Manual Code Number 982-705

re

IM 6 Megohmmeter

RE TECHNOLOGY

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TABLE OF CONTENTS

1 GENERAL INFORMATION

1.1 Introduction

The IM6 Megohmmeter is a solid-state, line-operated instrument for high-resistance measurements. It features the most advanced techniques available, offers a versatility of operation and is extremely easy to use.

It measures resistance from 1 MOhm to 1 POhm (Peta = thousand Terra Ohms) at an accuracy of 5 % of the individual value, or it may be used to measure current within the range 1 pA to 1 mA at the same accuracy.

A special feature is that it indicates 1 MOhm to 1 POhm (9 decades) on one logarithmic scale. For greater reading accuracy, an alternative scale covering two decades is provided.

The test voltage applied to the component under test is selected by means of three thumb wheel switches within the range 0-999 Volts in 1 Volt steps. Provision is made for external control of the test voltage by applying a voltage of either 0-10 Volts or 0-100 Volts for full range control of the test voltage. A current limiter in the test voltage source prevents lethal accidents, and the non-lock (downward) position of the TEST VOLTAGE, ON/OFF switch provides additional safety. An indicator lamp is lit when the test voltage is switched on.

A MULTIPLIER switch is provided for the selection of the meter range. It covers the ranges 1 to 1 POhm and 10 to 100 TOhms, respectively.

The low input resistance obviates the necessity for any manual pre-charging procedures of capacitors prior to measuring. The 0 V line (chassis) is connected to the GUARD terminal, but is isolated from the GROUND terminal. The GROUND terminal is provided with a captive link which must be connected either to the GUARD terminal (normal position) or to the TEST VOLTAGE terminal when it is required to make measurements with the positive test voltage connected to ground. Facilities are provided for connection of an analogue recorder or a limit sensor with an output corresponding to -0.5 V/decade up to 9 decades.

The stability of the test voltage is better than 0.1 ppm for a +/- 10% change in the line supply.

1.2 Specifications

RESISTANCE MEASUREMENTS

Ranges:	1. 1 MOhm to 1 POhm in 1 range of 9 decades
	2. 1 MOhm to 1 POhm in 8 ranges of 2 decades
Scales:	2 logarithmic: Upper - 2 decades Lower - 9 decades
Accuracy:	
Rx $\leq$ 1 MOhm * Vtest	5 % of the indicated value (within temperature range 15 to 35 degrees C)
Rx > 1 MOhm * Vtest	(0.05 * Rx/Vtest) of the indicated value (Rx measured in Terra Ohms (TOhm)
Input Resistance:	10 kOhms for Itest > 2 nA
	1 MOhm for Itest < 2 nA
Recorder Output:	-0.5 V +/- 0.5 % per decade +/- 10 mV
	At 1 MOhm, 0 V +/- 10 mV
	Rout = 10 kOhms

TEST VOLTAGE

Range:	
Internal Control	0 to 999 Volts in 1 Volt steps by means of 3 thumb-wheel switches showing direct digital value of selected voltage.
External Control	2 inputs:
	1. Vtest = 10 * (-Vext), Vext MAX.=100 V dc
	(-Vext of minus 0-100 V dc provides 0-1000 Vtest)

2. Vtest = 100 * (-Vext), Vext MAX.=10 V dc

(-Vext of minus 0-10 V dc provides 0-1000 Vtest)

Accuracy: +/- 5 %

Stability: Better than 10 ppm per degree centigrade for +/- 10% voltage variation

Temperature Stability: +/- 0.01 %/ C. (Vtest $\geq$ 10 V)

Short-circuit Current: Max. 2 mA

Switching: ON/OFF function manually on front panel or by remote control

Source Resistance: 10 kOhms

DC CURRENT MEASUREMENT

Ranges: 1. 1 pA - 1 mA in 1 range of 9 decades

2. 1 pA - 1 mA in 8 ranges of 2 decades

Scales: 2 logarithmic: Upper - 2 decades
Lower - 9 decades

Accuracy: 5 % of indicated value (within temperature range 15 to 35 degrees C)

Input Resistance: 10 kOhms for Ix > 2 nA

1 MOhm for Ix < 2 nA

Recorder Output: 0.5 V +/- 0.5 % per decade +/- 10 mV

At 10 uA, 0 V +/- 10 mV

Rout = 10 kOhms

MEASURING TIME

Resistance:	<1 sec. with Ix > 10 nA
	<3 sec. with 10 nA > Ix > 1 pA
Capacitors:	Charge: for Cx < 1 uF: ≤ 3 sec.
	for Cx > 1 uF: = Cx (Vtest * 1 kOhm+0.3)
	Discharge: t= 0.1 x Cx (with Vtest falling to 1% of the test value)
	(Cx in uF, t in seconds, Vtest in Volts)
GUARD	GUARD terminal is connected to 0 V line (chassis), but isolated from the GROUND terminal.
POWER REQUIREMENTS	220/115 V, 50 to 60 Hz, 17 VA
DIMENSIONS	
Width:	30 cm (12")
Depth:	33 cm (13 1/4")
Height:	14 cm 5 1/2")
WEIGHT	4.5 kg (9 lbs.)
ACCESSORIES SUPPLIED	Code 805-453 12-pin connector
ACCESSORIES AVAILABLE	Code 807-200 1 pair of component clips
	LMS1 Limit Sensor

2 PRINCIPLES OF OPERATION

2.1 General Description

General

Fig. 2.1 shows a schematic diagram of the IM6 Megohmmeter to which this description refers. The test voltage is fed to the resistor under test, Rx. The current passing through Rx is fed to a logarithmic amplifier I, either directly if the current through Rx exceeds 2 nA, or via an FET current amplifier if less than 2 nA. The choice is made by a limit sensor connected at the output of the log. amp. I, which operates the relays K100 and K101 when the current exceeds 2 nA.

The output of the amp. I results in a voltage V equal to log(Vtest/Rx). A corresponding reference current passing through a reference resistor Rref is applied to a second amplifier II, whose output V2 is equal to log (Vtest/Rref). This results in a difference voltage at the emitter of Q204b equal to V1-V2, which, with Rref= 1, becomes V1-V2 = -log(Rx).

This voltage is then fed via the attenuator/range selector, MULTIPLIER, to the meter which has two scales. One scale covers 9 decades in one range, and the other covers 2 decades in 8 overlapping ranges. Calibration of the IM6 is effected by means of the preset potentiometer, SET to .1.

The value of the test voltage may be selected from 0 to 999 Volts in 1 Volt steps, and facilities are provided for a full-range control of the test voltage by means of an external voltage of either 0 - 10 V or 0 - 100 V, (dc).

A recorder output is provided, which is connected to the output of the amp. II. The output corresponds to an analogue of -0.5 V/decade. The recorder connection is located in the multiconnector on the rear of the instrument.

Controls and Terminals

Refer to figs. 2.1, 2.2 and 2.3.

a) MULTIPLIER switch. This is the range switch for the meter.

b) SET TO .1. Calibration preset potentiometer.

c) POWER. On/off switch with built-in indicator lamp which lights when the supply is turned on.

d) GUARD terminal; is connected to the electronic circuit 0 V line and is isolated from ground.

e) GROUND terminal; is connected to the ground of the line supply. A captive link is provided which must be connected either to the GUARD or to the TEST VOLTAGE terminals.

f) TEST VOLTAGE terminal. The test voltage is connected to this terminal.

g) R-I terminal. Input terminal to input amplifier.

h) Indicator lamp which lights when the TEST VOLTAGE switch is switched on.

i) TEST VOLTAGE switch. Provided to switch the test voltage ON or OFF. (Downwards: non-lock, upwards: lock position).

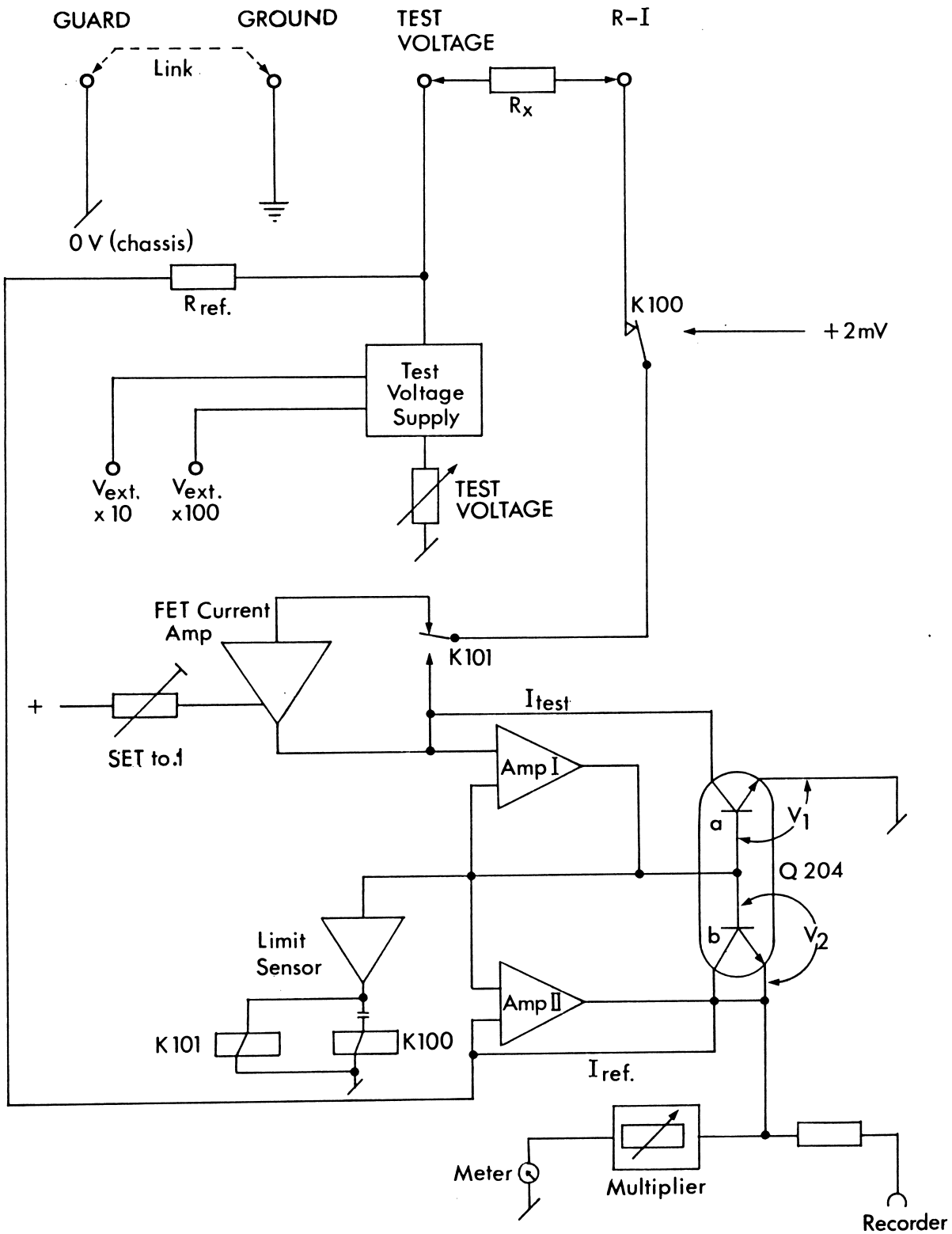


Fig. 2.1 - Schematic diagram of IM6 Megohmmeter

k) INT/EXT. switch. Refers to test voltage selector. When set to INT., switch L is used as test voltage selector. When set to EXT., control of the test voltage value is possible by means of an external supply of either 0-10 V dc or 0-100 V dc.

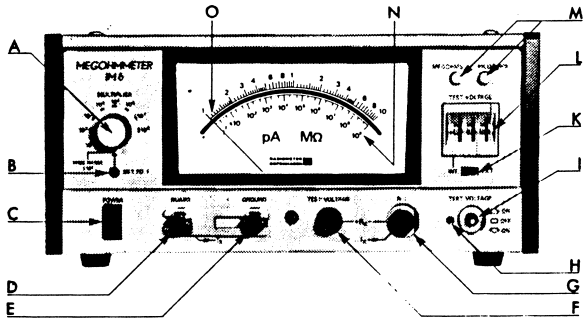


Fig. 2.2 - Front Panel Controls and Terminals

1) TEST VOLTAGE selector; 3-bank thumb-wheel switch with digital display of selected test voltage from 0 to 999 Volts in 1 V steps. This selector is in circuit when the INT/EXT. switch is set to INT.

m) MEGOHMS/PICOAMPS. Pushbutton switch selects the mode of measurements, i.e. resistance or current.

n) Meter scale, 1 GOhm f.s.d., 9 decades in one scale.

o) Meter scale, .1 - 10, 2 decades in one scale.

p) Line fuse: 0.25 A for 115 V, 0.125 A for 220 V.

q) 12-pole multiconnector (J6).

***** Note *****

The voltages given are with reference to 0 V (chassis). With the TEST VOLTAGE terminal grounded via the captive link on the GROUND terminal, the 0 V line (chassis) will be at the test voltage value with respect to ground, i.e. up to -1000 V dc. This applies to any instruments such as recorders etc., which may be connected to the 0 V line (chassis) of the IM6.

Pin 1	0 V
Pin 2	Ground
Pin 3	Ext. test voltage x 100 (0-10 V dc)
Pin 4	Test voltage on
Pin 5	Ext. voltage (max. -15 V dc) for adjustment of ext. limit sensor
Pin 6	Ext. test voltage x 10 (0-100 V dc)

Pin 7	Recorder, 0 V
Pin 8	Recorder, -0.5 V/decade, R2: 10 kOhms
Pin 9	Ext. test voltage indicator lamp, 0 V
Pin 10	Ext. test voltage indicator lamp, -21 V, max. 50 mA
Pin 11	n.c.
Pin 12	n.c.

r) Voltage selector.

s) Power socket.

t) GROUND terminal.

u) Instrument identification and serial number plate.

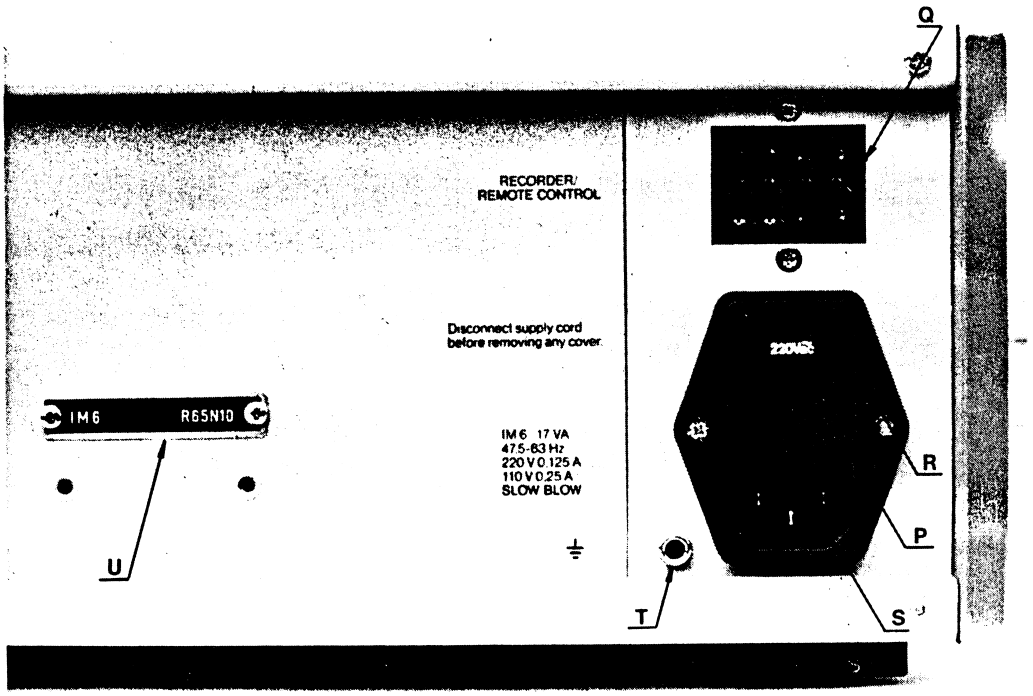


Fig. 2.3 - Rear Panel Controls and Terminals

2.2 Operating Instructions

General

Switching ON

a) Depress the power switch C, Fig. 2.4. The built-in lamp should light when the line supply is turned on.

b) Set the MULTIPLIER to SET TO .1 and, if necessary, adjust the preset potentiometer B, Fig. 2.4, until the meter pointer indicates ".1" on the upper scale.

