TELEVIS
PICTURE

MW36-24

RAGI
ANDLE WI
CARE

Mullard

Maintenance Manual

TELEVIS
PICTURE

MW36-24

RAGI
ANDLE WI
CARE

Price 10/6

Mullard

Maintenance Manual

Mullard
MAINTENANCE MANUAL

PREPARED BY
TECHNICAL SERVICE DEPARTMENT
MULLARD LIMITED
CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

TP270

PREFACE

In the past the service engineer has been rather overlooked when valve and tube data have been published. Either he has had to be content with very brief tables of 'characteristics' which often bear no relation to practical conditions of operation, or he has been overwhelmed with complex information originally aimed at the equipment designer and which appears to surround each type with a considerable number of mysterious and seemingly unnecessary limitations. The 'Mullard Maintenance Manual', having been prepared with the aim of providing the service engineer with the information most useful to him in repairing and maintaining radio and television receivers and amplifying equipment, is intended to supplement the 'first-aid' information given in the Mullard Wall Chart (1954/5 edition). Whilst *designers* will undoubtedly find this manual of assistance for general reference purposes they are recommended to use the Mullard Technical Handbook, available on a subscription basis, when designing their equipment. Details of the handbook service are available upon request.

The manual is divided into two main sections – receiving valves and television tubes. Each section commences with a comprehensive index listing both Mullard and other manufacturers' types. This index gives the recommended Mullard replacement where one is available and indicates the page numbers in the data section of the Mullard types and information on replacements. In addition to that on current types, information on obsolete Mullard valves and tubes likely to be encountered when servicing older receivers, is included in the data section.

In presenting the data, the conventional letter symbols have been used in order to save space. These symbols are listed on a linen fold-out at the back of the manual.

Whilst every care has been taken in the compilation of the information contained in this manual, particularly in the selection of suitable replacements for other manufacturers' types, Mullard Ltd. cannot accept responsibility for the accuracy thereof. It should be noted particularly that the fact that a Mullard direct replacement is given for another manufacturer's type does not imply that the reverse process will operate satisfactorily in all cases. In preparing the list of 'Other Equivalents' in the comprehensive index, only types listed by other manufacturers as equivalents and indicated by them as available have been included. It is important that wherever possible, when dealing with another manufacturer's types, the manufacturer's catalogue should be referred to for operational details or special limitations.

The information contained in this book is under constant review, particularly from the viewpoint of new and obsolete types. Further information on Mullard valves and tubes can be obtained from the Technical Service Department.

CONTENTS

REFERENCES AND NOTES

* Valves having a different heater current, and therefore not direct replacements in a.c./d.c. receivers.

Where necessary, the name of the manufacturer is indicated in bracketed italics immediately following the valve type number. Examples: AC/DD (*EM*), DD6 (*C*), PT4 (*F*).

C	Cossor
EK	Ekco
EM	Ediswan Mazda
F	Ferranti
H	Hivac
M	Mullard
MO	Marconi Osram
T	Tungsram.

The basing diagrams given in the data sections are viewed from the underside of the base.

VALVE EQUIVALENT LIST

Valve Type	Mullard Direct Equivalent	Other Equivalents
A11B	IW4–350	R2, R42, 1867
A11C	IW4–500	MU14, R3, UU5, 43IU
A11D	IW4–350	R2, R42, 1867
A20B	2D4A	DDL4, V914
A23A	TDD4	AC/HL/DD, DDT
A27D	PEN4DD	—
A30D	354V	AC/HL, 41MHL
A36A	See Page 212	41STH
A36B	TH4B	41STH
A36C	TH4B	AC/TH1, 4THA
A40M	—	AC/SG/VM
A50A	SP4	MS/PEN, SPT4A
A50B	SP4B	MS/PENB
A50M	—	AC/VP1, MVS/PEN, VPT4
A50N	—	MVS/PEN
A50P	VP4B	AC/VP2, MVS/PENB
A70B	PEN4VA	AC/PEN, MP/PEN, 7A2
A70C	PENA4	PT4 (*F*), 7A3, 42MP/PEN
A70D	PENA4	AC2PEN, PT4 (*F*), 42MP/PEN
A70E	PENB4	AC4PEN
A80A	FC4	VHT4, 15A2, 41MPG
A430N	354V	—
AB1	See Page 243	—
AB2	See Page 243	—
ABC1	See Page 208	—
ABL1	See Page 174	—
AC/DD (*EM*)	See Page 243	—
AC/DD (*H*)	2D4A	DDL4, D41
AC/DDT	TDD4	MHD4
AC/HL	354V	MH4, 41MHL
AC/HL/DD	TDD4	DDT, MHD4
AC/HP	SP4	MS/PEN, SPT4A
AC/P	See Page 92	L4, 41MP
AC/PEN	PEN4VA	MKT4, MP/PEN, 7A2
AC/Q	See Page 186	—
AC/Qa	See Page 138	—
AC/SG	See Page 204	—
AC/SGVM	—	—
AC/SH	See Page 204	MS4B
AC/SL	SP4	MS/PEN, SPT4A
AC/S1VM	—	VPT4

Valve Type	Mullard Direct Equivalent	Other Equivalents
AC/S2	SP4	MS4B, MS/PEN, SPT4A
AC/S2PEN	See Page 204	MS/PEN
AC/TH1	TH4B	X41
AC/TH1A	See Page 212	TH41
AC/TP	—	—
AC/VH	—	—
AC/VP	—	MVS/PEN
AC/VPB	VP4B	—
AC/VP1	See Page 238	MVS/PEN
AC/VP2	VP4B	MVS/PENB
AC/VS	—	—
AC/Y	See Page 175	—
AC/Z	PENA4	PT4 (*F*), 42MP/PEN
AC/ZDD	See Page 174	PT4D, 42OT/DD
AC2HL	—	—
AC2PEN	PENA4	KT41, PT4 (*F*), 7A3, 42MP/PEN
AC2PENDD	See Page 174	PT4D, 42OT/DD
AC4PEN	PENB4	—
AC5PEN	—	PT10
AC5PENDD	—	—
ACO42	See Page 43	2P, PA20
ACO44	ACO44	LP4, PP3/250, PX4, 4XP
ACO54	See Page 44	—
ACO64	See Page 45	—
ACO84	See Page 45	—
ACO84N	See Page 45	—
AC104	See Page 46	—
AF2	—	—
AF7	See Page 204	—
AK2	See Page 156	—
AL4	See Page 179	—
AL5	See Page 180	—
AL60	See Page 47	—
APP4A	PEN4VA	AC/PEN, MKT4
APP4As	See Page 175	—
APP4B	PENA4	AC2PEN, KT41, PT4 (*F*)
APP4Bs	See Page 179	—
APP4E	PENB4	—
APV4	IW4–350	MU14, R42, 1867
AS4120	SP4	AC/SG, MS/PEN, MS4B, SPT4A
AS4125	—	AC/SG/VM
AX50	See Page 47	—
AZ1	AZ1	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
AZ2	See Page 48	—
AZ3	See Page 48	—
AZ31	AZ31	U143
AZ32	See Page 49	—
AZ50	See Page 49	—
B36	12SN7GT	—
B65	6SN7GT	—
B152	ECC81	B309, 12AT7
B228	PM2HL	—
B309	ECC81	B152, 12AT7
B319	PCC84	7AN7, 30L1
B329	ECC82	12AU7
B339	ECC83	12AX7
B719/ECC85	ECC85	6AQ8
BVA211, BVA214, BVA215, BVA216	DW4–350 or IW4–350	R4 —
BVA243, BVA246, BVA247	EF39	—
BVA264, BVA265, BVA266, BVA267	EL33	—
BVA274, BVA275, BVA276	ECH35	—
C10B	UR1C	CY1C
C20C	See Page 83	—
C23B	See Page 85	202DDT
C27D	See Page 50	—
C30B	HL13C	4D1
C36A	TH21C	TH2321, 202STH
C36C	—	TH2321, 302THA
C50B	SP13C	8D2
C50N	See Page 116	VP1322, 9D2, 13VPA
C70D	See Page 52	7D6
C80B	FC13C	15D1
CB1	See Page 83	—
CB2	See Page 83	—
CBC1	See Page 85	—
CBL1	CBL1	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
CBL31	CBL31	—
CC2	HL13	—
CCH35	CCH35	—
CF1	SP13	—
CF2	VP13A	—
CF7	SP13	—
CK1	FC13	—
CL4	CL4	—
CL6	See Page 51	—
CL33	CL33	322PEN
CY1	CY1	—
CY1C	UR1C	—
CY2	See Page 53	—
CY31	CY31	—
CY32	See Page 54	—
D1	See Page 79	—
D4	354V	AC/HL, MH4, 41MHL
D41	2D4A	DDL4, V914
D42	—	—
D43	—	—
D63	EB34*	6H6G/GT
D77	EB91	DD6 (*C* or *F*), D152, 6AL5, 6D2
D152	EB91	DD6 (*C* or *F*), D77, 6AL5, 6D2
D400	2D4A	DDL4, D41
D1300	See Page 83	—
DA	See Page 162	4D1
DA30	—	—
DA40	—	—
DA41	—	—
DA90	DA90	1A3, 1D13
DAC1	See Page 55	—
DAC32 (Cl)	1H5G / DAC32 (Cl)	HD14
DAC32 (Met)	DAC32 (Met)	1H5GT
DAF91	DAF91	ZD17, 1FD9, 1FD9/1S5, 1S5
DAF96	DAF96	1AH5, 1FD1
DCC90	DCC90	3A5
DD4	2D4A	DDL4, D41, V914
DD4s	See Page 243	—
DD6 (*C* or *F*)	EB91	D77, D152, 6AL5, 6D2
DD6 / DD6ds	See Page 83	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
DD13 / DD13s	See Page 83	
DD41	—	—
DD465	See Page 243	—
DD620	See Page 83	—
DDA1	2D4A	DDL4
DDL4	2D4A	D41, V914
DDPP4B	See Page 174	AC2PENDD, DN41, PT4D, 42OT/DD
DDPP4Bs	See Page 174	—
DDPP4M	PEN4DD	—
DDPP6B	See Page 91	—
DDPP6Bs	EBL1	—
DDPP39	See Page 50	—
DDPP39M	See Page 50	—
DDPP39s	CBL1	—
DDT	See Page 208	AC/HL/DD, MHD4, H4D
DDT2	TDD2A	H2D, 210DDT
DDT4	TDD4	AC/HL/DD, MHD4
DDT4s	See Page 208	—
DDT6s	See Page 85	—
DDT13	See Page 85	202DDT
DDT13s	See Page 85	—
DDT215	See Page 207	—
DDT220	TDD2A	H2D, 210DDT
DF1	See Page 59	—
DF33	DF33	1N5GT
DF64	DF64	—
DF66	DF66	—
DF70	DF70	—
DF91	DF91	W17, 1F3/1T4, 1F3, 1T4
DF92	DF92	1F2, 1F2/1L4, 1L4
DF96	DF96	1AJ4, 1F1
DH42	TDD4	AC/HL/DD
DH63	6Q7G	—
DH63 (Met)	6Q7GT	—
DH76	—	—
DH77 / DH77/6AT6	EBC90	6AT6
DH81	See Page 87	7B6
DH101	See Page 221	—
DH107	See Page 221	—
DH142	UBC41	10LD3, 141DDT
DH147	EBC33	OM4

Valve Type	Mullard Direct Equivalent	Other Equivalents
DH149	See Page 254	7C6
DH150	EBC41	6LD3, 62DDT
DH719/EABC80	EABC80	6AK8, 6T8
DK1	See Page 63	—
DK32	DK32	1A7GT
DK91	DK91	X17, 1C1, 1C1/1R5, 1R5
DK92	DK92	X18, 1AC6, 1C2
DK96	DK96	1AB6, 1C3
DL2	See Page 67	—
DL33	DL33 / 3Q5GT	N16
DL35	DL35 / 1C5G	N14
DL63	EBC33*	DH147*, OM4*, 6R7G
DL64	DL64	—
DL66	DL66	—
DL68	DL68	—
DL71	DL71	—
DL72	See Page 71	—
DL74M	—	—
DL82	—	—
DL91	See Page 71	1S4
DL92	DL92	N17, 1P10, 1P10/3S4, 3S4
DL93	DL93	3A4
DL94	DL94	N19, 1P11, 1P11/3V4, 3V4
DL96	DL96	1P1, 3C4
DL145	—	10LD11
DM70	DM70	1M1, 1M3
DN41	See Page 174	AC2PENDD, PT4D, 42OT/DD
DN143	EBL21	—
DO24	See Page 76	PP5/400, PX25
DO26	See Page 76	—
DO30	See Page 76	DA30
DO42	PEN4DD	—
DP61	EF95	6AK5
DP495	PEN4DD	—
DP4480	See Page 50	—
DT3 / DT30	See Page 79	—
DT41	TDD4	—
DT436	TDD4	AC/HL/DD
DT1336	See Page 85	202DDT
DTU1	See Page 85	202DDT

Valve Type	Mullard Direct Equivalent	Other Equivalents
DW2	DW2	506BU, 1821
DW3	DW4–350	R2, R4
DW4	DW4–500	R3, U14, 1561
DW4–350	DW4–350	R4
DW4–500	DW4–500	U14, 1561
E235	PM202	—
E446	SP4	—
E447	—	—
EA50	EA50	SD61, 6D1 (*EM*)
EAB1	See Page 80	—
EABC80	EABC80	DH719/EABC80, 6AK8, 6T8
EAC91	EAC91	—
EAF41	See Page 81	—
EAF42	EAF42	WD150
EB4	See Page 82	—
EB34	EB34	D63*, 6H6G/GT*
EB41	EB41	—
EB91	EB91	DD6 (*C* or *F*), D77, D152, 6AL5, 6D2
EBC3	See Page 84	—
EBC33	EBC33	DH63*, DH147, OM4
EBC41	EBC41	DH150, 6LD3, 62DDT
EBC90	EBC90	DH77, DH77/6AT6, 6AT6
EBF2	See Page 87	—
EBF32	See Page 88	—
EBF80	EBF80	ZD152, 6N8
EBL1	EBL1	—
EBL21	EBL21	DN143
EBL31	EBL31	—
EC31	EC31	—
EC50	See Page 92	—
EC52	EC52	—
EC53	EC53	—
EC54	EC54	—
EC90	EC90	L77, 6C4
EC91	EC91	6AQ4, 6L34
ECC31	See Page 95	—
ECC32	ECC32	—
ECC33	ECC33	—
ECC34	ECC34	—
ECC35	ECC35	6SL7GT
ECC40	ECC40	—
ECC81	ECC81	B152, B309, 12AT7
ECC82	ECC82	B329/12AU7, 12AU7

Valve Type	Mullard Direct Equivalent	Other Equivalents
ECC83	ECC83	B339, 12AX7
ECC85	ECC85	B719/ECC85, 6AQ8
ECC91	ECC91	6J6
ECH2	See Page 102	—
ECH3	ECH3	—
ECH4	See Page 104	—
ECH21	ECH21	X143
ECH33	CCH35 (a.c./d.c.) ECH35 (a.c.)	—
ECH35	ECH35	OM10*, X61M, X147
ECH41	See Page 106	—
ECH42	ECH42	X150, 6C10, 62TH
ECH81	ECH81	X719, 6AJ8
ECL80	ECL80	LN152, 6AB8
EE50	See Page 110	—
EF2	See Page 111	—
EF5	EF9	—
EF6	See Page 112	—
EF8	EF9	—
EF9	EF9	—
EF22	EF22	W143
EF36	EF36	—
EF37	EF37A	—
EF37A	EF37A	OM5B
EF38	EF39	W147
EF39	EF39	OM6, W147
EF40	EF40	—
EF41	EF41	W150, 62VP
EF42	EF42	Z150
EF50	EF50	63SPT
EF54	EF54	—
EF55	EF55	—
EF80	EF80	Z152, Z719, 6BX6
EF85	EF85	W719, 6BY7
EF86	EF86	Z729, 6267
EF91	EF91	SP6, Z77, 6AM6, 6AM6/8D3, 6F12
EF92	EF92	VP6, W77, 6CQ6, 9D6
EF93	EF93	W727/6BA6, 6BA6
EF95	EF95	6AK5
EFM1	See Page 126	—
EH2	See Page 127	—
EK2	EK2	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
EK3	See Page 128	—
EK32	EK32	—
EK90	EK90	X727/6BE6, 6BE6
EL2	EL2	—
EL3	See Page 130	—
EL3N	See Page 134	—
EL5 EL6	See Page 131	—
EL31	EL31	—
EL32	EL32	—
EL33	EL33	N147, 6AG6G
EL35	See Page 135	—
EL36	See Page 136	
EL37	EL37	KT66
EL38	EL38	6CN6
EL38M	EL38	6CN6
EL41	EL41	N150, 67PT
EL42	EL42	N151
EL50	See Page 142	—
EL81	EL81	6CJ6
EL84	EL84	N709, 6BQ5
EL90	EL90	N727/6AQ5, 6AQ5
EL91	EL91	N77, N144, 6AM5, 7D9
EL820	EL820	—
EM1	See Page 147	—
EM3	See Page 147	—
EM4	EM4	—
EM34	EM34	6CD7, 64ME
EN31	EN31	—
EY51	EY51	R12, SU61, U43, U151, 6X2
EY86	EY86	—
EY91	EY91	—
EZ1	See Page 151	—
EZ2	See Page 151	—
EZ3	See Page 151	—
EZ35	EZ35 6X5GT	U147
EZ40	EZ40	U150, 66KU
EZ41	EZ41	—
EZ80	EZ80	6V4
EZ90	EZ90	U78/6X4, 6X4
FC2	FC2	X22, 210PG
FC2A	FC2A	VHT2A

Valve Type	Mullard Direct Equivalent	Other Equivalents
FC4	FC4	MX40, VHT4, 15A2, 41MPG
FC13	FC13	—
FC13C	FC13C	15D1
FC141	See Page 64	—
FW4–500	FW4–500	U18/20, 45IU
FW4–800	FW4–800	U18/20
FY	PM24M	PT41
G431	DW2	1821
G470	DW2	1821
G2080 (P base)	CY1	—
G2080 (5-pin)	UR1C	CY1C
G4120	DW4–500	1561
G4120N	IW4–500	UU5, 43IU, 1861
GDT4B	—	—
GDT4C	—	—
GN24	DW2	506BU, 1821
GU50	RG1–240A	—
GZ30	GZ30 / 5Z4GT	R52, 5Z4GT
GZ32	GZ32	54KU
H2	PM2HL	210HF
H2D	TDD2A	210DDT
H4D	See Page 208	AC/HL/DD, DDT
H63	—	6F5G
H141D	See Page 55	—
H210	PM2HL	—
HAD	See Page 85	11D3
HBC90	HBC90	12AT6
HBC91	HBC91	12AV6
HD14	1H5G / DAC32 (Cl)	—
HD22	TDD2A	H2D
HD23	TDD2A	H2D
HD24	TDD2A	H2D, 210DDT
HF93	HF93	12BA6
HK90	HK90	12BE6
HL2	PM2HL	210HF
HL2K	PM2HL	—
HL4+	354V	AC/HL
HL4g	See Page 265	MH4
HL4gs	See Page 265	—
HL13 (*H*)	See Page 162	—
HL13 (*M*)	HL13	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
HL13 (*T*)	HL13C	—
HL13C	HL13C	4D1
HL13s	HL13	—
HL21DD	TDD2A	H2D, 210DDT
HL22	See Page 189	—
HL23	See Page 189	—
HL23DD	See Page 167	—
HL41	See Page 265	—
HL41DD	See Page 208	—
HL42DD	—	—
HL92	HL92	50C5
HL133	See Page 162	—
HL133DD	See Page 85	—
HL210	PM2HL	210HF
HL1320	HL13C	4D1
HL/DD1320	See Page 85	11D3
HLA2	354V	AC2HL, 41MHL
HLB1	See Page 189	210HF
HP2	See Page 171	—
HP13	See Page 239	—
HP13s	VP13A	—
HP210nc (4-pin)	See Page 203	SPT2, Z21
HP210nc (7-pin)	SP2	Z22
HP215 (*H*)	See Page 203	Z21
HP4101c	SP4	SPT4A
HP4105	—	VPT4 (5-pin)
HP4106	—	VPT4 (5-pin)
HP4106c	—	VPT4 (5-pin)
HP4115c	—	—
HR1	—	—
HR2	—	—
HR210	PM2HL	210HF
HVR1	See Page 163	—
HVR2	HVR2	—
HVR2A	See Page 164	—
HY90	HY90	35W4
IW2	See Page 165	1881
IW2A	IW4–350	—
IW3	IW4–350	R2, R42, 1867
IW4	IW4–500	MU14, R3, UU5, 43IU
IW4–350	IW4–350	R2, R42, 1867
IW4–500	IW4–500	MU14, R3, UU5, 43IU
K23A	See Page 207	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
K23B	TDD2A	H2D, 210DDT
K30A	PM2HL	210HF
K30B	See Page 189	210LF
K30C	PM2HL	210HF
K30D	PM2HL	210HF
K30G	See Page 170	L2 (*F*), 220PA
K30K	PM2HL	210HF
K33A	See Page 171	—
K40B	See Page 190	—
K40N	PM12M	VS2, 215SG
K50M	See Page 168	VP210, 210VPT
K50N	VP2B	—
K70B	PM22A	PEN220, PT2, 220OT
K70D	PM22D	—
K77B	QP22B	240QP
K80A	FC2	210PG
K80B	FC2A	VHT2A
K435–10	ACO44	LP4
KBC32	KBC32	—
KCF30	—	—
KF35	KF35	—
KK2	See Page 155	—
KK32	KK32	—
KL4	See Page 192	—
KL35	KL35	—
KLL32	KLL32	—
KT2	PM22A	PEN220, PT2, 220OT
KT24	PM22A	PT2, 220OT
KT32	25L6GT	—
KT33C	—	—
KT36	—	—
KT41	See Page 179	AC2PEN, 7A3, 42MP/PEN
KT42	PEN4VA	AC/PEN, MP/PEN, 7A2
KT44	—	—
KT45	—	—
KT61	See Page 134	6AG6G, 6P25
KT63	6F6G	6F6
KT66	EL37	6L6G
KT71	—	—
KT76	—	—
KT81	—	—
KT101	—	—
KTW61	See Page 251	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
KTW61M	See Page 251	—
KTW63	See Page 251	—
KTW74M	—	—
KTZ41	—	—
KTZ63	See Page 250	—
L2 (*EM*)	PM2HL	210LF
L2 (*F*)	See Page 170	210LF
L2/B	PM2HL	210HF
L2/DD	See Page 207	—
L4	See Page 92	AC/P, 41MP
L21	PM2HL	210LF
L21/DD	TDD2A	H2D, 210DDT
L63	6J5G	—
L77	EC90	6C4
L210	PM2HL	210LF
LD210	See Page 189	—
LL2	PM2HL	210HF
LL2s	See Page 189	—
LL4	See Page 92	L4, 41MP
LN152	ECL80	6AB8
LN309	PCL83	—
LP2 (*MO*)	See Page 170	L2 (*F*), 220PA
LP2 (*F*)	PM202	230XP
LP4	ACO44	PP3/250, PX4, 4XP
LP220	See Page 170	L2 (*F*), 220PA
LZ319	PCF80	8A8, 30C1
ME41	—	—
ME91	—	—
MH4	354V	AC/HL, 41MHL
MH41	—	AC2HL
MH4105	—	MX40
MHD4	See Page 208	AC/HL/DD, DDT, H4D
MHL4	See Page 265	AC/HL
MKT4	PEN4VA	AC/PEN, MP/PEN, 7A2
ML4	See Page 92	AC/P, L4, 41MP
MM4V	—	AC/SG/VM
MP4106C	—	MVS/PEN, VPT4
MP/PEN	PEN4VA	AC/PEN, MKT4, 7A2
MPT4	PEN4VA	AC/PEN, MP/PEN, 7A2
MS4B	SP4	AC/SG, MS/PEN, SPT4A
MS4C	SP4	MS/PEN, SPT4A
MSG/HA	SP4	AC/SG, MS4B, MS/PEN, SPT4A
MSG/LA	SP4	AC/SG, MS4B, MS/PEN, SPT4A

Valve Type	Mullard Direct Equivalent	Other Equivalents
MSP4	SP4	MS/PEN, SPT4A
MSP41	—	—
MS/PEN	SP4	SPT4A
MS/PENA	SP4	MS/PEN, SPT4A
MS/PENB	See Page 204	—
MU12	IW4–350	R2, R42, UU5, 1867
MU12/14	IW4–500	43IU
MU14	IW4–500	R3, UU5, 43IU
MV/SG	—	AC/SG/VM
MVS/PEN	—	AC/VP1
MVS/PENB	See Page 238	AC/VP2
MX40	—	15A2, 41MPG
N14	DL35 1C5G	—
N15	See Page 67	—
N16	DL33 3Q5GT	—
N17	DL92	1P10, 1P10/3S4, 3S4
N18	See Page 74	3Q4
N19	DL94	1P11, 1P11/3V4, 3V4
N30	—	—
N37	See Page 183	—
N40	See Page 175	7A2
N41	PENA4	AC2PEN, PT4 (*F*), 7A3, 42MP/PEN
N63	See Page 133	—
N66	EL37	KT66
N77	EL91	N144, 6AM5, 7D9
N78	—	—
N108	—	—
N142	UL41	451PT
N144	EL91	N77, 6AM5, 7D9
N145	—	10P13
N147	EL33	6AG6G
N148	—	—
N150	EL41	67PT
N151	EL42	—
N152	PL81	21A6, 21A6/PL81
N153	PL83	N309, 15A6
N154	PL82	N329, 16A5
N309	PL83	N153/15A6
N329	PL82	N154, 16A5
N339	—	—
N349	—	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
N709	EL84	6BQ5
N727/6AQ5	EL90	6AQ5
O202	FC2	—
O406	FC4	VHT4
O1307 (P base)	FC13	—
O1307 (7-pin)	FC13C	—
OA60	OA60	1N87
OA61	OA61	1N88
OA70	OA70	—
OM1	CY31	—
OM3	EB34	6H6G/GT*
OM4	EBC33	DH147
OM5	EF36	OM5B
OM5A	EF37A	OM5B
OM5B	EF37A	—
OM6	EF39	W147
OM7	EF39	OM6, W147
OM9	EL32	—
OM10	CCH35 (ac/dc) ECH35 (ac)	X147*
OP41	PENB4	AC4PEN
OP42	PENA4	AC2PEN, PT4 (*F*)
P2	PM202	230XP
P12–250	ACO44	LP4, PP3/250, PX4
P27–500	—	PP5/400, PX25
P41	—	—
P61	—	—
P220 (*T*)	See Page 195	—
P220 (*EM*, *H*)	See Page 170	L2 (*F*), 220PA
P220A	PM202	230XP
P225 (5-pin)	PM22A	PEN220, PT2, 220OT
P240	PM202	220PT
P435	PM24M	PT41
P440N	PEN4VA	—
P441N	PEN4VA	—
P495	PENA4	PT4 (*F*)
PA1	—	41MXP
PA20	See Page 43	2P
PB1	See Page 170	L2 (*F*), 220PA
PCC84	PCC84	B319, 7AN7, 30L1
PCF80	PCF80	LZ319, 8A8, 30C1
PCF82	—	9U8

Valve Type	Mullard Direct Equivalent	Other Equivalents
PD220	See Page 171	—
PEN4DD	PEN4DD	—
PEN4V	See Page 175	—
PEN4VA	PEN4VA	AC/PEN, MKT4, MP/PEN, 7A2
PEN4VB	PENA4	AC2PEN, KT41, PT4 (*F*), 7A3, 42MP/PEN
PEN13C	—	—
PEN24	See Page 170	—
PEN25	See Page 170	—
PEN26	See Page 177	—
PEN36C	See Page 177	7D6
PEN40DD	See Page 178	—
PEN44	See Page 180	—
PEN45	—	—
PEN45DD	—	—
PEN46	—	—
PEN220	PM22A	KT2, PT2, 220OT
PEN230	See Page 192	—
PEN231	PM22D	—
PEN383	—	—
PEN384	—	—
PEN428	PEN428	—
PEN453DD	—	—
PEN650	See Page 179	—
PEN1340	—	7D8
PEN3520	See Page 52	7D6
PENA1	PM24M	PT41
PENA4	PENA4	AC2PEN, KT41, PT4 (*F*), 7A3, 42MP/PEN
PENB1	PM22A	KT2, PEN220, PT2, 220OT
PENB4	PENB4	AC4PEN
PENDD4020	See Page 50	—
PL33	PL33	—
PL38	PL38	—
PL38M	PL38M	—
PL81	PL81	N152, 21A6, 21A6/PL81
PL82	PL82	N154, N329, 16A5
PL83	PL83	N153, N309, 15A6
PL820	PL820	—
PM1A	PM2HL	210HF
PM1HF	PM2HL	210HF
PM1HL	PM2HL	210HF
PM1LF	See Page 186	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
PM2	See Page 186	220P
PM2A	See Page 187	L2 (*F*), 220PA
PM2B	See Page 187	—
PM2BA	See Page 188	—
PM2DL	PM2HL	210HF
PM2DX	PM2HL	210LF
PM2HL	PM2HL	—
PM12, PM12A	See Page 190	Z21
PM12M	PM12M	VS2, W21, 215SG
PM22	See Page 191	220PT
PM22A	PM22A	KT2, PEN220, PT2, 220OT
PM22D	PM22D	—
PM24	See Page 193	—
PM24A	PM24A	—
PM24B, PM24C	See Page 194	—
PM24M	PM24M	PT41
PM202	PM202	230XP
PM252	See Page 196	—
PP2	PM22A	PEN220, PT2, 220OT
PP2s	See Page 192	—
PP3–250	ACO44	LP4, PX4, 4XP
PP4	PM24M	PT41
PP4s	See Page 195	—
PP5–400	—	PX25
PP6As	EL2	—
PP6BG	EL33	N147, 6AG6G
PP6Bs	See Page 134	—
PP34	See Page 52	—
PP34s	See Page 52	—
PP35	See Page 52	—
PP36	See Page 52	—
PP220	PM202	KT2
PT2	PM22A	KT2, PEN220, 220OT
PT4 (*F*)	PENA4	AC2PEN, 7A3, 42MP/PEN
PT4 (*MO*)	PM24M	PT41
PT4D	See Page 174	AC2PENDD, 42OT/DD
PT10	—	AC5PEN
PT25H	—	—
PT41	PM24M	—
PT240	See Page 192	—
PTZ	See Page 52	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
PV4	DW4–350	R4
PV29s	See Page 235	—
PV30	See Page 235	—
PV30s	See Page 235	—
PV495	DW2	506BU, 1821
PV4200	DW4–500	1561
PVB6s	See Page 152	—
PX4	ACO44	LP4, PP3/250, 4XP
PX5	—	PX25
PX25	—	PP5/400
PX41	ACO44	LP4, PX4, 4XP
PX230	PM202	P2
PY31	PY31	—
PY80	PY80	U152, 19X3
PY81	PY81	U153, 17Z3
PY82	PY82	U154, U319, 19Y3
PY83	—	—
PZ30	PZ30	R14
QP21	See Page 200	QP230, 240QP
QP22A	See Page 199	—
QP22B	QP22B	QP230, 240QP
QP25	See Page 200	—
QP230	QP22B	240QP
QP240 (*H*)	See Page 200	—
QP240 (*EM*)	See Page 200	—
QPT2	See Page 200	QP230, 240QP
QS83/3	85A2	0G3
QV05–25	QV05–25	5B/250A, 807
R1	See Page 78	U10, UU5, 506BU
R2	IW4–350	MU14, R42, UU5, 1867
R3	IW4–500	MU14, UU5, 431U
R4	DW4–350	R2
R4A	DW4–500	R3, UU5, 1561
R10	—	HR2, 2T/270K
R12	EY51	SU61, U43, U151, 6X2
R12A	EY51	SU61, U151, 6X2
R14	PZ30	—
R16	—	U37, 1T2/R16
R19	—	—
R41	DW4–500	1561
R42	IW4–350	UU5, 1867
R43	See Page 157	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
R52	GZ30 / 5Z4GT	—
RG1–240A	RG1–240A	GU50
RL7	EF54	—
RL16	EC52	—
RL18	EC53	—
RL37	EC54	—
RV120/350	DW4–350	R4, U14
RV120/350s	See Page 78	—
RV120/500	DW4–500	U14, UU5, 1561
RV120/500s	See Page 79	—
RV200/600	FW4–500 or FW4–800	U18/20
RZ	UR1C	CY1C
S4V	SP4	—
S4VA, S4VB	SP4 (5-pin)	MS4B, MS/PEN
S11A	DW2	506BU, 1821
S11D	DW4–350	R2, R4
S21, S22, S23, S24	See Page 191	—
S30C	ACO44	LP4, PP3/250, 4XP
S30D	See Page 43	PA20, 2P
S213	PM12M	VS2, W21, 215SG
S215, S215A, S215B	See Page 191	—
S215VM	PM12M	VS2, W21, 215SG
S218	SP2	Z22
S420	VP4B	—
S434N	—	VPT4 (5-pin)
S435N	SP4	MS4B, MS/PEN, SPT4A
S1324	See Page 206	8D2, 13SPA
S1328	SP13	—
SD2	PM2HL	210HF
SD4	See Page 202	—
SD6	—	—
SD61	EA50	6D1 (*EM*)
SE211C	PM12M	VS2, 215SG
SG215	PM12M	VS2, 215SG
SG215A	PM12M	VS2, 215SG

Valve Type	Mullard Direct Equivalent	Other Equivalents
SP2	SP2	SPT2, 210SPT
SP4 (*M*)	SP4	MS/PEN, SPT4A
SP4 (*T*)	See Page 204	MS/PENB
SP4B	SP4B	MS/PENB
SP4C	See Page 205	—
SP4s	See Page 204	—
SP6	EF91	Z77, 6AM6, 6AM6/8D3
SP6s	See Page 113	—
SP13 (*M*)	SP13	—
SP13 (*T*)	See Page 205	—
SP13B	SP13C	—
SP13C	SP13C	8D2, 13SPA
SP13s	SP13	—
SP22	See Page 203	—
SP41	—	—
SP42	—	—
SP61	—	—
SP181	—	—
SP210	SP2	210SPT
SP215	See Page 203	—
SP220	PM202	—
SP1320	SP13C	—
SPT2	See Page 203	210SPT
SPT4A	SP4 (7-pin)	MS/PEN
SS210	See Page 191	—
SU25	—	—
SU61	EY51	R12, U43, U151, 6X2
SU2150	—	—
SU2150A	—	—
T4D	See Page 206	D1
T6D	EA50	SD61, 6D1 (*EM*)
T41 (*EK*)	354V	—
T41 (*EM*)	—	—
TDD2	See Page 207	—
TDD2A	TDD2A	HD24, H2D, 210DDT
TDD4	TDD4	AC/HL/DD, DDT, MHD4
TDD13	See Page 208	—
TDD13C	See Page 209	202DDT
TH2	See Page 209	X24, 220TH
TH4	See Page 210	X41, 41STH
TH4A	TH4B	AC/TH1
TH4B	TH4B	AC/TH1, 4THA
TH13C	See Page 212	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
TH21C	TH21C	TH2321, 202STH
TH22C	See Page 213	TH2321
TH29	—	TH2321
TH30	—	TH2321
TH30C	—	TH2321, 302THA
TH41	See Page 212	—
TH62	CCH35 (ac/dc) ECH35 (ac)	—
TH233	See Page 50	—
TH2320	See Page 50	—
TH2321	See Page 50	202STH
TP22	—	—
TP23	—	—
TP25	—	—
TP2620	—	—
TSE4	—	—
TSP4	See Page 215	—
TT4	See Page 216	AC/P, L4, 41MP
TT4A	See Page 217	—
TV4	See Page 217	—
TV4A	See Page 218	—
TV6	See Page 218	—
TX4	See Page 212	AC/TH1, X41
TX21	TH21C	TH2321, 202STH
TX41	TH4B	—
U10	See Page 78	UU5, 506BU
U12/13	DW4–350	R4
U14	DW4–500	R3, 1561
U16	—	—
U17	—	—
U18/20	FW4–500 or FW4–800	—
U19	—	—
U24	—	—
U25	—	—
U31	See Page 260	—
U33	—	—
U35	—	—
U37	—	1T2/R16
U41	—	1B3GT
U43	EY51	R12, SU61, U151, 6X2
U50	5Y3G/GT	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
U52	5U4G	—
U54	—	53KU
U70	EZ35 / 6X5GT	U147
U74	—	—
U76	—	—
U78 / U78/6X4	EZ90	6X4
U81	—	—
U82	See Page 152	7Z4
U84	See Page 48	—
U101	See Page 233	—
U107	See Page 235	—
U142	UY41	311SU
U143	AZ31	—
U145	See Page 235	U404
U147	EZ35 / 6X5GT	— / —
U149	See Page 152	7Y4
U150	EZ40	66KU
U151	EY51	R12, U43, SU61, 6X2
U152	PY80	19X3
U153	PY81	17Z3
U154	PY82	U319, 19Y3
U201	CY31	OM1
U251	—	U329
U281	—	—
U282	—	—
U301	—	—
U309	—	—
U319	PY82	U154, 19Y3
U329	—	U251
U403	See Page 53	—
U404	See Page 235	U145
U709	—	—
U801	—	—
U4020	See Page 232	40SUA
UAF41	See Page 218	—
UAF42	UAF42	WD142
UB41	UB41	—
UBC41	UBC41	DH142, 10LD3, 141DDT
UBF80	UBF80	171DDP
UBL21	UBL21	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
UCH4	See Page 225	—
UCH21	UCH21	—
UCH41	See Page 226	—
UCH42	UCH42	X142, 141TH
UD2	PM202	—
UF41	UF41	W142, 121VP
UF42	UF42	Z142
UL41	UL41	N142, 451PT
UL44	UL44	—
UL46	UL46	—
UM34	UM34	—
UR1	CY1	—
UR1C	UR1C	CY1C
UR2	See Page 232	—
UR3	See Page 232	—
UR3C	See Page 233	—
UU2	See Page 78	—
UU3	IW4–350	MU14, R2, R42, 1867
UU4	IW4–350	MU14, R2, R42, 1867
UU5	IW4–500	MU14, R3, 43IU
UU6	See Page 166	—
UU7	—	—
UU8	See Page 159	—
UU9	EZ40	U150, 66KU
UU10	See Page 157	—
UU60–250	IW4–350	R2, R42, 1867
UU120–350	IW4–350	MU14, R2, R42, 1867
UU120–350A	IW4–350	R42, 1867
UU120–500 (*H*)	IW4–500	MU14, R3
UU120–500 (*EM*)	DW4–500	1561
UY1N	UY1N	—
UY21	See Page 234	—
UY31	See Page 234	—
UY41	UY41	U142, 311SU
V20	UR1C	CY1C
V20s	CY1	—
V30	See Page 232	—
V312	—	41MTL
V503	—	—
V914	2D4A	DDL4, D41
V1907	—	—
VHT2	FC2	X22, 210PG
VHT2A	FC2A	210PG

