7045 OPERATING MANUAL

CONTENTS.

Your new 7045 from Solartron provides you with a whole new world of measurement technology. It employs the same circuit concepts as the 'big' Solartron voltmeters, backed by manufacturing and calibration facilities that are second to none. A special integrated circuit, designed by Solartron engineers, contains the pulse-width conversion system that is the heart of these products. Thus you can now use the sensitivity and precision of the most sophisticated voltmeters – here in 7045.

The push-button selectors on the front are identified with clear, concise captions. Measure what you will; voltage or current, dc or ac; resistance; even temperature. Automatic ranging and display is built in. But if you prefer to hold a range and change it manually, or to hold a reading and update on command, its all there, readily accessible at the touch of a few buttons.

A battery unit is supplied within 7045. Thus by fitting the optional rechargable cells, battery operation is instantly available as an alternative to 230V (or 115V) ac mains.

Part No. 70450010

Issue 2 November 1978

3. PRELIMINARIES.

3.1

Ensure that the mains supply plug is correctly connected. Figure 1 shows the correct coding.

The mains supply setting of the multimeter should correspond to the available mains supply – carry out *either* the procedure on page 20 *or* move the mains selector switch (if fitted). Fig. 2 refers.

Note 1. Multimeters from Ser. No. 001101 onward are fitted with the selector switch, positioned where shown, in broken outline, in Fig. 2.

2. **The mains supply adjustment given on page 20 should be carried out only by a competent engineer.**

3.2 FUSES

The following fuses are fitted: (Fig. 3 refers)

mains:	100mA sl-blo
current measurement circuit:	2A

3.3 BATTERIES

The battery unit is fitted as standard. If battery operation is required the four optional cells must be installed as described on page 23, and the cells must then be charged.

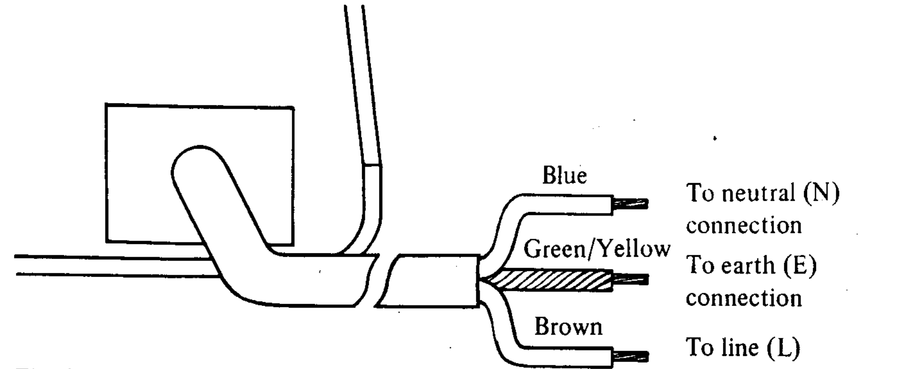

Fig. 1

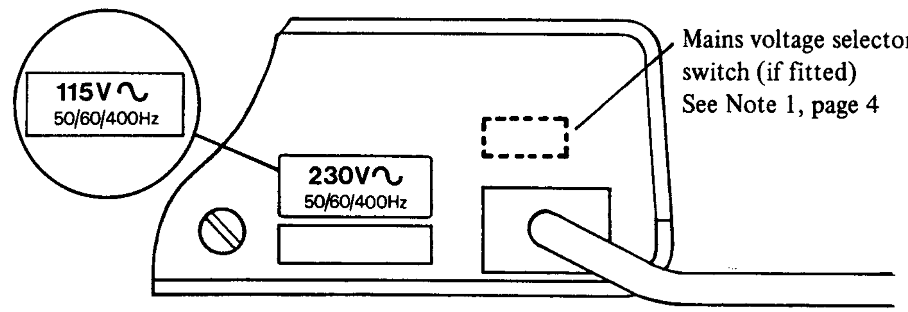

Fig. 2

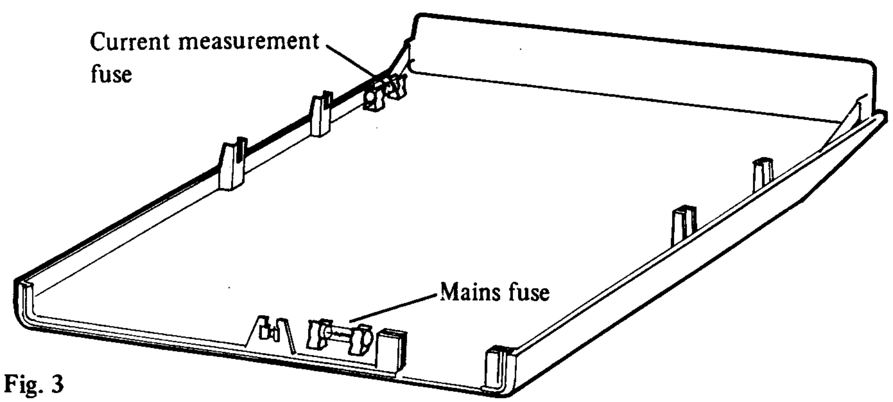

Fig. 3

5. OPERATING NOTES.

5.1 MΩ/mV μA Ω ANNUNCIATORS These two annunciators indicate the value of units shown on the display, e.g. with kΩ selected and the MΩ annunciator lit, the displayed reading is in megohms.

5.2 MICROVOLT ADJUSTMENT Although the instrument may be zeroed initially by using the μV adjustor in the front panel, after some 15 minutes warm-up the zero should be stable. This control can then be used to offset small spurious emfs that may occur in the circuit being measured.

5.3 TEMPERATURE MEASUREMENT With no probe connected to the °C socket, the multimeter will measure ambient temperature once the appropriate switches have been selected.

To measure temperature using the optional Temperature Probe refer to page 9.

5.4 WARNING INDICATIONS

Overload A flashing *1* – – – – display signifies that the input is too large for the selected range.

If the **Display Hold** facility is used and the input subsequently changes to a value beyond the selected range, the displayed reading will flash.

Invalid A flashing (random) display signifies that either kΩ or °C has been selected with the ac selector incorrectly set to ac functions.

Battery Low Indicated by the illumination of all the decimal points in addition to the displayed reading. This occurs only when the cells have been fitted.

6. TEMPERATURE PROBE.

This optional accessory enables the temperature of surfaces, fluids etc. to be monitored and read on the multimeter in °C. The necessary compensation for the temperature of the reference ('cold') junction is built in 7045 and is appropriate to Chromel/Alumel (type K) thermocouples.

The fully assembled thermocouple probe plugs into the °C socket on the front of the multimeter. With the probe tip pressed against a surface, or placed in the environment whose temperature is required, and °C selected, the multimeter reads °C. When assessing the temperature of small items the thermal mass of the probe may mean that a few moments are required to attain a stable result.

7. HIGH VOLTAGE PROBE.

The H.V. Probe effectively increases the dc voltage range of the 7045 to a maximum of 40kV.

The displayed reading should be multiplied by 1000 to obtain the true reading.

7.1 Safety Precautions

When using the H.V. Probe, the following safety precautions should be observed:

1. Know the equipment under test; locate all high voltage points before commencing work.
2. Do not work alone.
3. Do not depend on the insulation of high voltage cables for protection.
4. Remember that high voltage may appear at unexpected points in defective equipment. Furthermore, bleeder resistors may be open and capacitors may retain high voltages even though power is off.
5. High voltages can discharge from point to point or from point to air (corona). Keep hand closed on handle of probe and away from all high voltage points.
6. Keep hands, shoes, and test areas absolutely dry.
7. Ensure that the surface of the probe is clean and moisture free.
8. BEFORE MAKING ANY MEASUREMENTS, ENSURE THAT THE GROUND LEAD OF THE PROBE IS CONNECTED TO THE LOW POTENTIAL OR GROUND SIDE OF THE HIGH VOLTAGE SUPPLY BEING MEASURED.

7.2 USING THE H.V. PROBE

a. Fit Cone, or Hook adaptor, to probe end as appropriate.
b. Connect the two test leads to V/kΩ Hi and Lo input terminals.
c. Set multimeter switches for dc voltage measurement/auto-range.
d. Connect probe ground lead (see 8 above).
e. Connect probe to point being measured.

8. RADIO FREQUENCY PROBE.

The R.F. Probe permits voltage measurement within the range 100kHz to 750MHz at levels between 250mV and 30V.

The probe provides a rectified (dc) input to the multimeter proportional to the peak value of the ac signal, but is rms calibrated.

8.1 USING THE R.F. PROBE

a. Connect appropriate adaptor tc probe end.
b. Insert 4mm dual plug into multimeter V/kΩ Hi and Lo input sockets observing the correct polarity. ("Hi" has the Red insert)
c. Set multimeter selector switches to measure dc voltage.
d. Connect the free lead to signal Lo or to chassis earth.
e. Place tip of Probe on point being measured.

Resistance measurement   Calibration temp 23°C

Range	Sensitivity	Current through R	Limits of Error 24 hrs ± 1°C ±[% rdg + digits]		1 year ± 5°C ±[% rdg + digits]		Temp Coeff/°C ±[% rdg + digits]	
199.99Ω	10mΩ	100μA	0.02	10	0.04	10	0.0075	2
1.9999kΩ	100mΩ	100μA	0.02	4	0.04	4	0.0075	0.2
19.999kΩ	1Ω	100μA	0.02	2	0.04	2	0.0075	–
199.99kΩ	10Ω	1μA	0.02	2	0.04	2	0.0075	0.2
1.9999MΩ	100Ω	1μA	0.03	2	0.05	2	0.0075	–
19.999MΩ	1kΩ	0.1μA	0.1	2	0.2	2	0.01	–

Max allowable input: 350V peak
Max dissipation in unknown: <1mW
Max voltage across unknown: 6V
Max open circuit voltage: 6V

Temperature measurement

Resolution: 0.1°C
Ambient: without the optional thermocouple probe the multimeter will show ambient temperature.

Thermocouple: using the optional thermocouple probe the multimeter will compensate for the 'cold' junction and display probe temperature.
Limits of Error: ±2°C over −20 to +200°C

Interference rejection

SERIES MODE
At 50Hz ±0.1% and each 10Hz above: >70dB

EFFECTIVE COMMON MODE
With 1kΩ imbalance in the Lo lead
DC measurement:
Rejection of dc >120dB
Rejection of 50Hz ±0.1% and each 10Hz above >120dB
AC measurement:
Rejection of dc >120dB
Rejection of 50Hz ±0.1% and each 10Hz above >70dB
Max permissible common mode: dc + ac peak 1000V
Isolation of input to earth: >10GΩ//<300pF

10. GENERAL DATA.

A-to-D conversion:
Pulse-width, with calibration balance
Integration time: 100ms
Reading rate: nominal 4/s

Display: 7-bar LED
Over-range: flashing digits
Battery Low: all decimal points

Temperature:
Operating, to specification 0 to +50°C
Operating, without damage −5 to +50°C
Storage, without batteries −20 to +70°C
Storage, with batteries −20 to +50°C

Humidity: 80% RH at 40°C

Dimensions: width 200mm
height 70mm
depth 260mm

Weight: without batteries 1.45kg
with batteries 2.1kg

Power Supply:
AC mains: 115V/230V +10% − 10%
50/60/400Hz 6VA
Batteries (Optional) 4 - type D cells
Operating time: >6 h
Recharge time: <15 h

12. MAINS SUPPLY ADJUSTMENT.

Applicable only where mains selector switch is not fitted. (see page 4)

To remove the case (Figure 5):

a. Switch off mains supply and disconnect mains plug from multimeter.

b. Remove the single retaining screw on rear panel and remove panel.

c. Remove the two bottom securing screws and lift off top cover.

Carry out the adjustment as follows:

a. Examine the terminal board linking which should be as follows:

For 115V supply: link between terminal posts 1 and 2 also 3 and 4.
For 230V supply: link between terminal posts 2 and 3.

If the links are incorrectly set for the available mains supply.

b. Unsolder the links and re-solder in correct position.

c. Fit the correct size of fuse;

100mA for 230V mains operation.
200mA for 115V mains operation.

d. Replace top cover and rear panel.

e. Ensure rear panel indicates correct voltage setting; use adhesive label (supplied) if necessary.

