VALVE VOLTMETER
TYPE VM76

INSTRUCTION MANUAL

ADVANCE

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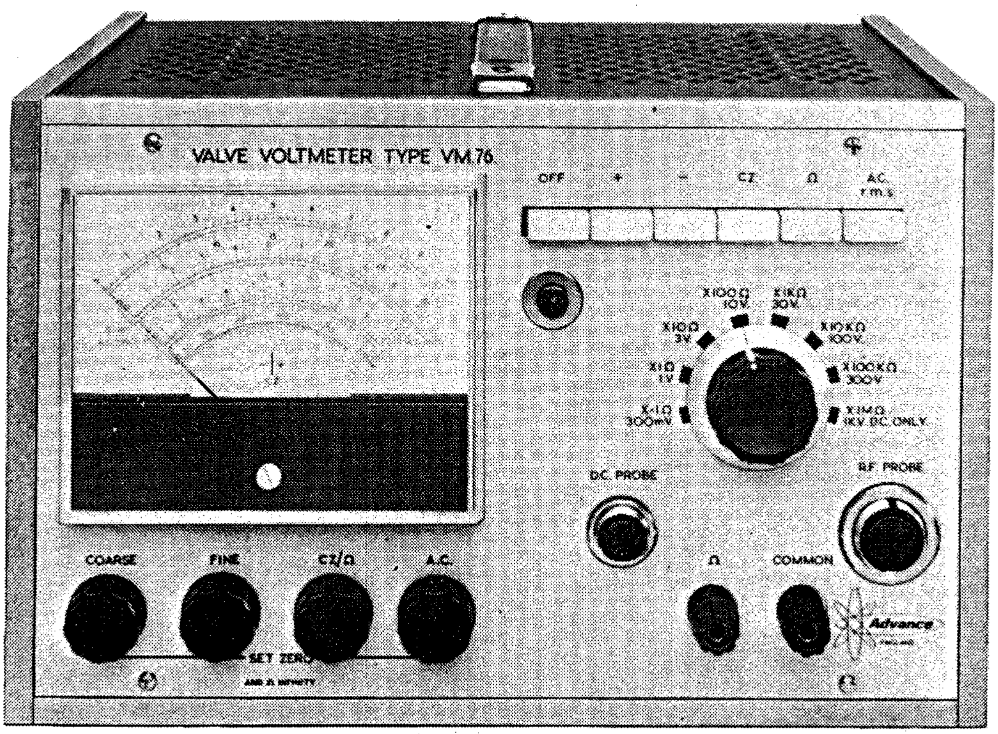
INTRODUCTION SECTION 1

The valve voltmeter type VM76 is an instrument with a high input impedance designed for laboratory and industrial use. It provides a means of measuring a.c. voltage in seven ranges up to 300V (at frequencies up to 1,000MHz) and d.c. voltage in eight ranges up to 1kV. Eight ranges for resistance measurement up to 500 Megohms are also available.

Probes and connecting leads are supplied with the instrument to facilitate the measurement of r.f. and d.c. voltages and resistance. Optional accessories are available which enable measurements to be taken from coaxial lines at high frequencies under operating conditions. Selection of the function required is made by means of a push-button switch.

Basically the measuring circuit consists of an amplifier feeding a high impedance bridge circuit across which is connected an accurate meter, the circuit operating from stabilised supplies. The meter circuit is temperature compensated and protected against excessive input voltages.

The accuracy of the instrument is 2% on voltage ranges and 5% when measuring resistance. The input impedance is 100MΩ on d.c. and approximately 7.5MΩ at 1kHz reducing to 150KΩ at 100MHz.



D.C. MEASUREMENT

Ranges

0 to 300mV	0 to 30V
0 to 1V	0 to 100V
0 to 3V	0 to 300V
0 to 10V	0 to 1kV

Accuracy

Below 100V ±2% f.s.d.
Above 100V ±3% f.s.d.

Input Facilities

Positive, negative or centre zero.

Input Impedance

Greater than 100MΩ
10MΩ isolating resistor in probe.

A.C. MEASUREMENT

Ranges

As for d.c. measurement excluding 1kV range. All measurements calibrated in r.m.s.

Maximum R.M.S. Voltage Measurements

At 100MHz, 300V r.m.s. maximum.
At 500MHz, 60V r.m.s. maximum.
At 1,000MHz, 20V r.m.s. maximum.
See also Fig.2.

Accuracy at 1kHz

Below 100V ±2% f.s.d.
Above 100V ±3% f.s.d.

Input Impedance

7.5MΩ at 1kHz)
150kΩ at 100MHz) 1.5pF shunt capacitance

Frequency Response

(Relative to 1kHz using probe, coaxial 'T' piece and termination pad).

20Hz	−1dB	Typical figures only
50Hz – 300MHz	±0.2dB	
500MHz	±0.3dB	
1,000MHz	+1.5dB	

RESISTANCE MEASUREMENT

Ranges
0 – 500 Ω basic
Multipliers X.1, X1, X10, X100, X1K, X10K, X100K, X1M

Accuracy
±5% at mid-scale

Polarising Voltage
Maximum of 1.5V

STABILITY
A variation in the supply voltage of 10% (within the supply voltage range of the instrument) will cause changes in indication at f.s.d. not exceeding 5mV on d.c. and 10mV on a.c.

POWER SUPPLY
100V to 125V or 200V to 250V a.c., 45 to 60Hz 40VA approx.

DIMENSIONS
7½″ high 11⅛″ wide 9½″ deep (19 x 28 x 24 cm)

WEIGHT
13lb (5.9 kg)

TEMPERATURE RANGE
0 to +40°C

ACCESSORIES SUPPLIED
1 A.C. Probe – PL62
1 D.C. Probe – PL63
1 COMMON Lead – PL68
1 Instruction Manual Part No. 18167

OPTIONAL ACCESSORIES

50Ω 'T' piece – VMA1		v.s.w.r. less than 1.2 at 1kMHz
50Ω 5W load – TP16		

3.1 GENERAL

The supply voltage adjustment, mounted on top of the supply transformer has two positions, i.e. 110V and 220V. Before the instrument is switched on, the wrap-round cover must be removed and the setting of this control checked to ensure that it is suitable for the local supply.