Valve Type	Mullard Direct Equivalent	Other Equivalents
VHT4	FC4	MX40, 15A2, 41MPG
VHTA	See Page 152	15D1
VM4V	—	—
VMP4	—	VPT4 (5-pin)
VMP4G	—	MVS/PEN (7-pin)
VMS4	—	—
VMS4B	—	AC/SG/VM
VO2	FC2A	VHT2A, X22
VO2s	See Page 155	—
VO4	FC4	MX40, VHT4, 41MPG
VO4s	See Page 156	—
VO6s	EK2	—
VO13	FC13C	—
VO13s	FC13	—
VP2	See Page 236	W21, 210VPT
VP2B	VP2B	—
VP4	—	AC/VP1, MVS/PEN, VPT4
VP4A	—	AC/VP1, MVS/PEN
VP4B	VP4B	AC/VP2, MVS/PENB
VP4C	See Page 238	—
VP6	EF92	W77, 6CQ6, 9D6
VP12D	—	—
VP13	See Page 239	—
VP13A	VP13A	—
VP13B	See Page 116	—
VP13C	See Page 239	VP1322, 9D2, 13VPA
VP22	See Page 168	—
VP23	See Page 168	—
VP41 (*EK*)	VP4B	AC/VP2
VP41 (*EM*)	See Page 238	—
VP133	See Page 116	—
VP210	See Page 168	W21, 210VPT
VP215	—	W21
VP1322	See Page 116	9D2, 13VPA
VPT2	—	VP210, 210VPT
VPT4	—	AC/VP1, MVS/PEN
VPT4B	—	AC/VP1, MVS/PEN (7-pin)
VS2	PM12M	W21, 215SG
VS24	PM12M	VS2, 215SG
VS24K	PM12M	VS2, 215SG
VS210	PM12M	VS2, W21, 215SG
VS215	PM12M	VS2, W21, 215SG
VX2	VP2B	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
VX2s	See Page 237	—
W17	DF91	1F3, 1F3/1T4, 1T4
W21	—	VP210, 210VPA
W42	—	AC/VP2, MVS/PENB
W61M	See Page 251	—
W63	See Page 251	—
W76	—	—
W77	EF92	VP6, 6CQ6, 9D6
W81	—	—
W101	See Page 228	—
W107	—	—
W142	UF41	121VP
W143	EF22	—
W145	—	10F9
W147	EF39	OM6
W148	—	7H7
W149	—	7B7
W150	EF41	62VP
W719	EF85	6BY7
W727/6BA6	EF93	6BA6
WD142	UAF42	—
WD150	EAF42	—
X14	1A7G	—
X17	DK91	1C1, 1C1/1R5, 1R5
X18	DK92	1AC6, 1C2
X21	FC2A	VHT2A
X22	FC2	210PG
X24	—	220TH
X30	—	—
X31	—	—
X41	—	AC/TH1, 41STH
X42	See Page 156	15A2, 41MPG
X61M	ECH35*	OM10*, X147*
X63	6A8G	—
X64	—	6L7G
X65	See Page 252	—
X71M	—	—
X76M	—	—
X77	EK90	X727/6BE6, 6BE6
X78	—	—
X79	—	6AE8
X81	—	7S7
X101	See Page 225	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
X109	—	—
X142	UCH42	141TH
X143	ECH21	—
X145	—	10C1
X147	ECH35	OM10*, X61M
X148	—	7S7
X150	ECH42	6C10, 62TH
X719	ECH81	6AJ8
X727/6BE6	EK90	6BE6
Y61	See Page 148	6M1, 6U5G, 63ME
Y62	See Page 148	—
Y63	See Page 148	6M1, 6U5G, 63ME
Y220	See Page 192	KT2, PT2, 220OT
Z14	1N5G	—
Z21 (4-pin)	See Page 203	SPT2
Z21 (7-pin)	See Page 203	210SPT
Z22	SP2	—
Z63	6J7G	—
Z66	—	—
Z77	EF91	SP6, 6AM6, 6AM6/8D3, 6F12
Z90	EF50	63SPT
Z142	UF42	—
Z145	See Page 229	10F1
Z150	EF42	—
Z152	EF80	Z719, 6BX6
Z309	—	—
Z359	—	—
Z719	EF80	Z152, 6BX6
Z729	EF86	6267
Z759	—	—
ZD17	DAF91	1FD9, 1FD9/1S5, 1S5
ZD152	EBF80	6N8
0G3	85A2	QS83/3
0Z4	—	0Z4
054V	See Page 240	41MXP
1A3	DA90	1D13
1A4E	See Page 168	—
1A4P	See Page 168	—
1A5GT	—	—
1A7G	1A7G	X14
1A7GT	DK32	—
1A7VG	DK32	1A7GT
1AB6	DK96	1C3

Valve Type	Mullard Direct Equivalent	Other Equivalents
1AC6	DK92	X18, 1C2
1AH5	DAF96	1FD1
1AJ4	DF96	1F1
1B3GT	—	U41
1C1 (*EM*)	DK91	X17, 1C1/1R5, 1R5
1C1/1R5	DK91	X17, 1C1 (*EM*), 1R5
1C2	DK92	X18, 1AC6
1C3	DK96	1AB6
1C5G	DL35 1C5G	N14
1C5GT	DL35 1C5GT	N14
1C6	See Page 169	—
1C7G	See Page 169	—
1D5	See Page 232	40SUA
1D6	See Page 260	—
1D7G	See Page 169	—
1D13	DA90	1A3
1E5G	See Page 168	—
1F1	DF96	1AJ4
1F2	DF92	1F2/1L4, 1L4
1F2/1L4	DF92	1F2, 1L4
1F3	DF91	W17, 1F3/1T4, 1T4
1F3/1T4	DF91	W17, 1F3, 1T4
1F4	See Page 170	—
1F5G	See Page 170	—
1FD1	DAF96	1AH5
1FD9	DAF91	ZD17, 1FD9/1S5, 1S5
1FD9/1S5	DAF91	ZD17, 1FD9, 1S5
1H5G	DAC32 (Cl) 1H5G	HD14
1H5GT	DAC32 (Met)	—
1H6G	See Page 167	—
1L4	DF92	1F2, 1F2/1L4
1LA6E	See Page 64	—
1LD5	See Page 57	—
1LH4	See Page 55	—
1LN5	See Page 59	—
1M1	DM70	1M3
1M3	DM70	1M1
1N5G	1N5G	Z14
1N5GT	DF33	—
1N5VG	DF33	1N5GT

Valve Type	Mullard Direct Equivalent	Other Equivalents
1N87	OA60	—
1N88	OA61	—
1P1	DL96	3C4
1P10	DL92	N17, 1P10/3S4, 3S4
1P10/3S4	DL92	N17, 1P10, 3S4
1P11	DL94	N19, 1P11/3V4, 3V4
1P11/3V4	DL94	N19, 1P11, 3V4
1Q5GT	See Page 68	—
1R5	DK91	X17, 1C1/1R5, 1C1 (*EM*)
1S4	See Page 72	—
1S5	DAF91	ZD17, 1FD9, 1FD9/1S5
1T2/R16	—	U37
1T4	DF91	W17, 1F3/1T4, 1F3
1T5GT	—	—
1U4	—	—
1U5	See Page 57	—
2D2	See Page 242	—
2D4	See Page 243	—
2D4A	2D4A	DDL4, D41, V914
2D4B	See Page 243	—
2D13, 2D13A, 2D13C	See Page 244	—
2P	See Page 43	PA20
2T/270K	—	HR2, R10
2XP	See Page 43	PA20
3A4	DL93	—
3A5	DCC90	—
3C4	DL96	1P1
3D6	—	—
3Q4	See Page 74	N18
3Q5G, 3Q5GT	DL33, 3Q5GT	N16
3S4	DL92	N17, 1P10, 1P10/3S4
3V4	DL94	N19, 1P11, 1P11/3V4
4/100BU	FW4–500	U18/20
4D1	See Page 162	—
4THA	See Page 212	—
4TPB	—	—
4TSA	—	—
4TSP	—	—
4XP	ACO44	LP4, PP3/250, PX4
5B/250A	QV05–25	807

Valve Type	Mullard Direct Equivalent	Other Equivalents
5U4G	5U4G	U52
5V4G	5V4G	—
5X4G	See Page 246	—
5Y3G/GT	5Y3G/GT	U50
5Y4G	See Page 246	—
5Z3	See Page 246	—
5Z4	GZ30	—
5Z4G	5Z4GT	—
5Z4GT		—
6A6	See Page 253	—
6A7	6A7	—
6A8G	6A8G	X63
6A8GT	6A8GT	—
6AB7	See Page 125	—
6AB8	ECL80	LN152
6AC7	—	—
6AD8	—	—
6AE8	—	X79
6AG6G	EL33	N147
6AJ8	ECH81	X719
6AK5	EF95	—
6AK6	See Page 146	—
6AK8	EABC80	DH719/EABC80, 6T8
6AL5	EB91	DD6 (*C* or *F*), D77, D152, 6D2
6AM5	EL91	N77, N144, 7D9
6AM6	EF91	SP6, Z77, 6AM6/8D3, 6F12
6AM6/8D3	EF91	SP6, Z77, 6F12
6AN7	—	—
6AQ4	EC91	—
6AQ5	EL90	N727/6AQ5
6AQ8	ECC85	B719/ECC85
6AS5	—	—
6AS7G	—	A1834
6AT6	EBC90	DH77
6AU6	—	—
6AV4	—	—
6B7	—	—
6B8G	—	—
6B8GT	—	—
6BA6	EF93	W727/6BA6
6BD7	—	—
6BE6	EK90	X727/6BE6
6BG6G	—	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
6BH6	—	—
6BJ5	—	N78
6BJ6	—	—
6BQ5	EL84	N709
6BR7	—	—
6BW6	—	—
6BW7	—	—
6BX6	EF80	Z152, Z719
6BY7	EF85	W719
6C4	EC90	L77
6C5G	6C5GT	—
6C5GT	6C5GT	—
6C6	See Page 250	—
6C9	See Page 107	—
6C10	ECH42	X150, 62TH
6C11	—	—
6C31	See Page 105	—
6CD6G	—	—
6CD7	EM34	64ME
6CH6	EL821	—
6CJ6	EL81	—
6CN6	EL38	—
6CQ6	EF92	W77, 9D6
6D1 (*EM*)	EA50	SD61
6D2	EB91	DD6 (*C* or *F*), D77, D152, 6AL5
6D3	—	—
6D6	See Page 251	—
6E8G	ECH35*	OM10*, X61M, X147*
6F1	See Page 118	—
6F5G	—	H63
6F6G	6F6G	KT63
6F8G	See Page 255	—
6F11	—	—
6F12	EF91	SP6, Z77, 6AM6, 6AM6/8D3
6F13	See Page 118	—
6F14	—	—
6F15	See Page 118	—
6F16	EF41	W150, 62VP
6G5G	—	6M1
6H6G	EB34*	D63
6H6GT	EB34*	—
6J5G	6J5G	L63
6J5GT	6J5GT	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
6J6	ECC91	—
6J7G	6J7G	Z63
6J7GT	6J7GT	—
6J8G	See Page 105	—
6K5G	—	—
6K6G	See Page 255	—
6K7G	6K7G	—
6K7GT	6K7GT	—
6K8G	6K8G	—
6K8GT	6K8GT	—
6K25	—	—
6L1	—	—
6L6G	6L6G	—
6L6GA	6L6G	—
6L7G	—	—
6L18	—	—
6L19	—	—
6L34	EC91	6AQ4
6LD3	EBC41	DH150, 62DDT
6LD20	—	—
6M1	See Page 148	6U5G, 63ME
6M2	—	—
6M6G	EL33	6AG6G
6N6G	—	—
6N7GT	6N7GT	—
6N8	EBF80	ZD152
6P1	—	—
6P8G	ECH35*	OM10, X147*
6P25	—	KT61
6P28	See Page 139	—
6Q7G	6Q7G	DH63
6Q7GT	6Q7GT	—
6R6G	—	—
6R7G	—	DL63
6SA7	See Page 130	—
6SC7, 6SC7GT	See Page 97	—
6SG7	See Page 125	—
6SH7	—	—
6SJ7, 6SJ7GT	See Page 250	—
6SK7GT	6SK7GT	—
6SL7GT	ECC35*	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
6SN7GT	6SN7GT	B65
6SQ7GT	See Page 254	—
6SS7	—	—
6T8	EABC80	DH719/EABC80, 6AK8
6U4GT	—	—
6U5/6G5	See Page 148	—
6U5G	See Page 148	6M1, 63ME
6U7G	6K7G	W63
6V4	EZ80	—
6V6G	6V6G	—
6V6GT	6V6GT	—
6W2	—	—
6W7G	See Page 250	—
6X2	EY51	R12, SU61, U151
6X4	EZ90	U78/6X4
6X5G	EZ35 / 6X5GT	U147
6X5GT	EZ35 / 6X5GT	U147
6ZY5G	See Page 152	—
7A2	PEN4VA	AC/PEN, MKT4, MP/PEN
7A3	PENA4	AC2PEN, KT41, PT4 (*F*), 42MP/PEN
7A4	See Page 249	—
7A7	See Page 251	—
7A8	See Page 248	—
7AN7	PCC84	B319, 30L1
7B5	See Page 255	—
7B6	See Page 87	DH81
7B7	See Page 251	—
7B8	See Page 248	—
7C5	See Page 255	—
7C6	See Page 254	DH149
7D3	—	—
7D6	See Page 52	—
7D8	—	—
7D9	EL91	N77, N144, 6AM5
7F7	See Page 97	—
7H7	See Page 125	—
7K7	—	—
7N7	See Page 255	—
7Q7	See Page 130	—
7R7	—	—
7S7	See Page 104	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
7Y4	See Page 152	U82
7Z4	—	—
8A1	SP4	AC/SG, MSP4, MS/PEN, SPT4A
8A8	PCF80	LZ319, 30C1
8D2	See Page 206	13SPA
8D3	EF91	SP6, Z77, 6AM6, 6AM6/8D3, 6F12
9A1	—	AC/VP1, MVS/PEN
9BW6	—	—
9D2	See Page 116	VP1322, 13VPA
9D6	EF92	W77, VP6, 6CQ6
9U8	—	PCF82
10C1	—	X145
10C2	—	—
10D1	See Page 83	—
10D2	—	—
10F1	See Page 229	Z145
10F3	See Page 229	—
10F9	—	W145
10LD3	UBC41	DH142, 141DDT
10LD11	—	DL145
10M1	—	—
10M2	—	—
10P13	—	N145
10P14	See Page 230	—
11A2	See Page 208	AC/HL/DD, DDT, MHD4
11D3	—	—
11D5	—	—
12A6	—	—
12AH7	—	—
12AH8	—	—
12AT6	HBC90	—
12AT7	ECC81	B152, B309
12AU7	ECC82	B329/12AU7
12AV6	HBC91	—
12AX7	ECC83	B339
12BA6	HF93	—
12BE6	HK90	—
12BH7	—	—
12C8GT	—	—
12J7GT	12J7GT	—
12K7GT	12K7GT	—
12K8GT	12K8GT	—
12Q7GT	12Q7GT	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
12SA7GT	—	—
12SC7	—	—
12SJ7GT	See Page 256	—
12SK7GT	12SK7GT	—
12SL7GT	—	—
12SN7GT	12SN7GT	B36
12SQ7GT	See Page 257	—
12SR7	—	—
12U5G	—	—
12Z3	See Page 196	—
13PGA	See Page 157	15D1
13SPA	See Page 206	8D2
13VPA	See Page 116	VP1322, 9D2
14B6	See Page 257	—
14H7	See Page 161	—
14R7	—	—
14S7	—	—
15	See Page 168	—
15A2	See Page 156	MX40, 41MPG
15A6	PL83	N153, N309
15D1	See Page 157	—
15D2	—	—
16A5	PL82	N154, N329
17Z3	PY81	U153
18	—	—
19AQ5	—	—
19BG6G	—	—
19T8	—	—
19X3	PY80	U152
19Y3	PY82	U154, U319
20A1	TH4B	AC/TH1, X41, 41STH
20D1	—	—
20D2	—	—
20F2	—	—
20L1	—	—
20P1	—	—
20P2	—	—
20P3	—	—
20P4	—	—
20P5	—	—
21A6	PL81	N152, 21A6/PL81
21A6/PL81	PL81	N152, 21A6
25A6G	25A6G	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
25L6GT	25L6GT	KT32
25RE	—	—
25U4GT	—	—
25Y5	—	—
25Z4G	25Z4G	—
25Z4GT	25Z4G	—
25Z5	See Page 260	—
25Z6GT	25Z6GT	—
27SU	—	—
30C1	PCF80	LZ319, 8A8
30L1	PCC84	B319, 7AN7
35A5	See Page 261	—
35L6GT	35L6GT	—
35W4	HY90	—
35RE	See Page 199	—
35Z3	See Page 261	—
35Z4GT	35Z4GT	—
35Z5GT	35Z5GT	—
36	See Page 250	—
39/44	See Page 251	—
40SUA	See Page 232	U4020, 1D5
41E	See Page 133	—
41FP	—	AC/P
41MH	—	AC2HL
41MHF	354V	41MHL
41MHL	354V	—
41MP	See Page 92	L4
41MPG	FC4	MX40, VHT4, 15A2
41MPL	354V	AC/HL
41MPT	—	—
41MSG	SP4	AC/SG, MS/PEN, SPT4A
41MTA	—	—
41MTL	354V	AC/HL, 41MHL
41MTS	—	—
41MXP	—	—
41STH	See Page 212	AC/TH1
42	42	—
42/42E	—	—
42MP/PEN	PENA4	AC2PEN, KT41, PT4 (*F*), 7A3
42MPT	—	—
42OT	PENA4	AC2PEN, KT41, PT4 (*F*), 42MP/PEN
42OT/DD	See Page 174	AC2PENDD, PT4D
42PTB	—	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
42SPT	—	—
43 } 43E }	43	—
43IU	See Page 167	MU14, R2, UU5
44IU	IW4-500	MU14, R3, UU5
45IU	See Page 157	—
50A5	—	—
50C5	HL92	—
50CD6G	—	—
50L6GT	50L6GT	KT71
52KU	—	—
53KU	—	U54
54KU	GZ32	—
61BT	—	—
61SPT	—	—
62BT	—	—
62DDT	EBC41	DH150
62TH	ECH42	X150, 6C10
62VP	EF41	W150
63ME	See Page 148	Y63, 6M1, 6U5G
63SPT	EF50	—
64ME	EM34	6CD7
66KU	EZ40	U150
67PT	EL41	N150
75	75	—
77/77E	See Page 250	—
78/78E	78	—
79	—	—
80	80	—
83	—	—
83V	See Page 246	—
84/6Z4	See Page 152	—
85A2	85A2	QS83/3, 0G3
121VP	UF41	W142
141DDT	UBC41	DH142, 10LD3
141TH	UCH42	X142
142BT	—	—
154V	See Page 264	MHL4
164V	See Page 264	MHL4
171DDP	UBF80	—
185BT	—	—
185BTA	—	—
202DDT	See Page 85	—

Valve Type	Mullard Direct Equivalent	Other Equivalents
202STH	TH21C	TH2321
202VP	—	—
202VPB	—	—
203THA	—	—
210DDT	TDD2A	H2D
210DET	—	210HF
210HF	PM2HL	—
210HL	PM2HL	210HF
210HPT	—	—
210LF	See Page 189	—
210PG	FC2	X22
210RC	—	—
210SPG	FC2	210PG
210SPT	See Page 203	Z22
210VPA	—	—
210VPT	—	VP210, W21
215P	—	—
215SG	PM12M	Z21
220B	See Page 171	—
220HPT	PM22A	KT2, PEN220, PT2, 220OT
220OT	PM22A	KT2, PEN220, PT2
220P	—	—
220PA	See Page 170	L2
220PT	See Page 192	—
220SG	See Page 191	Z21
220TH	—	X24
220VS	PM12M	VS2, W21, 215SG
220VSG	PM12M	VS2, W21, 215SG
225DU	—	—
230PT	See Page 192	
230XP	See Page 195	—
240QP	QP22B	QP230
244V	354V	MH4
302THA	—	TH2321
311SU	UY41	U142
332PEN	CL33	—
354V	354V	AC/HL, MH4
402P	—	—
402PEN	—	—
402PENA	—	—
405BU	—	—
408BU	DW2	506BU, 1821
442BU	DW4–350	R2, R4, U14, UU5

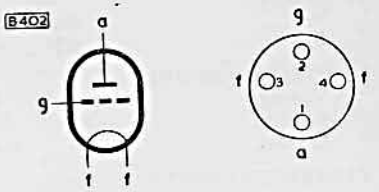
Valve Type	Mullard Direct Equivalent	Other Equivalents
451PT	UL41	N142
460BU	DW4–500	R3, U14, UU5, 1561
484V	See Page 266	—
506BU	DW2	U10, 1821
807	QV05–25	5B/250A
904V	—	—
994V	—	—
1561	DW4–500	U14
1629	—	—
1821	DW2	U10
1861	IW4–500	MU14
1867	IW4–350	R42
1877	HVR2	—
1881	See Page 166	—
2101	See Page 170	—
2102	See Page 167	—
6153T	See Page 267	—
6267	EF86	Z729

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

AC042

FILAMENT

V_f	2.0	V
I_f	2.0	A



Brit. 4-pin

Except for the filament ratings, the AC042 is identical to the AC044.

REPLACED BY: AC044—Raise filament voltage to 4.0V.

DIRECTLY HEATED OUTPUT TRIODE

AC044

FILAMENT

V_f	4.0	V
I_f	1.0	A

DIMENSIONS

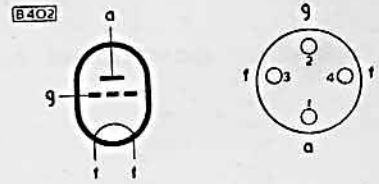
Max. Overall Length	158	mm
Max. Diameter	52	mm

LIMITING VALUES

V_a max.	300	V
p_a max.	15	W
I_k max.	90	mA
R_{g-k} max.	300	kΩ

CHARACTERISTICS

V_a	300	V
V_g	–38	V
I_a	50	mA
g_m	5.0	mA/V
μ	6.0	
r_a	1.2	kΩ



Brit. 4-pin

OPERATING CONDITIONS

V_a	300	V
I_a	50	mA
V_g	–38	V
R_k	760	Ω
R_a	2.3	kΩ
$V_{in\ (r.m.s.)}$	28	V
P_{out}	3.5	W

REPLACEMENT FOR:

K435–10, LP4, P12–250, PP3/250, PX4, PX41, S30C, 4XP—Direct.
AC042, PA20, 2P, 2XP, S30D—Raise filament voltage to 4.0V.
054V—Redesign output stage.

May also be used to replace AC054, AC064, AC084, AC084N and AC104 in certain cases but the full working conditions should be studied before substitution is made.

AC054

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

FILAMENT

V_f	4.0	V
I_f	1.0	A

LIMITING VALUES

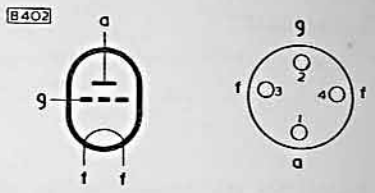
V_a max.	500	V
p_a max.	12	W
I_k max.	60	mA

CHARACTERISTICS

V_a	250	500	V
V_g	−22	−68	V
I_a	48	24	mA
r_a	1.7	2.0	kΩ
g_m	3.5	3.0	mA/V

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	250	500	V
I_a	48	24	mA
V_g	−22	−68	V
$V_{in(r.m.s.)}$	14.5	45	V
R_a	1.6	11.5	kΩ
P_{out}	1.5	5.3	W
D_{tot}	5	5	%



Brit. 4-pin

DIMENSIONS

Max. Overall Length	148	mm
Max. Seated Height	130	mm
Max. Diameter	51	mm

OPERATING CONDITIONS FOR TWO VALVES IN CLASS "AB" PUSH PULL

V_a	500	V
$I_{a(0)}$	2×20	mA
I_a (max. signal)	2×37.5	mA
V_{g1}	−70	V
R_{a-a}	12	kΩ
$V_{in(g-g)r.m.s.}$	96	V
P_{out}	15	W
D_{tot}	<1	%

REPLACED BY: There is no valve which will directly replace the AC054, but the working conditions of the AC044 should be studied with a view to substitution.

AC064

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

FILAMENT

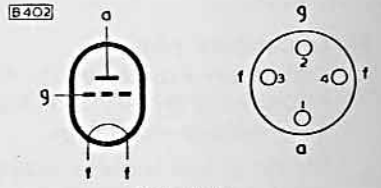
V_f	4.0	V
I_f	1.0	A

LIMITING VALUE

V_a max.	200	V

DIMENSIONS

Max. Overall Length	140	mm
Max. Diameter	60	mm



Brit. 4-pin

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE) AC064 (Cont.)

CHARACTERISTICS			OPERATING CONDITIONS		
V_a	100	V	V_a	200	V
V_g	0	V	V_g	−21	V
r_a	2.0	kΩ	I_a	20	mA
μ	6.0		R_a	5.0	kΩ
g_m	3.0	mA/V	P_{out}	620	mW

REPLACED BY: There is no valve which will directly replace the AC064, but the working conditions of the AC044 should be studied with a view to substitution

---

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

AC084

FILAMENT

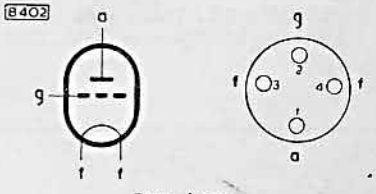
V_f	4.0	V
I_f	1.0	A

LIMITING VALUE

V_a max.	400	V

CHARACTERISTICS

V_a	400	V
V_g	−34	V
I_a	20	mA
g_m	1.1	mA/V
μ	8.0	
r_a	7.3	kΩ



Brit. 4-pin

REPLACED BY: There is no valve which will directly replace the AC084, but the working conditions of the AC044 should be studied with a view to substitution.

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

AC084N

FILAMENT

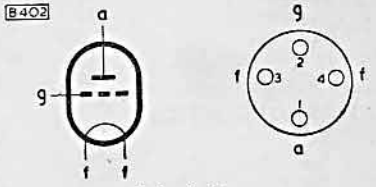
V_f	4.0	V
I_f	1.0	A

LIMITING VALUES

V_a max.	400	V
p_a max.	12	W

CHARACTERISTICS

V_a	100	V
V_g	0	V
I_a	21	mA
g_m	2.5	mA/V
μ	7.0	
r_a	2.8	kΩ



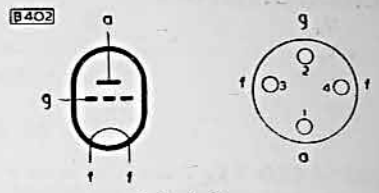
Brit. 4-pin

REPLACED BY: There is no valve which will directly replace the AC084N, but the working conditions of the AC044 should be studied with a view to substitution.

AC104

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

FILAMENT		
V_f	4.0	V
I_f	1.0	A
DIMENSIONS		
Max. Overall Length	115	mm
Max. Diameter	50	mm
LIMITING VALUE		
V_a max.	200	V
CHARACTERISTICS		
V_a	100	V
V_g	0	V
I_a	23	mA
g_m	3.5	mA/V
μ	10	
r_a	2.85	kΩ



Brit. 4-pin.

OPERATING CONDITIONS

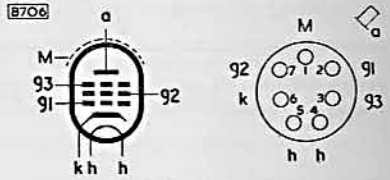
V_a	150	175	200	V
V_g	–10	–12	–14	V
I_a	8.5	9.75	11	mA
R_a	6.0	6.0	6.0	kΩ

REPLACED BY: There is no valve which will directly replace the AC104, but the working conditions of the ACO44 should be studied with a view to substitution.

AL60

OUTPUT PENTODE (OBSOLETE)

HEATER		
V_h	4.0	V
I_h	2.1	A
DIMENSIONS		
Max. Overall Length	155	mm
Max. Diameter	52	mm
LIMITING VALUES		
V_a max.	500	V
p_a max.	18	W
V_{g2} max.	275	V
p_{g2} max.	3.0	W
I_k max.	90	mA
V_{h-k} max.	50	V
CHARACTERISTICS		
V_a	250	V
V_{g2}	250	V
V_{g1}	–7.0	V
I_a	72	mA
I_{g2}	8.0	mA
g_m	14.5	mA/V
μ_{g1-g2}	20	
r_a	20	kΩ



Brit. 7-pin.

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	250 V
V_{g2}	250 V
V_{g1}	–7.0 V
I_a	72 mA
I_{g2}	8.0 mA
R_a	3.5 kΩ
$V_{in(r.m.s.)}$	4.8 V
P_{out}	8.0 W
D_{tot}	10 %

Mullard

AL60 (Cont.)

OUTPUT PENTODE (OBSOLETE)

TWO VALVES IN PUSH PULL (Self bias)

V_a	250	V
V_{g2}	250	V
*R_k	90	Ω
$I_{a(0)}$	2×45	mA
I_a (max. signal)	2×53	mA
$I_{g2(0)}$	2×5.1	mA
I_{g2} (max. signal)	2×8.5	mA
R_{a-a}	5.0	kΩ
$V_{in(g1-g1)r.m.s.}$	15	V
P_{out}	14.5	W
D_{tot}	2.2	%

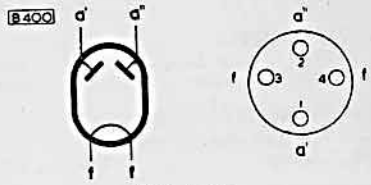
*Common cathode bias resistor

REPLACED BY: PENB4 (V_a max.=250V)—Rewire base. Adjust bias resistor to 180Ω. Where the anode voltage is greater than 250V, the operating conditions should be studied with a view to using the EL37.

AX50

DIRECTLY HEATED FULL-WAVE GAS-FILLED RECTIFIER (OBSOLETE)

FILAMENT		
V_f	4.0	V
I_f	3.75	A
DIMENSIONS		
Max. Overall Length	115	mm
Max. Diameter	50	mm
LIMITING VALUES		
$V_{a(r.m.s.)}$ max.	2×500	V
I_{out} max.	250	mA
Anode Voltage Drop	<15	V



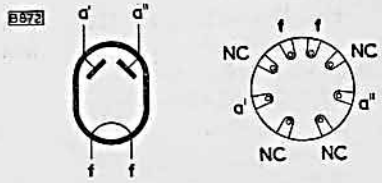
Brit. 4-pin.

REPLACED BY: FW4-500—Check value of limiting resistors.

AZ1

DIRECTLY HEATED FULL-WAVE RECTIFIER

FILAMENT		
V_f	4.0	V
I_f	1.1	A
DIMENSIONS		
Max. Overall Length	106	mm
Max. Diameter	46	mm



Side Contact

For limiting values see type AZ31. Except for base and dimensions, the AZ1 and AZ31 are identical.

Mullard

AZ2

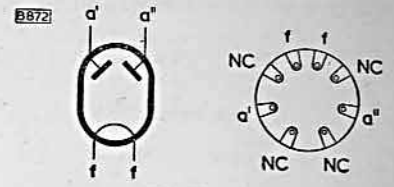
DIRECTLY HEATED FULL-WAVE RECTIFIER (OBSOLETE)

FILAMENT

V_f	4.0	V
I_f	2.0	A

DIMENSIONS

Max. Overall Length	107	mm
Max. Diameter	45	mm



Side Contact

For limiting values see type AZ32. Except for base and dimensions the AZ2 and AZ32 are identical.

REPLACED BY: FW4–500—Change base. FW4–500 I_f=3.0A.

AZ3

INDIRECTLY HEATED FULL-WAVE RECTIFIER (OBSOLETE)

HEATER

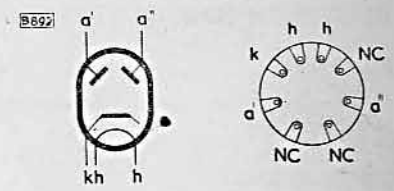
V_h	4.0	V
I_h	2.0	A

DIMENSIONS

Max. Overall Length	110	mm
Max. Diameter	47	mm

LIMITING VALUES

$V_{a(r.m.s.)}$ max.	2×350	V
I_{out} max.	120	mA



Side Contact

REPLACED BY: IW4–350—Change base.

AZ31

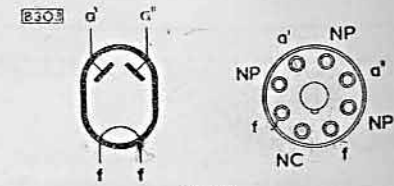
DIRECTLY HEATED FULL-WAVE RECTIFIER

FILAMENT

V_f	4.0	V
I_f	1.1	A

DIMENSIONS

Max. Overall Length	111	mm
Max. Diameter	46	mm



Octal

LIMITING VALUES

$V_{a\ (r.m.s.)}$ max.	2×500	2×400	2×300	V
I_{out} max.	60	75	100	mA
C max.	60	60	60	µF

REPLACEMENT FOR: U143—Direct.
U84—Change base.

Mullard

DIRECTLY HEATED FULL-WAVE RECTIFIER (OBSOLETE)

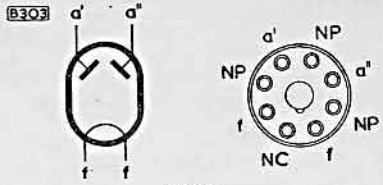
AZ32

FILAMENT

V_f	4.0	V
I_f	2.0	A

DIMENSIONS

Max. Overall Length	128	mm
Max. Diameter	50	mm



Octal

LIMITING VALUES

$V_{a(r.m.s.)}$ max.	2×500	2×300	V
I_{out} max.	120	160	mA

REPLACED BY: FW4–500—Change base. FW4–500 I_f=3.0A.

DIRECTLY HEATED FULL-WAVE RECTIFIER (OBSOLETE)

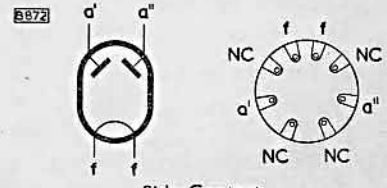
AZ50

FILAMENT

V_f	4.0	V
I_f	3.0	A

DIMENSIONS

Max. Overall Length	132	mm
Max. Diameter	51	mm



Side Contact

LIMITING VALUES

$V_{a(r.m.s.)}$ max.	2×500	V
I_{out} max.	250	mA
C max.	16	µF
R_{k1m} min. (per anode)	200	Ω

REPLACED BY: FW4–500—Change base.

DOUBLE DIODE OUTPUT PENTODE

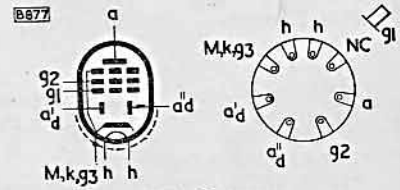
CBL1

HEATER

I_h	200	mA
V_h	44	V

DIMENSIONS

Max. Overall Length	129	mm
Max. Diameter	46	mm



Side Contact

For operating conditions and limiting values see type CBL31. Except for base and dimensions the CBL1 and CBL31 are identical.

REPLACEMENT FOR: DDPP39s—Direct.

Mullard

CBL31

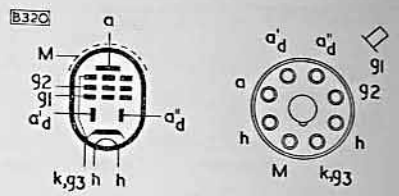
DOUBLE DIODE OUTPUT PENTODE

HEATER

I_h	200	mA
V_h	44	V

DIMENSIONS

Max. Overall Length	136	mm
Max. Diameter	46	mm



Octal

LIMITING VALUES

Pentode Section

V_a max.	250	V
p_a max.	9.0	W
I_k max.	70	mA
V_{g2} max.	250	V
p_{g2} max.	2.0	W
R_{g1-k} max. (self bias)	1.0	MΩ
V_{h-k} max.	125	V

Diode Sections (each section)

V_{ad} max.	200	V
I_{ad} max.	800	μA

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	200	V
V_{g2}	200	V
V_{g1}	–8.5	V
I_a	45	mA
I_{g2}	6.0	mA
R_k	167	Ω
g_m	8.0	mA/V
r_a	35	kΩ
R_a	4.5	kΩ
$V_{in(r.m.s)}$	5.0	V
P_{out}	4.0	W
D_{tot}	10	%

REPLACEMENT FOR: C27D, DDPP39, DDPP39M, DP4480, PEN40DD, PEN DD4020—Change base.

CCH35

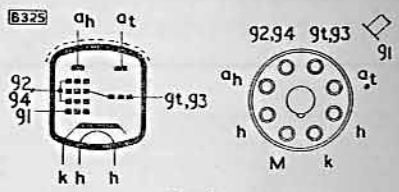
TRIODE HEXODE FREQUENCY CHANGER

HEATER

I_h	200	mA
V_h	7.0	V

DIMENSIONS

Max. Overall Length	113	mm
Max. Diameter	36	mm



Octal

For limiting values and operating data, see type ECH35. Except for the heater ratings, the ECH35 and CCH35 are identical.

REPLACEMENT FOR:

ECH33, OM10, TH62—In a.c./d.c. receivers.

TH233, TH2320, TH2321—Change base and check heater current=200mA. Receiver may need realigning.

TH22C—Change base. Feed screen grids from h.t.+ via potentiometer of 22kΩ and 33kΩ. TH22C has 29V heater.

CL4

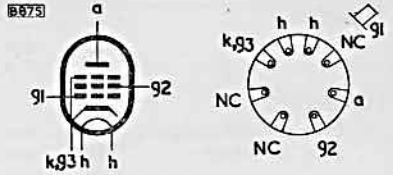
OUTPUT PENTODE

HEATER

I_h	200	mA
V_h	33	V

DIMENSIONS

Max. Overall Length	126	mm
Max. Diameter	44	mm



Side Contact

For limiting values, characteristics and operating data, see type CL33. Except for base and dimensions, the CL4 and CL33 are identical.

REPLACEMENT FOR:

CL6, PEN26—Change bias resistor to 170Ω. Raise screen grid voltage to 200V.

