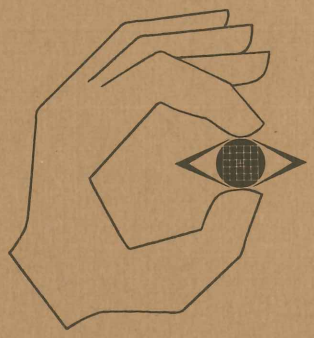


TELEQUIPMENT

OSCILLOSCOPE CALIBRATOR

TYPE C.1

MANUAL

OSCILLOSCOPE CALIBRATOR

TYPE C.1

GENERAL DESCRIPTION

OPERATING AND MAINTENANCE

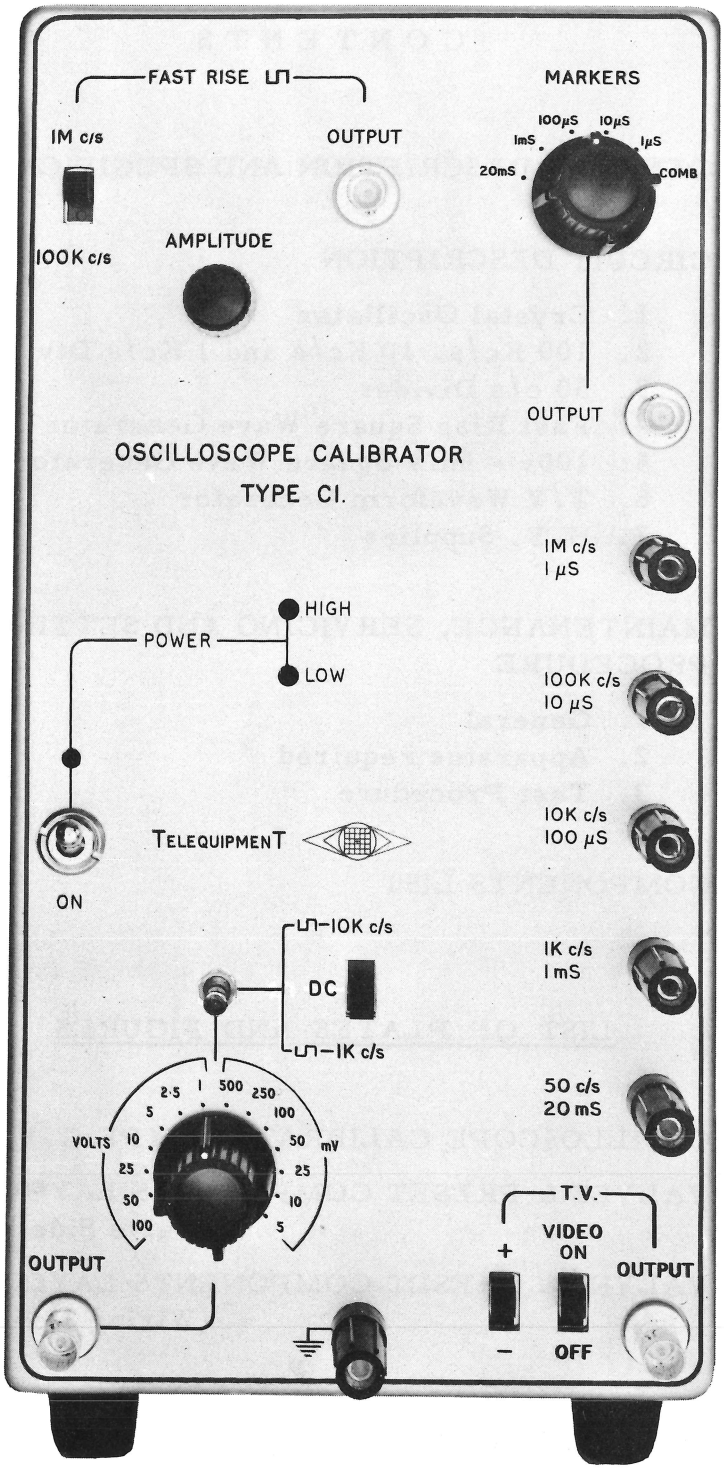
MANUAL

TELEQUIPMENT LIMITED
313, Chase Road, Southgate, London, N.14.

September 1964

CONTENTS

LIST OF PLATES AND FIGURES



OSCILLOSCOPE CALIBRATOR TYPE C.I.

PLATE.I.

CHAPTER 1

GENERAL DESCRIPTION AND SPECIFICATION

DESCRIPTION

The Calibrator Type C.1 is primarily intended for testing and calibrating Telequipment Oscilloscopes. It provides in one unit all waveforms and frequencies necessary for the complete alignment of any instrument in the Telequipment range. It is basically an economical source of accurate and undistorted pulse and square waveforms with a wide selection of frequencies and repetition rates.

The Calibrator operates from fully stabilized power supplies and incorporates a panel warning light to indicate variations of more than 10% in mains voltage. It is rated for continuous operation.

The Calibrator incorporates a crystal source and a number of accurate frequency dividers, which together produce all the relevant waveforms and ensure timing accuracy of a very high order. There are four entirely separate outputs available, which may be used independently, or all at once, without interaction between them. The whole unit is completely portable, rugged and economical of bench space, weighing 24 lbs. and measuring 13" x $6\frac{1}{2}$" x 13".

SPECIFICATION

The following signals are available:

1. A square wave switched at either 100 Kc/s or 1 Mc/s repetition rate.
   Rise time approximately 5 nSecs. No overshoot.
   Amplitude continuously variable 0 - .5v into an external 75 ohms.

2. A square wave switched at either 10 Kc/s, 1 Kc/s repetition rate, or single shot.
Rise time approximately 0.5 uSecs. No overshoot.
Amplitude adjustable from 100v to 5mV in steps of 1 - 2.5 - 5 ratio.
When the 0.5v range is accurately set all other ranges will be within 2%. Long term stability not greater than 1%.

3. Time marker pulses.
Pulses at switched rates of 1 Mc/s, 100 Kc/s, 10 Kc/s, 50 c/s and a timing comb, negative going with respect to Earth.
Amplitude approx. 0.3v; on comb, 0.1v to 1.5v.
The individual marker frequencies are also available on front panel terminals.
Marker accuracy crystal controlled.
Crystal accuracy .02%.
Stability .02%.
Width of marker at base - approx. 2mm of trace on appropriate oscilloscope sweep speed (1 marker per cm. display).
(Except 1 uSec markers.)

4. Non-interlaced television waveform available, switched $\pm$ ve, 200 lines, Amplitude 1v P/P (sync + video). The video signal consists of a sawtooth voltage.

5. Total power consumption approximately 90 watts.

CHAPTER 2

CIRCUIT DESCRIPTION

2.1 Crystal Oscillator

V1 (ECF 80) is a long-tailed pair crystal oscillator with a 1 Mc/s crystal X1 in the triode grid circuit. Positive feedback is taken from the pentode screen grid via R1 to the crystal. Square wave outputs are taken from the triode and pentode anodes.

