IM 6
Megohmmeter

982-705, 7706C

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PART I
OPERATING INSTRUCTIONS

IM6 Megohmmeter

Section A. Introduction

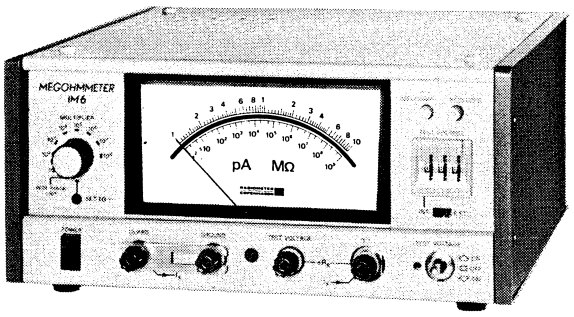


Fig.A1. Megohmmeter IM6.

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

It measures resistance from 1 MΩ to 10^9 MΩ at an accuracy of 5% of the indicated value, or it can 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 MΩ to 10^9 MΩ (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 V or 0 - 100 V 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 lights when the test voltage is switched on.

A MULTIPLIER switch is provided for the selection of the meter range. It covers the ranges of 1 to 10^9 and 10 to 10^8.

The low input resistance obviates the necessity for any manual pre-charging procedures of capacitors prior to measurement. 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 10^{-7} for a ± 10% change in the line supply.

Section B. Specifications

RESISTANCE MEASUREMENT

Ranges:	1. 1 MΩ to 10^9 MΩ in 1 range of 9 decades 2. 1 MΩ to 10^9 MΩ in 8 ranges of 2 decades
Scales:	2 logarithmic: upper - 2 decades lower - 9 decades
Accuracy:	
With $R_x \leq V_{test} \times 10^6$ MΩ:	5% of the indicated value (within temperature range 15-35°C)
With $R_x > V_{test} \times 10^6$ MΩ:	$\left[\frac{R_x\ [M\Omega]}{V_{test}} \times 10^{-6} \times 5\%\right]$ of the indicated value
Input resistance:	10 kΩ for I_{test} >2 nA 1 MΩ for I_{test} <2 nA
Recorder output:	-0.5 V ± 0.5% per decade ±10 mV At 1 MΩ, 0 V ± 10 mV R_{out} = 10 kΩ

TEST VOLTAGE

Range:	
Internal control	0-999 V in 1 V steps by means of 3 thumb-wheel switches showing direct digital value of selected voltage.

External control

2 inputs:

1. $V_{test} = 10 \times (-V_{ext})$, V_{ext} MAX.=100 V dc
   ($-V_{ext}$ of minus 0-100 V dc provides 0-1000 V_{test})
2. $V_{test} = 100 \times (-V_{ext})$, V_{ext} MAX.=10 V dc
   ($-V_{ext}$ of minus 0-10 V dc provides 0-1000 V_{test})

Accuracy: ±5%

Stability: Better than 10^{-7} for ±10% line voltage variation

Temperature stability: ±0.01%/°C. ($V_{test} \geq 10$ V)

Short-circuit current: Max. 2 mA

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

Source resistance: 10 kΩ

DC CURRENT MEASUREMENT

Ranges:
1. 1 pA - 1 mA in one 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 15-35°C)

Input resistance: 10 kΩ for $I_x > 2$ nA

1 MΩ for $I_x < 2$ nA

Recorder output: 0.5 V ±0.5% per decade ±10 mV

At 10 µA, 0 V ±10 mV

R_{out} = 10 kΩ

MEASURING TIME

Resistance:
<1 sec. with $I_x > 10$ nA
<3 sec. with 10 nA $> I_x >$ 1 pA

Capacitors:	Charge: for $C_x < 1\ \mu F$: $t \leq 3$ sec. for $C_x > 1\ \mu F$: $t = C_x (V_{test} \times 10^{-3} + 0.3)$ Discharge: $t = 0.1 \times C_x$ (with V_{test} falling to 1% of the test value) (C_x in μF, t in seconds, V_{test} in volts)
GUARD	GUARD terminal is connected to 0 V line (chassis), but isolated from the GROUND terminal
POWER REQUIREMENTS	220/115 V, 50 -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

Section C. Description

GENERAL

Fig. C1 shows a schematic diagram of the IM6 Megohmmeter to which this description refers. The test voltage is fed to the resistor under test, R_x. The current passing through R_x is fed to a logarithmic amplifier I, either directly if the current through R_x 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_1 equal to log (V_{test}/R). A corresponding reference current passing through a reference resistor R_{ref} is applied to a second amplifier II, whose output V_2 is equal to log (V_{test}/R_{ref}). This results in a difference voltage at the emitter of Q204b equal to V_1-V_2, which, with $R_{ref} = 1$, becomes $V_1 - V_2 = -\log R_x$.

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

General

Refer to Figs. C2 and C3.

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.)

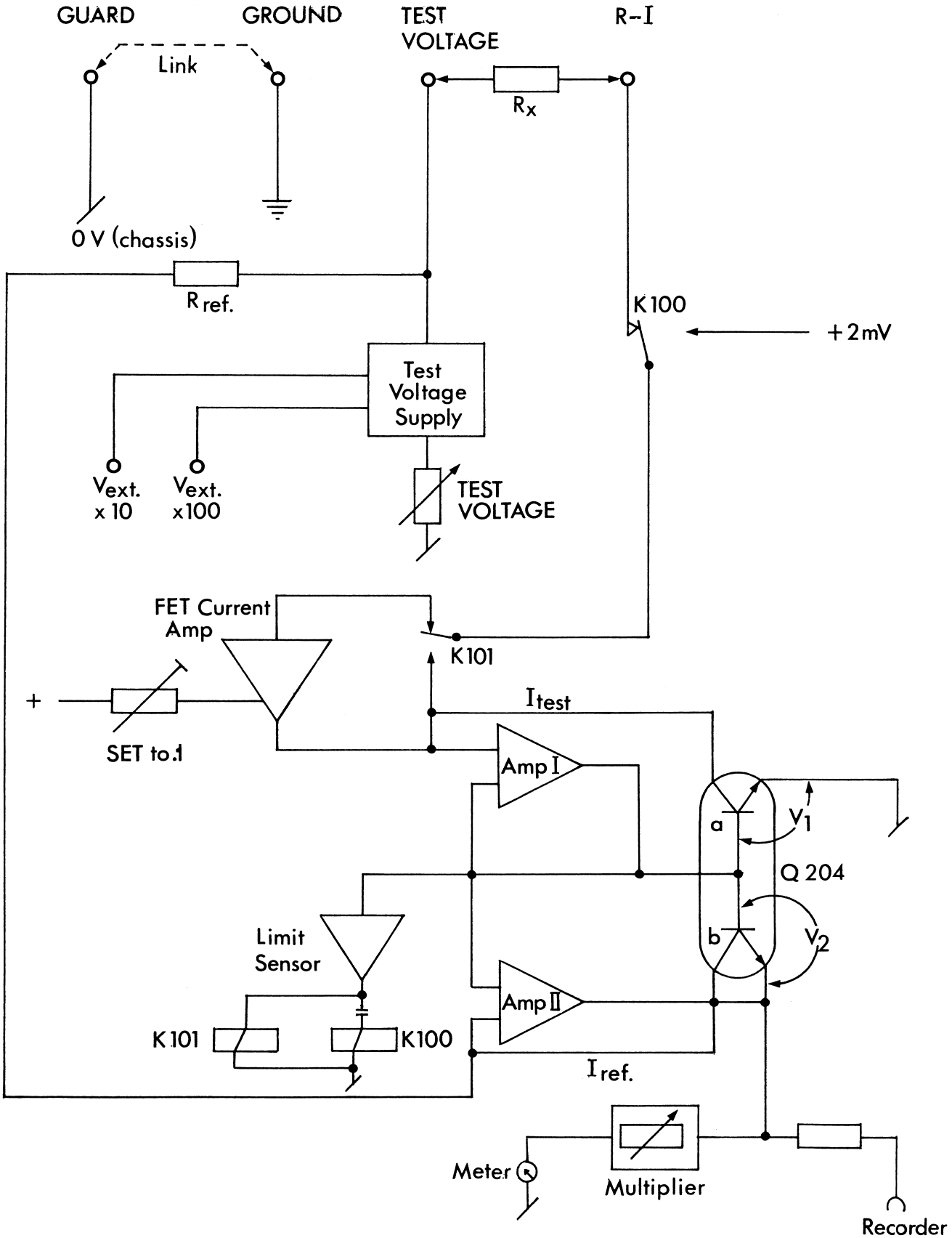


Fig. C1. Schematic diagram of IM6 Megohmmeter

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.

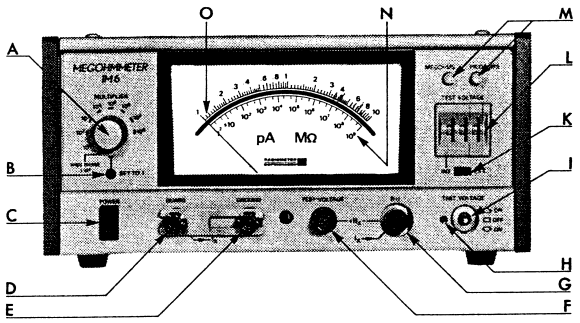


Fig.C2. Front Panel Controls and Terminals.

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

M. MEGOHMS/PICOAMPS. Push-button switch selects the mode of measurements, i.e., resistance or current.

N. Meter scale, 10^9 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).

CAUTION: 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, R_i: 10 kΩ

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. Cover plate for line supply connection.

S. Instrument identification and serial number plate.

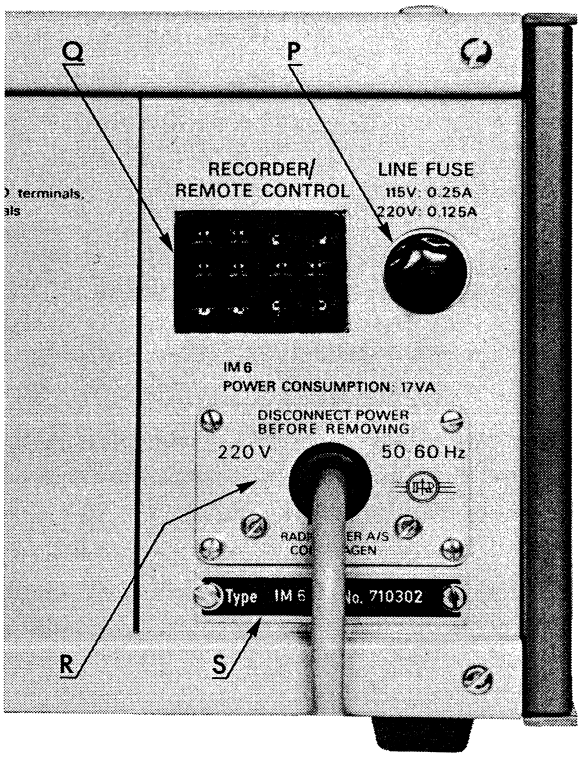


Fig.C3. Rear Panel Controls and Terminals.

Section D. Operating Instructions

GENERAL

Refer to Figs.D1 and D2.

Switching on

a) Depress the power switch C, Fig.D1. 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.D1, until the meter pointer indicates ".1" on the upper scale.

Measurement of resistance

a) Depress the MEGOHMS button M, Fig. D1.

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

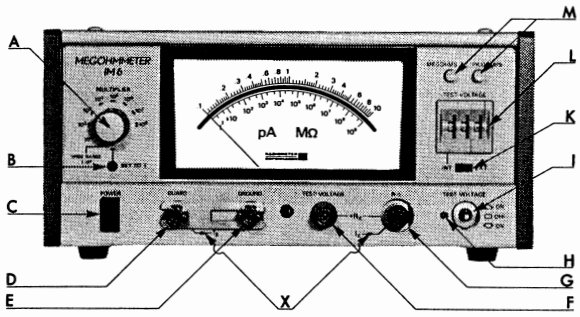


Fig.D1. Front Panel Controls and Terminals.

c) Set the MULTIPLIER A to WIDE RANGE 1-10^9.

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

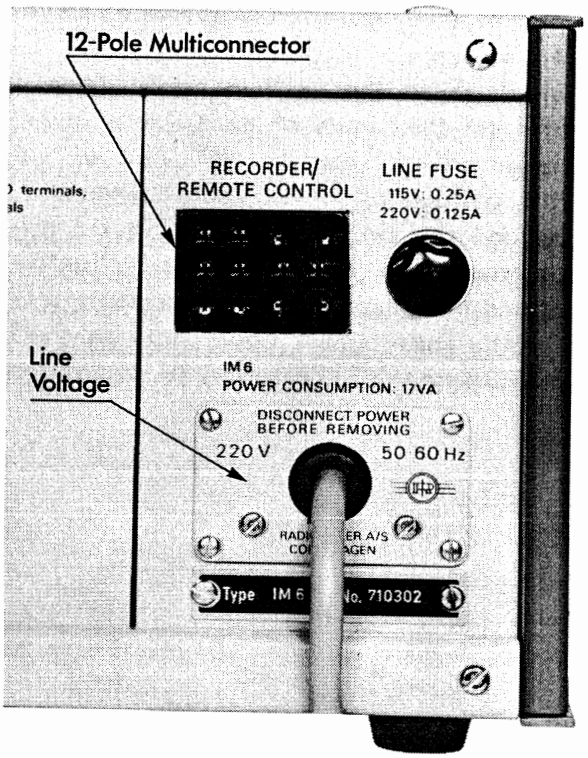


Fig.D2. Rear Connections.

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.

CAUTION: 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, can 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.D3 to ascertain the limits of the insulation value obtainable. An example is drawn in on Fig.D3, which shows that with a capacitance of 1 µF the limits of measurable insulation will be approx. 10^4 MΩ with a test voltage of 10 V. Measurements beyond the limits shown in Fig.D3 can, of course, be made, but meter fluctuations may make the measurements difficult. These limits apply only to the measurement of insulation on capacitors.

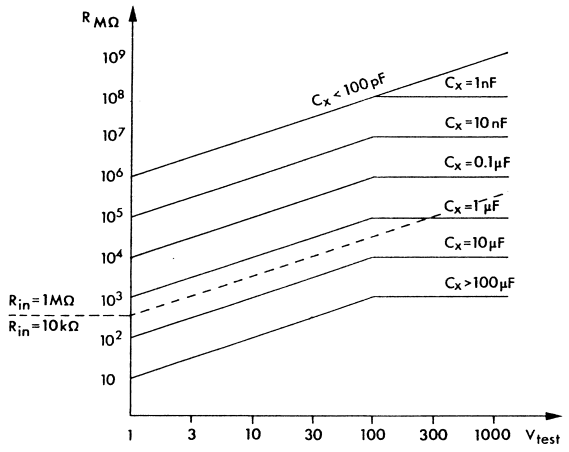


Fig.D3. Range limits when measuring the insulation of capacitors.

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 1-10^9.

c) Connect the I_x between the terminals GUARD and R-I (X in Fig.D1).

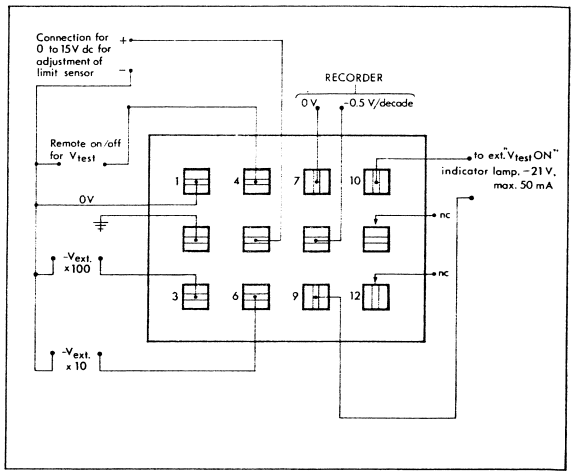


Fig.D4. Rear View of 12-pole Multiconnector when plugged into IM6.

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.D4 shows the tag connections to the 12-pole plug as seen from the rear of the plug.

Pins 1-3[X] Connection of 0 to -10 V dc will give a full range control of V_{test}. Pin 1 is 0 V.

Pins 1-6[X] Connection of 0 to -100 V dc will give a full range control of V_{test}. Pin 1 is 0 V.

Pin 2 GROUND

Pin 4 0 V when the TEST VOLTAGE switch 1 is switched to ON.

Pins 1-5 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 7-8 RECORDER. Pin 7 is 0 V and Pin 8 -0.5 V/decade.

Pins 1-4 A short-circuit connection between these pins switches on V_{test} for remote control operation.