CL6

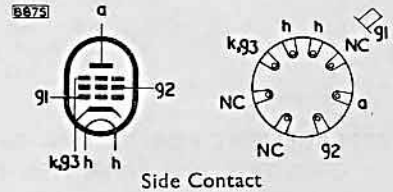
OUTPUT PENTODE (OBSOLETE)

HEATER

I_h	200	mA
V_h	35	V

DIMENSIONS

Max. Overall Length	134	mm
Max. Diameter	46	mm



Side Contact

LIMITING VALUES

V_a max.	250	V
p_a max.	9.0	W
V_{g2} max.	125	V
p_{g2} max.	1.0	W
I_k max.	70	mA
V_{h-k} max.	175	V

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	100	200	V
V_{g2}	100	100	V
I_a	50	45	mA
V_{g1}	–8.3	–9.5	V
I_{g2}	9.0	5.5	mA
R_k	140	190	Ω
R_a	2.0	4.5	kΩ
$V_{in(r.m.s.)}$	5.6	5.6	V
P_{out}	2.1	4.0	W
D_{tot}	10	10	%

REPLACED BY: CL4—See above.

CHARACTERISTICS

V_a	200	V
V_{g2}	100	V
I_a	45	mA
I_{g2}	5.5	mA
V_{g1}	–9.5	V
g_m	8.0	mA/V
r_a	19	kΩ
$\mu_{(g1-g2)}$	6.5	

OPERATING CONDITIONS
Two valves in push pull

V_a	100	250	V
V_{g2}	100	125	V
$I_{a(o)}$	2×42	2×36	mA
I_a (max. sig.)	2×48	2×42.5	mA
$I_{g2(o)}$	2×7.5	2×4.1	mA
I_{g2} (max. sig.)	2×12.5	2×12.5	mA
*R_k	95	180	Ω
R_{a-a}	3.0	7.0	kΩ
$V_{in(g1-g1)(r.m.s.)}$	13	28	V
P_{out}	4.0	13.5	W
D_{tot}	5.6	6.3	%

*Common cathode bias resistor.

CL33

OUTPUT PENTODE

HEATER

I_h	200	mA
V_h	33	V

DIMENSIONS

Max. Overall Length	126	mm
Max. Diameter	45	mm

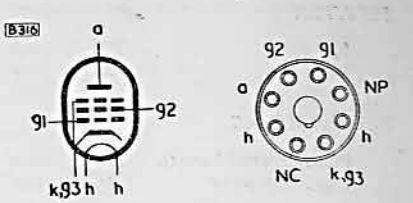
LIMITING VALUES

V_a max.	250	V
p_a max.	9.0	W
I_k max.	70	mA
V_{g_2} max.	250	V
p_{g_2} max.	2.0	W
R_{g_1-k} max. (self bias)	1.0	MΩ
V_{h-k} max.	175	V

CHARACTERISTICS

V_a	200	V
V_{g_2}	200	V
V_{g_1}	–8.5	V
I_a	45	mA
I_{g_2}	6.0	mA
g_m	8.0	mA/V
r_a	35	kΩ
$\mu_{(g_1-g_2)}$	13.5	

B316



Octal

OPERATING CONDITIONS

(As single valve class "A" amplifier)

V_a	200	V
V_{g_2}	200	V
V_{g_1}	–8.5	V
I_a	45	mA
I_{g_2}	6.0	mA
R_k	167	Ω
R_a	4.5	kΩ
$V_{in(r.m.s.)}$	5.0	V
P_{out}	4.0	W
D_{tot}	10	%

REPLACEMENT FOR: 322 PEN—Direct.
C70D, PP34, PP34s, PP35, PP36, PEN 36C, PEN3520, PTZ, 7D6—Change base.

CY1

INDIRECTLY HEATED HALF-WAVE RECTIFIER

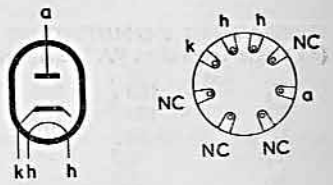
HEATER

I_h	200	mA
V_h	20	V

DIMENSIONS

Max. Overall Length	101	mm
Max. Diameter	44	mm

B671



Side Contact

For limiting values see type CY31. Except for base and dimensions the CY1 and CY31 are identical.

REPLACEMENT FOR: G2080 (Side Contact), UR1, V20s—Direct.

Mullard

CY1C

INDIRECTLY HEATED HALF-WAVE RECTIFIER (OBSOLETE)

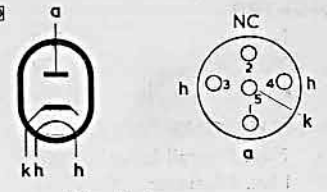
HEATER

I_h	200	mA
V_h	20	V

DIMENSIONS

Max. Overall Length	118	mm
Max. Diameter	43	mm

B500



Brit. 5-pin.

For limiting values see type CY31. Except for base and dimensions the CY1C and CY31 are identical.

REPLACED BY: UR1C—Direct.

CY2

INDIRECTLY HEATED MULTIPLE RECTIFIER (OBSOLETE)

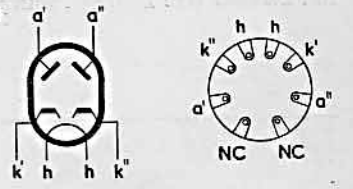
HEATER

I_h	200	mA
V_h	30	V

DIMENSIONS

Max. Overall Length	100	mm
Max. Diameter	43	mm

B879



Side Contact

For limiting values see type CY32. Except for base and dimensions the CY2 and CY32 are identical.

REPLACED BY: 2×UY41, with the heaters in parallel. UY41 I_{out} max.=100mA.

CY31

INDIRECTLY HEATED HALF-WAVE RECTIFIER

HEATER

I_h	200	mA
V_h	20	V

DIMENSIONS

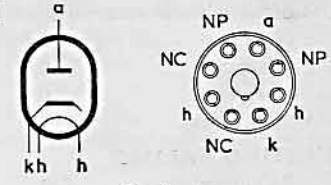
Max. Overall Length	112	mm
Max. Diameter	43	mm

LIMITING VALUES

$V_{a(r.m.s.)}$ max.	250	V
I_{out} max.	120	mA
$v_{h-k(pk)}$ max.	350	V

C max.	8	16	32 μF
R_{1tm} min.	0	75	125 Ω

B302



Octal

REPLACEMENT FOR:
OM1, U201—Direct.
U403—Change base and check heater current=200mA.

Mullard

CY32

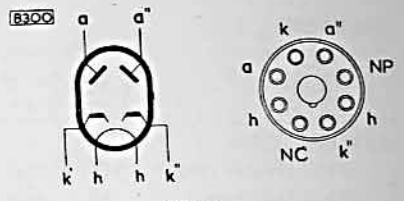
INDIRECTLY HEATED MULTIPLE RECTIFIER (OBSOLETE)

HEATER

I_h	200	mA
V_h	30	V

DIMENSIONS

Max. Overall Length	105	mm
Max. Diameter	43	mm



Octal

LIMITING VALUES

$V_{a(r.m.s.)}$ max.			250	V
I_{out} max.			120	mA
V_{h-k} max.			350	V
C max.	8	16	32	µF
R_{11m} min. (per anode)	0	75	125	Ω

REPLACED BY: 2×UY41, with the heaters in parallel. UY41 I_{out} max.=100mA.

DA90

INDIRECTLY HEATED SINGLE DIODE

HEATER

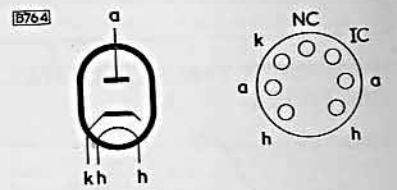
V_h	1.4	V
I_h	150	mA

CAPACITANCES
(measured without external shield)

c_{a-k}	0.4	pF
c_{a-h}	0.8	pF
c_{h-k}	0.6	pF

LIMITING VALUES

P.I.V. max.	330	V
I_a max.	500	µA
$i_{a(pk)}$ max.	5.0	mA
V_{h-k} max.	140	V



B7G

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

REPLACEMENT FOR: 1A3, 1D13—Direct.

DACI

SINGLE DIODE TRIODE (OBSOLETE)

FILAMENT

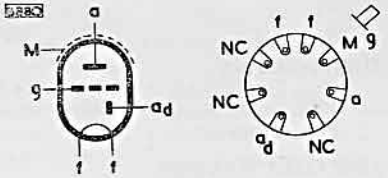
V_f	1.4	V
I_f	50	mA

LIMITING VALUE

V_a max.	90	V

CHARACTERISTICS

V_a	90	V
V_g	0	V
I_a	140	µA
µ	65	
r_a	240	kΩ
g_m	275	µA/V



Side Contact

DIMENSIONS

Max. Overall Length	102	mm
Max. Diameter	33	mm

REPLACED BY: DAC32 (Met)—Change base.

DAC32

SINGLE DIODE TRIODE

FILAMENT

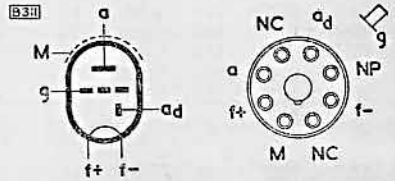
V_f	1.4	V
I_f	50	mA

LIMITING VALUE

V_a max.	110	V

CHARACTERISTICS

V_a	90	V
V_g	0	V
I_a	150	µA
µ	65	
r_a	240	kΩ
g_m	275	µA/V



Octal

DAC32 (Clear)—No connection to pin 1.

The diode anode is located at the negative end of the filament.

DIMENSIONS

Max. Overall Length	102	mm
Max. Diameter	30	mm

REPLACEMENT FOR:

HD14, 1H5G – DAC32 (Clear)—Direct.
1H5G/GT – DAC32 (Met)—Direct.
DAC1, H141D, 1LH4 – DAC32 (Met)—Change base.

DAF91

SINGLE DIODE A.F. PENTODE

FILAMENT

V_f	1.4	V
I_f	50	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

LIMITING VALUES

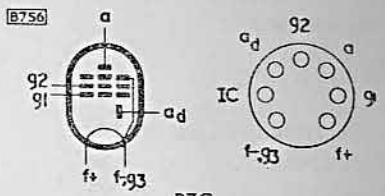
Pentode Section

V_a max.	90	V
p_a max.	250	mW
V_{g_2} max.	90	V
p_{g_2} max.	60	mW
V_{g_1} max.	0	V
I_k max.	4.5	mA
*R_{g_1-f} max.	3.0	MΩ

*R_{g_1-f} max.=22MΩ if grid current biasing is employed.

Diode Section

P.I.V. max.	100	V
I_{ad} max.	200	μA
$i_{ad(pk)}$max.	1.2	mA



B7G

Pin 2—No connection.

The diode anode is located at the negative end of the filament.

CHARACTERISTICS

Pentode Section

V_a	67.5	90	V
V_{g_2}	67.5	90	V
I_a	1.6	2.7	mA
I_{g_2}	400	630	μA
V_{g_1}	0	0	V
g_m	625	720	μA/V
r_a	600	500	kΩ
$\mu_{g_1-g_2}$	13.5	13.5	

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER,

Pentode connection (V_{g_1}=0V).

V_b (V)	R_a (MΩ)	I_a (μA)	R_{g_2} (MΩ)	I_{g_2} (μA)	$\frac{V_{out}}{V_{in}}$	V_{out} ($V_{r.m.s.}$)	D_{tot} (%)	$\frac{V_{out}}{V_{in}}$*	V_{out}* ($V_{r.m.s.}$)	R_{g_1}** (MΩ)
90	0.27	220	1.0	61	49	4.9	0.8	42.4	14.4	0.47
90	0.27	220	1.0	61	60	6.0	1.4	51.5	17.5	1.0
90	0.27	220	1.0	61	69	6.9	2.0	58.9	20	4.7
90	0.47	130	1.8	36	66.5	6.65	1.7	59	16.5	1.0
90	0.47	130	1.8	36	83.5	8.35	3.1	72.5	20.3	4.7
90	0.47	130	1.8	36	87	8.7	3.5	75	21	10
90	1.0	65	3.9	18.7	90	9.0	3.0	84	15.1	2.2
90	1.0	65	3.9	18.7	104	10.4	3.3	96.8	17.4	4.7
90	1.0	65	3.9	18.7	110	11	3.6	103.5	17.6	10
67.5	0.27	145	1.0	41	41	4.1	1.8	37.9	9.85	0.47
67.5	0.27	145	1.0	41	50	5.0	1.3	45	12.6	1.0
67.5	0.27	145	1.0	41	57	5.7	1.6	50.6	15.2	4.7
67.5	0.47	87	1.8	25	55	5.5	1.7	49.6	10.4	1.0
67.5	0.47	87	1.8	25	68	6.8	2.0	60.3	13.9	4.7
67.5	0.47	87	1.8	25	70	7.0	2.1	61.8	14.8	10
67.5	1.0	45	3.9	13	71	7.1	2.3	66.8	10	2.2
67.5	1.0	45	3.9	13	82	8.2	2.5	75.3	12.8	4.7
67.5	1.0	45	3.9	13	86.5	8.65	2.7	78.8	13.4	10
45	0.27	80	1.0	23.2	31	1.55	2.1	30.4	3.95	0.47
45	0.27	80	1.0	23.2	38.8	1.94	1.9	35.3	6.0	1.0
45	0.27	80	1.0	23.2	45	2.25	1.2	39.7	7.55	4.7
45	0.47	50	1.8	14.6	43	2.15	2.0	41.6	5.0	1.0
45	0.47	50	1.8	14.6	55	2.75	1.7	49.3	7.4	4.7
45	0.47	50	1.8	14.6	57	2.85	1.6	50.6	7.6	10
45	1.0	25	3.9	7.7	56	2.8	2.9	56	5.6	2.2
45	1.0	25	3.9	7.7	65	3.25	2.4	59	6.5	4.7
45	1.0	25	3.9	7.7	70	3.5	2.0	62.7	6.9	10

*D_{tot}=5%. **R_{g_1}=Grid resistor of following valve.

Mullard

SINGLE DIODE A.F. PENTODE

DAF91 (Cont.)

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

Triode connection (g_2 to a).

V_b (V)	R_a (kΩ)	I_a (μA)	$\frac{V_{out}}{V_{in}}$	V_{out} ($V_{r.m.s.}$)	D_{tot} (%)	R_{g_1}* (MΩ)
90	220	250	11	5.0	1.0	0.68
90	470	130	11.5	5.0	0.8	1.5

*R_{g_1}=Grid resistor of following valve.

REPLACEMENT FOR:

ZD17, 1FD9, 1FD9/1S5, 1S5—Direct.
1LD5—Change base.
1U5—Rewire base.

DAF96

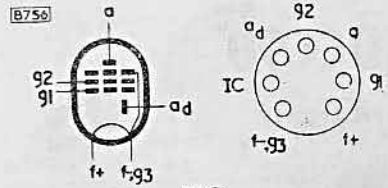
SINGLE DIODE A.F. PENTODE

FILAMENT

V_f	1.4	V
I_f	25	mA

DIMENSIONS

Max. Overall Length	56	mm
Max. Seated Height	50	mm
Max. Diameter	19	mm



B7G

The diode anode is located at the negative end of the filament.

LIMITING VALUES

Pentode Section

V_a max.	90	V
p_a max.	30	mW
V_{g_2} max.	90	V
p_{g_2} max.	10	mW
I_k max.	250	μA

Diode Section

P.I.V. max.	100	V
I_{ad} max.	200	μA
$i_{ad(pk)}$ max.	1.2	mA

CHARACTERISTICS

Pentode Section

V_a	67.5	V
V_{g_2}	67.5	V
I_a	170	μA
I_{g_2}	55	μA
V_{g_1}	−1.5	V
g_m	170	μA/V
$\mu_{g_1-g_2}$	16	

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

Pentode connection

V_b* (V)	R_a (MΩ)	R_{g_2}** (MΩ)	R_{g_1} (MΩ)	Source impedance (kΩ)	R_{g_1}*** (MΩ)	I_k (μA)	$\frac{V_{out}}{V_{in}}$	V_{out} ($V_{r.m.s.}$)	D_{tot} (%)
85	1.0	2.7	10	0	1.0	85	55	5.0	2.5
85	1.0	2.7	10	470	1.0	85	50	5.0	2.5
85	1.0	2.7	10	0	2.0	85	65	5.0	2.0
85	1.0	2.7	10	470	2.0	85	60	5.0	2.5
64	1.0	2.7	10	0	1.0	60	45	5.0	4.0
64	1.0	2.7	10	470	1.0	60	40	5.0	4.0
64	1.0	2.7	10	0	2.0	60	57	5.0	3.5
64	1.0	2.7	10	470	2.0	60	52	5.0	3.5

*Based on line voltages of 90V and 67.5V decreased by the negative bias for the output valve.
**R_{g_2} by-passed to earth by 0.47μF capacitor.
***Grid resistor of following valve.

Mullard

DAF96 (Cont.) SINGLE DIODE A.F. PENTODE

CONNECTED AS TRIODE (g_2 to a).

V_b* (V)	R_a (MΩ)	R_{g1} (MΩ)	Source impedance (MΩ)	R_{g1}** (MΩ)	I_k (μA)	$\frac{V_{out}}{V_{in}}$	V_{out} ($V_{r.m.s.}$)	D_{tot} (%)
85	0.22	10	0	1.0	210	11	5.0	2.0
85	1.0	10	0	1.0	60	12.5	5.0	2.0
64	0.22	10	0	1.0	135	11	5.0	3.0
64	1.0	10	0	1.0	40	12	5.0	3.0

*Based on line voltages of 90V and 67.5V decreased by the negative bias for the output valve.
**Grid resistor of following valve.

REPLACEMENT FOR: 1AH5, 1FD1—Direct.

DCC90 R.F. DOUBLE TRIODE

FILAMENT

	Series	Parallel	
V_f	2.8	1.4	V
I_f	110	220	mA

CAPACITANCES
(measured without external shield)

$c_{a'-a''}$	0.32	pF
c_{g-f} (each section)	0.9	pF
c_{a-f} (each section)	1.0	pF
c_{a-g} (each section)	3.2	pF

LIMITING VALUES (each section)
(Intermittent operation)

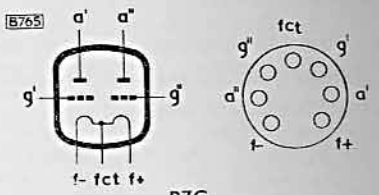
V_a max.	135	V
$-V_g$ max.	30	V
I_a max.	15	mA
I_g max.	2.5	mA
p_a max.	1.0	W

For continuous operation the above maximum current and power ratings must be reduced by 50%.

CHARACTERISTICS (each section)

V_a	90	V
V_g	–2.5	V
I_a	3.7	mA
μ	15	
r_a	8.3	kΩ
g_m	1.8	mA/V

REPLACEMENT FOR: 3A5—Direct.



B7G

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

OPERATING CONDITIONS
Push pull R.F. amplifier or oscillator at 40 Mc/s.
(Intermittent operation)

V_a	135	V
*V_g	–20	V
R_{g-f}	4.0	kΩ
R_k	570	Ω
$v_{in(pk)}$	2×45	V
I_a	2×15	mA
I_g (approx.)	2×2.5	mA
p_g (approx.)	200	mW
P_{out} (approx.)	2.0	W

*Obtained from fixed supply, or by means of cathode or grid resistor of value shown.

DF1 VARIABLE-MU R.F. PENTODE (OBSOLETE)

FILAMENT

V_f	1.4	V
I_f	50	mA

LIMITING VALUES

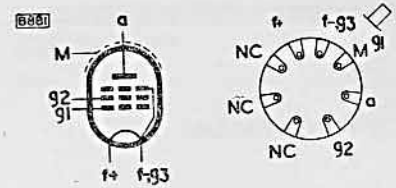
V_a max.	90	V
V_{g2} max.	90	V

OPERATING CONDITIONS

V_a	90	V
V_{g2}	90	V
V_{g1}	0	V
I_a	1.2	mA
I_{g2}	300	μA
r_a	1.5	MΩ
g_m	750	μA/V
*V_{g1}	–4.0	V

*For 150 : 1 reduction in g_m.

REPLACED BY: DF33—Change base.



Side Contact

DIMENSIONS

Max. Overall Length	96	mm
Max. Diameter	31	mm

DF33 VARIABLE-MU R.F. PENTODE

FILAMENT

V_f	1.4	V
I_f	50	mA

DIMENSIONS

Max. Overall Length	102	mm
Max. Diameter	30	mm

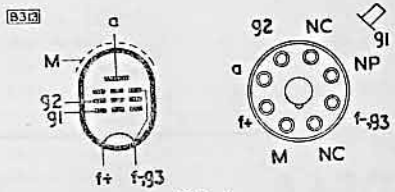
CAPACITANCES

c_{a-g1}	<0.007	pF
c_{in}	3.8	pF
c_{out}	9.5	pF

LIMITING VALUES

V_a max.	110	V
V_{g2} max.	110	V

REPLACEMENT FOR:
1N5GT, 1N5VG—Direct.
DF1, 1LN5—Change base.



Octal

OPERATING CONDITIONS

V_a	90	V
V_{g2}	90	V
V_{g1}	0	V
I_a	1.2	mA
I_{g2}	300	μA
r_a	1.5	MΩ
g_m	750	μA/V
*V_{g1}	–4.0	V

*For 150 : 1 reduction in g_m.

DF64

SUBMINIATURE A.F. VOLTAGE AMPLIFYING PENTODE

FILAMENT

V_f	620	mV
I_f	10	mA

LIMITING VALUES

V_a max.	45	V
V_{g2} max.	45	V
I_k max.	75	μA

CHARACTERISTICS

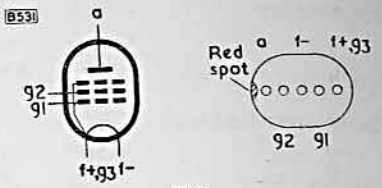
V_a	15	V
V_{g2}	15	V
I_a	50	μA
I_{g2}	17	μA
V_{g1}	–750	mV
g_m	90	μA/V
r_a	1.2	MΩ
μ_{g1-g2}	7.5	

OPERATING CONDITIONS

With fixed bias

V_b	15	V
R_a	2.2	MΩ
R_{g2}	2.7	MΩ
V_{g1}	–620	mV
I_k	6.6	μA
Gain	27.4	dB
R_{out}	5.0	MΩ

B531



B5A

Note.—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.

DIMENSIONS

Max. Bulb Length	25.4	mm
Max. Bulb Width	7.25	mm
Max. Bulb Depth	5.6	mm

OPERATING CONDITIONS

With grid current biasing (zero source impedance)

V_b	15	V
R_a	2.2	MΩ
R_{g2}	4.7	MΩ
R_{g1}	10	MΩ
I_k	5.9	μA
Gain	28	dB
R_{out}	5.0	MΩ

DF66

SUBMINIATURE A.F. VOLTAGE AMPLIFYING PENTODE

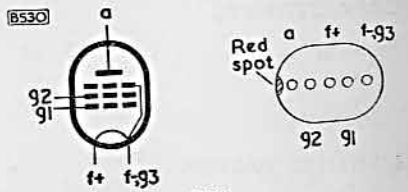
FILAMENT

V_f	625	mV
I_f	15	mA

DIMENSIONS

Max. Bulb Length	28	mm
Max. Bulb Width	8.4	mm
Max. Bulb Depth	6.1	mm

B530



B5A

Note.—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.

Mullard

SUBMINIATURE A.F. VOLTAGE AMPLIFYING PENTODE

DF66 (Cont.)

LIMITING VALUES

V_a max.	45	V
V_{g2} max.	45	V
I_k max.	100	μA

CHARACTERISTICS

V_a	22.5	V
V_{g2}	22.5	V
I_a	50	μA
I_{g2}	15	μA
V_{g1}	–1.05	V
g_m	100	μA/V
r_a	>2.0	MΩ
μ_{g1-g2}	11.5	

OPERATING CONDITIONS

With fixed bias

V_b	22.5	V
R_a	1.0	MΩ
R_{g2}	2.0	MΩ
V_{g1}	–625	mV
I_k	16	μA
$\frac{V_{out}}{V_{in}}$	33	
R_{out}	5.0	MΩ

With grid current biasing

V_b	22.5	V
R_a	1.0	MΩ
R_{g2}	2.7	MΩ
R_{g1}	10	MΩ
Z_s	0	
I_k	16	μA
$\frac{V_{out}}{V_{in}}$	35	
†R_{g1}	5.0	MΩ

†R_{g1}=Grid resistor of following valve

DF70

SUBMINIATURE A.F. VOLTAGE AMPLIFYING PENTODE

FILAMENT

V_f	625	mV
I_f	25	mA

DIMENSIONS

Max. Bulb Length	29.5	mm
Max. Diameter	10.1	mm

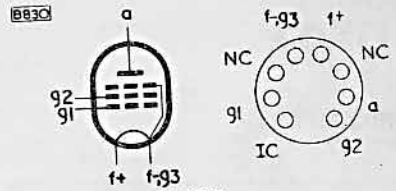
LIMITING VALUES

V_a max.	45	V
V_{g2} max.	45	V
I_k max.	500	μA

CHARACTERISTICS

V_a	30	V
V_{g2}	30	V
V_{g1}	0	V
I_a	375	μA
I_{g2}	125	μA
g_m	220	μA/V
r_a	500	kΩ

B8D



Note.—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.

OPERATING CONDITIONS

V_b	30		45		V
*V_{g1}	–625		–625		mV
R_{g2}	1.5	3.3	1.5	3.3	MΩ
I_k	48	24	81	40	μA
R_a	0.47	1.0	0.47	1.0	MΩ
$\frac{V_{out}}{V_{in}}$	37	44	43	57	
†R_{g1}	3.3		3.3		MΩ

*This voltage may be obtained from a separate source (e.g. the voltage drop across the filament of the previous valve) or from grid current biasing resistor (R_{g1}=22MΩ).

†Grid resistor of following valve

Mullard

DF91

VARIABLE-MU R.F. PENTODE

FILAMENT

V_f	1.4	V
I_f	50	mA

DIMENSIONS

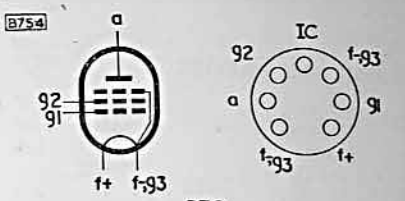
Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

CAPACITANCES

c_{a-g1}	<0.01	pF
c_{in}	3.6	pF
c_{out}	7.5	pF

LIMITING VALUES

V_a max.	90	V
V_{g2} max.	67.5	V
V_{g1} max.	0	V
I_k max.	5.5	mA



B7G
Pin 4—No connection

CHARACTERISTICS

V_a	45	67.5	90	90	V
V_{g2}	45	67.5	45	67.5	V
V_{g1}	0	0	0	0	V
I_a	1.7	3.4	1.8	3.5	mA
I_{g2}	0.7	1.5	0.65	1.4	mA
g_m	700	875	750	900	μA/V
*V_{g1}	–10	–16	–10	–16	V
r_a	350	250	800	500	kΩ

*For g_m=10 μA/V.

REPLACEMENT FOR: W17, 1F3, 1F3/1T4, 1T4—Direct.

DF92

R.F. PENTODE

FILAMENT

V_f	1.4	V
I_f	50	mA

DIMENSIONS

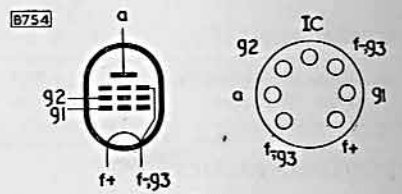
Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

CAPACITANCES
(Measured without external screening)

c_{a-g1}	<0.01	pF
c_{in}	3.6	pF
c_{out}	7.5	pF

LIMITING VALUES

V_a max.	90	V
V_{g2} max.	70	V
V_{g1} max.	0	V
I_k max.	6.0	mA



B7G
Pin 4—No connection

CHARACTERISTICS

V_a	90	90	V
V_{g2}	45	67.5	V
V_{g1}	0	0	V
I_a	1.9	3.7	mA
I_{g2}	0.7	1.4	mA
g_m	0.85	1.0	mA/V
r_a	900	500	kΩ
μ_{g1-g2}	11	11	

REPLACEMENT FOR: 1F2, 1F2/1L4, 1L4—Direct.

DF96

I.F. PENTODE

FILAMENT

V_f	1.4	V
I_f	25	mA

DIMENSIONS

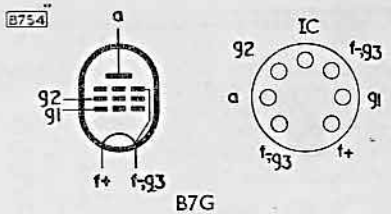
Max. Overall Length	56	mm
Max. Seated Height	50	mm
Max. Diameter	19	mm

CAPACITANCES

c_{a-g1}	<0.01	pF
c_{in}	3.3	pF
c_{out}	7.8	pF

LIMITING VALUES

V_a max.	90	V
p_a max.	250	mW
V_{g2} max.	90	V
p_{g2} max.	100	mW
I_k max.	2.2	mA
R_{g1-f} max.	3.0	MΩ



B7G

CHARACTERISTICS

†V_a=V_b	64	85	V
R_{g2}	0	39	kΩ
V_{g1}	0	0	V
V_{g2}	64	64	V
I_a	1.65	1.65	mA
I_{g2}	550	550	μA
g_m	750	750	μA/V
r_a	0.7	1.0	MΩ
μ_{g1-g2}	18	18	
*V_{g1}	–4.1	–5.5	V

†Based on line voltages of 67.5 and 90V decreased by the negative bias for the output valve.
*For 75:1 reduction in g_m.

REPLACEMENT FOR: 1AJ4, 1F1—Direct.

DK1

HEPTODE FREQUENCY CHANGER (OBSOLETE)

FILAMENT

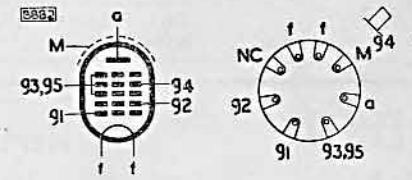
V_f	1.4	V
I_f	50	mA

OPERATING CONDITIONS

V_a	90	V
V_{g2}	90	V
*V_{g3+g5}	45	V
V_{g4}	0	V
I_a	550	μA
I_{g2}	1.2	mA
I_{g3+g5}	600	μA
I_{g1}	35	μA
I_k	2.4	mA
R_{g1-f}	200	kΩ
r_a	600	kΩ
g_c	250	μA/V
†V_{g4}	–3.0	V

*This voltage may be obtained by using a screen resistor of 68kΩ from a 90V supply.
†For 50:1 reduction in g_c.

REPLACED BY: DK32—Change base.



Side Contact

DIMENSIONS

Max. Overall Length	96	mm
Max. Diameter	31	mm

LIMITING VALUES

V_a max.	90	V
V_{g2} max.	90	V
V_{g3+g5} max.	90	V

DK32

HEPTODE FREQUENCY CHANGER

FILAMENT

V_f	1.4	V
I_f	50	mA

CAPACITANCES

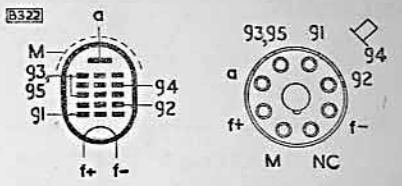
c_{a-g4}	<0.5	pF
c_{out}	10	pF
c_{g4-all}	7.0	pF
c_{g2-g4}	<0.4	pF
c_{g1-g4}	<0.2	pF
c_{g1-g2}	0.9	pF
c_{g2-all} (less g_1)	4.4	pF
c_{g1-all} (less g_2)	4.0	pF

LIMITING VALUES

V_a max.	110	V
V_{g3+g5} max.	60	V
V_{g2} max.	110	V
I_k max.	4.0	mA
R_{g4-f} max.	1.0	MΩ

CHARACTERISTICS (Oscillator Section)

V_a	90	V
V_{g3+g5}	45	V
V_{g4}	0	V
V_{g2}	90	V
V_{g1}	0	V
g_m	550	μA/V



Octal

DIMENSIONS

Max. Overall Length	102	mm
Max. Diameter	30	mm

OPERATING CONDITIONS

V_a	90	V
V_{g3+g5}	45	V
V_{g2}	90	V
V_{g4}	0	V
I_a	600	μA
I_{g3+g5}	700	μA
I_{g2}	1.2	mA
I_{g1}	35	μA
I_k	2.5	mA
R_{g1-f}	200	kΩ
r_a	600	kΩ
g_c	250	μA/V
$*V_{g4}$	−3.0	V

*For 50 : 1 reduction in g_c

REPLACEMENT FOR:
1A7GT, 1A7VG—Direct.
DK1, FC141, 1LA6E—Change base.
X14—Earth pin 1.

DK91

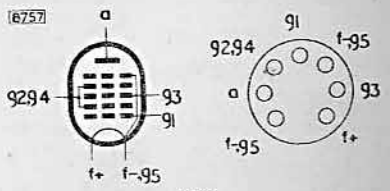
HEPTODE FREQUENCY CHANGER

FILAMENT

V_f	1.4	V
I_f	50	mA

CAPACITANCES

c_{g3-all}	7.0	pF
c_{a-all}	7.5	pF
c_{g1-all}	3.8	pF
c_{g3-a}	<0.4	pF
c_{g3-g1}	<0.2	pF
c_{a-g1}	<0.1	pF



B7G

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

Mullard

HEPTODE FREQUENCY CHANGER

DK91 (Cont.)

LIMITING VALUES

V_a max.	90	V
V_{g2+g4} max.	67.5	V
V_{g3} max.	0	V
I_k max.	5.5	mA

CHARACTERISTICS (Oscillator Section)

$V_{g1}=V_{g3}$	0	V
$V_{g2}=V_{g4}=V_a$	67.5	V
$g_{m\ (g1-g2+g4+a)}$	1.4	mA/V

OPERATING CONDITIONS

V_a	45	67.5	90	90	V
V_{g2+g4}	45	67.5	45	67.5	V
V_{g3}	0	0	0	0	V
R_{g1-f}	100	100	100	100	kΩ
r_a	600	500	800	600	kΩ
g_c	235	280	250	300	μA/V
I_a	0.7	1.4	0.8	1.6	mA
I_{g2+g4}	1.9	3.2	1.9	3.2	mA
I_{g1}	150	250	150	250	μA
I_k	2.75	5.0	2.75	5.0	mA
$*V_{g3}$	−9.0	−14	−9.0	−14	V

*For g_c=5μA/V

REPLACEMENT FOR: X17, 1C1 (Ediswan Mazda), 1C1/1R5, 1R5—Direct.

DK92

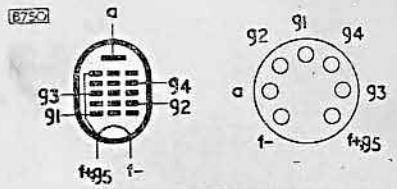
HEPTODE FREQUENCY CHANGER

FILAMENT

V_f	1.4	V
I_f	50	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm



B7G

CAPACITANCES

c_{a-all}	8.5	pF
c_{g3-all}	7.5	pF
c_{g2-all}	5.0	pF
c_{g1-all}	4.0	pF
c_{a-g3}	<0.4	pF
c_{g1-g3}	<0.2	pF
c_{g2-g3}	1.6	pF
c_{g1-g2}	3.0	pF

LIMITING VALUES

V_a max.	90	V
V_{g2} max.	60	V
V_{g4} max.	90	V
I_k max.	4.0	mA
R_{g3-f} max.	3.0	MΩ
R_{g1-f} max.	35	kΩ

OPERATING CONDITIONS

$V_a=V_b$	85	V
V_{g3}	0	V
R_{g1-f}	180	kΩ
R_{g2}	33	kΩ
R_{g1-f+}	27	kΩ
V_{g4} (approx.)	60	V
V_{g2} (approx.)	30	V
V_{osc}	4.0	V
I_k	2.55	mA
I_a	700	μA
I_{g4}	150	μA
I_{g2}	1.6	mA
$*I_{g1}$	100	μA
g_c	325	μA/V
r_a	650	kΩ
$\dagger V_{g3}$	−6.0	V

*Optimum value. In a typical circuit, I_{g1} should be between 50μA and 250μA.

†For 100 : 1 reduction in g_c.

Mullard

DK92 (Cont.) HEPTODE FREQUENCY CHANGER

CHARACTERISTICS

Oscillator Section (with g_1 returned to f_+)

V_a	85	V
V_{g4}	60	V
V_{g3}	0	V
V_{g2}	30	V
I_{g2}	2.5	mA
$g_{m(g1-g2)}$	900	μA/V
μ_{g1-g2}	7.5	

REPLACEMENT FOR: X18, 1AC6, 1C2—Direct.

DK96 HEPTODE FREQUENCY CHANGER

FILAMENT

V_f	1.4	V
I_f	25	mA

CAPACITANCES

C_{a-all}	8.4	pF
C_{g1-all}	3.9	pF
C_{g2-all}	4.8	pF
C_{g3-all}	7.6	pF
C_{a-g1}	<0.11	pF
C_{a-g2}	<0.3	pF
C_{a-g3}	<0.36	pF
C_{g1-g2}	3.0	pF
C_{g1-g3}	<0.2	pF
C_{g2-g3}	1.6	pF

LIMITING VALUES

V_a max.	90	V
p_a max.	150	mW
V_{g2} max.	60	V
p_{g2} max.	100	mW
V_{g4} max.	90	V
p_{g4} max.	30	mW
I_k max.	2.6	mA
R_{g3-f} max.	3.0	MΩ
R_{g1-f} max.	100	kΩ

CHARACTERISTICS

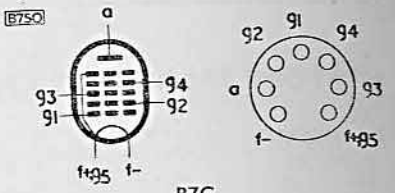
Oscillator Section

(With g_1 returned to f_+)

$V_a=V_b$	64	85	V
V_{g4}	64	64	V
V_{g3}	0	0	V
V_{g2}	35	35	V
V_{g1}	+1.4	+1.4	V
I_{g2}	1.7	1.7	mA
$g_{m(g1-g2)}$	700	700	μA
μ_{g1-g2}	7.5	7.5	

REPLACEMENT FOR: 1AB6, 1C3—Direct.