2.2 100 Kc/s, 10 Kc/s and 1 Kc/s Dividers

The output from V1, pentode anode, is differentiated and the positive going edge removed by MR1. The negative going pulse is fed to the 100 Kc/s divider via a cathode follower V2A and also to the 1 Mc/s output via an attenuator.

The 100 Kc/s divider, V4 (ECC88), is a symmetrical multivibrator, the timing being determined by C8, C9, R18, R27 and RV17. Negative sync. pulses are fed to the grid of the conducting valve via diodes V3A and V3B. The square wave from pin 6 of V4 is fed via a cathode follower V2B to the fast rise square wave generator and to the 10 Kc/s divider. The 10 Kc/s (V5, V6 and V7) and 1 Kc/s (V8, V9 and V10) dividers are similar to the 100 Kc/s divider but give larger square wave outputs.

2.3 50 c/s Divider

The 1 Kc/s square wave from V8B is differentiated by C55 and R167 and the negative pulses fed via MR12 to the anode of V16 (ECC88) the 50 c/s divider. This is a Scarrott multivibrator with the tuning circuits between the cathodes. C53, R141 and RV142 determine the period for which one valve is cut off and C53 and R139 the period for which the other valve is cut off. The output waveform therefore has a mark/space ratio of approx. 40:1 so giving a 500 u/sec pulse at 50 c/s

repetition rate. The output from pin 6 of V16 is integrated and attenuated by R143, C56 and C57 and fed to the 50 c/s output terminals. The output from pin 6 is also differentiated by C54 and MR3 and mixed with the 1 Kc/s, 10 Kc/s, 100 Kc/s and 1 Mc/s outputs to form the comb.

2.4 Fast Rise Square Wave Generator

This consists of V11 (E810F) and V12 (EF184) which square and clip the input waveform to give a 1 V square wave across R88 with a rise time of less than 5 nS and no overshoot. The amplitude of the output is varied by RV87 which controls the screen voltage of V12. The input can be switched to either the triode anode of V1 (1 Mc/s) or the attenuated output of V2B (100 Kc/s).

2.5 100v - 5mV Square Wave Generator

The square waves from either the 10 Kc/s or 1 Kc/s dividers are D.C. restored negatively by V13B to a voltage level which can be adjusted by RV93, and fed to the grid of cathode follower V14B (ECC88). Both square waves are of sufficient amplitude to cut off V14B so that the output amplitude is dependent only on the setting of RV93. An additional position on S4 removes the square wave thus giving a D.C. output voltage equal to the peak amplitude of the square wave. A push button S8 disconnects the output when pressed and is useful for checking low frequency transient responses.

2.6 TV Waveform Generator

A 10 Kc/s square wave from the anode of V5B is differentiated by C46 and R129 and the negative pulse removed by MR10. The positive pulses trigger the monostable V15 (ECC88) via diode V13A(EB91). This produces a line pulse of 10 uS duration (determined by C45, R131 and the potential to which R131 is taken) every 100 uS. During the frame period when pin 1 of V16 goes positive for approximately 500 uS the potential to which R131 is taken also goes positive due to C51. This increases the duration of the pulse produced by V15 to 40 uS. In addition further positive triggering pulses derived from an antiphase

output of the 10 Kc/s divider are fed via MR11 during the frame period to V13A. This means that V15 now produces a frame pulse of 40 uS duration every 50 uS for the duration of the frame period. The mixed line and frame pulses are developed across a diode MR16 which limits the amplitude to approximately 0.25v negative. During the picture period, between line pulses, C43 charges up through R118 giving an approximate linear sawtooth waveform of amplitude 0.75v. C43 is discharged during the line pulse by V15. The combined video plus sync signal is fed to a phase-splitter V14A (ECC88), positive output being taken from the cathode and negative output from the anode.

2.7 H.T. Supplies

The main H.T. supply of +250v is derived from a voltage doubler MR14, MR15, C62 and C63 followed by a stabiliser V17 (EL86), V18 (EL86), V19A (ECF80) and N3 (85A2). The screen supply for the series valves V17 and V18 and the anode supply for the amplifier V19A are derived from a separate transformer winding and half wave rectifier circuit MR13, C16 and R147 connected to the stabilised output.

The +150 line is obtained from cathode follower V19B whose grid is fed from a voltage divider R159 and R161 across the +250v line.

The voltage across the series valves in the +250v line is monitored by neons N1 and N2. N1 lights when the mains input voltage is 7% high and N2 lights when the mains input voltage is 7% low. In order to overcome the backlash caused by difference between striking and extinguishing voltage of the neons a 6.3v A.C. is added in series with the neons.

CHAPTER 3

MAINTENANCE, SERVICING AND SETTING UP PROCEDURE

1. GENERAL

For the most part, servicing will be limited to the replacement of defective valves, but should a less common fault occur, no difficulty should be experienced in detecting the source, if the circuit diagrams are used in conjunction with the test procedure.

Test voltages at critical points are shown on the circuit diagrams and the location of major components is given on Plates 2 and 3.

2. APPARATUS REQUIRED

The following apparatus will be required: Voltmeter, such as an Avometer Model 8; Variac producing 90-250 volts when loaded with 90 watts; a good quality oscilloscope for waveform checking; a sub-standard Voltmeter, reading 0.5v D.C. full scale, or, preferably, a standard cell and null potentiometer.

3. TEST PROCEDURE

3.1 Check that the mains selector is correct for the supply to be used.

3.2 Set the 250v H.T. line with RV156.
Check the 150v line at pin 8 V19. Should be 151-155v.
Check the 100v line at the junction of R8, R9. Should be 96.5 – 99.5v.
Check the 75v line at the junction of R11, R12. Should be 71 - 74v.

3.3 Connect an oscilloscope to the Marker Output socket. Set the marker switch to 1 uSec. and adjust L1 for maximum amplitude of signal.

3.4 Set the marker switch to comb, and the oscilloscope to 5 uSec/cm.
Adjust RV17 for a count of 10.
There will be a range on the potentiometer for the correct count, so set RV17 to the middle of the range.
Operate S2, the 1 Mc/s / 100 Kc/s switch, and check that it does not affect the count.

3.5 Set the oscilloscope to 50 uSec/cm.
Adjust RV37 for a count of 10.
Set RV37 to the mid-position of the range of correct count.
Operate S4, the 10 Kc/s /D.C./1 Kc/s switch and check that it does not affect the count.
(It may change the amplitude of the 100 uSec. pulses, but not the count.)

3.6 Set the oscilloscope to 500 uSec/cm.
Adjust RV59 for a count of 10, and set it to the mid-position of the correct count range.
Check that S4 does not affect the count.
(It may affect the 10 Kc/s amplitude, but not the count.)