3.2 PRELIMINARY ADJUSTMENTS

The following procedure should be carried out before making a.c. or d.c. voltage, or resistance measurements.

(1) Allow at least half an hour warm up period.
(2) Press the + push button.
(3) Select 300mV on the range switch.
(4) Connect the d.c. probe tip to the COMMON terminal.
(5) Adjust the COARSE and FINE SET ZERO controls to set the meter pointer to zero.

3.3 VOLTAGE MEASUREMENTS

The r.f. probe has an input capacitance of 1.5pF and a shunt resistance which varies with frequency as shown in Fig. 1.

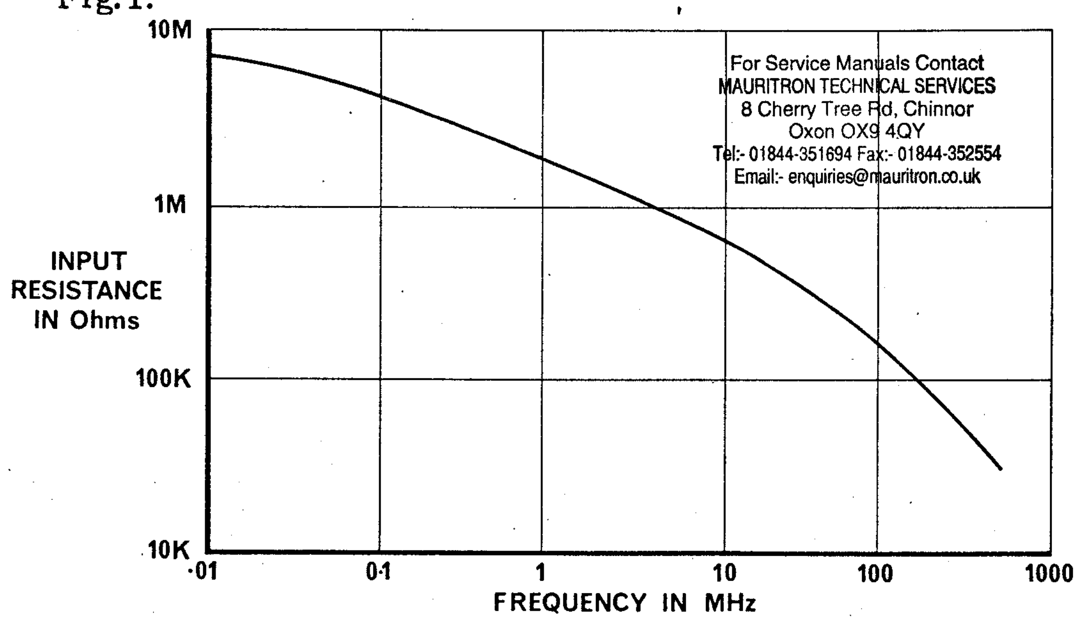


Fig. 1 Resistance/Frequency Response of R.F.. Probe.

The input capacitance of the d.c. probe is approximately 2pF. The shunt resistance between the probe and the COMMON terminal is 100 MΩ.

For low frequency measurements, other than those at supply frequencies, the COMMON terminal may be used as the low potential connection on the 300mV to 3V ranges.

At higher frequencies the "low" connection is made by means of a short lead and clip attached to the r.f. probe casing.

The COMMON terminal is d.c. isolated from the voltmeter chassis by a 45 MΩ resistor in parallel with a 0.01μF capacitor; thus the point to which it is connected on the equipment under test need not be at earth potential. It is, however, desirable that the point has a low impedance to earth to prevent hum being introduced into the test circuit and to prevent errors due to a potential developing across the decoupling capacitor C11.

The meter has been calibrated to indicate the r.m.s. value of a sinusoidal voltage. The shunt diode rectifier circuit employed in the r.f. probe responds to the peak value of the r.f. waveform, therefore it is possible to calculate the peak value of many types of non-sinusoidal waveform by using the appropriate formulae.

Due to the effect known as "peak clipping", caused by the input capacitor in the r.f. probe, small inaccuracies occur where voltage measurements are made on a source having a resistance up to 100kΩ. These inaccuracies are usually not greater than 2% and decrease with decrease in resistance and frequency.

The voltage applied between the low and high connections on the r.f. probe must not exceed 425V and allowances must therefore be made when measuring a.c. signals superimposed on d.c. signals. Similarly, the voltage between the low connection and earth must not exceed 375V.

Due to the peak inverse voltage characteristics of the r.f. probe diode the maximum r.m.s. voltage that may be applied to the probe decreases as frequency is increased, as illustrated in Fig.2.

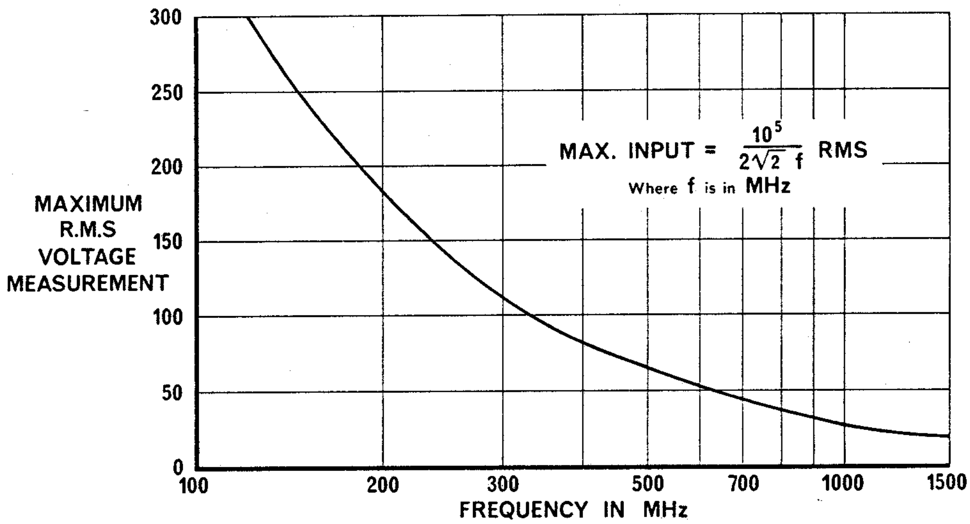


Fig. 2 Maximum R.M.S. Voltage/Frequency Charasteristic of R.F. Probe.