B7SO



B7G

DIMENSIONS

Max. Overall Length	56	mm
Max. Seated Height	50	mm
Max. Diameter	19	mm

OPERATING CONDITIONS

*$V_a=V_b$	64	85	V
V_{g3}	0	0	V
R_{g4}	0	120	kΩ
R_{g2}	18	33	kΩ
R_{g1-f+}	27	27	kΩ
V_{g4} (approx.)	64	68	V
V_{g2} (approx.)	35	35	V
V_{osc}	4.0	4.0	V
I_k	2.45	2.4	mA
I_a	550	600	μA
I_{g4}	120	140	μA
I_{g2}	1.6	1.5	mA
I_{g1}	85	85	μA
g_c	275	300	μA/V
r_a	0.9	1.0	MΩ
†V_{g3}	−4.5	−6.5	V

*Based on line voltages of 67.5V and 90V decreased by the negative bias for the output valve.

†For 110 : 1 reduction in g_c.

Mullard

OUTPUT PENTODE (OBSOLETE) DL2

FILAMENT

V_f	1.4	V
I_f	100	mA

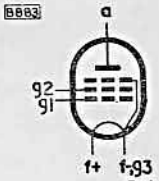
DIMENSIONS

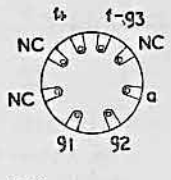
Max. Overall Length	88	mm
Max. Diameter	31	mm

LIMITING VALUES

V_a max.	110	V
V_{g2} max.	110	V
I_k max.	12	mA

B8B3





Side Contact

OPERATING CONDITIONS

V_a	83	90	V
V_{g2}	83	90	V
V_{g1}	−7.0	−7.5	V
I_a	7.0	7.5	mA
I_{g2}	1.6	1.6	mA
g_m	1.5	1.55	mA/V
r_a	110	115	kΩ
R_a	9.0	8.0	kΩ
P_{out}	200	240	mW
D_{tot}	10	10	%

REPLACED BY: DL35, 1C5G—Change Base.

OUTPUT PENTODE DL33

FILAMENT

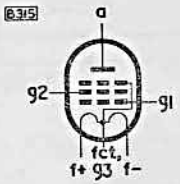
	Series	Parallel	
V_f	2.8	1.4	V
I_f	50	100	mA

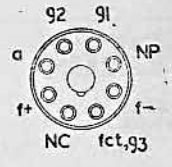
LIMITING VALUES

V_a max.	110	V
V_{g2} max.	110	V
*I_k max.	12	mA
R_{g1-f} max.	1.0	MΩ

*I_k max. for each 1.4V section of filament is 6mA.

B3F5





Octal

DIMENSIONS

Max. Overall Length	100	mm
Max. Diameter	30	mm

OPERATING CONDITIONS (As single valve class "A" amplifier)

Filament Arrangement:	Series		Parallel			
V_a	90	110	85	90	110	V
V_{g2}	90	110	85	90	110	V
V_{g1}	−4.5	−6.6	−5.0	−4.5	−6.6	V
$V_{in(r.m.s.)}$	3.2	3.6	3.5	3.2	3.8	V
I_a	8.0	8.5	7.0	9.5	10	mA
I_{g2}	1.0	1.1	0.8	1.3	1.4	mA
g_m	2.0	2.0	1.95	2.2	2.2	mA/V
r_a	80	110	70	90	100	kΩ
R_a	8.0	8.0	9.0	8.0	8.0	kΩ
P_{out}	230	330	250	270	400	mW
D_{tot}	8.5	8.5	5.5	6.0	6.0	%

REPLACEMENT FOR: N16, 3Q5G, 3Q5GT—Direct.
N15—Increase Bias.

Mullard

DL35

OUTPUT PENTODE

FILAMENT

V_f	1.4	V
I_f	100	mA

DIMENSIONS

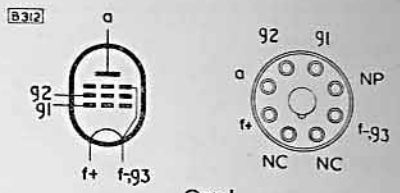
Max. Overall Length	92	mm
Max. Diameter	30	mm

LIMITING VALUES

V_a max.	110	V
V_{g_2} max.	110	V
I_k max.	12	mA

CHARACTERISTICS

V_a	83	90	V
V_{g_2}	83	90	V
V_{g_1}	–7.0	–7.5	V
I_a	7.0	7.5	mA
I_{g_2}	1.6	1.6	mA
r_a	110	115	kΩ
g_m	1.5	1.55	mA/V



Octal

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	83	90	V
V_{g_2}	83	90	V
V_{g_1}	–7.0	–7.5	V
$V_{in\ (r.m.s.)}$	5.0	5.3	V
$I_{a(o)}$	7.0	7.5	mA
I_a (max. sig.)	7.3	7.8	mA
$I_{g_2(o)}$	1.6	1.6	mA
I_{g_2} (max. sig.)	3.5	3.5	mA
R_a	9.0	8.0	kΩ
P_{out}	200	240	mW
D_{tot}	10	10	%

REPLACEMENT FOR: N14, 1C5G, 1C5GT—Direct.
1Q5GT—Bias may require adjustment.
DL2—Change Base.

DL64

SUBMINIATURE OUTPUT PENTODE

FILAMENT

V_f	1.25	V
I_f	10	mA

DIMENSIONS

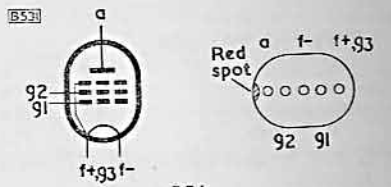
Max. Bulb Length	32.2	mm
Max. Bulb Width	7.25	mm
Max. Bulb Depth	5.6	mm

LIMITING VALUES

V_a max.	45	V
V_{g_2} max.	45	V
I_k max.	600	μA

CHARACTERISTICS

V_a	15	V
V_{g_2}	15	V
I_a	160	μA
I_{g_2}	40	μA
V_{g_1}	–1.5	V
g_m	180	μA/V
r_a	400	kΩ
$\mu_{g_1-g_2}$	4.5	



B5A

Note.—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.

OPERATING CONDITIONS

V_a	15	V
V_{g_2}	15	V
V_{g_1}	–1.55	V
$I_{a(o)}$	150	μA
$I_{g_2(o)}$	37	μA
$V_{in(r.m.s.)}$	850	mV
R_a	100	kΩ
P_{out}	950	μW
D_{tot}	10	%

Mullard

SUBMINIATURE OUTPUT PENTODE

DL66

FILAMENT

V_f	1.25	V
I_f	15	mA

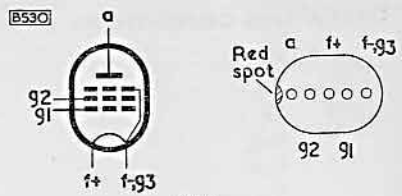
LIMITING VALUES

V_a max.	45	V
V_{g_2} max.	45	V
I_k max.	1.0	mA

CHARACTERISTICS

V_a	22.5	V
V_{g_2}	22.5	V
I_a	300	μA
I_{g_2}	75	μA
V_{g_1}	–1.4	V
g_m	350	μA/V
r_a	300	kΩ
$\mu_{g_1-g_2}$	8.0	

Note.—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5 mm from the seal.



B5A

DIMENSIONS

Max. Bulb Length	35	mm
Max. Bulb Width	8.4	mm
Max. Bulb Depth	6.1	mm

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_b	22.5	V
V_{g_2}	22.5	V
V_{g_1}	–1.4	V
$I_{a(o)}$	300	μA
$I_{g_2(o)}$	75	μA
$V_{in(r.m.s.)}$	850	mV
R_a	75	kΩ
P_{out}	2.7	mW
D_{tot}	10	%

DL68

SUBMINIATURE OUTPUT PENTODE

FILAMENT

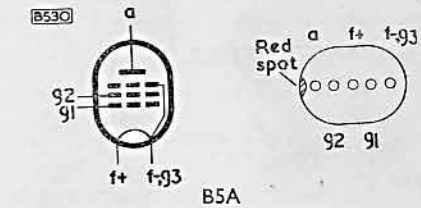
V_f	1.25	V
I_f	25	mA

LIMITING VALUES

V_a max.	45	V
V_{g_2} max.	45	V
P_a max.	100	mW
P_{g_2} max.	25	mW
I_k max.	2.3	mA

CHARACTERISTICS

V_a	22.5	V
V_{g_2}	22.5	V
I_a	600	μA
I_{g_2}	150	μA
V_{g_1}	–2.2	V
g_m	430	μA/V
r_a	100	kΩ
$\mu_{g_1-g_2}$	5.0	



B5A

Note.—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.

DIMENSIONS

Max. Bulb Length	37	mm
Max. Bulb Width	8.5	mm
Max. Bulb Depth	6.1	mm

Mullard

DL68 (Cont.) SUBMINIATURE OUTPUT PENTODE

OPERATING CONDITIONS (As single valve class "A" amplifier)

V_b	22.5	V
V_{g2}	22.5	V
V_{g1}	–2.2	V
$I_{a(o)}$	600	μA
$I_{g2(o)}$	150	μA
$V_{in\ (r.m.s.)}$	1.3	V
R_a	37.5	kΩ
P_{out}	5.0	mW
D_{tot}	10	%

REPLACEMENT FOR: DL72—Rewire connections.

DL71 SUBMINIATURE OUTPUT PENTODE

FILAMENT

V_f	1.25	V
I_f	25	mA

LIMITING VALUES

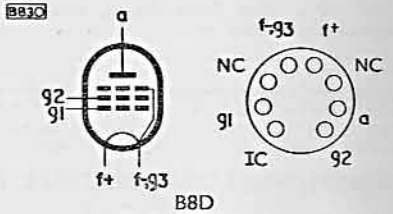
V_a max.	45	V
V_{g2} max.	45	V
I_k max.	1.7	mA

CHARACTERISTICS

V_a	45	V
V_{g2}	45	V
V_{g1}	–1.25	V
I_a	600	μA
I_{g2}	150	μA
g_m	550	μA/V
r_a	350	kΩ
μ_{g1-g2}	15	

Note.—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.

B8D



DIMENSIONS

Max. Bulb Length	38	mm
Max. Bulb Diameter	10.1	mm

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_b	45	V
V_{g2}	45	V
$I_{a(o)}$	590	μA
$I_{g2(o)}$	150	μA
R_k	1.5	kΩ
V_{g1}	–1.25	V
R_a	100	kΩ
$V_{in(r.m.s.)}$	880	mV
P_{out}	6.3	mW
D_{tot}	10	%

Mullard

SUBMINIATURE OUTPUT PENTODE (OBSOLETE) DL72

FILAMENT

V_f	1.25	V
I_f	25	mA

LIMITING VALUES

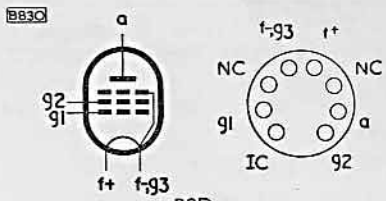
V_a max.	45	V
V_{g2} max.	45	V
I_k max.	1.7	mA

CHARACTERISTICS

V_a	45	V
V_{g2}	45	V
V_{g1}	–4.5	V
I_a	1.25	mA
I_{g2}	400	μA
g_m	500	μA/V
r_a	170	kΩ

Note.—Direct soldered connections to the leads of this valve must be at least 5mm. from the seal and any bending of the valve leads must be at least 1.5mm. from the seal.

B8D



DIMENSIONS

Max. Bulb Length	38	mm
Max. Bulb Diameter	10.1	mm

OPERATING CONDITIONS
(Self bias)

V_b	45	V
V_{g2}	45	V
R_k	2.7	kΩ
V_{g1}	–4.16	V
I_a	1.16	mA
I_{g2}	350	μA
R_a	30	kΩ
$V_{in(r.m.s.)}$	2.65	V
P_{out}	19.5	mW
D_{tot}	10	%

REPLACED BY: DL68—Rewire connections.

OUTPUT PENTODE (OBSOLETE) DL91

FILAMENT

V_f	1.4	V
I_f	100	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

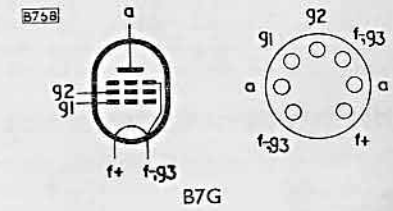
LIMITING VALUES

V_a max.	90	V
V_{g2} max.	67.5	V
I_k max.	9.0	mA

CHARACTERISTICS

V_a	90	V
V_{g2}	67.5	V
V_{g1}	–7.0	V
I_a	7.4	mA
I_{g2}	1.4	mA
r_a	100	kΩ
g_m	1.57	mA/V

B7G



OPERATING CONDITIONS

V_a	45	67.5	90	V
V_{g2}	45	67.5	67.5	V
V_{g1}	–4.5	–7.0	–7.0	V
$I_{a(o)}$	3.8	7.2	7.4	mA
$I_{g2(o)}$	0.8	1.5	1.4	mA
$V_{in(r.m.s.)}$	3.5	5.5	5.5	V
R_a	8.0	5.0	8.0	kΩ
P_{out}	65	180	270	mW
D_{tot}	12	10	12	%

REPLACED BY: DL92—Rewire base so that filament voltage is between pin 5 and pins 1 and 7 connected together.

Mullard

DL92

OUTPUT PENTODE

FILAMENT

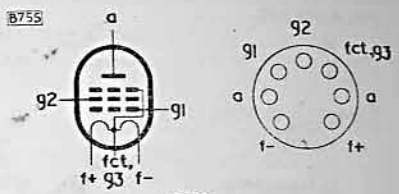
	Series	Parallel	Single Section	
V_f	2.8	1.4	1.4	V
I_f	50	100	50	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

LIMITING VALUES

V_a max.	90	V
p_a max.	700	mW
V_{g_2} max.	90	V
p_{g_2} max.	150	mW
I_k max.	12	mA
R_{g_1-f} max.	2.0	MΩ



B7G

CHARACTERISTICS

	Filament connection Series		Parallel		
V_a	45	90	45	90	V
V_{g_2}	45	67.5	45	67.5	V
V_{g_1}	–4.5	–7.0	–4.5	–7.0	V
I_a	3.0	6.1	3.8	7.4	mA
I_{g_2}	0.7	1.1	0.8	1.4	mA
g_m	1.1	1.42	1.15	1.57	mA/V
$\mu_{g_1-g_2}$	5.0	5.0	5.0	5.0	
r_a	100	100	100	100	kΩ

OPERATING CONDITIONS (As single valve class "A" amplifier)

	Series filament connection			Parallel filament connection				Single section of filament		
V_a	45	67.5	90	45	67.5	82	90	62	82	V
V_{g_2}	45	67.5	67.5	45	67.5	82	67.5	62	82	V
V_{g_1}	–4.5	–7.0	–7.0	–4.5	–7.0	–8.2	–7.0	–5.6	–8.3	V
$I_{a(o)}$	3.0	6.0	6.1	3.8	7.2	10	7.4	3.8	5.0	mA
$I_{g2(o)}$	0.7	1.2	1.1	0.8	1.5	2.2	1.4	0.8	1.1	mA
R_a	8.0	5.0	8.0	8.0	5.0	5.5	8.0	12	12	kΩ
$V_{in\ (r.m.s.)}$	3.5	5.5	5.5	3.5	5.5	6.3	5.5	4.6	6.6	V
P_{out}	50	160	235	65	180	320	270	91	192	mW
D_{tot}	12.5	12	13	12	10	13	12	10.5	12.3	%

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

Series or parallel filament connection				
V_a	67.5	76	90	V
V_{g_2}	67.5	76	90	V
V_{g_1}	–12	–13.6	–16.5	V
$I_{a(o)}$	2×1.5	2×1.5	2×2.0	mA
I_a (max. sig.)	2×5.6	2×7.0	2×8.4	mA
$I_{g2(o)}$	2×250	2×350	2×350	μA
I_{g_2} (max. sig.)	2×1.5	2×2.6	2×2.7	mA
R_{a-a}	10	9.0	10	kΩ.
$V_{in(g_1-g_1)r.m.s.}$	17	20	23	V
P_{out}	340	490	780	mW
D_{tot}	5.0	5.5	6.0	%

REPLACEMENT FOR:

N17, 1P10. 1P10/3S4, 3S4—Direct.

DL91, 1S4—Rewire base so that filament voltage is between pin 5 and pins 1 and 7 connected together.

Mullard

DL93

R.F. OR A.F. OUTPUT PENTODE

FILAMENT

	Series	Parallel	
V_f	2.8	1.4	V
I_f	100	200	mA

CAPACITANCES

(without external shield)

c_{a-g_1}	<0.34	pF
c_{in}	4.8	pF
c_{out}	4.2	pF

LIMITING VALUES

A.F. power amplifier

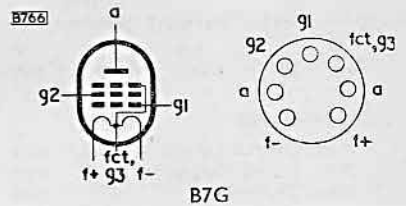
V_a max.	150	V
V_{g_2} max.	90	V
p_a max.	2.0	W
p_{g_2} max.	400	mW
I_k max.	18	mA

R.F. power amplifier

(Intermittent operation)

V_a max.	150	V
V_{g_2} max.	135	V
V_{g_1} max.	–30	V
p_a max.	2.0	W
p_{g_2} max.	900	mW
p_{in} max.	3.0	W
I_a max.	20	mA
I_{g_1} max.	250	μA
I_k max.	25	mA

REPLACEMENT FOR: 3A4—Direct.



B7G

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

OPERATING CONDITIONS

(As single valve class "A" a.f. amplifier)

Parallel filament arrangement

V_a	135	150	V
V_{g_2}	90	90	V
V_{g_1}	–7.5	–8.4	V
$I_{a(o)}$	14.8	13.3	mA
I_a (max. sig.)	14.9	14.1	mA
$I_{g2(o)}$	2.6	2.2	mA
I_{g_2} (max. sig.)	3.5	3.5	mA
g_m	1.9	1.9	mA/V
r_a	90	100	kΩ
R_a	8.0	8.0	kΩ
$V_{in(r.m.s.)}$	5.5	6.0	V
P_{out}	600	700	mW
D_{tot}	5.0	6.0	%

OPERATING CONDITIONS

(As r.f. power amplifier at 50 Mc/s)

(Intermittent operation)

V_a	150	V
V_{g_2}	135	V
R_{g_1-f}	200	kΩ
I_a	18.3	mA
I_{g_2}	6.5	mA
I_{g_1}	130	μA
P_{out} (approx.)	1.2	W

Mullard

DL94

OUTPUT PENTODE

FILAMENT

	Series	Parallel	Single Section	
V_f	2.8	1.4	1.4	V
I_f	50	100	50	mA

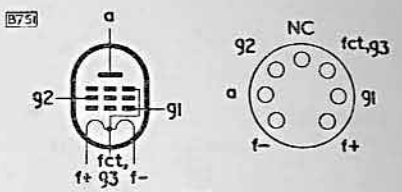
DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

LIMITING VALUES

V_a max.	90	V
p_a max.	1.0	W
V_{g_2} max.	90	V
p_{g_2} max.	300	mW
*I_k max.	12	mA
R_{g_1-f} max.	1.0	MΩ

*I_k max. for each 1.4V section of filament is 6mA.



B7G

CHARACTERISTICS

	Filament connection Series	Parallel	
V_a	90	90	V
V_{g_2}	90	90	V
V_{g_1}	–4.5	–4.5	V
I_a	7.7	9.5	mA
I_{g_2}	1.7	2.1	mA
g_m	2.0	2.15	mA/V
$\mu_{g_1-g_2}$	7.5	7.5	
r_a	120	100	kΩ

OPERATING CONDITIONS (As single valve class "A" amplifier)

	Series filament connection	Parallel filament connection		Single section of filament	
V_a	90	85	90	85	V
V_{g_2}	90	85	90	85	V
V_{g_1}	–4.5	–5.0	–4.5	–5.0	V
$I_{a(o)}$	7.7	6.9	9.5	3.5	mA
$I_{g_2(o)}$	1.7	1.5	2.1	0.8	mA
R_a	10	10	10	20	kΩ
$V_{in\ (r.m.s.)}$	3.2	3.5	3.2	3.9	V
P_{out}	240	250	270	150	mW
D_{tot}	7.0	10	7.0	12	%

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

	Series or parallel filament connection		Single section of filament		
V_a	82	90	82	90	V
V_{g_2}	82	90	82	90	V
V_{g_1}	–8.2	–9.4	–8.0	–9.1	V
$I_{a(o)}$	2×2.0	2×2.0	2×1.0	2×1.0	mA
I_a (max. sig.)	2×5.6	2×6.4	2×2.9	2×3.3	mA
$I_{g2(o)}$	2×500	2×500	2×300	2×300	mA
I_{g_2} (max. sig.)	2×2.1	2×2.3	2×1.1	2×1.3	mA
R_{a-a}	14	14	30	30	kΩ
$V_{in\ (g1-g1)r.m.s.}$	12.2	14	12	13.8	V
P_{out}	460	580	230	300	mW
D_{tot}	3.5	3.8	2.6	2.7	%

REPLACEMENT FOR: N19, 1P11, 1P11/3V4, 3V4—Direct.
N18, 3Q4—Rewire base.

DL96

OUTPUT PENTODE

FILAMENT

	Series	Parallel	
V_f	2.8	1.4	V
I_f	25	50	mA

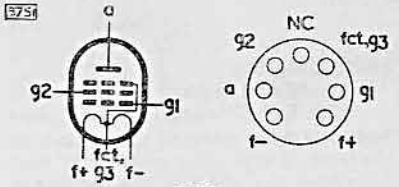
DIMENSIONS

Max. Overall Length	56	mm
Max. Seated Height	50	mm
Max. Diameter	19	mm

LIMITING VALUES

V_b max.	90	V
V_a max.	90	V
p_a max.	600	mW
V_{g_2} max.	90	V
p_{g_2} max.	200	mW
*I_k max.	6.0	mA
R_{g_1-f} max.	2.0	MΩ

*I_k max. for each 1.4V section of the filament is 3mA.



B7G

CHARACTERISTICS

(Parallel filament connection)

V_b	67.5	90	V
V_a	64	85	V
V_{g_2}	64	85	V
I_a	3.5	5.0	mA
V_{g_1}	–3.3	–5.2	V
I_{g_2}	650	900	μA
g_m	1.3	1.4	mA/V
$\mu_{g_1-g_2}$	7.0	7.0	
r_a	170	150	kΩ

OPERATING CONDITIONS (As single valve class "A" amplifier)

	Parallel Filament connection		Single 25mA Section of Filament		
V_b	67.5	90	67.5	90	V
V_a	64	85	64	85	V
V_{g_2}	64	85	64	85	V
V_{g_1}	–3.3	–5.2	–3.3	–5.2	V
I_a	3.5	5.0	1.75	2.5	mA
I_{g_2}	650	900	350	500	μA
R_a	15	13	30	25	kΩ
$V_{in(r.m.s.)}$	2.5	3.4	2.5	3.5	V
P_{out}	100	200	50	100	mW
D_{tot}	10	10	10	10	%

OPERATING CONDITIONS FOR TWO VALVES IN CLASS "AB" PUSH-PULL

	All Filament Sections in parallel		Operation in 50mA Filament chain		
V_b	67.5	90	67.5	90	V
Filament shunt resistor	—	—	470	330	Ω
*R_k	470	560	470	560	Ω
$I_{a(o)}$	2×2.3	2×3.25	2×2.0	2×2.85	mA
I_a (max. sig.)	2×3.15	2×4.25	2×2.85	2×4.0	mA
$I_{g2(o)}$	2×450	2×650	2×400	2×550	μA
I_{g_2} (max. sig.)	2×0.87	2×1.25	2×0.75	2×1.15	mA
R_{a-a}	20	20	20	20	kΩ
$V_{in(g1-g1)r.m.s.}$	9.8	13.8	10.1	14	V
P_{out}	220	420	190	380	mW
D_{tot}	3.3	4.0	1.8	3.2	%

*An additional 3.5mA is fed through R_k to simulate the current from previous stages

REPLACEMENT FOR: 1P1, 3C4—Direct.

DM70

SUBMINIATURE TUNING INDICATOR

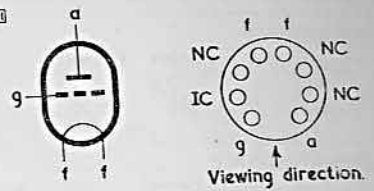
FILAMENT

V_f	1.4	V
I_f	25	mA

DIMENSIONS

Max. Bulb Length	44.3	mm
Max. Bulb Diameter	10.16	mm

Note.—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.



B8D

LIMITING VALUES

V_b max.	300	V
*V_a max.	90	V
V_a min.	45	V
**p_a max. (V_a<90 V)	25	mW
**p_a max. (V_a=200 V)	10	mW
I_k max.	300	µA
R_{g-f} max.	10	MΩ

*In circuits without anode series resistor.

**Values of p_a max. for intermediate values of V_a may be determined by linear interpolation.

†Length of fluorescent column observed, measured from the top of the aperture. The maximum value is approximately 14mm.

OPERATING CONDITIONS

Battery operated receivers

	Pin 4 earthed	Pin 5 earthed	
V_b	90	67.5	V
V_a	85	60	V
V_g	0	0	V
I_a	170	105	µA
†L	11	10	mm
V_g (for complete extinction)	–10	–7.0	V

Mains operated receivers

(Pin 5 earthed)

V_b	110	170	250	V
R_a	0.47	1.0	1.8	MΩ
V_g	0	0	0	V
I_a	105	110	105	µA
†L	10	10	10	mm
V_g (for complete extinction)	–15	–23	–34	V

REPLACEMENT FOR: 1M1, 1M3—Direct.

D024

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

FILAMENT

V_f	4.0	V
I_f	1.85	A

DIMENSIONS

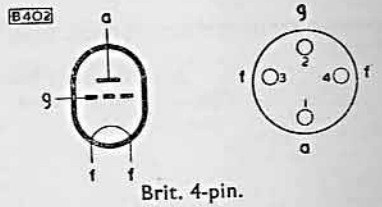
Max. Overall Length	155	mm
Max. Diameter	52	mm

LIMITING VALUES

V_a max.	400	V
p_a max.	25	W

CHARACTERISTICS

V_a	400	V
I_a	63	mA
V_g	–40	V
g_m	7.5	mA/V
µ	8.0	
r_a	1.0	kΩ



Brit. 4-pin.

OPERATING CONDITIONS

V_a	400	V
I_a	63	mA
V_g	–40	V
R_k	630	Ω
R_a	3.2	kΩ
$V_{in(r.m.s.)}$	28	V
P_{out}	7.1	W
D_{tot}	4.0	%

REPLACED BY: There is no valve which will directly replace this type but full working conditions of EL37 should be studied with a view to substitution.

Mullard

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

D026

FILAMENT

V_f	4.0	V
I_f	2.0	A

DIMENSIONS

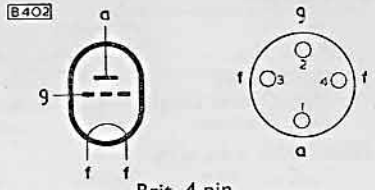
Max. Overall Length	158	mm
Max. Diameter	53	mm

LIMITING VALUES

V_a max.	400	V
p_a max.	25	W

CHARACTERISTICS

V_a	400	V
V_g	–92	V
I_a	63	mA
g_m	3.8	mA/V
µ	3.6	
r_a	950	Ω



Brit. 4-pin

OPERATING CONDITIONS

V_a	400	V
V_g	–92	V
I_a	63	mA
R_k	1.5	kΩ
R_a	3.0	kΩ
$V_{in(r.m.s.)}$	65	V
P_{out}	7.5	W
D_{tot}	10	%

REPLACED BY: There is no valve which will directly replace this type but full working conditions of the EL37 should be studied with a view to substitution.

DIRECTLY HEATED OUTPUT TRIODE (OBSOLETE)

D030

FILAMENT

V_f	4.0	V
I_f (approx.)	2.0	A

DIMENSIONS

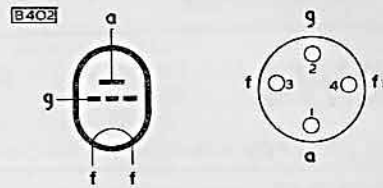
Max. Overall Length	160	mm
Max. Diameter	65.5	mm

LIMITING VALUES

V_a max.	500	V
p_a max.	30	W

CHARACTERISTICS

V_a	100	V
V_g	0	V
µ	4.0	
r_a	580	Ω
g_m	6.9	mA/V



Brit. 4-pin

OPERATING CONDITIONS

(As single valve class "A" amplifier)

V_a	400	500	V
V_g	–102	–134	V
$I_{a(o)}$	62.5	60	mA
R_a	4.5	6.0	kΩ
P_{out}	8.0	11	W

(Two valves in class "AB" push-pull)

V_a	440	500	V
V_g	–117	–145	V
$I_{a(o)}$	57	50	mA
R_a	2.8	3.4	kΩ
P_{out}	32	45	W

REPLACED BY: There is no valve which will directly replace this type, but full working conditions of the EL37 should be studied with a view to substitution.

Mullard

DW2

DIRECTLY HEATED FULL-WAVE RECTIFIER (OBSOLETE)

FILAMENT

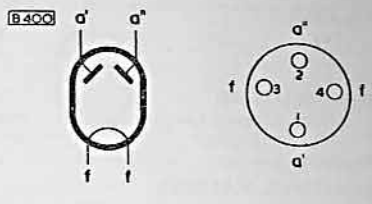
V_f	4.0	V
I_f	1.0	A

DIMENSIONS

Max. Overall Length	128	mm
Max. Diameter	52	mm

LIMITING VALUES

$V_{a(r.m.s.)}$ max.	2×250	V
I_{out} max.	60	mA
C max.	16	µF



Brit. 4-pin

REPLACEMENT FOR:
G431, G470, GN24, PV495, S11A, 408BU, 506BU, 1821—Direct.
U10, providing load current does not exceed 60mA.
R1, UU2, DW2 directly heated. Check that reservoir capacitors are capable of withstanding $350V_{(pk)}$.

DW3

DIRECTLY HEATED FULL-WAVE RECTIFIER (OBSOLETE)

This valve is identical with the DW4–350, except for the overall dimensions, which are:

Max. Overall Length	143	mm	Max. Diameter	55	mm

REPLACED BY: DW4–350—Direct.

DW4

DIRECTLY HEATED FULL-WAVE RECTIFIER (OBSOLETE)

This valve is identical with the DW4–500, which is the present replacement.

DW4-350

DIRECTLY HEATED FULL-WAVE RECTIFIER

FILAMENT

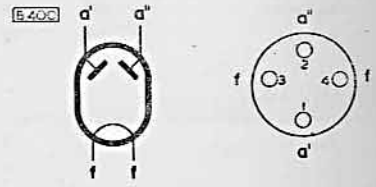
V_f	4.0	V
I_f	2.0	A

DIMENSIONS

Max. Overall Length	142	mm
Max. Diameter	51	mm

LIMITING VALUES

$V_{a(r.m.s.)}$ max.	2×350	V
I_{out} max.	120	mA
C max.	16	µF



Brit. 4-pin

REPLACEMENT FOR:
BVA211, BVA214, BVA215, BVA216, DW3, PV4, R4, RV120/350, S11D, U12/13, 442BU—Direct.
RV120/350s—Change base.

Mullard

DIRECTLY HEATED FULL-WAVE RECTIFIER

DW4-500

FILAMENT

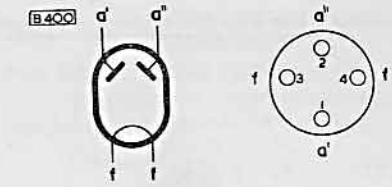
V_f	4.0	V
I_f	2.0	A

DIMENSIONS

Max. Overall Length	140	mm
Max. Diameter	50	mm

LIMITING VALUES

$V_{a\ (r.m.s.)}$ max.	2×500	V
I_{out} max.	120	mA



Brit. 4-pin

REPLACEMENT FOR: DW4, G4120, PV4200, R4A, R41, RV120/500, U14, UU120–500 (Ediswan Mazda), 460BU, 1561—Direct.
DT3, DT30—Add series filament resistor of 1.7Ω, 10W.
RV120/500s—Change base.

EA50

SINGLE DIODE

Miniature diode primarily designed for use as signal detector in television equipment.

HEATER

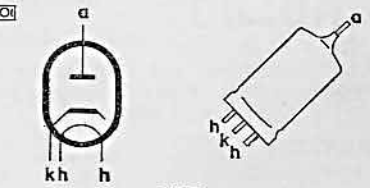
V_h	6.3	V
I_h	150	mA

CAPACITANCE

C_{a-k}	2.1	pF

LIMITING VALUES

V_a max.	50	V
I_a max.	5.0	mA
V_{h-k} max.	50	V



B3G

DIMENSIONS

Max. Overall Length	49	mm
Max. Diameter	12	mm

REPLACEMENT FOR: SD61, 6D1 (Ediswan Mazda)—Direct.
D1, T4D—Raise heater voltage to 6.3V.

EABI

TRIPLE DIODE (OBSOLETE)

HEATER

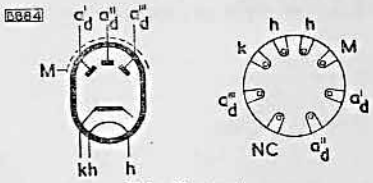
V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	79	mm
Max. Diameter	33	mm

LIMITING VALUES (Each section)

V_{ad}	200	V
I_{ad} max.	800	µA
V_{h-k} max.	100	V



Side Contact

CAPACITANCES

$C_{a'd-a''d}$	<0.65	pF
$C_{a'd-a'''d}$	<0.08	pF
$C_{a''d-a'''d}$	<0.4	pF
$C_{a'd-k}$	1.5	pF
$C_{a''d-k}$	1.35	pF
$C_{a'''d-k}$	2.2	pF

Mullard

EAB1 (Cont.)

TRIPLE DIODE

REPLACED BY: EBC41 (in Philips Receivers 753A and 895X, also Mullard MAS17, MAS109 and MAS112).

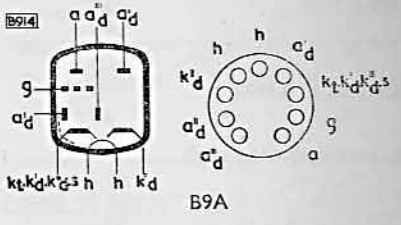
Change holder to B8A type and rewire as follows:

Contacts on EAB1 Holder		EBC41 Holder
No. 1	to	No. 4
2	to	1
3	to	8
4	to	7
5	to	5
7	to	6
8	to	2 & 3

EABC80

TRIPLE DIODE TRIODE

Triple diode triode, one diode having a separate cathode. Primarily designed for use in f.m. or f.m./a.m. receivers.



B9A

HEATER

V_h	6.3	V
I_h	450	mA

LIMITING VALUES

Triode Section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.0	W
I_k max.	5.0	mA
*R_{g-k} max.	3.0	MΩ
V_{h-k} max.	150	V

*With grid current biasing R_{g-k} max. =22MΩ.

Diode Sections

P.I.V.$_{(a'_d)}$ max.	350	V
P.I.V.$_{(a''_d)}$ max.	350	V
P.I.V.$_{(a'''_d)}$ max.	350	V
$I_{a'_d}$ max.	1.0	mA
$I_{a''_d}$ max.	10	mA
$I_{a'''_d}$ max.	10	mA
$i_{a'_{d(pk)}}$ max.	6.0	mA
$i_{a''_{d(pk)}}$ max.	75	mA
$i_{a'''_{d(pk)}}$ max.	75	mA

DIMENSIONS

Max. Overall Length	67	mm
Max. Seated Height	60	mm
Max. Diameter	22.2	mm

CHARACTERISTICS

Triode Section

V_a	100	250	V
V_g	−1.0	−3.0	V
I_a	0.8	1.0	mA
g_m	1.45	1.4	mA/V
μ	70	70	
r_a	54	50	kΩ

Diode Sections

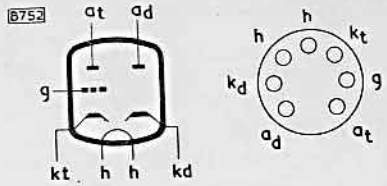
$r_{a'_d}$ ($V_{a'_d}$=+10 V)	5.0	kΩ
$r_{a''_d}$ ($V_{a''_d}$=+5 V)	200	Ω
$r_{a'''_d}$ ($V_{a'''_d}$=+5 V)	200	Ω
$r_{a''_d}/r_{a'''_d}$	0.65 to 1.5	

REPLACEMENT FOR: DH719/EABC80, 6AK8, 6T8—Direct.

EAC91

SINGLE DIODE TRIODE

Oscillator triode combined with a single diode for use as a u.h.f. frequency changer.



B7G

HEATER

V_h	6.3	V
I_h	300	mA

CAPACITANCES

(measured with an external shield)

c_{in}	1.85	pF
c_{out}	1.15	pF
c_{at-g}	1.7	pF
c_{g-ad}	0.05	pF
c_{at-ad}	<0.2	pF
c_{ad-kd}	1.6	pF
c_{kt-kd}	0.01	pF
c_{ad-h}	<0.25	pF

CHARACTERISTICS

Triode Section

V_a	200	V
I_a	7.5	mA
V_g	−3.2	V
g_m	2.8	mA/V
μ	36	
r_a	12.8	kΩ

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

LIMITING VALUES

Triode Section

V_a max.	250	V
p_a max.	2.0	W
I_k max.	10	mA
V_{h-k} max.	50	V

Diode Section

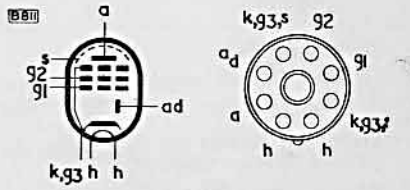
V_a max.	50	V
I_a max.	5.0	mA
Max. operating frequency as Frequency Changer	300	Mc/s
Limiting frequency of oscillation	600	Mc/s

EAF41

SINGLE DIODE R.F. PENTODE (OBSOLETE)

Except for the base connections, the EAF41 is identical with the EAF42.

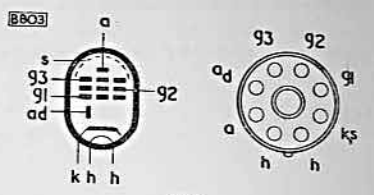
REPLACED BY: EAF42—Connect pins 4 and 7 together.



