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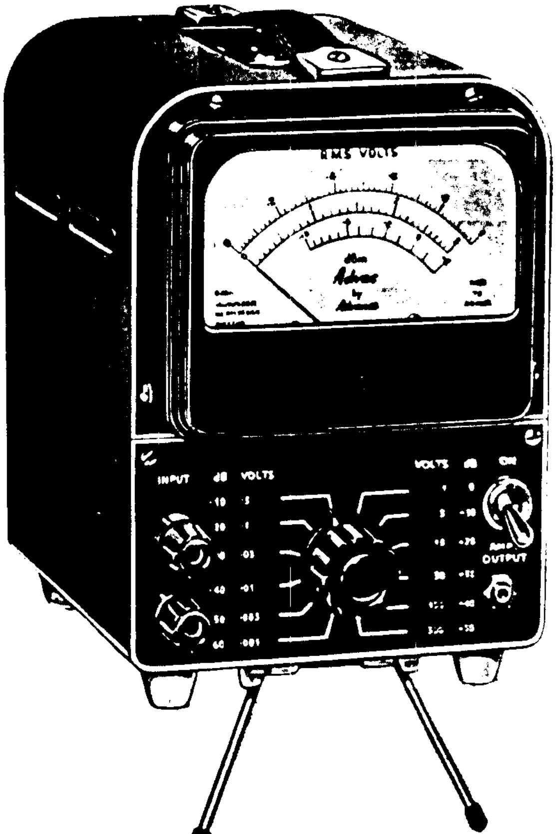
Advac

MODEL VM77A

WIDE-RANGE A.C. MILLI-VOLTMETER



DESCRIPTION

The ADVANCE model VM77A Wide-range A.C. Voltmeter consists of a 4-stage amplifier with two attenuators. The output of the amplifier is rectified by a bridge-rectifier across which is connected a meter having a 4-inch scale length.

The amplifier is arranged in two sections each of two stages, negative feed-back being applied over each section. The first attenuator operates between the input and the first section, and has three positions. The second attenuator operates between the first section and the second section, and has four positions, making twelve ranges in all, from 1 millivolt to 300 volts full-scale. Using the screened probe supplied, measurements as low as 100 micro-volts are possible.

The meter is calibrated in three scales:

0 — 1, Volts, RMS.
9 — 3, Volts, RMS. and
decibels, +2, - 10 (referred to 1 milliwatt into 600 ohms).

The model VM77A can be used as a sensitive voltmeter for circuit investigation, investigation of erratic operation in amplifier circuits, measurement of circuit voltages (where the input impedance of 10 megohms renders it particularly useful), or in any application where high sensitivity measurements are to be made. There is a 30% overlap between ranges so that the best accuracy of the instrument is always available. It may also be used as an amplifier, the gain of which is adjusted by the range switch in steps of 10 dB from - 60 dBm to + 50 dBm.

The amplifier frequency response, with a 100K resistive load and 40 pF capacitative load is within ±2 dB from 12 c/s to 200 kc/s. The response above this range depends upon the capacity of the load. With a load of 40 pF and 100 K it will rise up to 3 Mc/s and fall away thereafter. The harmonic distortion is very low, particularly at low input levels.

Note:—When the amplifier jack is inserted, the meter function is inaccurate, the jack plug must be removed for use as voltmeter.

The instrument is supplied with a low-capacity screened lead, Type PL,50

This lead completely screens the input terminal which is necessary in view of the very high sensitivity of the instrument when making measurements on the lower ranges The capacity of this lead is low.

The model VM77A is of compact construction, and operates on either 100—125 V or 200—250 V without mains tap adjustment (a stabilized h.t. supply is built-in). Other features include a winding bracket for the mains lead, which springs flat with the back when not required.

SPECIFICATION

VOLTAGE RANGES F.S.D.		ATTENUATOR SETTINGS F.S.D.	
0.001 V	1 V	- 60 dBm	0 dBm
0.003 V	3 V	- 50 dBm	+ 10 dBm
0 .01 V	10 V	- 40 dBm	+ 20 dBm
0 .03 V	30 V	- 30 dBm	+ 30 dBm
0 .1 V	100 V	- 20 dBm	+ 40 dBm
0 .3 V	300 V	- 10 dBm	+ 50 dBm

FREQUENCY RANGE

15 c/s to 2 Mc/s, Accuracy ±(3% + 3% F.S.D.)
2 Mc/s to 4.5 Mc/s, Accuracy ±2 dB

METER CALIBRATION

The meter reads r.m.s. voltages for sine-wave inputs. There are wo voltage cales, 0—1 and 0—3 volts, and a dB scale from - 10 to + 2 dB (relative to 1 milliwatt/600 ohms).