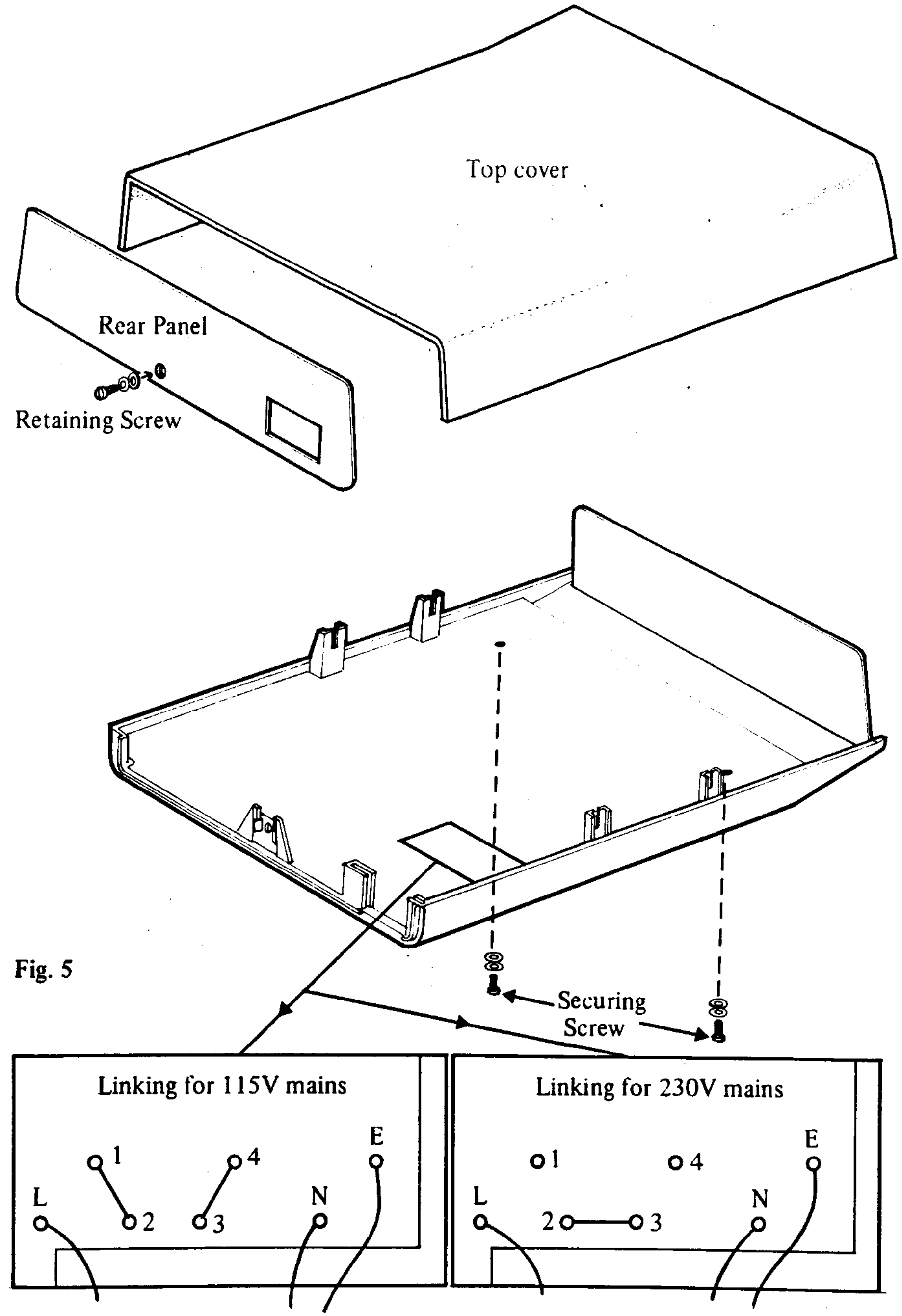

Fig. 5

7045
Digital Multimeter

Uses I.C. 596-03001

Part No. 7045011 0252/544433

Issue 1 July 1978

Schlumberger

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TECHNICAL MANUAL

Contents

Chapter 1
Introduction

This manual contains technical information and is written primarily to meet the needs of the service engineer. It is not intended to give a detailed explanation of the principles of operation, although each section of the circuit diagrams is accompanied by sufficient text to enable the reader to understand the purpose of the circuit. Since servicing on the Digital Section of the multimeter is minimal, reference is mainly by diagrams, their purpose being to facilitate fault diagnosis.

1 PRESENTATION OF INFORMATION

1.1 **FUNCTIONAL DIAGRAMS** An overall block diagram identifies the four functional sub-sections of the multimeter.

1.2 **CIRCUIT DIAGRAMS** Three circuit diagrams are included in the manual; these are on fold-out sheets and accompany the relevant text.

1.3 **ADDITIONAL ILLUSTRATIONS** Component layout diagrams with their associated parts lists accompany the circuit diagrams. A list of abbreviations used throughout the manual is given on page 1.4

Waveform diagrams are included in that part of the manual covering the Digital Section of the instrument.

2 SERVICING INFORMATION

2.1 **ELECTRICAL CONNECTIONS** Interconnection between pcbs is achieved generally using "Berg" type pin connectors, these are marked E (or B on the Battery Unit pcb) followed by a number. A 13-way "Spectra" ribbon connector makes the electrical connection between the main pcb and the Display board; these are marked by numbers (1–5) and letters (A to G and P).

2.2 **TEST POINTS** Several test points are located on the pcbs as an aid to circuit testing. These are marked either T or TP followed by a number.

2.3 **LINK LI** Consists of a soldered link which, when removed, isolates the inputs to the Operational Amplifier.

2.4 **SPLIT PADS** These are marked SP followed by a number. They are bridged by solder, open circuit being effected simply by removing the solder. Used mainly for setting-up purposes.

3 FUNCTIONAL BREAKDOWN (DIAG 1.1)

As illustrated by the block diagram, the 7045 can conveniently be regarded as having the following four main functional sub divisions;

1. THE SIGNAL CONDITIONING SECTION
2. THE ANALOGUE TO DIGITAL CONVERTER
3. THE DIGITAL SECTION
4. THE POWER SUPPLIES.

4 SUMMARY OF OPERATION

The 7045 is essentially a voltage measuring device. Where necessary, multimeter inputs must be converted into a dc voltage level and suitably scaled prior to analogue to digital conversion. This process is carried out in the Signal Conditioning Section.

The Analogue to Digital (A-to-D) Converter produces two balanced pulse trains at its output. Any measured input causes the pulse width of one of the trains to increase, with a proportionate decrease in the width of the other; the nett result is processed in the Digital Section of the multimeter.

This section includes a clock circuit. Pulses from the A-to-D Converter provide a clock-enable to a synchronous counter, thus a count is produced proportional to the measured input. The Digital Section also exercises control over the analogue circuitry with regard to range decision and control of the measurement function.

Power supplies for the multimeter are derived from a mains operated transformer with provision made for either 230 volts or 115 volt operation. A Battery Unit, when fitted with optional cells, provides an alternative power source.

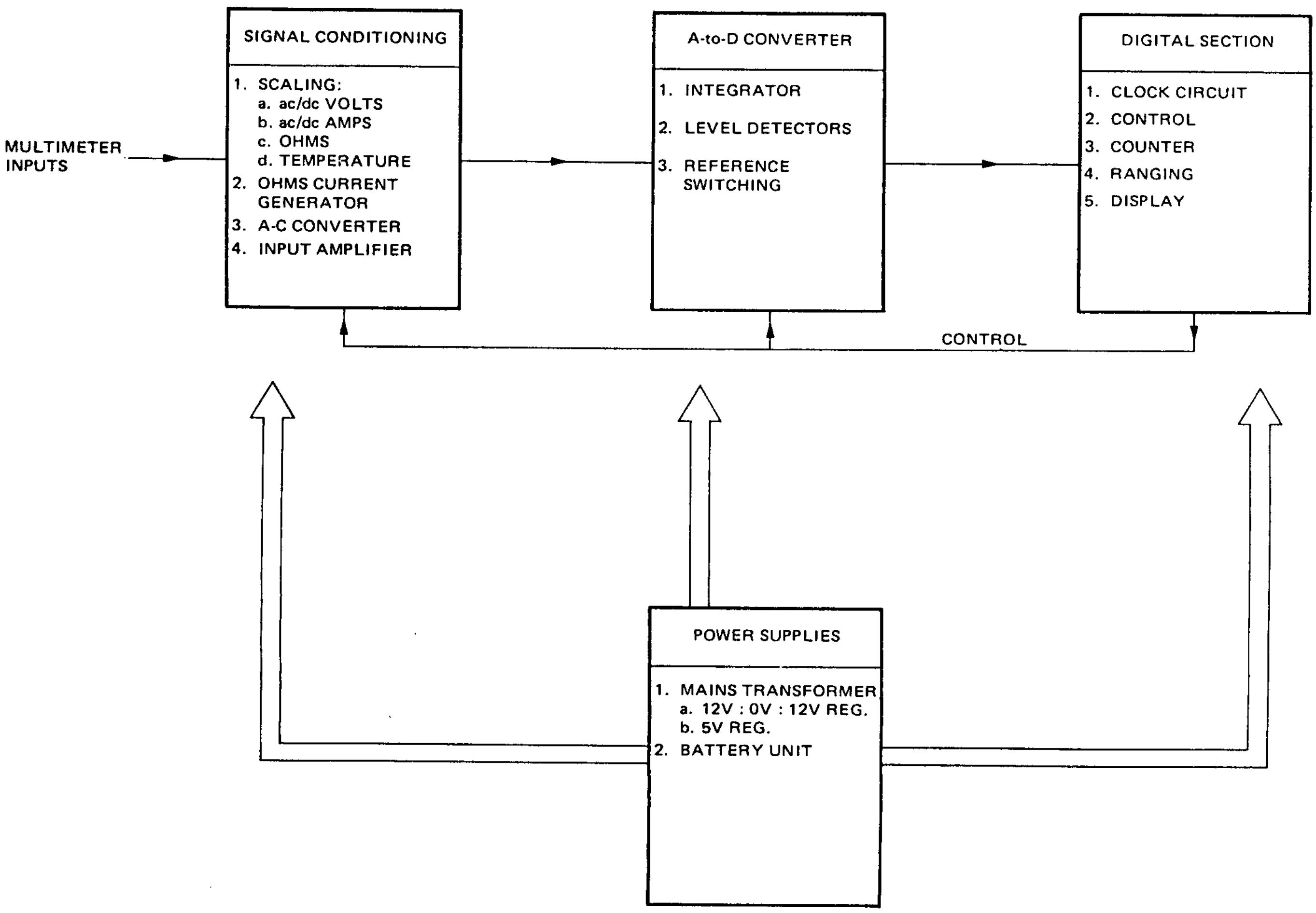


DIAGRAM 1.1 SIMPLIFIED BLOCK DIAGRAM

COMPONENT PARTS LIST ABBREVIATIONS

CIRCUIT REFERENCES

AE	Aerial
B	Battery
C	Capacitor (μF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Motor
ME	Meter
MSP	Mains Selector Panel
PL	Plug

R	Resistor (Ω)
RE	Recording Instrument
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

COMPONENT TYPES

Fixed Resistors

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Variable Resistors

Carbon Front Panel Multiturn	CAFM
Carbon Front Panel Single Turn	CAFS
Carbon Preset Multiturn	CAPM
Carbon Preset Single Turn	CAPS
Cermet Front Panel Multiturn	CMFM
Cermet Front Panel Single Turn	CMFS
Cermet Preset Multiturn	CMPM
Cermet Preset Single Turn	CMPS
Wirewound Front Panel Multiturn	WWFM
Wirewound Front Panel Single Turn	WWFS
Wirewound Preset Multiturn	WWPM
Wirewound Preset Single Turn	WWPS

Capacitors

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

Chapter 2
Technical Description

1 SIGNAL CONDITIONING (DIAGS 2.3, 2.4)

1.1 RELAY DRIVES

Range changes are controlled by pulsed outputs from IC8/25 and IC8/26 which activate the two latching relays RL1 and RL2. The pulses, either positive or negative, and of 10 ms duration, occur once during each (240 ms) measurement cycle, open circuit conditions prevailing during the intervening periods.

Consider RL1 with its contact as shown on the circuit diagram. The first negative pulse will cause TR7 to conduct resulting in contact 12 changing over. Subsequent negative pulses will not alter the state of the relay.

Similarly, a positive pulse will cause TR5 to conduct, thus the contact will revert back to its original position.

1.2 **DC VOLTAGE INPUT** The circuit shows the dc input attenuator which is switched by relays RL1 and RL2 contacts 8, 9 and 10. Attenuation is 1:1, 100:1 or 1000:1 depending on the state of the relays. Relay switching via IC8/25 and IC8/26 is so arranged that the maximum input to the input stage of the operational amplifier cannot exceed 2 volts under normal conditions.

Consider a 10 volt input to the multimeter. RL1 would be energised giving an attenuation through the network of 100:1; thus 0.1 volt would be seen by the operational amplifier.

Spark suppression for the relay contacts, necessary on the higher voltage ranges, is provided by C41 while D10, D11, D14 and D15 are for overload protection.

1.2.1 **Microvolt Adjustment** The μV adjustment, RV5, provides compensation of $\pm 30\mu$V to counteract the effects of any spurious emfs (eg thermal emfs) which may be apparent when using the 20 mV (most sensitive) dc range.

The multimeter should be stable approximately 15 minutes after initial adjustment.

1.3 **AC VOLTAGE INPUT** AC Voltage inputs are manually switched to the AC Converter via the ac attenuator network. Attenuator switching, via RL1 and RL2 contacts 14, 15 and 16, provides attenuation of 1:1, 100:1 and 1000:1 in a similar manner to that described in paragraph 1.2 above.

1.3.1 **AC Converter** IC1 is a bi-FET, high impedance amplifier driving a complementary common base stage TR1 and TR2. Rectification is achieved by the two Schottky diodes D3 and D4 with their associated filter networks. AC feedback to the negative input of IC1 is via C52 with R19 providing dc stabilisation.

Network R7, R8, R9 and RV1 scale the mean positive and negative dc outputs into rms values, the differential output being obtained between pins E7 and E8. Overload protection is provided by C50 with R1 as a by-pass resistor. R16, D5, R17 and D6 limit the input excursions of IC1 to a maximum ± 6 volts peak.

1.4 CURRENT INPUT Current measurement is achieved by measuring the potential produced across the shunt resistors R38, R39 and R40; the output is then fed either directly to the dc voltage measuring circuit or, in the case of ac, via the AC Converter. Scaling is achieved by switching the shunt via RL1 and RL2 contacts 5, 6 and 7.

With the contacts as shown on the circuit diagram, the multimeter would have either the 20 μA or 200 μA ranges selected, i.e.:

maximum output to voltage measuring circuit (I x R)

$$= 20 \times 10^{-6} \times 1 \times 10^{3}$$
$$= \underline{20\ \text{mV}}$$

or

$$200 \times 10^{-6} \times 1 \times 10^{3}$$
$$= \underline{200\ \text{mV}}$$

The switching of RL1 and RL2 contacts is so arranged that for any given current range the maximum output to the voltage measuring circuit is either 20 mV or 200 mV. Input overload protection is provided by F1 and D37.

1.5 RESISTANCE INPUT Resistance measurement is achieved by measuring the voltage developed across the unknown resistance when a known current is passed through it.

1.5.1 Ohms Current Generator The current generator comprises IC2 and its associated network. D12, R33 and D13, TR7 provide protection against accidental overload.

The positive input to IC2 is arranged to be –5.8 volts. The –6.8 volt reference is applied to the dc attenuator resistors R25 to R28 which are switched by RL1 and RL2 contacts according to the range selected. The other end of this resistor chain is connected to the negative input of IC2, thus IC2 defines a current to maintain a drop of 1 volt across R25 to R28.

On the 20 MΩ range, the relay contacts will be in the positions shown on the circuit diagram, thus the available current, $(\frac{V}{R})$.

$$= \frac{1}{10 \times 10^{6}}$$

$$= \underline{0.1\mu\text{A}}$$

On the 200 kΩ and 2 MΩ ranges RL1 will be energised and on the 20 kΩ and 2 kΩ ranges both RL1 and RL2 energised, increasing the available current to 1 μA and 100 μA respectively.