3.7 Set the oscilloscope to 5 mSec/cm and trigger on the largest amplitude pulses.
Adjust RV142 for a count of 20 and set it to the mid-position of the correct count range.

3.8 Check that each individual marker output has the correct frequency and amplitude.

1 uSec pulse	Amplitude is	approximately	0.4v	P to P.
10 uSec pulse	"	"	0.2v	P to P.
100 uSec pulse	"	"	0.2v	P to P.
1 mSec pulse	"	"	0.25v	P to P.
20 mSec pulse	"	"	0.7v	P to P.

Check the timing of the 20 mSec pulses against the supply frequency. This will cross check the accuracy of the crystal and dividers.

3.9 Check the square wave, 10 Kc/s / D.C. / 1 Kc/s output.
Set the oscilloscope to 500 uSec/cm. and the switch to 0.5v.
Check the output is approximately correct and the switch S4 operates correctly.
Disconnect the output from the oscilloscope and reconnect to the "Null Potentiometer".
Switch S4 to D.C.
Adjust RV93 until the "Null Potentiometer" is zeroed.

Alternatively :-

Set the 0.5v output, with RV93, using a sub-standard Voltmeter connected to the output socket, and S4 in the D.C. position. The output impedance on the 0.5v position is 98.5 ohms and the effect of meter current on output voltage must be allowed for.
Connect the oscilloscope to the output.
Set the oscilloscope to 0.1v/cm and the switch to 0.5v and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 0.2v/cm and the switch to 1v and 1Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 0.5v/cm and the switch to 2.5v and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 1v/cm and the switch to 5v and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 2v/cm and the switch to 10v and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 5v/cm and the switch to 25v and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 10v/cm and the switch to 50v and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 20v/cm and the switch to 100v and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 10mV/cm and the switch to 50mV and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 20mV/cm and the switch to 100mV and 1 Kc/s. Check there is 5 cm. of trace.

Set the oscilloscope to 50mV/cm and the switch to 250mV and 1 Kc/s. Check there is 5 cm. of trace.
Set the oscilloscope to 100mV/cm and the switch to 500mV and 1 Kc/s. Check there is 5 cm. of trace.

3.10 Connect the oscilloscope to the fast rise square wave socket. Set to 10 uSec/cm and S2 to 100 Kc/s.
Check that with the Amplitude control, RV87, turned to maximum there is at least 0.8v P to P with no external termination. Operate RV87 to check that the amplitude decreases to nearly zero.
Switch S2 to 1 Mc/s and the oscilloscope to 1 uSec/cm.
Recheck the operation of RV87.

3.11 Connect the oscilloscope to the T.V. output socket.
Set RV128 to its mid-position, Video switch S6 'Off' and S5 to '+ve'. Set oscilloscope to -ve trigger on the 10 uS/cm range.

3.12 Adjust C45 for the negative going line sync pulse width to be 10 uSecs. (1 cm.)

3.13 Switch the oscilloscope to T.V. frame, +ve trigger and 10 uS/cm and adjust RV128 so that the pulses in the field blanking period are :
+ve going, 10 uSecs wide (1 cm).
-ve going, 40 uSecs wide (4 cm).

3.14 Repeat 12 and 13, as there is some slight interaction between the controls.

3.15 With the oscilloscope set to 100 uS/cm, check that the T.V. waveform is correct. There will be approximately 12 pulses in the field blanking period. Check that the T.V. signal inverts when operating S6 (+, -).

3.16 Switch on the Video.
Check that the sync signal is approximately 0.25v P to P and the Video sawtooth signal is .75v P to P.

Operate the 10 Kc/s/D.C./1 Kc/s switch S4 and check that it does not affect the T.V. signal.
(If there is any jitter on the counters, then operation of S4 will break up the T.V. signal).

3.17 Connect the calibrator to the mains supply via a variac.
Set the mains selector to 220v - 20v, i.e. 200v.
Set the variac to 214v and adjust RV163 so that the high neon just strikes.
Set the variac to 186v and adjust RV165 till the low neon just strikes.
Check that with the variac at 200v both neons are out.

3.18 Set the mains selector to 110 -10 = 100v.
Set the variac at 107v and check the high neon strikes.
Set the variac at 93v and check the low neon strikes.

3.19 Set the mains selector to 220 + 20 = 240v.
Set the variac to 240v.
Check neither neon strikes.

COMPONENTS LIST

ABBREVIATIONS USED IN COMPONENTS LIST

Capacitors

SM	Silver Mica
CER	Ceramic
ELEC	Electrolytic
P	Paper
PC	Polycarbonate
PE	Polyester
PS	Polystyrene

Resistors

C	Carbon Composition
HS	High Stability Carbon
WW	Wire Wound
MO	Metal Oxide
MF	Metal Film

In the following components list, no manufacturers' names have been included. When replacing components, locally available alternatives may be used if exact replacements are not to hand, provided the physical size is the same.

It is, however, preferable to use exact replacements whenever possible, and these should be ordered direct from:

TELEQUIPMENT LIMITED
313 Chase Road,
Southgate,
LONDON, N.14.

Telephone: FOX Lane 1166
Telegraph: Telequipt. London. N.14.

or from our agents.

COMPONENTS LIST

Part No.	C.C.T. Ref.	Value	DESCRIPTION	Tol.	Rating
S33310	R1	33K	C	10%	$\frac{1}{4}$ w
S10110	R2	100	C	10%	$\frac{1}{4}$ w
S27210	R3	2700	C	10%	$\frac{1}{4}$ w
92L	R4	10K	HSC	1%	1 w
S27210	R5	2700	C	10%	$\frac{1}{4}$ w
S10510	R6	1M	C	10%	$\frac{1}{4}$ w
S10110	R7	100	C	10%	$\frac{1}{4}$ w
108M	R8	150K	HSC	1%	$\frac{1}{4}$ w
S47210	R9	4700	C	10%	$\frac{1}{4}$ w
• L78	R11	22K	HSC	1%	$\frac{1}{4}$ w
L79	R12	75K	HSC	1%	$\frac{1}{4}$ w
S27210	R13	2700	C	10%	$\frac{1}{4}$ w
S18110	R14	180	C	10%	$\frac{1}{4}$ w
S10110	R15	100	C	10%	$\frac{1}{4}$ w
98M	R16	12K	W/W	10%	3 w
61C	RV17	50K	CP Potentiometer	20%	2 w
17M	R18	330K	HSC	1%	$\frac{1}{4}$ w
S10110	R19	100	C	10%	$\frac{1}{4}$ w
S12410	R21	120K	C	10%	$\frac{1}{4}$ w
L87	R22	5.6K	HSC	1%	$\frac{1}{2}$ w
• L92	R23	10K	HSC	1%	1 w
L87	R24	5.6K	HSC	1%	$\frac{1}{2}$ w
S10110	R25	100	C	10%	$\frac{1}{4}$ w
S56210	R26	5600	C	10%	$\frac{1}{4}$ w
17M	R27	330K	HSC	1%	$\frac{1}{4}$ w
S10510	R28	1M	C	10%	$\frac{1}{4}$ w
S10110	R29	100	C	10%	$\frac{1}{4}$ w
S39210	R31	3.9K	C	10%	$\frac{1}{4}$ w
Y82210	R32	8.2K	C	10%	$\frac{1}{2}$ w
S10310	R33	10K	C	10%	$\frac{1}{4}$ w
S15110	R34	150	C	10%	$\frac{1}{4}$ w
S10110	R35	100	C	10%	$\frac{1}{4}$ w
Y10310	R36	10K	C	10%	$\frac{1}{2}$ w
126C	RV37	250K	C Potentiometer	20%	2 w
94L	R38	1.1m	HSC	1%	$\frac{1}{4}$ w