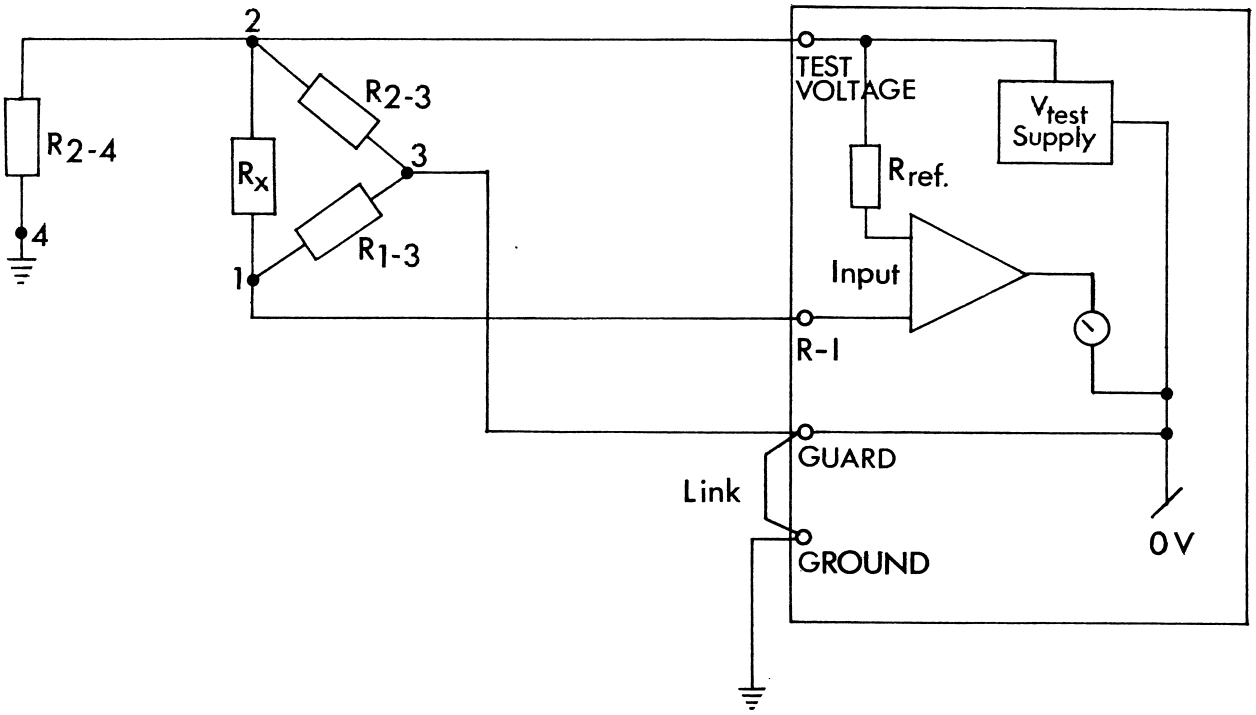


Fig.D5. Guard circuit principle.

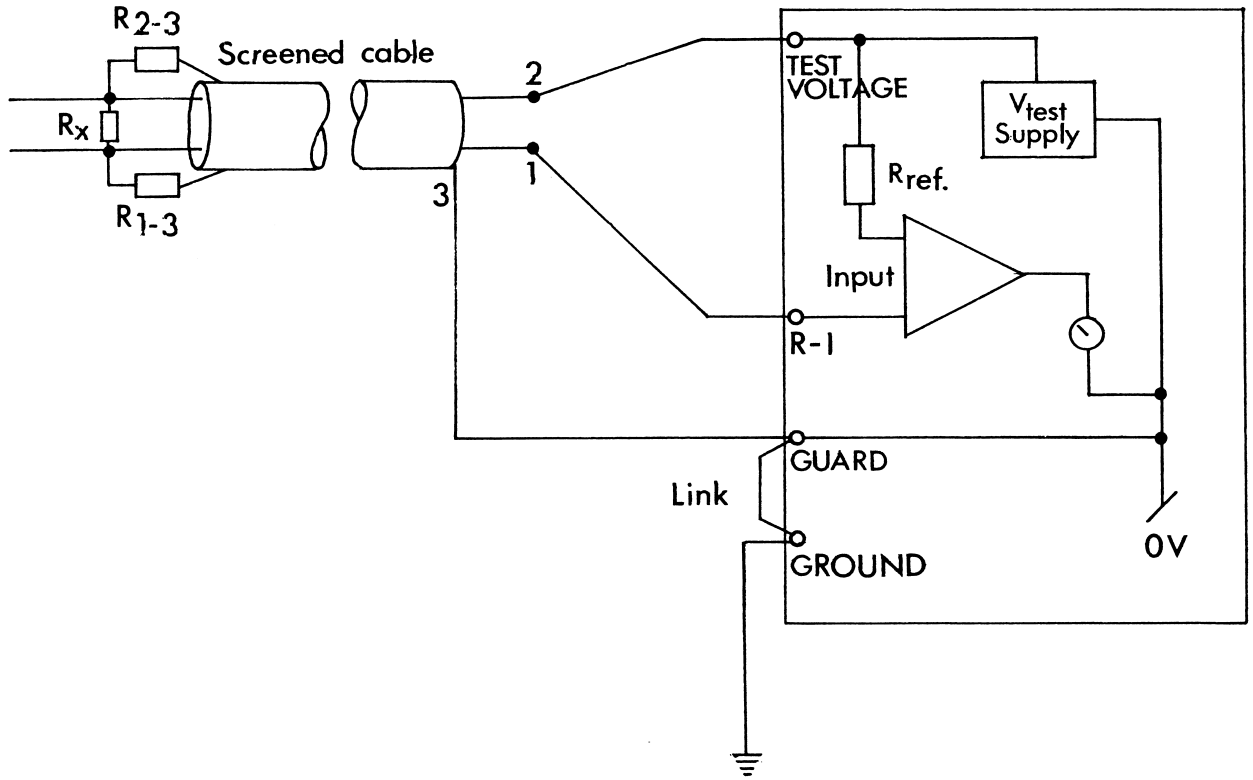


Fig.D6. Guard circuit - cable measurements.

Pins 9-10 -21 V dc source for connection to an external TEST VOLTAGE ON indicator lamp. Max. current 50 mA.

x) 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 1-3 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 1-6 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 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.D5 and D6.

Fig.D5 illustrates a test arrangement for measuring the specific resistance of an insulating material represented by R_x, 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.D5 shows an equivalence diagram where the leakage currents are represented by the equivalent leakage resistances R_{2-3}, R_{2-4} and R_{1-3}. It can be seen that R_{2-3} will, in effect, load the V_{test} supply, but this is not important if R_{2-3} is greater than about 1 MΩ. R_{1-3} shunts the input, but if its value is not much less than R_x, it will have no influence on the measurements. R_{2-4} shunts R_x and is in parallel with R_{2-3}. This is of no importance, however, if R_{2-4} and R_{2-3} in parallel are greater than about 1 MΩ. If, however, R_{2-4} and R_{2-3} in parallel are less than about 1 MΩ, the captive link may be reconnected between the GROUND and the TEST VOLTAGE terminals, which will cancel the effects of R_{2-4}. R_{2-3}, however, will continue to load the test voltage supply and should be greater than about 1 MΩ. Fig.D6 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 R_{1-3} and R_{2-3} do not affect the measurements. However, again, R_{2-3} loads the V_{test} supply, but this will be of no importance if it is greater than about 1 MΩ. Likewise, R_{1-3} will again shunt the input, but will be of no importance if its value is not much less than that of R_x.

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 MΩ resistor to the R_x 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).

PART II
SERVICE INSTRUCTIONS

SECTION A - SERVICE NOTES

Below will be found details of changes made to the IM6.

As both the original and the new components identifications are given, this Service Manual may be used with instruments of earlier serial numbers than those given in the subheadings. Future changes will be made the subject of Service Notes, which should be inserted in this section.

From app. No. 187966

I2, lamp, 1.2 W, 400-810 changed to 0.52 W, 400-813.

R2, pot., 10 kΩ, 182-108 introduced.

Q107, transistor, BC157, 360-100 changed to 2N5087, 360-087.

R263, resistor, 200 Ω, 0.1% changed to 0.05%.

R265, resistor, 200 Ω, 0.1% changed to 0.05%.

R267, resistor, 200 Ω, 0.1% changed to 0.05%.

R268, resistor, 200 Ω, 0.1% changed to 0.05%.

R269, resistor, 200 Ω, 0.1% changed to 0.05%.

R271, resistor, 200 Ω, 0.1% changed to 0.05%.

R273, resistor, 200 Ω, 0.1% changed to 0.05%.

R274, resistor, 316 Ω, 1%, 140-481 changed to 309 Ω, 0.5%, 140-783.

CR300, diode, 10D8, 350-417 changed to BB8, 350-423.

CR301, diode, 10D8, 350-417 changed to BB8, 350-423.

R305, pot., 2 kΩ, 193-006 changed to 193-001.

CR404, diode, 10D8/350-417 changed to BB8, 350-423.

CR405, diode, 10D8, 350-417 changed to BB8, 350-423.

CR406, diode, 10D8, 350-417 changed to BB8, 350-423.

CR407, diode, 10D8, 350-417 changed to BB8, 350-423.

R422, resistor, 18 Ω, 106-218 changed to 15 Ω, 106-215.

From app. No. 192056

P1 plug, 805-709 changed to 805-706.

R2 potentiometer 100 Ω, 182-040 changed to 47 Ω, 182-042.

CORRECTIONS TO THE IM6 SERVICE INSTRUCTIONS

Page E - 9 R2 should be 0.99 MΩ throughout.
Position of the MULTIPLIER switch should be 10^5 throughout.

Page E - 10, step 80, line 1: Change GUARD to GROUND.

Page F - 5, steps 45 and 46: Replace R2 by R237 and vice versa.
Steps 45 and 46 should also be in reverse order.
Add, at the end of step 46, the following:

If trimmer R279 is found in the instrument, carry out the following:

a) Set the thumb-wheel switches to 010.

b) Read the digital voltmeter.

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.

SECTION B - TECHNICAL DESCRIPTION

OPERATING PRINCIPLE

Figure B - 1 shows the operating principle of the IM6 Megohmmeter. Current from the Test Voltage Supply flows through resistor R_x to logarithmic amplifier Log. Amp. I and through reference resistor $R_{ref.}$ to logarithmic amplifier Log. Amp. II. The difference between the outputs of the two log amplifiers (V_o) is measured and is equal to $\log R_x$ when $R_{ref.} = 1$.

$$V_o = \log I_{ref.} - \log I_x$$

$$= \log \frac{V_{test}}{R_{ref.}} - \log \frac{V_{test}}{R_x}$$

$$= \log \frac{R_x}{R_{ref.}}$$

For $R_{ref.} = 1$, $V_o = \log R_x$

GENERAL DESCRIPTION

Figure B - 2 shows a block diagram of the IM6 Megohmmeter. The test voltage is applied to the resistor under test, R_x. The current through R_x is fed to a logarithmic amplifier - directly if the current through R_x 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 $\log \frac{V_{test}}{R_x}$. A corresponding reference current passing through a reference resistor, R_{ref}, is applied to a second amplifier, Log. Amp. II, whose output is equal to $\log \frac{V_{test}}{R_{ref}}$. This results in a

difference voltage at the emitter of Q204b which, with $R_{ref} = 1$, becomes log R_x.

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 volt 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. B - 2 and circuit diagrams 1329 - A1, 1330 - A1 and 1331 - A1 found at the end of this manual.

TEST VOLTAGE SUPPLY (See diagrams 1329 - A1, 1331 - A1 and Fig. B-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 1329 - A1) 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 decade switches, the outputs of which are fed via the MEGOHMS/PICOAMPS switch and shielded cable W3 to the input of the regulation amplifier (diagram 1331 - A1, 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 driv 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 R_x 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 - R415, to the input of the regulator amplifier. The 10 kHz multivibrator is conventional and built up around transistors Q404 and Q405.

INPUT AMPLIFIER (See diagram 1330-A1 and Fig. B-2)

When R_x is connected between the R-I and TEST VOLTAGE terminals and a test voltage is applied, current will flow through R_x. 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:

$$A_i = \frac{i_{out}}{i_{in}} = \frac{R111 + R110}{R110} \approx 4 \times 10^4.$$

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 1329-A1, reference voltage supply, printed circuit board J3). Adequate dc isolation of the circuit is achieved by means of styroflex capacitors C104 and C105. I_{test} is fed from Q102/CR100 via cable W2 to Log. Amp. I.

LOGARITHMIC AMPLIFIERS I and II (see diagrams 1330-A1 and Fig. B-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 R_{ref} (R221-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.

LIMIT SENSOR (See diagram 1330-A1 and Fig. B-2)

When I_{test} 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 I_{test} 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, whereafter K100 will also release. I_{test} will then bypass the current amplifier.

METER CIRCUIT

The output voltage from the emitter of Q207 is fed via the attenuator/range switch, MULTIPLIER, to the meter circuit (see diagram 1329-A1, 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.

POWER SUPPLY (See diagram 1329-A1)

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.

SECTION C - SPECIFICATIONS

RESISTANCE MEASUREMENT

Ranges:

1. 1 MΩ to 10^9 in 1 range of 9 decades
2. 1 MΩ to 10^9 in 8 ranges of 2 decades

Scales:

2 logarithmic: upper - 2 decades
lower - 9 decades

Accuracy:

With $R_x \leq V_{test} \times 10^6$ MΩ: 5% of the indicated value

With $R_x > V_{test} \times 10^6$ MΩ: $\left[\frac{R_x \ [M\Omega]}{V_{test}} \times 10^{-6} \times 5\% \right]$ of the indicated value

Input resistance:

10 kΩ for $I_{test} > 2$ nA
1 MΩ for $I_{test} < 2$ nA

Recorder output:

-0.5 V ±0.5% per decade ±10 mV
At 1 MΩ, 0 V ±10 mV
R_{out} = 10 kΩ

TEST VOLTAGE

Range:

Internal control: 0-999 V in 1 V steps by means of 3 thumb-wheel switches showing direct digital value of selected voltage.

External control: 2 inputs:

1. $V_{test} = 10 \times (-V_{ext})$, V_{ext} MAX. = 100 V dc

   ($-V_{ext}$ of minus 0-100 V dc provides 0-1000 V_{test})

2. $V_{test} = 100 \times (-V_{ext})$, V_{ext} MAX. = 10 V dc

($-V_{ext}$ of minus 0 - 10 V dc provides 0 - 1000 V_{test})

Accuracy: ±5%

Stability: Better than 10^{-7} for ±10% line voltage variation

Temperature stability: ±0.01%/°C. ($V_{test} \geq 10$ V)

Short-circuit current: Max. 2 mA

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

Source resistance: 10 kΩ

DC CURRENT MEASUREMENT

Ranges:
1. 1 pA - 1 mA in one 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

Input resistance:
10 kΩ for $I_x > 2$ nA
1 MΩ for $I_x < 2$ nA

Recorder output:
0.5 V ±0.5% per decade ±10 mV
At 10 µA, 0 V ±10 mV
R_{out} = 10 kΩ

MEASURING TIME

Resistance:
<1 sec. with I_x >10 nA
<3 sec. with 10 nA > I_x >1 pA

Capacitors:	Charge: for C_x < 1 µF: ≤ 3 sec. for C_x > 1 µF: $t = C_x (V_{test} \times 10^{+3} + 0.3)$ Discharge: $t = 0.1 \times C_x$ (with V_{test} falling to 1% of the test value) (C_x in µF, t in seconds, V_{test} in volts)
GUARD	GUARD terminal is connected to 0 V line (chassis), but isolated from the GROUND terminal
POWER REQUIREMENTS	220/115 V, 50 - 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

SECTION D - 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.

SECTION E - PERFORMANCE CHECK

SHORT CHECK

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 beginning on page E - 3

Necessary Equipment

Resistor, 1 GΩ (10^9 Ω)
Battery, 1.5 V
(mA meter, 0 - 1 mA)

The accuracy of the following resistance measurement depends primarily upon the accuracy of the 1 GΩ 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 GΩ 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 approximately 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 GΩ 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 approximately 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 approximately 10.)

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 - 1000 V dc ± 1% R_i ≥10 MΩ
2) Voltage source, 1 - 100 V dc ± 2%, internal impedance R_i < 5kΩ.
3) PHA860 pH meter tester
4) Resistor, 10 kΩ ± 1%
5) Resistor, 90 kΩ ± 1% - R_i, where R_i = where R_i = the internal resistance of the voltage source.
6) Resistor, 0.99 MΩ ± 1%
7) Resistor, 1.11 MΩ ± 1%
8) Resistor, 10 MΩ ± 1%
9) Resistor, 100 MΩ ± 1%
10) Resistor, 1 GΩ ± 1%
11) Resistor, 10 GΩ ± 1%

(6) to (11): the tolerance is valid up to 100 V

12) Resistor, 1 TΩ (10^{12} Ω) ± 1% - the tolerance is valid up to 10 V

When using the two largest resistors (10 GΩ and 1 TΩ) it is necessary that these resistors be placed within a metal screen which should be connected to the GUARD terminal of the IM6. (Fig. E-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 - 1.04 V
002	1.92 - 2.08
004	3.84 - 4.16
008	7.68 - 8.32
010	9.6 - 10.4
020	19.2 - 20.8
040	38.4 - 41.6
080	76.8 - 83.2
100	96 - 104
200	192 - 208
400	384 - 416
800	768 - 832
999	959 - 1039

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

EXT. TEST VOLTAGE X 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 ($-V_{ext.}$ x 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 - 103.8 V.

EXT. TEST VOLTAGE X 100

14) Set the TEST VOLTAGE toggle switch to OFF.

15) Move the voltage source wire from terminal J6/6 to terminal J6/3 ($-V_{ext.}$ x 10).

16) Set the toggle switch to ON (upwards).

17) Check to see that the voltmeter reads 949 - 1028 V.

18) Remove the voltmeter.

19) Remove the voltage 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.

V_{test} 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 toggle switch's position.

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 MΩ 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 IM6's meter.

34) Set the toggle switch to ON (upward).

35) Check to see that the IM6 reads 10^2 MΩ ± 4.5 MΩ.

36) Set the MULTIPLIER switch to 10^2.

37) Check to see that the IM6 reads 0.955 - 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 - 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- 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 MΩ resistor connected to the R-I and TEST VOLTAGE terminals, and connect in its place a resistor of 0.99 MΩ ±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 - 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 MΩ resistor connected to screw terminals R -I and TEST VOLTAGE, and connect a 10 GΩ 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 - 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 GΩ resistor connected to screw terminals R-I and TEST VOLTAGE and connect a 1 TΩ 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 - 1.045 and that the voltmeter reads -2970 to -3030 mV.