1.6 TEMPERATURE INPUT Resistor R49, which is situated close to the temperature input socket, is a temperature sensitive resistor which, in conjunction with TR50, provides a current through the 620 kΩ resistor, R42, proportional to the ambient temperature.

With the Temperature Probe inserted, the emf produced raises or lowers this potential by an amount proportional to the difference between the probe temperature and the temperature of the input socket. The resultant output is fed to the voltage measuring circuit, scaled at 10 μV for each °C.

1.7 INPUT AMPLIFIER (DIAG 2.4) The Input Amplifier comprises a differential FET input stage, TR15, and an Operational Amplifier, IC3a. TR17 provides a constant current source for the differential input.

The gain of this amplifier is defined by the resistor chain RV8, R65, 66 and 67, and FET switches TR11, TR13 and TR14. FET switching via IC8/27 and IC8/28 sets the gain at X1, X10 or X100 as appropriate.

Input overload protection is provided by D10, D11, D14 and D15 while the combination D18, R69 limit the negative excursion at the output of the Operational Amplifier, thus ensuring satisfactory switching of TR11 and TR12.

The bootstrap connection via TR12, lifts the potential at the gates of TR9 and TR10 by an amount proportional to the output of IC3a. This is necessary in order to maintain satisfactory operation of the two FETS when measuring larger input values.

1.7.1 Calibration Balance Calibration balance (or drift correct) compensates for any drift originating in the Input Amplifier or from the A-to-D Converter. Typically this results from component ageing or from variations in temperature.

In the 7045, a drift correction is carried out for approximately half of each full measurement cycle and is controlled by the alternate on/off switching of FETS TR9 and TR10. With TR10 on, signal Lo (approximately 0 volts on dc measurement functions) is connected to the amplifier input, thus allowing the system to correct for any drift in the circuits that follow.

Since on ac functions, the output from the AC Converter is differential, signal Lo would in these cases be the negative dc voltage level.

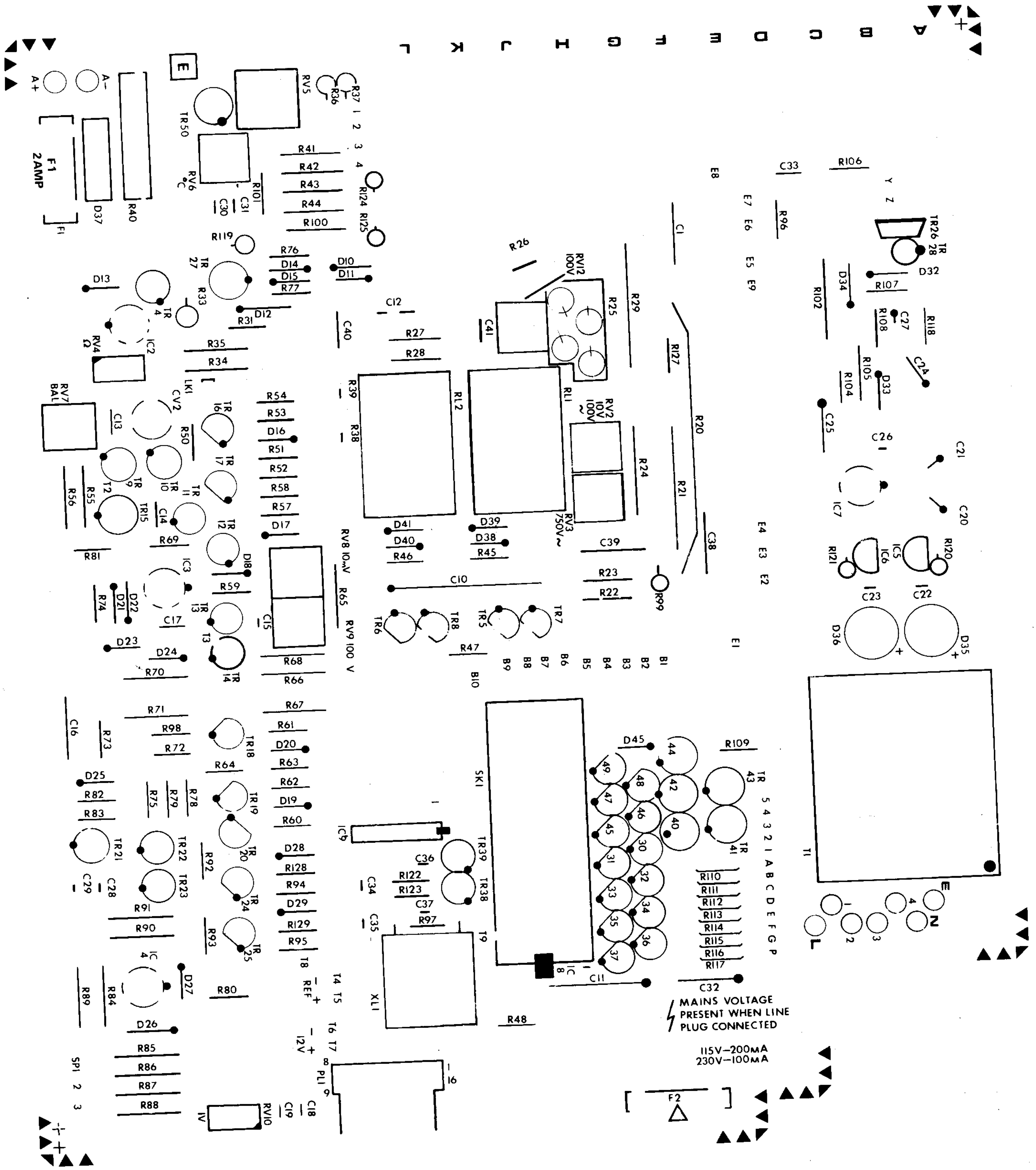


DIAGRAM 2.1 PCB 1 COMPONENT LAYOUT

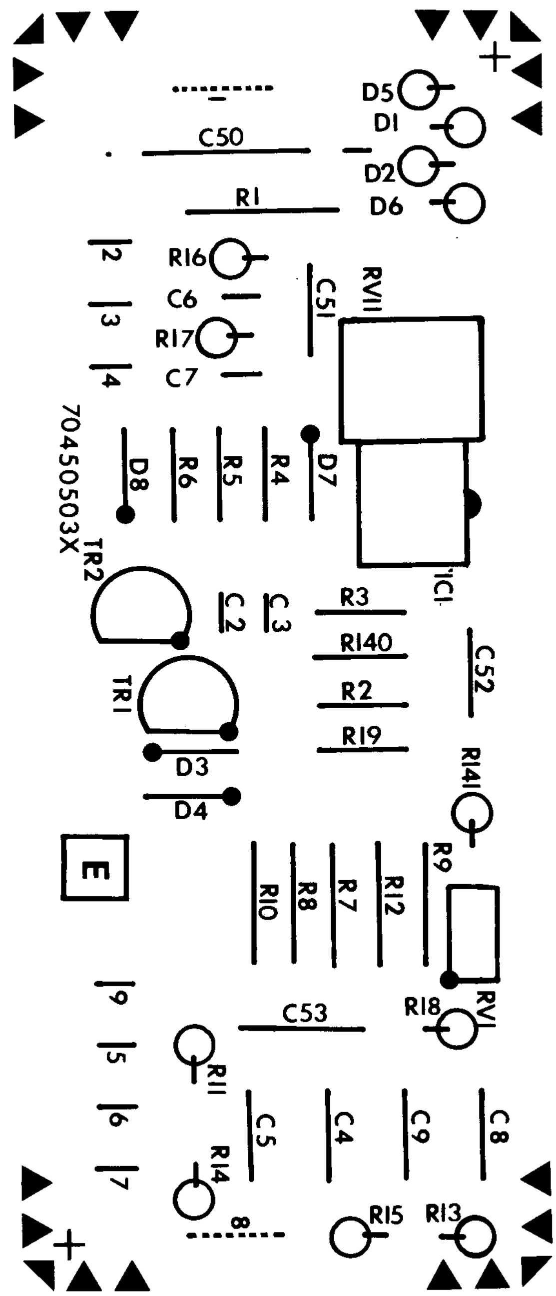
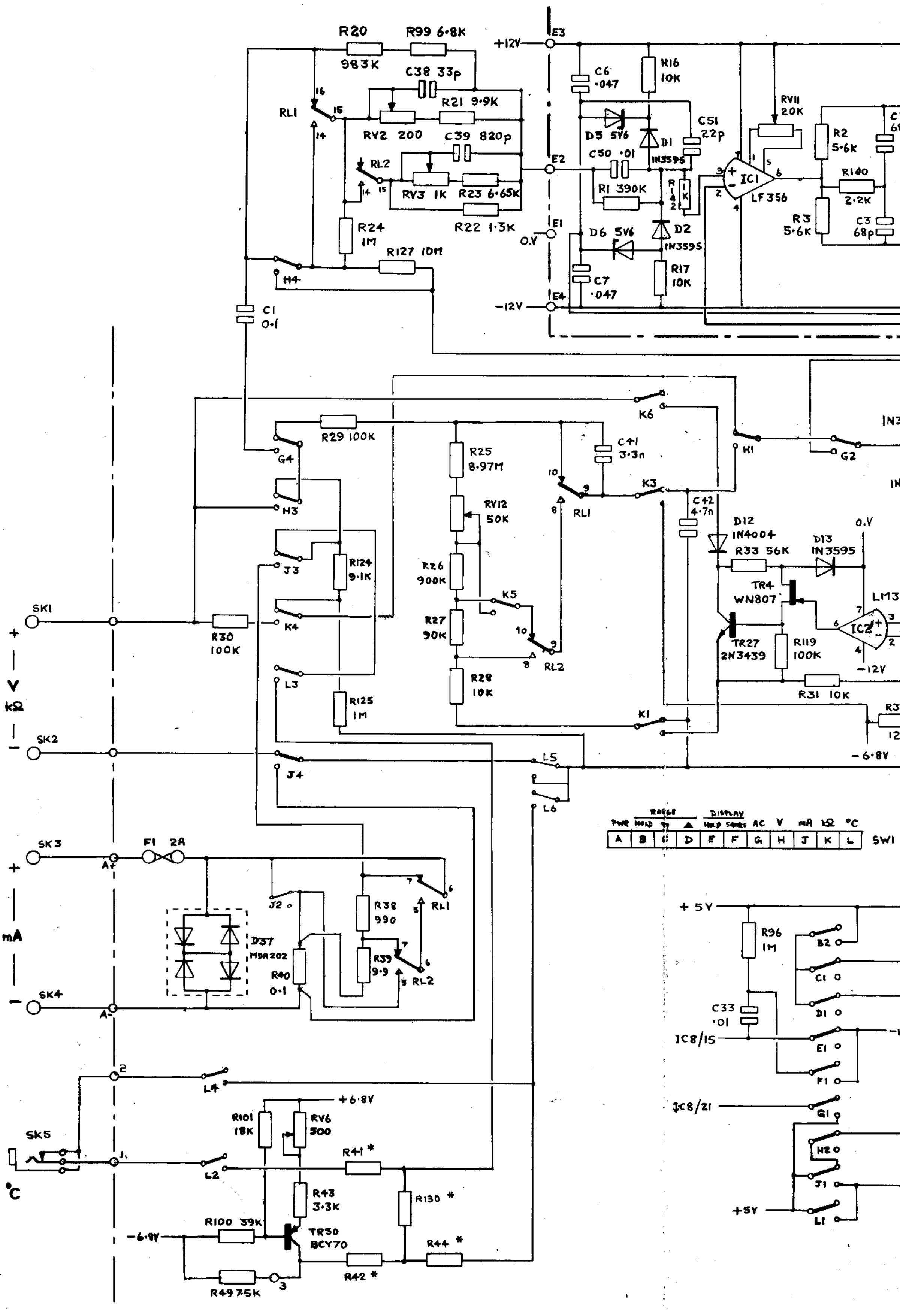