Measurement of Resistance

a) Depress the MEGOHMS button M, Fig. 2.4.

b) Set the TEST VOLTAGE selector L to the required test voltage and the INT/EXT. switch K to INT.

c) Set the MULTIPLIER A to WIDE RANGE 1 MOhm-1 GOhm.

d) Connect Rx between the TEST VOLTAGE terminal F and the R-I terminal G.

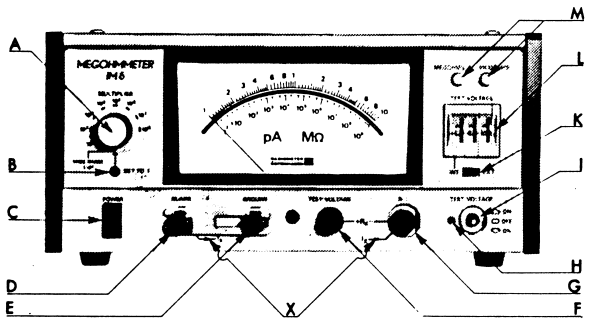


Fig. 2.4 - Front Panel Controls and Terminals

e) Depress the TEST VOLTAGE, ON/OFF switch I to the ON position and note the meter reading. The ON/OFF switch is non-locking in the depressed position and locks in the upper position.

f) Better accuracy can be obtained by switching the MULTIPLIER switch A to the range indicated on the meter scale.

*** Note ***

While the test voltage is current-limited to 2 mA, precaution should be taken at all times not to touch the TEST VOLTAGE terminal, especially at the higher voltage values, when the test voltage is switched ON. This precaution should be especially implemented when capacitors are connected, as voltages on the capacitor, particularly at high capacitance values, may be dangerous.

Measurement of Insulation of Capacitors

The measurement of insulation of capacitors is made in the same manner as for resistors. However, reference should be made to fig. 2.5 to ascertain the limits of the insulation value obtainable. An example is drawn in on fig. 2.4, which shows that with a capacitance of 1 uF the limits of measurable insulation will be approx. 10 GOhms with a test voltage of 10 V. Measurements beyond the limits shown in fig. 2.4 can, of course, be made, but meter fluctuations may make the measurements difficult. These limits apply only to the measurement of insulation on capacitors.

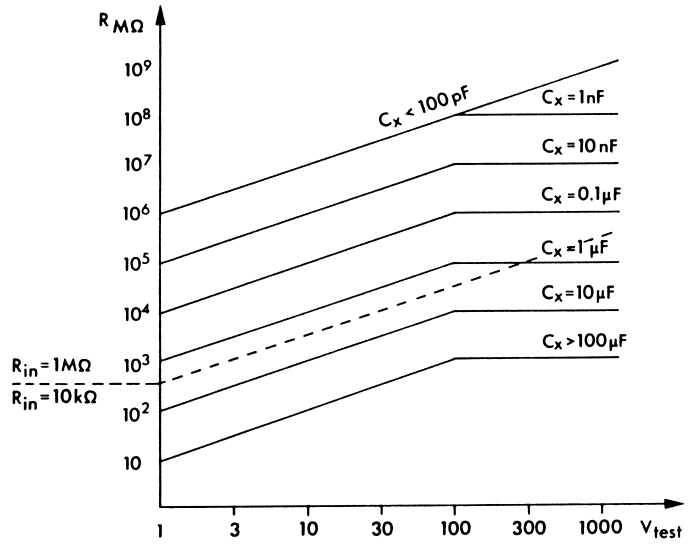


Fig. 2.5 - Range limits when measuring the insulation of capacitors

Measurement of Current

Measurements of small currents may be made within the range 1 pA to 1 mA. Proceed as follows:

a) Depress the PICOAMPS button M.

b) Set the MULTIPLIER to 1 MOhm-1 GOhm.

c) Connect the I between the terminals GUARD and R-I (X in fig. 2.4).

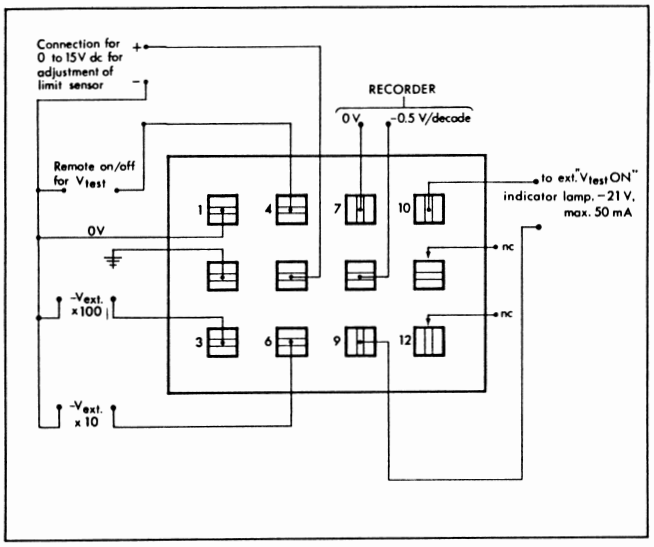


Fig. 2.6 - Rear View of 12-pole Multiconnector when Plugged into IM6

Remote Control and Recorder

The connections for remote control and for the recorder are made in the 12-pole multiconnector as set out below:

Fig. 2.6 shows the tag connections to the 12-pole plug as seen from the rear of the plug.

Pins 1 to 3 (Note 1)	Connection of 0 to -10 V dc will give a full range control of Vtest. Pin 1 is 0 V.
Pins 1 to 6 (Note 1)	Connection of 0 to -100 V dc will give a full range control of Vtest. Pin 1 is 0 V.
Pin 2	GROUND
Pin 4	0 V when the TEST VOLTAGE switch 1 is switched to ON.
Pins 1 to 5	The connection of 0 to 15 V dc can be made to these pins for setting up of a limit sensor connected to the RECORDER connections (pins 7 and 8). (For adjustment, see below "Adjustment of Limit Sensor").
Pins 7 to 8	RECORDER. Pin 7 is 0 V and pin 8 -0.5 V/decade.
Pins 1 to 4	A short-circuit connection between these pins switches on Vtest for remote control operation.
Pins 9 to 10	-21 V dc source for connection to an external TEST VOLTAGE ON indicator lamp. Max. current 50 mA.

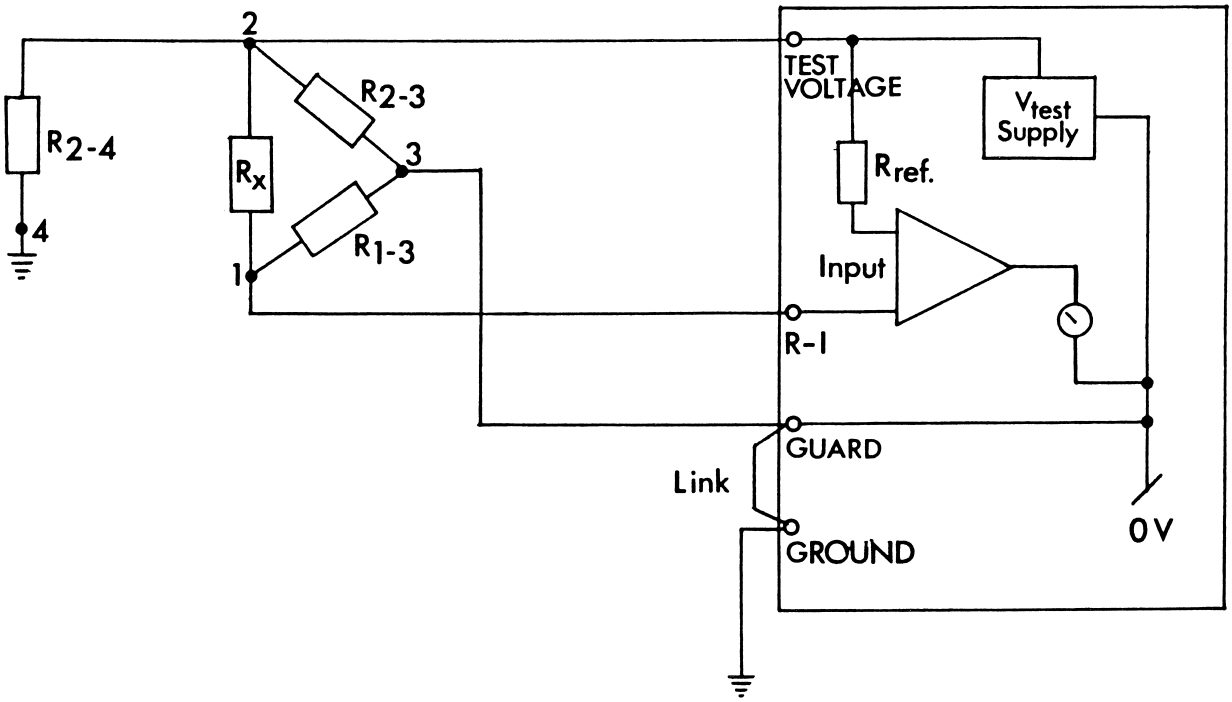


Fig. 2.7 - Guard Circuit Principle

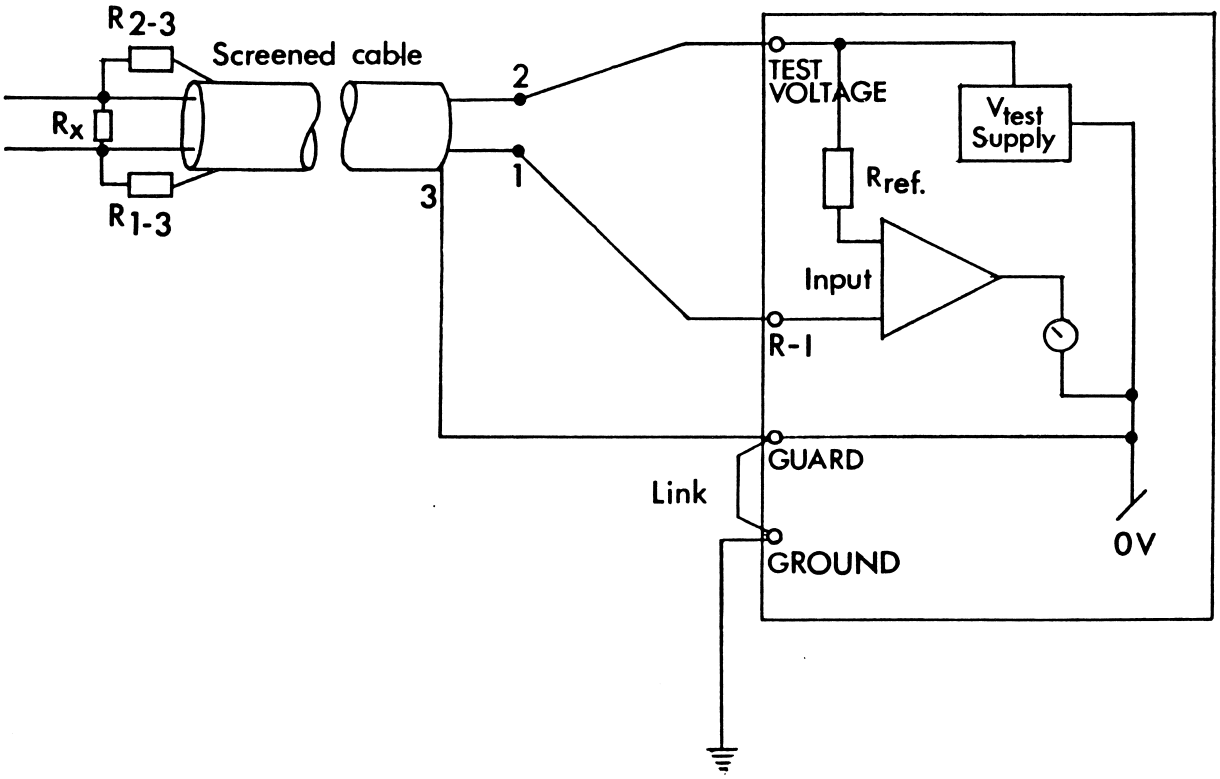


Fig. 2.8 - Guard Circuit - Cable Measurements

Note 1

Where measurements are to be made on capacitors when using these facilities, it is absolutely essential that the external dc supplies be free of noise. It is recommended, therefore, that battery supplies be used.

Pins 1 to 3 with 0 to -10 V should be used when noise is not so critical, for example, when utilizing the remote control facilities of the IM6 for resistance measurements.

Pins 1 to 6 with 0 to -100 V should always be used when noise is critical, for example, when utilizing the remote facilities for measurement of insulation on capacitors.

***** Warning *****

Extreme caution must be exercised when using the IM6 with the TEST VOLTAGE terminal connected to the GROUND terminal. In this condition the 0 V line (chassis) of the IM6 and any other equipment connected via the 12-pole multiconnector will be at the TEST VOLTAGE value with respect to ground (i.e., up to -1000 V dc).

Using the GUARD Facilities

The principle of the GUARD circuit is shown in figs. 2.7 and 2.8.

Fig. 2.7 illustrates a test arrangement for measuring the specific resistance of an insulating material represented by Rx, where the GUARD terminal is connected to point 3, and the captive link on the IM6 is connected between the GROUND and the GUARD terminals. The GUARD facilities are intended to guard against the effects on the insulation measurements of leakage currents along the surface of the material.

Fig. 2.7 shows an equivalence diagram where the leakage currents are represented by the equivalent leakage resistances R2-3, R2-4 and R1-3. It can be seen that R2-3, will, in effect, load the Vtest supply, but this is not important if R2-3 is greater than about 1 MOhm. R1-3 shunts the input, but if its value is not much less than Rx, it will have no influence on the measurements. R2-4 shunts Rx and is in parallel with R2-3. This is of no importance, however, if R2-4 and R2-3 in parallel are greater than about 1 MOhm. If, however, R2-4 and R2-3 in parallel are less than about 1 MOhm, the captive link may be reconnected between the GROUND and the TEST VOLTAGE terminals, which will cancel the effects of R2-4. R2-3, however, will continue to load the test voltage supply and should be greater than about 1 MOhm. Fig. 2.8 shows a further example of the use of the GUARD facilities. This time the measurement is of the leakage between two conductors in a screened cable. It can be seen that in this case, the leakage

resistances R1-3 and R2-3 do not affect the measurements. However, again, R2-3 loads the Vtest supply, but this will be of no importance if it is greater than about 1 MOhm. Likewise, R1-3 will again shunt the input, but will be of no importance if its value is not much less than that of Rx.

Adjustment of Limit Sensor

a) Where a limit sensor is provided with calibrated limits, it is only necessary to adjust these when it is connected to the RECORDER connections of the IM6 (pins 7 and 8).

b) Where the limit sensor is an uncalibrated type, it may be calibrated as follows:

1) Connect a 1 MOhm resistor to the Rx terminals of the IM6.
2) Set the TEST VOLTAGE to 1 V.
3) Connect a variable dc voltage source (preferably from batteries) of 0 to 15 V between pins 1 and 5.
4) Adjust the variable dc voltage source until the METER on the IM6 indicates the value at which the limit sensor is to operate.
5) Connect the limit sensor and adjust this to operate at the value selected in (4).

3 CIRCUIT DESCRIPTION

3.1 Operating Principle

Figure 3.1 shows the operating principle of the IM6 Megohmmeter. Current from the Test Voltage Supply flows through resistor Rx to logarithmic amplifier Log. Amp. I and through reference resistor Rref to logarithmic amplifier Log. Amp. II. The difference between the outputs of the two log amplifiers (Vo) is measured and is equal to log(Rx) when Rref = 1.

$$Vo = \log(Iref) - \log(Ix)$$

$$= \log(Vtest/Rref) - \log(Vtest/Rx)$$

$$= \log(Rx/Rref)$$

for Rref = 1, Vo = log (Rx)

3.2 General Description

Figure 3.2 shows a block diagram of the IM6 Megohmmeter. The test voltage is applied to the resistor under test, Rx. The current through Rx is fed to a logarithmic amplifier - directly if the current through Rx exceeds 2 nA, or via an FET current amplifier if less than 2 nA. The choice is made by a limit sensor connected to the output of Log. Amp. I. The limit sensor actuates relays K100, K101 and K102 when the current exceeds 2 nA.

The output of Log. Amp. I results in a voltage equal to log(Vtest/Rx).

A corresponding reference current passing through a reference resistor, Rref, is applied to a second amplifier, Log. Amp. II, whose output is equal to log(Vtest/Rref).

This results in a difference voltage at the emitter of Q204b which, with Rref = 1, becomes log(Rx).