3.4 D.C. OPERATION

(a) Normal Operation

Verify that the meter has been zeroed as instructed in para. 3.2 and proceed as follows:–

(1) Operate the + or – push-button, depending whether the voltage to be measured is positive or negative with respect to earth.

(2) Set the range switch to a position appropriate to the voltage which the instrument is to measure. If the voltage is unknown, set the switch to the 1kV position.

(3) Connect the COMMON terminal to the low potential side of the voltage, using the lead provided.

(4) Connect the d.c. probe to the high potential side of the voltage and note the reading on the scale appropriate to the setting of the range switch.

(b) Centre Zero Operation

Verify that the meter has been zeroed as instructed in para. 3.2 and proceed as follows:–

(1) Press the CZ push-button.

(2) Set the range switch to the appropriate position, remembering that when using the centre zero facility the range of the meter is half that indicated on the range switch.

(3) Connect the d.c. probe to the COMMON terminal and rotate the CZ/Ω SET ZERO control until the meter pointer is over the centre marker on the scale.

NOTE: On the 300mV range it may be found that adjustment of the CZ/Ω control is insufficient to centre the meter pointer. If this is the case proceed as follows:

(i) Set the CZ/Ω control to its central position.

(ii) Adjust the COARSE SET ZERO control to bring the pointer near to the centre marker.

(iii) Adjust the CZ/Ω control to bring the pointer exactly over the centre marker.

(4) Connect the d.c. probe and the COMMON terminal to either side of the voltage under test and note the meter indication. The pointer will deflect to the left if the d.c. probe is connected to the more negative point, and to the right if it has been connected to the more positive point.

NOTE: When the centre zero facility is being used to obtain null indications the range switch may be placed in more sensitive positions as the input voltage decreases, in order to obtain greater discrimination. It is advisable to reset the centre zero each time a range is changed, and is essential when the 300mV range is selected.

3.5 A.C. OPERATION

To make a.c. measurements, verify that the procedure in para. 3.2 has been carried out and then proceed as follows:

(1) Press the A.C. push button and connect the r.f. probe tip to the grounding clip on the probe.
(2) Rotate the A.C. SET ZERO control until the meter pointer is at zero.
(3) Set the range selector switch to the position appropriate to the voltage it is intended to measure. If the voltage is unknown, set the switch to the 300V position.
(4) Connect the probe to the high potential side of the a.c. signal, and the probe clip to the low potential side.
(5) Read the meter indication on the appropriate scale.

3.6 RESISTANCE MEASUREMENTS

To make resistance measurements, proceed as follows:
(1) Press the Ω push button.
(2) Set the range selector switch to the X10 position.
(3) Connect the Ω and the COMMON terminals using the PL68 lead provided.
(4) Adjust the COARSE and FINE SET ZERO controls until the meter pointer indicates zero.

NOTE: It is not necessary to carry out para. 3.6 (4) if readings are to be taken on the x1 and x.1 ranges.

(5) Disconnect the Ω and the COMMON terminals and adjust the CZ/Ω SET ZERO control until the meter pointer indicates infinity.
(6) Connect the unknown resistance between the Ω and the COMMON terminals and select a position of the range switch which provides a convenient deflection of the meter pointer.
(7) Note the reading on the meter and multiply it by the factor indicated on the range switch.

3.7 USE OF OPTIONAL ACCESSORIES

(a) T Connector

The T connector facilitates the measurement of high frequency voltages on coaxial lines using the r.f. probe. The connector consists of one male and one female 50Ω N-type connector which allows it to be connected in a coaxial line, and also contains a socket to permit the insertion of the voltmeter r.f. probe.

(b) Dummy Load

The dummy load consists of a 50Ω 5W load resistor with a male N-type socket which may be connected to the end of a 50Ω coaxial cable or to the T connector described above.

4.1 SIMPLIFIED MEASURING CIRCUIT

The basic measuring circuit is an amplifier coupled to a high impedance bridge network. In Fig 3(a), V1 and V3 form a long tailed pair amplifier with the grid of V3 referred to the common line. In Fig 3(b) V2a and V2b with their respective cathode loads form a bridge circuit with the front panel meter connected between the cathodes. The grid of V2a is connected to the anode of V1 and the grid of V2b is connected to the anode of V3.