DIAGRAM 2.2 PCB 3 COMPONENT LAYOUT



* See Circuit Changes page 2.12

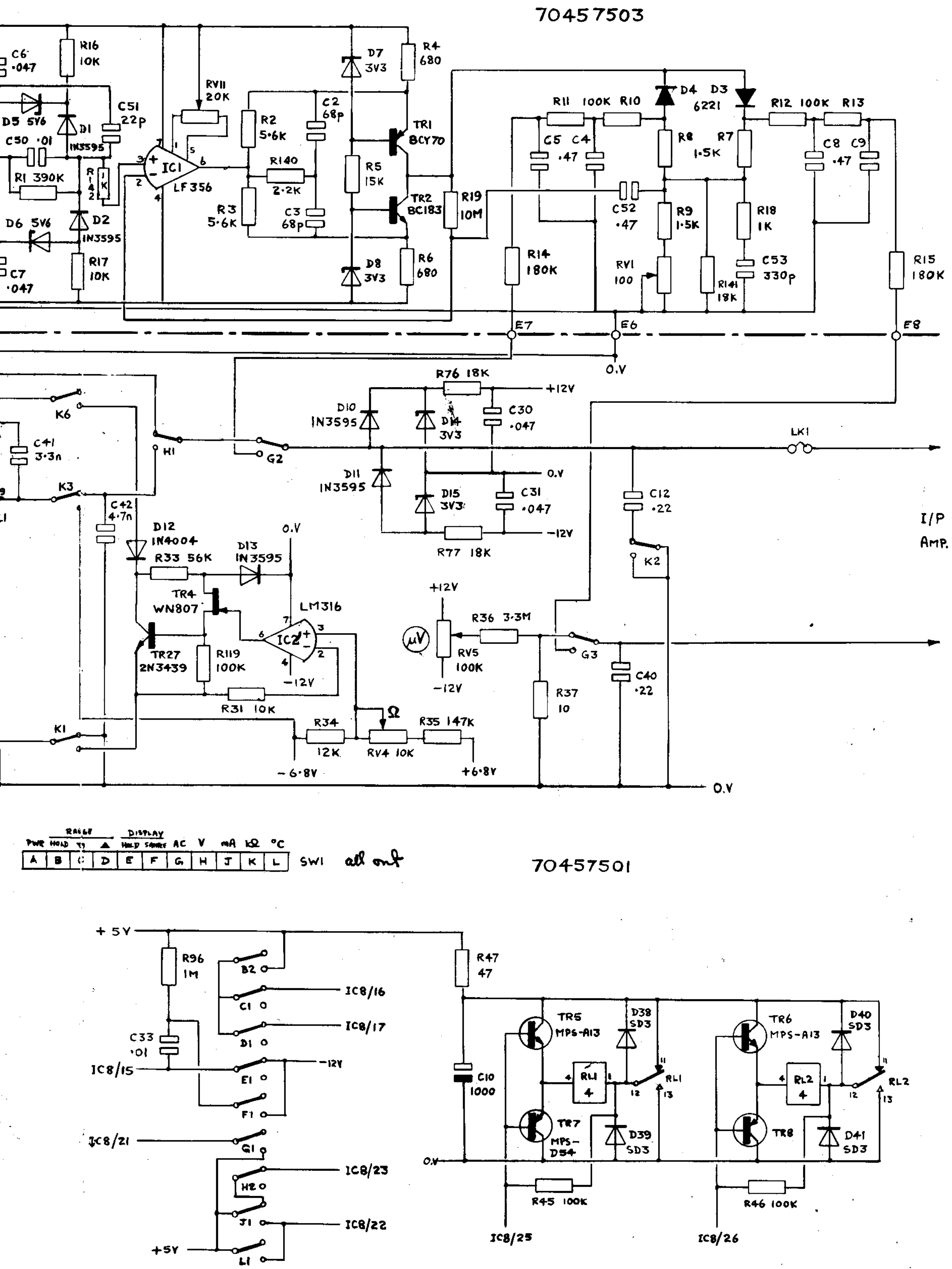


DIAGRAM 2.3 PCB 1 (PART) & PCB 3

PCB 1

Cct Ref	General Description				Solartron Part No.
R20	MEFM	983k	1.3W	0.5%	160400563
R21	MEFM	9.9k	1W	0.5%	198839904
R22	MEFM	1.3k	1/8W	0.5%	192731304
R23	MEFM	6.65k	1/8W	0.5%	192736652
R24	CAFM	1M	1W	5%	160000238
R25	MEFM	8.97M		0.1%	169611701
R26	PRWW	900k	Matched set		169611601
R27	PRWW	90k			169611601
R28	PRWW	10k			169611601
R29	TKFM	100k	4W	2%	175251000
R30	CACP	100k	4W	2%	172551000
R31	CACP	10k	1/4W	10%	172041000
R33	MEOX	56k	1W	5%	193445600
R34	MEFM	12k	1/8W	0.5%	192741204
R35	MEFM	147k	1/8W	0.5%	192751474
R36	CACP	3.3M	1/4W	10%	172063300
R37	MEFM	10	1/8W	0.5%	192711002
R38	PRWW	990	0.07W	0.1%	160300415
R39	PRWW	9.9	0.07W	0.1%	160300416
R40	WW	0.1			160300428
R41 *	MEFM	680	1/8W	0.25%	192826801
R42 *	MEFM	620k	1/8W	0.5%	192756202
R43	MEFM	3.3k	1/8W	0.5%	192733302
R44 *	MEFM	220	1/8W	0.25%	192822201
R45	CACP	100k	1/4W	10%	172051000
R46	CACP	100k	1/4W	10%	172051000
R47	CACP	47	1/4W	10%	172014700
R48	CACP	22	1/4W	10%	172012200
R49	WW	7.5k			169613601
R50	CACP	1M	1/4W	10%	172061000
R51	CACP	1M	1/4W	10%	172061000
R52	CACP	22k	1/4W	10%	172042200
R53	CACP	68k	1/4W	10%	172046800
R54	CACP	10k	1/4W	10%	172041000
R55	MEFM	22k	1/8W	0.5%	192742201
R56	MEFM	22k	1/8W	0.5%	192742201
R57	MEOX	12k	1/4W	5%	195641200
R58	CACP	2.7k	1/4W	10%	172032700
R59	CACP	1M	1/4W	10%	172061000
R60	CACP	1M	1/4W	10%	172061000
R61	CACP	1M	1/4W	10%	172061000
R62	CACP	150k	1/4W	10%	172051500
R63	CACP	150k	1/4W	10%	172051500
R64	CACP	10k	1/4W	10%	172041000
R65	PRWW	800		0.1%	169611401
R66	PRWW	800	Matched set	0.1%	169611401
R67	PRWW	800		0.1%	169611401
R68	MEFM	75k	1/8W	0.5%	192747501
R69	CACP	47k	1/4W	10%	172044700
R70	PRWW	100k	Matched pair	0.5%	1696115
R71	PRWW	270k		0.5%	1696115
R72	MEFM	15k	1/8W	0.5%	160400562
R73	CACP	47k	1/4W	10%	172044700
R74	CACP	1k	1/4W	10%	172031000
R75	CACP	22k	1/4W	10%	172042200
R76	CACP	18k	1/4W	10%	172041800
R77	CACP	18k	1/4W	10%	172041800
R78	CACP	1.5M	1/4W	10%	172042200
R79	CACP	22k	1/4W	10%	172042200

Cct Ref	General Description				Solartron Part No.
R80	CACP	10k	1/4W	10%	172041000
R81	CACP	1k	1/4W	10%	172031000
R82	CACP	2.2k	1/4W	10%	172032200
R83	CACP	47k	1/4W	10%	172044700
R84	MEFM	3.3k	1/8W	0.5%	192733302
R85	MEFM	22k	1/8W	0.5%	192742201
R86	MEFM	1.6k	1/8W	0.5%	192731601
R87	MEFM	820	1/8W	0.5%	192728202
R88	MEFM	430	1/8W	0.5%	192724302
R89	MEFM	9.1k	1/8W	0.5%	192739102
R90	MEFM	18k	Matched pair	0.5%	169607302
R91	MEFM	18k		0.5%	169607302
R92	CACP	100k	1/4W	10%	172051000
R93	CACP	100k	1/4W	10%	172051000
R94	CACP	10k	1/4W	10%	172041000
R95	CACP	10k	1/4W	10%	172041000
R96	CACP	1M	1/4W	10%	172061000
R97	CACP	10M	1/4W	10%	172071000
R98	MEFM	15k	1/8W	0.5%	160400562
R99	MEFM	6.8k	1/8W	0.5%	192736802
R100	MEOX	39k	1/4W	5%	195643900
R101	MEOX	18k	1/2W	5%	193541800
R102	POWW	10	2.6W	5%	173411000
R103	CACP	33k	1/4W	10%	172043300
R104	CACP	1.5k	1/4W	10%	172031500
R105	MEFM	220k	1/8W	0.5%	192752202
R106	CACP	100	1/4W	10%	172021000
R107	CACP	680	1/4W	10%	172026800
R108	CACP	680	1/4W	10%	172026800
R109	CACP	120	1/4W	10%	172021200
R110 to R117	CACP	82	1/4W	10%	172018200
R118	CACP	1k	1/4W	10%	172031000
R119	CACP	100k	1/4W	10%	172051000
R120	CACP	680	1/4W	10%	172026800
R121	CACP	470	1/4W	10%	172024700
R122	CACP	1M	1/4W	10%	172061000
R123	CACP	1M	1/4W	10%	172061000
R124	MEFM	9.1k	1/8W	5%	192739102
R125	MEFM	1M			192761002
R127	CACP	10M	1/4W	10%	172071000
R128	CACP	39k			172043900
R129	CACP	39k			172043900
RV2	CMPS	200	1/2W	10%	131222000
RV3	CMPS	1k	1/2W	10%	131231000
RV4	CMPM	10k	1/2W	10%	130941000
RV5	CAFS	100k	1W	20%	110024090
RV6	CMPS	500	1/2W	10%	131225000
RV7	CMPS	2k	1/2W	10%	131232000
RV8	CMPS	500	1/2W	10%	131225000
RV9	CMPS	500	1/2W	10%	131225000
RV10	CMPS	500	1/2W	10%	130925000
RV12	CMPS	50k	1/2W	10%	131245000

* See Circuit Changes page 2.12.

Cct Ref
C1
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28 to C31
C32
C33
C34
C35
C36
C37
C38
C39
C40
C41
C42
CV2
D10
D11
D12
D13
D14
D15
D16
D17
D18 to D22
D23

PCB 1 (cont)

Solartron Part No.
172041000
172031000
172032200
172044700
192733302
192742201
192731601
192728202
192724302
192739102
169607302
169607302
172051000
172051000
172041000
172041000
172061000
172071000
160400562
192736802
195643900
193541800
173411000
172043300
172031500
192752202
172021000
172026800
172026800
172021200
172018200
172031000
172051000
172026800
172024700
172061000
172061000
192739102
192761002
172071000
172043900
172043900
131222000
131231000
130941000
110024090
131225000
131232000
131225000
131225000
130925000
131245000

Cct Ref	General Description				Solartron Part No.
C1	ESTM	0.1	400V	± 20%	226151000
C10	ALME	1000	10V	-10% +50%	273191000
C11	ALME	47	25V	-10% +50%	273574700
C12	ESTM	0.22	100V	± 10%	225452200
C13	ESTM	0.047	100V	± 10%	225444700
C14	ESTM	4700p	100V	± 10%	227034700
C15	CERM	47p	500V	± 20%	241314700
C16	ESTM	0.47	100V	± 10%	225454700
C17	ESTM	0.033	100V	± 10%	225443300
C18	CERM	0.047	25V	+50% -25%	241944700
C19	CERM	0.047	25V	+50% -25%	241944700
C20	ALME	220	25V	-10% +50%	273582200
C21	ALME	220	25V	-10% +50%	273582200
C22	CERM	0.047	25V	+50% - 25%	241944700
C23	CERM	0.047	25V	+50% - 25%	24194970
C24	ALME	1000	10V	-10% +50%	273191000
C25	ALME	47	10V	-10% +50%	208600244
C26	CERM	33p	500V	± 20%	241313300
C27	TAND	22	16V	20%	208700106
C28 to C31	CERM	0.047	25V	+50% - 25%	241944700
C32	ALME	47	10V	-10% +50%	208600244
C33	ESTM	0.01	100V	± 10%	225441000
C34	CERM	33p	500V	± 20%	241313300
C35	CERM	33p	500V	± 20%	241313300
C36	CERM	100p	500V	± 20%	241321000
C37	CERM	100p	500V	± 20%	241321000
C38	STYR	33p	500V	± 0.5p	208100114
C39	STYR	820p	125V	± 2.5%	210128200
C40	ESTM	0.22	100V	± 10%	225452200
C41	PLYN	3300p	1.5kV	10%	208100186
C42	ESTF	4700p	100V	± 10%	227034700
CV2	PYLN	1.4p to 5.5p			290030220
D10	1N 3595				300523590
D11	1N 3595				300523590
D12	1N 4004				300522070
D13	1N 3595				300523590
D14	ZENER	3.3V			300521860
D15	ZENER	3.3V			300521860
D16	SD3				300522160
D17	ZENER	5.6V			300521450
D18 to D22	SD3				300522160
D23	ZENER	5.6V			300521450

Cct Ref	General Description		Solartron Part No.
D24	ZENER	5.6V	300521460
D25	ZENER	5.6V	300521450
D26	1N 4577		300525050
D27	SD3		300522160
D28	SD3		300522160
D29	SD3		300522160
D32	SD3		300522160
D33	ZENER	5.6V	300521450
D34	1N 4004		300522070
D35	W04		300524700
D36	W04		300524700
D37	MDA 202		300525640
D38 to D41	SD3		300522160
D45	ZENER	3.3V	300521860
TR4	WN 807		300555380
TR5	MPS-A13		300554560
TR6	MPS-A13		300554560
TR7	MPS-D54		300555600
TR8	MPS-D54		300555600
TR9	WN 807		300555380
TR10	WN 807		300555380
TR11 to TR14	U1 899		300554320
TR15	WD 401		300555370
TR16 to TR20	BC 183		300555590
TR21	BCY 70		300553590
TR22	U1 899		300554320
TR23	U1 899		300554320
TR24	BC 183		300555590
TR25	BC 183		300555590
TR26	BD 165		300555160
TR27	2N 3439		300552670
TR28	BC 183		300555590
TR30 to TR37	BC 183		300555590
TR38	P1 087E		300555550
TR39	U1 899		300554320
TR40 to TR44	2N 2907A		300554551
TR45 to TR49	BC 183		300555590
TR50	BCY 70		300553590
IC2	LM 316H		510090470
IC3	MC 1458G		510090400
IC4	MC 1458G		510090400
IC5	78L 12AC		510090450

continued on page 2.7

2 THE ANALOGUE TO DIGITAL CONVERTER (DIAG 2.4)

The A-to-D Converter comprises an integrator, level detectors, reference switching FETS and their associated drivers.

2.1 **INTEGRATOR** The Integrator IC3b has the following inputs connected to its summing point;

a The input to be measured

b The forcing waveform

c + Reference voltage, – reference voltage.

With zero input voltage and a 200 Hz square wave (forcing waveform) applied continuously to the integrator, the output is driven alternately positive and negative through the thresholds of the detectors, TR19 and TR20.

The state of the level detectors is sensed at IC8/35 and IC8/36 to provide clock-enabling pulses to counting circuits, and reference switching for the two FETS, TR22 and TR23.

With zero (measured) input to the integrator, the reference inputs are symmetrical. A negative input would result in the positive reference being applied for a longer period than the negative reference, and vice versa, in order to maintain the dynamic balance at the integrator output.

2.1.1 **Precision Reference Circuit** This circuit provides the positive and negative reference supplies for the A-to-D Converter and also for the Ohms Current Generator (paragraph 1.4.1).

There are two amplifiers in this circuit, IC4b and IC4a. The first amplifier has a precision reference zener D26 as its feedback element, defining its output at +6.8 volts and producing the positive reference voltage. This also provides the input to IC4a whose gain, defined by R90 and R91, is –1. The –6.8 volts output of this amplifier is used as the negative reference and also provides the constant current for the reference zener.

Split pads SP1 to 3 and their associated resistor chain are adjusted during calibration to allow for zener tolerances.