This voltage is then fed via the attenuator/range selector, MULTIPLIER, to the meter which has two scales. One scale covers 9 decades in one range; the other covers 2 decades in 8 overlapping ranges. Calibration of the IM6 is effected by means of the preset potentiometer, SET TO.1.

The value of the test voltage may be selected from 0 to 999 Volts in 1 V steps, and provision is made for full-range control of the test voltage by means of an external voltage of either 0 - 10 V or 0 - 100 V (dc).

A recorder output is connected to the output of Log. Amp. II. The output corresponds to -0.5 V/decade. The recorder connection is located in the multiconnector at the rear of the instrument.

Circuit Description

The following description refers to the Block Diagram in fig. 3.2 and circuit diagrams 985-010, 985-011 and 985-012 found at the end of this manual.

3.3 Test Voltage Supply

(See diagrams 985-010, 985-012 and Fig. 3.2).

The test voltage supply consists of four parts; a reference voltage source, a regulation amplifier, a driver amplifier and a dc/dc converter.

The reference voltage source is mounted on printed circuit board J3 (diagram 985-010) where a -80 V supply is regulated by gas diode ZZ1000 and passed to a voltage divider consisting of R306, R307, and R308. The output from the voltage divider is fed to the three thumb-wheel switches, S2, TEST VOLTAGE. The switches are connected as decode switches, the outputs of which are fed via the MEGOHMS/PICOAMPS switch and shielded cable W3 to the input of the regulation amplifier (diagram 985-012, print board J2). The regulation amplifier is a wideband, high-impedance amplifier and utilizes the differential amplifier Q400. Zener diode CR400 protects the input of Q400 against transients or overloads. Q400 is dc-coupled to integrated circuit, operational amplifier QA400, whose single-ended output is connected via buffer amplifier Q401 to a driver amplifier consisting of Q301, Q302 and Q303. The output of the driver (emitter of Q303) is connected to the centre tap of the dc/dc converter output transformer, T400. The dc/dc converter consists of the push-pull coupled pair Q402/Q403 which is driven from the 10 kHz multivibrator (Q404 and Q405) and controlled by the magnitude of the voltage from the driver amplifier.

Current limiting of Q402/Q403 is provided by the common emitter resistor R422. Voltage dividers R430/R419 and R424/R423 provide that current limiting commences when the value of Rx causes a load current between 1 and 2 mA. This value is chosen so that the current level of the test voltage will always be well below the lethal level. The output of T400 is connected to a quadrupler rectifier circuit, the output of which is passed to the TEST VOLTAGE terminal via the contacts of test voltage relay K400. Feedback is provided via the resistor chain, R408 to R415, to the input of the regulator amplifier. The 10 kHz multivibrator is conventional and built up around transistors Q404 and Q405.

3.4 Input Amplifier

(See diagram 985-011 and fig. 3.2).

When Rx is connected between the R-I and TEST VOLTAGE terminals and a test voltage is applied, current will flow through Rx. If this current exceeds 2 nA, it flows via R109 and the contacts of relays K100 and K101 to the MOS-FET, Q102. From here it is fed, via zener diode CR100 in the voltage bias circuit and shielded cable W2, to the input of Log. Amp. I. If the current is less than 2 nA, the limit sensor will activate relays K100, K101, and K102. The current amplifier utilizes a differential FET amplifier Q105 which is dc-connected to the integrated operational amplifier QA100. The voltage across R110 and R111 is kept equal - resulting in an amplification of:

$$Ai = (Iout/Iin) = (R111 + R110)/R110 = 40.000$$

Diode-coupled transistors Q103 and Q104 protect the input of the amplifier against transients and overloads.

If the amplifier input should become negatively charged, the output will go positive.

Q106 and CR103 will then conduct, and the negative charge will be removed. Q100 and Q101 provide a current bias to the MOS-FET which ensures that the reciprocal conductance 1/gm is always less than the value of R110. This is mandatory to achieve a fast response. The present potentiometer R1 (SET TO .1) provides a means of calibrating the instrument. The supply voltage for Q102 is derived from a floating voltage bias circuit consisting of a doubler rectifier (CR101/CR102, C104/C105, C101/C103 and CR100). The voltage supply for the rectifier is taken from an auxiliary winding (6-7) on transformer T300 (see diagram 985-010, reference voltage supply, printed circuit board J3). Adequate dc isolation of the circuit is achieved by means of styroflex capacitors C104 and C105. Itest is fed from Q102/CR100 via cable W2 to Log. Amp. I.

3.5 Logarithmic Amplifiers I and II

(See diagram 985-011 and fig. 3.2).

Log. Amp. I utilizes a logarithmic element, Q204, which is connected in a complex feedback loop across a unity gain amplifier consisting of Q201, QA200 and Q202/Q203.

The input of the unity gain amplifier is the gate of Q201, and the output is the collector of Q202, to which a feedback network consisting of R219/R227, R217/C203/C204 and Q204 is connected.

Log. Amp. II consists of Q204, Q205, QA201 and Q207, where Q204 is the logarithmic element. The input to Log. Amp. II is the current through Rref (R221 to R224). The output is taken from the emitter of Q207 and fed to the meter circuit via the MULTIPLIER. The output to the recorder connection is also taken from this point.

3.6 Limit Sensor

(See diagram 985-011 and fig. 3.2).

When Itest is less than 2 nA, the limit sensor energizes relays K100, K101 and K102 - thereby connecting the current amplifier into the circuit. The limit sensor is built up around integrated circuit, operational amplifier QA202 and is mounted on printed circuit board J4. R253 is preset so that the output of QA202 goes positive when a current of 2 nA is fed to the input of the instrument.

To ensure that the limit sensor does not switch out with short duration noise or transients, a time-dependent hysteresis is included in the circuit. C212 and R249 from the hysteresis time constant circuit, and R257 provides for adjustment of the time-dependent hysteresis. If Itest exceeds 2 nA, K100 will be momentarily activated. (K100 is provided to prevent instability when measuring capacitor insulation). K101 and K102 will release after a short time delay, where after K100 will also release. Itest will then bypass the current amplifier.

3.7 Meter Circuit

The output voltage from the emitter of Q207 is fed via the attenuator/ range switch, MULTIPLIER, to the meter circuit (see diagram 985-010, printed circuit board J4, etc.).

The connection for the recorder output is taken from this point via R246 (J4) - the output corresponding to 0.5 V/decade. The RECORDER terminals are pins 7 (0 V line) and 8 of the 12-pole multiconnector J6 mounted on the rear panel of the instrument.

3.8 Power Supply

(See diagram 985-010).

The power supply circuit is mounted on printed circuit board J1 and is conventional in operation. It utilizes a rectifier bridge, CR503, the output of which is an unregulated +21 V/0 V/-21 V supply. Each half of this supply is fed via a series regulator, Q501 and Q504, to provide a regulated +12 V/0 V/-12 V supply. Q501 is driven by Q502 and integrated circuit, operational amplifier QA501. R513 provides for adjustment of the +12 V supply. Q504 functions in a manner similar to Q501 and is driven by Q503 and QA502. In this case, the regulated +12 V supply is used as a reference. Zener diodes CR504 and

CR505 provide a regulated supply to operational amplifiers QA501 and QA502, respectively.

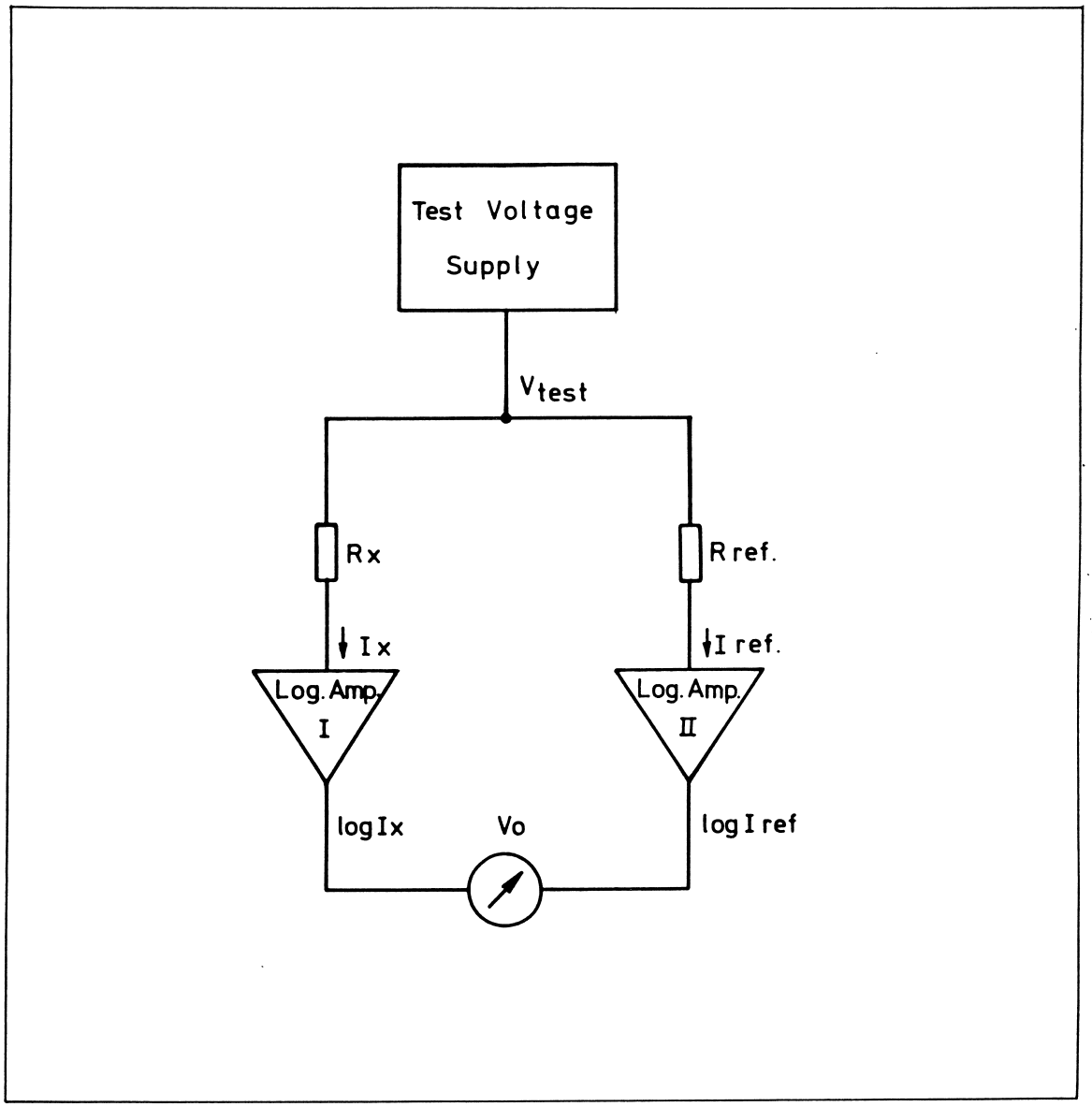


Fig. 3.1 - Operating Principle

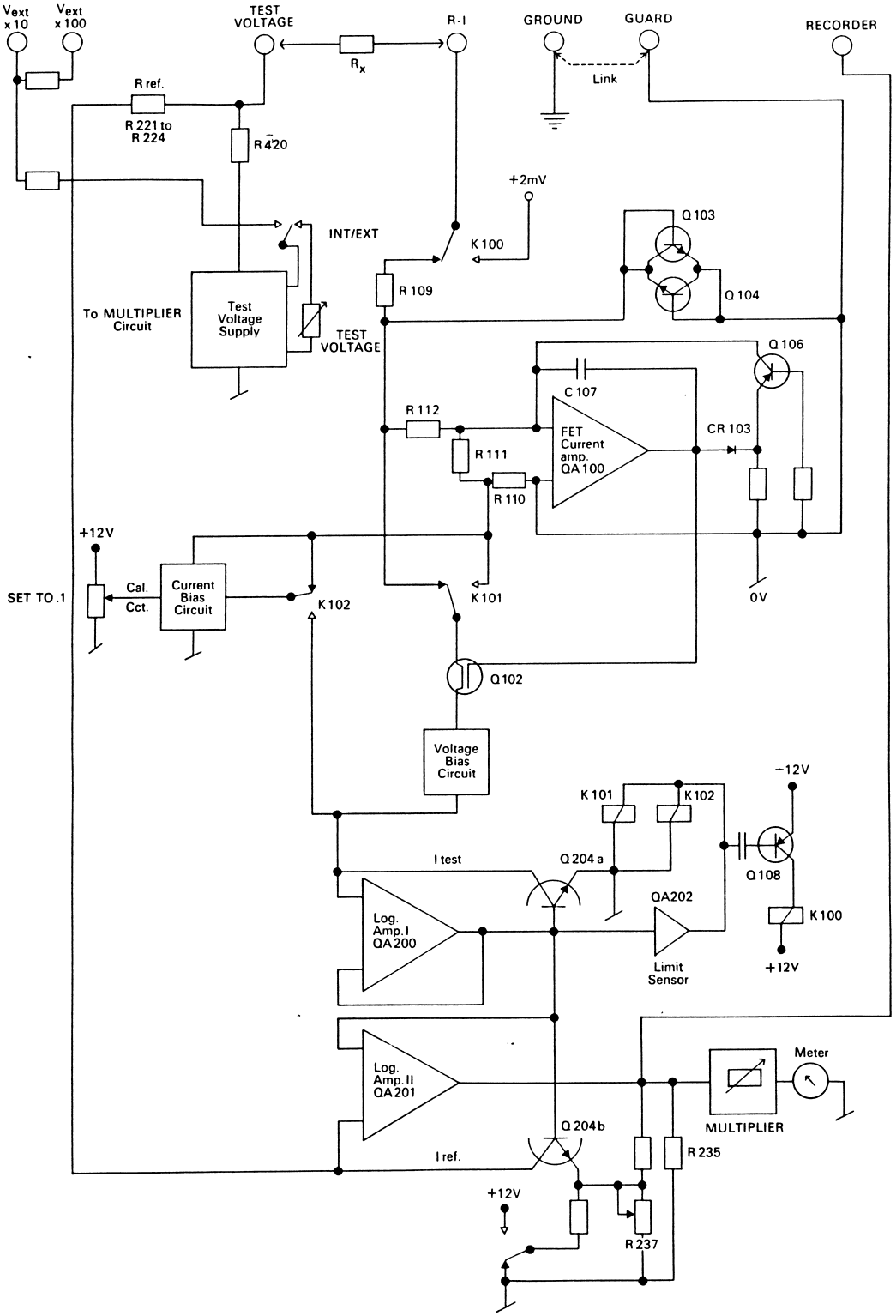


Fig. 3.2 - Block Diagram of Megohmmeter IM6

4 MAINTENANCE

4.1 Dismantling and Reassembly

Unscrew the 4 screws situated in the corners on the back of the IM6. The top and bottom as well as the sides can now be removed.

When the top and bottom plates are removed, the screws which hold the print board cover can be unscrewed and the print boards unplugged.

The TEST VOLTAGE thumb-wheel switches are held in place by spring clips and can be pressed out through the front plate. Do not press the thin terminal plates, since they are easily cracked.

4.2 Short Check Procedure

This check serves to test the most important functions using only simple equipment. If the check proves positive, the IM6 is probably in working order. To test all functions and tolerances, however, it is necessary to carry out the full length performance check described in 4.3.

Necessary Equipment

Resistor, 1 GOhm

Battery, 1.5 V
(mA meter, 0 to 1 mA).

The accuracy of the following resistance measurement depends primarily upon the accuracy of the 1 GOhm resistor. Added to this is the accuracy of the IM6 itself which is 5% of the measured value.

The accuracy of the voltage measurement is determined by the accuracy of the battery voltage and of resistor R109 which is 5%. Added to this is the accuracy of the IM6 which again is 5% of the measured value.

By connecting a mA meter between the 1.5 V battery and screw terminal R-I, the current can be checked directly. In this way, the tolerances of the battery voltage and resistance of R109 are rendered meaningless. The accuracy is now dependent on the mA meter and, of course, the accuracy of the IM6 which is 5% of the measured value.

Short Check Procedure

1) Set the toggle switch to OFF.
2) Connect the GUARD and GROUND screw terminals with the terminal strap.