B8A

EAF42

SINGLE DIODE R.F. PENTODE



B8A

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	60	mm
Max. Diameter	22	mm

LIMITING VALUES

Pentode Section

V_a max.	300	V
p_a max.	2.0	W
V_{g2} max. (I_a<2.5 mA)	300	V
V_{g2} max. (I_a=5.0 mA)	150	V
p_{g2} max.	300	mW
I_k max.	10	mA
R_{g1-k} max.	3.0	MΩ
*R_{g3-k} max.	3.0	MΩ
R_{h-k} max.	20	kΩ
V_{h-k} max.	100	V

*For $v_{g3(pk)}$ not exceeding +10 V.

Diode Section

$v_{ad(pk)}$ max.	200	V
I_{ad} max.	800	μA
V_{h-k} max.	100	V

CAPACITANCES

c_{ad-g1}	<0.0015	pF
c_{ad-ap}	<0.15	pF

Pentode Section

c_{a-g1}	<0.002	pF
c_{out}	5.1	pF
c_{in}	4.5	pF
c_{g1-h}	<0.05	pF

Diode Section

c_{ad-k}	3.8	pF
c_{ad-h}	<0.02	pF

OPERATING CONDITIONS

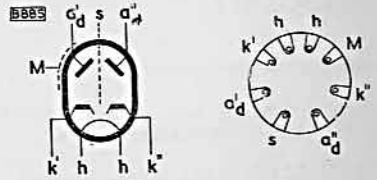
$V_a=V_b$	250	V
R_{g2}	110	kΩ
V_{g2}	85	V
R_k	310	Ω
V_{g1}	−2.0	V
I_a	5.0	mA
I_{g2}	1.5	mA
g_m	2.0	mA/V
r_a	1.4	MΩ
μ_{g1-g2}	18	
*V_{g1}	−43	V
R_{eq}	7.5	kΩ

*For 100 :1 reduction in g_m.

REPLACEMENT FOR: WD150—Direct.
EAF41—Connect pins 4 and 7 together.

EB4

DOUBLE DIODE (OBSOLETE)



Side Contact

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	64	mm
Max. Diameter	32	mm

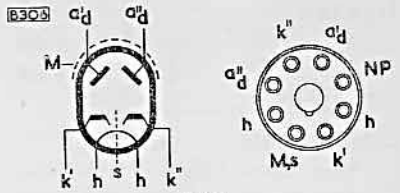
Except for the base and dimensions, the EB4 and EB34 are identical.

REPLACED BY: EB34—Change base.

Mullard

DOUBLE DIODE (separate cathodes)

EB34



Octal

HEATER

V_h	6.3	V
I_h	200	mA

LIMITING VALUES (each section)

V_{ad} max.	200	V
I_{ad} max.	800	μA
V_{h-k} max.	75	V
$V_{k'-k''}$ max.	50	V

DIMENSIONS

Max. Overall Length	82	mm
Max. Diameter	36	mm

REPLACEMENT FOR:

OM3—Direct.

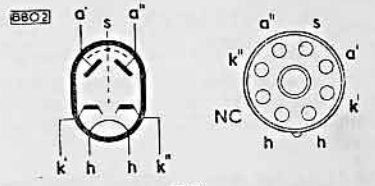
D63, 6H6G/GT. The heater current of these two types differs from that of the EB34, and they cannot therefore be interchanged in dc/ac receivers.

DD6, DD6ds, DD620, EB4—Change base.

C20C, CB1, CB2, D1300, DD13, DD13s, 2D13, 2D13A, 2D13C, 10D1—Change base. Connect pins 4 and 8 together. May be necessary to adjust heater chain current.
2D4B—Change base. Raise heater voltage to 6.3V.

DOUBLE DIODE (separate cathodes)

EB41



B8A

HEATER

V_h	6.3	V
I_h	300	mA

LIMITING VALUES (each section)

V_{ad} max.	150	V
I_{ad} max.	9.0	mA
$i_{ad(pk)}$ max.	54	mA
V_{h-k} max.	300	V

DIMENSIONS

Max. Overall Length	60	mm
Max. Seated Height	53	mm
Max. Diameter	20.3	mm

Mullard

EB91

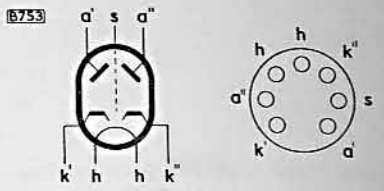
DOUBLE DIODE (separate cathodes)

HEATER

V_h	6.3	mV
I_h	300	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm



B7G

LIMITING VALUES (each section)

P.I.V.	420	V
I_a max.	9.0	mA
$i_{a(pk)}$ max.	54	mA
$v_{h-k(pk)}$ max.	330	V

CAPACITANCES

$c_{a'-k'+h+s}$	3.0	pF
$c_{a''-k''+h+s}$	3.0	pF
$c_{k'-a'+h+s}$	3.4	pF
$c_{k''-a''+h+s}$	3.4	pF
$c_{a'-a''}$	<0.025	pF

REPLACEMENT FOR: DD6 (Cossor or Ferranti), D77, D152, 6AL5, 6D2—Direct.

EBC3

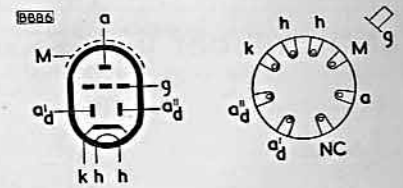
DOUBLE-DIODE TRIODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	90	mm
Max. Diameter	32	mm



Side Contact

For characteristics and operating data, see type EBC33. Except for base and dimensions, the EBC3 and EBC33 are identical.

REPLACED BY: EBC33—Change base.

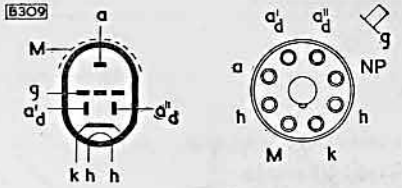
Mullard

EBC33

DOUBLE DIODE TRIODE

HEATER

V_h	6.3	V
I_h	200	mA



Octal

LIMITING VALUES

Triode Section

V_a max.	300	V
p_a max.	1.5	W
I_k max.	10	mA
R_{g-k} max. (Self bias)	3.0	MΩ
R_{g-k} max. (Fixed bias)	1.0	MΩ
V_{h-k} max.	150	V

Diode Sections (each section)

V_{ad} max.	200	V
I_{ad} max.	800	μA

DIMENSIONS

Max. Overall Length	100	mm
Max. Diameter	32	mm

CHARACTERISTICS

V_a	100	200	250	V
I_a	2.0	4.0	5.0	mA
V_g	–2.1	–4.3	–5.5	V
μ	30	30	30	
g_m	1.6	2.0	2.0	mA/V
r_a	19	15	15	kΩ

OPERATING CONDITIONS AS RESISTANCE COUPLED A.F. AMPLIFIER

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	D_{tot} (%)	R_{g1}† (kΩ)
300	47	2.8	1.2	19.5	45	5.8	150
250	47	2.3	1.2	19	34	5.5	150
200	47	1.8	1.2	18.5	26	5.2	150
100	47	0.5	4.7	13	8.0	10	150
300	100	1.5	2.2	22	49	5.2	330
250	100	1.27	2.2	22	41	5.2	330
200	100	1.0	2.2	21.5	31	5.0	330
100	100	0.32	6.8	16.5	14	10	330
300	220	0.83	3.9	23.5	52	4.8	680
250	220	0.69	3.9	23.5	41	4.6	680
200	220	0.53	3.9	23	31	4.5	680
100	220	0.2	10	19	20	10	680

*V_{out}=Output voltage at start of I_g or D_{tot}=10%.

†R_{g1}=Grid resistor of following valve.

REPLACEMENT FOR:

DH147, OM4—Direct.

DL63—Replacement in a.c. operated receivers only.

C23B, CB1C, DDT13, DDT13s, DT1336, DTU1, HL133DD, TDD13, TDD13C, 202DDT—Change base. Check that heater chain current=200mA.

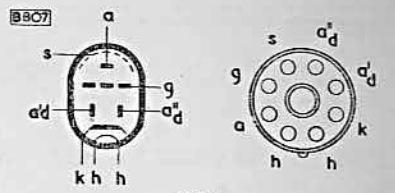
DDT6s, EBC3—Change base.

HAD, HLDD1320—Change base. Check that heater chain current=200mA and check bias voltage.

Mullard

EBC41

DOUBLE DIODE TRIODE



B8A

HEATER

V_h	6.3	V
I_h	230	mA

LIMITING VALUES

Triode Section

V_a max.	300	V
p_a max.	1.0	W
I_k max.	5.0	mA
R_{g-k} max. (cathode bias)	3.0	MΩ
V_{h-k} max.	100	V

Diode Sections (each section)

$v_{ad(pk)}$ max.	200	V
I_{ad} max.	800	μA

DIMENSIONS

Max. Overall Length	60	mm
Max. Seated Height	53	mm
Max. Diameter	22	mm

CHARACTERISTICS

V_a	250	V
V_g	−3.0	V
I_a	1.0	mA
μ	70	
g_m	1.3	mA/V
r_a	54	kΩ

OPERATING CONDITIONS AS RESISTANCE COUPLED A.F. AMPLIFIER

Cathode Bias

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out} ($V_{r.m.s.}$) (D_{tot}=2.5%)	V_{out} ($V_{r.m.s.}$) (D_{tot}=5%)	V_{out} ($V_{r.m.s.}$) (D_{tot}=10%)	R_{g1}† (kΩ)
400	100	1.35	2.2	43.5	—	35.5	62.5	330
350	100	1.18	2.2	43	—	30.5	54	330
300	100	1.0	2.2	42.5	—	25.5	46	330
250	100	0.85	2.2	42	—	21	38	330
200	100	0.70	2.2	41	—	16	28.5	330
150	100	0.50	2.2	40	—	12	19.5	330
100	100	0.28	3.3	33.5	—	6.0	10.5	330
400	220	0.76	3.9	48	—	40	74.5	680
350	220	0.67	3.9	47.5	—	34.5	64	680
300	220	0.56	3.9	47	—	27	54	680
250	220	0.48	3.9	46.5	—	24.5	44.5	680
200	220	0.40	3.9	46	—	19	34	680
150	220	0.32	3.9	44	—	16.5	24	680
100	220	0.18	5.6	38	—	8.0	13.5	680

Grid Current Bias (Grid resistance of 20 MΩ; Zero source impedance)

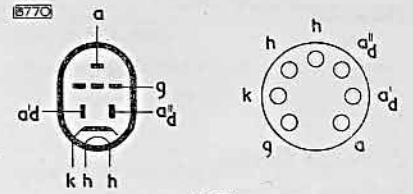
400	100	2.4	—	56.5	33	51	—	330
350	100	2.0	—	55	27	43	—	330
300	100	1.95	—	53.5	22	35	—	330
250	100	1.3	—	51	17	27	—	330
200	100	0.95	—	48.5	12	19	—	330
150	100	0.6	—	44	7.0	11	—	330
100	100	0.3	—	35.5	3.0	5.0	—	330
400	220	1.3	—	62.5	34	55.5	—	680
350	220	1.1	—	61.5	29	47	—	680
300	220	0.9	—	59.5	23	38	—	680
250	220	0.7	—	57	17	29.5	—	680
200	220	0.5	—	54	12.5	21	—	680
150	220	0.33	—	49	8.0	14	—	680
100	220	0.18	—	40	4.0	7.0	—	680

†R_{g1}=Grid resistor of following valve.

REPLACEMENT FOR: DH150, 6LD3, 62DDT—Direct.
EAB1. (See page 78.)

DOUBLE DIODE TRIODE

EBC90



B7G

HEATER

V_h	6.3	V
I_h	300	mA

LIMITING VALUES

Triode Section

V_a max.	300	V
p_a max.	1.0	W
V_{h-k} max.	90	V
R_{g-k} max.	3.0	MΩ

Diode Sections (each section)

I_{ad} max.	1.0	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

CHARACTERISTICS

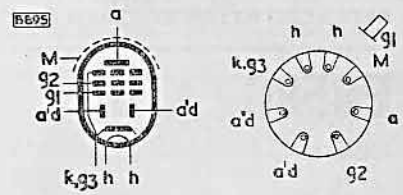
V_a	100	250	V
V_g	−1.0	−3.0	V
I_a	0.8	1.0	mA
g_m	1.3	1.2	mA/V
μ	70	70	
r_a	54	58	kΩ

REPLACEMENT FOR:

DH77, DH77/6AT6, 6AT6—Direct.
DH81, 7B6—Change base. Bias may require adjustment.

DOUBLE DIODE PENTODE (OBSOLETE)

EBF2



Side Contact

HEATER

V_h	6.3	V
I_h	200	mA

CAPACITANCES

Pentode Section

c_{in}	4.4	pF
c_{out}	8.6	pF
c_{a-g1}	<0.002	pF

Diode Sections (each section)

$c_{a'd-k}$	3.0	pF
$c_{a''d-k}$	3.0	pF
$c_{a'd-a''d}$	<0.3	pF

DIMENSIONS

Max. Overall Length	93	mm
Max. Diameter	32	mm

Except for the base, dimensions and capacitances, the EBF2 and EBF32 are identical.

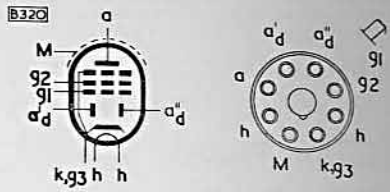
REPLACED BY: EBF80—Change base. EBF80 has 300mA heater current.

EBF32

DOUBLE DIODE PENTODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	200	mA



Octal

CAPACITANCES

Pentode Section

c_{in}	3.9	pF
c_{out}	8.5	pF
c_{a-g1}	<0.002	pF

Diode Sections (each section)

$c_{a'd-k}$	2.9	pF
$c_{a''d-k}$	2.9	pF
$c_{a'd-a''d}$	<0.45	pF

DIMENSIONS

Max. Overall Length	120	mm
Max. Seated Height	95	mm
Max. Diameter	33	mm

LIMITING VALUES

Pentode Section

V_a max.	300	V
p_a max.	1.5	W
V_{g2} max. (I_a<2mA)	300	V
V_{g2} max. (I_a=5mA)	125	V
p_{g2} max.	300	mW
I_k max.	10	mA

Diode Sections (each section)

$v_{ad(pk)}$ max.	200	V
I_{ad} max.	800	μA

OPERATING CONDITIONS

$V_a=V_b$	250	200	V
R_{g2}	95	60	kΩ
R_k	300	300	Ω
V_{g1}	–2.0	–2.0	V
V_{g2}	100	100	V
I_a	5.0	5.0	mA
I_{g2}	1.6	1.6	mA
g_m	1.8	1.8	mA/V
r_a	1.3	1.0	MΩ
†V_{g1}	–38	–32	V

†For 100 : 1 reduction in g_m

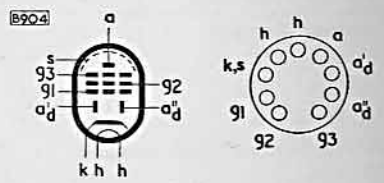
REPLACED BY: EBF80—Change base. EBF80 has 300mA heater current.

EBF80

DOUBLE DIODE PENTODE

HEATER

V_h	6.3	V
I_h	300	mA



B9A

CAPACITANCES

$c_{a'd-g1}$	<0.0008	pF
$c_{a''d-g1}$	<0.001	pF
$c_{a'd-a}$	<0.2	pF
$c_{a''d-a}$	<0.05	pF

Pentode Section

c_{a-g1}	<0.0025	pF
c_{out}	4.9	pF
c_{in}	4.2	pF
c_{g1-h}	<0.07	pF

Diode Sections (each section)

$c_{a'd-k}$	2.2	pF
$c_{a''d-k}$	2.35	pF
$c_{a'd-a''d}$	<0.35	pF
$c_{a'd-h}$	<0.02	pF
$c_{a''d-h}$	<0.005	pF

Mullard

DOUBLE DIODE PENTODE

EBF80 (Cont.)

LIMITING VALUES

Pentode Section

V_a max.	300	V
p_a max.	1.5	W
V_{g2} max. (I_a<2.5 mA)	300	V
V_{g2} max. (I_a=5 mA)	125	V
p_{g2} max.	300	mW
I_k max.	10	mA
*R_{g1-k} max.	3.0	MΩ
V_{h-k} max.	100	V

*R_{g1-k}=22MΩ if grid current biasing is employed.

Diode Sections (each section)

P.I.V. max.	350	V
I_{ad} max.	800	μA
$i_{ad(pk)}$ max.	5.0	mA
V_{h-k} max.	100	V

DIMENSIONS

Max. Overall Length	67.5	mm
Max. Seated Height	60.5	mm
Max. Diameter	22.2	mm

OPERATING CONDITIONS

$V_a=V_b$	250	V
R_{g2}	95	kΩ
V_{g2}	85	V
V_{g3}	0	V
R_k	300	Ω
I_a	5.0	mA
I_{g2}	1.75	mA
V_{g1}	–2.0	V
g_m	2.2	mA/V
r_a	1.4	MΩ
μ_{g1-g2}	18	
R_{eq}	6.8	kΩ
†V_{g1}	–41.5	V

†For 100 : 1 reduction in g_m.

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

Pentode Connection

V_b (V)	R_a (kΩ)	I_a (mA)	R_{g2} (MΩ)	I_{g2} (μA)	R_k (kΩ)	R_{g1} (MΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	R_{g1}† (kΩ)
250	220	0.75	0.82	250	1.8	1.0	110	19	680
250	100	1.5	0.39	500	1.0	1.0	80	18	330
250	220	0.71	1.0	220	0	10	160	19	680
250	100	1.4	0.47	450	0	10	110	19	330

Triode Connection (g_2 connected to a, g_3 connected to k)

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (Ω)	R_{g1} (MΩ)	$\frac{V_{out}}{V_{in}}$	D_{tot}‡ (%)	R_{g1}† (kΩ)
250	100	2.08	820	1.0	14	2.5	330
250	47	4.1	560	1.0	13	2.0	150
250	100	2.16	0	10	15	3.1	330
250	47	4.5	0	10	15	2.7	150

*D_{tot}=5%.

†R_{g1}=Grid resistor of following valve.

‡V_{out}=5.0$V_{(r.m.s.)}$.

REPLACEMENT FOR:

ZD152, 6N8—Direct.

EBF2, EBF32—Change base. EBF80 has 300mA heater current.

Mullard

EBL1

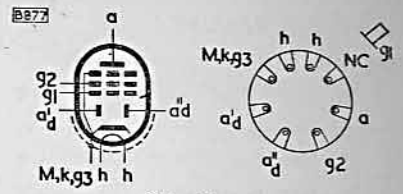
DOUBLE DIODE OUTPUT PENTODE

HEATER

V_h	6.3	V
I_h	1.2	A

DIMENSIONS

Max. Overall Length	129	mm
Max. Diameter	46	mm



Side Contact

For characteristics and operating data, see Type EBL31. Except for base and dimensions, the EBL1 and EBL31 are identical.

REPLACEMENT FOR: DDPP6Bs—Direct.

EBL21

DOUBLE DIODE OUTPUT PENTODE

HEATER

V_h	6.3	V
I_h	800	mA

DIMENSIONS

Max. Overall Length	96	mm
Max. Bulb Diameter	29	mm

LIMITING VALUES

Pentode Section

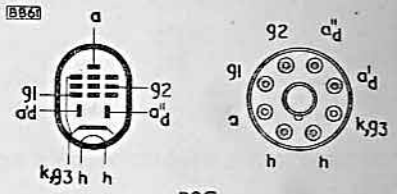
V_a max.	300	V
p_a max.	11	W
V_{g_2} max.	300	V
p_{g_2} max.	3.5	W
I_k max.	60	mA
V_{h-k} max.	50	V

Diode Sections (each section)

V_{ad} max.	200	V
I_{ad} max.	800	μA

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	250	250	V
V_{g_2}	250	275	V
I_a	36	44	mA
I_{g_2}	4.5	5.8	mA
R_k	150	125	Ω
R_a	7.0	5.7	kΩ
$V_{in(r.m.s.)}$	4.2	4.5	V
P_{out}	4.5	5.5	W
D_{tot}	10	10	%



B8G

CHARACTERISTICS

V_a	250	250	V
V_{g_2}	250	275	V
V_{g_1}	−6.0	−6.2	V
I_a	36	44	mA
I_{g_2}	4.5	5.8	mA
g_m	9.0	9.5	mA/V
$\mu_{g_1-g_2}$	23	23	
r_a	50	50	kΩ

OPERATING CONDITIONS

Two valves in class "AB" push-pull

V_a	300	V
V_{g_2}	300	V
*R_k	130	Ω
$I_{a(o)}$	2×30	mA
I_a (max. sig.)	2×36	mA
$I_{g_2(o)}$	2×3.8	mA
I_{g_2} (max. sig.)	2×6.5	mA
R_{a-a}	9.0	kΩ
$V_{in(g_1-g_1)\ r.m.s.}$	14	V
P_{out}	13.2	W
D_{tot}	1.8	%

*Common cathode bias resistor

REPLACEMENT FOR: DN143—Direct.

Mullard

EBL31

DOUBLE DIODE OUTPUT PENTODE

HEATER

V_h	6.3	V
I_h	1.2	A

DIMENSIONS

Max. Overall Length	136	mm
Max. Diameter	46	mm

LIMITING VALUES

Pentode Section

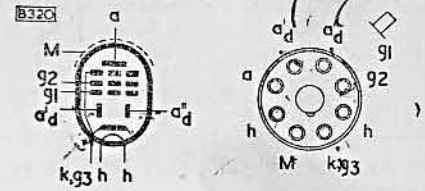
V_a max.	250	V
p_a max.	9.0	W
I_k max.	55	mA
V_{g_2} max.	250	V
p_{g_2} max.	1.5	W
V_{h-k} max.	50	V

Diode Sections (each section)

V_{ad} max.	200	V
I_{ad} max.	800	μA

CHARACTERISTICS

V_a	250	V
V_{g_2}	250	V
V_{g_1}	−6.0	V
I_a	36	mA
I_{g_2}	5.0	mA
g_m	9.5	mA/V
r_a	55	kΩ



Octal

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	250	V
V_{g_2}	250	V
I_a	36	mA
R_k	146	Ω
I_{g_2}	5.0	mA
R_a	7.0	kΩ
$V_{in(r.m.s.)}$	3.6	V
P_{out}	4.3	W
D_{tot}	10	%

REPLACEMENT FOR: DDPP6B—Change base.

EC31

A.F. TRIODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	650	mA

DIMENSIONS

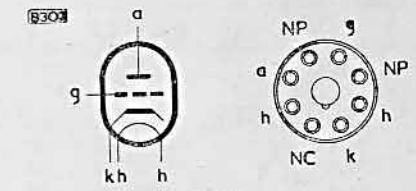
Max. Overall Length	124	mm
Max. Diameter	48	mm

LIMITING VALUES

V_a max.	250	V
p_a max.	5.0	W
I_k max.	30	mA
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	50	V

CHARACTERISTICS

V_a	250	V
V_g	−16	V
I_a	20	mA
g_m	3.2	mA/V
μ	10.5	
r_a	3.0	kΩ



Octal

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	250	V
V_g	−16	V
I_a	20	mA
R_k	800	Ω
R_a	10	kΩ
$V_{in(r.m.s.)}$	9.1	V
P_{out}	500	mW
D_{tot}	5.0	%

Mullard

EC31 (Cont.) — A.F. TRIODE (OBSOLETE)

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

V_b (V)	R_a (kΩ)	R_k (kΩ)	I_a (mA)	$\frac{V_{out}}{V_{in}}$
550	160	9.0	2.5	7.4
450	125	9.0	2.3	7.0
350	100	9.0	2.0	6.5
250	80	9.0	1.6	7.2

REPLACEMENT FOR: AC/P, L4,LL4, ML4, TT4, 41MP—Change base. Raise heater voltage to 6.3V.
TT4A—Change base. Raise heater voltage to 6.3V. Adjust bias.

EC50 — GAS-FILLED TRIODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	1.3	A

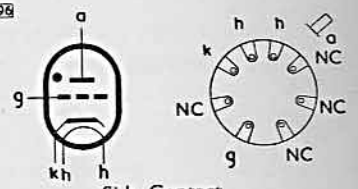
CAPACITANCES

c_{a-k}	3.8	pF
c_{g-k}	6.1	pF
c_{a-g}	2.7	pF

Except for base and dimensions the EC50 and EN31 are identical.

REPLACED BY: EN31—Change base.

B8G



Side Contact

DIMENSIONS

Max. Overall Length	108	mm
Max. Diameter	43	mm

EC52 — U.H.F. OSCILLATOR TRIODE

HEATER

V_h	6.3	V
I_h	430	mA

CAPACITANCES

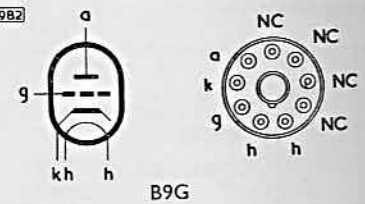
c_{g-k}	5.2	pF
c_{a-k}	1.3	pF
c_{a-g}	3.1	pF

CHARACTERISTICS

V_a	250	V
V_g	–2.6	V
I_a	10	mA
g_m	6.5	mA/V
μ	60	
r_a	9.2	kΩ
R_{eq}	310	Ω

REPLACEMENT FOR: RL16—Direct.

B9B2



B9G

DIMENSIONS

Max. Overall Length	78	mm
Max. Seated Height	64	mm
Max. Diameter	38	mm

LIMITING VALUES

V_a max.	400	V
p_a max.	7.5	W
Limiting frequency of oscillation	400	Mc/s

Mullard

U.H.F. OSCILLATOR TRIODE (OBSOLETE) — EC53

HEATER

V_h	6.3	V
I_h	250	mA

CAPACITANCES

c_{g-k}	1.3	pF
c_{a-k}	0.13	pF
c_{a-g}	1.3	pF

LIMITING VALUES

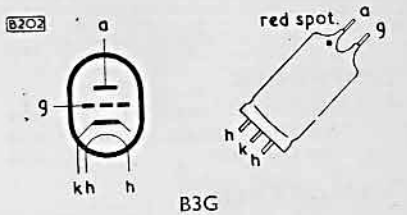
V_a max.	250	V
p_a max.	2.5	W
I_k max.	20	mA
R_{g-k} max.	500	kΩ
V_{h-k} max.	40	V
f max.	600	Mc/s

CHARACTERISTICS

V_a	200	V
V_g	–3.3	V
I_a	7.5	mA
g_m	2.9	mA/V
μ	33	
r_a	11.4	kΩ
g_m (V_g=0V)	4.0	mA/V

REPLACEMENT FOR: RL18—Direct.

B2O2



B3G

DIMENSIONS

Max. Overall Length	54	mm
Max. Seated Height	46	mm
Max. Diameter	16	mm

OPERATING CONDITIONS
(As power oscillator up to f=400 Mc/s

f= (Mc/s)	V_a (V)	I_a (mA)	I_g (mA)	P_{out} (W)	η (%)
110	250	14.5	5.0	1.3	35
165	250	14.5	5.0	1.2	33
210	250	12.5	3.6	0.8	26
285	250	12.5	3.6	0.5	16
335	200	12.5	3.6	0.35	14
400	200	12.5	3.6	0.3	12

Note—The input power is reduced at the higher frequencies in order to keep within the rated maximum anode dissipation.

GROUNDED GRID TRIODE — EC54

HEATER

V_h	6.3	V
I_h	430	mA

CAPACITANCES

c_{a-k}	0.12	pF
c_{g-k}	9.8	pF
c_{a-g}	7.5	pF

LIMITING VALUES

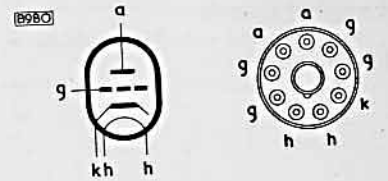
V_a max.	250	V
I_k max.	25	mA
p_a max.	3.0	W

CHARACTERISTICS

V_a	250	V
V_g	–1.5	V
I_a	10	mA
g_m	9.0	mA/V
μ	98	

REPLACEMENT FOR: RL37—Direct.

B9BO



B9G

DIMENSIONS

Max. Overall Length	78	mm
Max. Seated Height	62	mm
Max. Diameter	38	mm

Mullard

EC90

R.F. POWER TRIODE

HEATER

V_h	6.3	V
I_h	150	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

CAPACITANCES

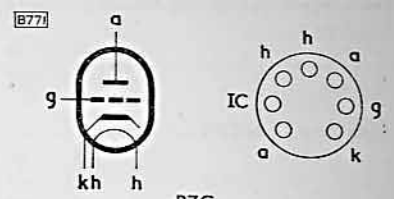
(measured without an external shield)

c_{a-g}	1.6	pF
c_{g-k}	1.8	pF
c_{a-k}	1.3	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	3.5	W
I_a max.	25	mA
I_g max.	8.0	mA
$-V_g$ max.	50	V
R_{g-k} max. (fixed bias)	250	kΩ
R_{g-k} max. (self bias)	1.0	MΩ

REPLACEMENT FOR: L77, 6C4.—Direct.



B7G

OPERATING CONDITIONS

As r.f. amplifier or oscillator

(Class "C" telegraphy or f.m.)

V_a	300	V
V_g	−27	V
I_a	25	mA
I_g (approx.)	7.0	mA
P_{drive} (approx.)	350	mW
P_{out} (approx.)	5.5	W

Note—An output of 2.5W may be obtained from an EC90 as an oscillator at f=150Mc/s with a grid resistor of 10kΩ and maximum rated input.

EC91

GROUNDED GRID TRIODE

HEATER

V_h	6.3	V
I_h	300	mA

CAPACITANCES

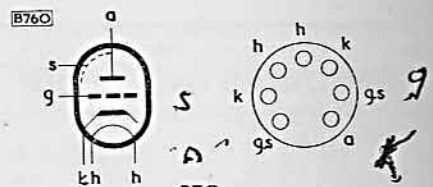
(measured with external shield connected to grid)

c_{a-g}	3.8	pF
c_{a-k+h}	<0.2	pF
c_{g-k+h}	5.3	pF

LIMITING VALUES

V_a max.	250	V
p_a max.	2.5	W
I_k max.	15	mA
V_{h-k} max.	150	V
V_{g-k} max.	100	V
f max.	250	Mc/s

REPLACEMENT FOR: 6AQ4, 6L34—Direct.



B7G

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

CHARACTERISTICS

V_a	250	V
R_k	150	Ω
I_a	10	mA
V_g	−1.5	V
g_m	8.5	mA/V
μ	100	
r_a	12	kΩ
R_{eq}	400	Ω

Mullard

ECC31

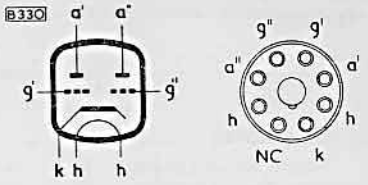
DOUBLE TRIODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	950	mA

DIMENSIONS

Max. Overall Length	106	mm
Max. Diameter	46	mm



Octal

For characteristics and operating data, see type ECC32. Except for base connections, the ECC31 and ECC32 are identical.

REPLACED BY: ECC33—Rewire base. Connect pins 3 and 6 together.

ECC32

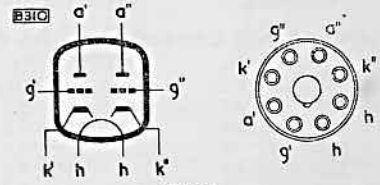
DOUBLE TRIODE (separate cathodes)

HEATER

V_h	6.3	V
I_h	950	mA

DIMENSIONS

Max. Overall Length	106	mm
Max. Diameter	46	mm



Octal

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	5.0	W
I_k max.	50	mA
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	50	V

CHARACTERISTICS (each section)

V_a	250	V
V_g	−4.6	V
I_a	6.0	mA
g_m	2.3	mA/V
μ	32	
r_a	14	kΩ

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	D_{tot} (%)	R_{g1}† (kΩ)
400	47	3.9	1.2	21	67	3.7	150
350	47	3.4	1.2	20.5	57	3.6	150
300	47	2.9	1.2	20	48	3.5	150
250	47	2.4	1.2	19.5	37	3.4	150
200	47	1.9	1.2	19.5	26	3.2	150
400	100	2.1	2.7	25	81	3.0	330
350	100	1.8	2.2	25	69	2.9	330
300	100	1.6	2.2	24.5	54	2.8	330
250	100	1.3	2.2	24.5	44	2.6	330
200	100	1.05	2.2	24	32	2.4	330
400	220	1.1	3.9	27.5	81	2.3	680
350	220	0.95	3.9	27.5	68	2.2	680
300	220	0.85	3.9	27	56	2.2	680
250	220	0.7	3.9	27	45	2.1	680
200	220	0.55	3.9	26.5	34	2.0	680

Notes.

*V_{out}=Output voltage at start of I_{g1} or at D_{tot}=10%.

†R_{g1}=Grid resistor of following valve.

Mullard

ECC33

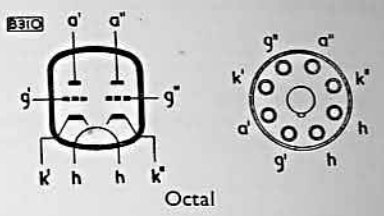
DOUBLE TRIODE (separate cathodes)

HEATER

V_h	6.3	V
I_h	400	mA

DIMENSIONS

Max. Overall Length	82	mm
Max. Seated Height	68	mm
Max. Diameter	33	mm



Octal

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	2.5	W
I_k max.	20	mA
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	100	V

CHARACTERISTICS (each section)

V_a	250	V
V_g	−4.0	V
I_a	9.0	mA
g_m	3.6	mA/V
μ	35	
r_a	9.7	kΩ

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	D_{tot} (%)	R_{g1}† (kΩ)
400	47	4.0	1.2	25.5	74	6.1	150
350	47	3.5	1.2	25	62.5	5.9	150
300	47	3.0	1.2	25	50	5.6	150
250	47	2.5	1.2	25	41	5.6	150
200	47	2.0	1.2	24.5	30.5	5.3	150
400	100	2.05	2.2	28	78.5	5.7	330
350	100	1.8	2.2	27.5	66.5	5.6	330
300	100	1.55	2.2	27	54.5	5.6	330
250	100	1.3	2.2	27	43	5.4	330
200	100	1.05	2.2	26.5	32	5.2	330
400	220	1.1	3.9	28	74.5	5.1	680
350	220	0.98	3.9	28	63	5.0	680
300	220	0.83	3.9	28	51	5.0	680
250	220	0.7	3.9	27.5	41	4.8	680
200	220	0.53	3.9	27	30.5	4.8	680

*V_{out}=Output voltage at the start of I_g. At output voltages lower than those shown the distortion is approximately proportional to voltage.

†R_{g1}=Grid resistor of following valve.

REPLACEMENT FOR: ECC31—Rewire base and connect pins 3 and 6 together.

ECC34

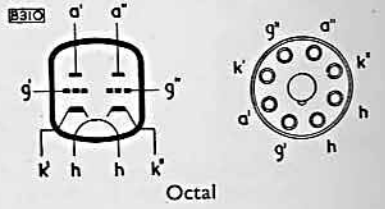
DOUBLE TRIODE (separate cathodes)

HEATER

V_h	6.3	V
I_h	950	mA

DIMENSIONS

Max. Overall Length	106	
Max. Diameter	46	



Octal

DOUBLE TRIODE (separate cathodes)

ECC34 (Cont.)

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	3.25	W
I_k max.	50	mA
V_{h-k} max.	50	V
R_{g-k} max.	2.0	MΩ

CHARACTERISTICS (each section)

V_a	250	V
I_a	10	mA
V_g	−16	V
g_m	2.2	mA/V
r_a	5.2	kΩ
μ	11.5	

DOUBLE TRIODE (separate cathodes)

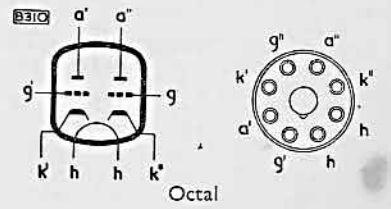
ECC35

HEATER

V_h	6.3	V
I_h	400	mA

DIMENSIONS

Max. Overall Length	83	mm
Max. Diameter	33	mm



Octal

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	1.5	W
I_k max.	8.0	mA
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	90	V

CHARACTERISTICS (each section)

V_a	250	V
V_g	−2.5	V
I_a	2.3	mA
g_m	2.0	mA/V
μ	68	
r_a	34	kΩ

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out} ($V_{r.m.s.}$) (D_{tot}=5%)	V_{out} ($V_{r.m.s.}$) (D_{tot}=10%)	R_{g1}† (kΩ)
400	100	1.3	2.7	40.5	37.5	66.2	330
350	100	1.1	2.7	40.5	32.2	57	330
300	100	1.0	2.7	40	28	48.7	330
250	100	0.8	2.7	40	23.2	41.1	330
200	100	0.65	2.7	39.5	18.7	28.5	330
400	220	0.73	4.7	46	44	80	680
350	220	0.63	4.7	45.5	38	69.3	680
300	220	0.53	4.7	45.5	32.5	59	680
250	220	0.45	4.7	45	27	43	680
200	220	0.38	4.7	45	21.5	33.6	680

†R_{g1}=Grid resistor of following valve.

REPLACEMENT FOR:

6SL7GT—In a.c. mains-operated equipment only.
6SC7, 6SC7GT, 7F7—Rewire base. In a.c. mains-operated equipment only.

ECC40

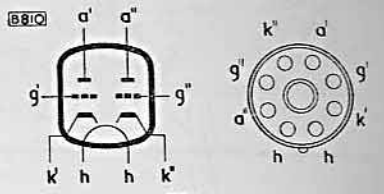
DOUBLE TRIODE (separate cathodes)

HEATER

V_h	6.3	V
I_h	600	mA

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	1.5	W
p_g max.	50	mW
I_k max.	10	mA
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	175	V



B8A

DIMENSIONS

Max. Overall Length	68	mm
Max. Seated Height	61	mm
Max. Diameter	22	mm

CHARACTERISTICS (each section)

V_a	250	V
V_g	−5.2	V
I_a	6.0	mA
g_m	2.7	mA/V
r_a	11	kΩ
μ	30	

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	D_{tot} (%)	R_{g1}† (kΩ)
400	47	4.1	1.2	21	72.5	4.4	150
350	47	3.6	1.2	20.5	60	4.1	150
300	47	3.1	1.2	20	50	4.0	150
250	47	2.6	1.2	20	40	3.8	150
200	47	2.0	1.2	20	29.5	3.4	150
400	100	2.2	2.2	24.5	76	3.9	330
350	100	1.9	2.2	24	65	3.9	330
300	100	1.6	2.2	24	54	3.8	330
250	100	1.4	2.2	24	44	3.7	330
200	100	1.1	2.2	24	33	3.6	330
400	220	1.1	3.9	25	72	3.8	680
350	220	1.0	3.9	25	63	3.7	680
300	220	0.87	3.9	25	53	3.7	680
250	220	0.72	3.9	25	44	3.6	680
200	220	0.58	3.9	24.5	32	3.5	680

*V_{out}=Output voltage at start of I_{g1}. At output voltages lower than those shown the distortion is approximately proportional to voltage.