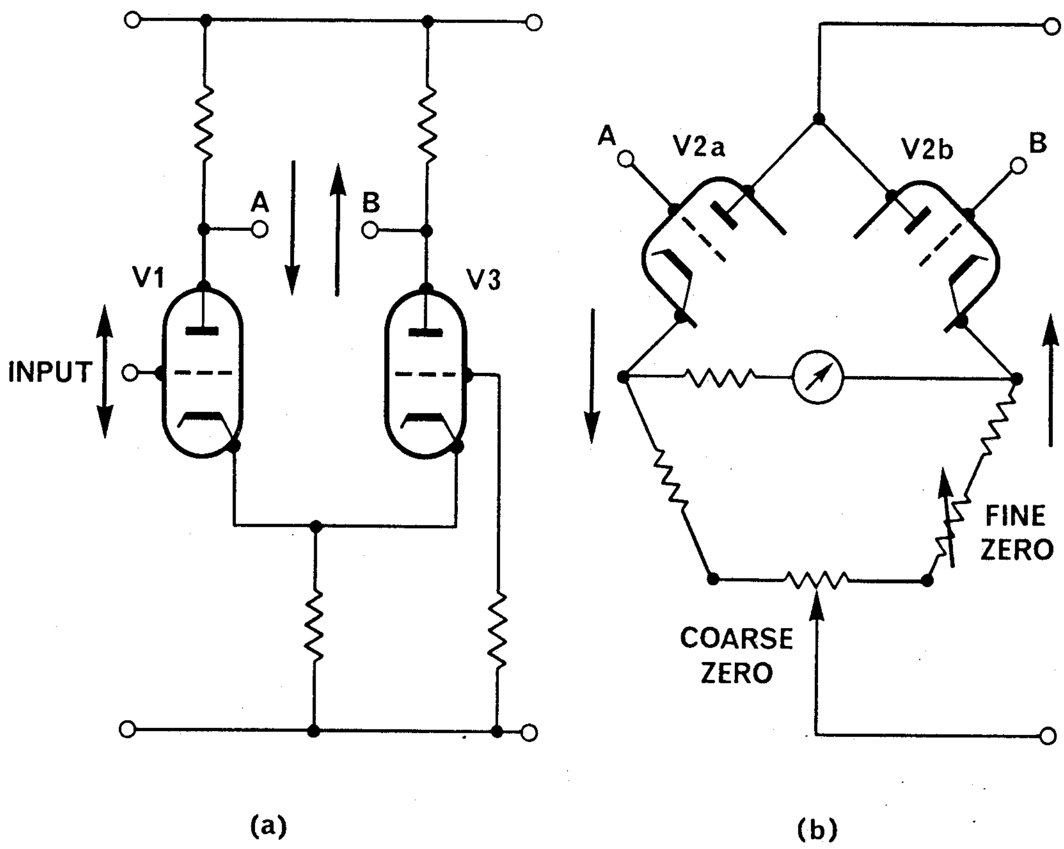


Fig. 3 Simplified Measuring Circuit

The bridge is set up by adjustment of the SET ZERO controls so that under no-signal conditions the potentials on the cathodes of V2a and V2b are equal and no current flows in M.1. When a signal is applied to the grid of V1the circuit becomes unbalanced and the meter pointer is deflected by an amount proportional to the amplitude of the input signal. Various multiplier resistors may be connected in series with M1, the value selected depending on the setting of the range switch S1, and the position of the push-button switch, which may be operated to select the d.c., a.c., or resistance modes of operation.

4.2. D.C. MEASUREMENTS

As shown in Fig.6, the input signal from the d.c. probe is fed to the grid of V1 through wafer S1a of the range switch and section S2b, S2c or S2d of the push-button function selector switch depending whether the instrument is set up to indicate positive, negative or centre zero d.c. readings.

Alterations to the meter range are effected by wafer S1e of the range switch, which connects a multiplier resistor in series with the meter, the value of which depends on the range selected. On the three highest d.c. ranges, wafer S1a brings R3 into circuit and the resulting formation of a potential divider attenuates the input signal to a level which can be accommodated by the bridge.

When the centre zero push button CZ is operated its contacts connect a bias voltage, obtained from the bridge rectifier BR3, across the meter and cause the needle to be deflected to near the centre marker. Final setting up is effected by manual adjustment of the CZ/Ω SET ZERO RV10.

4.3 A.C. MEASUREMENTS

A.C. measurements are carried out using the r.f. probe

4.5 METER CIRCUIT

The meter is a moving-coil instrument providing full scale deflection indications for a current of 200μA. It is protected against overload by diodes MR1 and MR2 and temperature compensated by thermistor TH1 in parallel with R37. The preset control RV2 allows the meter to be calibrated on the 300mV d.c. range.

4.6 POWER SUPPLIES

Apart from the reference voltage provided by the bridge rectifier BR3, the instrument employs a 6V d.c. supply for the bridge valve heaters and a 530V h.t. supply. All supplies are stabilised to minimise the effects of supply fluctuations, and can accomodate wide variations in local supplies either side of the 100V and 220V nominal settings available on the supply transformer.

The h.t. stabiliser is a conventional series valve regulator circuit, driven by the output from the bridge rectifier BR1. A triode pentode, V6, is used as the series valve and its associated drive amplifier, while voltage stabiliser V7 provides the reference voltage level at the cathode of V6a. The h.t. output is set up by means of RV13.

The l.t. stabiliser is fed from the bridge rectifier BR2 and contains the series regulator transistor VT1 which is driven by the emitter follower VT2. Changes in output voltage are detected in the base-emitter circuit of VT3 by comparison with the reference level provided by Zener diode MR3, and the operation of the stabiliser is such that the voltage drop across VT1 is automatically adjusted to compensate for any change in output voltage. The l.t. output may be set up using the preset control RV12. The reference supply fed from BR3 is stabilised by Zener MR4.

5.1 INTRODUCTION

The circuit description provided in Section 4 should be read before any attempt is made to carry out the servicing, setting up and calibration procedures described in this section.

The circuit diagram (Fig.6) and the associated component lists in Section 6, together with the component layout diagrams (Figs. 4 and 5) provide complete information on the internal construction of the instrument.

5.2 ACCESS TO INTERIOR OF INSTRUMENT

(a) Dismantling the voltmeter

All the components inside the voltmeter become accessible when the following items are removed from the main frame of the instrument:–

(1) The wrap-round cover, secured by 4 half-inch 4BA screws at the rear.

(2) The two side covers, each secured by 4 quarter-inch 4BA screws.

The printed board assembly, which carries the bridge and stabiliser circuits, may be removed from the instrument after detaching the edge connector and removing the 5 securing screws.

(b) Dismantling of r.f. probe

The r.f. probe may be dismantled by carrying out the following procedures:–

(1) Remove the probe clip. Point the probe downwards, and, holding the probe cap, unscrew the main casing from the probe cap ferrule.
DO NOT UNSCREW THE FERRULE

The probe diode can now be removed :–

(2) Extract the diode anode connector from the disk capacitor C1, after removing the small piece of sleeving from the end of the connector.

(3) Disconnect the resistor from the diode anode connector by unsoldering and removing the retaining collet.
(4) Disconnect the soldered joints between the heater wires and the copper contacts on the printed circuit panel.
(5) Remove the diode.

NOTE: On replacement of the resistor, ensure that the lead connecting it to the printed circuit panel is properly housed in the slot in the valve cathode contact.

To re-assemble the r.f. probe carry out the following procedure:–

(1) Ensure that the location of the compression spring and sleeve, within the probe cap, is correct so that there is no restriction of movement when the spring is compressed.
(2) Locate C1 and the diode anode connector on the compression spring within the probe cap.
(3) Align the printed circuit panel with the slots in the probe cap ferrule.
(4) Push the probe casing over the printed circuit panel and secure it on the thread of the probe cap ferrule. THE FERRULE MUST NOT BE ROTATED DURING THIS OPERATION.

(c) Dismantling the d.c. probe

The d.c. probe may be dismantled by carrying out the following procedure:–

(1) Unscrew the rear end of the probe.
(2) Unscrew the front end.
(3) Pull the probe needle and the internal resistor out out of the front of the probe.