3 THE DIGITAL SECTION

Diag. 2.5 represents the Digital Section of the multimeter, IC8. Where the pin voltage/waveform is not shown, reference should be made to the appropriate waveform diagram as indicated. (Diags, 2.6 and 2.7). The integrator output, IC3/7. is also shown diagramatically in Diag 2.7b.

3.1 **CLOCK CIRCUIT** IC9a is a CMOS Inverter arranged as a conventional crystal controlled oscillator circuit. IC9b is a buffer driving complementary FETS TR38 and TR39, producing a +5V and –12V 960 kHz square-wave at T9.

PCB 1 (cont)

Cct Ref	General Description		Solartron Part No.
IC6	79L 12AC		510090460
IC7	LM301A		510000620
IC8	40 Pin DIL Plessey		519603801
IC9	4007CP		510003020
RL1	YPR4/DM/CFB/3/CELANEX		
RL2	YPR4/DM/CFB/3/CELANEX		
SK1	AUGAT 340–A939D		300584970
FS1	Fuse Skt	PCB MTG	
FS2	Fuse Skt	PCB MTG	
FS1	Fuse	2A	360106150
FS2	Fuse	100mA	360106260
T1			309611202
SW1	11 Way Pushbutton SW Assy.		379617002
XL1	Crystal	960 kHz	300810450

PCB 2

Cct Ref	General Description		Solartron Part No.
D42 to D44	LED		300750080
X1	LED	±1 Display	300730340
X2 to X5	LED	7 Bar Displays	300730330

MAINFRAME

Cct Ref	General Description	Solartron Part No.
SK1	4mm RED	352501470
SK2	4mm RED	352501470
SK3	4mm BLACK	352501480
SK4	4mm BLACK	352501480
SK5	2.5mm Jack socket	Tape Rec. Spaces 2844
PL1	Mains plug	352303140

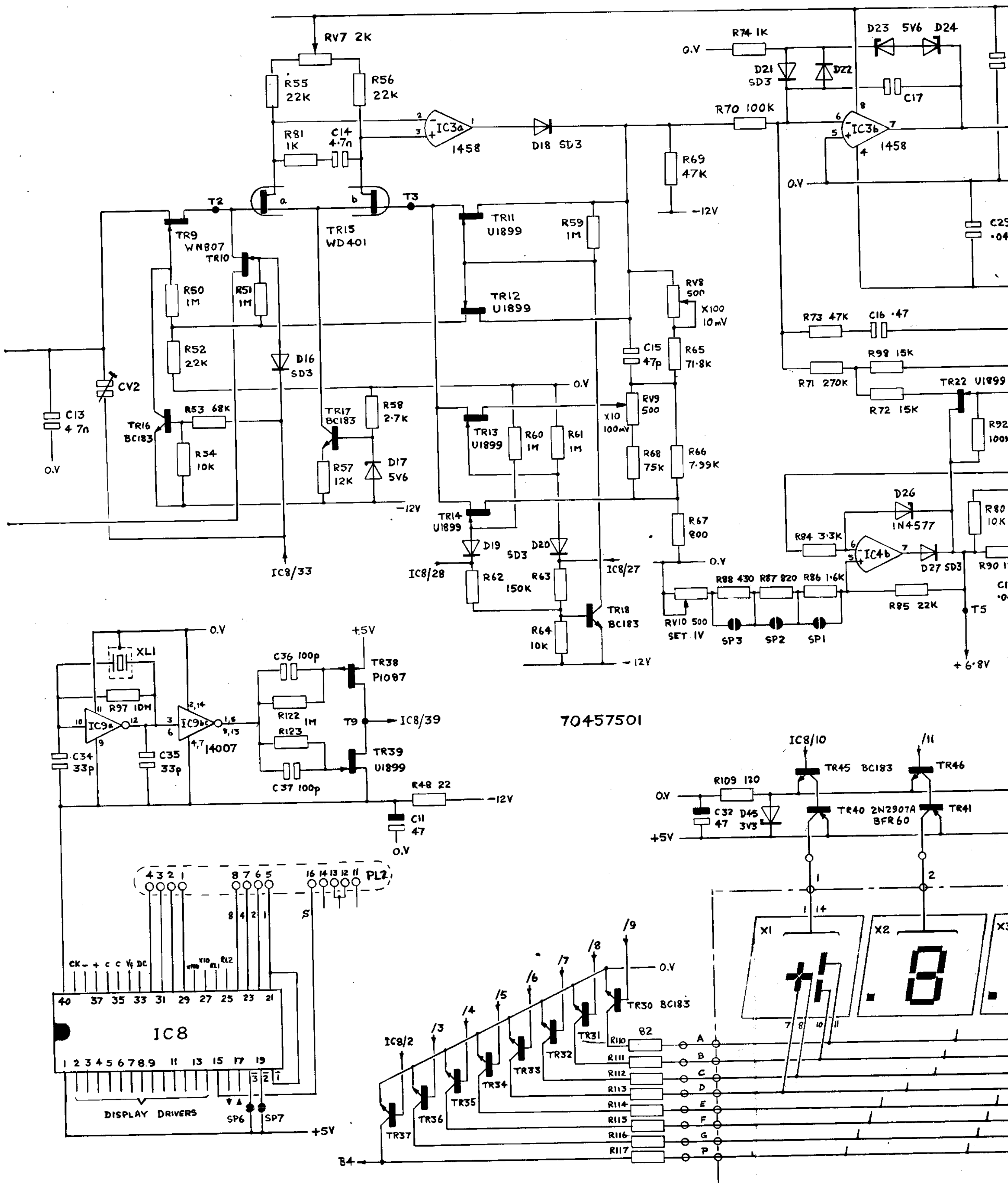
ACCESSORIES

General Description	Solarton Part No.
Mains cable	480140220
Input lead/probe red	359900190
Input lead/probe black	359900180
Croc clip red	355900670
Croc clip black	355900660
Fuse 2A	360106150
Fuse 100mA	360106260
Fuse 200mA	360106280

PCB 3

Cct Ref	General Description				Solartron Part No.
R1	MEOX	390k	1/2W	1%	195453900
R2	CACP	5.6k	1/4W	10%	172035600
R3	CACP	5.6k	1/4W	10%	172035600
R4	CACP	680	1/4W	10%	172026800
R5	CACP	15k	1/4W	10%	172041500
R6	CACP	680	1/4W	10%	172026800
R7	MEFM	1.5k	1/8W	0.5%	192731501
R8	MEFM	1.5k	1/8W	0.5%	192731501
R9	MEFM	1.5k	1/8W	0.5%	192731501
R10	MEFM	100k	1/8W	0.5%	192751002
R11	CACP	100k	1/4W	10%	172051000
R12	MEFM	100k	1/8W	0.5%	192751002
R13	CACP	100k	1/4W	10%	172051000
R14	CACP	180k	1/4W	10%	172051800
R15	CACP	180k	1/4W	10%	172051800
R16	CACP	10k	1/4W	10%	172041000
R17	CACP	10k	1/4W	10%	172041000
R18	MEOX	1k	1/4W	1%	195331000
R19	CACP	10M	1/4W	10%	172071000
R140	CACP	2.2k	1/4W	10%	172032200
R141	MEOX	18k	1/4W	1%	195341800
RV1	CMPM	100	1/2W	10%	130921000
RV11	CMPS	20k	1/2W	10%	131242000
C2	CERM	68p	200V	± 10%	240716800
C3	CERM	68p	200V	± 10%	240716800
C4	ESTM	0.47	63V	± 10%	225154700
C5	ESTM	0.47	63V	± 10%	225154700
C6	CERM	0.047	25V	+50% -25%	241944700
C7	CERM	0.047	25V	+50% -25%	241944700
C8	ESTM	0.47	63V	± 10%	225154700
C9	ESTM	0.47	63V	± 10%	225154700
C50	WIMA MKP10	0.01	630V		NAF
C51	STYR	22p	125V	10%	210212200
C52	ESTM	0.47	63V	± 10%	225154700
C53	STYR	330p	125V	2.5%	210123300
D1	1N 3595				300523590
D2	1N 3595				300523590
D3	HP 6721				300525380
D4	HP 6721				300525380
D5	ZENER	5.6V			300521450
D6	ZENER	5.6V			300521450
D7	ZENER	3.3V			300521860
D8	ZENER	3.3V			300521860
TR1	BCY 70				300553590
TR2	BC 183				300555590
IC1	LF 536H				510090440

PCB 4 parts list on page 2.11



RV7 2K
R55 22K
R56 22K
R81 1K
C14 4.7n
IC3a
1458
D18 SD3
R70 100K
R74 1K
0.V
D21 SD3
D22
D23 5V6 D24
C17
IC3b
1458
R69 47K
-12V
T2
T3
TR9 WN807
TR10
TR15 WD401
TR11 U1899
R59 1M
R50 1M
R51 1M
TR12 U1899
RV8 500
X100 10mV
R73 47K
C16 ·47
R98 15K
R71 270K
R72 15K
TR22 U1899
R52 22K
D16 SD3
CV2
C13 4 7n
C15 47p
R65 71·8K
RV9 500
X10 100mV
TR16 BC183
R53 68K
R54 10K
TR17 BC183
R58 2·7K
R57 12K
D17 5V6
TR13 U1899
R60 1M
R61 1M
R68 75K
R66 7·99K
-12V
TR14 U1899
D19
SD3
D20
R67 800
D26 1N4577
R84 3·3K
IC4b
D27 SD3
R90
R80 10K
IC8/33
IC8/28
R62 150K
R63
IC8/27
TR18 BC183
R64 10K
RV10 500 SET 1V
R88 430 R87 820 R86 1·6K
R85 22K
T5
SP3 SP2 SP1
+6·8V
XL1
R97 10M
IC9a
IC9b
14007
C34 33p
C35 33p
+5V
C36 100p
TR38 P1087
R122 1M
R123
T9
IC8/39
TR39 U1899
C37 100p
R48 22
C11 47
70457501
IC8/10
TR45 BC183
TR46
R109 120
C32 47
D45 3V3
TR40 2N2907A BFR60
TR41
+5V
PL2
DISPLAY DRIVERS
IC8
SP6
SP7
+5V
X1
X2
TR30 BC183
TR31
TR32
TR33
TR34
TR35
TR36
TR37
IC8/2
R110 82
R111
R112
R113
R114
R115
R116
R117
A B C D E F G P
B4

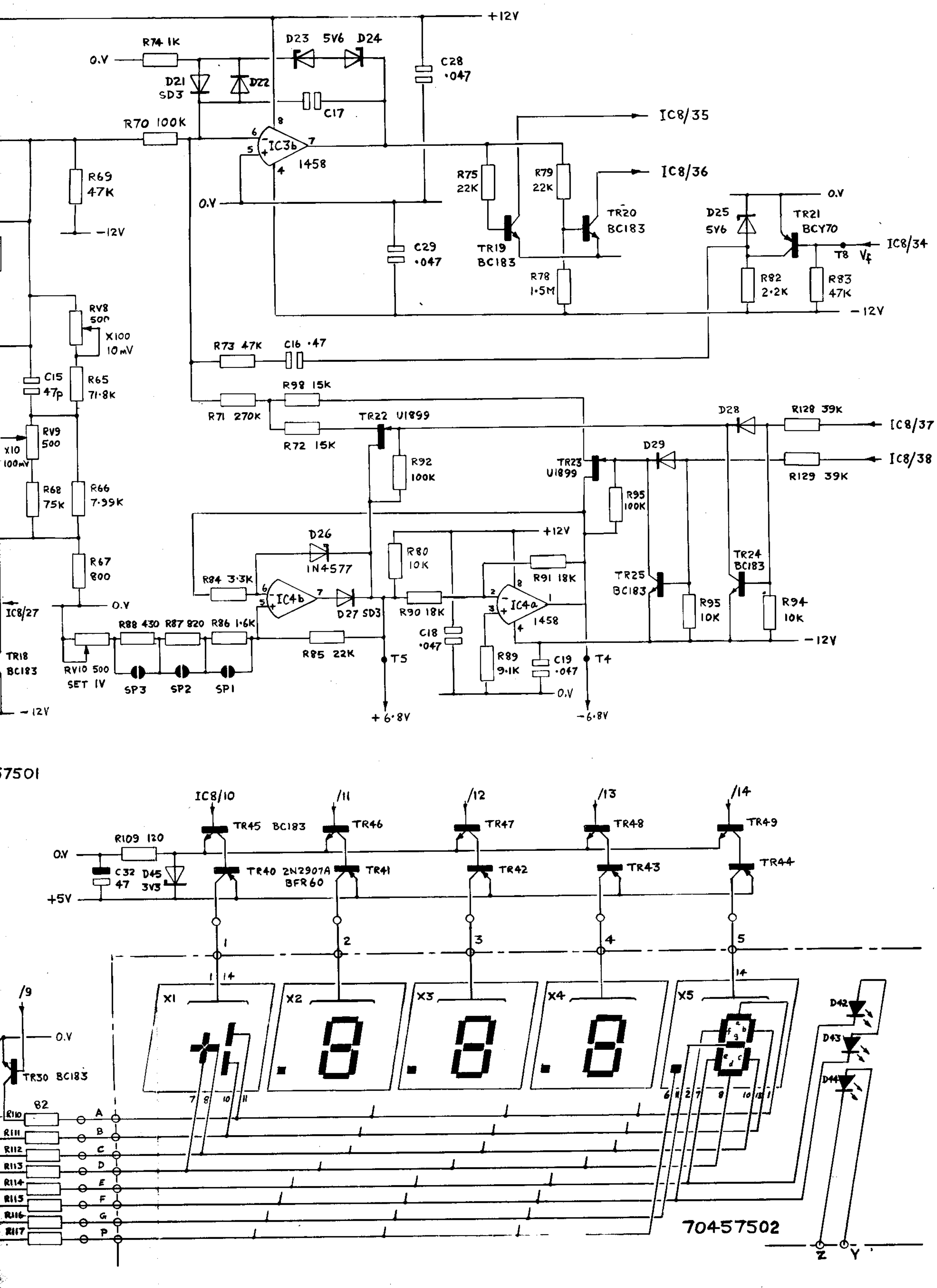
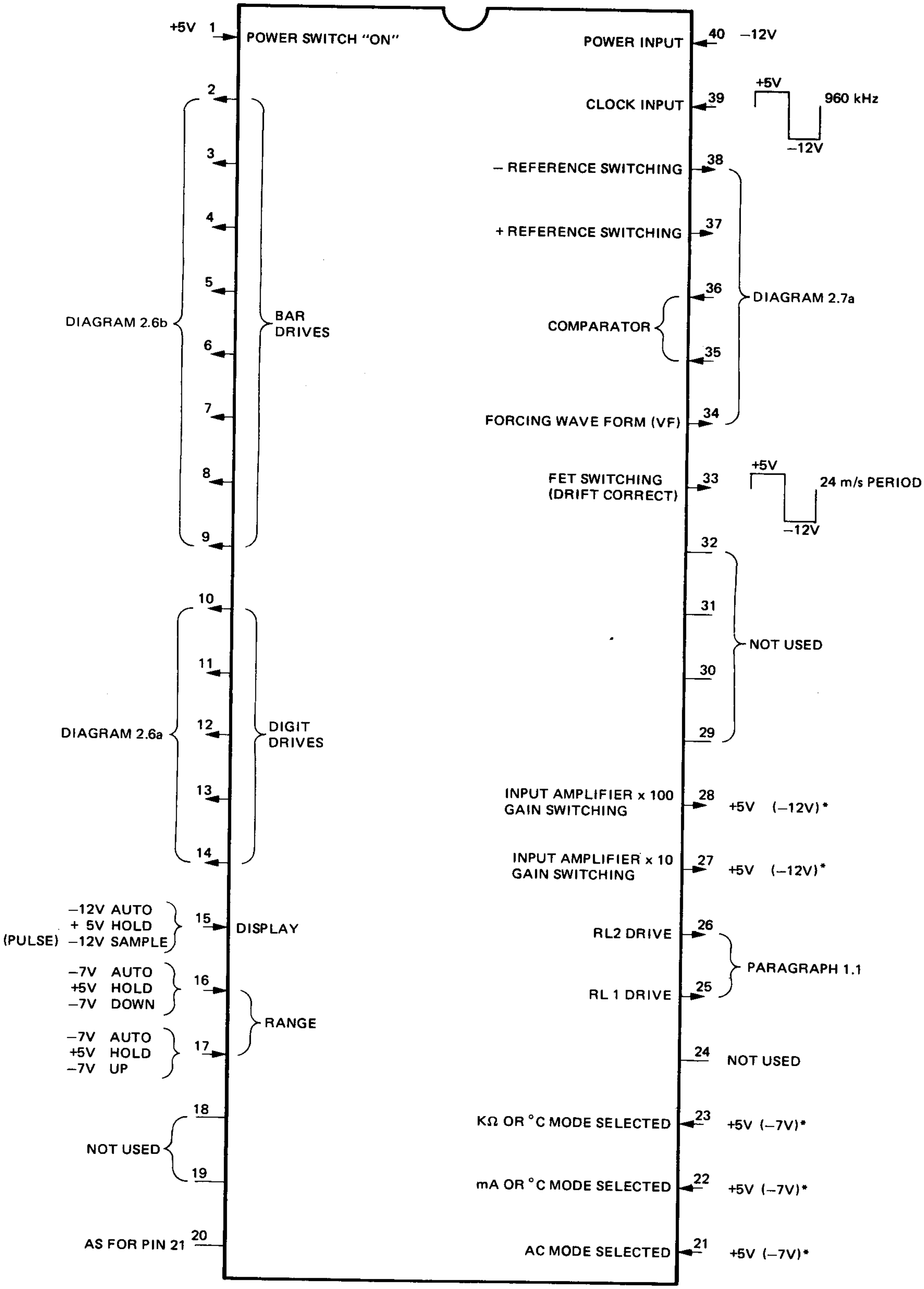