†R_{g1}=Grid resistor of following valve.

ECC81

DOUBLE TRIODE (separate cathodes)

HEATER

	Series	Parallel	
V_h	12.6	6.3	V
I_h	150	300	mA

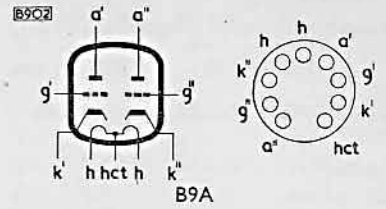
CAPACITANCES

*c_{a-g}	1.7	pF
*c_{in}	2.5	pF
c_{out}'	0.4	pF
c_{out}''	0.3	pF
*c_{a-k}	0.18	pF
*c_{h-k}	2.4	pF
*c_{k-g+h}	4.8	pF
$c_{a'-g'+h}$	1.9	pF
$c_{a''-g''+h}$	1.8	pF
$c_{a'-a''}$	<0.4	pF

*Each section.

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	2.5	W
I_k max.	15	mA
$-V_g$ max.	50	V
R_{g-k} max. (self-bias)	1.0	MΩ
V_{h-k} max.	150	V



B9A

DIMENSIONS

Max. Overall Length	56	mm
Max. Seated Height	49	mm
Max. Diameter	22.2	mm

CHARACTERISTICS (each section)

V_a	100	170	200	250	V
I_a	3.0	8.5	11.5	10	mA
V_g	−1.0	−1.0	−1.0	−2.0	V
g_m	3.5	5.5	6.4	5.0	mA/V
μ	58	66	66	60	
r_a	17	12	10	12	kΩ
†r_{ip}	22	17	15	27	kΩ

†Measured at 50Mc/s.

REPLACEMENT FOR: B152, B309, 12AT7—Direct.

ECC82

DOUBLE TRIODE (separate cathodes)

HEATER

	Series	Parallel	
V_h	12.6	6.3	V
I_h	150	300	mA

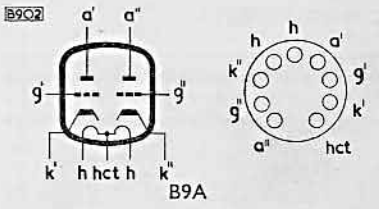
DIMENSIONS

Max. Overall Length	56	mm
Max. Seated Height	49	mm
Max. Diameter	22.2	mm

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	2.75	W
I_k max.	20	mA
R_{g-k} max. (cathode bias)	1.0	MΩ
R_{g-k} max. (fixed bias)	250	kΩ
V_{h-k} max.	180	V
†R_{h-k} max.	20	kΩ

*When used as a phase inverter immediately preceding the output stage, R_{h-k} max. may be 120kΩ.



B9A

CAPACITANCES

*c_{a-g}	1.5	pF
*c_{g-k}	1.6	pF
$c_{a'-k}'$	0.5	pF
$c_{a''-k}''$	0.35	pF

*Each section.

CHARACTERISTICS (each section)

V_a	100	250	V
I_a	12	10.5	mA
V_g	0	−8.5	V
g_m	3.1	2.2	mA/V
μ	19	17	
r_a	6.2	7.7	kΩ

REPLACEMENT FOR: B329, 12AU7—Direct.

ECC83

DOUBLE TRIODE (separate cathodes)

HEATER

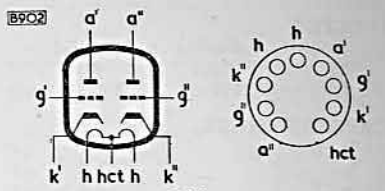
	Series	Parallel	
V_h	12.6	6.3	V
I_h	150	300	mA

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	1.0	W
I_k max.	8.0	mA
$-V_g$ max.	50	V
*R_{g-k} max.	2.2	MΩ
V_{h-k} max.	180	V
†R_{h-k} max.	20	kΩ

*With grid current biasing R_{g-k} max.= 22MΩ.

†When used as a phase inverter immediately preceding the output stage, R_{h-k} max. may be 120kΩ.



B9A

DIMENSIONS

Max. Overall Length	56	mm
Max. Seated Height	49	mm
Max. Diameter	22.2	mm

CHARACTERISTICS (each section)

V_a	100	250	V
I_a	0.5	1.2	mA
V_g	–1.0	–2.0	V
g_m	1.25	1.6	mA/V
μ	100	100	
r_a	80	62.5	kΩ

REPLACEMENT FOR: B339, 12AX7—Direct.

ECC85

R.F. DOUBLE TRIODE

Double triode primarily intended for use in f.m. receivers as an r.f. amplifier and self-oscillating additive mixer.

HEATER

V_h	6.3	V
I_h	435	mA

CAPACITANCES

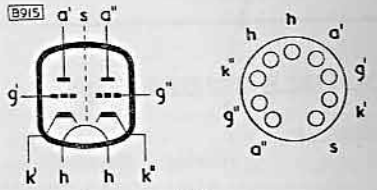
*c_{a-g}	1.5	pF
*$c_{g-k+h+s}$	3.0	pF
*c_{a-k}	0.18	pF
*$c_{a-k+h+s}$	1.2	pF
†$c_{a'-k'+h+s}$	1.9	pF
†$c_{a''-k''+h+s}$	1.8	pF
$c_{a'-a''}$	<0.04	pF
†$c_{a'-a''}$	<0.008	pF
$c_{a'-k''}$	<0.008	pF
$c_{g'-g''}$	<0.003	pF
$c_{a'-g''}$	<0.008	pF
$c_{a''-g'}$	<0.008	pF
$c_{a''-k'}$	<0.008	pF
$c_{g'-k''}$	<0.003	pF
$c_{g''-k'}$	<0.003	pF

*Each section.

†Measured with an external shield.

LIMITING VALUES
(each section unless otherwise specified)

V_a max.	300	V
p_a max.	2.5	W
$p_a'+p_a''$ max.	4.5	W
I_k max.	15	mA
$-V_g$ max.	100	V
V_{h-k} max.	90	V



B9A

DIMENSIONS

Max. Overall Length	56	mm
Max. Seated Height	49	mm
Max. Diameter	22.2	mm

OPERATING CONDITIONS
As R.F. amplifier

V_b	250	V
V_a	230	V
R_a	1.8	kΩ
I_a	10	mA
V_g	–2.0	V
g_m	6.0	mA/V
r_a	9.7	kΩ
R_k	200	Ω
r_{in} (f=100 Mc/s)	6.0	kΩ
R_{eq}	500	Ω

Mullard

R.F. DOUBLE TRIODE

ECC85 (Cont.)

CHARACTERISTICS (each section)

V_a	250	V
I_a	10	mA
V_g	–2.3	V
g_m	5.9	mA/V
μ	57	

OPERATING CONDITIONS
As self-oscillating frequency changer

V_b	250	V
R_a	12	kΩ
R_{g-k}	1.0	MΩ
I_a	5.2	mA
$V_{osc(r.m.s.)}$	3.0	V
g_c	2.3	mA/V
r_a	22	kΩ

REPLACEMENT FOR: B719/ECC85, 6AQ8—Direct.

ECC91

V.H.F. DOUBLE TRIODE

Double triode with common cathode for use as r.f. power amplifier or oscillator.

HEATER

V_h	6.3	V
I_h	450	mA

CAPACITANCES (each section)

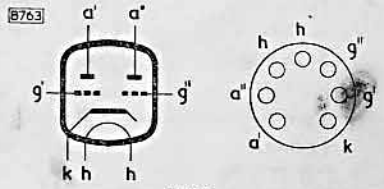
c_{a-g}	1.6	pF
c_{g-k}	2.2	pF
c_{a-k}	0.4	pF

LIMITING VALUES (each section)

V_a max.	300	V
p_a max.	2×1.5	W
$-V_g$ max.	40	V
I_g max.	2×8.0	mA
V_{h-k} max.	100	V
R_{g-k} max. (self-bias)	500	kΩ

CHARACTERISTICS (each section)

V_a	100	V
I_a	8.5	mA
V_g	–850	mV
g_m	5.3	mA/V
μ	38	
r_a	7.1	kΩ



B7G

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

OPERATING CONDITIONS
Class "C" telegraphy push-pull r.f. amplifier and oscillator at 80 Mc/s approx.

V_a	150	V
*V_g	–10	V
R_g	625	Ω
R_k	220	Ω
I_a	2×15	mA
I_g	2×8	mA
P_{drive}	350	mW
P_{out}	3.5	W

*Obtained from a fixed supply or from a grid or cathode resistor of value shown.

Note—An output of 1W may be obtained from an ECC91 in a push-pull oscillator circuit at 250Mc/s with V_a=150V, p_a=2×1.5W and with a common grid resistor of 2.0kΩ.

REPLACEMENT FOR: 6J6—Direct.

Mullard

ECH2

TRIODE HEPTODE FREQUENCY CHANGER (OBSOLETE)

HEATER

V_h	6.3	V
I_h	950	mA

DIMENSIONS

Max. Overall Length	138	mm
Max. Diameter	37	mm

LIMITING VALUES

Heptode

V_a max.	300	V
V_{g2+g4} max.	125	V
p_a max.	1.0	W
p_{g2+g4} max.	600	mW
I_k max.	25	mA
V_{h-k} max.	50	V

Triode

V_a max.	125	V
p_a max.	1.0	W

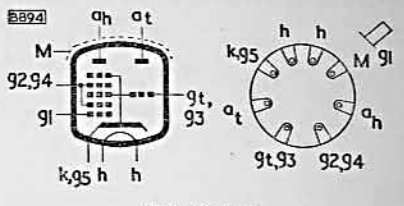
OPERATING CONDITIONS

Heptode Section

V_a	250	V
V_{g2+g4}	100	V
V_{g1}	−2.5	V
$V_{osc(r.m.s.)}$	8.0	V
I_a	3.25	mA
I_{g2+g4}	6.0	mA
g_c	750	μA/V
r_a	1.5	MΩ
I_{g3}	200	μA
†V_{g1}	−30	V

†For 100 : 1 reduction in g_c

REPLACED BY: ECH3—Direct.



Side Contact

CAPACITANCES

c_{at-g1h}	0.06	pF
c_{at-ah}	0.9	pF
c_{gt-g1}	0.16	pF

Heptode

c_{in}	8.4	pF
c_{out}	13.8	pF

Triode

c_{a-k}	3.5	pF
c_{g-k}	17	pF
c_{a-g}	3.5	pF

CHARACTERISTICS

Triode Section

V_a	100	V
V_g	0	V
I_a	24	mA
g_m	5.5	mA/V
μ	17.5	

Mullard

TRIODE HEXODE FREQUENCY CHANGER

ECH3

HEATER

V_h	6.3	V
I_h	200	mA

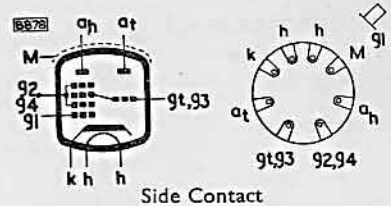
CAPACITANCES

Hexode

c_{gt-g1}	<0.3	pF
c_{g1-k}	4.9	pF
c_{a-k}	9.0	pF
c_{a-g1}	<0.003	pF

Triode

c_{g-k}	8.8	pF
c_{a-k}	4.4	pF
c_{a-g1}	1.4	pF



Side Contact

DIMENSIONS

Max. Overall Length	94	mm
Max. Diameter	36	mm

For characteristics, operating data and limting values see type ECH35.

Except for base, capacitances and heater current, the ECH3 and ECH35 are identical.

REPLACEMENT FOR:

ECH2—Direct.

EH2—Rewire base. Use hexode section only, in extreme cases.

TRIODE HEPTODE

ECH21

HEATER

V_h	6.3	V
I_h	330	mA

DIMENSIONS

Max. Overall Length	77	mm
Max. Seated Height	62	mm
Max. Diameter	32	mm

CAPACITANCES

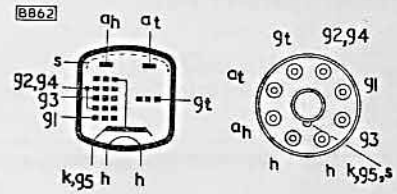
c_{gt-g1}	<0.1	pF
$c_{(gt+g3)-k}$	12.8	pF
$c_{(gt+g3)-g1}$	<0.35	pF
$c_{(gt+g3)-ah}$	<0.1	pF

Heptode Section

c_{in}	6.8	pF
c_{out}	9.5	pF
c_{a-g1}	<0.002	pF
c_{g1-g3}	<0.3	pF
c_{g3-all}	8.0	pF

Triode Section

c_{in}	4.5	pF
c_{out}	3.5	pF
c_{g-k}	3.2	pF
c_{a-k}	2.0	pF
c_{a-g}	1.1	pF



B8G

LIMITING VALUES

Heptode Section

V_a max.	300	V
p_a max.	1.5	V
V_{g2+g4} (I_a=3 mA) max.	100	V
V_{g2+g4} (I_a<1 mA) max.	300	V
p_{g2+g4} max.	1.0	W
I_k max.	15	mA
R_{g1-k} max.	3.0	MΩ
R_{g3-k} max.	3.0	MΩ
V_{h-k} max.	50	V

Triode Section

V_a max.	175	V
p_a max.	800	mW
R_{g-k} max.	3.0	MΩ

Mullard

ECH21 (Cont.)

TRIODE HEPTODE

CHARACTERISTICS

Triode Section

V_a	100	V
V_g	0	V
I_a	12	mA
g_m	3.2	mA/V
μ	21	

OPERATING CONDITIONS

Heptode Section as I.F. Amplifier

$V_a=V_b$	250	V
V_{g3}	0	V
R_{g2+g4}	45	kΩ
V_{g1}	–2.0	V
V_{g2+g4}	90	V
I_a	5.3	mA
I_{g2+g4}	3.5	mA
g_m	2.2	mA/V
r_a	900	kΩ
μ_{g1-g2}	18	
R_{eq}	7.5	kΩ
†V_{g1}	–36	V

†For 100 : 1 reduction in g_m

OPERATING CONDITIONS

Heptode section as mixer

$V_a=V_b$	250	V
R_{g2+g4}	24	kΩ
R_k	150	Ω
R_{g3+gt}	47	kΩ
I_{g3+gt}	190	μA
V_{g1}	–2.0	V
V_{g2+g4}	100	V
I_a	3.0	mA
I_{g2+g4}	6.2	mA
r_a	1.4	MΩ
g_c	750	μA/V
R_{eq}	55	kΩ
†V_{g1}	–24.5	V

†For 100 : 1 reduction in g_m

OPERATING CONDITIONS

Triode section as r.f. oscillator

V_b	250	V
R_a	20	kΩ
R_{gt+g3}	47	kΩ
I_{gt+g3}	190	μA
I_a	4.5	mA
g_m (effective)	550	μA

REPLACEMENT FOR:

X143—Direct.

ECH4, 6153T—Change base.

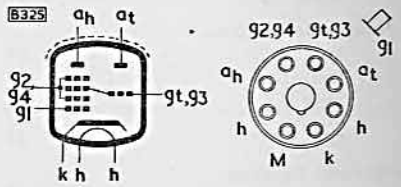
7S7—Rewire base. Receiver may need realigning.

TRIODE HEXODE (OBSOLETE)

ECH33

HEATER

V_h	6.3	V
I_h	200	mA



Octal

For characteristics, operating data and limiting values see type ECH35. Except for heater current, the ECH33 and ECH35 are identical.

REPLACED BY:

ECH35—In a.c. receivers.

CCH35—In a.c./d.c. receivers.

TRIODE HEXODE

ECH35

HEATER

V_h	6.3	V
I_h	225	mA

CAPACITANCES

c_{gt-g1}	<0.3	pF

Hexode Section

c_{g1-k}	5.0	pF
c_{a-k}	10	pF
c_{a-g1}	<0.003	pF

Triode Section

c_{g-k}	9.0	pF
c_{a-k}	3.0	pF
c_{a-g}	1.6	pF

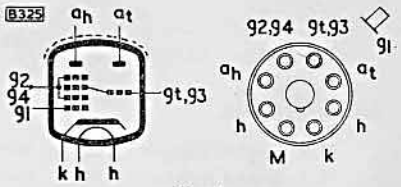
LIMITING VALUES

Hexode Section

V_a max.	300	V
p_a max.	1.2	W
V_{g2+g4} max. (I_a=4.5mA)	125	V
V_{g2+g4} max. (I_a=<0.5mA)	200	V
p_{g2+g4} max.	600	mW
I_k max.	15	mA
R_{g1-k} max.	3.0	MΩ
V_{h-k} max.	100	V
R_{g3-k} max.	100	kΩ

Triode Section

V_a max.	100	V
p_a max.	1.5	W
R_{gt-k} max.	100	kΩ



Octal

DIMENSIONS

Max. Overall Length	113	mm
Max. Diameter	36	mm

OPERATING CONDITIONS AS A FREQUENCY CHANGER

Hexode Section

(with fixed screen grid voltage)

V_a	250	V
V_{g2+g4}	100	V
R_k	215	Ω
R_{g3+gt}	47	kΩ
I_{g3+gt}	200	μA
V_{g1}	–2.0	V
I_a	3.0	mA
I_{g2+g4}	3.0	mA
g_c	650	μA/V
r_a	1.3	MΩ
†V_{g1}	–17	V

†For 100 : 1 reduction in g_c

Triode Section

V_b	100	250	V
R_a	—	45	kΩ
I_a (R_{gt}=47 kΩ, I_{gt}=200 μA)	3.3	3.3	mA
I_a (V_{gt}=0 V, V_{osc}=0 V)	10	4.5	mA
g_m (V_{gt}=0 V, V_{osc}=0 V)	2.8	2.2	mA/V
μ (V_{gt}=0 V, V_{osc}=0 V)	24	24	

REPLACEMENT FOR:

X147—Direct.

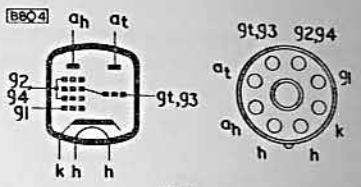
BVA274, BVA275, BVA276, ECH33, OM10, TH62, X61M, 6E8G, 6P8G—Direct in a.c. mains-operated receivers only.

6C31—Screen resistors will require adjustment. Change bias resistor to 210Ω. Receiver may need realigning.

6J8G—Earth pin 1. Bias may require adjustment and receiver realigning.

ECH41

TRIODE HEXODE (OBSOLETE)



B8A

HEATER

V_h	6.3	V
I_h	225	mA

DIMENSIONS

Max. Overall Length	60	mm
Max. Seated Height	54	mm
Max. Diameter	22	mm

CAPACITANCES

C_{gt-g1}	<0.35	pF
C_{gt-ah}	<0.2	pF
Hexode Section		
$C_{g1-h+k+g2+g4+skirt}$	3.4	pF
$C_{a-h+k+g2+g4+skirt}$	6.0	pF
C_{a-g1}	<0.1	pF
C_{g1-h}	<0.15	pF
Triode Section		
$C_{gt-h+k+g2+g4+skirt}$	4.8	pF
$C_{at-h+k+g2+g4+skirt}$	1.5	pF
C_{at-gt}	1.2	pF

LIMITING VALUES

Hexode		
V_a max.	300	V
V_{g2+g4} max.	125	V
p_a max.	800	mW
p_{g2+g4} max.	300	mW
I_k max.	7.0	mA
V_{h-k} max.	100	V
Triode		
V_a max.	175	V
p_a max.	900	mW
I_k max.	5.5	mA

OPERATING CONDITIONS AS A FREQUENCY CHANGER (with screen grid fed from a potentiometer—consisting of R_1 and R_2)

Hexode Section		
$V_a = V_b$	250	V
R_1	33	kΩ
R_2	47	kΩ
R_k	200	Ω
R_{gt+g3}	22	kΩ
V_{g1}	–2.0	V
I_{gt+g3}	350	μA
V_{g2+g4}	105	V
I_a	3.0	mA
I_{g2+g4}	2.2	mA
g_c	500	μA/V
r_a	2.0	MΩ
R_{eq}	170	kΩ
†V_{g1}	–28	V

†For 100 : 1 reduction in g_c.

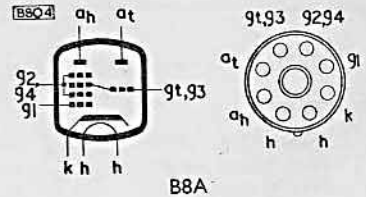
Triode Section		
V_b	250	V
R_a	33	kΩ
I_a	4.9	mA
R_{gt+g3}	22	kΩ
I_{gt+g3}	350	μA
V_{osc}	8.0	V
g_m (effective)	550	μA

REPLACED BY: ECH42—Screen grid resistors may require alteration. Oscillator grid resistor should be increased to 47kΩ. Receiver may require realigning.

Mullard

TRIODE HEXODE FREQUENCY CHANGER

ECH42



B8A

HEATER

V_h	6.3	V
I_h	230	mA

CAPACITANCES

C_{gt-g1}	<0.35	pF
C_{gt-ah}	<0.2	pF
Hexode Section		
$C_{g1-h+k+g2+g4+skirt}$	4.0	pF
$C_{a-h+k+g2+g4+skirt}$	9.2	pF
C_{a-g1}	<0.1	pF
C_{g1-h}	<0.15	pF
Triode Section		
$C_{gt-h+k+g2+g4+skirt}$	5.5	pF
$C_{at-h+k+g2+g4+skirt}$	2.3	pF
C_{at-gt}	1.2	pF

LIMITING VALUES

Hexode Section		
V_a max.	250	V
p_a max.	1.5	W
V_{g2+g4} max. (i_a=3 mA)	125	V
V_{g2+g4} max. (I_a<1 mA)	250	V
p_{g2+g4} max.	300	mW
I_k max.	7.0	mA
R_{g1-k} max.	3.0	MΩ
R_{g3-k} max.	3.0	MΩ
V_{h-k} max.	50	V
Triode Section		
V_a max.	175	V
p_a max.	800	mW
I_k max.	6.0	mA
R_{gt-k} max.	3.0	MΩ

CHARACTERISTICS

Triode Section		
V_a	100	V
V_g	0	V
I_a	10	mA
g_m	2.8	mA/V
μ	22	

REPLACEMENT FOR:

X150, 6C10, 62TH—Direct.
ECH41—See page 106.
6C9—Screen resistors will require adjustment. Change bias resistor to 180Ω. Receiver may require realigning.

DIMENSIONS

Max. Overall Length	60	mm
Max. Seated Height	53	mm
Max. Diameter	22	mm

OPERATING CONDITIONS AS A FREQUENCY CHANGER (with screen grid fed from a potentiometer—consisting of R_1 and R_2)

Hexode Section		
$V_a = V_b$	250	V
R_1	27	kΩ
R_2	27	kΩ
R_k	180	Ω
R_{g3+gt}	47	kΩ
I_{g3+gt}	200	μA
V_{g1}	–2.0	V
V_{g2+g4}	85	V
I_a	3.0	mA
I_{g2+g4}	3.0	mA
g_c	750	μA/V
r_a	>1.0	MΩ
R_{eq}	75	kΩ
†V_{g1}	–29	V

†For 100 : 1 reduction in g_c

Triode Section		
V_b	250	V
R_a	33	kΩ
R_{gt+g3}	47	kΩ
I_{gt+g3}	200	μA
I_a	4.8	mA
g_m (effective)	550	μA/V

Mullard

ECH81

TRIODE HEPTODE

HEATER

V_h	6.3	V
I_h	300	mA

DIMENSIONS

Max. Overall Length	67.5	mm
Max. Seated Height	60.5	mm
Max. Diameter	22.2	mm

CAPACITANCES

C_{ah-at}	0.20	pF
C_{ah-gt}	<0.09	pF
$C_{ah-(g3+gt)}$	<0.35	pF
C_{g1-at}	<0.06	pF
C_{g1-gt}	<0.17	pF
$C_{g1-(g3+gt)}$	<0.45	pF

Heptode Section

$C_{in(g1)}$	4.8	pF
$C_{in(g3)}$	6.0	pF
C_{out}	7.9	pF
C_{a-g1}	<0.006	pF
C_{g1-g3}	<0.3	pF
C_{g1-h}	<0.17	pF
C_{g3-h}	<0.06	pF

Triode Section

C_{in}	2.6	pF
C_{out}	2.1	pF
C_{a-g}	1.0	pF
C_{g-h}	<0.02	pF

LIMITING VALUES

Heptode Section

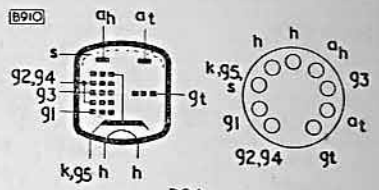
V_a max.	300	V
p_a max.	1.7	W
V_{g2+g4} max.	125	V
V_{g2+g4} max. (I_a<1 mA)	300	V
p_{g2+g4} max.	1.0	W
I_k max.	12.5	mA
V_{h-k} max.	100	V

Triode Section

V_a max.	250	V
p_a max.	800	mW
I_k max.	6.5	mA

REPLACEMENT FOR:

X719, 6AJ8—Direct.
TH13C—Change base. Connect 22Ω 3W resistor in series with heater. Join pins 7 and 9. Receiver may require realigning.



B9A

OPERATING CONDITIONS AS A FREQUENCY CHANGER

Heptode Section

$V_a=V_b$	250	250	250	V
R_{g2+g4}	22	18*	22†	kΩ
R_{g3+gt}	47	47	47	kΩ
V_{g1}	–2.0	–1.9	–2.0	V
V_{g2+g4}	103	97	92	V
I_a	3.25	3.0	2.5	mA
I_{g2+g4}	6.7	6.1	5.5	mA
I_{g3+gt}	200	200	200	μA
g_c	775	750	700	μA/V
r_a	1.0	1.0	1.0	MΩ
R_{eq}	70	70	66	kΩ
†V_{g1}	–28.5	–28.5	–28.5	V

†For 100 : 1 reduction in g_c.

*Common screen grid resistor for ECH81 and EF85. The current through this resistor is 8.5mA.

†Common screen grid resistor for ECH81 and EBF80. The current through this resistor is 7.2mA.

Triode Section

V_b	250	V
R_{at}	33	kΩ
R_{gt+g3}	47	kΩ
I_{gt+g3}	200	μA
I_{at}	4.5	mA
g_m (effective)	650	μA/V

CHARACTERISTICS

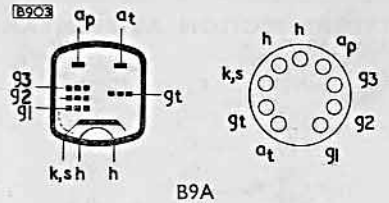
Triode Section

V_a	100	V
I_a	13.5	mA
V_g	0	V
g_m	3.7	mA/V
μ	22	

ECL80

TRIODE PENTODE

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.



B9A

HEATER

V_h	6.3	V
I_h	300	mA

LIMITING VALUES

Pentode Section

$v_{a(pk)}$ max.	1.2	kV
V_a max.	400	V
p_a max.	3.5	W
V_{g2} max.	250	V
p_{g2} max.	1.2	W
I_k max.	25	mA
*$i_{k(pk)}$ max.	350	mA
V_{h-k} max.	150	V

Triode Section

V_a max.	200	V
p_a max.	1.0	W
I_k max.	8.0	mA
*$i_{k(pk)}$ max.	200	mA

*Max. pulse duration 10% of one cycle, with a maximum of 2 msecs.

CHARACTERISTICS

Pentode Section

V_a	170	200	V
V_{g2}	170	200	V
V_{g3}	0	0	V
I_a	15	17.5	mA
I_{g2}	2.8	3.3	mA
V_{g1}	–6.7	–8.0	V
g_m	3.2	3.3	mA/V
r_a	150	150	kΩ
μ_{g1-g2}	14	14	

Triode Section

V_a	100	V
I_a	4.0	mA
V_g	–2.3	V
g_m	1.4	mA/V
r_a	12.5	kΩ
μ	17.5	

DIMENSIONS

Max. Overall Length	67.5	mm
Max. Seated Height	60.5	mm
Max. Diameter	22.2	mm

OPERATING CONDITIONS

Pentode Section (As audio output valve)

V_a	170	200	V
V_{g2}	170	200	V
V_{g3}	0	0	V
V_{g1}	–6.7	–8.0	V
R_a	11	11	kΩ
$I_{a(o)}$	15	17.5	mA
$I_{g2(o)}$	2.8	3.3	mA
$V_{in(r.m.s.)}$ (D_{tot}=10%)	3.5	4.0	V
P_{out} (D_{tot}=10%)	1.0	1.4	W
$V_{in(r.m.s.)}$ (up to η=50%)	4.1	4.7	V
$P_{out(r.m.s.)}$ (up to η=50%)	1.27	1.75	W
$D_{tot(r.m.s.)}$ (up to η=50%)	12	12	%

As Synchronising Pulse Separator

V_a	20	V
V_{g2}	15	V
V_{g3}	0	V
V_{g1} (I_a=100μA)	–1.4	V
I_a (V_{g1}=0V)	2.0	mA

As Frame Output Valve

V_a	170	200	V
V_{g2}	170	200	V
V_{g3}	0	0	V
V_{g1}	–9.0	–10.6	V
$I_{a(o)}$	8.5	10	mA
$I_{g2(o)}$	1.6	1.9	mA

ECL80 (Cont.)

TRIODE PENTODE

TRIODE SECTION AS RESISTANCE COUPLED VOLTAGE AMPLIFIER

V_b (V)	R_a (kΩ)	I_a (mA)	$-V_g$ (V)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	D_{tot}* (%)	R_{g1}† (kΩ)
170	47	1.8	3.5	9.5	22	8.7	150
170	100	1.0	3.5	10.5	24	7.6	330
170	220	0.5	3.5	11	24.5	6.5	680
200	47	2.2	4.2	9.5	27	9.0	150
200	100	1.2	4.2	10.5	29	8.0	330
200	220	0.6	4.2	11	30	6.5	680

*V_{out}=Output voltage and distortion at the start of positive grid current. At lower output voltages the distortion is approximately proportional to the voltage.

†R_{g1}=Grid resistor of the following valve.

REPLACEMENT FOR: LN152, 6AB8—Direct.

EE50

SECONDARY EMISSION R.F. PENTODE (OBSOLETE)

HEATER

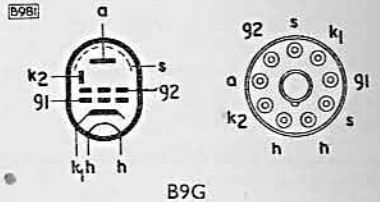
V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{out}	7.7	pF
c_{in}	7.7	pF
c_{a-g1}	<0.005	pF

LIMITING VALUES

V_a max.	250	V
p_a max.	2.5	W
V_{g2} max.	250	V
p_{g2} max.	200	mW
V_{k2} max.	150	V
p_{k2} max.	1.5	W
I_k max.	5.0	mA
V_{h-k} max.	50	V



B9G

DIMENSIONS

Max. Overall Length	78	mm
Max. Seated Height	62	mm
Max. Diameter	38	mm

OPERATING CONDITIONS

V_a	250	V
V_{g2}	250	V
V_{k2}	150	V
V_{g1}	–3.0	V
I_a	10	mA
I_{g2}	600	μA
I_{k2}	–8.0	mA
g_m	14	mA/V

REPLACED BY:

There is no valve which will replace this type. Where the EE50 is used in television receivers consideration should be given to a redesign employing the EF80.

Mullard

EF2

VARIABLE-MU R.F. PENTODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	400	mA

DIMENSIONS

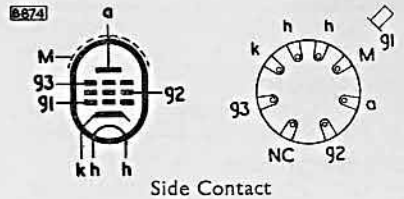
Max. Overall Length	100	mm
Max. Diameter	42	mm

CAPACITANCES

c_{in}	7.1	pF
c_{out}	7.7	pF
c_{a-g1}	<0.003	pF

LIMITING VALUES

V_a max.	250	V
V_{g2} max.	125	V
p_a max.	1.5	W
p_{g2} max.	300	mW
I_k max.	8.0	mA
V_{h-k} max.	80	V



Side Contact

OPERATING CONDITIONS

V_a	250	V
V_{g2}	100	V
V_{g1}	–2.0	V
I_a	4.5	mA
I_{g2}	1.4	mA
g_m	2.2	mA/V
r_a	1.4	MΩ
*V_{g1}	–22	V

*For 100 : 1 reduction in g_m.

REPLACED BY: EF9—Bias may require adjustment.

EF5

VARIABLE-MU R.F. PENTODE (OBSOLETE)

HEATER

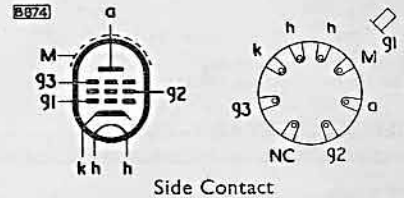
V_h	6.3	V
I_h	200	mA

CAPACITANCES

c_{out}	6.9	pF
c_{in}	5.4	pF
c_{a-g1}	<0.003	pF

LIMITING VALUES

V_a max.	250	V
p_a max.	2.0	W
V_{g2} max.	125	V
p_{g2} max.	400	mW
I_k max.	15	mA
V_{h-k} max.	75	V



Side Contact

DIMENSIONS

Max. Overall Length	90	mm
Max. Diameter	32	mm

OPERATING CONDITIONS

V_a	250	200	V
V_{g2}	100	60	V
V_{g1}	–3.0	–2.0	V
I_a	8.0	4.0	mA
I_{g2}	2.6	1.3	mA
g_m	1.7	1.4	mA/V
r_a	1.2	1.35	MΩ
*V_{g1}	–50	–35	V

*For 100 : 1 reduction in g_m.

REPLACED BY: EF9—Direct.

Mullard

EF6

R.F. PENTODE (OBSOLETE)

HEATER

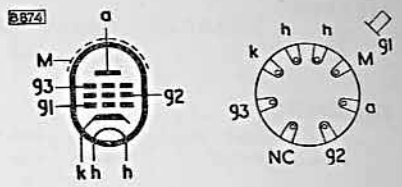
V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	90	mm
Max. Diameter	32	mm

CAPACITANCES

C_{in}	5.2	pF
C_{out}	6.9	pF
C_{a-g1}	<0.003	pF



Side Contact

For characteristics, operating data and limiting values see type EF37A. Except for base, dimensions and capacitances EF6 and EF37A are identical.

REPLACED BY: EF36—Change base.

EF8

LOW-NOISE R.F. PENTODE (OBSOLETE)

HEATER

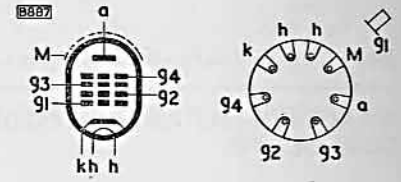
V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	90	mm
Max. Diameter	32	mm

CAPACITANCES

C_{in}	4.9	pF
C_{out}	7.8	pF
C_{a-g1}	<0.007	pF



Side Contact

For characteristics, operating data and limiting values see type EF38. Except for base and dimensions EF8 and EF38 are identical.

REPLACED BY: EF9—Direct.

EF9

VARIABLE-MU R.F. PENTODE

HEATER

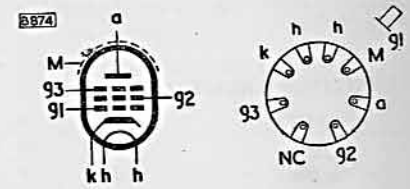
V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	90	mm
Max. Diameter	32	mm

CAPACITANCES

C_{a-g1}	<0.002	pF
C_{g1-k}	5.5	pF
C_{a-k}	7.2	pF



Side Contact

For characteristics, operating data and limiting values see type EF39. Except for base, dimensions and capacitances, EF9 and EF39 are identical.

REPLACEMENT FOR: EF5, EF8—Direct.
EF2—Bias may require adjustment.

Mullard

EF22

VARIABLE-MU R.F. PENTODE

HEATER

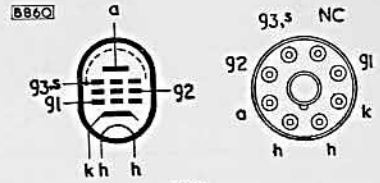
V_h	6.3	V
I_h	200	mA

CAPACITANCES

C_{a-g1}	<0.002	pF
C_{in}	5.5	pF
C_{out}	6.4	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	2.0	W
V_{g2} max. (I_a=<3.0 mA)	300	V
V_{g2} max. (I_a=6.0 mA)	125	V
p_{g2} max.	300	mW
I_k max.	10	mA
V_{h-k} max.	50	V



B8G

DIMENSIONS

Max. Overall Length	91	mm
Max. Seated Height	76	mm
Max. Diameter	32	mm

OPERATING CONDITIONS

V_a	250	V
V_{g3}	0	V
R_{g2}	90	kΩ
R_k	325	Ω
V_{g1}	–2.5	V
V_{g2}	100	V
I_a	6.0	mA
I_{g2}	1.7	mA
g_m	2.0	mA/V
r_a	1.2	MΩ
μ_{g1-g2}	17	
R_{eq}	6.2	kΩ
*V_{g1}	–46	V

*For 100 : 1 reduction in g_m.

REPLACEMENT FOR: W143—Direct.

EF36

R.F. PENTODE

HEATER

V_h	6.3	V
I_h	200	mA

For characteristics, limiting values and base connections, see type EF37A.

REPLACEMENT FOR: OM5—Direct. EF6, SP6s—Change base.

Mullard

EF37

LOW MICROPHONY A.F. VOLTAGE AMPLIFYING PENTODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	200	mA

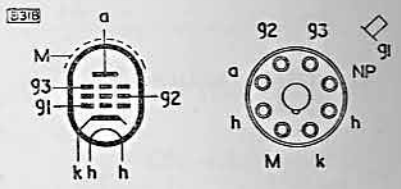
For characteristics, operating data, limiting values and base connections, see type EF37A.

REPLACED BY: EF37A—Direct.