INPUT IMPEDANCE

Less than 10% change with range switching.
10 megohms, 20 pF.

MAINS VARIATIONS

Stability ±1% for the line voltage changes from 105 to 125 V, or 210 to 250 V (15 c/s to 2 Mc/s). Less than - 1½% at 200 V and 100 V.

AMPLIFIER GAIN

60 dB maximum. Adjustable in 10 dB steps.

AMPLIFIER FREQUENCY RESPONSE

±2 dB from 12 c/s to 200 kc/s (with 100K, 40pF load). Response rises to 3 Mc/s and falls away above this frequency.

AMPLIFIER OUTPUT

Maximum output 1 V r.m.s. Output is 0.5 V ± 2 dB when meter reads 0.5 on top scale, up to 200 kc/s.

AMPLIFIER OUTPUT IMPEDANCE

Approximately 1,500 ohms.

METER OVERLOAD PROTECTION

It is not possible to permanently damage the meter by applying an input voltage too high for the range selected.

NON-SINUSOIDAL OPERATION

The circuit used gives readings which are close to r.m.s. values even when the harmonic content is comparatively high. Error with

10% second harmonic content is about 0.5%.
20% second harmonic content, −2%.
50% second harmonic content, up to −10%.
10% third harmonic content, ±4%.
50% third harmonic content, −20% to +4%.

MAXIMUM INPUT VOLTAGE

500 volts (d.c. plus peak a.c.).

VALVES (Tubes)

Four 6AK5; one XC12; one 6AQ5; one ECF80; one L.E.S. 5 mm 6.3 volt indicator lamp.

ACCESSORIES

One low-capacity lead type PL-50, with screened hood for input terminal.

POWER SUPPLY

100 to 125V and 200 to 250V, 30W, 50 to 60 c/s.

These two voltage ranges are selected internally by soldered links.

No mains voltage adjustment is necessary between 100 and 125V, or between 200 and 250V.

The valve voltmeter may be used at higher frequency supplies with some deterioration in accuracy.

WEIGHT

7 lb (3.2 kg).

DIMENSIONS

4¾ in. wide × 7½ in. high × 6¾ in. deep (12 cm × 19 cm × 17 cm) overall.

PRESENTATION

Mounted on a photo-etched panel with a maroon enamel background and housed in a steel case finished in a dark grey polychromatic stoved enamel.

CONTROLS AND CONNECTIONS

Controls on the front of the instrument are:—

MAINS SWITCH

On the right of the instrument. A red indicator light in the centre of the meter indicates when power is on. (This light is produced via a perspex lens from a miniature bulb fitted externally to the meter.)

RANGE SWITCH

In the centre of the instrument panel. The VOLTS indications give the voltage at the input terminals for full-scale deflection; the dB indications are the level in dBm (referred to 1 milliwatt into 600 ohms) which will cause the meter to read zero on the dBm scale.

INPUT TERMINALS

Two terminals on the left of the instrument panel which will accommodate wires, spade or pin terminals, or 4 mm plugs. The lower terminal is earthed.

OUTPUT JACK

At the right-hand bottom side of the panel; the jack ring is earthed to the chassis of the instrument.

FUSE

A 1 ampere fuse is located in the back of the instrument.

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A.C. BALANCE

This control is accessible through a hole near the centre of the back of the instrument. The setting need only be checked at infrequent intervals when using the more sensitive ranges. It may be quickly set by shorting the input terminals and adjusting for minimum reading on the .001 volts range. It may be more accurately set by completely screening, but not short-circuiting, the input terminal. (This may be effected by plugging-in the screened probe and placing its tip inside a screened and earthed box or can.)

GAIN SETTING

The gain control, a small flat potentiometer with screwdriver-slot adjustment, is located inside the instrument on the right-hand tag-board. It should only need adjustment at long intervals, or when very accurate measurements are to be taken, and is located internally to prevent accidental or unnecessary movement. The control is readily accessible by removing the two screws in the back of the case and sliding out the chassis. Anti-clockwise movement increases the reading. The reading should be set (preferably near full scale) with a known voltage at the input terminals. (This voltage being measured with a standard meter.)