Part No.	C.C.T. Ref.	Value	DESCRIPTION	Tol.	Rating
S10110	R39	100	C	10%	$\frac{1}{4}$ w
S47110	R41	470	C	10%	$\frac{1}{4}$ w
S10210	R42	1000	C	10%	$\frac{1}{4}$ w
L92	R43	10K	HSC	1%	1 w
L93	R44	7500	HSC	1%	1 w
S10210	R45	1000	C	10%	$\frac{1}{4}$ w
L92	R46	10K	HSC	1%	1 w
S10110	R47	100	C	10%	$\frac{1}{4}$ w
94L	R48	1.1m	HSC	1%	$\frac{1}{4}$ w
S10310	R49	10K	C	10%	$\frac{1}{4}$ w
S10510	R51	1M	C	10%	$\frac{1}{4}$ w
S10110	R52	100	C	10%	$\frac{1}{4}$ w
Y10310	R53	10K	C	10%	~~$\frac{1}{4}$~~ w ½W
S15210	R54	1500	C	10%	$\frac{1}{4}$ w
S10310	R55	10K	C	10%	$\frac{1}{4}$ w
S22110	R56	220	C	10%	$\frac{1}{4}$ w
S10110	R57	100	C	10%	$\frac{1}{4}$ w
Y12310	R58	12K	C	10%	$\frac{1}{2}$ w
126C	RV59	250K	CP Potentiometer	20%	2 w
12M	R61	900K	HSC	1%	$\frac{1}{4}$ w
S10110	R62	100	C	10%	$\frac{1}{4}$ w
S39410	R63	390K	C	10%	$\frac{1}{4}$ w
L90	R64	18K	HSC	1%	$\frac{1}{2}$ w
L91	R65	12K	HSC	1%	$\frac{1}{2}$ w
L90	R66	18K	HSC	1%	$\frac{1}{2}$ w
S10110	R67	100	C	10%	$\frac{1}{4}$ w
S18310	R68	18K	C	10%	$\frac{1}{4}$ w
12M	R69	900K	HSC	1%	$\frac{1}{4}$ w
S10510	R70	1M	C	10%	$\frac{1}{4}$ w
S10510	R71	1M	C	10%	$\frac{1}{4}$ w
S10110	R72	100	C	10%	$\frac{1}{4}$ w
Y15310	R73	15K	C	10%	$\frac{1}{2}$ w
S47110	R74	470	C	10%	$\frac{1}{4}$ w
S15410	R75	150K	C	10%	$\frac{1}{4}$ w
S10310	R76	10K	C	10%	$\frac{1}{4}$ w
S10110	R77	100	C	10%	$\frac{1}{4}$ w
Y22310	R78	22K	C	10%	$\frac{1}{2}$ w
S10310	R79	10K	C	10%	$\frac{1}{4}$ w

Part No.	C.C.T. Ref.	Value	DESCRIPTION	Tol.	Rating
S33210	R83	3300	C	10%	$\frac{1}{4}$ w
S56210	R84	5600	C	10%	$\frac{1}{4}$ w
S22210	R85	2200	C	10%	$\frac{1}{4}$ w
Y18310	R86	18K	C	10%	$\frac{1}{2}$ w
61C	RV87	50K	C Potentiometer	20%	2 w
S75005	R88	75	C	5%	$\frac{1}{4}$ w
108M	R91	150K	HSC	1%	$\frac{1}{4}$ w
67L	R92	91K	HSC	1%	$\frac{1}{4}$ w
117C	R93	10K	CP Potentiometer	20%	2 w
968510	R94	6.8M	C	10%	$\frac{1}{4}$ w
S10110	R95	100	C	10%	$\frac{1}{4}$ w
L80	R96	10K	HSC	1%	$\frac{1}{4}$ w
L81	R97	5000	HSC	1%	$\frac{1}{4}$ w
82L	R98	3000	HSC	1%	$\frac{1}{4}$ w
L83	R99	1000	HSC	1%	$\frac{1}{4}$ w
922510	R101	2.2M	C	10%	$\frac{1}{4}$ w
L84	R102	500	HSC	1%	$\frac{1}{4}$ w
L85	R103	300	HSC	1%	$\frac{1}{4}$ w
L86	R104	100	HSC	1%	$\frac{1}{4}$ w
L86	R105	100	HSC	1%	$\frac{1}{4}$ w
L81	R106	5000	HSC	1%	$\frac{1}{4}$ w
82L	R107	3000	HSC	1%	$\frac{1}{4}$ w
L83	R108	1000	HSC	1%	$\frac{1}{4}$ w
L84	R109	500	HSC	1%	$\frac{1}{4}$ w
L85	R111	300	HSC	1%	$\frac{1}{4}$ w
L86	R112	100	HSC	1%	$\frac{1}{4}$ w
L86	R113	100	HSC	1%	$\frac{1}{4}$ w
S15210	R114	1500	C	10%	$\frac{1}{4}$ w
S15210	R115	1500	C	10%	$\frac{1}{4}$ w
S10110	R116	100	C	10%	$\frac{1}{4}$ w
S10510	R117	1M	C	10%	$\frac{1}{4}$ w
910610	R118	10M	C	10%	$\frac{1}{4}$ w
S10210	R119	1000	C	10%	$\frac{1}{4}$ w
S82410	R120	820K	C	10%	$\frac{1}{4}$ w
S10110	R121	100	C	10%	$\frac{1}{4}$ w
S33210	R122	3300	C	10%	$\frac{1}{4}$ w
Y33310	R123	33K	C	10%	$\frac{1}{2}$ w
S10110	R124	100	C	10%	$\frac{1}{4}$ w