EF37A

LOW MICROPHONY, LOW HUM A.F. VOLTAGE AMPLIFYING PENTODE

High gain pentode primarily intended for use in A.F. pre-amplifier stages. It has an anti-microphonic construction and its heater is designed to reduce hum.



Octal

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	100	mm
Max. Seated Height	85	mm
Max. Diameter	32	mm

LIMITING VALUES

V_a max.	300	V
p_a max.	1.0	W
V_{g2} max.	200	V
p_{g2} max.	300	mW
I_k max.	6.0	mA
V_{h-k} max.	100	V

CHARACTERISTICS

V_a	250	V
V_{g2}	100	V
V_{g3}	0	V
I_a	3.0	mA
V_{g1}	–2.0	V
I_{g2}	800	μA
g_m	1.8	mA/V
r_a	2.5	MΩ
μ_{g1-g2}	28	

OPERATING CONDITIONS AS RESISTANCE COUPLED AMPLIFIER

Pentode Connection

V_b (V)	R_a (kΩ)	I_k (mA)	R_{g2} (kΩ)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	R_{g1}** (kΩ)
400	100	3.4	330	1.2	115	80	330
350	100	2.9	330	1.2	112	69	330
300	100	2.5	330	1.2	108	59	330
250	100	2.1	330	1.2	103	49	330
200	100	1.7	330	1.2	98	39	330
400	220	1.8	680	2.2	180	81	680
350	220	1.6	680	2.2	176	69	680
300	220	1.3	680	2.2	170	58	680
250	220	1.1	680	2.2	163	48	680
200	220	0.9	680	2.2	152	37	680

*D_{tot}=5%.

**R_{g1}=Grid resistor of following valve.

Mullard

LOW MICROPHONY, LOW HUM, A.F. VOLTAGE AMPLIFYING PENTODE — EF37A (Cont.)

Triode Connection (with g_2 connected to a, g_3 connected to k)

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}† ($V_{r.m.s.}$)	D_{tot}† (%)	R_{g1}* (kΩ)
400	47	4.6	1.2	18.4	67	4.5	150
350	47	4.0	1.2	18.2	57	4.4	150
300	47	3.4	1.2	18	48	4.3	150
250	47	2.8	1.2	17.7	38	4.2	150
200	47	2.3	1.2	17.5	29	4.0	150
400	100	2.4	2.2	20.1	66	3.9	330
350	100	2.1	2.2	20	57	3.9	330
300	100	1.8	2.2	19.9	48	3.8	330
250	100	1.5	2.2	19.7	38	3.7	330
200	100	1.2	2.2	19.5	28	3.5	330
400	220	1.2	3.9	20.6	61	3.4	680
350	220	1.0	3.9	20.4	52	3.3	680
300	220	0.9	3.9	20.3	44	3.3	680
250	220	0.8	3.9	20.2	35	3.2	680
200	220	0.6	3.9	20	26	3.0	680

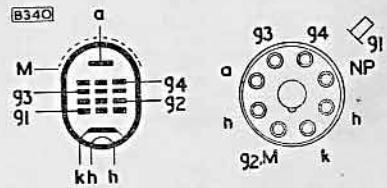
*R_{g1}=grid resistor of following valve.

†Output voltage and distortion at the start of positive grid current. At lower output voltages the distortion is approximately proportional to the voltage.

REPLACEMENT FOR: EF37, OM5A, OM5B—Direct.

EF38

LOW-NOISE R.F. PENTODE (OBSOLETE)



Octal

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	102	mm
Max. Seated Height	88	mm
Max. Diameter	32	mm

LIMITING VALUES

V_a max.	300	V
p_a max.	2.5	W
V_{g3} max.	300	V
p_{g3} max.	80	mW
I_k max.	12	mA
V_{h-k} max.	100	V

OPERATING CONDITIONS

V_a	250	V
V_{g2}	0	V
V_{g4}	0	V
V_{g3}	250	V
V_{g1}	–2.5	V
I_a	8.0	mA
I_{g3}	200	μA
g_m	1.8	mA/V
*V_{g1}	–50	V

*For 100 : 1 reduction in g_m.

REPLACED BY: EF39—Direct.

Mullard

EF39

VARIABLE-MU R.F. PENTODE

HEATER

V_h	6.3	V
I_h	200	mA

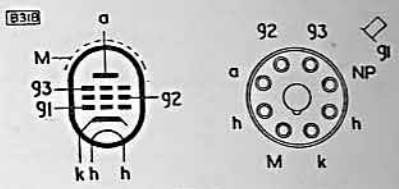
LIMITING VALUES

V_a max.	300	V
p_a max.	2.0	W
I_k max.	10	mA
V_{g_2} max. (I_a=6 mA)	125	V
V_{g_2} max. (I_a=3 mA)	300	V
p_{g_2} max.	300	mW
V_{h-k} max.	100	V

OPERATING CONDITIONS

$V_a=V_b$	200	250	V
R_{g_2}	60	90	kΩ
V_{g_2}	100	100	V
V_{g_3}	0	0	V
V_{g_1}	−2.5	−2.5	V
R_k	325	325	Ω
I_a	6.0	6.0	mA
I_{g_2}	1.7	1.7	mA
g_m	2.2	2.2	mA/V
r_a	0.9	1.25	MΩ
*V_{g_1}	−34	−40	V

*For 100 : 1 reduction in g_m.



Octal

DIMENSIONS

Max. Overall Length	100	mm
Max. Seated Height	86	mm
Max. Diameter	32	mm

CAPACITANCES

c_{a-g_1}	<0.003	pF
c_{in}	5.5	pF
c_{out}	7.2	pF

OPERATING CONDITIONS AS CONTROLLED GAIN RESISTANCE COUPLED AMPLIFIER

V_b (V)	R_a (kΩ)	R_{g_2} (kΩ)	I_a (mA)	I_{g_2} (μA)	R_k (kΩ)	$-V_c$* (V)	V_{out} ($V_{r.m.s.}$)	$\frac{V_{out}}{V_{in}}$	D_{tot} (%)
250	200	800	0.87	260	1.75	0	10	106	2.7
250	200	800	0.69	210	1.75	5.0	10	40	2.7
250	200	800	0.55	170	1.75	10	10	23	3.7
250	200	800	0.37	110	1.75	18	10	11.6	4.8
250	200	800	0.17	50	1.75	25	10	6.7	8.8
250	100	400	1.6	450	1.0	0	10	85	2.5
250	100	400	1.22	360	1.0	5.0	10	36	2.7
250	100	400	0.92	280	1.0	10	10	20	4.1
250	100	400	0.57	180	1.0	18	10	9.2	6.1
250	100	400	0.36	110	1.0	25	10	5.5	9.5

*$-V_c$=Negative grid control voltage.

REPLACEMENT FOR:

BVA243, BVA246, BVA247, EF38, OM6, OM7, W147—Direct.

C50N, VP13B, VP13C, VP133, VP1322—Change base. Feed screen from h.t.+ through 68kΩ resistor. EF39 has 6.3V heater.

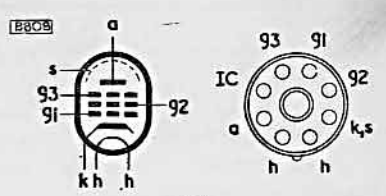
9D2, 13VPA—Change base. Bias will require adjustment. EF39 has 6.3V heater.

EFM1 (Pentode Section)—See page 126.

EF40

VOLTAGE AMPLIFYING PENTODE

Low noise pentode primarily intended for use in high gain r.c. coupled a.f. voltage amplifier stages.



B8A

HEATER

V_h	6.3	V
I_h	200	mA

LIMITING VALUES

V_a max.	300	V
p_a max.	1.0	W
V_{g_2} max.	200	V
p_{g_2} max.	200	mW
I_k max.	6.0	mA
V_{h-k} max.	50	V

CHARACTERISTICS

V_a	250	V
V_{g_2}	140	V
I_a	3.0	mA
I_{g_2}	550	μA
V_{g_1}	−2.0	V
V_{g_3}	0	V
g_m	1.85	mA/V
r_a	2.5	MΩ
$\mu_{g_1-g_2}$	38	

DIMENSIONS

Max. Overall Length	60	mm
Max. Seated Height	53	mm
Max. Diameter	22	mm

OPERATING CONDITIONS
As Resistance Coupled Amplifier

Pentode Connection

V_b	250	250	V
R_a	†100	†220	kΩ
R_{g_2}	†0.39	†1.0	MΩ
R_k	†1.0	†2.2	kΩ
*R_{g_1}	330	680	kΩ
I_k	2.05	0.95	mA
$\frac{V_{out}}{V_{in}}$	112	180	

†Values ± 10%.

*R_{g_1}=Grid resistor of following valve.

TRIODE CONNECTION (g2 to a: g3 to k)

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	D_{tot}* (%)	R_{g_1}† (kΩ)
400	47	3.7	1.2	24.5	64	4.5	150
350	47	3.2	1.2	24.5	53	4.0	150
300	47	2.7	1.2	24	43	3.8	150
250	47	2.3	1.2	23.5	32	3.5	150
200	47	1.85	1.2	23.5	22	3.1	150
400	100	2.0	2.2	28.5	73	4.0	330
350	100	1.7	2.2	28.5	62	4.0	330
300	100	1.5	2.2	28.5	50	3.8	330
250	100	1.25	2.2	28	39	3.7	330
200	100	1.0	2.2	27.5	27.5	3.3	330
400	220	1.05	3.9	32	74	3.8	680
350	220	0.9	3.9	31.5	62	3.7	680
300	220	0.8	3.9	31	51	3.7	680
250	220	0.65	3.9	30.5	39	3.5	680
200	220	0.5	3.9	30.5	28	3.1	680

*V_{out}=Output voltage and distortion at the start of positive grid current. At lower output voltages the distortion is approximately proportional to the voltage.

†R_{g_1}=Grid resistor of the following valve.

EF41

VARIABLE-MU H.F. PENTODE

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	60	mm
Max. Seated Height	53	mm
Max. Diameter	22	mm

CAPACITANCES

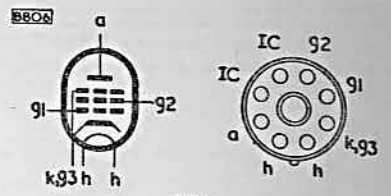
c_{a-g1}	<0.002	pF
c_{g1-h}	<0.05	pF
c_{out}	8.0	pF
c_{in}	4.7	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	2.0	W
I_k max.	10	mA
V_{g2} max. (I_a<3 mA)	300	V
V_{g2} max. (I_a=6 mA)	125	V
p_{g2} max.	300	mW
V_{h-k} max.	50	V

REPLACEMENT FOR:

W150, 6F16, 62VP—Direct.
6F15—Rewire base. (Check V_{h-k} does not exceed 50V.)



B8A

Internal shield (s) connected to Pin 7.

OPERATING CONDITIONS

V_a	250	V
R_{g2}	90	kΩ
R_k	325	Ω
V_{g1}	–2.5	V
I_a	6.0	mA
I_{g2}	1.7	mA
g_m	2.2	mA/V
r_a	1.0	MΩ
μ_{g1-g2}	18	
R_{eq}	7.4	kΩ
*V_{g1}	–39	V

*For 100 : 1 reduction in g_m.

EF42

HIGH SLOPE R.F. PENTODE

HEATER

V_h	6.3	V
I_h	330	mA

CAPACITANCES

c_{in}	9.5	pF
c_{out}	4.5	pF
c_{a-g}	<0.005	pF

DIMENSIONS

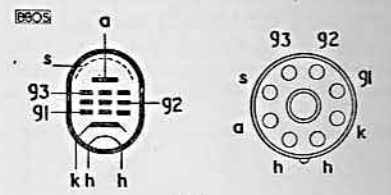
Max. Overall Length	58	mm
Max. Seated Height	51	mm
Max. Diameter	22	mm

LIMITING VALUES

V_a max.	300	V
p_a max.	2.5	W
V_{g2} max.	300	V
p_{g2} max. •	700	mW
I_k max.	13	mA
V_{h-k} max.	90	V

REPLACEMENT FOR:

Z150—Direct.
6F1 (rewire base) and 6F13—Bias will require adjustment in each case.



B8A

CHARACTERISTICS

V_a	250	V
V_{g2}	250	V
V_{g1}	–2.0	V
I_a	10	mA
I_{g2}	2.3	mA
g_m	9.5	mA/V
r_a	440	kΩ
V_{g3} (for I_a cut-off)	–60	V
R_{eq}	750	Ω
R_{in} (50Mc/s)	5.0	kΩ

Mullard

EF50

HIGH SLOPE R.F. PENTODE

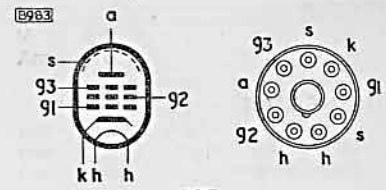
Single-ended r.f. pentode, fully controlled by voltages of 0 to –6V or 0 to –55V according to the circuit used.

HEATER

V_h	6.3	V
I_h	300	mA

LIMITING VALUES

V_a max.	300	V
p_a max.	3.0	W
I_k max.	15	mA
V_{g2} max.	300	V
p_{g2} max.	1.7	W
V_{h-k} max.	100	V



B9G

DIMENSIONS

Max. Overall Length	78	mm
Max. Seated Height	62	mm
Max. Diameter	38	mm

CAPACITANCES

c_{a-g1}	<0.007	pF
c_{g1-g2}	2.4	pF
c_{in}	8.3	pF
c_{out}	5.2	pF

OPERATING CONDITIONS

Controlled by Grid 1
with R_k=33Ω and C_k=50pF

V_a	250	V
V_{g2}	250	V
V_{g3}	0	V
*V_{g1}	–1.55	V
I_a	10	mA
I_{g2}	3.0	mA
g_m	6.5	mA/V
†V_{g1}	–4.5	V

†For 10 : 1 reduction in g_m

Controlled by Grid 3

V_a	250	V
V_{g2}	250	V
V_{g1}	–2.0	V
*V_{g3}	0	V
I_a	10	mA
I_{g2}	3.0	mA
g_m	6.5	mA/V
μ_{g1-g2}	75	
R_{eq}	1.4	kΩ
†V_{g3}	–54	V

†For 15 : 1 reduction in g_m

OPERATING CONDITIONS—Controlled by Grids 1 and 3 via a Potentiometer of 47 kΩ + 3.3 kΩ

V_a	250	V
V_{g2}	250	V
*V_{g3}	–30	V
I_a	10	mA
I_{g2}	5.5	mA
g_m	5.2	mA/V
†V_{g3}	–55.5	V

†For 10 : 1 reduction in g_m.

OPERATING CONDITIONS—Controlled by Grids 1 and 3 via a Potentiometer of 47 kΩ + 3.9 kΩ with R_k=33Ω and C_k=50 pF

V_a	250	V
V_{g2}	250	V
*V_{g3}	–20	V
I_a	10	mA
I_{g2}	4.0	mA
g_m	6.0	mA/V
†V_{g3}	–51.5	V

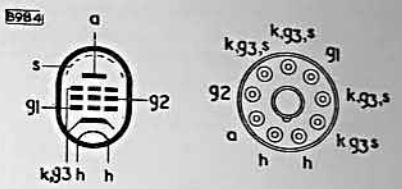
†For 10 : 1 reduction in g_m.
*Valve not controlled by a.g.c.

REPLACEMENT FOR: Z90, 63SPT—Direct.

Mullard

EF54

V.H.F. PENTODE



B9G

HEATER

V_h	6.3	V
I_h	300	mA

DIMENSIONS

Max. Overall Length	78	mm
Max. Seated Height	62	mm
Max. Diameter	38	mm

CAPACITANCES

c_{in}	6.2	pF
c_{out}	4.9	pF
c_{a-g1}	0.02	pF
c_{g1-g2}	2.2	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	3.0	W
V_{g2} max.	300	V
p_{g2} max.	1.7	W
I_k max.	15	mA
V_{h-k} max.	100	V
f max.	250	Mc/s

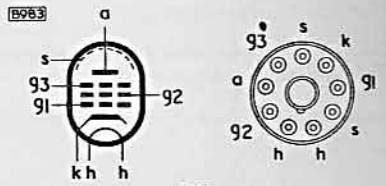
OPERATING CONDITIONS

V_a	250	V
V_{g2}	250	V
V_{g1}	–1.7	V
R_k	150	Ω
I_a	10	mA
I_{g2}	1.45	mA
g_m	7.7	mA/V
r_a	500	kΩ
μ_{g1-g2}	80	
R_{eq}	700	Ω
R_{in} (at 50Mc/s)	10	kΩ

REPLACEMENT FOR: RL7—Direct.

EF55

VIDEO FREQUENCY PENTODE



B9G

HEATER

V_h	6.3	V
I_h	1.0	A

CAPACITANCES

c_{out}	12	pF
c_{in}	15	pF
c_{a-g1}	0.15	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	10	W
V_{g2} max.	250	V
p_{g2} max.	2.0	W
V_{h-k} max.	150	V
R_{g1-k} max.	700	kΩ

DIMENSIONS

Max. Overall Length	100	mm
Max. Seated Height	84	mm
Max. Diameter	38	mm

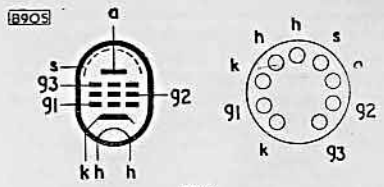
OPERATING CONDITIONS

V_a	250	250	V
V_{g2}	250	150	V
V_{g1}	–4.5	–4.0	V
I_a	40	10	mA
I_{g2}	5.5	1.0	mA
R_k	100	360	Ω
g_m	12	7.0	mA/V
μ_{g1-g2}	28	27	
r_a	55	100	kΩ

EF80

HIGH SLOPE R.F. PENTODE

High slope r.f. pentode primarily intended for r.f. or i.f. amplification in television receivers. It is suitable for use as a video amplifier, mixer or synchronising pulse separator.



B9A

HEATER

V_h	6.3	V
I_h	300	mA

CAPACITANCES

$c_{in(g1)}$	7.5	pF
$c_{in(g2)}$	5.4	pF
c_{out}	3.3	pF
c_{a-g1}	<0.007	pF
c_{g2-g1}	2.6	pF
c_{a-k}	<0.01	pF
c_{g1-h}	<0.15	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	2.5	W
V_{g2} max.	300	V
p_{g2} max.	700	mW
I_k max.	15	mA
V_{h-k} max.	150	V

DIMENSIONS

Max. Overall Length	67.5	mm
Max. Seated Height	60.5	mm
Max. Diameter	22.2	mm

CHARACTERISTICS

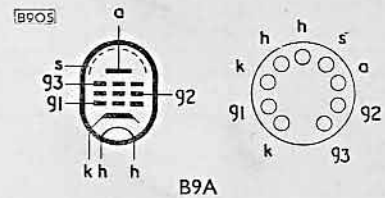
V_a	170	V
V_{g2}	170	V
V_{g3}	0	V
I_a	10	mA
I_{g2}	2.5	mA
V_{g1}	–2.0	V
g_m	7.4	mA/V
r_a	400	kΩ
μ_{g1-g2}	50	
R_{eq}	1.0	kΩ
R_{in} (at 50Mc/s)	10	kΩ

REPLACEMENT FOR: Z152, Z719, 6BX6—Direct.
TSP4—Change base, raise heater voltage to 6.3V. Adjust bias.
EE50—In some cases.

EF85

VARIABLE-MU R.F. PENTODE

High slope variable-mu r.f. pentode primarily intended for use in f.m. and f.m./a.m. receivers



B9A

HEATER

V_h	6.3	V
I_h	300	mA

DIMENSIONS

Max. Overall Length	67.5	mm
Max. Seated Height	60.5	mm
Max. Diameter	22.2	mm

CAPACITANCES
(Measured without external shield)

c_{in}	7.2	pF
c_{out}	3.7	pF
c_{a-g1}	<0.007	pF
c_{g1-h}	<0.15	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	2.5	W
V_{g2} max.	300	V
p_{g2} max.	650	mW
I_k max.	15	mA
V_{h-k} max.	150	V

CHARACTERISTICS

$V_b=V_a$	250	250	250	V
R_{g2}	60	*18	**22	kΩ
V_{g2}	100	97	103	V
I_a	10	10	10	mA
I_{g2}	2.5	2.4	2.6	mA
V_{g1}	–2.0	–1.9	–2.1	V
g_m	6.0	6.0	6.0	mA/V
†V_{g1}	–35	–33	–35	V

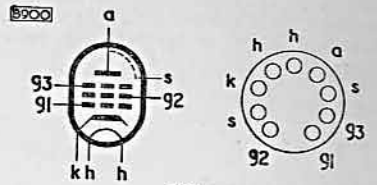
†For 100 : 1 reduction in g_m
*Common screen grid resistor for EF85 and ECH81 used as frequency changer.
**Common screen grid resistor for EF85 and ECH81 used as r.f. or i.f. amplifier.

REPLACEMENT FOR: W719, 6BY7—Direct.

EF86

LOW NOISE A.F. VOLTAGE AMPLIFYING PENTODE

Low noise pentode intended for use as r.c. coupled a.f. voltage amplifier, particularly in the early stages of high-gain audio amplifiers, microphone pre-amplifiers and magnetic tape recorders.



B9A

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	56	mm
Max. Seated Height	49	mm
Max. Diameter	22.2	mm

LIMITING VALUES

V_a max.	300	V
p_a max.	1.0	W
V_{g_2} max.	200	V
p_{g_2} max.	200	mW
I_k max.	6.0	mA
V_{h-k} max. (cathode positive)	150	V
V_{h-k} max. (cathode negative)	100	V

CHARACTERISTICS

V_a	250	V
V_{g_3}	0	V
V_{g_2}	140	V
I_a	3.0	mA
I_{g_2}	600	μA
V_{g_1}	−2.0	V
g_m	1.8	mA/V
r_a	2.5	MΩ
$\mu_{g_1-g_2}$	38	

OPERATING CONDITIONS AS RESISTANCE COUPLED A.F. AMPLIFIER

Pentode Connection

V_b (V)	R_a (kΩ)	I_k (mA)	R_{g_2} (MΩ)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out} $V_{r.m.s.}$	D_{tot} (%)	R_{g_1}† (kΩ)
400	100	3.3	0.39	1.0	124	87	5.0	330
350	100	2.85	0.39	1.0	120	75	5.0	330
300	100	2.45	0.39	1.0	116	64	5.0	330
250	100	2.05	0.39	1.0	112	50	5.0	330
200	100	1.65	0.39	1.0	106	40	5.0	330
150	100	1.0	0.47	1.5	95	22	5.0	330
400	220	1.55	1.0	2.2	200	73	5.0	680
350	220	1.4	1.0	2.2	196	63	5.0	680
300	220	1.1	1.0	2.2	188	54	5.0	680
250	220	0.9	1.0	2.2	180	46	5.0	680
200	220	0.75	1.0	2.2	170	36	5.0	680
150	220	0.55	1.0	2.7	150	24.5	5.0	680

†R_{g_1}=Grid resistor of following valve.

OPERATING CONDITIONS AS RESISTANCE COUPLED A.F. AMPLIFIER

Triode Connection (g_2 to a, g_3 to k)

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	D_{tot}* (%)	R_{g_1}† (kΩ)
400	47	3.7	1.2	24.5	64	4.5	150
350	47	3.2	1.2	24.5	53	4.0	150
300	47	2.7	1.2	24	43	3.8	150
250	47	2.3	1.2	23.5	32	3.5	150
200	47	1.85	1.2	23.5	22	3.1	150
400	100	2.0	2.2	28.5	73	4.0	330
350	100	1.7	2.2	28.5	62	4.0	330
300	100	1.5	2.2	28.5	50	3.8	330
250	100	1.25	2.2	28	39	3.7	330
200	100	1.0	2.2	27.5	27.5	3.3	330
400	220	1.05	3.9	32	74	3.8	680
350	220	0.9	3.9	31.5	62	3.7	680
300	220	0.8	3.9	31	51	3.7	680
250	220	0.65	3.9	30.5	39	3.5	680
200	220	0.5	3.9	30.5	28	3.1	680

*V_{out}=Output voltage and distortion at the start of positive grid current. At lower output voltages the distortion is approximately proportional to the voltage.

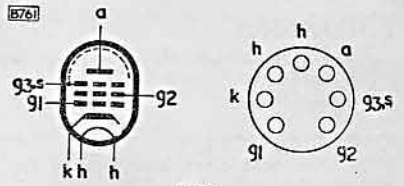
†R_{g_1}=Grid resistor of the following valve.

REPLACEMENT FOR: Z729, 6267—Direct.

EF91

HIGH SLOPE R.F. PENTODE

High slope r.f. pentode primarily intended for use as r.f. amplifier or mixer valve in television receivers.



B7G

HEATER

V_h	6.3	V
I_h	300	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

CAPACITANCES

c_{in}	7.0	pF
c_{out}	2.0	pF
c_{a-g_1}	<0.008	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	2.5	W
V_{g_2} max.	300	V
p_{g_2} max.	650	mW
I_k max.	15	mA
V_{h-k} max.	150	V

CHARACTERISTICS

V_a	250	V
V_{g_2}	250	V
V_{g_3}	0	V
V_{g_1}	−2.0	V
I_a	10	mA
I_{g_2}	2.5	mA
g_m	7.6	mA/V
r_a	1.0	MΩ
$\mu_{g_1-g_2}$	70	
R_{eq}	1.2	kΩ
R_{in} (at 50Mc/s)	7.5	kΩ

EF91 (Cont.)

HIGH SLOPE R.F. PENTODE

OPERATING CONDITIONS AS MIXER AT 45 Mc/s

V_b	250	V
R_k	470	Ω
I_a (V_{osc}=0V)	4.4	mA
I_a (V_{osc}=2.25 V)	5.5	mA
I_{g1}	0.5	μA
g_c	2.5	mA/V
R_{g1-k}	1.0	MΩ

OPERATING CONDITIONS AS SINGLE VALVE CLASS "C" R.F. AMPLIFIER

f	10	50	75	100	125	150	Mc/s
V_a	300	300	300	300	300	300	V
V_{g2}	175	175	175	175	175	175	V
V_{g1}	–4.0	–4.0	–4.0	–4.0	–4.0	–4.0	V
I_a	9.5	10	10.2	10.4	10.5	10.7	mA
I_{g2}	3.8	3.6	3.4	3.2	3.2	3.2	mA
I_{g1}	1.7	1.4	1.4	1.4	1.3	1.1	mA
*P_{load}	1.6	1.5	1.3	1.0	0.8	0.57	W
P_{out}	1.8	1.7	1.5	1.3	1.1	0.86	W
η	63	57	51	43	35	29	%

*These figures are observed as the power output in a load coupled with a lumped circuit.

REPLACEMENT FOR: SP6, Z77, 6AM6, 6AM6/8D3, 6F12, 8D3—Direct.

EF92

VARIABLE-MU R.F. PENTODE

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

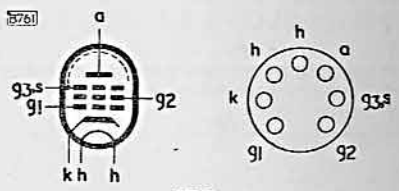
CAPACITANCES

(Measured with close fitting metal can and shielded socket)

c_{in}	4.5	pF
c_{out}	7.0	pF
c_{a-g1}	0.004	pF

LIMITING VALUES

V_a max.	250	V
p_a max.	2.5	W
V_{g2} max.	250	V
p_{g2} max.	600	mW
I_k max.	12	mA
V_{h-k} max.	100	V



B7G

CHARACTERISTICS

V_a	250	250	V
V_{g2}	150	200	V
V_{g3}	0	0	V
I_a	8.0	8.0	mA
I_{g2}	2.0	2.1	mA
V_{g1}	–0.65	–2.5	V
g_m	2.5	2.5	mA/V
μ_{g1-g2}	30	30	
r_a	500	500	kΩ
*V_{g1}	–11	–21	V

*For 100 : 1 reduction in g_m.

REPLACEMENT FOR: VP6, W77, 6CQ6, 9D6—Direct.

Mullard

VARIABLE-MU R.F. PENTODE

EF93

HEATER

V_h	6.3	V
I_h	300	mA

DIMENSIONS

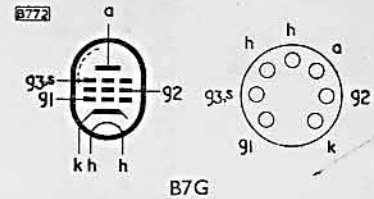
Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

CAPACITANCES

c_{in}	5.5	pF
c_{out}	5.0	pF
c_{a-g1}	0.0035	pF

LIMITING VALUES

V_a max.	300	V
V_{g2} max.	125	V
p_a max.	3.0	W
p_{g2} max.	600	mW
I_k max.	18	mA
V_{h-k} max.	90	V



B7G

CHARACTERISTICS

V_a	100	250	V
V_{g3}	0	0	V
R_{g2}	0	33	kΩ
V_{g2}	100	100	V
I_a	10.8	11	mA
I_{g2}	4.4	4.2	mA
V_{g1}	–1.0	–1.0	V
g_m	4.3	4.4	mA/V
r_a	0.25	1.5	MΩ
*V_{g1}	–20	–20	V

*For 100 : 1 reduction in g_m

REPLACEMENT FOR: W727/6BA6, 6BA6—Direct.
6AB7, 6SG7, 7H7—Change base. Check screen-grid voltage is less than 125V. Bias may require adjustment.

V.H.F. PENTODE

EF95

Low noise, high slope pentode primarily intended for use as an amplifier at frequencies up to 400Mc/s.

HEATER

V_h	6.3	V
I_h	175	mA

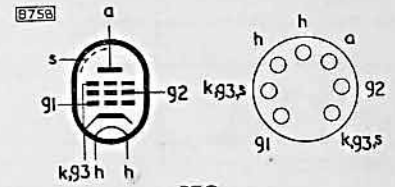
CAPACITANCES

Pentode Connection

c_{in}	4.0	pF
c_{out}	2.8	pF
c_{a-g1}	0.02	pF

Triode Connection

c_{in}	2.0	pF
c_{out}	5.0	pF
c_{a-g1}	1.3	pF



B7G

DIMENSIONS

Max. Overall Length	45	mm
Max. Seated Height	38	mm
Max. Diameter	19	mm

LIMITING VALUES

V_a max.	180	V
p_a max.	1.7	W
V_{g2} max.	140	V
p_{g2} max.	500	mW
I_k max.	18	mA
V_{h-k} max.	90	V

Mullard

EF95 (Cont.) — V.H.F. PENTODE

CHARACTERISTICS

V_a	120	180	V
V_{g2}	120	120	V
R_k	200	200	Ω
I_a	7.5	7.7	mA
I_{g2}	2.5	2.4	mA
V_{g1}	−2.0	−2.0	V
g_m	5.0	5.1	mA/V
r_a	340	690	kΩ
R_{eq}	2.0	2.0	kΩ
*R_{in} (Pentode or Triode)	25	25	kΩ
Noise Factor (at 100 Mc/s)	3.5	3.5	

*At 50 Mc/s.

REPLACEMENT FOR: DP61, 6AK5—Direct.

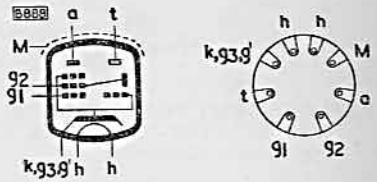
EFM1 — A.F. AMPLIFIER AND TUNING INDICATOR (OBSOLETE)

HEATER

V_h	6.3	V
I_h	200	mA

OPERATING CONDITIONS

$V_b = V_t$		250	V
R_a		150	kΩ
R_{g2}		350	kΩ
R_k		980	Ω
V_{g1}	−2.0	−20	V
I_a	800	500	μA
I_{g2}	600	200	μA
I_t	650	800	μA
V_a	146	185	V
V_{g2}	40	180	V
$\frac{V_{out}}{V_{in}}$	60	13	
D_{tot} (V_{out} = 5.0$V_{r.m.s.}$)	2.0	1.7	%
Shadow Angle	>70	<5	



Side Contact

DIMENSIONS

Max. Overall Length	83	mm
Max. Diameter	37	mm

LIMITING VALUES

V_a max.	300	V
p_a max.	400	mW
V_{g2} max.	300	V
p_{g2} max.	400	mW
V_t max.	300	V
I_k max.	5.0	mA
V_{h-k} max.	100	V

REPLACED BY: EF39 and EM34

1. Replace existing side contact base by an octal type for EM34 and reconnect heater leads to pins 2 and 7. Earth pin 8.
2. Mount one end of a second octal holder for EF39 on existing EM34 bracket, supporting other end of base by means of a pillar screwed to the chassis. Connect pins 2 and 7 of this holder in parallel with pins 2 and 7 on EM34. Reconnect leads from pins 4, 7 and 8 of EFM1 to pins 8, 4 and 3 respectively on EF39 holder. Strap pins 5 and 8 together and earth pin 1.
3. Replace 39kΩ and 150kΩ anode resistors with 10kΩ and 47kΩ resistors respectively for EF39.
4. Connect pins 3 and 6 on EM34 through a 1MΩ resistor to pin 5, which is connected in turn through 100kΩ to the h.t. line.
5. Connect pin 4 of EM34 to the a.g.c. line.
6. Remove existing lead from pin 6 of EFM1 and run new screened lead in its place to top cap of the EF39.

EH2 — HEXODE (OBSOLETE)

HEATER

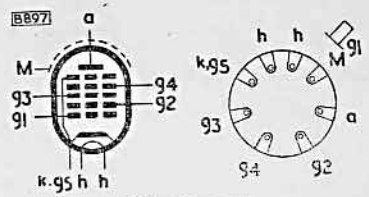
V_h	6.3	V
I_h	200	mA

CAPACITANCES

c_{in}	5.0	pF
c_{out}	11	pF
c_{g1-g3}	0.2	pF
c_{g1-a}	<0.0015	pF

LIMITING VALUES

V_a max.	250	V
p_a max.	1.5	W
V_{g2} max.	125	V
p_{g2} max.	500	mW
I_k max.	10	mA
V_{h-k} max.	50	V



Side Contact

DIMENSIONS

Max. Overall Length	90	mm
Max. Diameter	32	mm

OPERATING CONDITIONS

As Frequency Changer

V_a	250	250	V
V_{g2}	100	80	V
V_{g4}	100	80	V
V_{g1}	−3.0	−2.0	V
I_a	1.85	1.8	mA
I_{g2+g4}	3.8	3.5	mA
g_c	400	400	μA/V
r_a	2.0	2.0	MΩ
*V_{g1}	−25	−20	V

*For 40 : 1 reduction in g_c.

As I.F. Amplifier

V_a	250	250	V
V_{g2}	100	80	V
V_{g4}	100	80	V
V_{g1}	−3.0	−2.0	V
I_a	4.2	4.0	mA
I_{g2+g4}	2.8	2.5	mA
g_m	1.4	1.4	mA/V
r_a	1.0	1.0	MΩ
†V_{g1}	−25	−20	V

†For 100 : 1 reduction in g_m.

REPLACED BY: ECH3—In extreme cases use hexode section only. Rewire base.

EK2

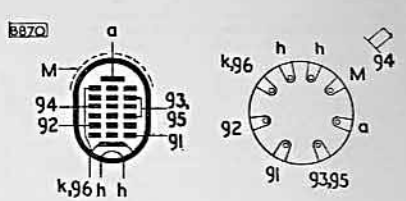
OCTODE FREQUENCY CHANGER

HEATER

V_h	6.3	V
I_h	200	mA

CAPACITANCES

c_{a-g4}	<0.07	pF
c_{a-k}	10	pF
c_{g1-k}	6.0	pF
c_{g1-g4}	1.1	pF
c_{g2-k}	4.5	pF
c_{g2-g4}	<0.25	pF
c_{g4-k}	8.8	pF



Side contact

DIMENSIONS

Max. Overall Length	88	mm
Max. Diameter	32	mm

For characteristics, operating data and limiting values see type EK32 Except for base, capacitances and dimensions, EK2 and EK32 are identical.

REPLACEMENT FOR: VO6s—Direct.
EK3 (See below).

EK3

OCTODE FREQUENCY CHANGER (OBSOLETE)

HEATER

V_h	6.3	V
I_h	600	mA

DIMENSIONS

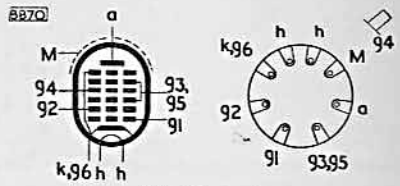
Max. Overall Length	125	mm
Max. Diameter	48	mm

CAPACITANCES

c_{a-g4}	<0.07	pF
c_{out}	16.5	pF
$c_{in(g1)}$	14	pF
c_{g1-g4}	1.1	pF
$c_{in(g2)}$	8.6	pF
$c_{in(g4)}$	15.2	pF

LIMITING VALUES

V_a max.	300	V
p_a max.	1.0	W
V_{g3+g5} max.	150	V
p_{g3+g5} max.	1.0	W
V_{g2} max.	150	V
p_{g2} max.	1.0	W
I_k max.	23	mA
V_{h-k} max.	50	V



Side Contact

OPERATING CONDITIONS

V_a	250	V
V_{g3+g5}	100	V
V_{g2}	100	V
R_k	190	Ω
R_{g1-k}	47	kΩ
V_{osc}	12	V
I_{g1}	300	μA
V_{g4}	−2.5	V
I_a	2.5	mA
I_{g3+g5}	5.5	mA
I_{g2}	5.0	mA
g_c	650	μA/V
r_a	2.0	MΩ
†$g_{m(g1-g2)}$	4.0	mA/V
†I_{g2}	18	mA
*V_{g4}	−38	V

*For 100 : 1 reduction in g_c
†At V_{osc}=0V.

REPLACED BY: EK2—Raise screen voltage to 200V.