58) Set the toggle switch to OFF.

59) Remove the 1 TΩ resistor.

Input resistance for a current $> 3 \times 10^3$ 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 kΩ ± 1% resistor.

62) Set the MULTIPLIER switch to 10^7.

63) Check to see that the IM6 reads 4.65 - 5.15.

Input resistance for a current $< 3 \times 10^3$ pA

64) Replace the 1 V source with the PHA860 pH Meter Tester.

65) Set the PHA860 at -10 mV, SOURCE RESISTANCE 0.

66) Replace the 10 kΩ resistor with a 10 MΩ ± 1% resistor.

67) Set the MULTIPLIER switch to 10^2.

68) Check to see that the IM6 reads 8.5 - 9.7.

MULTIPLIER switch and RECORDER/REMOTE CONTROL output

(See figure E-2 and the table in step 77.)

69) Set the voltage source to 100 V ±2%.

70) Remove the 10 MΩ resistor, and replace it with a resistor of 90 kΩ - R_i, where R_i 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 resistance of 10 kΩ.)

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 - 10.45 and that the voltmeter reads +0.985 - +1.015.

77) Remove the 90 kΩ (90 kΩ - R_i) resistor, and check the IM6 according to Fig. E-2 and the following table.

78) Remove resistors R_1, R_2, and R_3 and the voltage source.

79) Remove the voltmeter connected to terminals J6/7 and J6/8 on the RECORDER/REMOTE CONTROL socket.

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 - -3.0[illegible]

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	10 M	∞	1.0	10^5	9.55 - 10.45	-0.488 - -0.512
900	0	10 M	∞	0.9	10^5	8.60 -9.40	-0.508 - -0.538
800	0	10 M	∞	0.8	10^5	7.64 -8.36	-0.534 - -0.564
700	0	10 M	∞	0.7	10^5	6.69 -7.31	-0.563 - -0.593
600	0	10 M	∞	0.6	10^5	5.73 -6.27	-0.596 - -0.626
500	0	10 M	∞	0.5	10^5	4.78 -5.22	-0.635 - -0.665
400	0	10 M	∞	0.4	10^5	3.82 -4.18	-0.685 - -0.715
300	0	10 M	∞	0.3	10^5	2.87 -313	-0.747 - - 0.777
200	0	10 M	∞	0.2	10^5	1.191 -2.09	-0.835 - -0.865
100	0	10 M	∞	0.10	10^7	0.955 -1.04	-0.985 - -1.015
90	0	10 M	∞	0.09	10^7	0.860 -0.940	-1.006 - -1.040
80	0	10 M	∞	0.08	10^7	0.764 -0.836	-1.032 - -1.066
70	0	10 M	∞	0.07	10^7	0.669 -0.731	-1.061 - -1.095
60	0	10 M	∞	0.06	10^7	0.573 -0.627	-1.094 - -1.128
50	0	10 M	∞	0.05	10^7	0.478 -0.522	-1.133 - -1.167
40	0	10 M	∞	0.04	10^7	0.382 -0.418	-1.183 - -1.217
30	0	10 M	∞	0.03	10^7	0.287 -0.313	-1.245 - -1.279
20	0	10 M	∞	0.02	10^7	0.191 -0.209	-1.333 - -1.367
10	0	10 M	∞	0.01	10^7	0.096 -0.104	-1.483 - -1.517

Insulation between GUARD and GROUND

80) Connect the terminal strap across GROUND and TEST VOLTAGE instead of across GUARD and GROUND.

81) Connect a 100 MΩ ±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 - 1.045.

87) Set the toggle switch to OFF.

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 MΩ resistor.

SECTION F - REPAIR, REALIGNMENT AND MAINTENANCE

REPAIR

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 Radiometer 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.

	collector (drain)	base (gate)	emitter (source)
Q100	0	-7.7	-8.1
Q101	0	+7.7	+8.1
Q102	-8.7	-1.8	-0.8
Q103	0	0	0
Q104	0	0	0
Q105A	+6.7	0	+0.4
Q105B	+6.7	0	+0.4
Q106	0	0	0
Q107	-12	+12	+12
Q108	+12	-12	-12
Q109	+12	-12	-12
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
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	-0.6
Q207	+1.8	0	-0.6
Q208	0	-2.3	0
Q300	0 (8.5 ac)	-12	-10.5
Q301	+24.5	-9.0	-9.6
Q302	-10	+24.5	+24.5
Q303	+24.5	-10	-10.5
Q501	+12	+23	+23.5
Q502	23	+2.8	+2.25
Q503	-21	-3.8	-3.3
Q504	-12	-21	-21.5

	collector (drain)	base (gate)	emitter (source)
Q400A	+6.2	0	+0.9
Q400B	+6.2	0	+0.9
Q401	+12	-8.4	-9.0
Q402	-7.0	-10.5	-11
Q403	-7.0	-10.5	-11
Q404	-9(1.6 ac)	-11.3	-11
Q405	-9	-11.3	-11

REALIGNMENT

Necessary Equipment

PHA860 pH meter tester

GVM30 Galvanometer

Digital voltmeter capable of measuring 10 V and 12 V ±0.1%. (The PHA860 in combination with the GVM30 can also be used.)

Resistor: 0.99 MΩ ±0.5%	1 - 1000 V see remarks on page E - 3 concerning screening of resistor
Resistor: 100 MΩ ±1%	
Resistor: 1 GΩ ±1%	
Resistor: 10 GΩ ±1%	

(See figure F - 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 1100) does not touch the back plate.

Realignment Procedure

1) Connect a digital voltmeter to print board terminal J1/4 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 digital voltmeter reads +12 V ±12 mV.
5) Move the voltmeter wire from print board terminal J1/4 to J2/9.
6) Adjust trimmer R305 so that the digital voltmeter reads 10 V ±20 mV.
7) Remove the digital voltmeter.
8) Connect a 1 GΩ 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 GVM30 Galvanometer 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 GVM30 reads 0 V ±0.1 mV.

18) Move the GVM30 wire from screw terminal R-I to print board terminal J5/5.

19) Adjust trimmer R121 so that the GVM30 reads -0.2 V ±10 mV.

20) Repeat the adjustment of R118 and R121 (points 15-18).

21) Remove the GVM30, the 1 GΩ resistor and the top plate.

22) Connect a PHA860 pH meter tester as a voltage source to the GUARD and R-I screw terminals.

23) Set the PHA860 to -120 mV, SOURCE RESISTANCE 100 MΩ.

24) Turn trimmer R253 slowly counterclockwise until the relays click.

25) Set the PHA860 to -220 mV.

26) Turn trimmer R257 slowly clockwise until the relays click again.

27) Remove the PHA860.

28) Connect the GVM30 Galvanometer to print board terminals J4/24 (LOW) and J4/25 (HIGH).

29) Connect a 1 GΩ ±1% resistor to the TEST VOLTAGE and R-I screw terminals.

30) Depress the MEGOHMS button.

31) Set the thumb-wheel switches to 001 and further to 003. The relays will now click.

32) Adjust trimmer R203 so that the GVM30 reads 0 V ±5 mV.

33) As in step 31.

34) If the GVM30 now reads outside ±5 mV, repeat from step 31.

35) Remove the 1 GΩ resistor and the GVM30 Galvanometer.

36) Set the toggle switch to OFF.

37) Adjust the meter's mechanical zero point.
(The adjusting screw is located behind a plug halfway between the GROUND and TEST VOLTAGE screw terminals.)

38) Set the toggle switch to ON (upward).

39) Connect a 0.99 MΩ ±0.5% resistor to the TEST VOLTAGE and R-I screw terminals.

40) Set the MULTIPLIER switch to 10.

41) Set the TEST VOLTAGE thumb-wheel switches to 100.

42) Adjust trimmer R241 so that the IM6 reads 0.1.

43) Connect a digital voltmeter to terminals J6/7 (0 V) and J6/8 (-0.5 V/decade) on the RECORDER/REMOTE CONTROL socket.

44) Connect a 100 MΩ ±1% resistor to the TEST VOLTAGE and R-I screw terminals instead of the 0.99 MΩ resistor.

45) Adjust trimmer R237 so that the IM6 reads 10 (full scale deflection).

46) Adjust trimmer R2, which is mounted on a small print board on the back of the meter, so that the digital voltmeter reads -1000 mV ±2 mV. (For IM6 serial numbers prior to 182220, there is no potentiometer, and the resistance must be adjusted as shown in figure F-2.)

47) Remove the digital voltmeter and the 100 MΩ resistor.

48) Connect a 10 GΩ ±1% resistor to the TEST VOLTAGE and R-I screw terminals.

49) Set the MULTIPLIER switch to 10^5.

50) Adjust trimmer R277 so that the IM6 reads .1.

51) Set the TEST VOLTAGE thumb-wheel switches to 005.

52) Wait until the relays have clicked and adjust trimmer 262 so that the IM6 reads .1.

53) Remove the 10 GΩ resistor.

Changing the line voltage

From 220 V ac to 115 V ac, 50-60 Hz

1) Disconnect the power cord.

2) Remove the 4 screws which hold the plate through which the power cord runs, and pull the plate away.

3) Unscrew the ground wire solder lug.

4) Remove the two other wires from print board 970-252.

5) Move the short circuit from terminals 3 and 5 to terminals 1 and 3 on print board 970-252.

6) Mount the 3 wires from the new line voltage unit 900-072, and fasten the 4 screws which hold the plate bearing the voltage declaration.

7) Replace the line fuse with a 250 mA, 5 x 20 mm, code 450-014 fuse. (Possibly a 6.3 x 32 mm, code 450-114 fuse can also be used.)

From 115 Vac to 220 Vac, 50-60 Hz

1) Disconnect the power cord.

2) Remove the 4 screws which hold the plate through which the power cord runs, and pull the plate away.

3) Unscrew the ground wire solder lug.

4) Remove the two other wires from print board 970-252.

5) Move the short circuit from terminals 1 and 3 to terminals 3 and 5 on print board 970-252.

6) Mount the 3 wires from the new line voltage unit 900-072, and fasten the 4 screws which hold the plate bearing the voltage declaration.

7) Replace the line fuse with a 125 mA, 6.3 x 32 mm, code 450-111 fuse. (Possibly a 5 x 20 mm, code 450-011 fuse can also be used.)

SECTION G - SPARE PARTS

The Parts List is prepared for instrument No. 192056 and thus updated in accordance with pages A - 1 and 2 in SECTION A - SERVICE NOTES. Changes relative to earlier instruments can be checked in these notes.

In the following parts list a group code prefix number is used. To facilitate the use of this code, the different types of parts and their corresponding group code prefixes are listed below:

Standard resistors	100- to 139-
Precision resistors	140- to 152-
Non-linear resistors	160-
UHF resistors	170- to 172-
Carbon potentiometers	180- to 185-
Wire-wound potentiometers	190- to 195-
Mica capacitors	200- to 208-
Ceramic capacitors	210- to 214-
Paper capacitors	220- to 222-
Metal-paper capacitors	224- to 229-
Plastic capacitors	240- to 245-
Electrolytic capacitors	260- to 267-
Variable capacitors	280- to 286-
Special tubes	310-
Rectifiers	340- to 341-
Diodes	350-
Transistors	360-
Integrated circuits	364-
Lamps, batteries, fuses	400- to 486-
Switches	500- to 580-
Coils, coil material and transformers	700- to 785-

x Indicates that the component is made by Radiometer.

As we are continually improving our instruments, it is important, when ordering spa parts, that you include the following information:

The code number and description of the part

The circuit reference from the wiring diagram

The complete type designation of your instrument

The serial number of your instrument.

The position of the parts mounted on the printed circuit boards can be found by referring to the Figures G-1, G-2, G-3, G-4 and G-5.

MAIN PARTS LIST

FUSES

Designation	Type	Code No.
F1	fuse, 250 mA for 115 V, ø 6.3 x 32 mm	450-114
F2	fuse, 125 mA for 220 V, ø 5 x 20 mm	450-011

LAMPS

Designation	Type	Code No.
I1	lamp, 24 V 0.02 A	400-902
I2	lamp, 24 V 0.52 W, red	400-815

MULTICONNECTORS AND TERMINALS

Designation	Type	Code No.
J1	edge connector, 18-pole	805-657
J2	edge connector, 18-pole	805-657
J3	edge connector, 30-pole	805-658
J4	edge connector, 30-pole	805-658
J5	edge connector, 24-pole	805-667
J6	multiconnector, 12-pole	805-454
J7	binding post, insulated, green	807-039
J8	binding post, insulated, black	807-031
J9	binding post, insulated, red	807-032
J10	binding post, insulated, black	807-031
P1	plug for print, ø 1.3	805-709

METER

Designation	Type	Code No.
M1	meter, 450 µA, with scale	482-155

RESISTOR

	Designation	Type	Code No.
	R1	carbon pot. 10 kΩ line (SET TO .1)	182-108
	R2	carbon pot. 100 Ω	182-040

SWITCHES

	Designation	Type	Code No.
	S1	switch with built-in lamp, red, "POWER"	501-000
	S2	switch, 3-bank, "TEST VOLTAGE"	546-006
	S3	switch, "MULTIPLIER"	551-078
	S4	switch, rocker, "MEGOHMS/PICOAMPS"	551-077
	S5	switch, lock/non-lock, "TEST VOLTAGE - ON/OFF"	510-103
	S6	switch, slide, "INT/EXT."	510-204

TRANSFORMER

	Designation	Type	Code No.
×	T1	line transformer	770-619

CABLES

	Designation	Type	Code No.
	W1	coaxial cable RG174, 0.3 m	400-008
	W2	coaxial cable RG174, 0.1 m	600-008

MAIN LEAD UNITS

		Type	Code No.
×		main lead unit for 115 V	900-072
×		main lead unit for 220 V	900-073

MISCELLANEOUS

Type	Code No.
pushbuttons	550-021
cover for knob ø 21, grey	852-602
knob ø 21, black	852-619
rubber foot	855-001
plug button, ø 5	856-012

INPUT AMPLIFIER PRINTED CIRCUIT BOARD, CODE 900-375

CAPACITORS

Designation	Type	Value	Code No.
C100	polyester	0.33 µF 10% 100 V	241-024
C101	polyester	0.22 µF 10% 63 V	241-036
C102	styroflex	10 nF 1% 63 V	243-020
C103	polystyrene	4.7 nF 63 V	243-021
C104	polystyrene	16 nF 1% 63 V	243-018
C105	polystyrene	16 nF 1% 63 V	243-018
C106	ceramic	33 pF 5%	210-233
C107	styroflex	100 pF 5% 160 V	243-037
C108	polyester	0.1 µF 10% 100 V	241-025
C109	polyester	0.68 µF 10% 63 V	241-030
C110	tantalum	2 µF 25 V	267-007

DIODES

Designation	Type	Code No.
CR100	zener diode BZY88C9V1	350-606
CR101	diode BAX16	350-023
CR102	diode BAX16	350-023
CR103	diode BAX16	350-023

DIODES (cont'd.)

Designation	Type	Code No.
CR104	diode BAX16	350-023
CR105	diode BAX16	350-023
CR106	diode BAX16	350-023
CR107	diode BAX16	350-023

JACK

Designation	Type	Code No.
J1	jack, printed circuit	805-708

RELAYS

Designation	Type	Code No.
K100	relay, single contact	570-055
K101	relay, single contact	570-055
K102	relay, 4 contacts	570-036

RESISTORS

Designation	Type	Value	Code No.
R100	carbon film	470 kΩ 5% 0.2 W	106-647
R101	carbon film	180 kΩ 5% 0.2 W	106-618
R102	carbon film	5 kΩ 5% 0.5 W	143-002
R103	carbon film	18 kΩ 5% 0.2 W	106-518
R104	carbon film	5 kΩ 5% 0.5 W	143-002
R105	carbon film	2.5 MΩ 0.5% 0.5 W	143-003
R106	carbon film	2.5 MΩ 0.5% 0.5 W	143-003
R107	carbon film	100 Ω 5% 0.2 W	106-310
R108	carbon film	330 kΩ 5% 0.2 W	106-633
R109	carbon film	10 kΩ 5% 1 W	101-510
R110	metal film	50 kΩ 1% 0.25 W	140-405
R11	special high resistance	2 GΩ 1%	145-005

RESISTORS (cont'd.)

Designation	Type	Value	Code No.
R112	carbon film	1 MΩ 5% 0.2 W	106-710
R113	metal film	464 kΩ 1% 0.25 W	140-456
R114	metal film	100 kΩ 1% 0.1 W	140-474
R115	metal film	464 kΩ 1% 0.25 W	140-456
R116	carbon film	390 kΩ 5% 0.2 W	106-339
R117	carbon film	180 kΩ 5% 0.2 W	106-618
R118	carbon pot.	100 kΩ 0.1 W	182-035
R119	carbon film	10 kΩ 5% 0.2 W	106-510
R120	carbon film	1 MΩ 5% 0.2 W	106-710
R121	trimmer pot.	10 kΩ 0.1 W	182-033
R122	carbon film	10 kΩ 5% 0.2 W	106-510
R123	carbon film	1 kΩ 5% 0.2 W	106-410
R124	carbon film	100 kΩ 5% 0.2 W	106-610
R125	carbon film	320 kΩ 5% 0.2 W	106-622
R126	carbon film	330 kΩ 5% 0.2 W	106-633
R127	carbon film	68 kΩ 5% 0.2 W	106-568
R128	carbon film	1 kΩ 5% 0.2 W	100-410
R129	carbon film	10 kΩ 5% 0.2 W	106-510
R130	carbon film	12 kΩ 5% 0.2 W	106-512
R131	carbon film	12 kΩ 5% 0.2 W	106-512
R132	carbon film	2.7 kΩ 5% 0.2 W	106-427
R133	carbon film	22 kΩ 5% 0.2 W	106-522

SEMICONDUCTORS

Designation	Type	Code No.
Q100	transistor 2N930	360-038
Q101	transistor 2N2905A	360-073
Q102	MOS-FET 3N157A (3N157A replaced by 3N164)	360-121
Q103	transistor 2N930	360-038
Q104	transistor 2N930	360-038
Q105	diff. FET WD017 (WD017 replaced by AD832)	360-113

SEMICONDUCTORS (cont'd.)