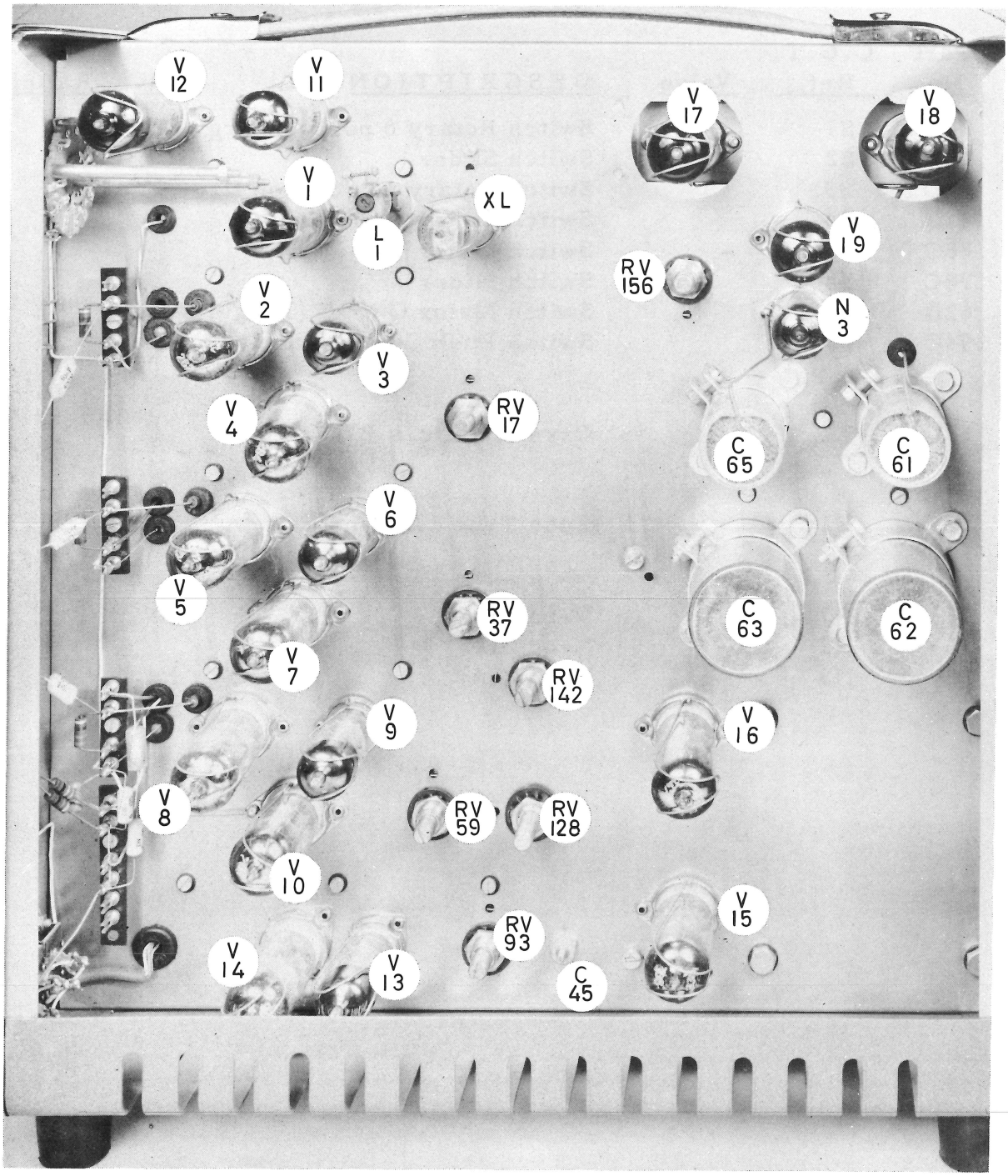
Part No.	C.C.T. Ref.	Value	DESCRIPTION	Tol.	Rating
S10410	R125	100K	C	10%	$\frac{1}{4}$ w
S39210	R126	3.9K	C	10%	$\frac{1}{4}$ w
S15410	R127	150K	C	10%	$\frac{1}{4}$ w
7C	RV128	1M	C Potentiometer	20%	2 w
S22310	R129	22K	C	10%	$\frac{1}{4}$ w
S10510	R130	1M	C	10%	$\frac{1}{4}$ w
S56410	R131	560K	C	10%	$\frac{1}{4}$ w
S27410	R132	270K	C	10%	$\frac{1}{4}$ w
S10310	R133	10K	C	10%	$\frac{1}{4}$ w
S22310	R134	22K	C	10%	$\frac{1}{4}$ w
S10510	R135	1M	C	10%	$\frac{1}{4}$ w
S10110	R136	100	C	10%	$\frac{1}{4}$ w
S10210	R137	1000	C	10%	$\frac{1}{4}$ w
S47210	R138	4700	C	10%	$\frac{1}{4}$ w
• 92L	R139	10K	C ?	1%	1 w
S56210	R140	5600	C	10%	$\frac{1}{4}$ w
16M	R141	350K	HSC	1%	$\frac{1}{4}$ w
118C	RV142	100K	C Potentiometer	20%	2 w
S27410	R143	270K	C	10%	$\frac{1}{4}$ w
S10110	R144	100	C	10%	$\frac{1}{4}$ w
S10210	R145	1000	C	10%	$\frac{1}{4}$ w
S10310	R146	10K	C	10%	$\frac{1}{4}$ w
S10210	R147	1000	C	10%	$\frac{1}{4}$ w
99L	R148	3.3K		5%	6 w
S10510	R149	1M	C	10%	$\frac{1}{4}$ w
S10110	R150	100	C	10%	$\frac{1}{4}$ w
Y47010	R151	47	C	10%	$\frac{1}{2}$ w
S10110	R152	100	C	10%	$\frac{1}{4}$ w
S47010	R153	47	C	10%	$\frac{1}{2}$ w
Y47310	R154	47K	C	10%	$\frac{1}{2}$ w
96L	R155	560K	HSC	1%	$\frac{1}{4}$ w
61C	RV156	50K	C Potentiometer	20%	2 w
17M	R157	250K	HSC	1%	$\frac{1}{4}$ w
33M	R158	4700	WW	5%	5 w
88L	R159	100K	HSC	1%	$\frac{1}{4}$ w
• S10110	R160	100	C	10%	$\frac{1}{4}$ w
108M	R161	150K	HSC	1%	$\frac{1}{4}$ w
S68310	R162	68K	C	10%	$\frac{1}{4}$ w