5.3 REPLACEMENT OF COMPONENTS

With the exception of valves and preset potentiometers, changing components in the voltmeter circuit does not necessitate repetition of any part of the setting up and calibration procedure, providing the tolerance limits and values stated on the component lists are observed. If a preset potentiometer is changed, it will be necessary to carry out the part of the setting up or calibration procedure relevant to its adjustment. Readjustments involved due to the changing of valves are listed below:–

V1 Set up d.c. zero and centre zero and check
V2 d.c. calibration
V3

V4 Set up a.c. zero and check a.c. calibration

V5 Set up a.c. zero

V6 Set up h.t. voltage
V7

5.4 SETTING UP PROCEDURE

(a) Adjusting the stabilised supplies:-

(1) Connect the supply to the voltmeter via a suitable variable transformer.
(2) Adjust the transformer output to exactly the value required by the voltmeter (110V or 220V, depending on the connections to the voltmeter supply transformer).
(3) After the initial warming up period, adjust the setting of RV13 until the voltage between terminals 24 and 30, on the printed circuit panel, is 350V d.c.
(4) Adjust RV12 to provide d.c. between pins 1 and 16 on the printed board.

(b) Adjusting the d.c. zero:–

(1) Connect the d.c. probe to the COMMON terminal.
(2) Set the range switch to 300mV and press the +

push-button.

(3) Set the FINE and COARSE SET ZERO controls to their mid-positions and adjust RV7 to bring the meter pointer to zero.

(4) Press the – push-button and verify that the meter pointer remains at zero.

(5) Rotate the range switch and verify that the meter pointer remains at zero in each switch position.

(6) Set the range switch to the 300mV position and press the + push-button.

(7) Connect 300mV d.c. between the d.c. probe and the COMMON terminal and vary the supply voltage 10% either side of the setting made in para. 5.4 (a)(2). Verify that the meter reading does not change by more than 5mV.

(c) Checking the centre zero facility:–

(1) Press the CZ push-button.

(2) Set the range switch to the 1kV, 300V, 100V, 30V, 10V and 1V positions in turn and verify that the meter pointer can be set to the centre zero marker on the scale using the CZ/Ω control in each case.

(3) Set the range switch to 300mV and verify that the meter pointer can be set to the centre zero marker on the scale using the CZ/Ω control, and the FINE COARSE SET ZERO and controls if necessary.

(d) Adjusting the a.c. zero:–

(1) Connect the d.c. probe to the COMMON terminal and adjust the COARSE and FINE SET ZERO controls to bring the meter pointer to zero.

(2) Connect the r.f. probe to the COMMON terminal and press the A.C. push-button.

(3) Set the meter pointer to zero by adjusting the setting of the A.C. SET ZERO control.

(4) Verify that the meter pointer remains at zero in each position of the range switch or can be re-zeroed by using the A.C. SET ZERO control.

(5) Connect the r.f. probe to a 300mV a.c. source. Vary the supply voltage 10% either side of the nominal setting made in para. 5.4 (a)(2) and check that the variation in the meter indication does not exceed 10mV.

5.5 CALIBRATION PROCEDURE

(a) D.C. measurements

(1) Press the + push-button and set the range switch.
(2) Connect the d.c. probe to the COMMON terminal and adjust the FINE and COARSE SET ZERO controls to set the meter pointer to zero.
(3) Connect a 300mV d.c. (± 0.5%) supply between the d.c. probe and the COMMON terminal.
(4) Adjust RV2 until the meter indicates 300mV.

NOTE: The value of R36 may be modified, if necessary, to bring the final adjustment within the range of potentiometer movement.

(5) Set the range switch to 30V.
(6) Connect a precision 30V d.c. (± 0.5%) supply between the d.c. probe and the COMMON terminal.
(7) Adjust RV5 until the meter indicates 30V.

NOTE: The value of R40 may be modified, if necessary, to bring the final adjustment within the range of potentiometer movement.

(8) Set the range switch to the 1kv position.
(9) Connect a 1000V d.c. supply (± 0.5%) between the d.c. probe and the COMMON terminal.
(10) Adjust RV1 until the meter indicates 1000V.

NOTE: R5 and R6 may be shorted out, as required, to bring the final adjustment within the range of potentiometer movement.

(b). A.C. measurements

(1) Press the +push-button and set the range switch to 300mV.
(2) Connect the d.c. probe to the COMMON terminal and adjust the FINE and COARSE SET ZERO controls to bring the meter pointer to zero.
(3) Press the A.C. push-button and set the range switch to the 30V position.
(4) Connect the probe clip to the probe point on the r.f. probe and adjust the A.C. SET ZERO control until the meter pointer indicates zero.
(5) Connect a sine wave source to 30V r.m.s. (± 0.5%) at 1,000Hz to the r.f. probe.
(6) Adjust RV6 until the meter indicates 30V.

NOTE: The value of R42 may be modified, if necessary, to bring the final adjustment within the range of potentiometer movement.

(7) Set the range switch to the 1V position.
(8) Connect a sine wave source of 1V r.m.s. (± 0.5%) at 1000Hz to the r.f. probe.
(9) Adjust RV3 until the meter indicates ~~100V~~. 1V.
(10) Connect a precision sine wave source of 300mV r.m.s. (± 0.5%) to the r.f. probe.
(11) Set the range switch to 300mV.
(12) Adjust RV4 until the meter indicates 300mV.

(c) Resistance calibration

(1) Set up the instrument to measure resistance as described in para. 3.6, Section 3
(2) Select eight precision resistors (± 0.5%) the values of which fall approximately at half scale on each resistance range of the meter.
(3) Connect each resistor between the Ω and the COMMON terminals in turn, and verify that the meter indicates the correct value (± 4.5%) in each case when the appropriate position of the range switch is selected.