Designation	Type	Code No.
Q106	transistor 2N5087	360-087
Q107	transistor 2N5087	360-087
Q108	transistor BC147	360-074
Q109	transistor BC147	360-074
QA100	operational amp. LM301A	364-016

LOG. AMP. PRINTED CIRCUIT BOARD, CODE 900-374

CAPACITORS

Designation	Type	Value	Code No.
C200	ceramic	47 nF -20+80% 30 V	213-016
C201	ceramic	2.2 nF -20+80% 25 V	213-012
C202	polystyrene	4.7 nF 5% 63 V	243-021
C203	polyester	33 nF 20% 250 V	241-021
C204	polyester	10 nF 20% 250 V	241-020
C205	polyester	0.22 µF 10% 63 V	241-032
C206	tantalum	10 µF -20+80% 15 V	267-000
C207	ceramic	47 nF -20+80% 30 V	213-016
C208	ceramic	2.2 nF -20+80% 25 V	213-012
C209	ceramic	10 nF -20+80% 40 V	213-020
C210	polystyrene	200 pF 5% 160 V	243-001
C211	ceramic	4.7 nF -20+80% 40 V	213-010
C212	polyester	1 µF 10% 63 V	241-027
C213	polyester	1 µF 10% 63 V	241-027

DIODES

Designation	Type	Code No.
CR200	diode BAX16	350-023
CR201	diode BAX16	350-023
CR202	diode BAX16	350-023
CR203	diode BAX16	350-023

RESISTORS

Designation	Type	Value	Code No.
R200	carbon film	470 kΩ 5% 0.2 W	106-647
R201	carbon film	4.7 kΩ 5% 0.2 W	106-447
R202	carbon film	4.7 kΩ 5% 0.2 W	106-447

RESISTORS (cont'd.)

Designation	Type	Value	Code No.
R203	trimmer pot.	10 kΩ 0.1 W	182-033
R204	carbon film	39 kΩ 5% 0.2 W	106-539
R205	carbon film	47 kΩ 5% 0.2 W	106-547
R206	carbon film	47 kΩ 5% 0.2 W	106-547
R207	carbon film	18 kΩ 5% 0.2 W	106-518
R208	carbon film	1.5 kΩ 5% 0.2 W	106-415
R209	carbon film	1 kΩ 5% 0.2 W	106-410
R210	carbon film	15 kΩ 5% 0.2 W	106-515
R211	carbon film	2.2 kΩ 5% 0.2 W	106-422
R212	carbon film	820 Ω 5% 0.2 W	106-382
R213	carbon film	2.7 kΩ 5% 0.2 W	106-427
R214	carbon film	1 kΩ 5% 0.2 W	106-410
R215	carbon film	390 Ω 5% 0.2 W	106-339
R216	carbon film	5.6 kΩ 5% 0.2 W	106-456
R217	carbon film	1 kΩ 5% 0.2 W	106-410
R218	carbon film	4.7 Ω 5% 0.2 W	106-447
R219	metal film	4.99 kΩ 1% 0.1 W	140-422
R220	carbon film	20 MΩ 2% 0.5 W	143-023
R221	carbon film	10 MΩ 1% 0.5 W	143-008
R222	carbon film	10 MΩ 1% 0.5 W	143-008
R223	carbon film	10 MΩ 1% 0.5 W	143-008
R224	carbon film	10 MΩ 1% 0.5 W	143-008
R225	carbon film	125 MΩ 5% 0.5 W	143-052
R226	carbon film	1 kΩ 5% 0.2 W	106-410
R227	metal film	10 kΩ 1% 0.1 W	140-423
R228	copper wire-wound	22 Ω 1% at 25°C, TK=3900	172-007
R229	carbon film	27 kΩ 5% 0.2 W	106-527
R230	metal film	30.1 kΩ 1% 0.1 W	140-639
R231	metal film	30.1 kΩ 1% 0.1 W	140-639
R232	carbon film	1.5 kΩ 5% 0.2 W	106-415
R233	carbon film	22 Ω 5% 0.2 W	106-222
R234	carbon film	150 Ω 5% 0.2 W	106-315

RESISTORS (cont'd.)

	Designation	Type	Value	Code No.
	R235	metal film	200 Ω 1% 0.25 W	140-412
	R236	metal film	499 Ω 1% 0.1 W	140-582
	R237	carbon pot.	470 Ω lin.	182-038
	R238	metal film	2.49 kΩ 1% 0.25 W	140-464
	R239	carbon film	470 Ω 5% 0.5 W	104-347
	R240	metal film	10 kΩ 0.1 W	140-423
	R241	trimmer pot.	2.5 kΩ 0.1 W	182-031
x	R242	wire-wound	32.75 kΩ 0.1%	4244-A5
x	R243	wire-wound	10 kΩ 1%	152-032
x	R244	wire-wound	6.42 kΩ 0.1%	4245-A5
	R245	wire-wound	2.07 kΩ 0.1%	152-109
	R246	carbon film	10 kΩ 5% 0.2 W	106-510
	R247	carbon film	1 MΩ 5% 0.2 W	106-710
	R248	carbon film	1.5 kΩ 5% 0.2 W	106-415
	R249	carbon film	270 kΩ 5% 0.2 W	106-627
	R250	carbon film	47 kΩ 5% 0.2 W	106-547
	R251	carbon film	82 kΩ 5% 0.2 W	106-582
	R252	carbon film	120 kΩ 5% 0.2 W	106-612
	R253	trimmer pot.	5 kΩ 0.1 W	182-032
	R254	carbon film	82 kΩ 5% 0.2 W	106-582
	R255	carbon film	180 kΩ 5% 0.2 W	106-618
	R256	carbon film	47 kΩ 5% 0.2 W	106-547
	R257	trimmer pot.	10 kΩ 0.1 W	182-033
x	R258	nickel wire-wound	1.8 kΩ	4246-A5
	R259	carbon film	2.2 kΩ 5% 0.2 W	106-622
	R260	metal film	850 Ω 10% 0.25 W	140-399
	R261	metal film	5.11 kΩ 1% 0.1 W	140-422
	R262	trimmer pot.	2.5 kΩ 0.1 W	182-031
x	R263	wire-wound	200 Ω 0.5%	152-034
	R264	carbon film	180 Ω 5% 0.2 W	106-318
	R265	wire-wound	200 Ω 0.5%	152-034

RESISTORS (cont'd.)

	Designation	Type	Value	Code No.
	R266	carbon film	68 Ω 5% 0.2 W	106-268
x	R267	wire-wound	200 Ω 0.5%	152-034
x	R268	wire-wound	200 Ω 0.5%	152-034
x	R269	wire-wound	200 Ω 0.5%	152-034
	R270	carbon film	47 Ω 5% 0.2W	106-247
x	R271	wire-wound	200 Ω 0.5%	152-034
	R272	metal film	150 Ω 1% 0.1 W	140-712
	R273	wire-wound	200 Ω 0.5%	152-034
	R274	metal film	309 Ω 0.5% 0.1 W	140-783
	R275	metal film	51.1 Ω 1% 0.1 W	140-504
	R276	metal film	2 kΩ 0.1 W	140-440
	R277	trimmer pot.	2.5 kΩ 0.1 W	182-031
	R278	carbon film	125 MΩ 5% 0.5 W	143-052

SEMICONDUCTORS

Designation	Type	Code No.
Q200	transistor BC157	360-100
Q201	diff. FET MT102B (MT102B replaced by 3N165)	
Q202	transistor BC147	360-074
Q203	transistor BC157	360-100
Q204	diff. transistor TD121 (TD121 replaced by LM394)	
Q205	diff. FET U232	360-103
Q206	transistor BC147	360-074
Q207	transistor BC157	360-100
Q208	transistor FET U1897	360-116
QA200	integrated circuit amp. 709	364-010
QA201	integrated circuit amp. 709	364-010
QA202	integrated circuit amp. 709	364-010

REF. VOLTAGE SUPPLY PRINTED CIRCUIT BOARD, CODE 900-372

CAPACITORS

Designation	Type	Value	Code No.
C300	tantalum	10 µF -20+50% 15 V	267-000
C301	polyester	2.2 µF 10% 63 V	241-031
C302	polystyrene	6.7 nF 5% 630 V	243-125
C303	polyester	0.1 µF 10% 250 V	241-017
C304	polyester	0.1 µF 10% 250 V	241-017
C305	polyester	27 nF 10% 400 V	240-527
C306	polyester	2.2 µF 10% 63 V	241-031
C307	ceramic	47 nF -20+80% 30 V	213-016
C308	ceramic	470 pF 10%	212-347

DIODES

Designation	Type	Code No.
CR300	diode BB8	350-423
CR301	diode BB8	350-423

RESISTORS

Designation	Type	Value	Code No.
R300	carbon film	4.7 kΩ 5% 0.2 W	106-447
R301	carbon film	100 Ω 5% 0.2 W	106-310
R302	carbon film	1 MΩ 5% 0.2 W	106-710
R303	carbon film	10 Ω 5% 0.2 W	106-210
R304	carbon film	8.2 kΩ 5% 0.5 W	100-482
R305	wire-wound trimmer pot.	2 kΩ (10K, 10%, 0.5W, 192-422)	193-001
R306	metal film	36.1 kΩ 1% 0.25 W ~~0.25%~~	140-404
R307	metal film	2 kΩ 0.25% 0.25 W	140-420

RESISTORS (cont'd.)

Designation	Type	Value	Code No.
R308	metal film	2 kΩ 0.25% 0.25 W	140-420
R309	carbon film	2 MΩ 0.5% 0.5 W	143-021
R310	carbon film	2.5 MΩ 0.5% 0.5 W	143-003
R311	carbon film	5 MΩ 1% 0.5 W	143-007
R312	carbon film	10 MΩ 1% 0.5 W	143-008
R313	carbon film	20 MΩ 2% 0.5 W	143-023
R314	metal film	500 kΩ 1% 1 W	140-720
R315	metal film	1 MΩ 1% 1 W	140-719
R316	metal film	2 MΩ 1% 1 W	140-721
R317	metal film	4 MΩ 1% 1 W	140-722
R318	metal film	500 kΩ 1% 1 W	140-720
R319	metal film	1 MΩ 1% 1 W	140-719
R320	metal film	2 MΩ 1% 1 W	140-721
R321	metal film	4 MΩ 1% 1 W	140-722
R322	metal film	500 kΩ 1% 1 W	140-720
R323	metal film	50 kΩ 1% 0.5 W	140-180
R324	carbon film	22 kΩ 5% 0.2 W	106-522
R325	carbon film	1.5 kΩ 5% 0.2 W	106-415
R326	carbon film	2.2 kΩ 5% 0.2 W	106-422
R327	carbon film	1.5 kΩ 5% 0.2 W	106-415
R328	carbon film	820 Ω 5% 0.2 W	106-383
R329	carbon film	3.9 MΩ 5% 0.5 W	100-739

TRANSFORMER

	Designation	Type	Code No.
x	T300	transformer, special	7236-A4

TRANSISTORS

Designation	Type	Code No.
Q300	transistor BFY50	360-125
Q301	transistor 2N930	360-038
Q302	transistor 2N2905	360-073
Q303	transistor TIP31A	360-122

TUBE

Designation	Type	Code No.
V300	voltage stabilizer ZZ1000	310-011

TEST VOLTAGE SUPPLY PRINTED CIRCUIT BOARD, CODE 900-373

CAPACITORS

Designation	Type	Value	Code No.
C400	polystyrene	474 pF 1% 63 V	243-144
C401	polystyrene	1 nF 1% 63 V	243-014
C402	polycarbonate	10 nF 1600 V	242-010
C403	ceramic	39 pF 5%	211-239
C404	tantalum	10 µF 15 V	267-000
C405	polycarbonate	10 nF 1600 V	242-101
C406	tantalum	10 µF 15 V	267-000
C407	polycarbonate	10 nF 1600 V	242-010
C408	polycarbonate	10 nF 1600 V	242-101
C409	polycarbonate	10 nF 1600 V	242-010
C410	polyester	47 nF 10% 250 V	241-035
C411	polycarbonate	2.2 nF 1600 V	242-009
C412	polyester	47 nF 10% 150 V	241-035
C413	polyester	33 nF 10% 250 V	241-021
C414	polyester	33 nF 10% 250 V	241-021
C415	tantalum	10 pF 15 V	267-000

DIODES

Designation	Type	Code No.
CR400	zener diode BZY88 C6V2	350-604
CR401	diode BAX16	350-023
CR402	diode BAX38	350-022
CR403	diode BAX38	350-022
CR404	diode BB8 BYV 96D	350-423
CR405	diode BB8	350-423 350-430
CR406	diode BB8	350-423
CR407	diode BB8	350-423
CR408	diode BAX16	350-023

DIODES (cont'd.)

Designation	Type	Code No.
CR409	diode BAX16	350-023
CR410	diode BAX16	350-023
CR411	diode BAX16	350-023
CR412	diode BAX16	350-023
CR413	diode BAX16	350-023

RELAY

Designation	Type	Code No.
R400	relay, 24 V, single contact	570-054

RESISTORS

Designation	Type	Value	Code No.
R402	carbon film	4.7 kΩ 5% 0.2 W	106-447
R403	metal film	20 kΩ 0.5% 0.1 W	140-473
R404	metal film	22.1 kΩ 1% 0.1 W	140-631
R405	metal film	20 kΩ 0.5% 0.1 W	140-473
R406	carbon film	4.7 kΩ 5% 0.2 W	106-447
R407	carbon film	1 kΩ 5% 0.2 W	106-410
R408	metal film	1 MΩ 1% 1 W	140-719
R409	metal film	1 MΩ 1% 1 W	140-719
R410	carbon film	1.5 kΩ 5% 0.2 W	106-415
R411	metal film	1 MΩ 1% 1 W	140-719
R412	carbon film	1.8 kΩ 5% 0.2 W	106-418
R413	metal film	1 MΩ 1% 1 W	140-719
R414	carbon film	1 kΩ 5% 0.2 W	106-410
R415	metal film	1 MΩ 1% 1 W	140-719
R416	carbon film	1 kΩ 5% 0.2 W	106-410
R417	carbon film	47 kΩ 5% 0.2 W	106-547
R418	carbon film	10 Ω 5% 0.2 W	106-210
R419	carbon film	150 Ω 5% 0.2 W	106-315

RESISTORS (cont'd.)

Designation	Type	Value	Code No.
R420	carbon film	10 kΩ 5% 1 W	101-510
R421	carbon film	10 kΩ 5% 1 W	101-510
R422	carbon film	15 Ω 5% 0.2 W	106-215
R423	carbon fim	150 Ω 5% 0.2 W	106-315
R424	carbon film	150 Ω 5% 0.2 W	106-315
R425	carbon film	330 Ω 5% 0.2 W	106-333
R426	carbon film	2.2 kΩ 5% 0.2 W	106-422
R427	carbon film	2.2 kΩ 5% 0.2 W	106-422
R428	carbon film	2.2 kΩ 5% 0.2 W	106-422
R429	carbon film	2.2 kΩ 5% 0.2 W	106-422
R430	carbon film	150 Ω 5% 0.2 W	106-315
R431	carbon film	330 Ω 5% 0.2 W	106-333

TRANSFORMER

	Designation	Type	Code No.
x	T400	transformer, special	7237-A4

SEMICONDUCTORS

Designation	Type	Code No.
Q400	diff. FET U232	360-103
Q401	transistor 2N1711	360-047
Q402	transistor BFY50	360-125
Q403	transistor BFY50	360-125
Q404	transistor BC147A	360-074
Q405	transistor BC147A	360-074
QA400	integrated circuit amp. 709	364-010

CABLE

Designation	Type	Code No.
W3	coaxial cable RG196/U, 0.15 m	600-014

POWER SUPPLY PRINRED CIRCUIT BOARD, CODE 900-371

CAPACITORS

Designation	Type	Value	Code No.
C501	electrolyte	1000 µF 50 V	260-056
C502	electrolyte	1000 µF 50 V	260-056
C503	ceramic	33 pF 5% NPO	210-233
C504	polystyrene	150 pF 5% 63 V	243-030
C505	polystyrene	150 pF 5% 63 V	243-030
C506	ceramic	33 pF 5%	210-233
C507	ceramic	2.2 nF 20%	212-422
C508	ceramic	2.2 nF 20%	212-422
C509	polyester	1 µF	241-027
C510	polyester	1 µF	241-027

DIODES AND RECTIFIER

Designation	Type	Code No.
CR503	rectifier B80/C2200	340-204
CR504	zener diode BZY88 C9V1	350-606
CR505	zener diode BZY88 C9V1	350-606
CR507	reference diode IN3497	350-637

RESISTORS

Designation	Type	Value	Cable No.
R501	wire-wound	1.8 Ω	121-118
R502	carbon film	39 kΩ 5% 0.2 W	106-239
R503	carbon film	560 Ω 5% 0.5 W	100-356
R504	carbon film	33 kΩ 5% 0.2 W	106-533
R505	carbon film	100 Ω 5% 0.5 W	100-310
R506	carbon film	220 kΩ 5% 0.2 W	106-622
R507	carbon film	330 kΩ 5% 0.2 W	106-633
R508	carbon film	470 Ω 5% 0.2 W	106-347

RESISTORS (cont'd.)