3) Connect GROUND to ground.
4) Set the MULTIPLIER switch to WIDE RANGE.
5) Depress the MEGOHMS button.
6) Check the meter's mechanical zero point.
7) Set the thumb-wheel switches to 003.
8) Set the INT./EXT. switch to INT..
9) Set the MULTIPLIER switch to SET TO .1.
10) Check to see that the slotted potentiometer can adjust the IM6 reading to .1.
11) Set the MULTIPLIER switch to WIDE RANGE.
12) Connect a 1 GOhm resistor between screw terminals R-I and TEST VOLTAGE.
13) Set the toggle switch to ON (upward).
14) Check to see that the red TEST VOLTAGE lamp lights.
15) Check to see that the IM6 reads 10^3.
16) Set the MULTIPLIER switch to 10^4.
17) Check to see that the IM6 reads .1.
18) Set the MULTIPLIER switch to 10^3.
19) Check to see that the IM6 reads 1.
20) Set the MULTIPLIER switch to 10^2.
21) Check to see that the IM6 reads 10.
22) Set the thumb-wheel switches to 001.
23) Check to see that the IM6 reads 10. (It takes approx. 2 seconds for the relay to actuate).
24) Depress the PICOAMPS button.
25) Check to see that the red TEST VOLTAGE lamp goes out.
26) Remove the 1 GOhm resistor from the R-I and TEST VOLTAGE screw terminals.
27) Set the MULTIPLIER switch to 10^8.
28) Connect a 1.5 V battery between screw terminals GROUND and R-I with the plus side on R-I.
29) Check to see that the IM6 reads 1.5.

(The current of approx. 0.15 mA can be directly measured by inserting a mA meter in series with the battery. If a larger current is desired, the battery voltage can be increased to as much as 10 V at which point the IM6 should read approx. 10).

4.3 Performance Check

The purpose of this procedure is to check every function and tolerance. If all points prove positive, the IM6 is in proper working order. It is not necessary to remove the apparatus from its case.

Necessary Equipment

1) Voltmeter, 0.01 to 1000 V dc +/- 1% Ri $\geq$ 10 MOhms
2) Voltage source, 1 to 100 V dc +/- 2%, internal impedance Ri < 5 kOhms
3) Voltage source, 1 mV to 1000 mV dc +/- 1% Ri 0 Ohm

4) Resistor, 10 kOhms +/- 1%
5) Resistor, 90 kOhms +/- 1% -Ri, where Ri = the internal resistance of the voltage source
6) Resistor, 0.99 MOhm +/- 1%
7) Resistor, 1.00 MOhm +/- 1%
8) Resistor, 1.11 MOhms +/- 1%
9) Resistor, 10 MOhms +/- 1% the tolerance is valid up to 100 V
10) Resistor, 100 MOhms +/- 1%
11) Resistor, 1 GOhm +/- 1%
12) Resistor, 10 GOhms +/- 1%
13) Resistor, 1 TOhm +/- 1 % - the tolerance is valid up to 10 V

When using the two largest resistors (10 GOhms and 1 TOhm) it is necessary that these resistors be placed within a metal screen which should be connected to the GUARD terminal of the IM6. (Fig. 4.3 shows the dimensions of a suitable screen). All external power leads etc., must be kept well away from the IM6, which must be adequately grounded.

Test Voltage Check

1) Connect the GUARD and GROUND screw terminals with the terminal strap.
2) Connect a voltmeter between the TEST VOLTAGE and GUARD screw terminals.
3) Depress the MEGOHMS button.
4) Set the MULTIPLIER switch to WIDE RANGE.
5) Set the INT./EXT. switch to INT..
6) Set the TEST VOLTAGE toggle switch to ON (upward).
7) Check the TEST VOLTAGE thumb-wheel switches according to the following table:

Switch Position	Voltmeter Reading
001	0.96 to 1.04 V
002	1.92 to 2.08
004	3.84 to 4.16
008	7.68 to 8.32
010	9.6 to 10.4
020	19.2 to 20.8
040	38.4 to 41.6
080	76.8 to 83.2
100	96 to 104
200	192 to 208
400	384 to 416
800	768 to 832
999	959 to 1039

8) Set the TEST VOLTAGE thumb-wheel switches to 000.

EXT. TEST VOLTAGE * 10

9) Set the TEST VOLTAGE toggle switch to OFF.
10) Connect a -10 V source to terminals J6/1 (0 V) and J6/6 (-Vext * 10) on the RECORDER/REMOTE CONTROL socket.
11) Set the INT./EXT. switch to EXT..
12) Set the toggle switch to ON (upward).
13) Check to see that the voltmeter reads 95.8 to 103.8 V.

EXT. TEST VOLTAGE * 100

14) Set the TEST VOLTAGE toggle switch to OFF.
15) Move the voltage source wire from terminal J6/6 to terminal J6/3 (-Vext * 10).
16) Set the toggle switch to ON (upward).
17) Check to see that the voltmeter reads 949 to 1028 V.
18) Remove the voltmeter.
19) Remove the voltmeter source.

EXT. TEST VOLTAGE and Indicator Lamp

20) Connect a voltmeter between terminals J6/9 and J6/10 on the RECORDER/REMOTE CONTROL socket.
21) Check to see that the voltmeter reads approximately -21 V and that the indicator lamp on the front panel lights when the toggle switch is in the two ON positions.
22) Set the toggle switch to OFF.
23) Check to see that the voltmeter reads 0 V and that the indicator lamp is out.

Vtest Remote Control Switch

24) Short terminals J6/4 and J6/1 on the RECORDER/REMOTE CONTROL socket.
25) Check to see that the voltmeter reads approximately -21 V and that the indicator lamp on the front panel remains lit regardless of the position of the toggle switch.
26) Set the MULTIPLIER switch to SET TO .1.
27) Check to see that the voltmeter reads 0 V and that the indicator lamp on the front panel is out.
28) Set the toggle switch to OFF.
29) Remove the voltmeter and the short across terminals J6/4 and J6/1.

Scale Reading Deviation with External Bias Voltage for Adjusting an External Limit Sensor

30) Connect a 100 MOhm resistor +/- 1% between screw terminals R-I and TEST VOLTAGE.
31) Set the MULTIPLIER switch to WIDE RANGE.
32) Set the thumb-wheel switches to 100.

33) Check the mechanical zero point on the meter of the IM6.
34) Set the toggle switch to ON (upward).
35) Check to see that the IM6 reads 100 MOhms +/- 4.5 MOhms.
36) Set the MULTIPLIER switch to 10^2.
37) Check to see that the IM6 reads 0.955 to 1.045.
38) Connect a 1 V +/- 5% voltage source to the RECORDER/REMOTE CONTROL socket with - to terminal J6/1 and + to terminal J6/5.
39) Check to see that the IM6 reading deviates 0.6 to 0.8 decades from 1.
40) Remove the 1 V source.

The Resistance Measurement and its Independence of the TEST VOLTAGE

41) Connect a voltmeter to terminals J6/7 (0 V) and J6/8 (-0.5 V/ decade) on the RECORDER/REMOTE CONTROL socket.
42) Set the TEST VOLTAGE thumb-wheel switches to 001, 009, 099, 499 and 999, and check to see that the IM6 reads 0.955 to 1.045 and that the voltmeter reads -985 to -1015 mV.
43) Set the TEST VOLTAGE toggle switch to OFF.
44) Set the MULTIPLIER switch to 10.
45) Remove the 100 MOhm resistor connected to the R-I and TEST VOLTAGE terminals, and connect in its place a resistor of 0.99 MOhm +/- 1%.
46) Set the toggle switch to ON (upward).
47) Set the TEST VOLTAGE thumb-wheel switches to 001, 009, 099, 499 and 999, and check to see that the IM6 reads 0.0955 to 0.1045 and that the voltmeter reads -10 to +10 mV.
48) Set the TEST VOLTAGE toggle switch to OFF.
49) Set the MULTIPLIER switch to 10^4.
50) Remove the 0.99 MOhm resistor connected to screw terminals R-I and TEST VOLTAGE, and connect a 10 GOhm resistor in its place.
51) Set the toggle switch to ON (upward).
52) Set the TEST VOLTAGE thumb-wheel switches to 001, 009, 099, 499 and 999, and check to see that the IM6 reads 0.955 to 1.045 and that the voltmeter reads -1980 to -2020 mV.
53) Set the toggle switch to OFF.
54) Set the MULTIPLIER switch to 10^6.
55) Remove the 10 GOhm resistor connected to screw terminals R-I and TEST VOLTAGE, and connect a 1 TOhm resistor in its place.
56) Set the toggle switch to ON (upward).
57) Set the thumb-wheel switches to 001 and 009, and check to see that the IM6 reads 0.955 to 1.045 and that the voltmeter reads -2970 to -3030 mV.
58) Set the toggle switch to OFF.
59) Remove the 1 TOhm resistor.

Input Resistance for a Current > 3000 pA

60) Depress the PICOAMPS button.
61) Connect a voltage source of 1 V +/- 2% with - to the GUARD terminal and + to the R-I terminal in series with a 10 kOhm +/- 1% resistor.
62) Set the MULTIPLIER switch to 10^7.
63) Check to see that the IM6 reads 4.65 to 5.15.

Input Resistance for a Current < 3000 pA

64) Replace the 1 V source with the millivoltage source.
65) Set the millivoltage source at 10 mV.
66) Replace the 10 kOhm resistor with a 10 MOhm +/- 1% resistor.
67) Set the MULTIPLIER switch to 10^2.
68) Check to see that the IM6 reads 8.5 to 9.7.

MULTIPLIER Switch and RECORDER/REMOTE CONTROL Output
(See figure 4.2 and the table in step 77).

69) Set the voltage source to 100 V +/- 2%.
70) Remove the 10 MOhm resistor, and replace it with a resistor of 90 kOhm - Ri, where Ri is equal to the internal resistance of the voltage source. (This should result in a nominal current of 10^9 pA, since the IM6 has an internal resistanc e of 10 kOhms).
71) Set the MULTIPLIER switch to SET TO .1.
72) Adjust the slotted potentiometer SET TO .1 so that the IM6 reads .1.
73) Set the MULTIPLIER switch to WIDE RANGE.
74) Check to see that the IM6 reads 10^9.
75) Set the MULTIPLIER switch to 10^8.
76) Check to see that the Im6 reads 9.55 to 10.45 and that the voltmeter reads +0.985 to +1.015.
77) Remove the 90 kOhm (90 kOhm - R) resistor, and check the IM6 according to fig. 4.2 and the following table.
78) Remove resistors R1, R2, and R3 and the voltage source.
79) Remove the voltmeter connected to terminals J6/7 and J6/8 on the RECORDER/REMOTE CONTROL socket.

Insulation between GUARD and GROUND

80) Connect the terminal strap across GUARD and TEST VOLTAGE instead of across GUARD and GROUND.
81) Connect a 100 MOhm +/- 1% resistor across screw terminals R-I and TEST VOLTAGE.
82) Set the MULTIPLIER switch to 10^2.
83) Depress the MEGOHMS button.
84) Set the TEST VOLTAGE thumb-wheel switches to 999.
85) Set the toggle switch to ON (upward).

86) Wait 5 minutes, then check to see that the IM6 reads 0.995 to 1.045.
87) Set the toggle switch to ON (upward).
88) Move the terminal strap back to its original position between GUARD and GROUND.
89) Set the toggle switch to ON.
90) Check to see that the IM6 gives the same reading as that obtained in step 86.
91) Set the toggle switch to OFF, and remove the 100 MOhms resistor.

TABLE 1

I_{nom} pA	DIVIDER RESISTANCES R1 Ω	R2 Ω	R3 Ω	VOLTAGE SOURCE OUTPUT (Volts)	Position of the MULTIPLIER switch	Scale readings of IM6	Voltmeter readings (terminals J6/7 - J6/8)
10^9	0	90 k	∞	100	WIDE RANGE	10^9 ±1 mm	
10^9	0	90 k	∞	100	10^8	9.55 -10.45	+0.985 - +1.015
10^8	0	0.99 M	∞	100	WIDE RANGE	10^8 ±1 mm	
10^8	0	0.99 M	∞	100	10^7	9.55 -10.45	+0.488 - +0.512
10^7	0	10 M	∞	100	WIDE RANGE	10^7 ± 1 mm	
10^7	0	10 M	∞	100	10^6	9.55 -10.45	-0.010 - +0.010
10^6	0	100 M	∞	100	WIDE RANGE	10^6 ±1 mm	
10^6	0	100 M	∞	100	10^5	9.55 -10.45	-0.483 - -0.512
10^5	0	1 G	∞	100	WIDE RANGE	10^5 ±1 mm	
10^5	0	1 G	∞	100	10^4	9.55 -10.45	-0.985 - -1.015
10^4	0	10 G	∞	100	WIDE RANGE	10^4 ±1 mm	
10^4	0	10 G	∞	100	10^3	9.55 -10.45	-1.483 - -1.517
10^3	10 M	10 G	1.11 M	100	WIDE RANGE	10^3 ±1 mm	
10^3	10 M	10 G	1.11 M	100	10^2	9.55 -10.45	-1.980 - -2.020
10^2	0	1 T	∞	100	WIDE RANGE	10^2 ±1 mm	
10^2	0	1 T	∞	100	10	9.55 -10.45	-2.478 - -2.522
10	10 M	1 T	1.11 M	100	WIDE RANGE	10 ±1 mm	
10	10 M	1 T	1.11 M	100	10	0.955 -1.045	-2.975 - -3.025

TABLE 1 (cont'd.)

I_{nom} pA	DIVIDER RESISTANCES			VOLTAGE SOURCE OUTPUT (Volts)	Position of the MULTIPLIER switch	Scale readings of IM6	Voltmeter readings (terminals J6/7 - J6/8)
	R1 Ω	R2 Ω	R3 Ω				
1000	0	1M	∞	1.0	10^5	9.55 - 10.45	-0.488 - -0.512
900	0	1M	∞	0.9	10^5	8.60 -9.40	-0.508 - -0.538
800	0	1M	∞	0.8	10^5	7.64 -8.36	-0.534 - -0.564
700	0	1M	∞	0.7	10^5	6.69 -7.31	-0.563 - -0.593
600	0	1M	∞	0.6	10^5	5.73 -6.27	-0.596 - -0.626
500	0	1M	∞	0.5	10^5	4.78 -5.22	-0.635 - -0.665
400	0	1M	∞	0.4	10^5	3.82 -4.18	-0.685 - -0.715
300	0	1M	∞	0.3	10^5	2.87 -313	-0.747 - - 0.777
200	0	1M	∞	0.2	10^5	1.191 -2.09	-0.835 - -0.865
100	0	1M	∞	0.10	10^5	0.955 -1.04	-0.985 - -1.015
90	0	1M	∞	0.09	10^5	0.860 -0.940	-1.006 - -1.040
80	0	1M	∞	0.08	10^5	0.764 -0.836	-1.032 - -1.066
70	0	1M	∞	0.07	10^5	0.669 -0.731	-1.061 - -1.095
60	0	1M	∞	0.06	10^5	0.573 -0.627	-1.094 - -1.128
50	0	1M	∞	0.05	10^5	0.478 -0.522	-1.133 - -1.167
40	0	1M	∞	0.04	10^5	0.382 -0.418	-1.183 - -1.217
30	0	1M	∞	0.03	10^5	0.287 -0.313	-1.245 - -1.279
20	0	1M	∞	0.02	10^5	0.191 -0.209	-1.333 - -1.367
10	0	1M	∞	0.01	10^5	0.096 -0.104	-1.483 - -1.517