MAINS LEAD

The three-wire lead should be connected red to live, black to neutral and green to earth. The earth connection is not essential and may be cut back for connection to two-wire systems. Earthing is preferable when making measurements at very low voltages and may be effected by connecting the black terminal to earth. (See Caution Note under " Operation ".)

OPERATION

Note.—The maximum d.c. plus peak a.c. voltage applied to the input terminals should not exceed 500V.

CAUTION

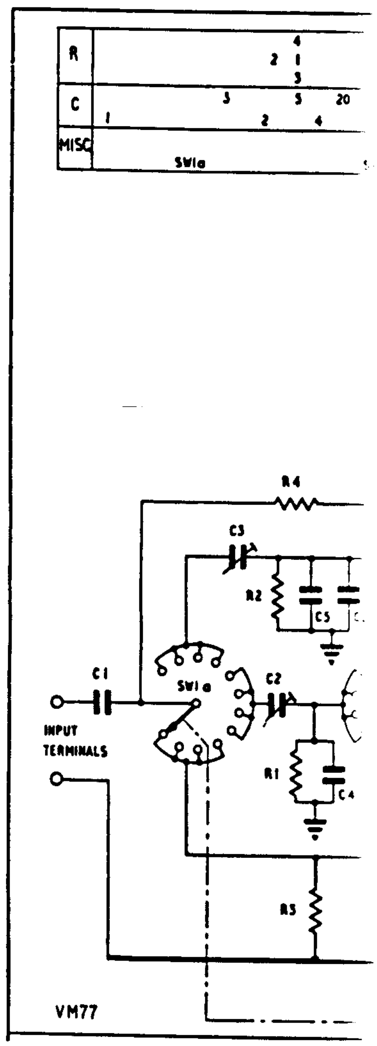
The instrument is provided with a 3-core lead, enabling the case and front panel to be earthed. This is desirable, especially when making measurements above a few kc/s.

RESISTORS

Ref.	DESCRIPTION	Pt. No.
R 1	101K ±1%, ¼W, H.S. RRC	11496
R 2	1K ±1%, ¼W, H.S. RRC	11499
R 3	10M ±2%, ¼W, H.S. RRC	11506
R 4	10M ±1%, ¼W, H.S. RRC	12327
R 5	2.7 Ω ±20%, Erie RMA 9	11512
R 6	2.7 Ω ±20%, Erie RMA 9	11512
R 7	180 Ω ±5%, RRC 5SCD3	11582
R 8	100 Ω ±5%, H.S. RRC 5SCD2	11504
R 9	27K ±5%, Dubilier BTS	405
R10	4.7K ±1%, ¼W, H.S. RRS	11497
R11	1M ±10%, Dubilier BTS	406
R12	22K ±10%, Erie type 8	6706
R13	180 Ω ±5%, RRC 5SCD3	11582
R14	2.7K ±5%, Erie type 8	413
R15	1.2K ±10%, Dubilier BTS	10621
R16	100K ±10%, Erie type 9	1270
R17	1K ±10%, Erie type 9	1175
R18	100 Ω ±5%, H.S. RRC 5SCD2	11504
R19	100 Ω Pot. Egen 170	11518
R20	100 Ω ±5%, H.S. RRC 5SCD2	11504
R21	100 Ω ±10%, Dubilier BTS	10985
R22	51 Ω ±5%, H.S. RRC 5SCD2	11511
R23	4.7K ±1%, ¼W, H.S. RRC	11497
R24	1.5K ±1%, ¼W, H.S. RRC	11498
R25	470 Ω ±1%, ¼W, H.S. RRC	11501
R26	220 Ω ±1%, ¼W, H.S. RRC	11502
R27	1.2K ±10%, Dubilier BTS	10621
R28	820K ±10%, Dubilier BTS	408
R29	27K ±5%, Dubilier BTS	405
R30	15K ±10%, Dubilier BTS	412
R31	1M ±10%, Dubilier BTS	406
R32	470 Ω ±10%, Dubilier BTS	10987
R33	2K Pot. Egan type 123	11309
R34	22K ±5%, H.S. RRC 2HS2	508
R35	470 Ω ±10%, Dubilier BTS	10987
R36	1.2K ±10%, Dubilier BTS	10621
R37	470 Ω ±10%, Dubilier BTS	10987
R38	27K ±5%, Dubilier BTS	405
R39	10K ±5%, Erie type 8	415
R40	180K ±10%, Erie type 9	5080
R41	100Ω Preset pot. Reliance type MW	11534
R42	12 Ω ±10%, Dubilier BTS	409
R43	Selected on test	
R44	18K ±5%, H.S. RRC-2HS2	507
R45	27K ±5%, Dubilier BTS	405
R46	1.5K ±5%, Dubilier BTS	407
R47	33K ±10%, Dubilier BTS	439