COMPONENTS LIST AND CIRCUIT DIAGRAM

SECTION 6

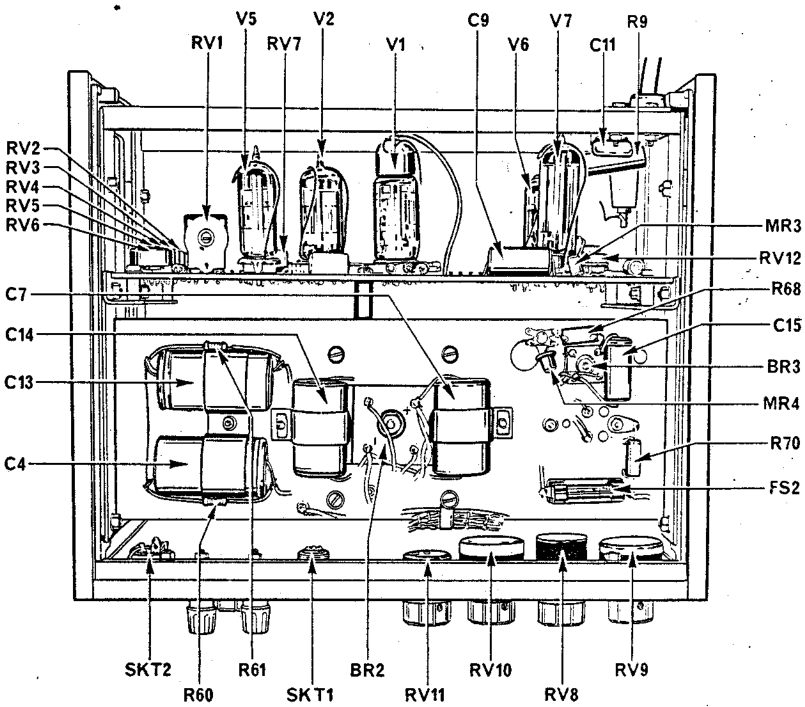


Fig. 4 Component Location — Chassis ~~topside~~ UNDER view.

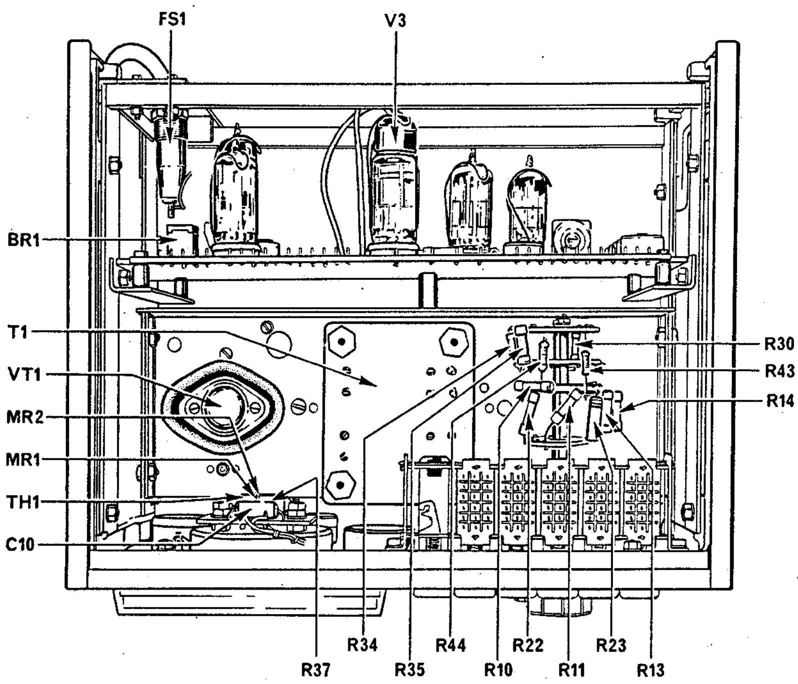
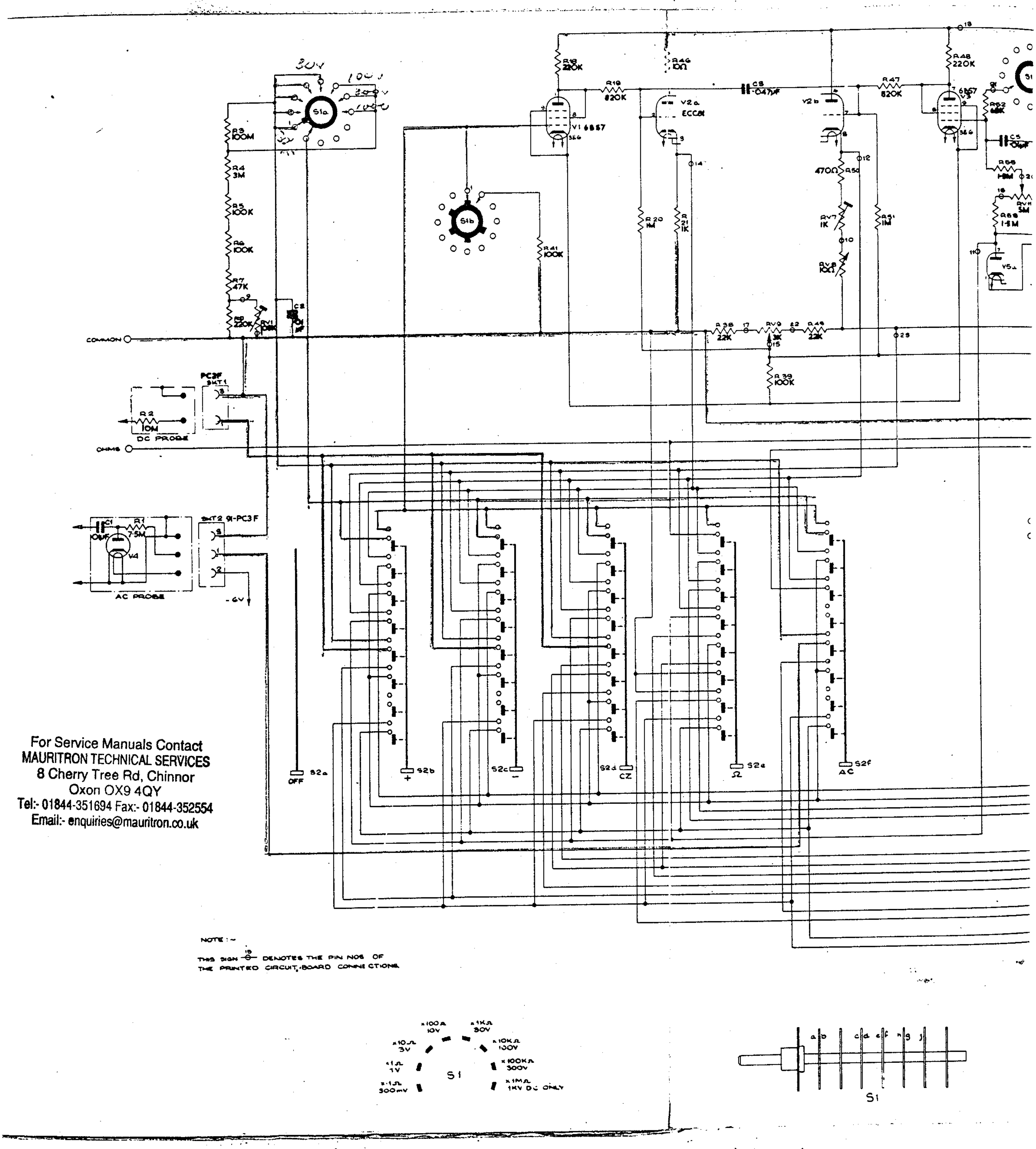
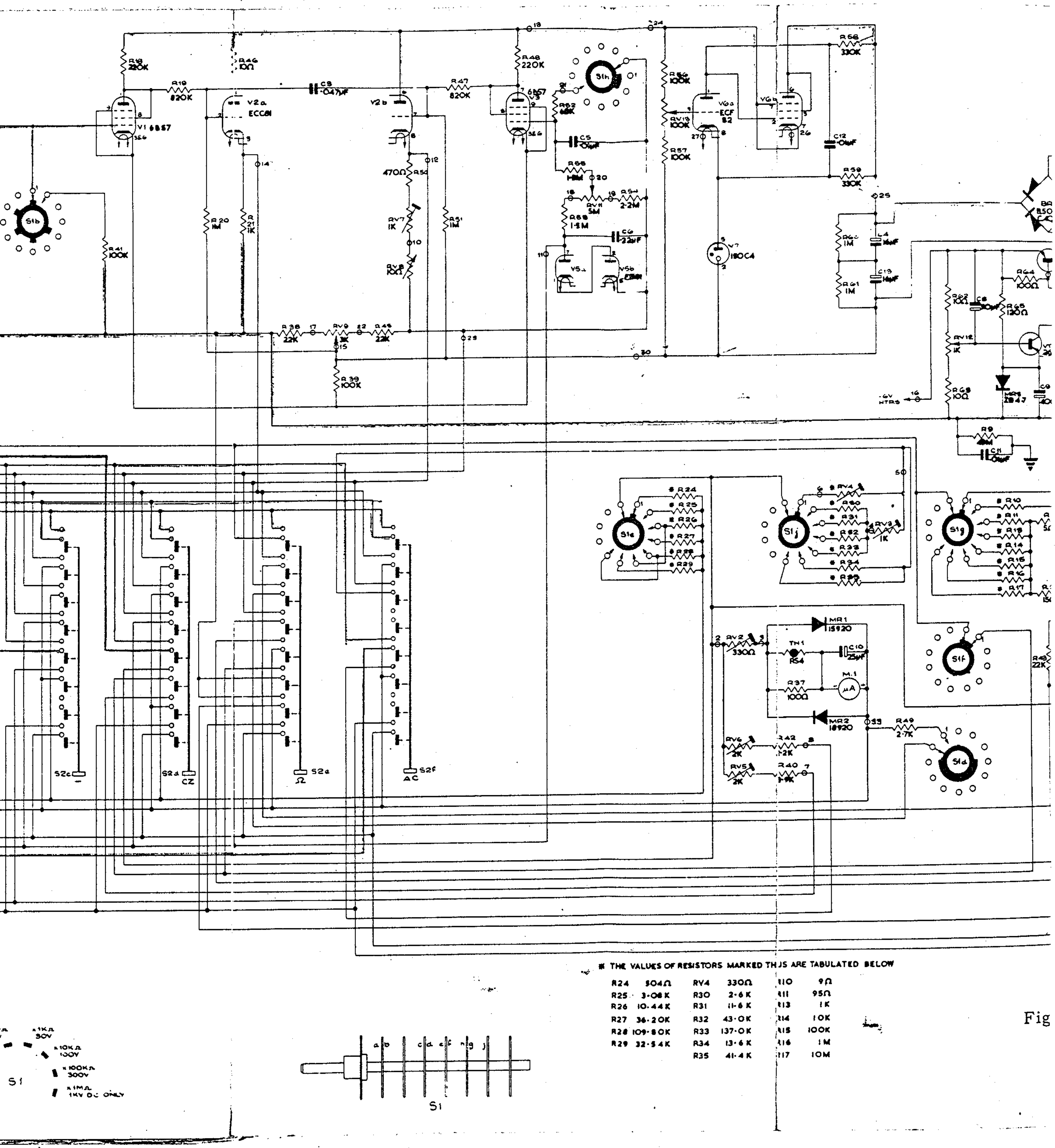