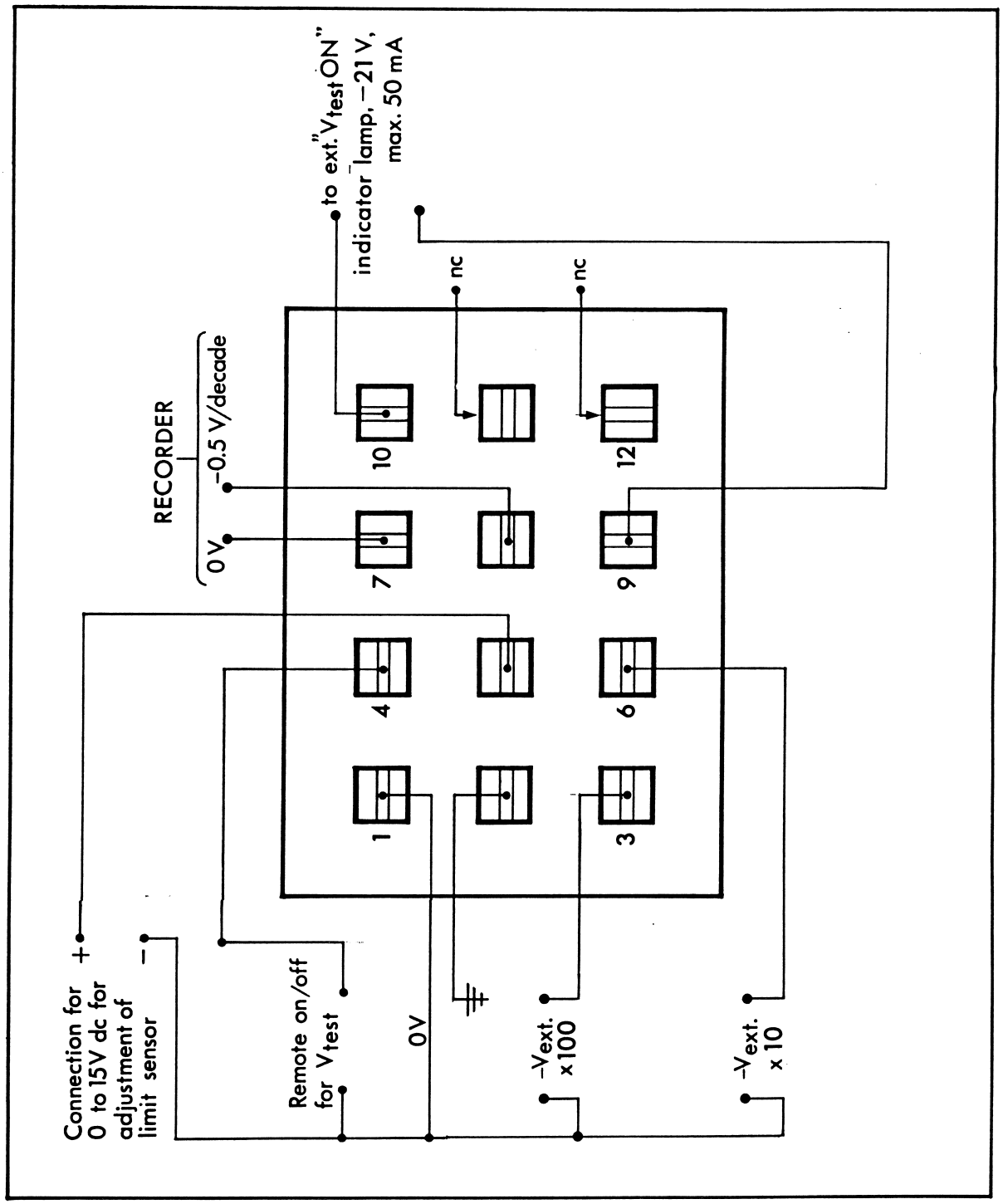


Fig. 4.1 - Rear View of the RECORDER/REMOTE CONTROL Socket

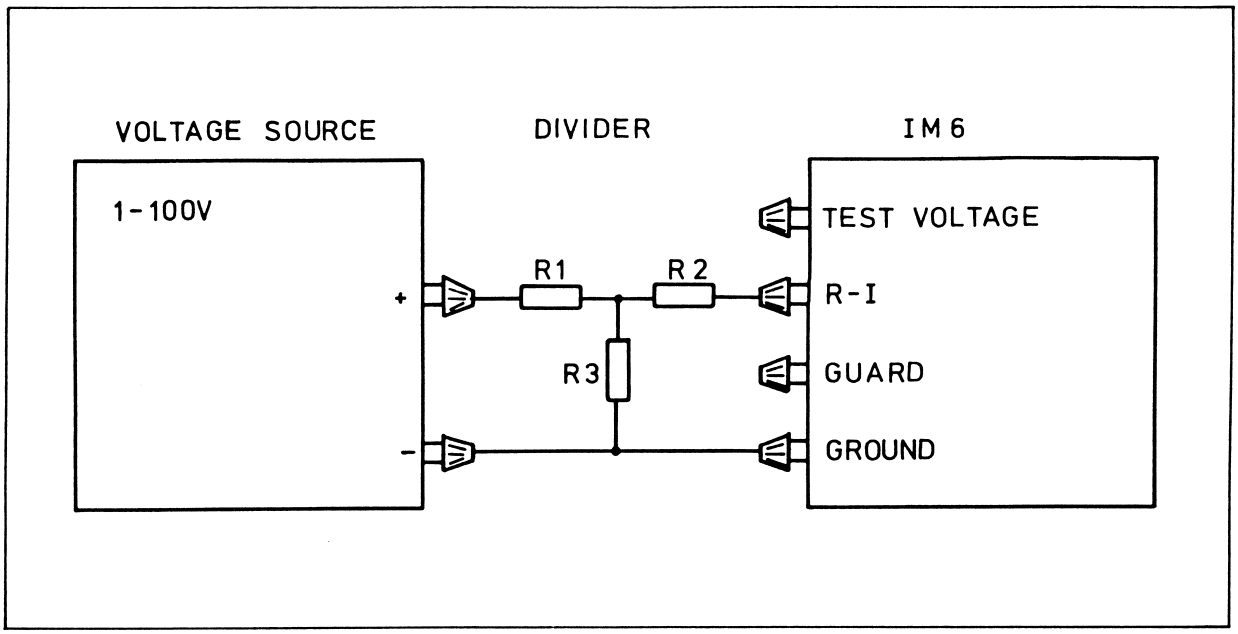


Fig. 4.2 - Set-up for Diode of MULTIPLIER Switch

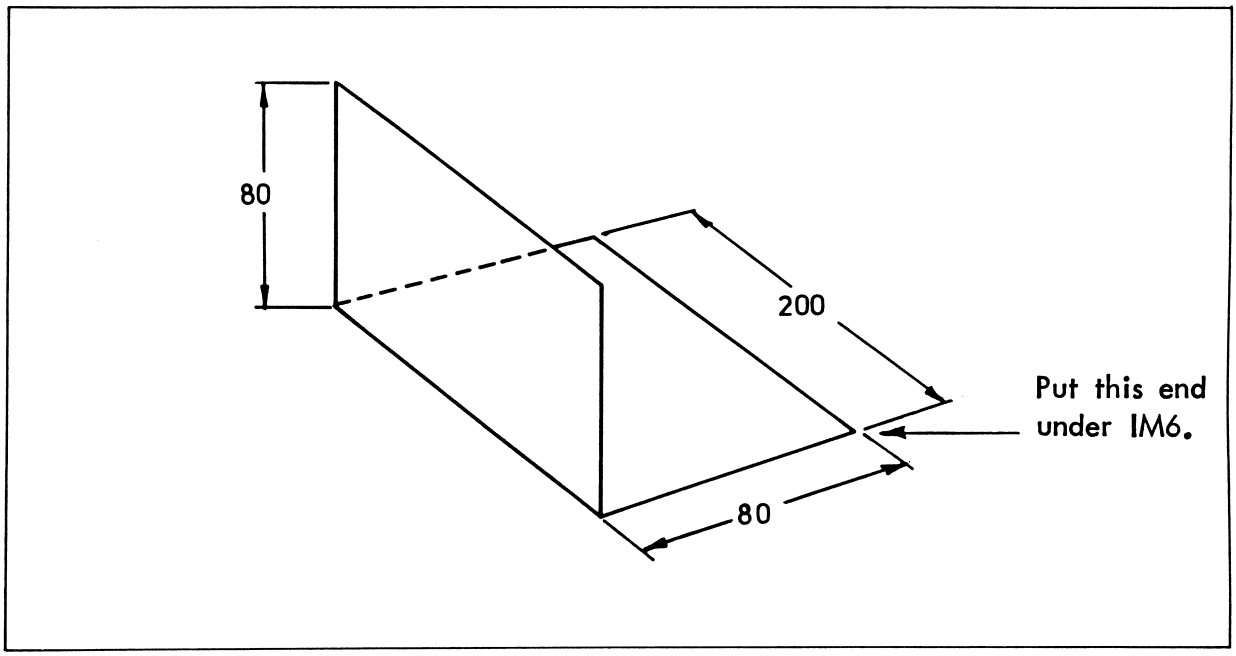


Fig. 4.3 - Screen Plate for Use under Check with Resistors > 1 GOhm

5 TROUBLESHOOTING

5.1 Troubleshooting

If the performance check proves negative, a realignment is required. After realignment, the entire performance check must be carried out again.

If realignment proves impossible, a defect is indicated. Try replacing the print boards one at a time, and in this way localize the trouble. If the fault lies in one print board, it is easiest to put in a new one and readjust the entire IM6 according to the realignment procedure. The defective print board can then be sent to RE INSTRUMENTS for repair.

If replacement print boards are not available, it may still be possible to localize the trouble by measuring voltages on the print board connections and comparing them with the typical voltages given below:

Typical Transistor Voltages in V dc

Short circuit the terminals GUARD and GROUND.

Short circuit the terminals TEST VOLTAGE and R-I.

Set the switch MULTIPLIER at position WIDE RANGE.

Push the button MEGOHMS.

Set the thumb-wheel TEST VOLTAGE at 000.

Set the toggle switch TEST VOLTAGE in position ON.

See table page 2.

5.2 Adjustments

Necessary Equipment

DC-Voltmeter

Accuracy better than +/- 0,1%.
Resolution: 10μ V.

NB: Be aware that some DVM's can inject noise to the IM6.

	collector (drain)	base (gate)	emitter (source)
Q100	0.0	- 7.7	- 8.1
Q101	0.0	+ 7.7	+ 8.1
Q102	- 8.7	- 1.8	- 0.8
Q103	0.0	0.0	0.0
Q104	0.0	0.0	0.0
Q105A	+ 6.7	0.0	+ 0.4
Q105B	+ 6.7	0.0	+ 0.4
Q106	0.0	0.0	0.0
Q107	- 12.0	+ 12.0	+ 12.0
Q108	+ 12.0	- 12.0	- 12.0
Q109	+ 12.0	- 12.0	- 12.0
Q200	+ 5.5	+ 9.1	+ 9.8
Q201A	+ 5.5	+ 0.3	- 0.9
Q201B	+ 5.5	+ 0.3	- 0.9
Q202	+ 0.55	+ 0.3	- 0.3
Q203	- 1.6	- 1.0	- 0.3
Q204A	+ 0.44	+ 0.38	0.0
Q204B	+ 0.38	+ 0.38	+ 0.33
Q205A	+ 5.5	+ 0.38	+ 1.8
Q205B	+ 5.5	+ 0.38	+ 1.8
Q206	+ 1.8	0.0	- 0.6
Q207	+ 1.8	0.0	- 0.6
Q208	0.0	- 2.3	0.0
Q300	0.0 (8.5 ac)	- 12.0	- 10.5
Q301	+ 24.5	- 9.0	- 9.6
Q302	- 10.0	+ 24.5	+ 24.5
Q303	+ 24.5	- 10.0	- 10.5
Q400A	+ 6.2	0.0	+ 0.9
Q400B	+ 6.2	0.0	+ 0.9
Q401	+ 12.0	- 8.4	- 9.0
Q402	- 7.0	- 10.5	- 11.0
Q403	- 7.0	- 10.5	- 11.0
Q404	- 9.0 (1.6 ac)	- 11.3	- 11.0
Q405	- 9.0	- 11.3	- 11.0
Q501	+ 12.0	+ 23.0	+ 23.5
Q502	+ 23.0	+ 2.8	+ 2.25
Q503	- 21.0	- 3.8	- 3.3
Q504	- 12.0	- 21.0	- 21.5

Resistor:	0.99 MOhm +/- 0.5%	1 - 1000 V See remarks in section 4, page 3 concerning screening of resistor
Resistor:	100 MOhms +/- 1%	
Resistor:	1 GOhm +/- 1%	
Resistor:	10 GOhms +/- 1%	

(See figure 5.1 for trimmer and terminal positions).

Before realignment is attempted, the IM6 must have warmed up for a few hours, and a ground wire must be connected. All wires connected to the R-I and TEST VOLTAGE screw terminals must be as short as possible.

If the IM6 has been dismantled, the IM6 must be remounted with bottom plate, side plates and back plate. The top plate may be absent if not otherwise specified. Take care that the screen cable W1 (with the plug I100) does not touch the back plate.

Realignment Procedure

1) Connect a DC-voltmeter to print board terminal J1/A6 and to the GUARD (0 V) screw terminal.
2) Depress the PICOAMPS button.
3) Set the MULTIPLIER switch to WIDE RANGE.
4) Adjust trimmer R513 so that the DC-voltmeter reads +12 V +/- 12 mV.
5) Move the DC-voltmeter wire from print board terminal J1/A6 to J2/C16.
6) Adjust trimmer R305 so that the DC-voltmeter reads 10 V +/- 20 mV.
7) Remove the DC-voltmeter.
8) Connect a 1 GOhm resistor between the TEST VOLTAGE and R-I screw terminals.
9) Set the INT./EXT. switch to INT..
10) Set the TEST VOLTAGE thumb-wheel switches to 010.
11) Set the TEST VOLTAGE toggle switch to ON (upward).
12) Depress the MEGOHMS button.
13) Turn trimmer R253 fully clockwise.
14) Turn trimmer R257 fully counter clockwise.
15) Connect a DC-voltmeter to the R-I and GUARD screw terminals.
16) Protect the input amplifier against light by means of the top plate placed with the inner side up. Connect the top plate to ground.
17) Adjust trimmer R118 so that the DC-voltmeter reads 0 V +/- 0.1 mV.
18) Move the DC-voltmeter wire from screw terminal R-I to print board terminal J5/C8.
19) Adjust trimmer R121 so that the DC-voltmeter reads -0.2 V +/- 10 mV.
20) Repeat the adjustment of R118 and R121 (points 15 to 18).
21) Remove the DC-voltmeter, the 1 GOhm resistor and the top plate.
22) Set the IM6 to WIDE RANGE and MEGOHMS.
23) Connect a 10 GOhms resistor between the TEST VOLTAGE and the R-I screw terminals.

24) Set the TEST VOLTAGE thumb-wheel switches to 012 (12V) and set the TEST VOLTAGE switch ON.
25) Adjust R253 slowly counter clockwise until the relays click.
26) Set the TEST VOLTAGE thumb-wheel switches to 022 (22V).
27) Adjust R257 slowly clockwise until the relays click again.
28) Repeat from step 24 a few times.
29) Connect the DC-voltmeter to print board terminals J4/C26 (LOW) and J4/C28 (HIGH).
30) Connect a 1 GOhm +/- 1% resistor to the TEST VOLTAGE and R-I screw terminals.
31) Depress the MEGOHMS button.
32) Set the thumb-wheel switches to 001 and further to 003. The relays will now click.
33) Adjust trimmer R203 so that the DC-voltmeter reads 0 V +/- 5 mV.
34) As in step 32.
35) If the DC-voltmeter now reads outside +/- 5 mV, repeat from step 32.
36) Remove the 1 GOhm resistor and the DC-voltmeter.
37) Set the toggle switch to OFF.
38) Adjust the mechanical zero point of the meter. (The adjusting screw is located behind a plug halfway between the GROUND and TEST VOLTAGE screw terminals).
39) Set the toggle switch to ON (upward).
40) Connect a 0.99 MOhm +/- 0.5% resistor to the TEST VOLTAGE and R-I screw terminals.
41) Set the MULTIPLIER switch to 10.
42) Set the TEST VOLTAGE thumb-wheel switches to 100.
43) Adjust trimmer R241 so that the IM6 reads 0.1.
44) Connect a digital voltmeter to terminals J6/7 (0 V) and J6/8 (-0.5 V/decade) on the RECORDER/REMOTE CONTROL socket.
45) Connect a 100 MOhm +/- 1% resistor to the TEST VOLTAGE and R-I screw terminals instead of the 0.99 MOhm resistor.
46) Adjust trimmer R237 so that the DVM reads -1000 mV +/- 2 mV.
    a) Set the thumb-wheel switches to 010.
    b) Read the DVM.
    c) Set the thumb-wheel switches to 001.
    d) Adjust trimmer R279 to the same reading as in step b.
    e) Set the thumb-wheel switches to 100.
47) Adjust trimmer R2, which is mounted on a small print board on the back of the meter, so that the IM6 reads 10 (full scale deflection). For IM6 serial number prior to 182220, there is no potentiometer, and the resistance must be adjusted as shown in figure 5.2.).
48) Remove the digital voltmeter and the 100 MOhm resistor.
49) Connect a 10 GOhm +/- 1% resistor to the TEST VOLTAGE and R-I screw terminals.
50) Set the MULTIPLIER switch to 10^5.
51) Adjust trimmer R277 so that the IM6 reads .1.
52) Set the TEST VOLTAGE thumb-wheel switches to 005.
53) Wait until the relays have clicked and adjust trimmer R262 so that the IM6 reads .1.
54) Remove the 10 GOhm resistor.

Voltage Selector and Line Fuse

To get to the selector drum and fuse, use a mid-size screwdriver to remove the cover over the line socket.

The fuse is placed in the socket marked with an arrow. The sockets can be removed by pulling them towards yourself. The sockets have to be placed in the rightmost position.