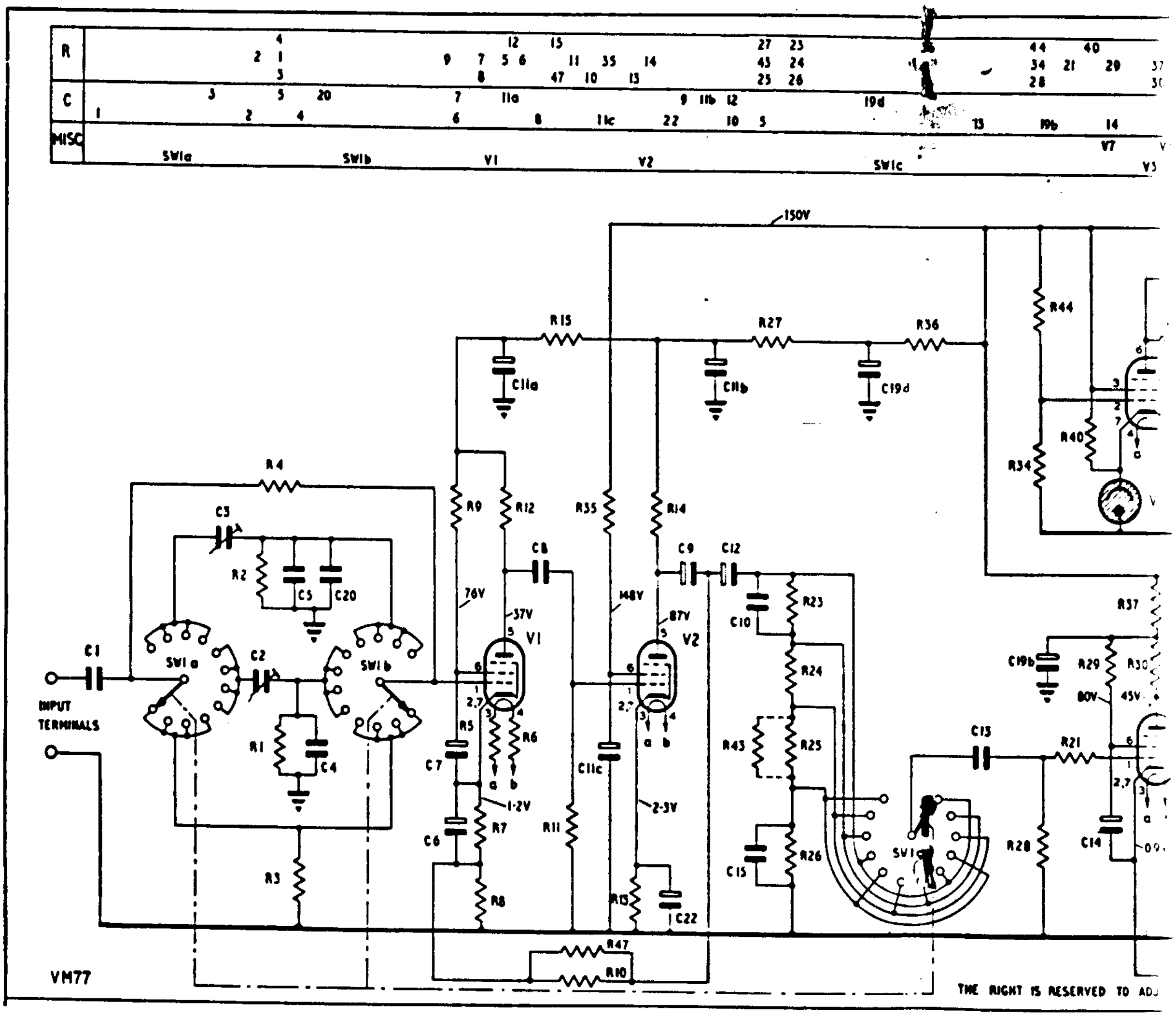
CAPACITORS

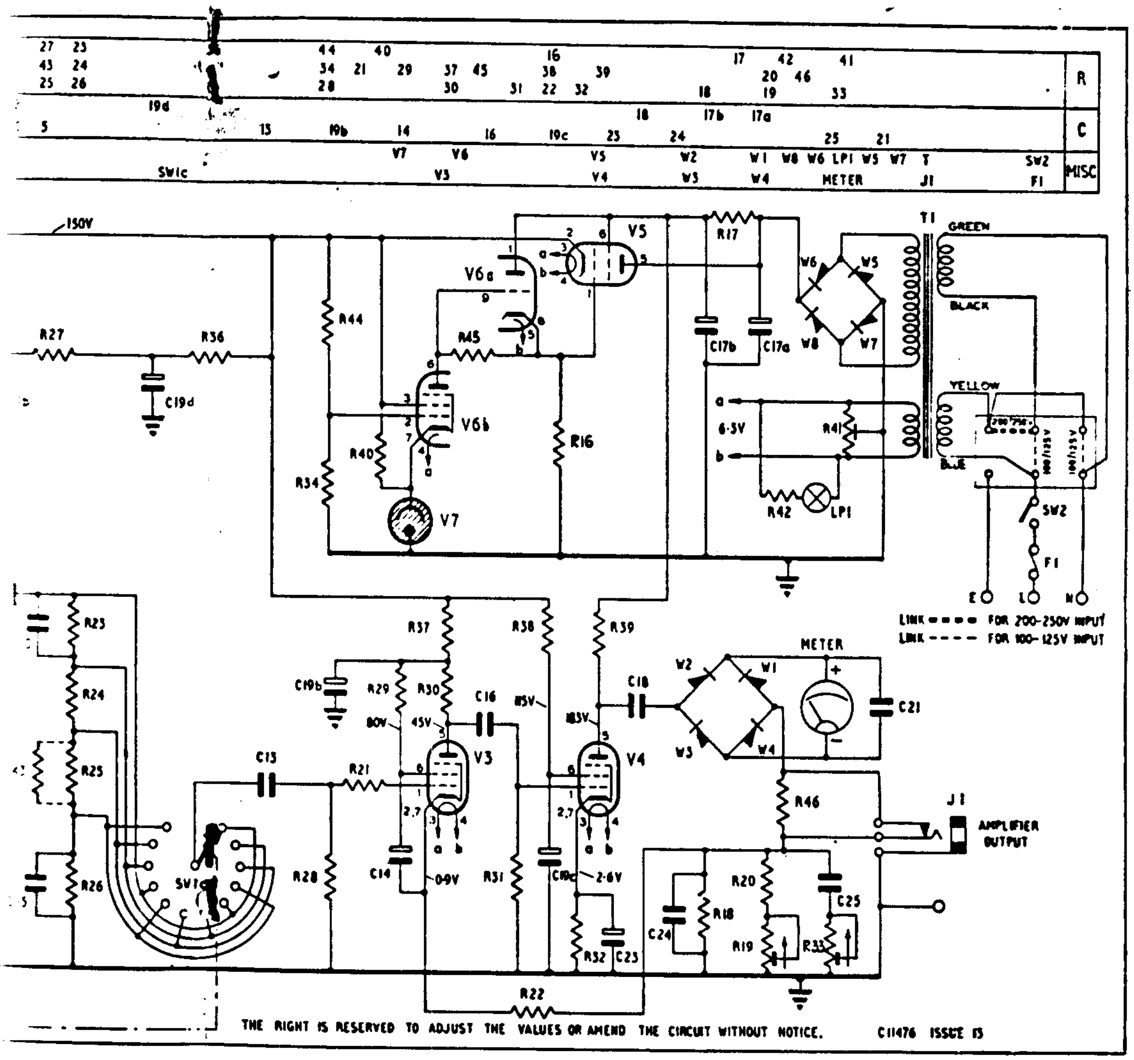
Ref.	DESCRIPTION	Pt. No.
C 1	0.05μF 500V Pleseal	11489
C 2	1.5–7pF Trimmer 004A 10BM. 020 Strico ...	13110



	Pt. No.
...	11496
...	11499
...	11506
...	12327
...	11512
...	11512
...	11582
...	11504
...	405
...	11497
...	406
...	6706
...	11582
...	413
...	10621
...	1270
...	1175
...	11504
...	11518
...	11504
...	10985
...	11511
...	11497
...	11498
...	11501
...	11502
...	10621
...	408
...	405
...	412
...	406
...	10987
...	11309
...	508
...	10987
...	10621
...	10987
...	405
...	415
...	5080
...	11534
...	409
...	507
...	405
...	407
...	439