Fig. 5 Component Location — Chassis ~~under~~side TOP view.


COMMON
OHMS
DC PROBE
AC PROBE
PC3F SKT1
SKT2 91-PC3F
-6V
R2 10M
R3 100M
R4 3M
R5 100K
R6 100K
R7 47K
R18 220K
R19 820K
R46 10Ω
C8 ·047μF
V2a ECC81
V1 6BS7
V3 6BS7
R47 820K
R48 220K
R41 100K
R20 1M
R21 1K
R51 1M
RV7 1K
R39 100K
V4
V5a
S1a
S1b
S2a OFF
S2b +
S2c −
S2d CZ
S2e Ω
S2f AC
NOTE :-
THIS SIGN DENOTES THE PIN NOS OF THE PRINTED CIRCUIT BOARD CONNECTIONS
S1
x100Ω 10V
x1KΩ 30V
x10Ω 3V
x10KΩ 100V
x1Ω 1V
x100KΩ 300V
x·1Ω 300mV
x1MΩ 1KV DC ONLY



∗ THE VALUES OF RESISTORS MARKED THUS ARE TABULATED BELOW

R24	504Ω	RV4	330Ω	110	9Ω
R25	3·08K	R30	2·6K	111	95Ω
R26	10·44K	R31	11·6K	113	1K
R27	36·20K	R32	43·0K	114	10K
R28	109·80K	R33	137·0K	115	100K
R29	32·54K	R34	13·6K	116	1M
		R35	41·4K	117	10M

Fig

COMPONENTS LIST AND CIRCUIT DIAGRAMS

SECTION 6

RESISTORS (RRC 2HS2 ± 1% unless specified)