	Designation	Type	Value	Cable No.
	R509	carbon film	820 Ω 5% 0.2 W	106-382
x	R510	wire-wound	1 kΩ 0.1%	152-058
	R511	metal film	10 kΩ 1% 0.1 W	140-423
x	R512	wire-wound	1.07 kΩ 0.1%	152-115
	R513	trimmer pot.	2.2 kΩ	182-031
	R514	carbon film	100 Ω 5% 0.5 W	100-310
	R515	carbon film	560 Ω 5% 0.5 W	100-356
	R516	carbon film	39 Ω 5% 0.2 W	106-239
	R517	wire-wound	1.8 Ω	121-118
	R518	carbon film	33 kΩ 5% 0.2 W	106-533
	R519	carbon film	330 kΩ 5% 0.2 W	106-633
	R520	carbon film	470 Ω 5% 0.2 W	106-347
x	R521	wire-wound	1 kΩ 0.1%	152-058
x	R522	wire-wound	1 kΩ 0.1%	152-058

SEMICONDUCTORS

Designation	Type	Code No.
Q501	transistor TIP32A	360-120
Q502	transistor 2N1711	360-047
Q503	transistor 2N2905A	360-073
Q504	transistor TIP31A	360-122
QA501	integrated circuit amp. LM301A	364-016
QA502	integrated circuit amp. LM301A	364-016

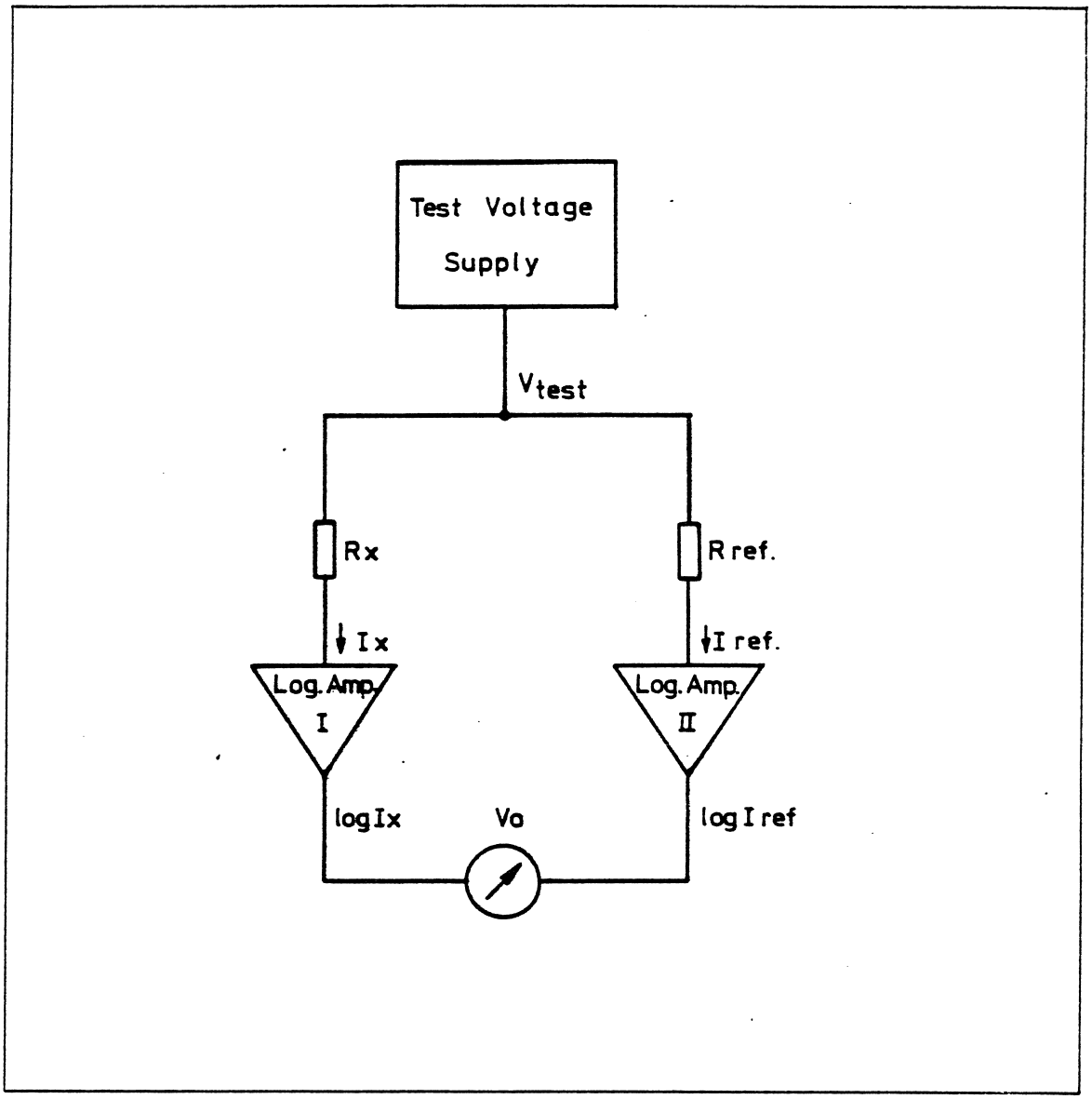


Fig. B - 1. Operating Principle.

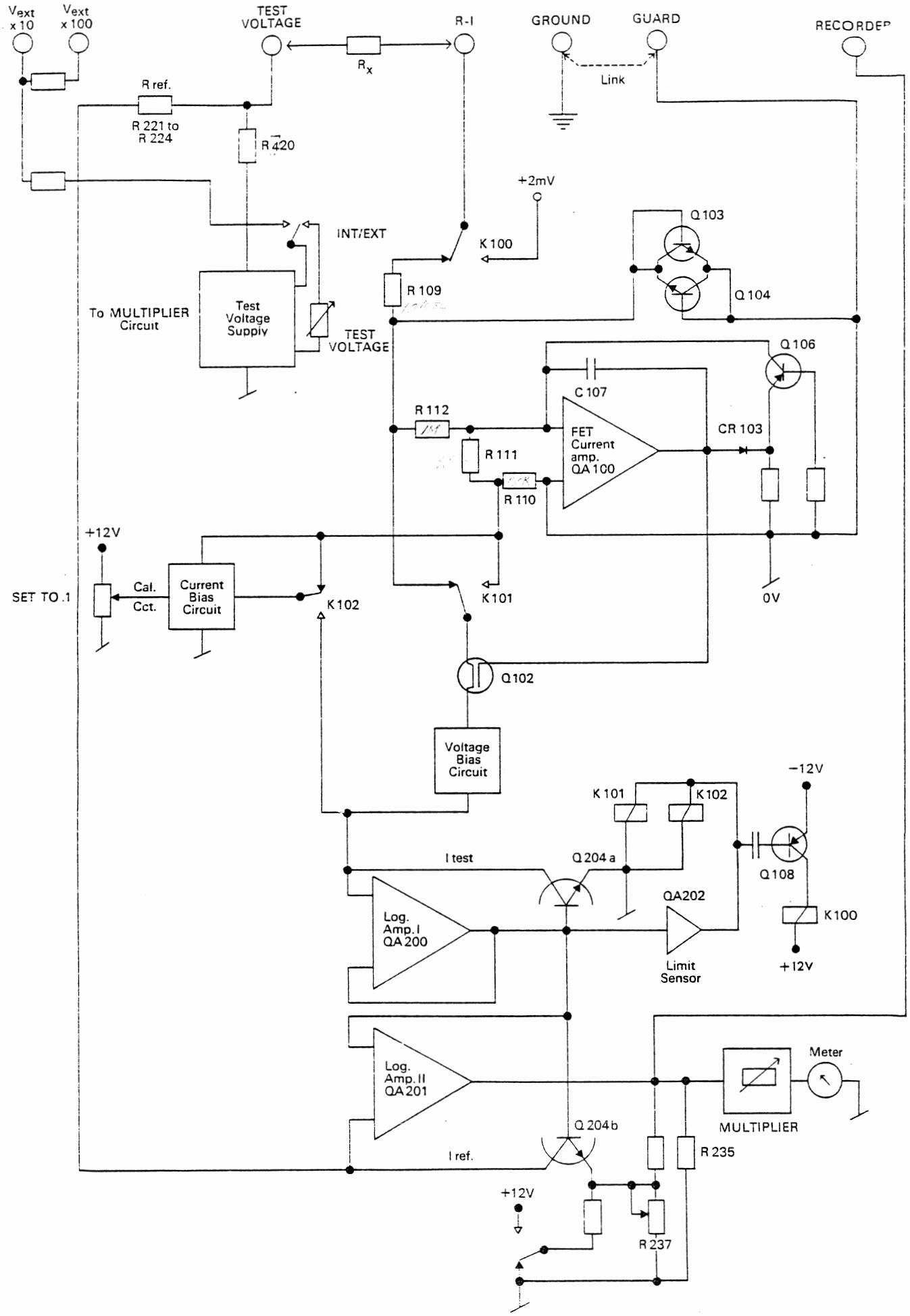


Fig. B - 2. Block Diagram of Megohmmeter IM6.

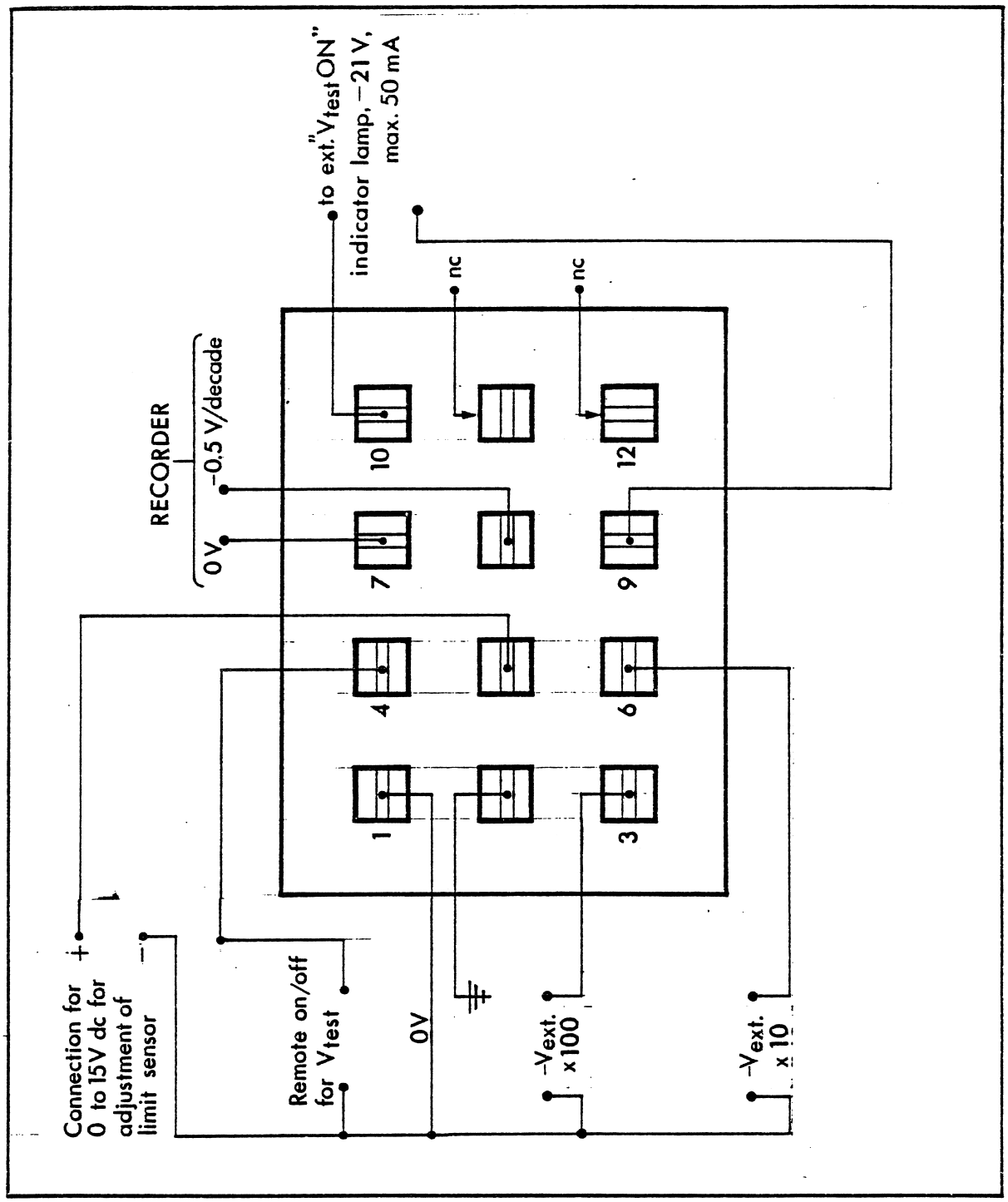


Fig. E - 1. Rear View of the RECORDER/REMOTE CONTROL Socket.

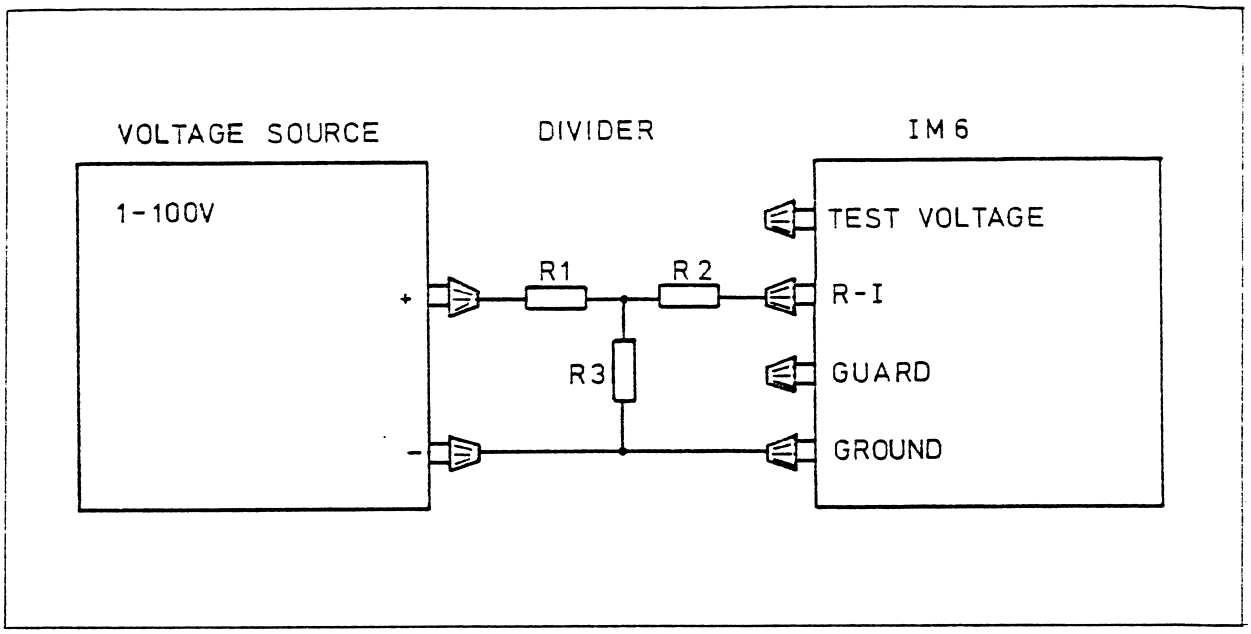


Fig. E - 2. Set-up for diode of MULTIPLIER switch.

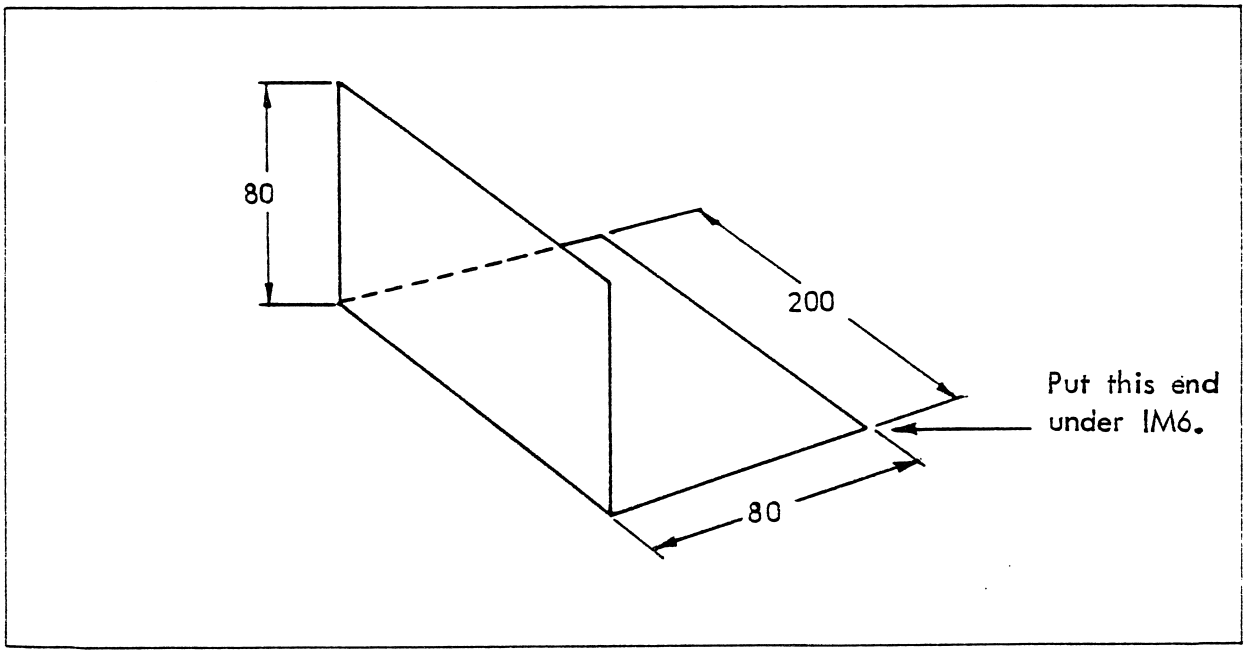


Fig. E - 3. Screen plate for use under check with resistors > 1 GΩ.