To change the line voltage for the instruments, pull out the drum and rotate the drum to the proper line voltage, reinsert the drum and close the cover before mounting the cord.

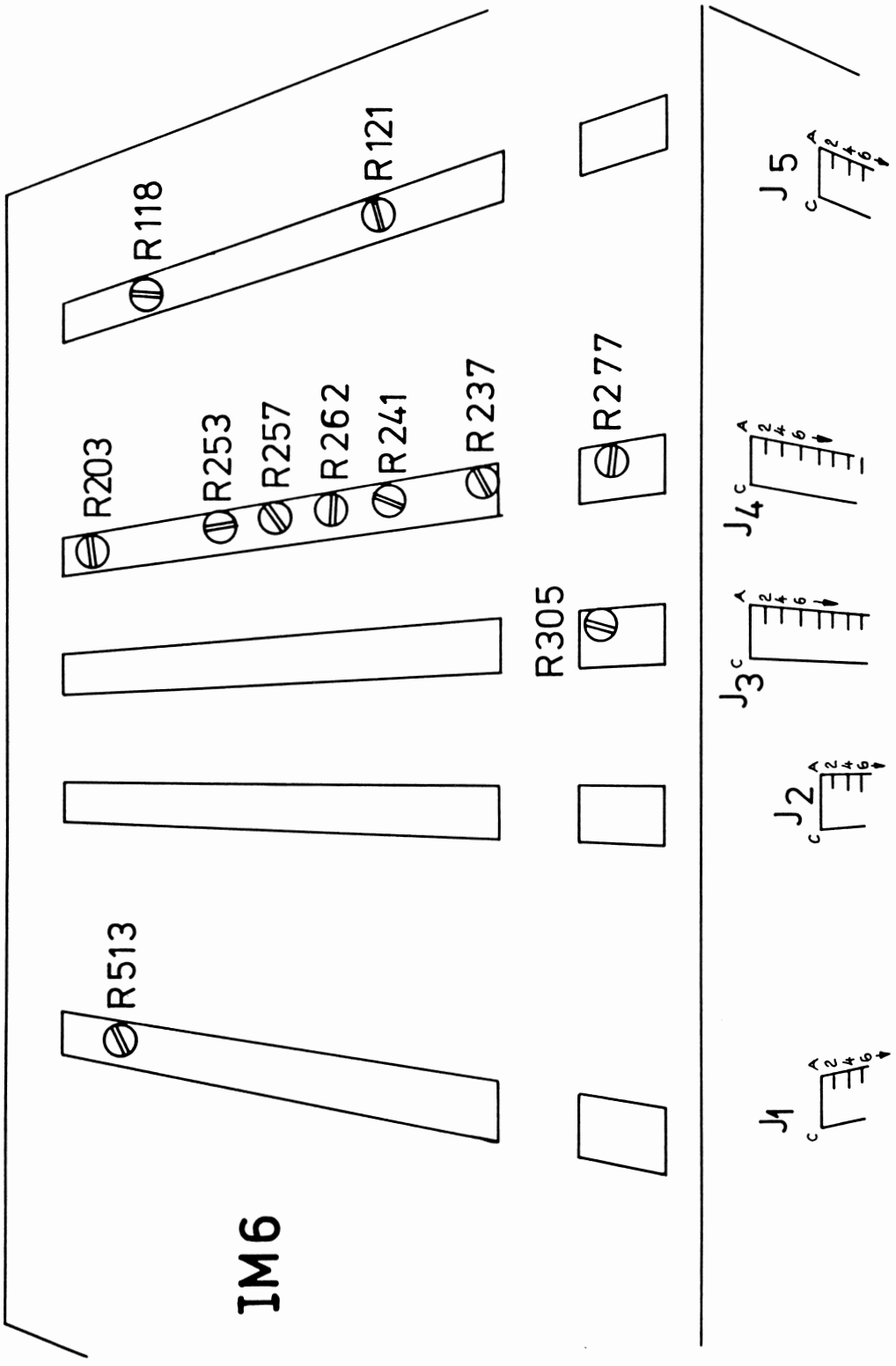


Fig. 5.1 - Location of Printed Circuit Boards and Trimmers.
Trimmer R2, Not Shown, is Located on the Back of the Meter

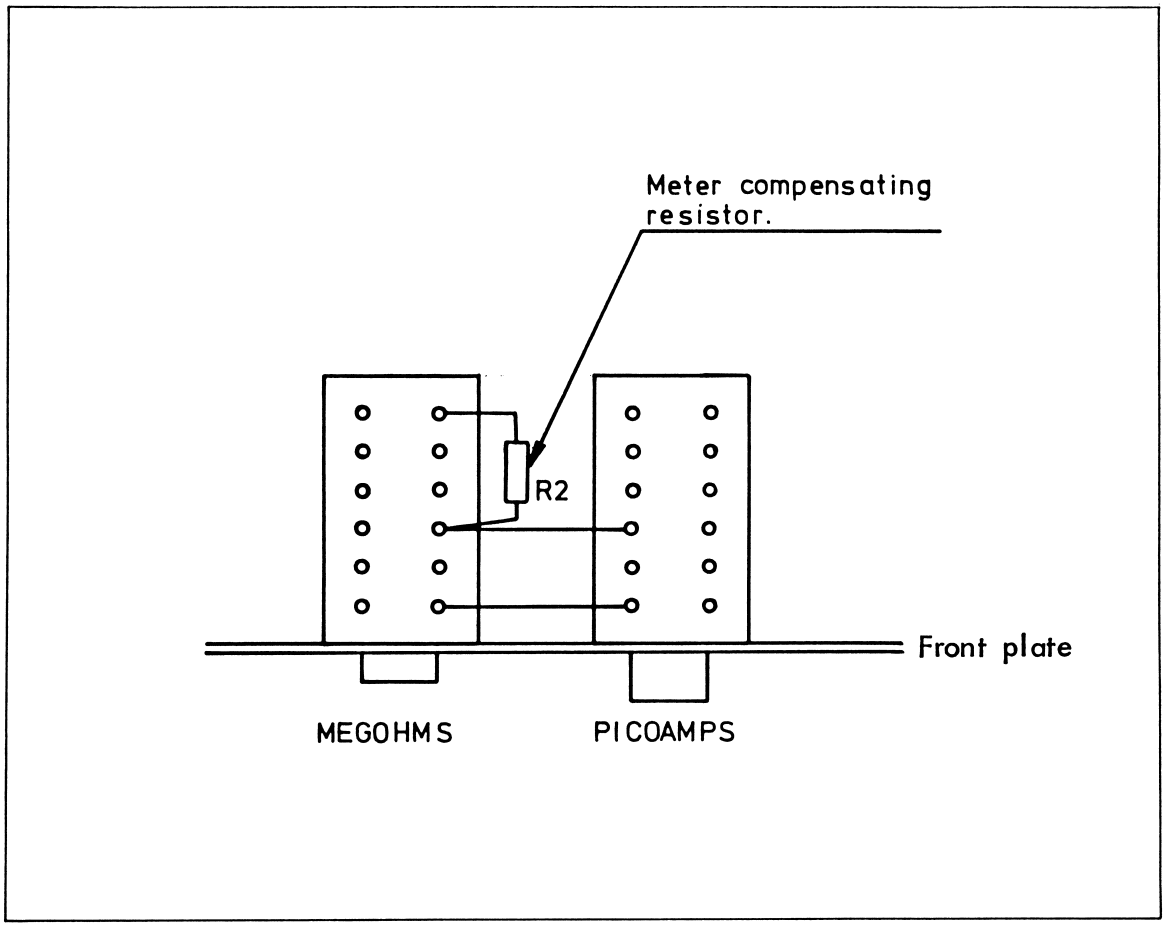


Fig. 5.2 - Top View of Compensating Resistor R2 Used on IM6 Meters up to Number 182220. (On IM6 Number 187966, R2 is Replaced by a Potentiometer Mounted on a Small Print Board on the Back of the Meter).

6 PARTS LISTS AND SCHEMATIC DIAGRAMS

6.1 Parts Lists

All electronic components are included in the parts list. Parts marked with an * are manufactured by RE INSTRUMENTS AS.

When ordering spare parts it is important that the following information is included:

* Code No. and description of the part.
* Circuit reference from the schematic diagram.
* Complete type designation of RE product.

