3
Output Power ...	P out		
Drive Power ...	P drive		

	Internal.	External.
Anode Resistance	r_a	R_a
Insulation Resistance (heater to cathode) ...	r_{h-k}	
Resistance between Control Grid and Cathode	r_{g1-k}	R_{g1-k}
Capacitance (cold)—		
Anode to all other electrodes	c_{a-all}	
Anode to control grid	c_{a-g1}	
Control grid to cathode at working temperature	$c_{g1-k(w)}$	
Control grid to all other electrodes except anode (Input Capacitance)	c_{in}	
Anode to all other electrodes except control grid (Output Capacitance)	c_{out}	

INTERPRETATION OF DATA

The principal characteristics quoted for each valve in this Handbook are normally those corresponding to a value of anode current representing typical operating conditions. The control grid voltage given for this anode current is approximate only, the anode current being taken as the standard.

The values given are the mean values of measurements made on a large number of valves.

Where the "equivalent noise resistance" is quoted, this is the value of a resistance which, if introduced into the grid circuit of a perfectly noiseless valve, would produce noise of the same level as that of the shot and partition noise occurring in the actual valve. Curves showing the equivalent noise resistance plotted against mutual conductance or anode current are provided for certain types.

The values of input damping resistance represent the extent to which a parallel tuned circuit would be damped by the valve at the stated frequency.

The data presented graphically is that most generally required for equipment design calculations.

Curves showing cross-modulation and modulation plotted on a logarithmic scale against anode current and mutual conductance are provided for those R.F. amplifiers and frequency changers which are designed for automatic volume control.

The cross-modulation curves show the amplitude of an unwanted signal, modulated to a depth of 30% at 400 c.p.s., which will result in a cross-modulation factor of 1%. The cross-modulation factor (k) is the ratio, expressed as a percentage, of the modulation depth caused by a modulated interfering carrier to the modulation depth of the wanted signal appearing on the wanted carrier frequency at the output of the valve, assuming that both carriers are modulated to the same depth. The cross-

INTERPRETATION OF DATA

modulation factor may be considered to be independent of the amplitude of the wanted signal where this amplitude is small. The measurements plotted correspond to a wanted signal amplitude of 100mV

The modulation curve shows the unwanted input voltage at 400 c.p.s. which will produce 1% modulation (mb = 1) of the wanted carrier at the output of the valve.

For frequency changers, these values are plotted against conversion conductance instead of against mutual conductance.

Curves showing anode impedance, conversion conductance and oscillator volts plotted against oscillator grid current are also given for frequency changers.

For diode detectors, curves showing audio frequency output voltage plotted against a 30% modulated R.F. input, and D.C. output voltage against R.F. input are normally provided.

For output valves, in addition to the normal static characteristics, curves showing drive voltage, distortion, and electrode currents as functions of the output power are provided. For output pentodes these parameters are also plotted against line voltage over a limited range.

Curves other than those already referred to are given for certain valve types where the additional information is necessary for design purposes for special applications.

valve type nomenclature

The type nomenclature for Mullard Receiving Valves generally consists of two or three letters followed by two figures. These symbols provide information concerning the principal uses of the valves, the heater or filament rating, and the type of base, according to the following code:—

The first letter indicates the filament or heater voltage or current:

A—4.0 V. filament
C—200 mA. heater
D—1.4 V. to 1.5 V. filament
E—6.3 V. heater
G—5.0 V. filament
K—2.0 V. filament
P—300 mA. heater
U—100 mA. heater

The second and subsequent letters indicate the general class of valve :

A—single diode
B—double diode
C—triode
D—output triode
E—tetrode
F—Voltage amplifying pentode
H—Hexode
K—Heptode or octode
L—output pentode
M—electron beam indicator
N—gas triode
*P—secondary emission valve
W—half-wave gas-filled rectifier
X—full-wave gas-filled rectifier
Y—half-wave rectifier
Z—full-wave rectifier

*Used as a third letter only.

Note: Two of the above letters may be combined, e.g., BC—double diode triode.

The first figure indicates the type of base :

2 — B8G (Loctal) base
3 — Octal base
4 — B8A base
5 — B9G and other special bases
7—Sub-miniature construction
9 — B7G base

The second figure indicates the order of development, and serves to distinguish between two or more valves of the same type but of different performance ratings.

Example: ECH 35

E	C	H	3	5
6.3 V. heater	triode	hexode	octal base	fifth development

Mullard

GENERAL OPERATIONAL RECOMMENDATIONS

LIMITING VALUES

The operating maxima quoted on individual data sheets should on no account be exceeded. The following general limitations should also be observed, and should be interpreted in conjunction with British Standard Specification No.1106, "Code of Practice on the Use of Radio Valves in Equipment", upon which these notes have, in part, been based.