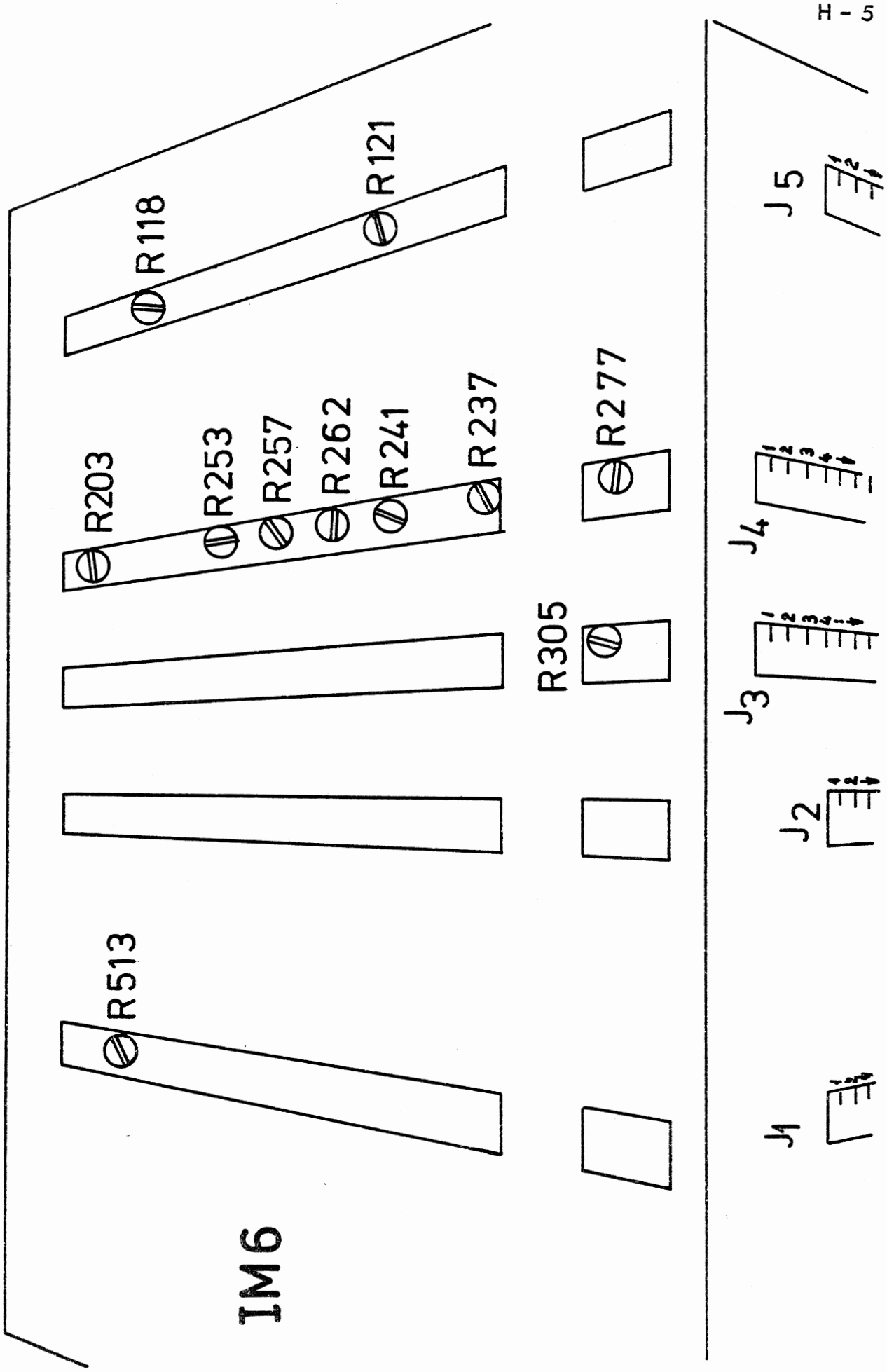


Fig. F - 1. Location of printed circuit boards and trimmers. Trimmer R2, not shown, is located on the back of the meter.

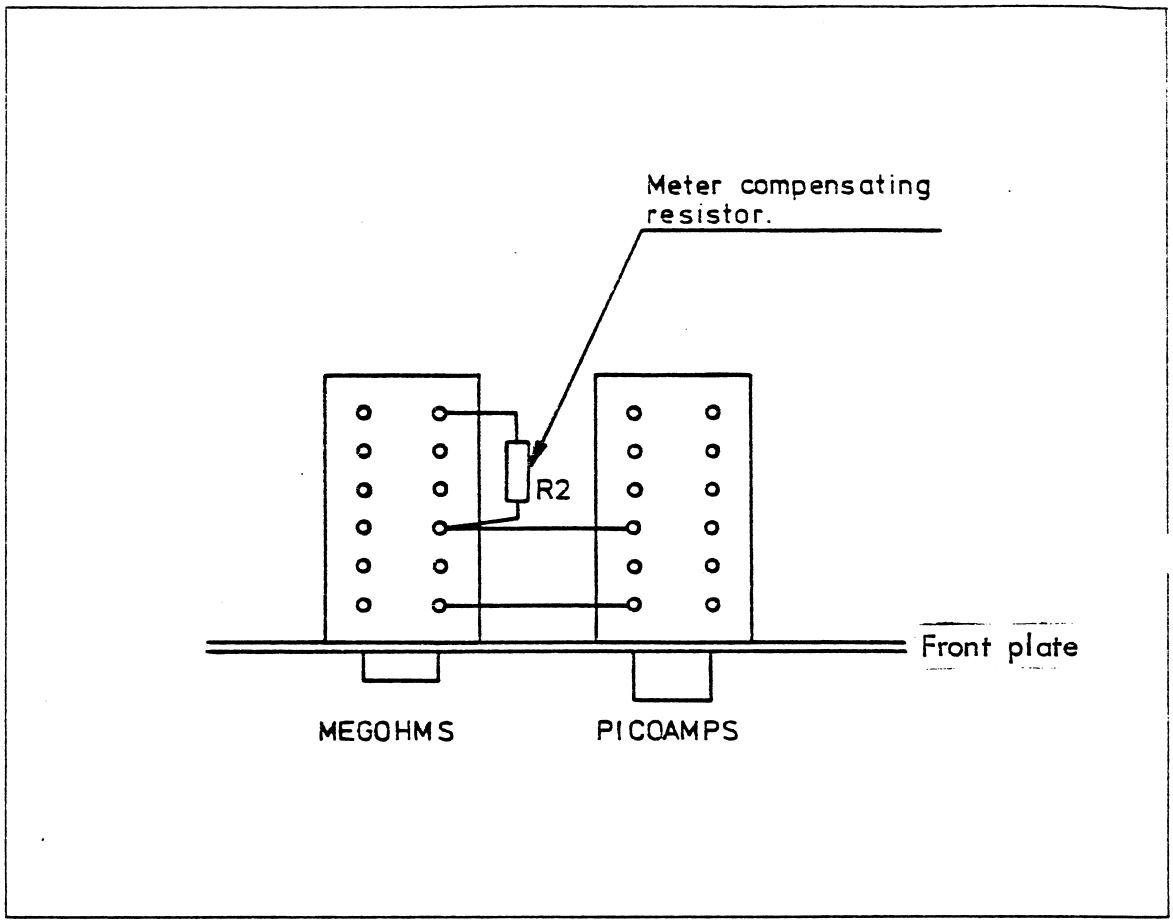


Fig. F - 2. Top view of compensating resistor R2 used on IM6 meters up to number 182220.
(On IM6 number 187966, R2 is replaced by a potentiometer mounted on a small print board on the back of the meter.)

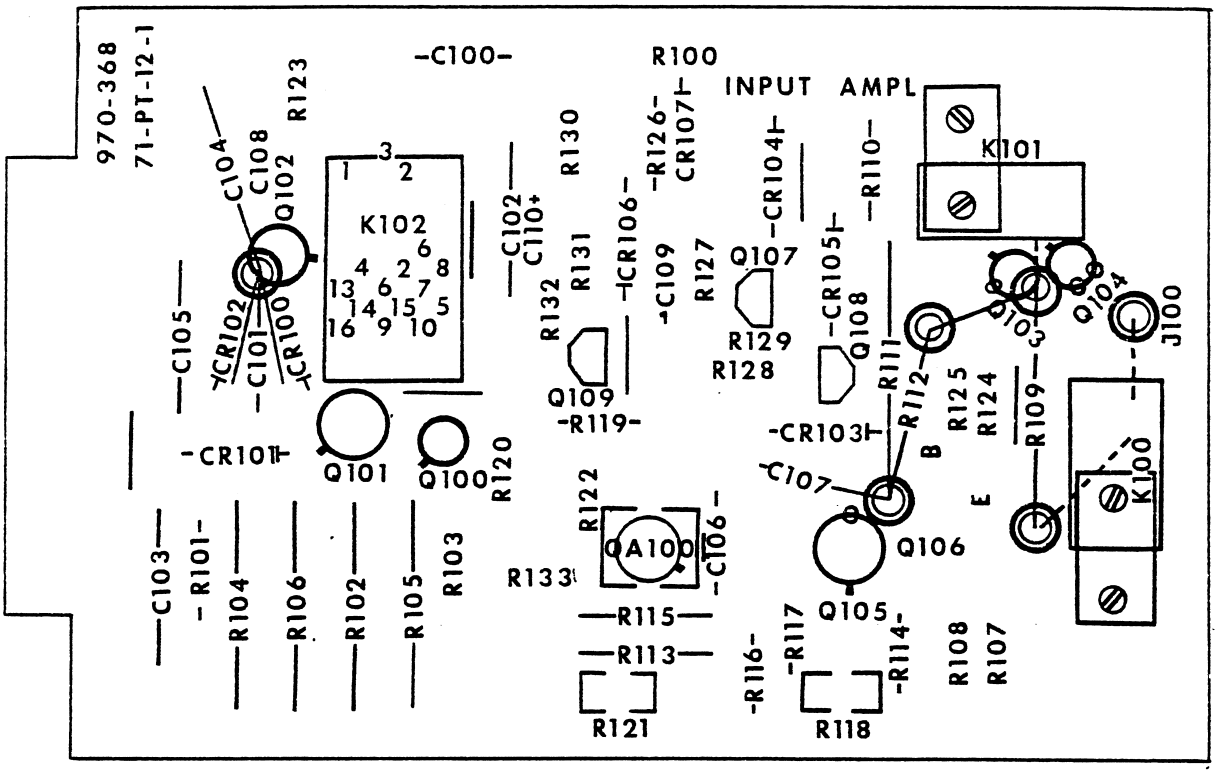


Fig. G - 1. J5 Input Amp. Printed-circuit Board, code 900-375.

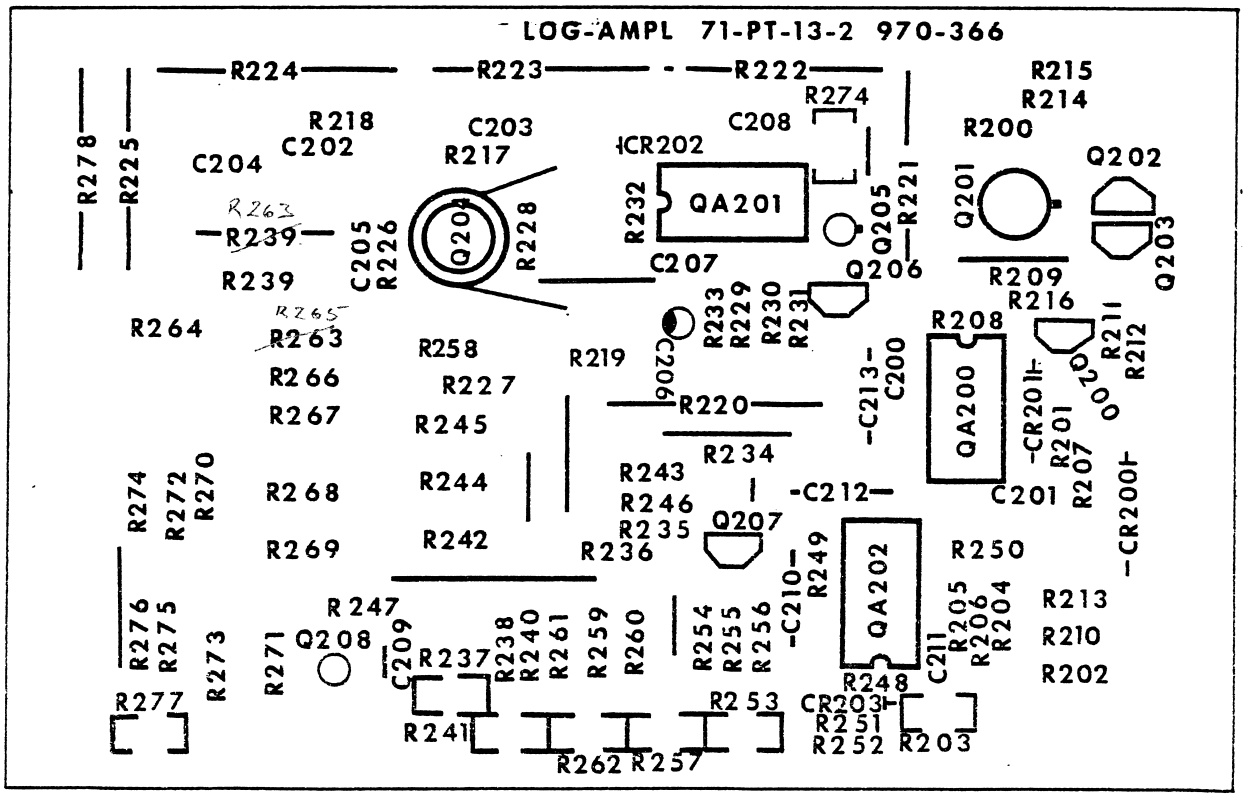


Fig. G - 2. J4 Log. Amp. Printed-circuit Board, code 900-374.

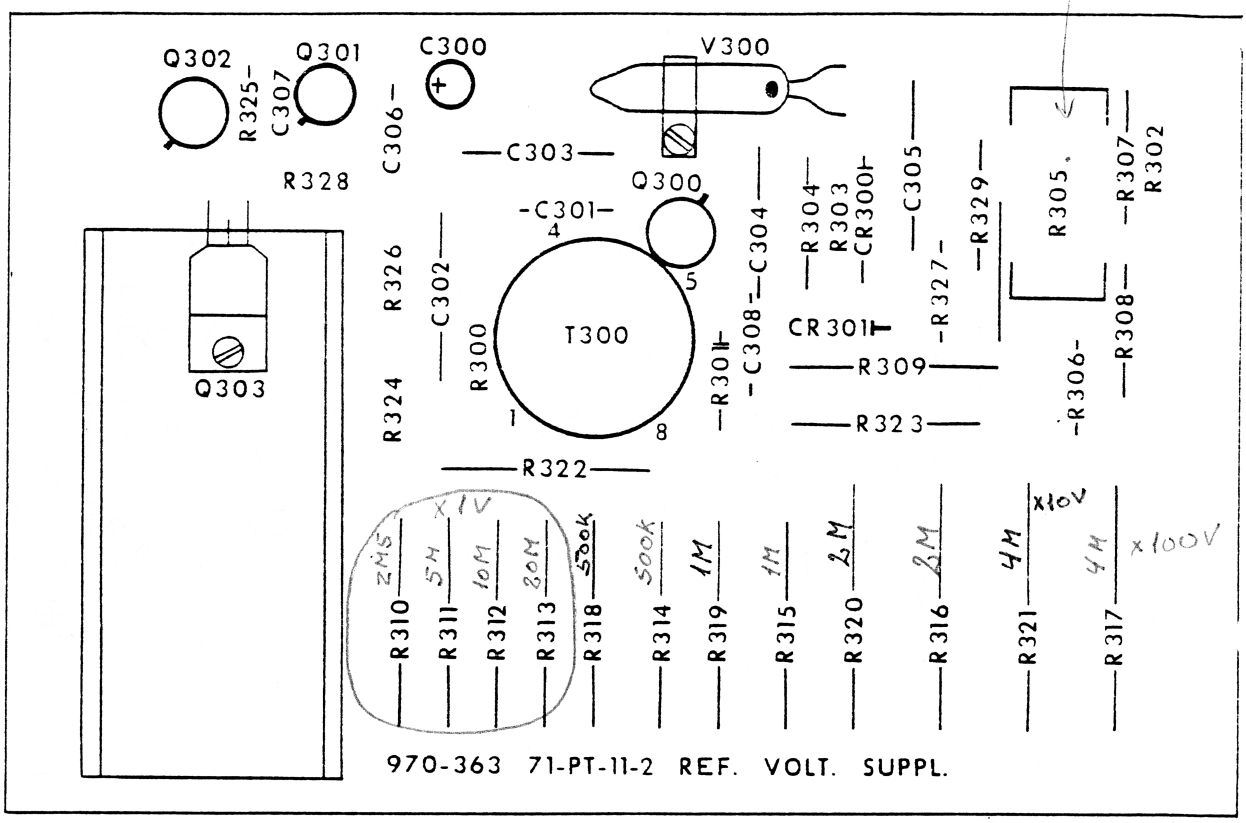


Fig. G - 3. J3 Voltage Supply Printed-circuit Board, code 900-372.