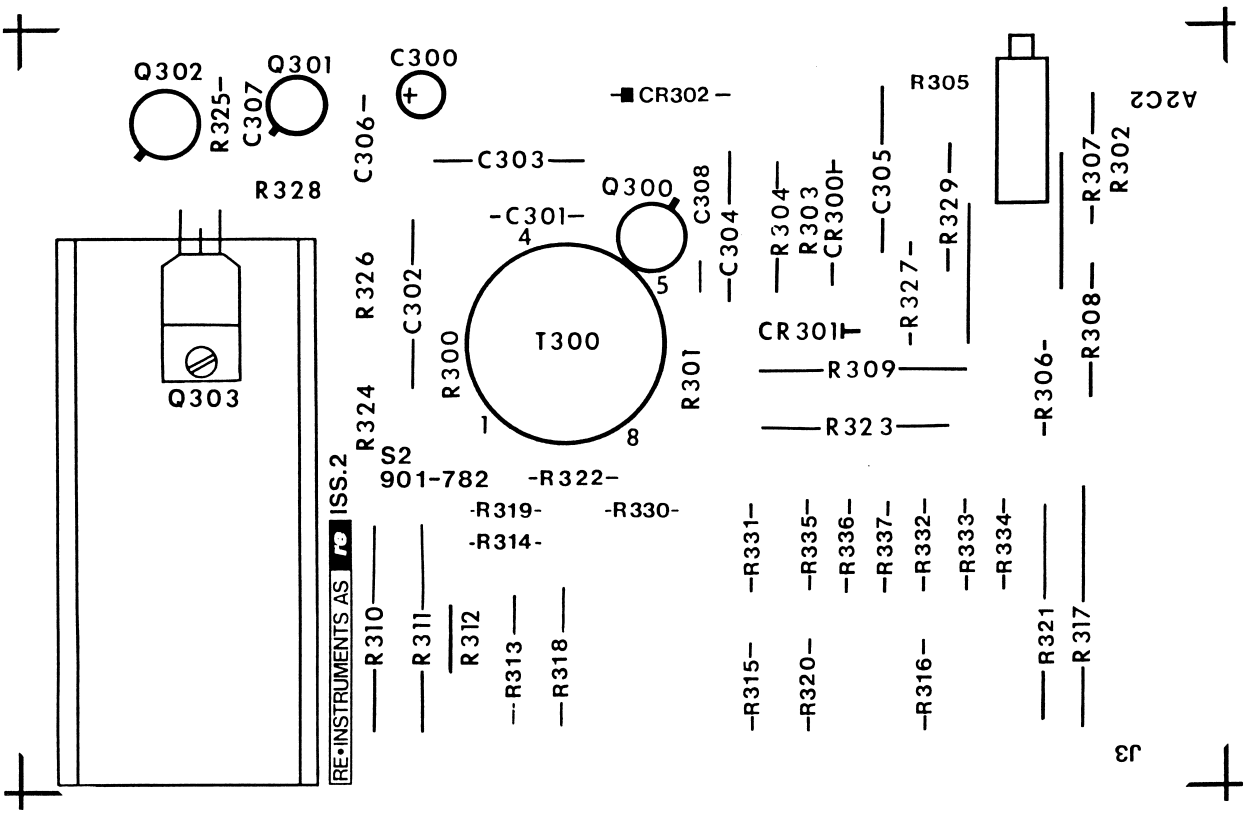


Fig. 6.1 - J3 Voltage Supply Printed-Circuit Board, Code 901-782

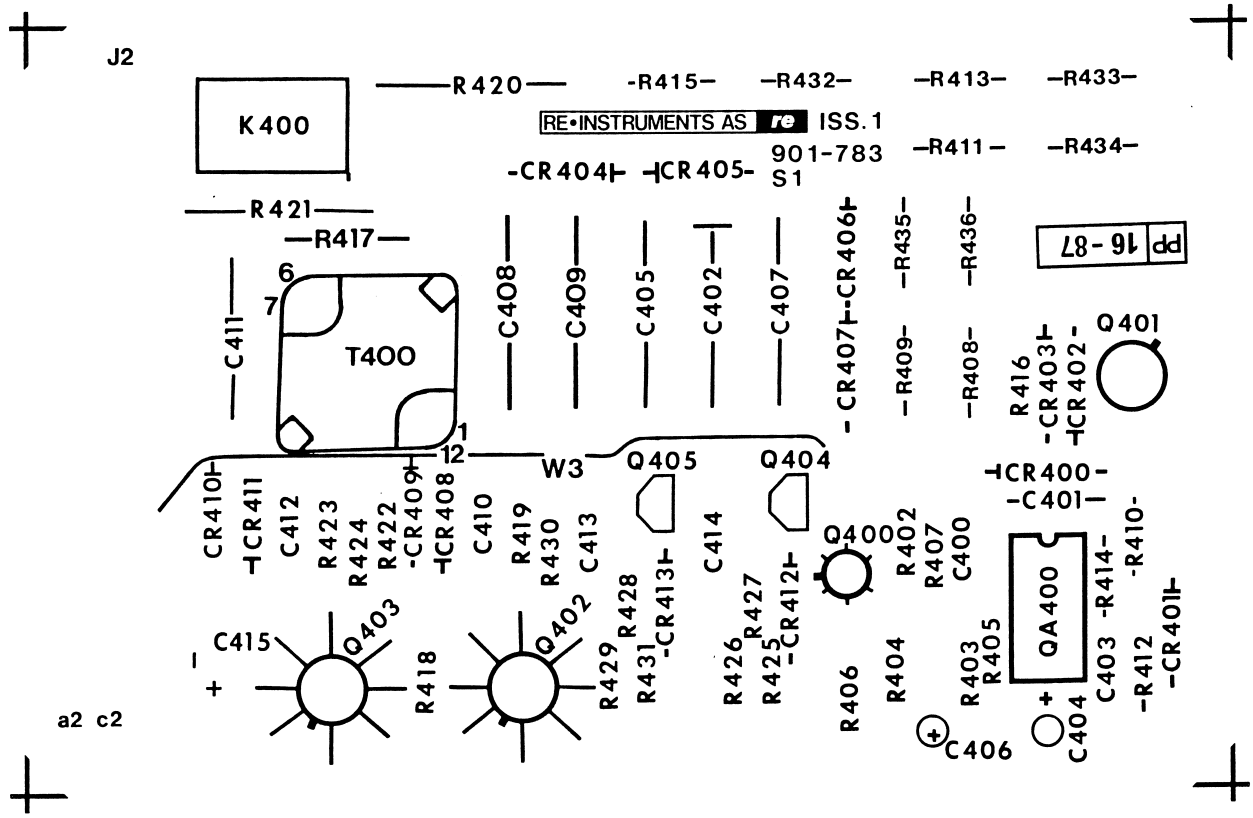


Fig. 6.2 - J2 Test Voltage Supply Printed-Circuit Board, Code 901-783

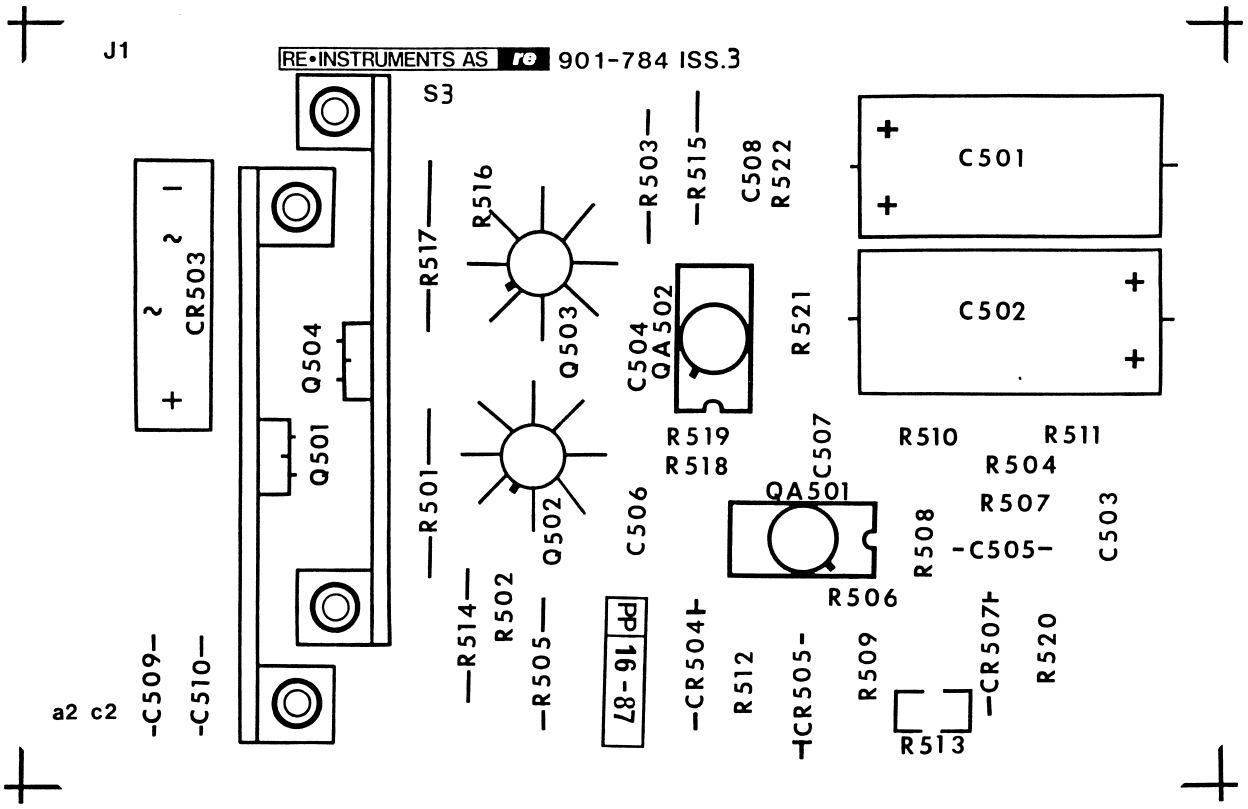


Fig. 6.3 - J1 Power Supply Printed-Circuit Board, Code 901-784

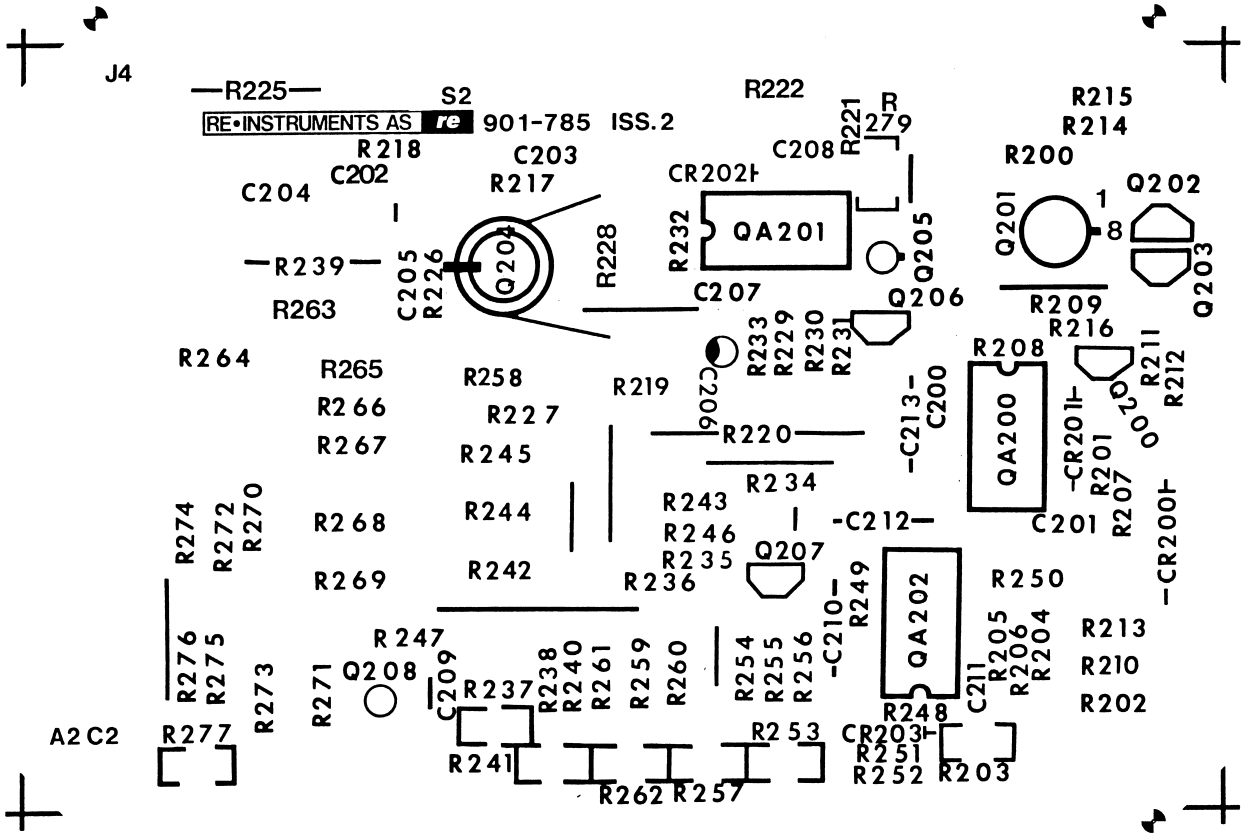


Fig. 6.4 - J4 Log. Amp. Printed-Circuit Board, Code 901-785

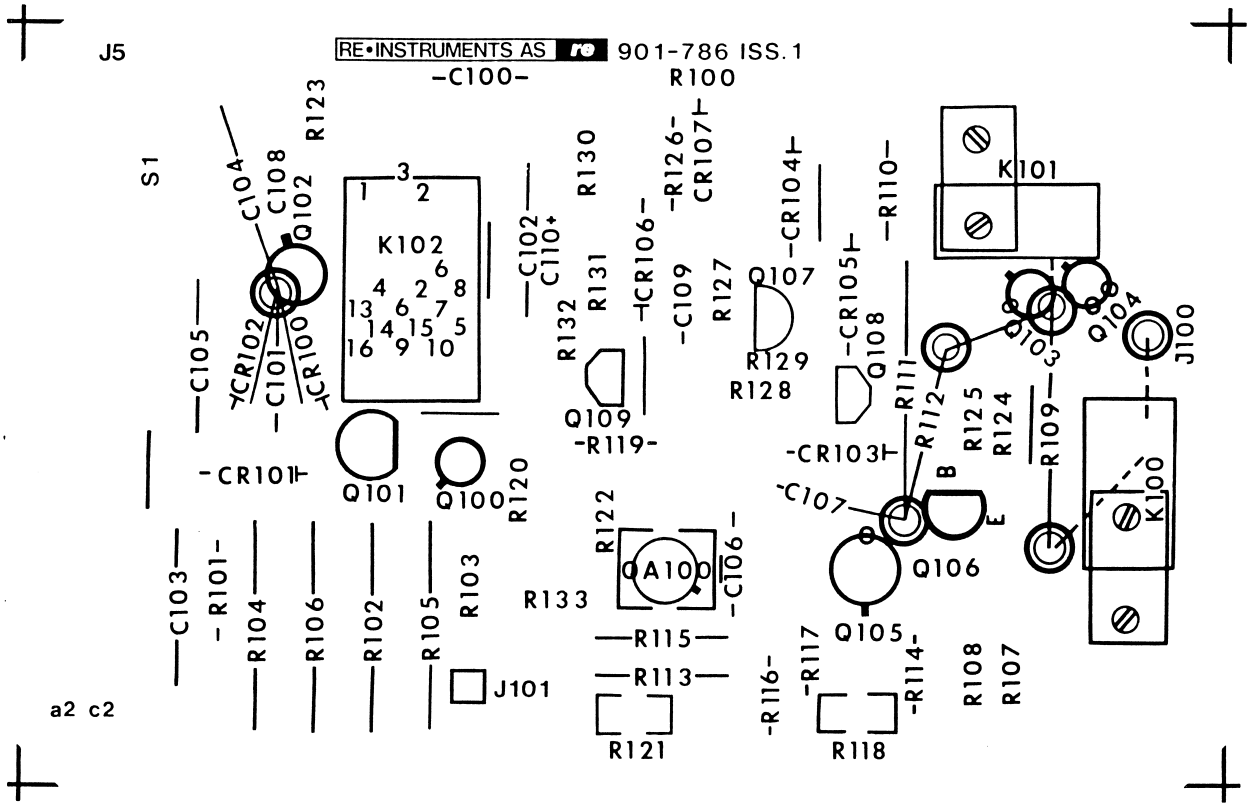


Fig. 6.5 - J5 Input Amp. Printed-Circuit Board, Code 901-786

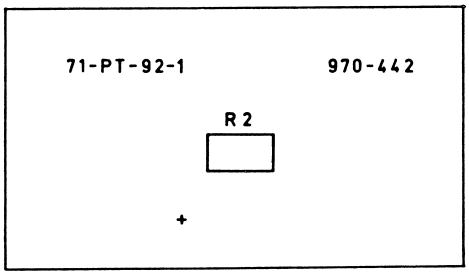


Fig. 6.6 - Printed-Circuit Board for Meter

Common Parts (908-019)

FUSES

F 1	Fuse 250mA for 115V, 6.3x32mm	450-114
F 2	Fuse 125mA for 220V, 5x20mm	450-011

LAMPS

I 1	Lamp 24V 20mA Socket T46	400-902
I 2	Lamp 24V red	400-815

CONNECTORS

J 1	Conn Edge 18-Pol F/Cable	805-657
J 2	Conn Edge 18-Pol F/Cable	805-657
J 3	Conn Edge 30-POL F/Cable	805-658
J 4	Conn Edge 30-POL F/Cable	805-658
J 5	Conn Edge 24-Pol F/Cable	805-667
J 6	Conn Multiplug 12 PIN F/Chassis	805-454
J 7	Binding Post, insulated, green	807-039
J 8	Binding Post, insulated, black	807-031
J 9	Binding Post, insulated, red	807-032
J 10	Binding Post, insulated, black	807-031

METERS

M 1	Meter 450uA with Scale	482-155

PLUGS

P 1	Plug for Print 1.3mm	805-709

RESISTORS

R 1	R Cermet Trimpot 10K 20% 0.15W	182-108
R 2	R Cermet Trimpot 100E 20% 0.5W TC150	182-040

SWITCHES

S 1	Power Switch w/Light, clear Button	501-000
S 2	Edge Switch 0-9 MO31	546-006
S 3	Switch M120	551-078
S 4	Push Button Switch 2xG17.5 4u	551-077
S 5	Toggle Switch	510-103
S 6	Slide Switch	510-204

TRANSFORMERS

T 1	Line Transformer	770-619

CABLES

W 1	Coax Cable 50E RK001	600-008
W 2	Coax Cable 50E RK001	600-008

MISCELLANEOUS

Crossslotted Screw with panhead M4*12	008-412
Screw Pozidrive panhead M5x40	008-540
Screw Pozidrive countersunk M3x6	009-306
Nut.hexagon M5	035-505
Threaded Socket M3x22	037-322
Washer D3,5/9x1	042-359
Pushbutton	550-021
Cover for Knob 21mm, grey	852-602
Knob 21mm, black	852-619
Rubber Foot	855-001
Plug Button 5mm	856-012
Main Lead Unit for 115V	900-071
Main Lead Unit 220V	901-302
Mount.Plate F/Trafo IM6	933-108

Reference Voltage Supply (901-782)

CAPACITORS

C 300	C Tantalum 10u 20% 16V	267-000
C 301	MKT, 2.2/63/10, R:8.5*15*18, RM6	241-031
C 302	C Polystyrol 6n7 5% 630V	243-125
C 303	MKT, 0.1/250/10, A:6*14	241-017
C 304	MKT, 0.1/250/10, A:6*14	241-017
C 305	C Polyester 27n 10% 400V	240-527
C 306	MKT, 2.2/63/10, R:8.5*15*18, RM6	241-031
C 307	C Caramic 47n -20+80% 30V	213-016
C 308	C Ceramic n47 20% 400VDC KL2	212-347

DIODES

CR 300	Diode BYV96D SI 800V 750mA DO14	350-430
CR 301	Diode BYV96D SI 800V 750mA DO14	350-430
CR 302	Diode Zener BZT03-C91=0,4W	350-665

TRANSISTORS

Q 300	Transistor BFY50 SI NPN 35V 1A 700mW TO39	360-125
Q 301	Transistor 2N930 SI NPN 45V 30mA 300mW TO18	360-038
Q 302	Transistor 2N2905A SI PNP 60V 600mA 600mW TO39	360-073
Q 303	Transistor TIP31A SI NPN 60V 3A 40W	360-122

RESISTORS

R 300	R Carbon Film 4K7 5% 0.2W	106-447
R 301	R Carbon Film 100E 5% 0.2W	106-310
R 302	R Carbon 1M 5% 0.2W	106-710
R 303	R Carbon Film 10E 5% 0.2W	106-210
R 304	R Carbon Film 6K8 5% 0.5W	100-468
R 305	R Wirewound Trimpot 10K 10% 0.75W 40ppm	193-002
R 306	R Metal Film 36K1 0.5% 0.25W TC50	140-404
R 307	R Metal Film 2k00 0.25% 0.25W	140-420
R 308	R Metal Film 2k00 0.25% 0.25W	140-420
R 309	R Carbon Film 2M0 0.5% 0.5W TC200	143-021
R 310	R Metal Film 2M50 0.5% 0.5W TC50	141-049
R 311	R Metal Film 5M00 1% 0.5W TC50	117-500
R 312	R High Ohmic 10M 1% 0.25W	145-007
R 313	R Carbon Film 20M 2% 0.5W TC200	143-023
R 314	R Metal Film 499K 1% 0.5W TC50	116-499
R 315	R Metal Film 499K 1% 0.5W TC50	116-499
R 316	R Metal Film 499K 1% 0.5W TC50	116-499
R 317	R Metal Film 4M 1% TC15	145-011
R 318	R Metal Film 499K 1% 0.5W TC50	116-499
R 319	R Metal Film 499K 1% 0.5W TC50	116-499
R 320	R Metal Film 499K 1% 0.5W TC50	116-499
R 321	R Metal Film 4M 1% TC15	145-011
R 322	R Metal Film 499K 1% 0.5W TC50	116-499
R 323	R Metal Film 50K0 1% 0.5W TC50	115-500
R 324	R Carbon Film 22K 5% 0.2W	106-522

R 325	R Carbon Film 1K5 5% 0.2W		106-415
R 326	R Carbon Film 2K2 5% 0.2W		106-422
R 327	R Carbon Film 1K5 5% 0.2W		106-415
R 328	R Carbon Film 820E 5% 0.2W		106-382
R 329	R Carbon Film 3M9 5% 0.5W		100-739
R 330	R Metal Film 499K 1% 0.5W TC50		116-499
R 331	R Metal Film 499K 1% 0.5W TC50		116-499
R 332	R Metal Film 499K 1% 0.5W TC50		116-499
R 333	R Metal Film 499K 1% 0.5W TC50		116-499
R 334	R Metal Film 499K 1% 0.5W TC50		116-499
R 335	R Metal Film 499K 1% 0.5W TC50		116-499
R 336	R Metal Film 499K 1% 0.5W TC50		116-499
R 337	R Metal Film 499K 1% 0.5W TC50		116-499

TRANSFORMERS

T 300	Transformer, special		740-019

MISCELLANEOUS

	Slot Screw w/Cylinder Head M3x10	002-807
	Nut hexagon M3	031-302
	Lock washer D3,2/5,5x0,45	046-405
	DIN 41612 64 pol male 90°, C class II NND	805-974
	Spacer Transistor Pads TO-5	816-106
	Cooling Plate	816-122
	PCB Ref Voltage Supply IM6	971-345

Test Voltage Supply (901-783)

CAPACITORS

C 400	C Polystyrol 474p 1% 63V	243-144
C 401	C Ceramic 68p0 2% 100V NP0	213-215
C 402	C Polycarbonate 10n 10% 1600V 150PPM	242-010
C 404	C electrolytic 10u0 25V	261-081
C 405	C Polycarbonate 10n 10% 1600V 150PPM	242-010
C 406	C electrolytic 10u0 25V	261-081
C 407	C Polycarbonate 10n 10% 1600V 150PPM	242-010
C 408	C Polycarbonate 10n 10% 1600V 150PPM	242-010
C 409	C Polycarbonate 10n 10% 1600V 150PPM	242-010
C 410	MKT, 0.047/250/10, R:4*9*13, RM4	241-049
C 411	C Polycarbonate 2n2 20% 2000V 150PPM	242-009
C 412	MKT, 0.047/250/10, R:4*9*13, RM4	241-049
C 413	MKT, 0.033/400/10, R:4*10*13,RM4	241-021
C 414	MKT, 0.033/400/10, R:4*10*13,RM4	241-021
C 415	C electrolytic 10u0 25V	261-081