Mullard

OCTODE FREQUENCY CHANGER

EK32

HEATER

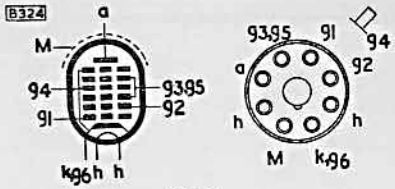
V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	100	mm
Max. Diameter	36	mm

LIMITING VALUES

V_a max.	250	V
p_a max.	1.0	W
V_{g3+g5} max.	125	V
p_{g3+g5} max.	300	mW
V_{g2} max.	225	V
p_{g2} max.	1.3	W
I_k max.	12	mA
V_{h-k} max.	50	V



Octal

CAPACITANCES

c_{in}	9.0	pF
c_{out}	10.5	pF
c_{g1-g4}	<1.0	pF
c_{g2-g4}	<0.25	pF
c_{a-g4}	<0.1	pF
c_{g1-all}	6.0	pF
c_{g2-all}	5.0	pF

OPERATING CONDITIONS

	Medium and Long Wavelengths		Short Wavelengths		
V_a	250	V	250	250	V
V_{g2}	200	V	200	200	V
V_{g3+g5}	50	V	80	80	V
R_{g1-k}	47	kΩ	15	47	kΩ
V_{osc}	15	V	5.0	9.0	V
I_{g1}	300	μA	275	200	μA
V_{g1}	−2.0	V	−4.0	−4.0	V
I_a	1.0	mA	2.3	1.7	mA
I_{g2}	2.5	mA	5.3	4.0	mA
I_{g3+g5}	800	μA	1.9	1.3	mA
g_c	550	μA/V	650	500	μA/V
r_a	2.0	MΩ	0.9	1.4	MΩ
*V_{g4}	−25	V			

*For 270 : 1 reduction in g_c

HEPTODE FREQUENCY CHANGER

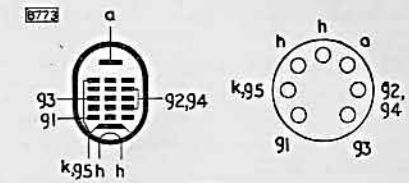
EK90

HEATER

V_h	6.3	V
I_h	300	mA

CAPACITANCES
(measured without an external shield)

c_{a-all}	8.6	pF
c_{g1-all}	5.5	pF
c_{g3-all}	7.2	pF
c_{a-g1}	<0.05	pF
c_{a-g3}	<0.3	pF
c_{g1-g3}	<0.15	pF
c_{g1-k}	2.8	pF



B7G

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

EK90 (Cont.) HEPTODE FREQUENCY CHANGER

LIMITING VALUES

V_a max.	300	V
p_a max.	1.0	W
V_{g2+g4} max.	100	V
p_{g2+g4} max.	1.0	W
I_k max.	14	mA
V_{h-k} max.	90	V

CHARACTERISTICS

Oscillator Section

V_a	100	V
V_{g2+g4}	100	V
V_{g3}	0	V
V_{g1}	0	V
I_a	25	mA
$g_{m(g1-g2+g4+a)}$	7.25	mA/V
$\mu_{(g1-g2+g4+a)}$	20	

OPERATING CONDITIONS

(with separate excitation)*

V_a	100	250	V
V_{g2+g4}	100	100	V
V_{g3}	−1.5	−1.5	V
R_{g1-k}	20	20	kΩ
I_k	10.6	10.6	mA
I_a	2.8	3.0	mA
I_{g2+g4}	7.3	7.1	mA
I_{g1}	500	500	μA
g_c	455	475	μA/V
r_a	0.5	1.0	MΩ
†V_{g1}	−30	−30	V

†For 100 : 1 reduction in g_c.

*The operating conditions shown with separate excitation correspond very closely to those obtained in a self-excited oscillator circuit operating with zero bias.

REPLACEMENT FOR:
X77, X727/6BE6, 6BE6—Direct.
6SA7, 7Q7—Change base. Receiver may require realigning.

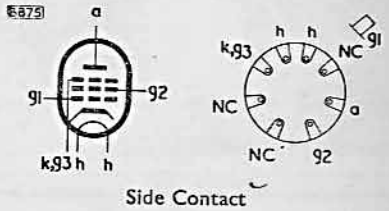
EL2 OUTPUT PENTODE

HEATER

V_h	6.3	V
I_h	200	mA

DIMENSIONS

Max. Overall Length	95	mm
Max. Diameter	37	mm



Side Contact

For characteristics, operating data and limiting values see type EL32. Except for base EL2 and EL32 are identical.

REPLACEMENT FOR: PP6As—Direct.

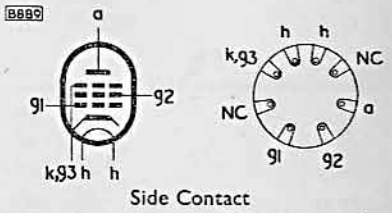
EL3 OUTPUT PENTODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	900	mA

DIMENSIONS

Max. Overall Length	120	mm
Max. Diameter	46	mm



Side Contact

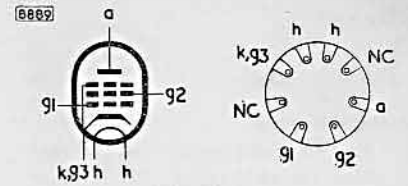
For characteristics, operating data and limiting values, see type EL33. Except for base and dimensions, the EL3 and EL33 are identical.

REPLACED BY: EL33—Change base.

OUTPUT PENTODE (OBSOLETE) EL5

HEATER

V_h	6.3	V
I_h	1.35	A



Side Contact

LIMITING VALUES

V_a max.	250	V
p_a max.	18	W
V_{g2} max.	275	V
p_{g2} max.	3.0	W
I_k max.	90	mA
V_{h-k} max.	50	V

CHARACTERISTICS

V_a	250	V
V_{g2}	275	V
V_{g1}	−14	V
I_a	72	mA
I_{g2}	7.0	mA
g_m	8.5	mA/V
r_a	22	kΩ

DIMENSIONS

Max. Overall Length	117	mm
Max. Diameter	51	mm

OPERATING CONDITIONS

(As single valve class "A" amplifier)

V_a	250	V
V_{g2}	275	V
I_a	72	mA
I_{g2}	7.0	mA
R_a	3.5	kΩ
R_k	175	Ω
P_{out}	8.8	W
D_{tot}	10	%
$V_{in(r.m.s.)}$	9.1	V

REPLACED BY: EL37—Change base. May require some alteration in push-pull stages.

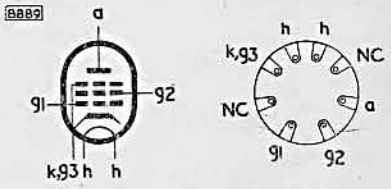
OUTPUT PENTODE (OBSOLETE) EL6

HEATER

V_h	6.3	V
I_h	1.2	A

DIMENSIONS

Max. Overall Length	121	mm
Max. Diameter	52	mm



Side Contact

For characteristics, operating data and limiting values see type EL36. Except for base and dimensions, the EL6 and EL36 are identical.

REPLACED BY: EL37—Change base. May require some alteration in push-pull stages.

EL31

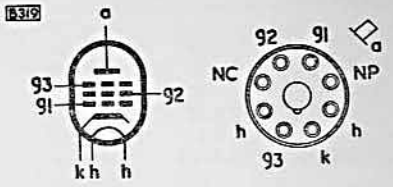
OUTPUT PENTODE

HEATER

V_h	6.3	V
I_h	1.4	A

DIMENSIONS

Max. Overall Length	141	mm
Max. Seated Height	127	mm
Max. Diameter	54	mm



Octal

LIMITING VALUES

V_a max.	800	V
V_{g_2} max.	400	V
p_a max.	25	W
p_{g_2} max.	8.0	W
I_k max.	200	mA
V_{h-k} max.	100	V

CHARACTERISTICS

V_a	275	600	V
V_{g_2}	275	400	V
V_{g_1}	–9.0	–22	V
I_a	91	42	mA
I_{g_2}	11	5.0	mA
g_m	14	7.0	mA/V
r_a	20	43	kΩ
$\mu_{g_1-g_2}$	16.5	—	

OPERATING CONDITIONS—TWO VALVES IN PUSH-PULL

(Self Bias)

V_a	350	375	400	V
V_{g_2}	350	375	400	V
R_k	100	122	145	Ω
$I_{a(o)}$	2×71	2×67	2×63	mA
I_a (max. sig.)	2×83	2×75	2×69	mA
$I_{g_2(o)}$	2×8.8	2×8.8	2×8.3	mA
I_{g_2} (max. sig.)	2×23.5	2×24.5	2×24	mA
R_{a-a}	5.0	6.0	7.0	kΩ
$V_{in(g_1-g_1)r.m.s.}$	29.4	30	31	V
*P_{out}	38	37.5	37	W
D_{tot}	4.2	5.0	5.0	%

OPERATING CONDITIONS—TWO VALVES IN PUSH-PULL

(Fixed bias)

V_a	400	600	800	V
V_{g_2}	400	400	400	V
V_{g_1}	–23	–25.2	–26	V
$I_{a(o)}$	2×40	2×30	2×30	mA
I_a (max. sig.)	2×110	2×103	2×107	mA
$I_{g_2(o)}$	2×5.2	2×3.4	2×3.1	mA
I_{g_2} (max. sig.)	2×26.8	2×28.5	2×28.5	mA
R_{a-a}	4.0	7.5	10	kΩ
$V_{in(g_1-g_1)r.m.s.}$	31.4	34.6	36	V
*P_{out}	55	84	102	W
D_{tot}	3.2	5.0	5.0	%

*Measured at start of I_{g_1} or 5% distortion.

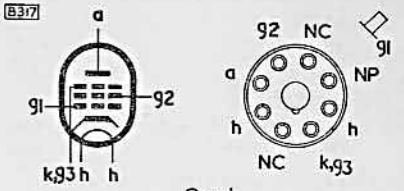
REPLACEMENT FOR: EL50, PEN650 (when used as audio output valves)—Change base. Adjust screen voltage, bias and load.

EL32

OUTPUT PENTODE

HEATER

V_h	6.3	V
I_h	200	mA



Octal

LIMITING VALUES

V_a max.	250	V
p_a max.	8.0	W
I_k max.	45	mA
V_{g_2} max.	250	V
p_{g_2} max.	1.6	W
V_{h-k} max.	50	V

DIMENSIONS

Max. Overall Length	110	mm
Max. Diameter	37	mm

OPERATING CONDITIONS

(As single valve class "A" amplifier)

V_a	250	V
V_{g_2}	250	V
V_{g_1}	–18	V
I_a	32	mA
I_{g_2}	5.0	mA
g_m	2.8	mA/V
r_a	70	kΩ
R_a	8.0	kΩ
P_{out}	3.6	W
$V_{in\ (r.m.s.)}$	10	V
D_{tot}	10	%

OPERATING CONDITIONS

Two Valves in Push-pull

V_a	200	250	V
V_{g_2}	200	250	V
*R_k	300	310	Ω
$I_{a(o)}$	2×21	2×27.5	mA
I_a (max. sig.)	2×24.5	2×32	mA
$I_{g_2(o)}$	2×3.85	2×4.4	mA
I_{g_2} (max. sig.)	2×6.1	2×8.0	mA
R_{a-a}	9.0	8.0	kΩ
P_{out}	5.1	7.0	W
D_{tot}	1.6	1.5	%

*Common cathode bias resistor.

CHARACTERISTICS AS TRIODE

V_a	200	200	250	250	V
V_{g_1}	–19	–14	–27	–23	V
I_a	15	30	15	30	mA
g_m	2.1	3.2	1.7	2.6	mA/V
r_a	3.3	2.4	4.1	3.1	kΩ
μ	7.0	8.0	7.0	8.0	

REPLACEMENT FOR:

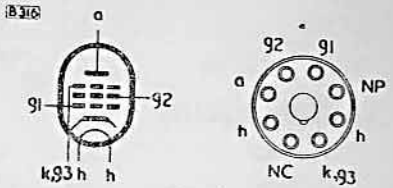
OM9—Direct.

N63—Rewire base.

41E—Change base.

EL33

OUTPUT PENTODE



Octal

HEATER

V_h	6.3	V
I_h	900	mA

DIMENSIONS

Max. Overall Length	126	mm
Max. Diameter	46	mm

LIMITING VALUES

V_a max.	250	V
p_a max.	9.0	W
V_{g2} max.	275	V
p_{g2} max. (zero sig.)	1.2	W
p_{g2} max. (max. sig.)	2.5	W
I_k max.	55	mA
V_{h-k} max.	50	V

CHARACTERISTICS

Pentode Connection

V_a	250	V
V_{g2}	250	V
V_{g1}	–6.0	V
I_a	36	mA
I_{g2}	4.0	mA
g_m	9.0	mA/V
r_a	50	kΩ

Triode Connection

V_a	250	V
V_g	–8.5	V
I_a	20	mA
g_m	6.5	mA/V
r_a	3.0	kΩ
μ	20	

OPERATING CONDITIONS

(As single valve class "A" amplifier)

V_a	250	V
V_{g2}	250	V
I_a	36	mA
I_{g2}	4.0	mA
R_k	150	Ω
P_{out}	4.0	W
R_a	7.0	kΩ
$V_{in(r.m.s.)}$	4.2	V
D_{tot}	10	%

OPERATING CONDITIONS

Two Valves in Push-pull

V_a	250	V
V_{g2}	250	V
$I_{a(o)}$	2×24	mA
I_a (max. sig.)	2×28.5	mA
$I_{g2(o)}$	2×2.8	mA
I_{g2} (max. sig.)	2×4.6	mA
*R_k	140	Ω
R_{a-a}	10	kΩ
P_{out}	8.2	W
$V_{in(g1-g1)r.m.s.}$	13	V
D_{tot}	3.1	%

*Common cathode bias resistor.

OPERATING CONDITIONS

Triode Connection

V_a	250	V
I_a	20	mA
R_k	425	Ω
R_a	7.0	kΩ
P_{out}	1.1	W
D_{tot}	5.0	%
$V_{in(r.m.s.)}$	5.9	V

REPLACEMENT FOR:

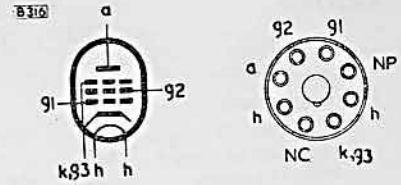
BVA264, BVA265, BVA266, BVA267, N147, PP6BG, 6AG6G, 6M6G—Direct.

EL3, EL3N, PP6Bs—Change base.

KT61—Bias may require adjustment.

EL35

OUTPUT PENTODE (OBSOLETE)



Octal

HEATER

V_h	6.3	V
I_h	1.35	A

DIMENSIONS

Max. Overall Length	125	mm
Max. Diameter	47	mm

LIMITING VALUES

V_a max.	375	V
p_a max.	18	W
V_{g2} max.	250	V
p_{g2} max.	3.5	W
I_k max.	90	mA
V_{h-k} max.	50	V

CHARACTERISTICS

V_a	250	V
V_{g2}	250	V
V_{g1}	–15.5	V
I_a	72	mA
I_{g2}	8.0	mA
g_m	5.0	mA/V
r_a	15.5	kΩ
μ_{g1-g2}	8.0	

OPERATING CONDITIONS

(As single valve class "A" amplifier)

V_a	250	V
V_{g2}	250	V
R_k	180	Ω
I_a	72	mA
I_{g2}	8.0	mA
R_a	2.5	kΩ
P_{out}	6.0	W
$V_{in(r.m.s.)}$	13	V
D_{tot}	10	%

OPERATING CONDITIONS

Two Valves in Class "AB" Push-pull

(Self Bias)

V_a	270	360	V
V_{g2}	270	270	V
*R_k	135	250	Ω
$I_{g2(o)}$	2×8	2×4.25	mA
I_{g2} (max. sig.)	2×12.5	2×8.75	mA
$I_{g2(o)}$	16	8.5	mA
I_{g2} (max. sig.)	25	17.5	mA
R_{a-a}	5.0	7.0	kΩ
P_{out}	17	21	W
$V_{in(g1-g1)r.m.s.}$	31	46	V
D_{tot}	6.0	<3.0	%

*Common cathode bias resistor.

Two Valves in Class "AB" Push-pull

(Fixed Bias)

V_a	360	V
V_{g2}	270	V
V_{g1}	–26	V
$I_{a(o)}$	2×44	mA
I_a (max. sig.)	2×70	mA
$I_{g2(o)}$	2×4.25	mA
I_{g2} (max. sig.)	2×9.75	mA
R_{a-a}	6.25	kΩ
P_{out}	26	W
$V_{in(g1-g1)r.m.s.}$	36	V
D_{tot}	<3.0	%

REPLACED BY: EL37—No alteration necessary in single valve output stages, but may be necessary in push-pull stages.

EL36

OUTPUT PENTODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	1.2	A

DIMENSIONS

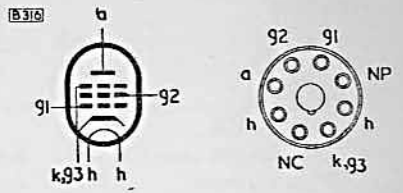
Max. Overall Length	143	mm
Max. Seated Height	129	mm
Max. Diameter	52	mm

LIMITING VALUES

V_a max.	250	V
p_a max.	18	W
V_{g_2} max.	275	V
p_{g_2} max.	3.0	W
I_k max.	90	mA
V_{h-k} max.	50	V

CHARACTERISTICS

V_a	250	V
V_{g_2}	250	V
V_{g_1}	–7.0	V
I_a	72	mA
I_{g_2}	8.0	mA
g_m	14.5	mA/V
r_a	20	kΩ
$\mu_{g_1-g_2}$	20	



Octal

OPERATING CONDITIONS

(As single valve class "A" amplifier)

V_a	250	V
V_{g_2}	250	V
R_k	90	Ω
I_a	72	mA
I_{g_2}	8.0	mA
R_a	3.5	kΩ
P_{out}	8.0	W
$V_{in(r.m.s.)}$	4.8	V
D_{tot}	10	%

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

(Self Bias)

V_a	250	V
V_{g_2}	250	V
*R_k	90	Ω
$I_{a(o)}$	2×45	mA
I_a (max. sig.)	2×53	mA
$I_{g_2(o)}$	2×5.1	mA
I_{g_2} (max. sig.)	2×8.5	mA
R_{a-a}	5.0	kΩ
P_{out}	14.5	W
D_{tot}	2.2	%
$V_{in(g_1-g_1)r.m.s.}$	14.5	V

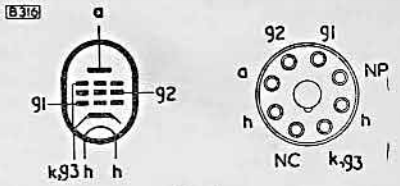
*Common cathode bias resistor.

REPLACED BY: EL37—Direct substitute in single valve output stages, but may require some alteration in push-pull stages.

EL37

OUTPUT PENTODE

25-watt pentode, particularly suitable for use in push-pull combination for outputs up to 69W, or as drivers for large power triode push-pull output stage.



Octal

HEATER

V_h	6.3	V
I_h	1.4	A

DIMENSIONS

Max. Overall Length	131	mm
Max. Diameter	54	mm

LIMITING VALUES

Pentode Connection

V_a max.	400	V
V_{g_2} max.	400	V
p_a max.	25	W
p_{g_2} max.	6.0	W
I_k max.	200	mA
V_{h-k} max.	75	V

Triode Connection

(Normal applications)

V_{a+g_2} max.	400	V
p_{a+g_2} max.	28	W

Triode Connection

(In cathode-coupled push-pull driver stage for large power triodes)

V_{a+g_2} max.	500	V
p_{a+g_2} max.	12.5	W

OPERATING CONDITIONS

Pentode Connection

V_a	250	V
V_{g_2}	250	V
V_{g_1}	–13.5	V
I_a	100	mA
I_{g_2}	13.5	mA
R_k	120	Ω
g_m	11	mA/V
r_a	13.5	kΩ
$\mu_{g_1-g_2}$	10	
R_a	2.5	kΩ
$V_{in(r.m.s.)}$	10.8	V
D_{tot}	13.5	%
P_{out}	11.5	W

Triode Connection

(g_2 connected to a by 100Ω resistor)

V_a	300	400	V
I_a	50	37.5	mA
V_g	–26	–39	V
g_m	6.5	4.5	mA/V
μ	9.0	9.0	
r_a	1.4	2.0	kΩ

OPERATING CONDITIONS—TWO VALVES IN PUSH-PULL

(Self Bias)

V_a	250	325	V
V_{g_2}	250	325	V
$I_{a(o)}$	2×59	2×77	mA
I_a (max. sig.)	2×68	2×90	mA
$I_{g_2(o)}$	2×7.5	2×9.75	mA
I_{g_2} (max. sig.)	2×18	2×30	mA
*R_k	130	130	Ω
R_{a-a}	4.0	4.0	kΩ
P_{out}	20	35	W
$V_{in(g_1-g_1)r.m.s.}$	29	43	V
D_{tot}	2.25	4.4	%

*Common cathode bias resistor

EL37 (Cont.)

OUTPUT PENTODE

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

(Fixed Bias)

V_a	350	400	V
V_{g2}	350	400	V
$I_{a(o)}$	2×40	2×50	mA
I_a (max. sig.)	2×118	2×138	mA
$I_{g2(o)}$	2×5.0	2×6.0	mA
I_{g2} (max. sig.)	2×29	2×36	mA
V_{g1}	−31	−36	V
R_{a-a}	3.25	3.25	kΩ
P_{out}	46	69	W
$V_{in(g1-g1)r.m.s.}$	43.4	49	V
D_{tot}	2.8	2.5	%

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

Triode Connection (Self Bias)

V_b	350	435	V
V_a	320	400	V
$I_{a+g2(o)}$	2×56	2×70	mA
I_{a+g2} (max. sig.)	2×64	2×80	mA
P_{a+g2}	2×18	2×28	W
*R_k	245	245	Ω
R_{a-a}	4.0	4.0	kΩ
$V_{in(g1-g1)r.m.s.}$	42	54	V
P_{out}	12.5	20.6	W
D_{tot}	4.1	4.3	%

*Common cathode bias resistor

REPLACEMENT FOR:

KT66, N66—Direct.

AC/Qa—Bias may require adjustment.

EL5, EL6 (change base), EL35, EL36 } Direct substitute in single valve output stages. May not always be suitable without alteration in push-pull stages.

DO24, DO26, DO30—In some cases. Redesign circuit.

EL38

LINE TIMEBASE OUTPUT PENTODE

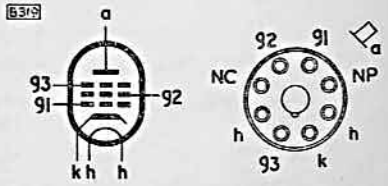
Output pentode primarily intended for use as line timebase output valve in a.c. operated television receivers.

HEATER

V_h	6.3	V
I_h	1.4	A

DIMENSIONS

Max. Overall Length	141	mm
Max. Seated Height	127	mm
Max. Diameter	45.5	mm



Octal

Mullard

LINE TIMEBASE OUTPUT PENTODE

EL38 (Cont.)

LIMITING VALUES

V_a max.	800	V
$v_{a(pk)}$ max.	8.0	kV
V_{g2} max.	400	V
p_a max.	25	W
p_{g2} max.	8.0	W
I_k max.	200	mA
V_{h-k} max.	100	V

CHARACTERISTICS

V_a	275	V
V_{g2}	275	V
I_a	91	mA
I_{g2}	11	mA
V_{g1}	−9.0	V
g_m	14	mA/V
μ_{g1-g2}	16.5	
r_a	20	kΩ

REPLACEMENT FOR:

EL38M, 6CN6—Direct.

EL50 (As line output valve)—Change base. Adjust bias and load.

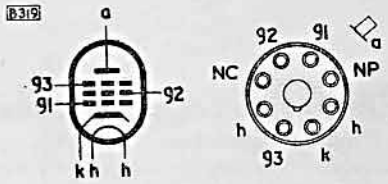
6P28—Rewire base.

LINE TIME BASE OUTPUT PENTODE (OBSOLETE)

EL38M

For data, see EL38 above. Except for the fact that the EL38M is metallised, these two valves are identical.

REPLACED BY: EL38.



Octal
Pin 3—Metallising

OUTPUT PENTODE

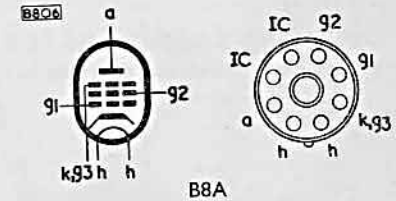
EL41

HEATER

V_h	6.3	V
I_h	700	mA

LIMITING VALUES

V_a max.	300	V
p_a max.	9.0	W
V_{g2} max.	300	V
p_{g2} (zero sig.) max.	1.4	W
p_{g2} (max. sig.) max.	3.3	W
I_k max.	55	mA
V_{h-k} max.	50	V



B8A

DIMENSIONS

Max. Overall Length	76	mm
Max. Seated Height	69	mm
Max. Diameter	22	mm

Mullard

EL41 (Cont.)

OUTPUT PENTODE

CHARACTERISTICS

V_a	250	V
V_{g2}	250	V
I_a	36	mA
I_{g2}	5.2	mA
V_{g1}	–7.0	V
g_m	10	mA/V
r_a	40	kΩ
μ_{g1-g2}	22	

OPERATING CONDITIONS
(As single valve class "A" amplifier)

Triode Connection (g_2 connected to a)

V_a	250	V
R_k	250	Ω
R_a	3.5	kΩ
I_a	33	mA
P_{out}	1.55	W
$V_{in(r.m.s.)}$	6.0	V
D_{tot}	8.0	%

OPERATING CONDITIONS (As single valve class "A" amplifier)

Pentode Connection

V_a	250	V
V_{g2}	250	V
V_{g1}	–7.0	V
R_k	170	Ω
I_a	36	mA
I_{g2}	5.2	mA
R_a	7.0	kΩ
$V_{in(r.m.s.)}$	3.7	V
P_{out}	4.2	W
D_{tot}	10	%

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

Pentode Connection

V_a	250	300	V
V_{g2}	250	300	V
$I_{a(o)}$	2×25	2×30	mA
I_a (max. sig.)	2×30	2×36	mA
$I_{g2(o)}$	2×3.5	2×4.0	mA
I_{g2} (max. sig.)	2×8.0	2×9.5	mA
*R_k	140	140	Ω
R_{a-a}	9.0	9.0	kΩ
P_{out}	9.0	13	W
$V_{in(g1-g1)r.m.s.}$	14	17	V
D_{tot}	2.5	2.5	%

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

Triode Connection (g_2 connected to a)

V_a	250	300	V
$I_{a(o)}$	2×27.5	2×33	mA
*R_k	150	150	Ω
R_{a-a}	10	10	kΩ
P_{out}	2.5	4.0	W
$V_{in(g1-g1)r.m.s.}$	11	13	V
D_{tot}	1.0	1.0	%

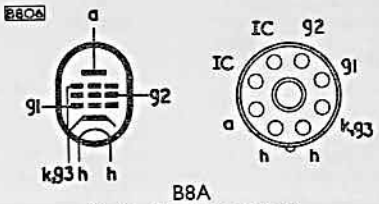
*Common cathode bias resistor

REPLACEMENT FOR: N150, 67PT—Direct.

OUTPUT PENTODE

EL42

Output pentode capable of 6 watts dissipation at the anode. Its small consumption heater and compact dimensions render it particularly suitable for use in car radio receivers.



B8A
Pin 4—No Connection

HEATER

V_h	6.3	V
I_h	200	mA

LIMITING VALUES

V_a max.	300	V
p_a max.	6.0	W
V_{g2} max.	300	V
p_{g2} max. (zero sig.)	1.0	W
p_{g2} max. (max. sig.)	2.0	W
I_k max.	35	mA
V_{h-k} max.	50	V

CHARACTERISTICS

V_a	200	225	V
V_{g2}	200	225	V
V_{g1}	9.4	10.8	V
I_a	22.5	26	mA
I_{g2}	3.5	4.1	mA
g_m	3.2	3.2	mA/V
r_a	90	90	kΩ
μ_{g1-g2}	11	11	

DIMENSIONS

Max. Overall Length	60	mm
Max. Seated Height	53	mm
Max. Diameter	22	mm

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	200	225	V
V_{g2}	200	225	V
R_k	360	360	Ω
I_a	22.5	26	mA
I_{g2}	3.5	4.1	mA
R_a	9.0	9.0	kΩ
$V_{in(r.m.s.)}$	6.4	7.2	V
P_{out}	1.9	2.5	W
D_{tot}	10	10	%

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

	Class "AB" (Self Bias)		Class "B" (Fixed Bias)		
V_a	200	250	200	250	V
V_{g2}	200	250	250	250	V
V_{g1}	—	—	–17	–22.5	V
R_k	310	310	—	—	Ω
$I_{a(o)}$	2×16	2×20	2×5.0	2×5.0	mA
I_a (max. sig.)	2×17	2×21.5	2×16	2×20	mA
$I_{g2(o)}$	2×2.6	2×3.2	2×0.8	2×0.8	mA
I_{g2} (max. sig.)	2×5.6	2×6.7	2×4.6	2×6.5	mA
R_{a-a}	15	15	16	16	kΩ
$V_{in(g1-g1)r.m.s.}$	19.2	25	24	32	V
P_{out}	4.1	7.0	4.0	6.5	W
D_{tot}	5.5	5.5	3.5	5.0	%

REPLACEMENT FOR: N151—Direct.

EL50

OUTPUT PENTODE (OBSOLETE)

HEATER

V_h	6.3	V
I_h	1.35	A

LIMITING VALUES

V_a max.	600	V
p_a max.	18	W
V_{g_2} max.	325	V
p_{g_2} max.	5.0	W
I_k max.	110	mA
V_{h-k} max.	100	V

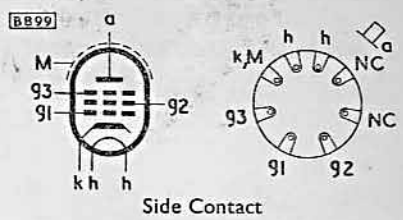
OPERATING CONDITIONS
Two Valves in Class "AB" Push-pull

V_a	600	V
V_{g_2}	300	V
V_{g_3}	0	V
V_{g_1}	–25	V
$I_{a(o)}$	2×25	mA
I_a (max. sig.)	2×73	mA
$I_{g_2(o)}$	2×2.2	mA
I_{g_2} (max. sig.)	2×11	mA
R_{a-a}	10	kΩ
P_{out}	55	W
D_{tot}	1.3	%
$V_{in(g_1-g_1)r.m.s.}$	36	V

REPLACED BY:

EL31 (*As Audio Amplifier*)—Change base. Adjust screen voltage, bias and load.

EL38 (*As Television Line Output Valve*)—Change base and check operating conditions.



Side Contact

DIMENSIONS

Max. Overall Length	135	mm
Max. Diameter	51	mm

CHARACTERISTICS

V_a	600	V
V_{g_2}	300	V
V_{g_3}	0	V
V_{g_1}	–24	V
I_a	30	mA
I_{g_2}	3.0	mA
R_k	730	Ω
g_m	5.0	mA/V
r_a	30	kΩ

EL81

OUTPUT PENTODE

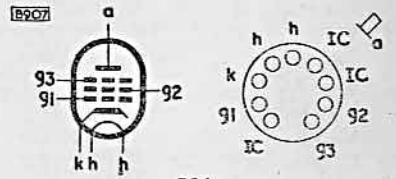
HEATER

V_h	6.3	V
I_h	1.05	A

LIMITING VALUES

V_a max.	300	V
*$V_{a\ (pk)}$ max.	7.0	kV
p_a max.	8.0	W
V_{g_2} max.	300	V
p_{g_2} max.	4.5	W
p_{a+g_2} max.	10	W
I_k max.	180	mA
V_{h-k} max.	100	V

*Max. pulse duration 18% of one cycle, with a maximum of 18 μsec.



B9A

DIMENSIONS

Max. Overall Length	83	mm
Max. Seated Height	76	mm
Max. Diameter	22.2	mm

Mullard

OUTPUT PENTODE

EL81 (Cont.)

CHARACTERISTICS

V_a	250	V
V_{g_2}	250	V
V_{g_3}	0	V
I_a	32	mA
I_{g_2}	2.4	mA
V_{g_1}	–38.5	V
g_m	4.6	mA/V
$\mu_{g_1-g_2}$	5.1	
r_a	15	kΩ

REPLACEMENT FOR: 6CJ6—Direct.

EL84

OUTPUT PENTODE

HEATER

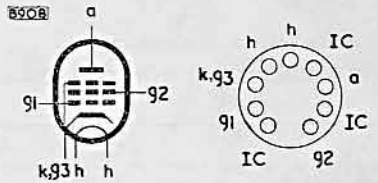
V_h	6.3	V
I_h	760	mA

LIMITING VALUES

V_a max.	300	V
p_a max.	12	W
V_{g_2} max.	300	V
p_{g_2} max. (zero sig.)	2.0	W
p_{g_2} max. (max. sig.)	4.0	W
I_k max.	65	mA
V_{h-k} max.	100	V

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	250	250	V
V_{g_2}	250	250	V
R_a	5.2	4.5	kΩ
R_k	135	135	Ω
V_{g_1}	–7.3	–7.3	V
I_a	48	48	mA
I_{g_2}	5.5	5.5	mA
*P_{out}	5.7	5.7	W
$R_{i(r.m.s.)}$	4.3.	4.4	V
D_{tot}	10	10	%
D_3	9.5	8.0	%
D_2	2.0	5.0	%



B9A

DIMENSIONS

Max. Overall Length	78.5	mm
Max. Seated Height	71.5	mm
Max. Diameter	22.2	mm

CHARACTERISTICS

V_a	250	V
V_{g_2}	250	V
I_a	48	mA
I_{g_2}	5.5	mA
V_{g_1}	–7.3	V
g_m	11.3	mA/V
r_a	38	kΩ
$\mu_{g_1-g_2}$	19	

Mullard

EL84 (Cont.)

OUTPUT PENTODE

OPERATING CONDITIONS (As single valve class "A" amplifier)
Triode Connection (g_2 connected to a)

V_a	250	V
$I_{a(o)}$	34	mA
I_a (max. sig.)	36	mA
R_k	270	Ω
R_a	3.5	kΩ
P_{out}	1.9	W
$V_{in\ (r.m.s.)}$	6.7	V
D_{tot}	9.0	%

OPERATING CONDITIONS Two Valves in Class "AB" Push-pull

Pentode Connection

V_a	250	300	V
V_{g2}	250	300	V
*R_k	130	130	Ω
R_{a-a}	8.0	8.0	kΩ
$I_{a(o)}$	2×31	2×36	mA
I_a (max. sig.)	2×37.5	2×46	mA
$I_{g2(o)}$	2×3.5	2×4.0	mA
I_{g2} (max. sig.)	2×7.	52×11	mA
$V_{in(g1-g1)r.m.s.}$	16	20	V
P_{out}	11	17	W
D_{tot}	3.0	4.0	%

Triode Connection (g_2 connected to a)

V_a	250	300	V
$I_{a(o)}$	2×20	2×24	mA
I_a	2×21.5	2×26	mA
*R_k	270	270	Ω
R_{a-a}	10	10	kΩ
P_{out}	3.4	5.2	W
$V_{in(g1-g1)r.m.s.}$	16.5	20	V
D_{tot}	2.5	2.5	%

*Common cathode bias resistor.

REPLACEMENT FOR: N709, 6BQ5—Direct.

EL90

OUTPUT PENTODE

HEATER

V_h	6.3	V
I_h	450	mA

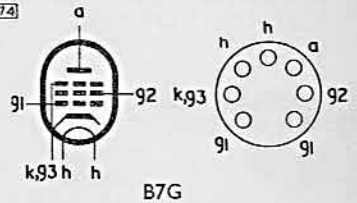
DIMENSIONS

Max. Overall Length	67.5	mm
Max. Seated Height	60.5	mm
Max. Diameter	19	mm

LIMITING VALUES

V_a max.	250	V
V_{g2} max.	250	V
p_a max.	12	W
p_{g2} max.	2.0	W
I_k max.	55	mA
V_{h-k} max.	90	V

B774



B7G

CHARACTERISTICS

V_a	180	250	V
V_{g2}	180	250	V
I_a	29	45	mA
I_{g2}	3.0	4.5	mA
V_{g1}	−8.5	−12.5	V
g_m	3.7	4.1	mA/V
μ_{g1-g2}	10	10	
r_a	58	52	kΩ

Mullard

OUTPUT PENTODE

EL90 (Cont.)

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	180	250	V
V_{g2}	180	250	V
R_k	270	250	Ω
$I_{a(o)}$	29	45	mA
I_a (max. sig.)	30	47	mA
$I_{g2(o)}$	3.0	4.5	mA
I_{g2} (max. sig.)	4.0	7.0	mA
R_a	5.5	5.0	kΩ
$V_{in(r.m.s.)}$	6.0	8.8	V
P_{out}	2.0	4.5	W
D_{tot}	8.0	8.0	%

OPERATING CONDITIONS
Two Valves in Class "AB" Push-pull
(Self Bias)

V_a	250	V
V_{g2}	250	V
$I_{a(o)}$	2×35	mA
I_a (max. sig.)	2×38.5	mA
$I_{g2(o)}$	2×2.5	mA
I_{g2} (max. sig.)	2×6.5	mA
R_k	200	Ω
R_{a-a}	10	kΩ
P_{out}	10	W
$V_{in(g1-g1)r.m.s.}$	21	V
D_{tot}	5.0	%

REPLACEMEMT FOR: N727/6AQ5, 6AQ5—Direct.

EL91

OUTPUT PENTODE

HEATER

V_h	6.3	V
I_h	200	mA

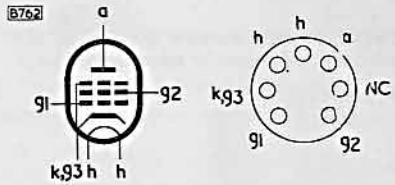
LIMITING VALUES

V_a max.	250	V
V_{g2} max.	250	V
p_a max.	4.0	W
p_{g2} max.	600	mW
I_k max.	25	mA
V_{h-k} max.	50	V

OPERATING CONDITIONS
(As single valve class "A" amplifier)

V_a	250	V
V_{g2}	250	V
I_a	16	mA
I_{g2}	2.4	mA
g_m	2.6	mA/V
μ_{g1-g2}	12	
r_a	130	kΩ
R_k	680	Ω
R_a	16	kΩ
$V_{in(r.m.s.)}$	5.3	V
P_{out}	1.4	W
D_{tot}	10	%

B762



B7G

DIMENSIONS

Max. Overall Length	54.5	mm
Max. Seated Height	47.5	mm
Max. Diameter	19	mm

OPERATING CONDITIONS
Two Valves in Class "AB" Push-pull
(Fixed Bias)

V_a	250	V
V_{g2}	250	V
V_{g1}	−19	V
$I_{a(o)}$	2×5.0	mA
I_a (max. sig.)	2×16	mA
$I_{g2(o)}$	2×650	μA
I_{g2} (max. sig.)	2×4.5	mA
R_{a-a}	20	kΩ
$V_{in(g1-g1)r.m.s.}$	26	V
P_{out}	4.8	W
D_{tot}	3.3	%

Mullard