Part No.	C.C.T. Ref.	Value	DESCRIPTION	Tol.	Rating
110C	RV163	50K	C Potentiometer		
S22310	R164	22K	C	10%	$\frac{1}{4}$ w
110C	RV165	50K	C Potentiometer		
S18410	R166	180K	C	10%	$\frac{1}{4}$ w
S10310	R167	10K	C	10%	$\frac{1}{4}$ w
910610	R168	10M	C	10%	$\frac{1}{4}$ w
28K	C1	.01	POL	10%	400 v
J82	C2	120pF	CER	10%	750 v
29K	C3	0.47	POL	10%	125 v
29K	C4	0.47	POL	10%	125 v
40K	C5	20pF	CER	10%	750 v
28K	C6	.01	CER	10%	750 v
44K	C7	5pF	CER	10%	750 v
J86	C8	50pF	SM	1%	750 v
J86	C9	50pF	SM	1%	750 v
16K	C11	0.1	POL	10%	400 v
45K	C12	10pF	CER	10%	750 v
28K	C13	.01	POL	10%	400 v
43K	C14	2.2pF	CER	10%	750 v
J84	C15	100pF	SM	1%	750 v
J84	C16	100pF	SM	1%	750 v
16K	C17	0.1	POL	10%	400 v
54K	C18	200pF	CER	10%	750 v
28K	C19	.01	POL	10%	400 v
45K	C21	10pF	CER	10%	750 v
J85	C22	1000pF	POL	1%	400 v
J85	C23	1000pF	POL	1%	400 v
16K	C24	.1	POL	10%	400 v
J72	C25	2200pF	POL	20%	400 v
52K	C26	50pF	CER	10%	750 v
J10	C27	0.5	POL	10%	400 v
16K	C28	0.1	POL	10%	400 v
33K	C30	0.1	POL	10%	125 v
29K	C31	0.47	POL	10%	125 v
29K	C33	0.47	POL	10%	125 v
40X	C34	32	ELEC		300 v

Part No.	C.C.T. Ref.	Value	DESCRIPTION	Tol.	Rating
29K	C35	0.47	POL	10%	125 v
16K	C36	0.1	POL	10%	400 v
16K	C37	0.1	POL	10%	400 v
29K	C38	0.47	POL	10%	125 v
29K	C39	0.47	POL	10%	125 v
16K	C40	0.1	POL	10%	400 v
16K	C41	0.1	POL	10%	400 v
16K	C42	0.1	POL	10%	400 v
72J	C43	2200pF	POL	20%	400 v
16K	C44	0.1	POL	10%	400 v
15J	C45	75/450pF			
54K	C46	200pF	CER	10%	750 v
29K	C47	0.47	POL	10%	125 v
29J	C48	0.01	POL	20%	125 v
54K	C49	200pF	CER	10%	750 v
33K	C50	0.1	POL	10%	125 v
29K	C51	0.47	POL	10%	125 v
16K	C52	0.1	POL	10%	400 v
37J	C53	0.2	POL	3%	160 v
44K	C54	5p	CER	10%	750 v
72J	C55	2200pF	POL	20%	400 v
72J	C56	2200pF	POL	20%	400 v
16K	C57	0.1	POL	10%	400 v
16K	C58	0.1	POL	10%	400 v
16K	C59	0.1	POL	10%	400 v
57J	C61	32/32	ELEC		275 v
58J	C62	100	ELEC		275 v
58J	C63	100	ELEC		275 v
10J	C64	0.22	POL	10%	400 v
57J	C65	32/32	ELEC		275 v
40X	C66	32	ELEC		300 v
42S	L1	160/260uH	Inductor Preset		
34E	MR1		OA81		
34E	MR2		OA81		
34E	MR3		OA81		

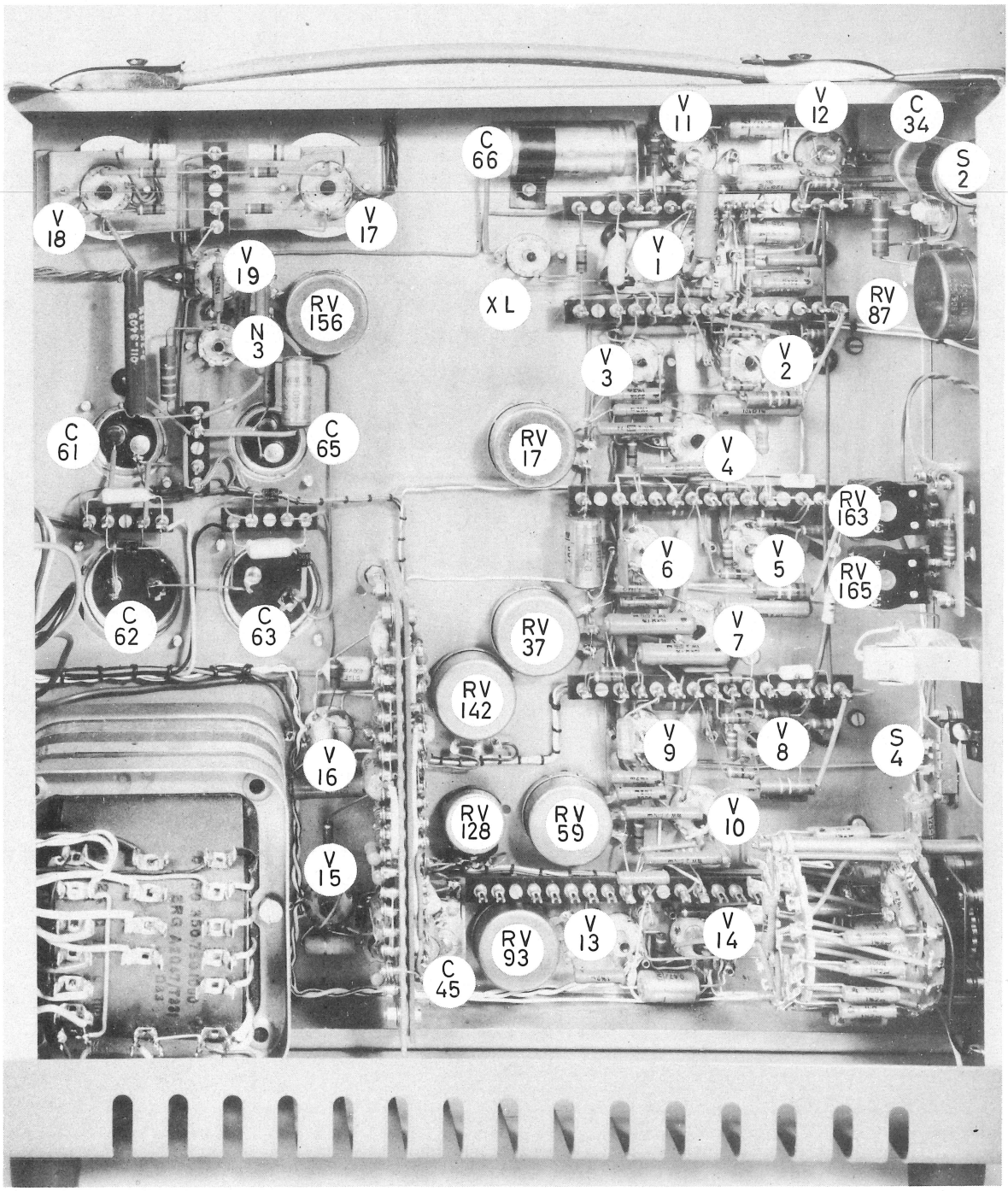
Part No.	C.C.T. Ref.	Value	DESCRIPTION	Tol.	Rating
34E	MR4		OA81		
34E	MR5		OA81		
34E	MR6		OA81		
34E	MR7		OA81		
69T	MR8		OA47		
34E	MR9		OA81		
36E	MR10		OA81		
34E	MR11		OA81		
34E	MR12		OA81		
180	MR13		DD056		
180	MR14		DD056		
180	MR15		DD056		
71T	MR16		1S920		
10T	V1		ECF80		
18T	V2		ECC88		
11T	V3		EB91		
18T	V4		ECC88		
18T	V5		ECC88		
11T	V6		EB91		
18T	V7		ECC88		
18T	V8		ECC88		
11T	V9		EB91		
18T	V10		ECC88		
27T	V11		E810F		
26T	V12		EF184		
11T	V13		EB91		
18T	V14		ECC88		
18T	V15		ECC88		
18T	V16		ECC88		
38T	V17		EL86		
38T	V18		EL86		
10T	V19		ECF80		
52S	T1		D33 Main Transformer		