DIAGRAM 2.4 PCB 1 (PART) & PCB 2

DIAGRAM 2.5 ▶



*Figures in brackets indicate quiescent state

DIAGRAM 2.5 PIN IDENTIFICATION IC8

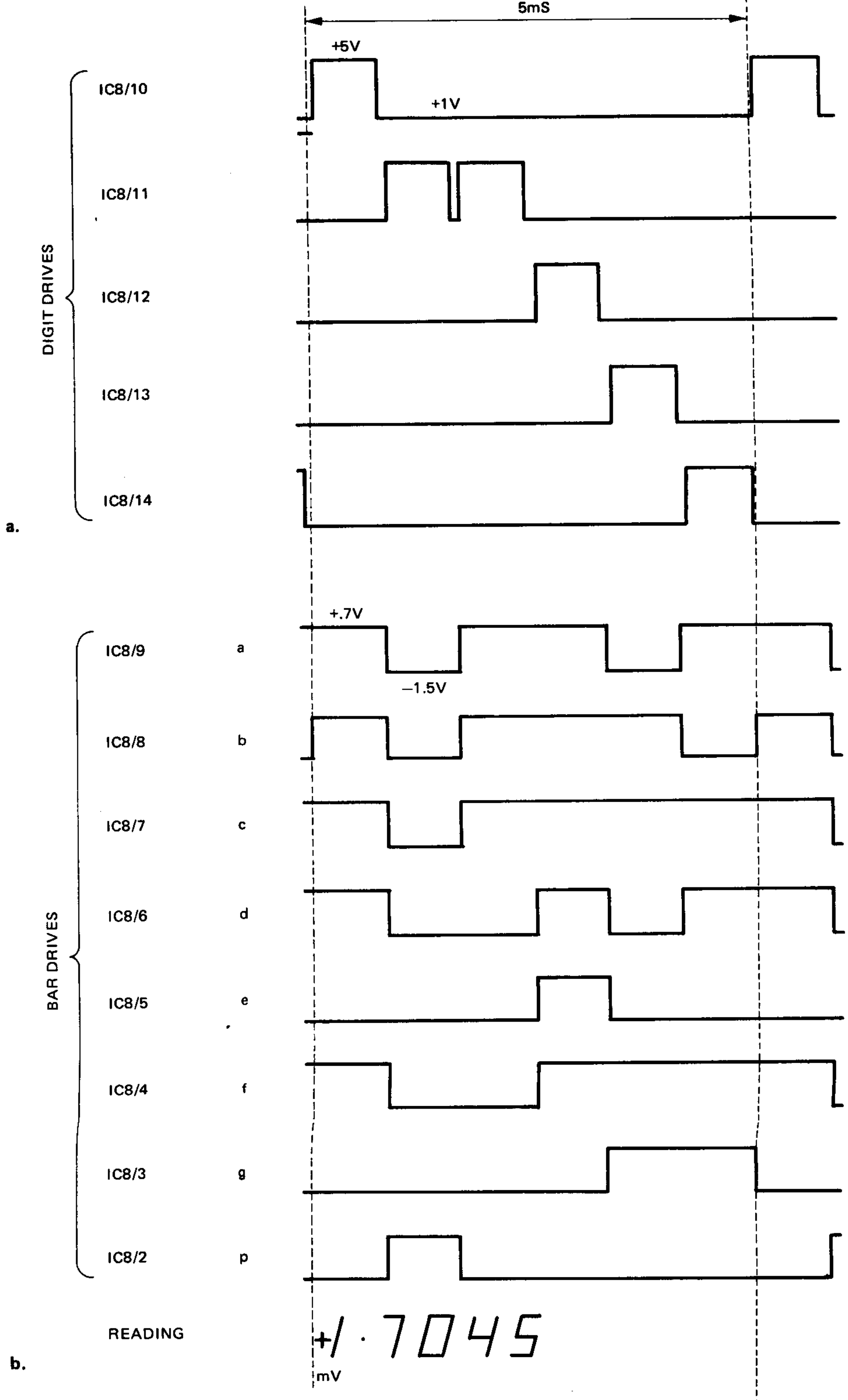


DIAGRAM 2.6 DISPLAY WAVEFORMS

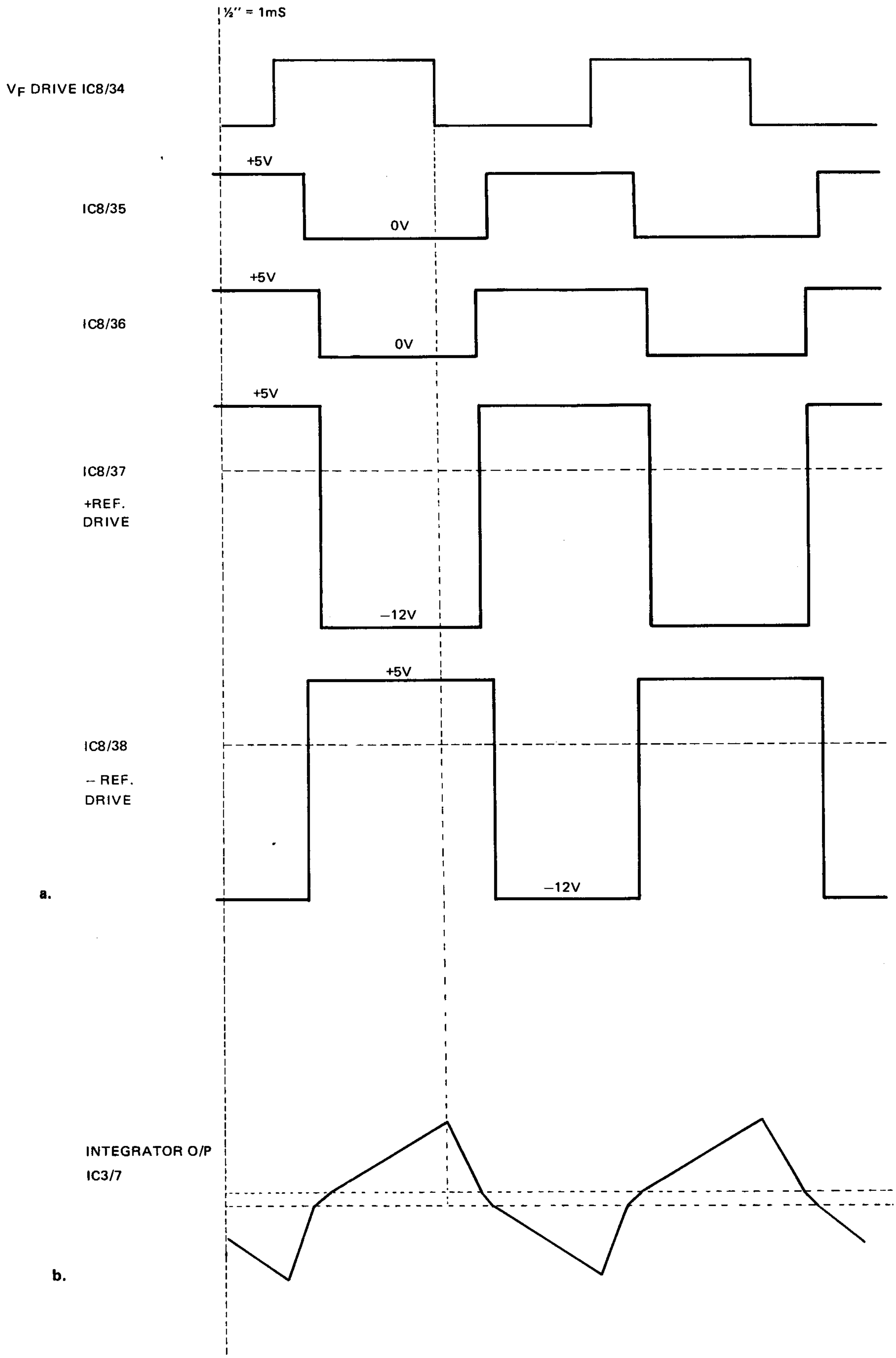


DIAGRAM 2.7   A-TO-D CONVERTER WAVEFORMS

4 POWER SUPPLIES (DIAG 2.9)

Power supplies for the multimeter are derived from the mains transformer T1. A Battery Unit provides an alternative source of power once the optional battery-pack, comprising four re-chargeable nickel cadmium cells, is fitted.

The multimeter may be operated from either a 230V or 115V mains supply depending upon the supply link arrangement at the input to T1. The 7045, on leaving the factory, would normally be set-up to operate from a 230 V supply; reference should be made to the marking on the rear panel of the multimeter to ascertain the correct operating voltage setting. Access to the links is gained by removing the rear panel and top cover.

The supply link arrangement should be as follows:

230V mains operation : link between terminals 2 and 3

115V mains operation : link between terminals 1 and 2 also 3 and 4

T1 has two secondary windings which give nominally ± 17V centre-tapped, and 10V respectively.

4.1 **± 17V OUTPUT** This output after rectification (D35) and regulation (IC5/6) produces the ± 12V supplies for the instruments main supply rails. Inputs B1, B2 and B3, shown on the circuit diagram, are inputs from the Battery Unit, when this is used in lieu of the mains supply.

4.2 **10V OUTPUT** This secondary output produces the +5V for the clock circuit, the display drivers and for the Digital Section of the multimeter IC8. Rectification is achieved by D36 with zener D33 defining the output at 5V. IC7 with its associated network provides regulation. Outputs from this secondary are also used in the Battery Unit circuitry; these are discussed in the following paragraphs:

4.3 **BATTERY UNIT** The Battery Unit comprises the battery case, pcb, and four optional NiCd batteries. The 7045 is supplied with the Battery Unit installed; the optional cells require fitting and charging before use.

4.3.1 **Operation** The Battery Unit output is fed to the Voltage Switching Regulator IC150 via RL150 contacts 1 and 4 and the power switch SW1/A4. The regulator produces a pulsed output, via the current amplification stages TR154 and TR155 to the primary of T150, to produce the +15V: 0V: −15V secondary output.

Stabilisation is achieved by sensing the +15V output via the feedback network R170, R154 and R152.

With the mains supply available and the power switch selected, RL150 is energised by the rectified output of D36, disconnecting the Battery Unit output to the multimeter including the supply to the Voltage Switching Regulator. The regulator is also inhibited via the resistor R150.

4.3.2 **Charging** The Battery Unit can be charged in one of two ways:

a With the mains supply available and the power switch off the batteries receive a high charge of approximately 300mA. In this case the charging (lower) annunciator will be lit.

b With the mains supply available and the power switch selected, (i.e. multimeter in normal use) the batteries receive a trickle charge of approximately 40 mA.