DIODES

CR 400	Diode Zener BZX79-C6V2 0.4W	350-604
CR 402	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 403	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 404	Diode BYV96D SI 800V 750mA DO14	350-430
CR 405	Diode BYV96D SI 800V 750mA DO14	350-430
CR 406	Diode BYV96D SI 800V 750mA DO14	350-430
CR 407	Diode BYV96D SI 800V 750mA DO14	350-430
CR 408	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 409	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 410	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 411	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 412	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 413	Diode BAV20 Si Vr-150V If-250mA	350-023

RELAYS & JUMPERS

K 400	Relay Single Contact 24V	570-054

TRANSISTORS

Q 400	Transistor 2N3958 N fet	360-103
Q 401	Transister 2N1711	360-047
Q 402	Transistor BFY50 SI NPN 35V 1A 700mW TO39	360-125
Q 403	Transistor BFY50 SI NPN 35V 1A 700mW TO39	360-125
Q 404	Transistor BC547B npn	360-159
Q 405	Transistor BC547B npn	360-159

INTEGRATED ANALOG CIRCUITS

QA 400	IC LM301AH OP-AMP	364-016

RESISTORS

R 402	R Carbon Film 4K7 5% 0.2W	106-447
R 403	R Metal Film 20K0 0.5% 0.25W TC25	140-473
R 404	R Metal Film 22K1 1% 0.5W TC50	115-221
R 405	R Metal Film 20K0 0.5% 0.25W TC25	140-473
R 406	R Carbon Film 4K7 5% 0.2W	106-447
R 407	R Carbon Film 1K 5% 0.2W	106-410
R 408	R Metal Film 499K 1% 0.5W TC50	116-499
R 409	R Metal Film 499K 1% 0.5W TC50	116-499
R 410	R Metal Film Zero OHM < =0E01	141-272
R 411	R Metal Film 499K 1% 0.5W TC50	116-499
R 413	R Metal Film 499K 1% 0.5W TC50	116-499
R 414	R Carbon Film 1K 5% 0.2W	106-410
R 415	R Metal Film 499K 1% 0.5W TC50	116-499
R 416	R Carbon Film 1K 5% 0.2W	106-410
R 417	R Carbon Film 47K 5% 0.5W	100-547
R 418	R Carbon Film 10E 5% 0.2W	106-210
R 419	R Carbon 150E 5% 0.2W	106-315
R 420	R Carbon 10K 5% 1W	101-510
R 421	R Carbon 10K 5% 1W	101-510
R 422	R Carbon Film 15E 5% 0.2W	106-215
R 423	R Carbon 150E 5% 0.2W	106-315
R 424	R Carbon 150E 5% 0.2W	106-315
R 425	R Carbon Film 330E 5% 0.2W	106-333
R 426	R Carbon Film 1K8 5% 0.2W	106-418
R 427	R Carbon Film 1K8 5% 0.2W	106-418
R 428	R Carbon Film 1K8 5% 0.2W	106-418
R 429	R Carbon Film 1K8 5% 0.2W	106-418
R 430	R Carbon 150E 5% 0.2W	106-315
R 431	R Carbon Film 330E 5% 0.2W	106-333
R 432	R Metal Film 499K 1% 0.5W TC50	116-499
R 433	R Metal Film 499K 1% 0.5W TC50	116-499
R 434	R Metal Film 499K 1% 0.5W TC50	116-499
R 435	R Metal Film 499K 1% 0.5W TC50	116-499
R 436	R Metal Film 499K 1% 0.5W TC50	116-499

TRANSFORMERS

T 400	Transformer, special	740-018

CABLES

W 3	Coax Cable 50E RG 196/U	600-014

MISCELLANEOUS

Tubular Rivet 2.5X10		060-310
DIN 41612 64 pol male 90°, C class II	NND	805-974
Spacer Transistor Pads TO-5		816-106
Heat Sink Transistor TO-5		816-109
PCB Test Voltage Supply IM6		971-346

Power Supply (901-784)

CAPACITORS

C 501	Electrolytic 1000/63, 2000h/85°, A:18*30, RM14	260-056
C 502	Electrolytic 1000/63, 2000h/85°, A:18*30, RM14	260-056
C 503	C Ceramic 33p 5% 400VDC NPO	210-233
C 504	C Polystyrol 150p 5% 160V	243-030
C 505	C Polystyrol 150p 5% 160V	243-030
C 506	C Ceramic 33p 5% 400VDC NPO	210-233
C 507	C Ceramic 2n2 20% 400V	212-422
C 508	C Ceramic 2n2 20% 400V	212-422
C 509	MKT, 1/63/10, R:6*12*18, RM6	241-027
C 510	MKT, 1/63/10, R:6*12*18, RM6	241-027

DIODES

CR 503	Bridge Rectifier Vin:80V Io:2.2A	NNM	340-204
CR 504	Diode Zener BZX79-C9V1 0.4W		350-606
CR 505	Diode Zener BZX79-C9V1 0.4W		350-606
CR 507	Diode Zener 1N825 C6V2 0.4W		350-637

TRANSISTORS

Q 501	Transistor TIP32A SI PNP 60V 3A 40W	360-120
Q 502	Transister 2N1711	360-047
Q 503	Transistor 2N2905A SI PNP 60V 600mA 600mW TO39	360-073
Q 504	Transistor TIP31A SI NPN 60V 3A 40W	360-122

INTEGRATED ANALOG CIRCUITS

QA 501	IC LM301AH OP-AMP	364-016
QA 502	IC LM301AH OP-AMP	364-016

RESISTORS

R 501	R Wire Wound 1E8 10% 1W	121-118
R 502	R Carbon Film 39E 5% 0.2W	106-239
R 503	R Carbon Film 560E 5% 0.5W	100-356
R 504	R Carbon 10K 5% 0.2W	106-510
R 505	R Metal Film 100E 1% 0.5W TC50	113-100
R 506	R Carbon Film 220K 5% 0.2W	106-622
R 507	R Carbon Film 330K 5% 0.2W	106-633
R 508	R Carbon Film 470E 5% 0.2W	106-347
R 509	R Carbon Film 820E 5% 0.2W	106-382
R 510	R Metal Film 1K00 0.1% TC10	141-052
R 511	R Metal Film 10K0 1% 0.5W TC50	115-100
R 512	R Metal Film 1K07 0.1% TC10	141-053
R 513	R Cermet Trimpot 2K2 20% 0.5W	182-031
R 514	R Metal Film 100E 1% 0.5W TC50	113-100
R 515	R Carbon Film 560E 5% 0.5W	100-356
R 516	R Carbon Film 39E 5% 0.2W	106-239
R 517	R Wire Wound 1E8 10% 1W	121-118
R 518	R Carbon 10K 5% 0.2W	106-510

R 519	R Carbon Film 330K 5% 0.2W		106-633
R 520	R Carbon Film 470E 5% 0.2W		106-347
R 521	R Metal Film 1K00 0.1% TC10		141-052
R 522	R Metal Film 1K00 0.1% TC10		141-052

MISCELLANEOUS

Screw Pozidrive panhead M3x6		008-306
Nut hexagon M3		031-302
Lock washer D3,2/5,5x0,45		046-405
Tubular Rivet 2.5X10		060-310
DIN 41612 64 pol male 90°, C class II	NND	805-974
Spacer Transistor Pads TO-5		816-106
Heat Sink		816-118
Heat Sink 40x75		816-123
PCB Power Supply IM6		971-347

R 269	R Metal Film 200E 0.5% TC10		141-051
R 270	R Carbon Film 47E 5% 0.2W		106-247
R 271	R Metal Film 200E 0.5% TC10		141-051
R 272	R Metal Film 150E 1% 0.5W TC50		113-150
R 273	R Metal Film 200E 0.5% TC10		141-051
R 274	R Metal Film 309E 0.5% 0.4W TC50		140-783
R 275	R Metal Film 51E1 1% 0.5W TC50		112-511
R 276	R Metal Film 1K00 1% 0.5W TC50		114-100
R 277	R Cermet Trimpot 2K2 20% 0.5W		182-031
R 279	R Cermet Trimpot 100E 20% 0.5W TC150		182-040

MISCELLANEOUS

DIN 41612 64 pol male 90°, C class II	NND	805-974
PCB Log Amplifier IM6		971-348

Input Amplifier (901-786)

CAPACITORS

C 100	MKT, 0.33/160/10, R:6*12*18, RM6	241-024
C 101	MKT, 0.22/100/10, A:6*14	241-036
C 102	C Polyst 10n0 2% 63V	243-020
C 103	KP, 0.0047/63/1, A:5*13, RM7	243-021
C 104	C Polystyrol 16n 1% 63V	243-018
C 105	C Polystyrol 16n 1% 63V	243-018
C 106	C Ceramic 33p 5% 400VDC NPO	210-233
C 107	C Polystyrol 100p 5% 160V	243-037
C 108	MKT, 0.1/100/10, R:4*9*13, RM4	241-025
C 109	MKT, 0.68/63/10, R:5*11*18, RM6	241-030
C 110	C Tantal 2u2 20% 35V	267-007

DIODES

CR 100	Diode Zener BZX79-C9V1 0.4W	350-606
CR 101	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 102	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 103	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 104	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 105	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 106	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 107	Diode BAV20 Si Vr-150V If-250mA	350-023

CONNECTORS

J 1	Jack, Printed Circuit	805-708

RELAYS & JUMPERS

K 100	Relay, Single Contact	570-055
K 101	Relay, Single Contact	570-055
K 102	Relay, 4 Contacts	570-036

TRANSISTORS

Q 100	Transistor 2N930 SI NPN 45V 30mA 300mW TO18	360-038
Q 101	Transistor 2N2905A SI PNP 60V 600mA 600mW TO39	360-073
Q 102	Transistor MOS-FET 3N164P	360-259
Q 103	Transistor 2N930 SI NPN 45V 30mA 300mW TO18	360-038
Q 104	Transistor 2N930 SI NPN 45V 30mA 300mW TO18	360-038
Q 105	Transistor AD832N 40V 40mW TO99	360-113
Q 106	Transistor 2N5087 SI PNP 50V 50mA 350mW TO92	360-087
Q 107	Transistor 2N5087 SI PNP 50V 50mA 350mW TO92	360-087
Q 108	Transistor BC547B npn	360-159
Q 109	Transistor BC547B npn	360-159

INTEGRATED ANALOG CIRCUITS

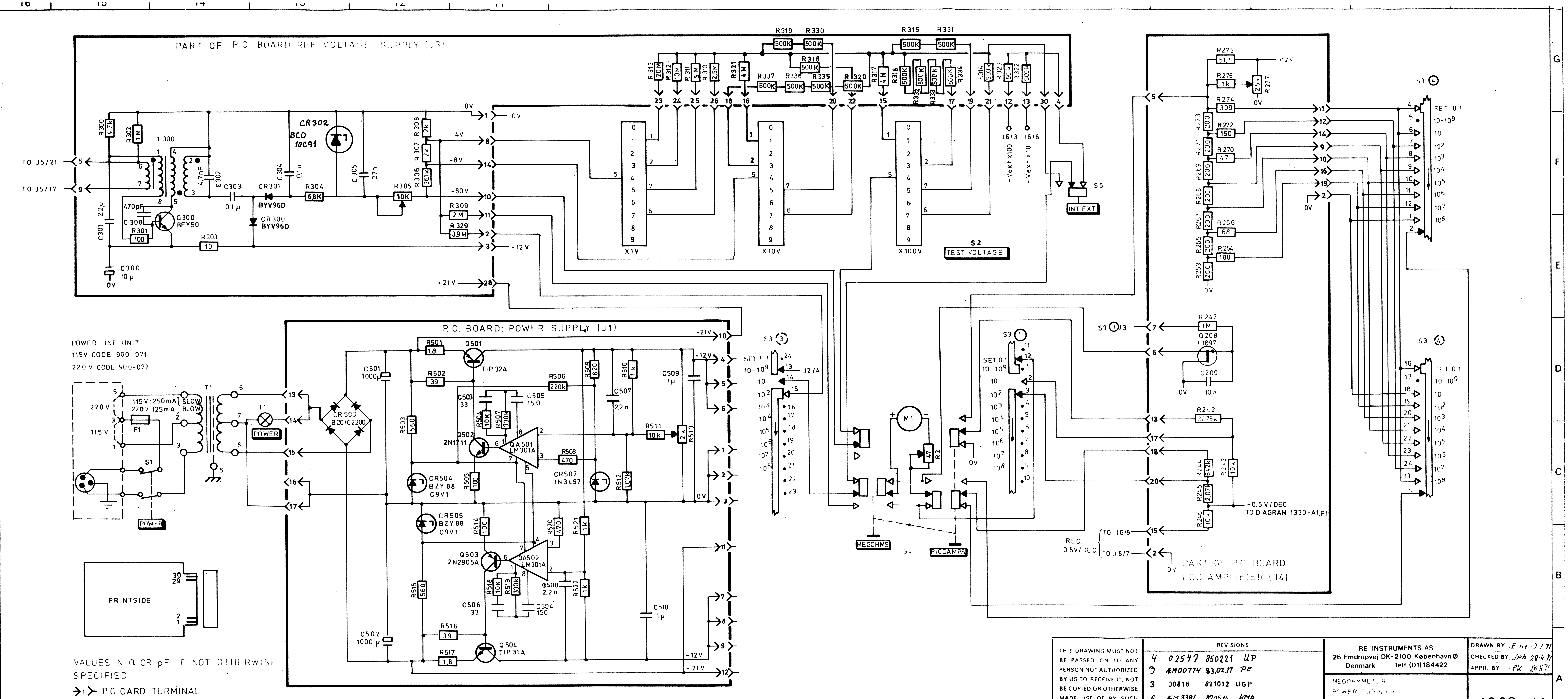
QA 100	IC LM301AH OP-AMP	364-016

RESISTORS

R 100	R Carbon Film 470K 5% 0.2W	106-647
R 101	R Carbon Film 180K 5% 0.2W	106-618
R 102	R Metal Film 5K00 0.5% 0.5W TC50	141-048
R 103	R Carbon Film 18K 5% 0.2W	106-518
R 104	R Metal Film 5K00 0.5% 0.5W TC50	141-048
R 105	R Metal Film 2M50 0.5% 0.5W TC50	141-049
R 106	R Metal Film 2M50 0.5% 0.5W TC50	141-049
R 107	R Carbon Film 100E 5% 0.2W	106-310
R 108	R Carbon Film 330K 5% 0.2W	106-633
R 109	R Carbon 10K 5% 1W	101-510
R 110	R Metal Film 49K9 1% 0.5W TC50	115-499
R 111	R High Ohmic 2G 1% 1W	145-005
R 112	R Carbon 1M 5% 0.2W	106-710
R 113	R Metal Film 464K 1% 0.5W TC50	116-464
R 114	R Metal Film 100K 1% 0.5W TC50	116-100
R 115	R Metal Film 464K 1% 0.5W TC50	116-464
R 116	R Carbon Film 390E 5% 0.2W	106-339
R 117	R Carbon Film 180K 5% 0.2W	106-618
R 118	R Cermet Trimpot 100K 20% 0.5W TC150	182-035
R 119	R Carbon 10K 5% 0.2W	106-510
R 120	R Carbon 1M 5% 0.2W	106-710
R 121	R Cermet Trimpot 10K 20% 0.5W	182-033
R 122	R Carbon 10K 5% 0.2W	106-510
R 123	R Carbon Film 1K 5% 0.2W	106-410
R 124	R Carbon Film 100K 5% 0.2W	106-610
R 125	R Carbon Film 220K 5% 0.2W	106-622
R 126	R Carbon Film 330K 5% 0.2W	106-633
R 127	R Carbon Film 68K 5% 0.2W	106-568
R 128	R Carbon Film 1K 5% 0.2W	100-410
R 129	R Carbon 10K 5% 0.2W	106-510
R 130	R Carbon Film 12K 5% 0.2W	106-512
R 131	R Carbon Film 12K 5% 0.2W	106-512
R 132	R Carbon Film 2K7 5% 0.2W	106-427
R 133	R Carbon Film 22K 5% 0.2W	106-522

MISCELLANEOUS

DIN 41612 64 pol male 90°, C class II	NND	805-974
PCB Input AMP. IM6		971-349



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5	ÆM2788	850618	GF			

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MEGOHMMETER
POWER SUPPLY /
METER CIRCUIT
TYPE M5

FROM NO. TO NO.

~~1329-A1~~
985-010

RE Technology

IM6 Megohmmeter

Unfortunately, the schematics 985-011 and 985-012 are missing in the manual!

If you have a complete manual with these schematics, please email me at: peterandersen@mespilus.dk

Look in the Radiometer version of the manual for the IM6 for these schematics.