	Pt. No.
...	11489
...	13110



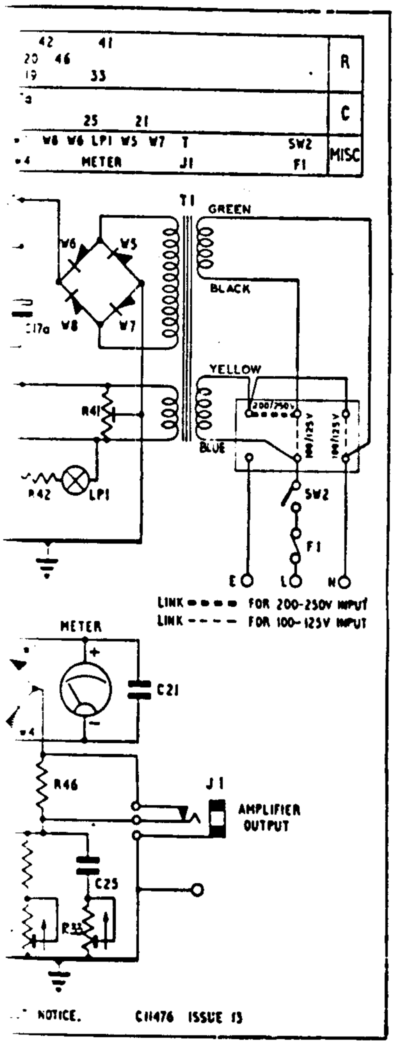


Capacitors continued

C 3	1.5–7pF Tr
C 4	470pF ±10
C 5	0.01μF 150V
C 6	200μF 6V
C 7	5μF 150V
C 8	0.04μF 150
C 9	5μF 150V
C10	4.7pF ±10
C11A	60μF } 150V
C11B	40μF
C11 C	20μF
C12	200μF 6V
C13	0.05μF 500V
C14	16μF 150V
C15	100pF ±5%
C16	0.04μF 150V
C17A	20μF } 350V
C17B	20μF
C18	0.5μF ±20
C19A	60μF } 150V
C19B	40μF
C19C	20μF
C20	0.01μF 150
C21	0.02μF 200
C22	200μF 6V
C23	200μF 6V
C24	Selected on
C25	0.001μF Hu

M

Ref.	
W 1	Diode WG5
W 2	Diode WG5
W 3	Diode WG5
W 4	Diode WG5
W 5	Diode 2E4
W 6	Diode 2E4
W 7	Diode 2E4
W 8	Diode 2E4
V 1	6AK5 ...
V 2	6AK5 ...
V 3	6AK5 ...
V 4	6AK5 ...
V 5	6AQ5 ...
V 6	6BL8 ...
V 7	XC12 (Hiv
I 1	130 (Bulgin
T 1	Transformer
F 1	Fuse, 1A B
L 1	Lamp, Pilot
SW1A	} Plessey
SW1B	
SW1C	
SW2	Arrow 804



Capacitors continued

C 3	1.5–7pF Trimmer 004A 10BM. 020 Strico ...	13110
C 4	470pF ±10% 350V Polystyrene GEC ...	11492
C 5	0.01μF 150V Hunts W99	8587
C 6	200μF 6V Elect. Plessey CE206	12972
C 7	5μF 150V Elect. Plessey CE1348	497
C 8	0.04μF 150V Hunts B858	7485
C 9	5μF 150V Elect. Plessey CE1348	497
C10	4.7pF ±10% Polystyrene GEC	11494
C11A	60μF	
C11B	40μF } 150V. Elect. Plessey CE17202 ...	11569
C11 C	20μF	
C12	200μF 6V Elect. Plessey CE206	12972
C13	0.05μF 500V Pleseal	11489
C14	16μF 150V. Elect. Plessey CE461/13 ...	11485
C15	100pF±5% Silver mica, insul.	12714
C16	0.04μF 150V Hunts B858	7485
C17A	20μF } 350V CE, 840	11482
C17B	20μF	
C18	0.5μF ±20% 150V Hunts W48 A308 ...	12056
C19A	60μF	
C19B	40μF } 150V Elect. Plessey CE17202	11569
C19C	20μF	
C20	0.01μF 150V Hunts W99	8587
C21	0.02μF 200V Hunts W94	10604
C22	200μF 6V Elect. Plessey CE206	12972
C23	200μF 6V Elect. Plessey CE206	12972
C24	Selected on test	
C25	0.001μF Hunts type 99	8245