Part No.	C.C.T. Ref.	Value	DESCRIPTION	Tol.	Rating
26D	S1		Switch Rotary 6 position Drg. SW1021A		
78C	S2		Switch Slider		
36D	S3		Switch Rotary 14 position Drg. SW1193		
43D	S4		Switch Slider 3 position		
78C	S5		Switch Slider		
78C	S6		Switch Slider		
62D	S7		Switch Mains On/Off (Toggle Type)		
94C	S8		Switch Push Button (push to break)		
62U	XL		Crystal 1 Mc/s B7G		
12Y	F1		Fuse Type 1.5 Amp.		
36Y	N1		Neon 3L		
36Y	N2		Neon 3L		
1T	N3		Neon 85A2		



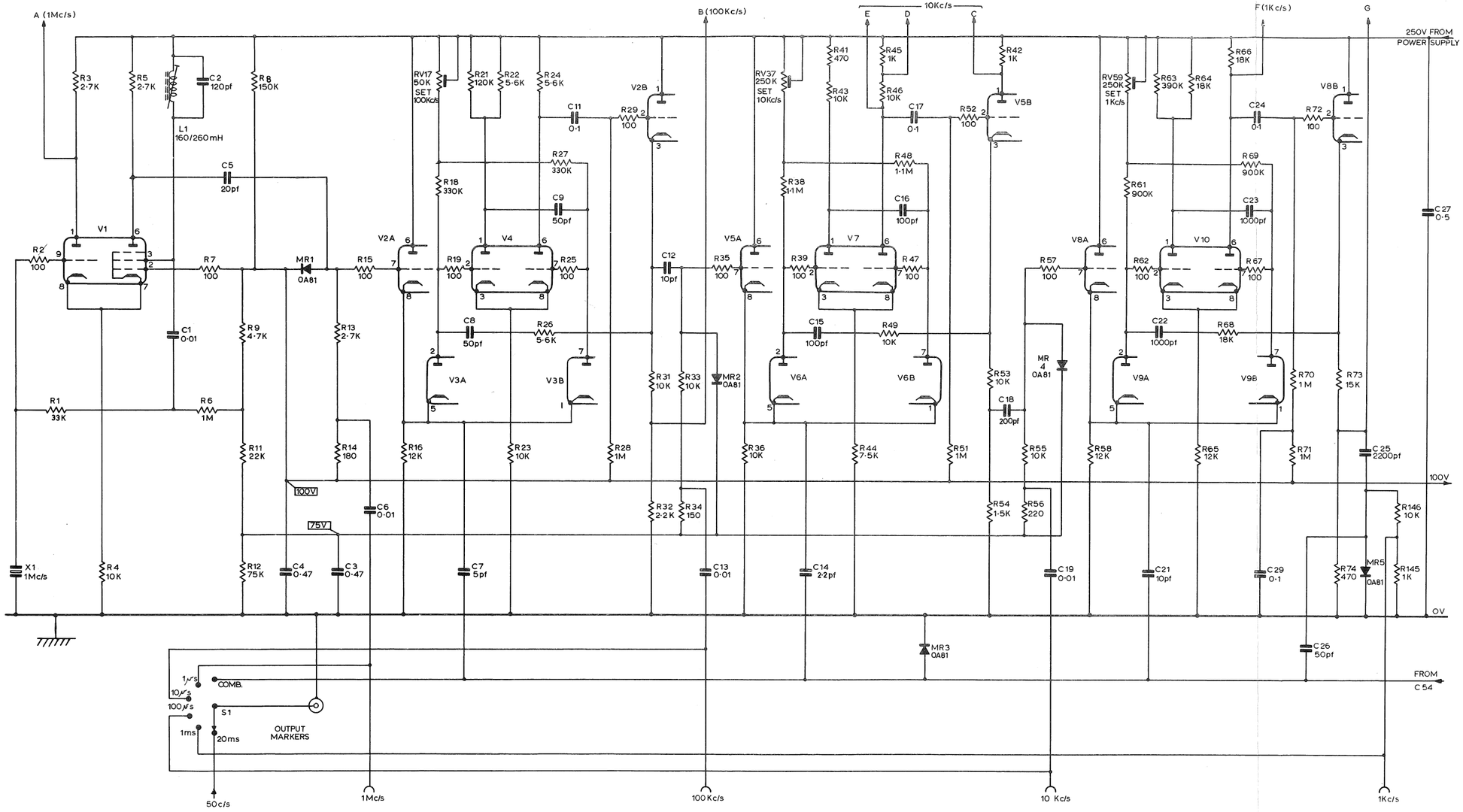
VALVES AND PRESET COMPONENTS LAYOUT
(VALVE SIDE)

PLATE. 2.