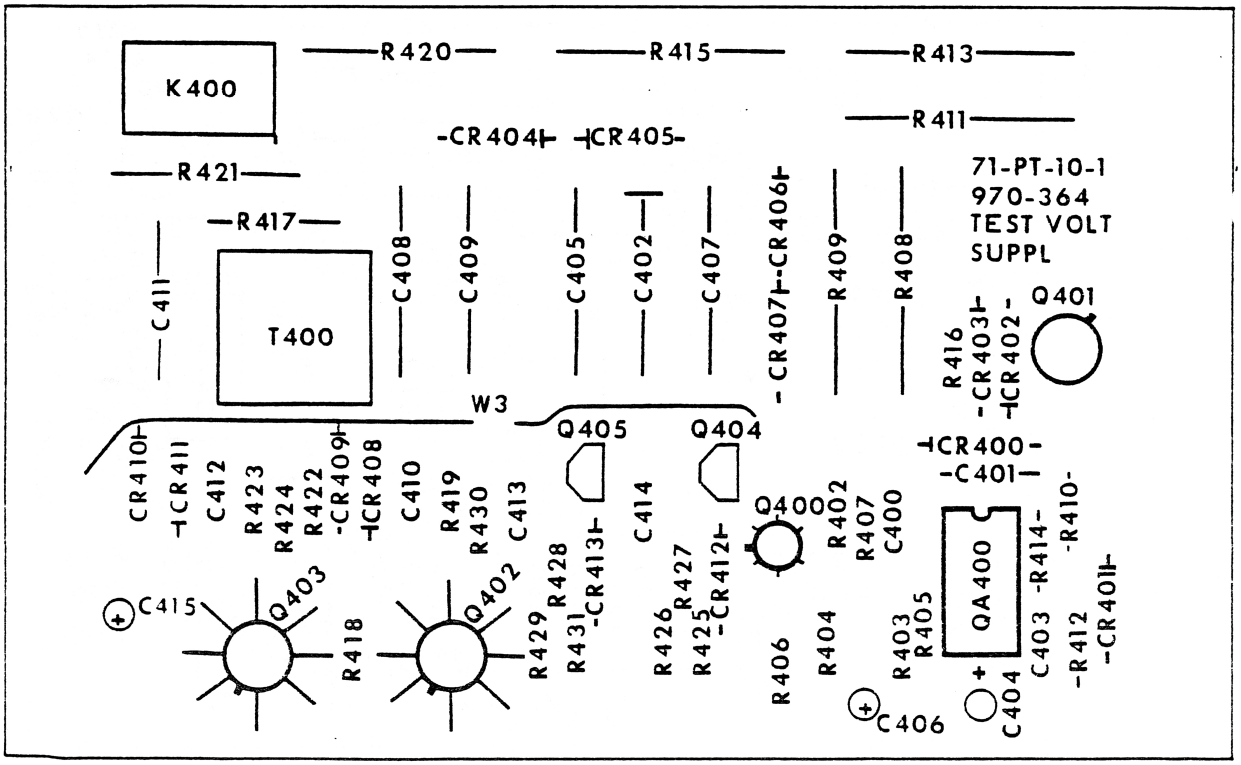


Fig. G - 4. J2 Test Voltage Supply Printed-circuit Board, code 900-373.

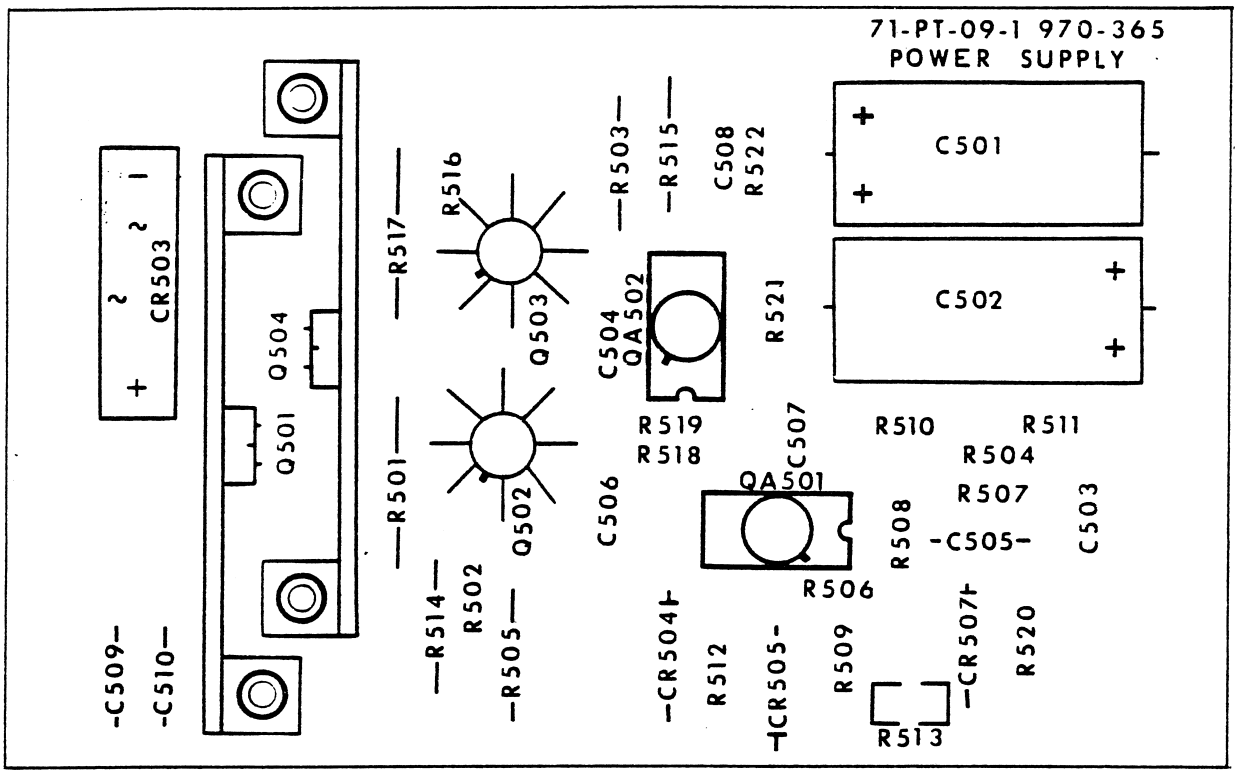


Fig. G - 5. J1 Power Supply Printed-circuit Board, code 900-371.

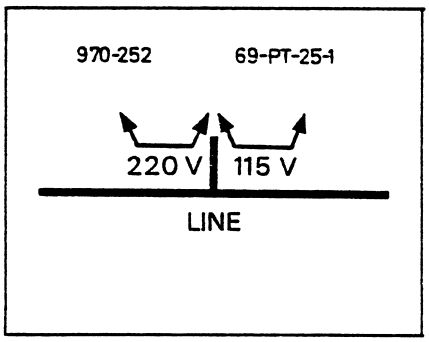


Fig. G - 6. Power Line Unit Printed-circuit Board.
115 V code 900-071
220 V code 900-072.

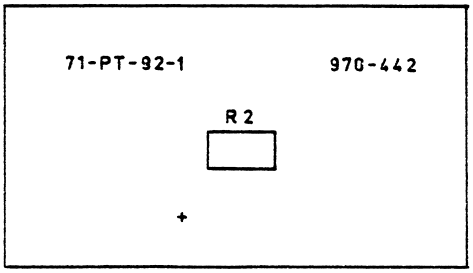
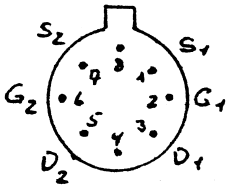
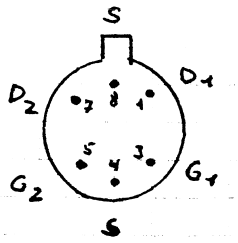


Fig. G - 7. Printed-circuit Board for Meter.

MT 102 (PLESSEY) 360-119

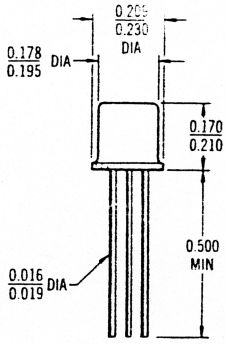


SN 165 (INTERSIL) 360-223

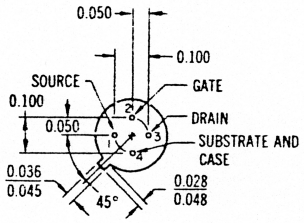


BOTTOM VIEW

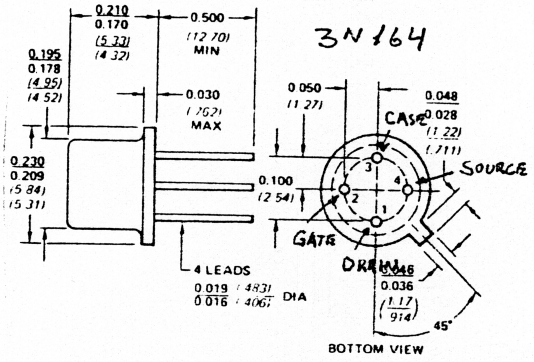
REPLACEMENT OF 3N157A BY 3N164



3N157A

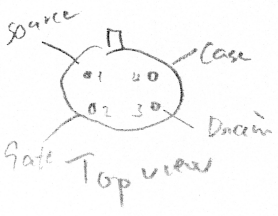


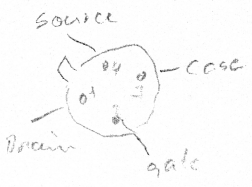
TO-72
CASE 20 (2)



TO-72

360-259





J5	INPUT AMP. 970-368 / 900-375
	971-349 / 901-786

30			
29			
28			
27			
26			
25			
24	2 SORT	=	A32 + C32
23	Skærm W/ (R-1)	=	A30
22		=	C30
21	GUL/BRUN	=	A28
20	GUL	=	C28
19	VIOLET/ORANGE	=	A26
18	SORT/ORANGE	=	C26
17	BLÅ/BRUN	=	A24
16		=	C24
15	ORANGE	=	~~A18~~ A22
14		=	C22
13	SORT	=	A20
12	BRUN	=	C20
11			
10	C16 COAX-SKÆRM		
9	C14 COAX-LEDER		
8		=	C10
7			
6	RØD	=	A8
5		=	C8
4	BLÅ	=	C6
3	GRØN/ORANGE	=	A4
2	BLÅ	=	C4
1	RØD	=	C2

ændret ledning fra A18 til A22.

FRIE BEN: A2 + A6 + A10 + A12 + C12 + A14 + A16 + A18 + C18

J4	LOG. AMP. 970-366 / 900-374
	971-348 / 901-785

print bane m. Lin R272 og R274 skal afbrydes!

30	2 GUL (TEFLON)	= C32 (TO I SAMME)
29		
28	A32 RØD LØS (TEFLON)	
27		
W2 26	C30 COAX - SKÆRM	
W2 25	~~A30~~ COAX - LEDER C28	
24	C26	
23	RØD / ORANGE	= A26
22		
21	SORT / ORANGE	= C24
20	GRÅ / BRUN	= A24
19	BLÅ / BRUN	= C22
18	GRØN / BRUN	= A22
17	GUL / BRUN	= C20
16	ORANGE / BRUN	= A20
15	RØD / BRUN	= C18
14	SORT / BRUN	= A18
13	HVID	= C16
12	GRÅ	= A16
11	VIOLET	= C14
10	GUL	= A14
9	ORANGE	= C12
8	BRUN	= A12
7	2 RØD / GUL	= C10 (TO I SAMME)
6	VIOLET / HVID	= A10
5	BLÅ / HVID	= C8
4	2 BLÅ	= A8 (TO I SAMME)
3	2 RØD	= A6 + C6
2	2 SORT	= A4 + C4
1	2 SORT	= A2 + C2

lås rød teflon ledning flyttes fra J4-32a til J4-30a

Ændringer af ledningsmontage: coax-leder fra A3 flyttes til C28.

J3	RF VOLTAGE SUPP. 970-363 / 900-378
	971-345 / 901-782

30	GRØN / HVID	=	A30	
29	GUL / HVID	=	A32	
28	BRUN	=	C32	+21 V
27	ORANGE / HVID	=	C30	
26	RØD / HVID	=	A28	
25	BRUN / HVID	=	C28	
24	SORT / HVID	=	A26	
23	GRÅ / GUL	=	C26	
22	VIOLET / GUL	=	A24	
21	BLÅ / GUL	=	C24	
20	GRØN / GUL	=	A22	
19	RØD / GUL	=	C22	
18	SORT / GUL	=	C20	
17	GRÅ / ORANGE	=	C18	
16	VIOLET / ORANGE	=	C16	
15	BLÅ / ORANGE	=	A14	
14	GRØN / ORANGE	=	C14	-8,0V
13	GUL / ORANGE	=	A12	
12	RØD / ORANGE	=	C12	
11	SORT / ORANGE	=	A10	-3,3V
10	GRÅ / BRUN	=	C10	-80,0V
9	BLÅ / BRUN	=	A8	•
8	GRØN / BRUN	=	C8	-4,0V
7				31 KHz
6				
5	GUL / BRUN	=	C6	•
4	ORANGE / BRUN	=	A6	
3	BLÅ	=	C4	-12V
2	BRUN / RØD	=	A4	-2,9V
1	2 SORT	=	A2 + C2	stel

FRIE BEN : A16 + A18 + A20

J2	TEST VOLT. SUPP. 970-364/900-373
	971-346/901-783

30			
29			
28			
27			
26			
25			
24			
23			
22			
21			
20			
19			
18	ORANGE	= C26	-21V
17	2 BRUN/SORT	= A24+C24	
16			
15	2 SORT	= A22+C22	
14			
13			
12	C18 RØD LØS		
11			
10			
9	C16 RØD LØS		(PICOAMPS) +10V
8			
7			
6	HVID/GUL	= C14	
5	HVID/ORANGE	= C12	
4	VIOLET	= C10	
3	2 BLÅ	= A8+C8	-12V
2	RØD	= C6	+12V
1	2 SORT	= A4+C4	s/el

FRIE BEN: A2+C2+A6+A10+A12+A14+
A16+A18+A20+C20+A26+A28+
C28+A30+C30+A32+C32

Strømforbrug (med alle print monteret) ved ~220V : 95 mA (ESO)
115 V : 190 mA

J1	POWER SUPP. 970-365/900-371
	971-347/901-784

30				
29				
28				
27				
26				
25				
24				
23				
22				
21				
20				
19				
18				
17	HVID/VIOLET	=	A26 på 0V, midt punkt for sekundærs viklinger	
16		=	C26 24 sort	
15	HVID/GRÅ	=	C22 Grå en halvdel af sekundær viklinger	
14	ORANGE / RØD	=	A20 + C20 hvirp andre ——— " ———	
13	GRÅ	=		
12	2 HVID/GUL	=	A16 + A18 + C18	-21V
11	ORANGE	=		
10	BRUN	=	C14	+21V
9	BLÅ	=		-12V
8	2 BLÅ	=	A10 + C10 + A12 + C12	—"—
7	BLÅ	=		—"—
6	RØD	=		+12V
5	RØD	=	A6 + C6 + A8 + C8	—"—
4	2 RØD	=		—"—
3	2 SORT	=		stel
2	SORT	=	A2 + C2 + A4 + C4	—"—
1	SORT	=		—"—

21C : Sort
26C : Blå } skrigtut mønster på Power supply print.

FRIE BEN : A14 + C16 + A22 + A24 + C24 +

A28 + C28 + A30 + C30 + A32 + C32

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 GROUND 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 -3.13	-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

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.