MISCELLANEOUS

Ref.	DESCRIPTION	Pt. No.
W 1	Diode WG5B	11538
W 2	Diode WG5B	11538
W 3	Diode WG5B	11538
W 4	Diode WG5B	11538
W 5	Diode 2E4	500
W 6	Diode 2E4	500
W 7	Diode 2E4	500
W 8	Diode 2E4	500
V 1	6AK5	9064
V 2	6AK5	9064
V 3	6AK5	9064
V 4	6AK5	9064
V 5	6AQ5	498
V 6	6BL8	11005
V 7	XC12 (Hivac)	499
I 1	130 (Bulgin)	449
T 1	Transformer, Power	MT352/2
F 1	Fuse, 1A B/Lee 1055/1	4752
L 1	Lamp, Pilot, LES. 150mA	11547
SW1A		
SW1B	} Plessey	A13397
SW1C		
SW2	Arrow 8040/BT/13 Long/Chrome	12180

When making mains measurements, however, it is preferable not to have the instrument earthed but care must still be taken to avoid connection of the black terminal to the live line.

VOLTAGE MEASUREMENTS

The instrument normally reads correctly after a few minutes' warming-up period. Set to the range required and apply the voltage to be measured. When the voltage is unknown, set to the highest (300V) range and reduce until the meter reads the voltage. Select the range which gives the greatest meter movement. For greatest accuracy, where below ⅓ scale, use next lower range. (Although it is impossible to over-load the instrument, it is not good practice to allow the meter pointer to go hard over, unnecessarily.)

With the input terminal shorted, the residual noise in the first amplifier stage may give a very small reading. This reading need not be subtracted from the meter reading when the input voltage is greater than the residual noise.

When measuring voltages near mains frequencies, or at harmonics or sub-harmonics of the mains frequency, a small fluctuation in the reading may be noticeable. This is worse if the a.c. balance is incorrectly adjusted. Where possible, avoid measurements at mains frequency at high impedance (e.g., when measuring the response of an amplifier).

Where the input is other than sinusoidal, a small error in readings may result. The circuit used reads close to the true r.m.s. value even when the harmonic content is comparatively high. (See "Non-sinusoidal Operation" under "Specification".)

DB MEASUREMENTS

As with voltage measurements, set to the range required. The range indicates the number of dB to be added to the meter reading, using the dB scale. For example, if the meter reads - 10 dB and the range is - 40 dB, the level is - 50 dB. (Zero dB being 1 milliwatt into 600 ohms.)

Note that the dB relationship to voltages is correct only if the two voltages are measured across equal impedances. The instrument is calibrated in voltage and dB ratios.

USE AS AN AMPLIFIER

Connect signal to the input terminals and the output load (which should be high-impedance, e.g., oscilloscope, high-impedance headphones, etc.), to the output jack. Reactive loads may impair amplifier response. A capacitive load will actually increase response at higher frequencies.

The amplifier is specified ± 2 dB, 12 c/s to 200 kc/s (with 100K, 40pF load). It will be found that the response rises to 3 Mc/s and falls away above this frequency.

The amplifier output, in r.m.s. volts, with 100K, 40pF load, is within 2 dB of meter reading on top scale, at half-scale. This holds on all range settings.

USE OF SCREENED PROBE, PL50

With open terminals, stray pick-up will cause a meter reading on the most sensitive ranges. Similarly, if measurements are being made across a high-impedance source, hum or other pick-up may add to the voltage being measured. These effects can be avoided by shielding the input lead. Shielding is essential when measuring low voltages at high impedances. Adequate shielding will introduce input capacity which may affect the operation of the circuit being measured, and, at higher frequencies, may affect the reading.

The screened input lead PL50 will add approximately 60pf to the input capacity of 20pf. Where excessive shunt capacity is likely to cause error it will be necessary to add a trimmer capacitor covering 6pf in series with the input to form a capacity divider. This will reduce the input capacity to one tenth and, of course, the sensitivity. The trimmer may be accurately calibrated by noting the reading of a low impedance R.F. signal generator without the trimmer on a given range and trimming for the same reading with the range switch 20 db's more sensitive and the trimmer in circuit.