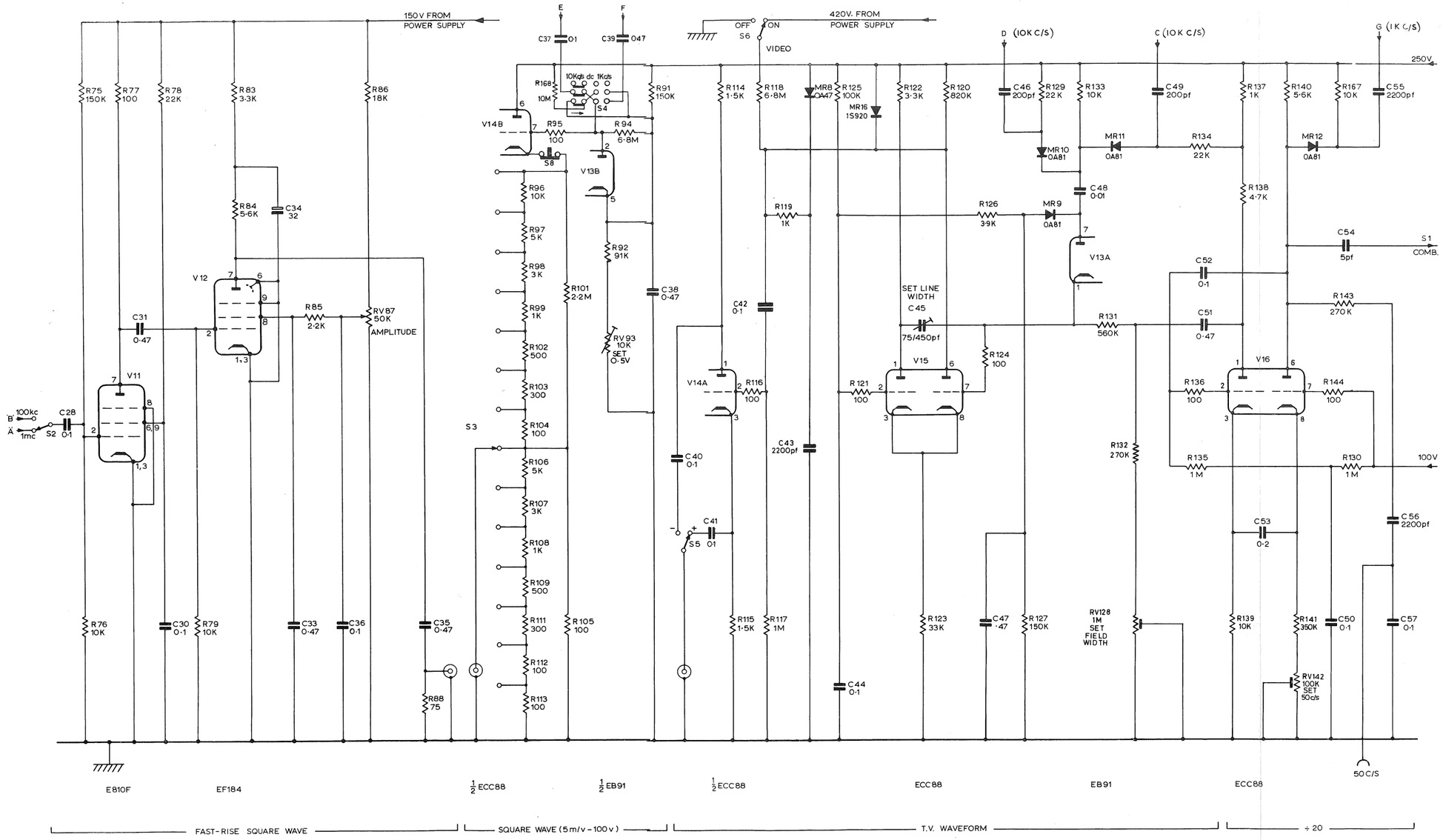
VALVES AND PRESET COMPONENTS LAYOUT
(WIRING SIDE)

PLATE .3.



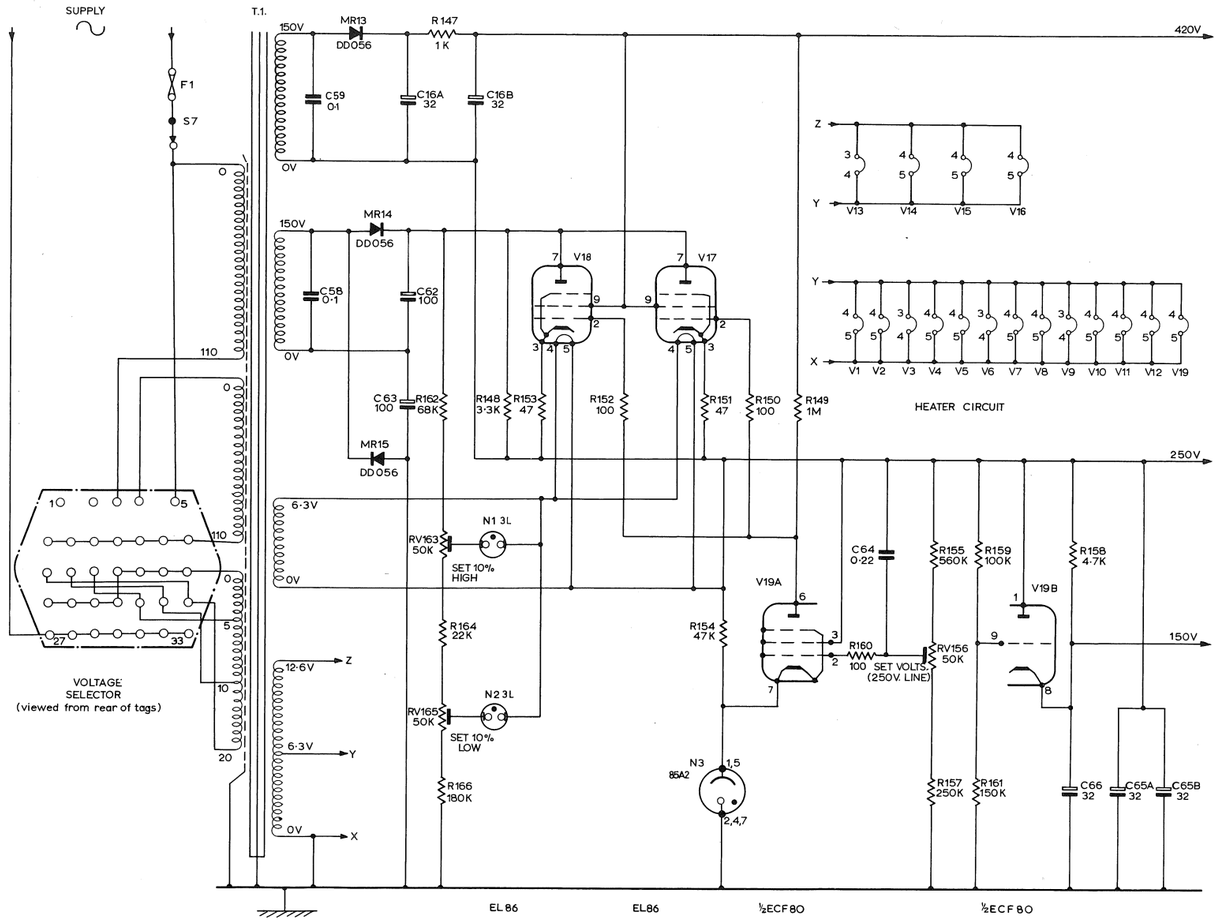
OSCILLOSCOPE CALIBRATOR

FIG. 1.



OSCILLOSCOPE CALIBRATOR

FIG. 2.



POWER SUPPLY OSCILLOSCOPE CALIBRATOR FIG. 3.