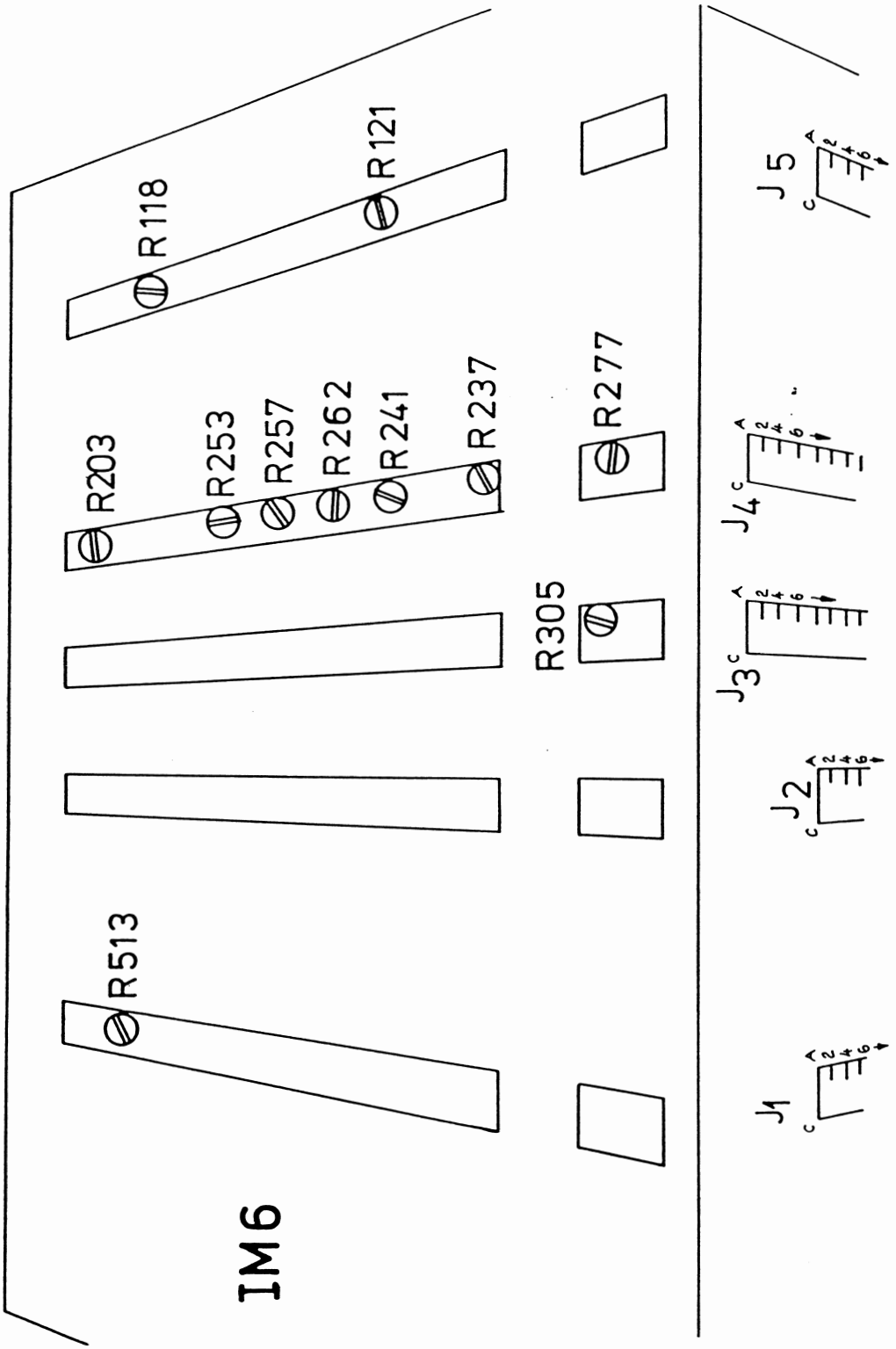


Fig. 5.1 - Location of Printed Circuit Boards and Trimmers.
Trimmer R2, Not Shown, is Located on the Back of the Meter

IM 6 MEGOHMMETER 220V 390-280
115V 390-281

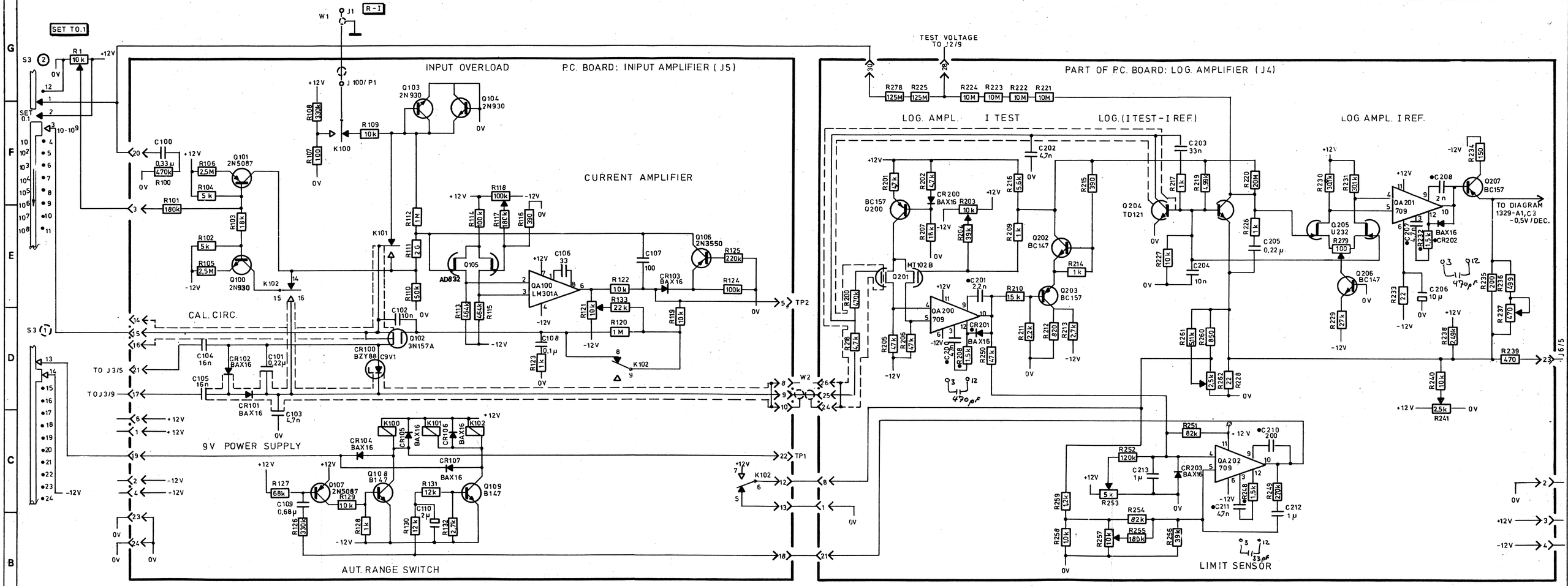
Serial no. R____ N____

Date: _____

Operator, Sign.:_____

Inspector, Sign.:_____

DIVIDER RESISTANCES	MULTIPLIER	VOLTAGE SOURCE V.	SCALE READING GARANT. SPECS.	SCALE READING MEASURED VALUE	VOLTMETER READING mV. GARANT. SPECS.	VOLTMETER READING mV. MEASURED VALUE
		0.1	0.096-0.104	0.	-1500 +/- 14	-
		0.2	0.192-0.208	0.	-1350 +/- 14	-
		0.3	0.287-0.313	0.	-1262 +/- 13	-
		0.4	0.384-0.416	0.	-1199 +/- 13	-
10M ohm		0.5	0.478-0.522	0.	-1150 +/- 13	-
(10^7)		0.6	0.576-0.624	0.	-1111 +/- 13	-
		0.7	0.672-0.728	0.	-1078 +/- 13	-
		0.8	0.768-0.832	0.	-1049 +/- 13	-
		0.9	0.864-0.936	0.	-1023 +/- 12	-
	10E5	1	0.955-1.04	.	-1000 +/- 12	-
		0.1	0.955-1.04	.	-1000 +/- 12	-
		0.2	1.91 -2.09	.	- 850 +/- 12	-
		0.3	2.87 -3.13	.	- 762 +/- 11	-
		0.4	3.82 -4.18	.	- 699 +/- 11	-
1M ohm		0.5	4.78 -5.22	.	- 650 +/- 11	-
(10^8)		0.6	5.73 -6.27	.	- 611 +/- 11	-
		0.7	6.68 -7.31	.	- 578 +/- 11	-
		0.8	7.64 -8.36	.	- 549 +/- 11	-
		0.9	8.60 -9.40	.	- 523 +/- 10	-
		1	9.55 -10.45	.	- 500 +/- 10	-
(10) 10T Ω		10	1 +/- 1mm	. mm	-3500 +/- 22	-
(10) 10T Ω			10 +/- 1mm	. mm	-3000 +/- 20	-
(10E2) 1T Ω			10E2 +/- 1mm	. mm	-2500 +/- 18	-
(10E3) 0.1T Ω			10E3 +/- 1mm	. mm	-2000 +/- 16	-
(10E4) 10G Ω	wide		10E4 +/- 1mm	. mm	-1500 +/- 14	-
(10E5) 1G Ω	range		10E5 +/- 1mm	. mm	-1000 +/- 12	-
(10E6) 0.1G Ω		100	10E6 +/- 1mm	. mm	- 500 +/- 10	-
(10E7) 10M Ω			10E7 +/- 1mm	. mm	- 0 +/- 8	
(10E8) 1M Ω			10E8 +/- 1mm	. mm	500 +/- 10	
(10E9) 0.1M Ω			10E9 +/- 1mm	. mm	1000 +/- 14	
(10) 10T Ω	10	10	0.1 +/- 4%	0.	-3500 +/- 22	-
(10) 10T Ω				.	-3000 +/- 20	-
(10E2) 1T Ω	10E2			.	-2500 +/- 18	-
(10E3) 0.1T Ω	10E3			.	-2000 +/- 16	-
(10E4) 10G Ω	10E4			.	-1500 +/- 14	-
(10E5) 1G Ω	10E5	100	1 +/- 4%	.	-1000 +/- 12	-
(10E6) 0.1G Ω	10E6			.	- 500 +/- 10	-
(10E7) 10M Ω	10E7			.	0 +/- 8	
(10E8) 1M Ω	10E8			.	500 +/- 10	
(10E9) 0.1M Ω			10 +/- 4%	.	1000 +/- 14	



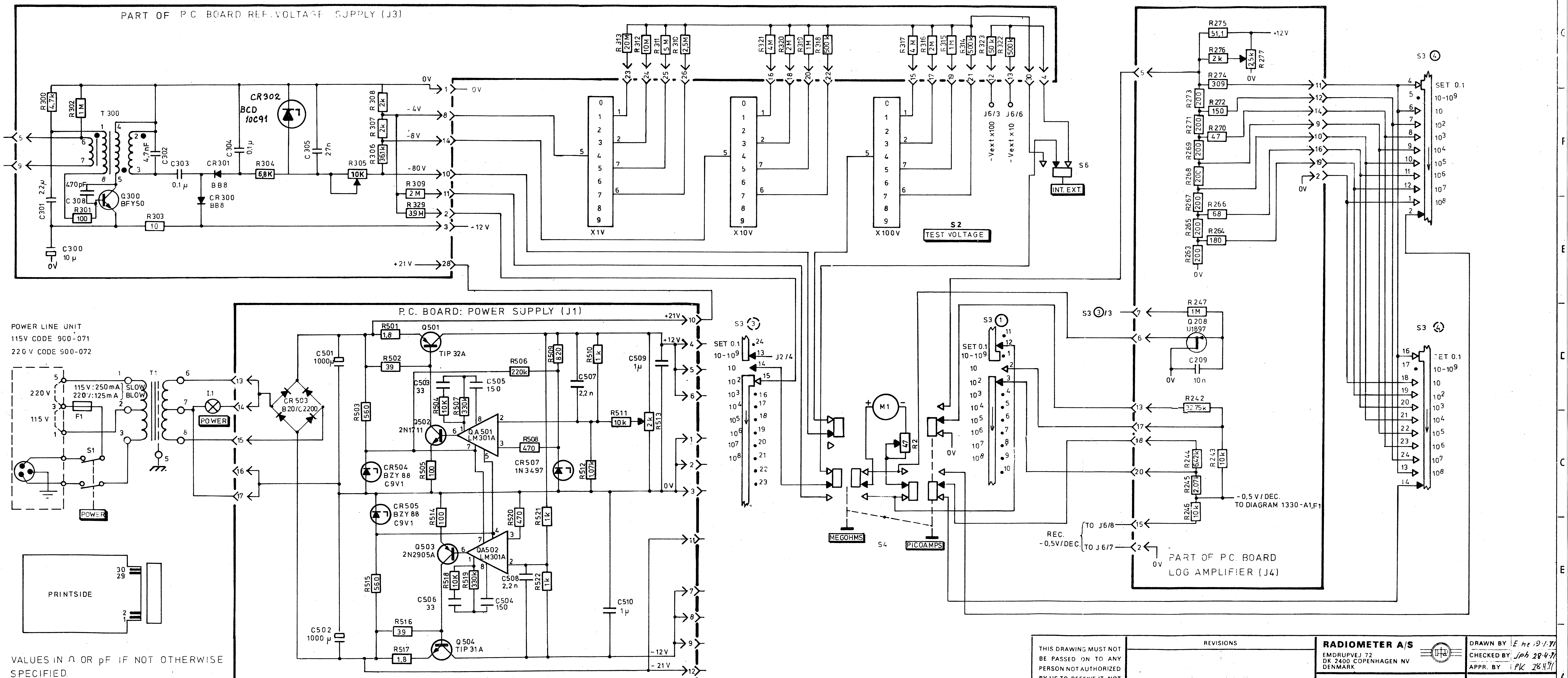
REVISIONS					
ISSUE	FROM NO.	DATE	DRAWN BY	CHECKED BY	APPR. BY
5	235089	1-10-74	BLØ		
4	201337	17.1.73	OH	jph	
3		4.5.72.	BG.	jph	jph
2	190706	8.2.72.	BG.	jph	PK
6	266970	20.1.78	SP	jph	

RADIOMETER A/S
EMDRUPVEJ 72
DK 2400 COPENHAGEN NV
DENMARK

DRAWN BY	E.Ho	28.4.71
CHECKED BY	jph	28.4.71
APPR. BY	PK	28.4.71

MEGOHMMETER
INPUT AMPLIFIER / LOG. AMPLIFIER
TYPE IM 6a
FROM NO. * TO NO.

1330-A1



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REVISIONS

ISSUE	FROM NO.	DATE	DRAWN BY	CHECKED BY	APPR. BY
3	00816	821012	UGP		
2	213248	30.1.74	OH	jph	
1	187966	10.12.71	OH	jph	pk

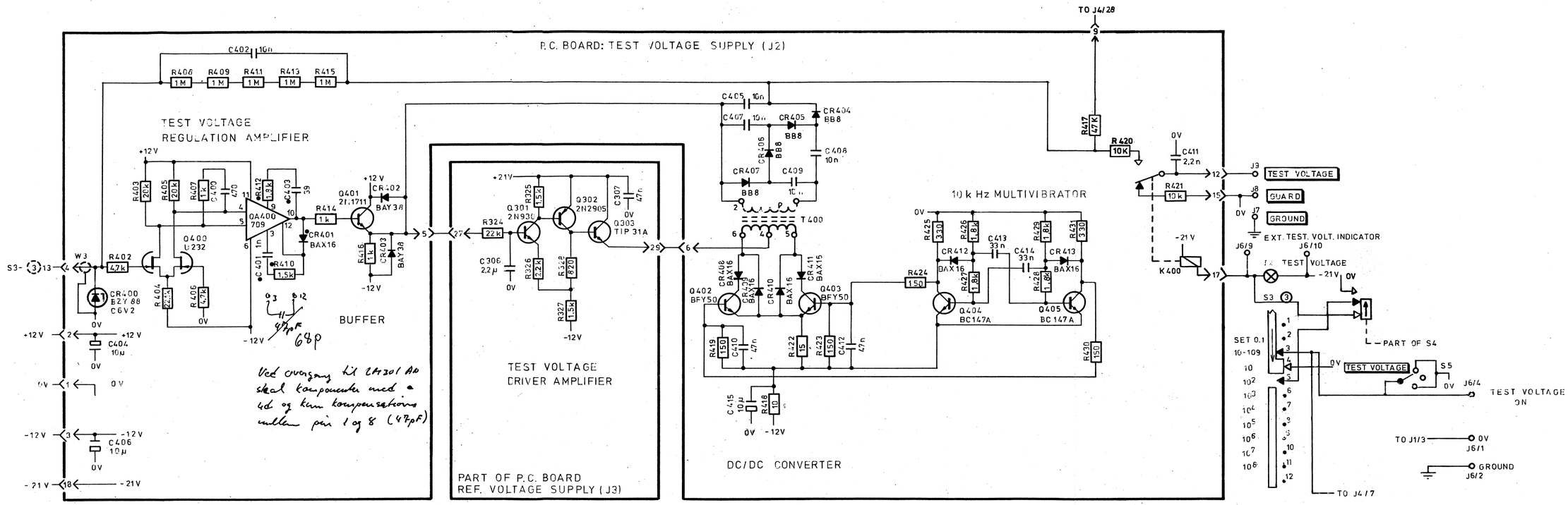
RADIOMETER A/S
EMDRUPVEJ 72
DK 2400 COPENHAGEN NV
DENMARK

MEGOHMMETER
POWER SUPPLY /
METER CIRCUIT
TYPE IM6

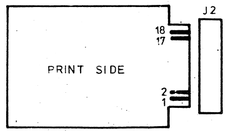
FROM NO. TO NO.

DRAWN BY E.he 9.7.71
CHECKED BY jph 28.4.71
APPR. BY PK 28.4.71

1329-A1



TEST VOLTAGE SUPPLY



REVISIONS

ISSUE	FROM NO.	DATE	DRAWN BY	CHECKED BY	APPR. BY
3	266970	20.1.78	SP	jph	
2	221783	2-7-74	AK	jph	
1	187956	10.12.71	OH	jph	PK

RADIOMETER A/S
EMDRUPVEJ 72
DK 2400 COPENHAGEN NV
DENMARK

DRAWN BY	EHe.	4-12-70
CHECKED BY	jph	28-4-71
APPR. BY	PK	28.4.71

MEGOHMMETER
TEST VOLTAGE SUPPLY
TYPE IM6a
FROM NO. TO NO.

1331-A1