Where reference is made to a particular electrode, it should also be considered as referring to an electrode performing a similar function in a more complex valve.

FILAMENT

(a) Valves with 2-volt Filaments

The filament voltage should be maintained between ± 7% of the rated value. If, however, some variation of the valve characteristics is acceptable, the filament voltage limits may be extended to ± 10%.

(b) Valves with 1.4 volt Filaments

(i) Dry-battery Operation. Valves with 1.4 volt filaments are designed to be operated from a dry-cell battery with a rated terminal voltage of 1.5V. In no circumstances should the voltage across any 1.4-volt section of filament exceed 1.6V. If these valves are operated with their filaments in series from dry batteries with a higher terminal voltage, shunting resistors may be required to ensure the correct voltage across individual 1.4-volt filaments.

(ii) Accumulator or Mains Operation. When valves with 1.4-volt filaments are operated from an accumulator or from a mains supply unit, the voltage drop across each 1.4-volt section of filament of valves with rated filament current should have a nominal valve of 1.3V and should be maintained between 1.25V and 1.4V at normal line voltage, that is to say at voltages equivalent to 2 volts per cell for accumulators or to nominal line voltage for supply mains. If the filaments are operated in series, shunting resistors may be required to ensure the correct voltage across individual 1.4-volt filaments.

HEATER (INDIRECTLY-HEATED VALVES)

Heater voltages should be maintained within ± 7% of the rated values. Under-running the heater may cause as much damage to a valve as over-running. Where it is permissible to operate heaters in series, this is clearly stated on the data sheets. When heaters are so operated the heater current should be maintained within ± 5% of the rated value.

CATHODE

Cathode voltages, with respect to earth, should be kept as low as possible. Maximum values for specific valves are indicated on the data sheets.

In order to avoid hum and instability, the heater-cathode path should not be included either in the A.F. or the R.F. circuit. This precaution is particularly important where the signal level is low.

Disintegration of the cathode coating may occur in both indirectly-heated and directly-heated rectifiers if the total resistance in series with the anode is less than that specified on the data sheet for the particular valve. The value of the resistance depends upon the effective resistance, R_t, due to the transformer.

$$R_t = R_s + n^2 R_p$$

where:

R_s = Resistance of the transformer secondary in anode circuit.

R_p = Resistance of the transformer primary

n = Primary to secondary ratio in half-wave circuits or primary to half secondary ratio in full-wave circuits.

If the resistance R_t is less than the minimum specified value for the series resistance, an additional series resistance must be included.

The maximum cathode-to-heater voltage specified for a particular valve is intended to be the D.C. value or the peak A.C. value. This point should receive particular attention in inverse feed-back circuits in which the cathode bias resistor is not decoupled.

CONTROL GRID

The resistance in series with the control grid must be kept as low as possible, and should in no circumstances exceed the maximum value quoted on the data sheet.

Care should be taken when selecting valves for use as oscillators or for other circuit conditions where appreciable grid current is drawn, to ensure that the maximum grid ratings are not exceeded.

If grid bias is provided by grid rectification, precautions should be taken to ensure that the valve ratings will not be exceeded in the event of loss of drive. Normally this risk is avoided by providing a certain amount of cathode bias.

GENERAL OPERATIONAL RECOMMENDATIONS

SCREEN GRID

In circuits where large anode voltage swing occurs care should be taken that the maximum screen-grid dissipation is not exceeded.
The method of feeding the screen grid will have a considerable effect on the cross-modulation characteristics of valves designed for operation over a large A.V.C. range. Recommendations in this connection are given on individual data sheets.

SUPPRESSOR GRID

Suppressor grids should be maintained at cathode potential except in applications for which conditions involving the application of voltage to the suppressor grid are quoted on data sheets.

For applications where it is desired to employ the secondary emission characteristic of a valve, it should be noted that this characteristic may vary considerably as between valve and valve, and the circuit design should not be critical in this respect. On account of this variability, the use of this characteristic is in general not recommended.

MOUNTING

Care should be taken when mounting indirectly-heated valves having high mutual conductance and directly-heated valves having long filaments in a horizontal position that the major axis of the first grid or the plane of the filament is vertical. The direction of this plane is indicated on the data sheets of all valves to which this recommendation applies.

Valves not falling within this category may be mounted in any position.

GENERAL OPERATIONAL RECOMMENDATIONS

VENTILATION

Adequate ventilation for the dissipation of heat must be provided, particularly for power valves and rectifiers.

GENERAL

Valves should not be operated without a D.C. connection between each electrode and the cathode. Any apparent advantage to be gained by so doing may be neutralised by secondary emission from the electrode concerned.