This arrangement allows for over-night charging at the high rate if required while normal operation should maintain the batteries in a good state of charge.

CAUTION Charging at the high rate should not exceed 15 hours.

PCB 4

Cct Ref	General Description				Solartron Part No.
R150	CACP	1.5k	1/4W	10%	172031500
R151	CACP	100	1/4W	10%	172021000
R152	MEFM	1k	1/8W	0.5%	192731002
R153	MEFM	330k	1/8W	0.5%	192753302
R154	MEFM	12k	1/8W	0.5%	192741202
R155	MEFM	5.6k	1/8W	0.5%	192735602
R156	MEFM	10k	1/8W	0.5%	192741002
R157	CACP	3.3k	1/4W	10%	172033300
R158	CACP	68	1/4W	10%	172016800
R159	CACP	1.5k	1/4W	10%	172031500
R160	CACP	27k	1/4W	10%	172042700
R161	CACP	100	1/4W	10%	172021000
R162	CACP	10	1/4W	10%	172011000
R163	CACP	1k	1/4W	10%	172031000
R164	CACP	1k	1/4W	10%	172031000
R165	CACP	10k	1/4W	10%	172041000
R166	CACP	56	1/4W	10%	172315600
R167	CACP	1k	1/4W	10%	172031000
R168	CACP	1k	1/4W	10%	172031000
R169	MEOX	33k	1/4W	5%	195643300
R170	MEFM	1k	1/8W	0.5%	192731002
R171	CACP	10k	1/8W	10%	172041000
C150	STYR	330p	125V	5%	208100084
C151	CERM	68p	500V	20%	241316800
C152	TAND	22	16V	20%	208700106
C153	CERM	1000p	500V	20%	241331000
C154 to C157	CERM	0.047	25V	20%	241944700
C158	TAND	22	16V	20%	208700106
D150	1N 4933				300524830
D151	1N 4933				300524830
D152	ZENER	3.3V			300521860
D153	SD3				300522160
D154	SD3				300522160
TR150	BCY 70				300553590
TR151	BCY 70				300553590
TR152	BC 183				300555590
TR153	BC 183				300555590
TR154	2N 2369				300552390
TR155	BFX 134				300554540
IC150	TL497CN				510090550
RL150	RS5	5V			300652030
T150					X3096131

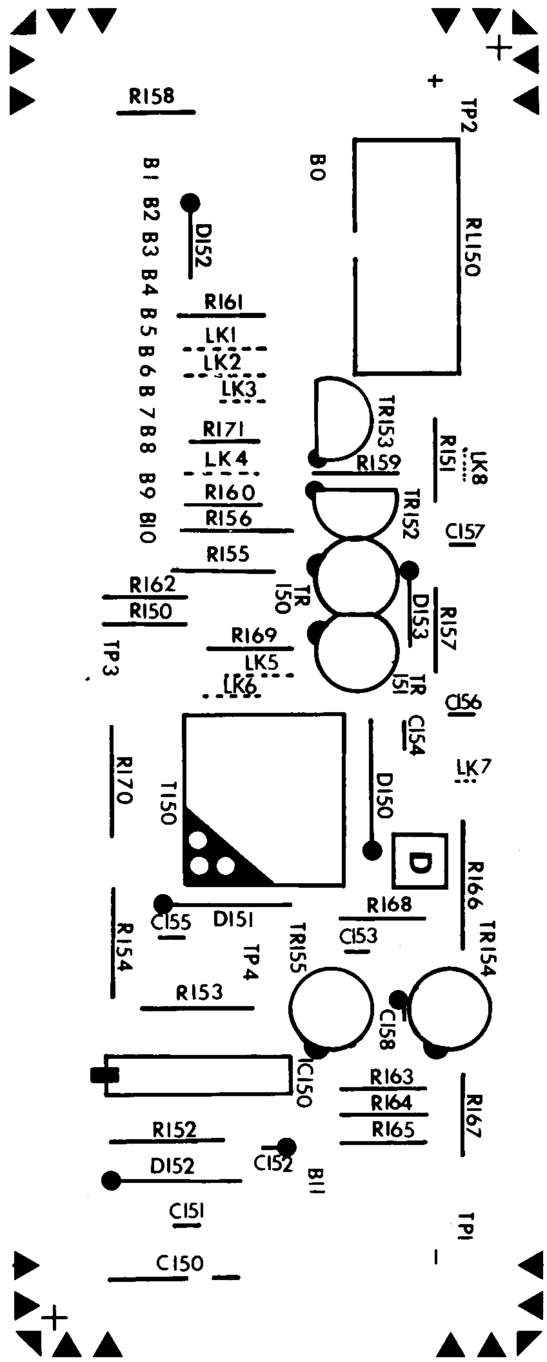
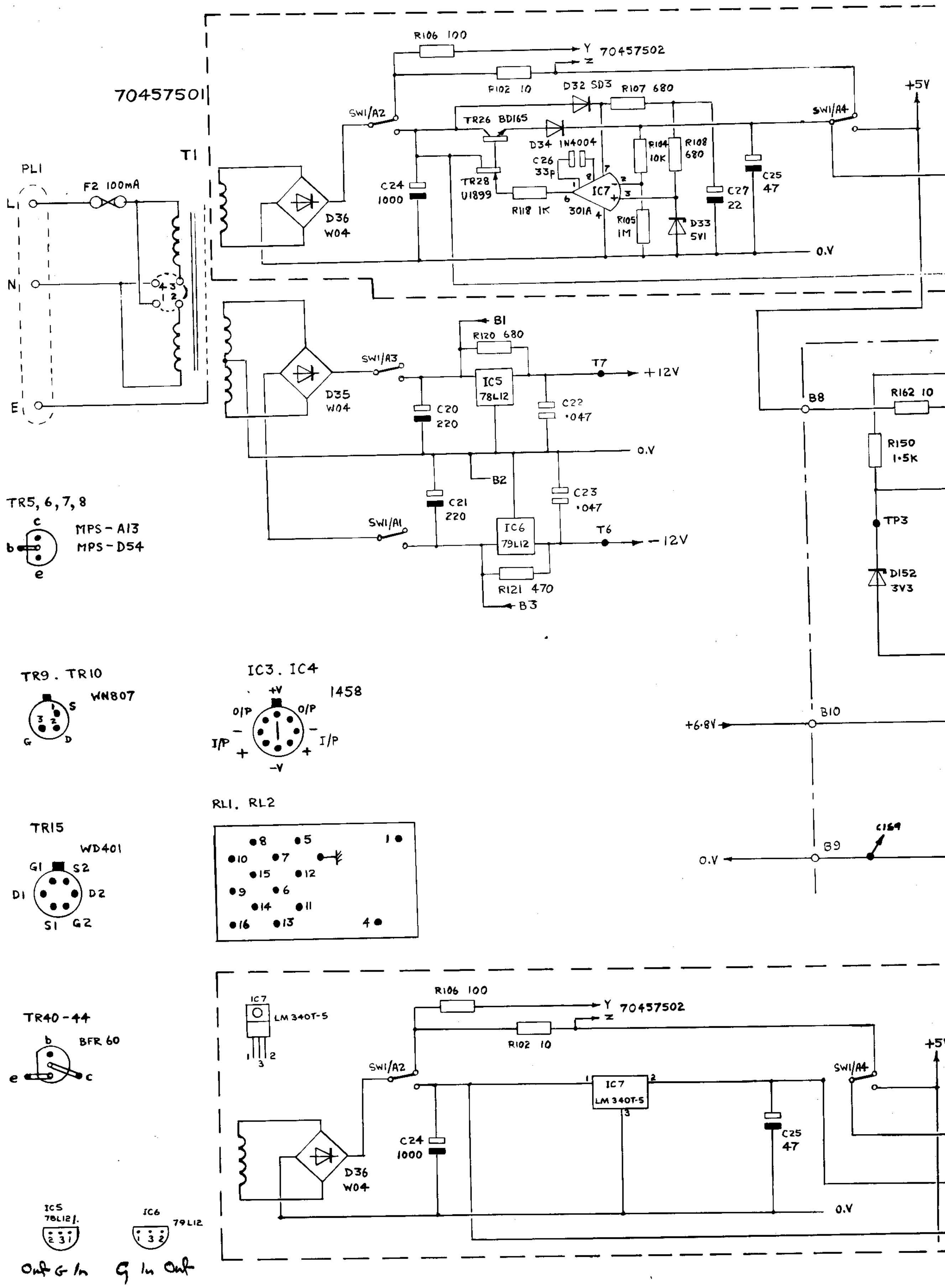
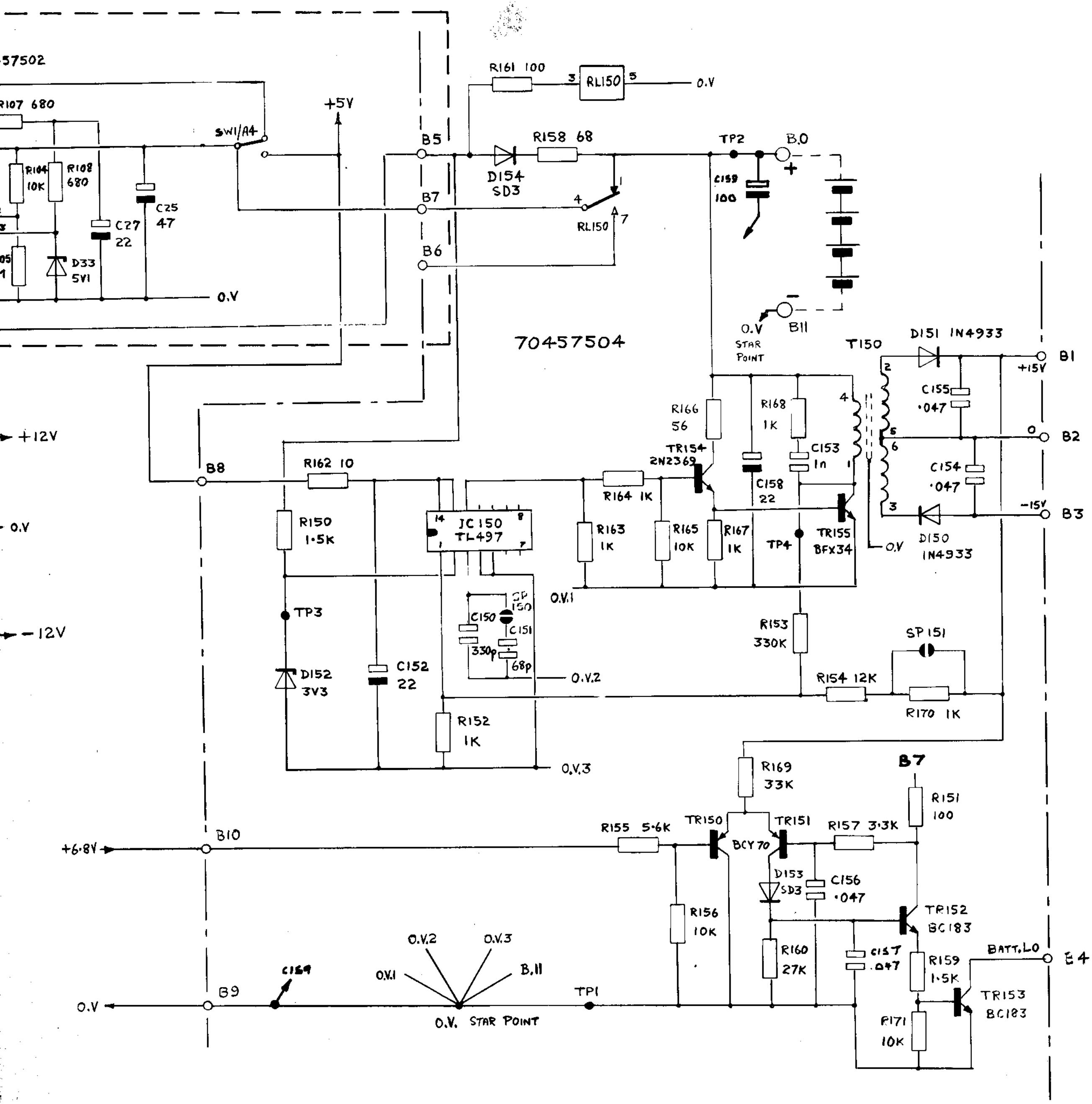
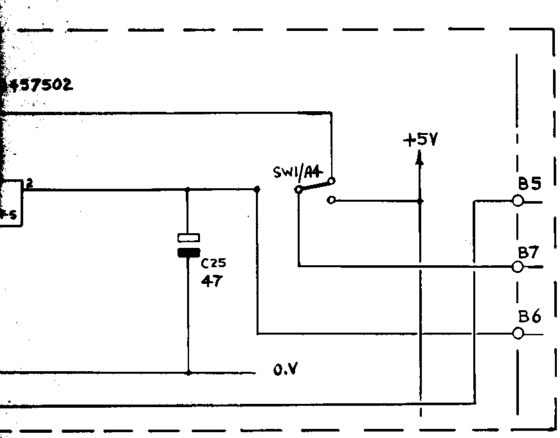


DIAGRAM 2.8 PCB4 COMPONENT LAYOUT.