Alternatively, probe PL45 may be purchased as an accessory.

HUM PICK-UP

Under some circumstances, difficulties due to hum pick-up may be reduced by experimenting with the orientation of the power plugs of the voltmeter and other apparatus with which it is in use. Reversal of one or more plugs may reduce the pick-up. When measuring voltages at mains frequencies, hum pick-up may affect the reading, the amount being dependent upon the phase. Adequate screening, using screened probe, or experiment with earth connections, will minimise this. When measuring power supply frequencies, hum pick-up will cause a "beat" giving a fluctuating reading.

MAINTENANCE

CIRCUIT NOTES

The first attenuator, between the input and first stage, operates in 40 dB steps, the attenuation being:—

Ranges	
0.001 0.003 0.01 0.03	0 dB (Input straight through).
0.1 0.3 1.0 3.0	- 40 dB.
10.0 30.0 100.0 300.0	- 80 dB.

Feed-back is taken over the first two stages from coupling capacitor C9 to the cathode of V1.

The second attenuator operates between the second and third stages, and selects four ranges for each range of the input attenuator. (Rear wafer of attenuator switch.)

From this attenuator the signal is fed to the third and fourth stages via a grid-stopper resistor R21. Negative feed-back is applied between the meter and the cathode of V3.

The power supply is arranged through a mains transformer, the primary windings of which can be connected in series for 200 to 250V working and in parallel for 100 to 125V working. The top fuse in the back of the instrument is rated at 1 amp.

The four amplifying valves (tubes) are 6AK5's or EF95's. V1 is best selected for minimum hum and noise.

The meter-bridge consists of four germanium diodes. Westinghouse WG5B or G.E.C. CG6E, or any similar type.

R41, on the back bracket, balances the heaters and is adjustable through the back of the instrument. It is best adjusted by completely screening the red input terminal, or by plugging in the screened probe and completely screening its tip. The potentiometer is then adjusted for minimum scale reading, which should be about .05 on the top scale on the .001V range.

CALIBRATION

The calibration may be carried out with any low-distortion signal source up to 2 Mc/s, or at the mains frequency, using an accurate meter. Apply a voltage which will give a full-scale deflection, e.g., 1 volt when on the 1V scale. Adjust the calibration potentiometer R19, on the right-hand side of the chassis, until the instrument reads correctly. When adjusting at frequencies above 10 kc/s, the reading may vary 1% or 2% when replacing case; this can be allowed for when setting. Although the specified accuracy above 2 Mc/s is decreased to ± 2 dB, the calibration control can, if desired, be set so that the meter is truly accurate for any one frequency up to 4.5 Mc/s. (Note—the instrument will normally read towards the upper specification limit between 2 Mc/s and 4½ Mc/s; i.e., it is more sensitive at higher frequencies.) Capacitors C2 and C3, adjustable from the left-hand side of the first attenuator, are frequency-compensating capacitors. If the correspondence between ranges above 10 kc/s should necessitate correction, these capacitors should be adjusted as follows:—

1. Inject signal at 1 Mc/s to input, set to range .03V.
2. Adjust input volts to read full scale.
3. Switch to 0.1V range and adjust C2, the bottom capacitor, until the instrument read .03V on this range.
4. Switch to 3V range and inject a signal of 3V at 1 Mc/s.
5. Switch to the 10V range and adjust C3, the upper capacitor, until the instrument reads 3V on this range.

There is no adjustment for frequencies below 10 kc/s as the resistors are of sufficiently close tolerance to ensure accuracy. Should any range become inaccurate at low frequencies due to a resistor in the first attenuator, the error will repeat on each group of four adjacent ranges. If the inaccuracy is due to a resistor on the second attenuator, it will repeat on each fourth range position.

FACTORY SERVICE

Our factory Service Department is at your disposal should you wish to obtain further repair information by telephone or letter. The Type and Serial Number of the instrument should always be quoted. We maintain an efficient Service facility, and the instrument can, if desired, be returned to our factory for repair.

The instrument is guaranteed for a period of one year from its delivery to the purchaser, for the replacement of defective parts other than valves (tubes) and fuses.

Valves (tubes) are subject to the manufacturer's guarantee.

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 charged and put in hand without delay unless other instructions are received.

OUR SALES, SERVICE AND ENGINEERING DEPARTMENTS ARE AT YOUR SERVICE AT ALL TIMES