Ref.	*Value*	*Description*	*Part No.*
R1		Part of r.f. probe	
R2	10M	10% Erie 16	
R3		(Select to 5%)	1179
R3	100M	2% Welwyn F43D	18082
R4	3M		18083
R5	100K		2044
R6	100K		2044
R7	47K		3902
R8	220K		2045
R9	45M	5% Welwyn F43D	18084
R10	9		18085
R11	95		18086
R12	5		18087
R13	1K		11499
R14	10K		2037
R15	100K		2044
R16	1M		3639
R17	10M		4175
R18	220K		2045
R19	820K		18088
R20	1M		3639
R21	1K		11499
R22	1		3637
R23	15	5% Erie 8	18102
R24	504		18089
R25	3·08K		18090
R26	10·44K		18091
R27	36·2K		18092
R28	109·8K		18093
R29	32·54K		18094
R30	2·6K		18095
R31	11·6K		18096
R32	43K		18097
R33	137K		18098
R34	13·6K		18099
R35	41·4K		18100
R37	100 5%		11504
R38	22K		2041
R39	100K 1%		2044
R40	3·3K 1%	RRC 5SWD33	2524
R41	100K 5%	RRC 5SWD18	319
R42	1K 5%	RRC 5SWD33	1538
R43	15K 5%	RRC 5SWD	2354
R44	6·8K 5%	RRC 5SWD33	2222
R45	22K		2041
R46	10 5%	RRC 5SWD18	2259
R47	820K		18088
R48	220K		2045

COMPONENTS LIST AND CIRCUIT DIAGRAMS

Ref.	*Value*	*Description*	*Part No.*
R49	2·7K 5%	RRC 5SWD18	311
R50	470		11501
R51	1M		3639
R52	68K		2043
R53	1·5M	RRC 5SWD33	18588
R54	2·2M	RRC 5SWD33	18104
R55	1·5M		18101
R56	100K 5%	RRC 5SWD33	2064
R57	100K 5%	RRC 5SWD33	2064
R58	330K 5%	Erie 8	18103
R59	330K 5%	Erie 8	18103
R60	1M 5%	RRC 5SWD33	2069
R61	1M 5%	RRC 5SWD33	2069
R62	10 5%	RRC 5SWD18	2259
R63	10 5%	RRC 5SWD18	2259
R64	100 5%	RRC 5SWD18	11504
R65	120 5%	RRC 5SWD18	735
R66	68 10%	Erie 16	3415
R67	6·8K 5%	RRC 5SWD18	313
R68	30 20%	AW. 3101	3572
R69	Not used.	Not used.	
R70	3·3 5%	RWV4J	3478

PRESET AND VARIABLE RESISTORS
(Welwyn P25M unless specified)

RV1	100K	P343	18106
RV2	330		18107
RV3	1K		18108
RV4	330		18107
RV5	2K		18109
RV6	2K		18109
RV7	1K		18108
RV8	10	Colven CLR 1106/10	20456
RV9	3K	Colven CLR 1106/10	20458
RV10	50	Colven CLR 1106/10	20457
RV11	5M	Morgan 30N	18113
RV12	1K	Plessey MPD	1054
RV13	100K	Plessey MPD	2383

CAPACITORS

C1		Part of r.f. probe	
C2	0·01μF 2kV	Erie	5001
C3	0·047μF 125V	Tropyfol	3779
C4	16μF 500V	Plessey CE5001/1	12754
C5	0·01μF 125V	Tropyfol	3399
C6	0·22μF 125V	Tropyfol	2001
C7	1000μF 35V	Neuberger EN540	1810[illegible]

COMPONENTS LIST AND CIRCUIT DIAGRAMS

Ref.	*Value*	*Description*	*Part No.*
C8	50μF 15V	Printilyt	2750
C9	400μF 15V	Printilyt	2772
C10	25μF 15V	Wima Printilyt	17997
C11	0·01μF 2KV	Erie K6994/CP1	5001
C12	0·01μF 2KV	Erie K6994/CP1	5001
C13	16μF 500V	Plessey CE5001/1	12754
C14	100μF 35V	Neuberger EN540	18105
C15	400μF 15V	Wima Printilyt	2772

VALVES

V1	Brimar 6BS7	18115
V2	Mullard ECC81	7106
V3	Brimar 6BS7	18115
V4	Mullard EA52	911
V5	Mullard EB91 (6AL5)	5970
V6	Mullard ECF 82	10811
V7	150C4	154

SEMICONDUCTORS

VT1	Mullard PC35	347
VT2	Newmarket NKT128	2092
VT3	Texas 2G302	2226
BR1	Semikron B500 C400	18116
BR2	Texas 1B20K05	2279
BR3	Texas 1B05J05	2753
MR1	Texas 1S920 D626	2542
MR2	Texas 1S920 D626	2542
MR3	Brush Zener ZB4.7	2784
MR4	AEI Zener VR475F	4036

MISCELLANEOUS

FS1	1A Belling-Lee L1055	4732
FS2	2A Beswick TDA12 Slow blow	20439
M1	Meter	A18137
N1	Neon 125V	1165
S1	Range switch	18131
S2	Function switch	B18132
SKT1	Amphenol 91 – PC3F	18952
SKT2	Amphenol 80 – MC2M	18955
T1	Supply Transformer	MT456
TH1	Thermistor STC R54	18114

GUARANTEE AND SERVICE FACILITIES

SECTION 7

This instrument is guaranteed for a period of one year from its delivery to the purchaser, covering the replacement of defective parts other than valves, semiconductors and fuses. Valves and semiconductors are subject to the manufacturers' guarantee.

We maintain comprehensive after sales facilities and the instrument can, if necessary, be returned to our factory for servicing. The Type and Serial Number of the instrument should always be quoted, together with full details of any fault and the service required. The Service Department can also provide maintenance and repair information by telephone or letter.

Equipment returned to us for servicing must be adequately packed, preferably in the special box supplied, and shipped with transportation charges prepaid. We can accept no responsibility for instruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired, the repair will be put in hand without delay and charged unless other instructions are received.

OUR SALES, SERVICE AND ENGINEERING DEPARTMENTS ARE READY TO ASSIST YOU AT ALL TIMES.

Manual Part No. 18167