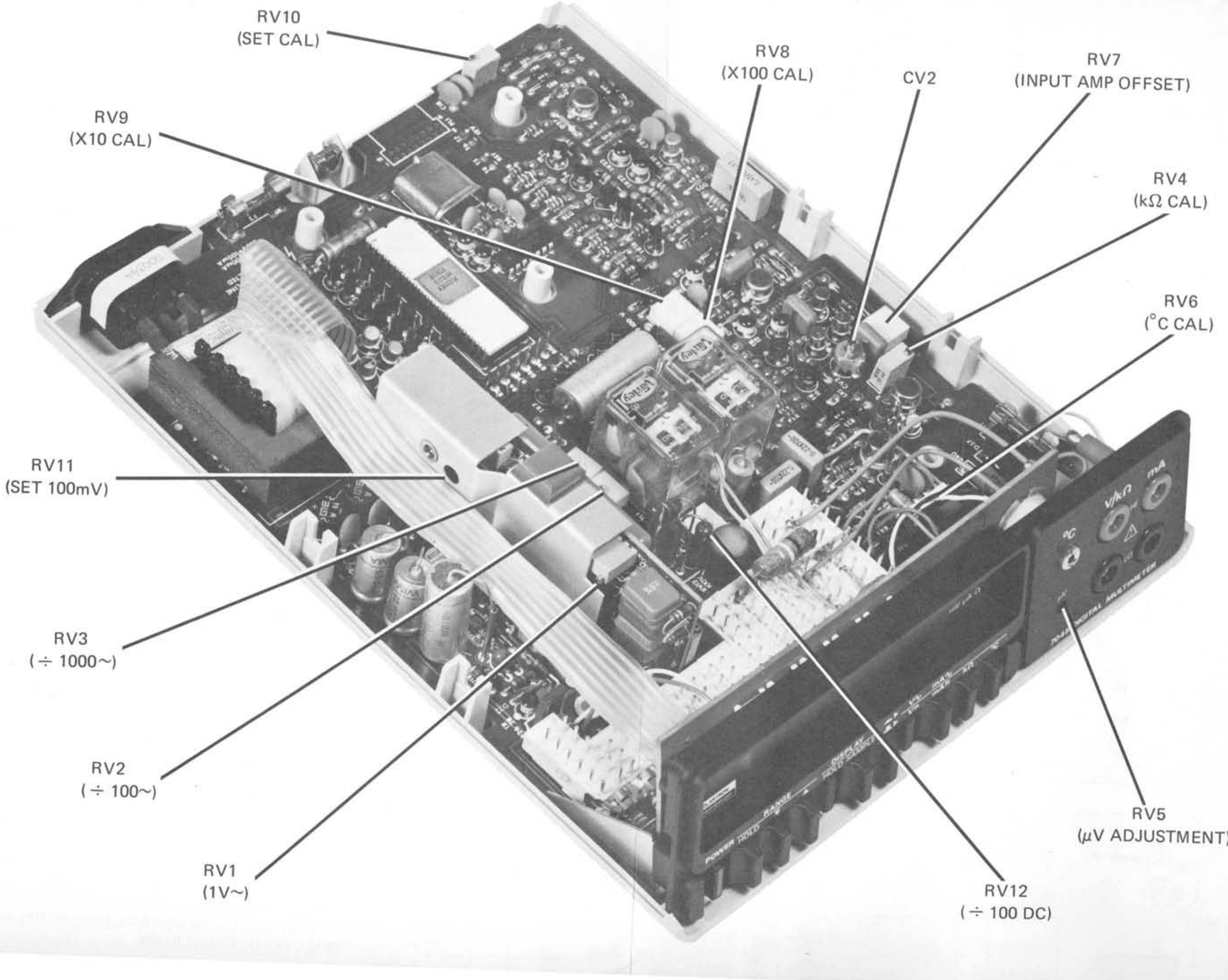

70457501
70457502
R106 100
R102 10
D32 SD3
R107 680
SW1/A2
TR26 BD165
D34 1N4004
SW1/A4
+5V
T1
PL1
F2 100mA
L
N
E
C24 1000
TR28 U1899
C26 33p
IC7
301A
R104 10K
R108 680
R105 1M
D33 5V1
C27 22
C25 47
R118 1K
D36 W04
0.V
B1
R120 680
SW1/A3
IC5 78L12
T7
+12V
D35 W04
C20 220
C22 ·047
B2
C21 220
C23 ·047
SW1/A1
IC6 79L12
T6
-12V
R121 470
B3
B8
R162 10
R150 1·5K
TP3
D152 3V3
B10
+6·8V
B9
C164
TR5, 6, 7, 8
MPS-A13
MPS-D54
TR9. TR10
WN807
IC3. IC4
1458
+V
O/P
I/P
-V
RL1. RL2
TR15
WD401
G1
S2
D1
D2
S1
G2
TR40-44
BFR 60
IC7
LM 340T-5
IC5 78L12
IC6 79L12
Out G In
G In Out





INSERT SHOWS A 3-TERMINAL 5V REGULATOR USED IN LATER MULTIMETER BATCHES, THE DISCRETE COMPONENTS SHOWN IN THE CIRCUIT ABOVE ARE UNNECESSARY WITH THIS TYPE OF REGULATOR.

DIAGRAM 2.9 PCB 1 (PART) & PCB 4



RV10
(SET CAL)
RV8
(X100 CAL)
CV2
RV7
(INPUT AMP OFFSET)
RV9
(X10 CAL)
RV4
(kΩ CAL)
RV6
(°C CAL)
RV11
(SET 100mV)
RV3
(÷ 1000~)
RV2
(÷ 100~)
RV1
(1V~)
RV12
(÷ 100 DC)
RV5
(µV ADJUSTMENT)

CIRCUIT CHANGES

The values shown in Pcb 1 parts list for R41, R42 and R44 apply to multimeters with serial numbers up to 001500. On later models (001501 onwards) these components have been changed as follows:

R41	MEFM	15k	1/8W	0.25%	192841501
R42	MEFM	820k	1/4W	0.5%	198358202
R44	MEFM	180	1/8W	0.5%	192721802

In addition R130 has been added;

R130	MEFM	4.7k	1/8W	0.25%	192834701

Chapter 3
Calibration & Setting–up

This chapter provides a comprehensive setting-up and calibration procedure which may be necessary after rectification and/or component replacement on the digital multimeter.

There are three sections to this chapter;

1 ; **PRELIMINARIES**

2 ; **SETTING-UP PROCEDURES**

3 ; **CALIBRATION PROCEDURE**

CAUTION. BEFORE ATTEMPTING TO REMOVE COVERS, THE INSTRUMENT SHOULD BE DISCONNECTED FROM THE MAINS SUPPLY. IT SHOULD BE NOTED THAT THE SWITCHING OFF OF THE MULTIMETER POWER SWITCH DOES NOT IN ITSELF REMOVE MAINS VOLTAGE FROM THE INSTRUMENT.

1. PRELIMINARIES

1.1 TEST EQUIPMENT The test equipment listed below should be available to perform the operations given in section 1 and 2 of this chapter. The items listed should have an accuracy equal to or better than that given in the calibration tables.

a.	RESISTANCE STANDARD	0 to 1MΩ
b.	DC VOLTAGE STANDARD	0 to 1000V
c.	AC VOLTAGE STANDARD	0 to 750V
d.	DC CURRENT STANDARD	0 to 1A
e.	AC CURRENT STANDARD	0 to 1A
f.	PRECISION THERMOMETER	0 to +50°C
g.	OSCILLOSCOPE	
h.	FREQUENCY METER	to 1 MHz

1.2 INSTRUMENT ENVIRONMENT Ideally, the test procedures should be carried out with the multimeter fitted with a calibration cover. Where this is not possible, every attempt should be made to create normal operating conditions, i.e. loosely refitting covers and allowing the instrument to settle after making adjustments. Certain components, i.e. D10, D11 and D12 are light sensitive, these should always be shielded from direct light during setting-up/calibration.

1.3 **REMOVAL OF COVERS** After disconnecting the mains supply from the instrument, the covers may be removed. A single retaining screw holds the rear-panel in position while the two forward retaining screws in the base of the instrument hold the top cover in position.

1.4 **TEST SEQUENCE** It is important that the tests are carried out in the order given in the manual. Where D26 (precision reference zener) has been replaced however, then the sequence given in paragraph 2.2 should be carried out before commencing the setting-up procedure.

2 SETTING-UP PROCEDURE

After removal of covers, carry out the setting up procedures as follows:

TABLE 3.1 ; SET ZERO

TEST	MODE	INPUT	ACTION	DISPLAYED READING	COMMENTS
3.1.1	V⎓	S/C 220kΩ	Adjust RV5 Adjust CV2	± 0.000 mV ⩽ ± 0.001 mV	Repeat until no further adjustment is required.
3.1.2	V∿	S/C	Check	< 0.05mV	–
3.1.3	KΩ	S/C	Check	< 0.10Ω	–
3.1.4	mA⎓	S/C	Check	< ± 0.003 μA	–
3.1.5	mA∿	S/C	Check	< ± 0.05 μA	–

TABLE 3.2 ; V⎓ MODE

TEST	MODE	INPUT	ACTION	DISPLAYED READING	COMMENTS
3.2.1	V⎓	+1.7000V	Adjust RV10	+1.7000 ±1 digit	Basic calibration (2V range)
3.2.2	V⎓	–1.7000V	Check	–1.7000 ±2 digits	–
3.2.3	V⎓	+17.000nV	Adjust RV8	+17.00mV ±1 digit	×100 calibration (20mV range)
3.2.4	V⎓	+170.00mV	Adjust RV9	+170.00mV ±1 digit	×10 calibration (200mV range)
3.2.5	V⎓	+9.900V	Adjust RV12	+9.900 ±1 digit	÷100 DC calibration (20V range)
3.2.6	V⎓	+9.900V	Operate RANGE HOLD and ▲	+9.90 ±1 digit	200V range check
3.2.7	V⎓	+9.900V	Operate ▲ again	+9.9 ±1 digit	1kV range check

TABLE 3.3 ; kΩ MODE

TEST	MODE	INPUT	ACTION	DISPLAYED READING	COMMENTS
3.3.1	KΩ	10.000kΩ	Adjust RV4	10.000 ±1 digit	KΩ calibration (RANGE HOLD out)
3.3.2	KΩ	1.000mΩ	Check	1.000mΩ ±4 digits	2MΩ range check

TABLE 3.4 ; °C MODE

TEST	MODE	INPUT (2.5mm socket)	ACTION	DISPLAYED READING	COMMENTS
3.4.1	°C	Plug out	Check range of RV6	< +15.0 > +30.0	–
3.4.2	°C	Plug out	Adjust RV6	+ 25.0	Approximate setting of ambient temp.
3.4.3	°C	4.09mV	Check	+125.0 ± 5 digits	Scaling check

TABLE 3.5 ; V∿ MODE

TEST	MODE	INPUT	ACTION	DISPLAYED READING	COMMENTS
3.5.1	V∿	1.000V @ 1KHz	Adjust RV1	1.0000V ±1 digit	Repeat these tests until no further adjustment is required
3.5.2	V∿	100.00mV @ 1KHz	Adjust RV11	100.00mV ±2 digits	
3.5.3	V∿	100.00V @ 1KHz	Adjust RV2	100.00 ±2 digits	–
3.5.4	V∿	100.00V @ 1KHz	Operate RANGE HOLD Operate ▲ Adjust RV3	100.0 ±1 digit	–

TABLE 3.6 ; mA ∿ MODE

TEST	MODE	INPUT	SERIES RESISTOR	ACTION	DISPLAYED READING
3.6.1	mA∿	110.00mV @ 1KHz	10.000KΩ	Check	10.00μA ±8 digits
3.6.2	mA∿	1.1000V @ 1KHz	10.000KΩ	Check	100.0μA ±3 digits
3.6.3	mA∿	1.0100V @ 1KHz	1.0000KΩ	Check	1.000 ±8 digits
3.6.4	mA∿	10.100V @ 1KHz	1.0000KΩ	Check	10.00 ±3 digits
3.6.5	mA∿	10.100V @ 1KHz	1.0000KΩ	Operate RANGE HOLD Operate ▲	10.0 ±8 digits
3.6.6	mA∿	10.100V @ 1KHz	1.0000KΩ	Operate ▲ again	10 ±1 digit

TABLE 3.7 ; mA⎓ MODE

TEST	MODE	INPUT	SERIES RESISTANCE	ACTION	DISPLAYED READING
3.7.1	mA⎓	+180.00V	1.0000MΩ	RANGE HOLD out Check	179.80μA ±20 digits
3.7.2	mA⎓	+18.000mA	None	Check	+18.000 ±36 digits
3.7.3	mA⎓	1.0000A	None	Check	+1000.0 ±40 digits

2.1 **INVERTER BOARD CHECK** This check on pcb 4 requires a 5V dc regulated supply; the 4 NiCd batteries should be removed.

a. Select instrument POWER button "off" and disconnect mains supply.

b. Connect regulated power supply unit to inverter board; negative to TP1, positive to TP2.

c. Set power supply to +5.0V with current limited to 1A and switch supply on.

d. Select instrument POWER switch "on" and check that the display lights-up and that the current from the power supply is 600 mA ± 100 mA. If a current overload should occur, **switch off at once.**

e. Check that the waveform on TP4 is as shown in Figure 3.1. If the "ON" time is less than 24 μs, short SP150. To synchronise the waveform, it is convenient to trigger from the junction of R163 and R164.

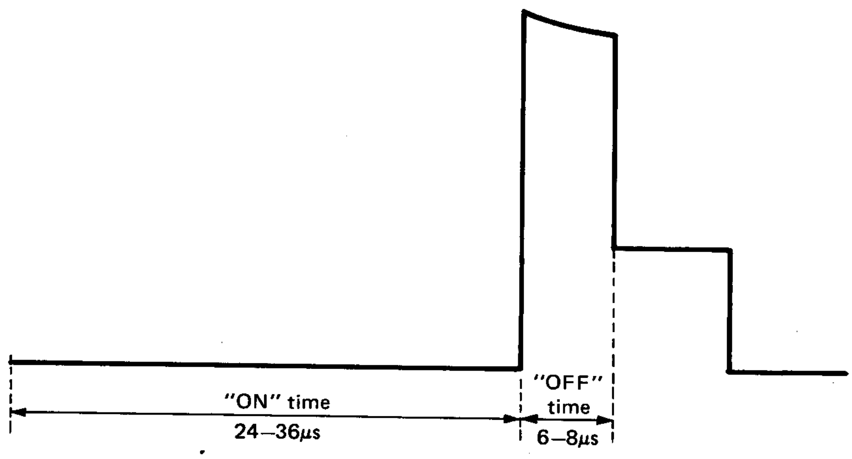


Fig. 3.1

f. Check that the voltage on pin B1 is between +15V and +18V. If it exceeds +16.2V, link SP151 to bring it within the range +15V to +16.2V.

g. Select V⎓ and RANGE HOLD, then short circuit the V/kΩ Hi and Lo input terminals. Check that the reading on the display does not exceed ± 0.004 mV.

h. Select V∿; the reading should not exceed 0.04 mV.

j. Reduce the power supply output voltage in 0.1V steps and check that a battery low indication (all decimal points lit) appears for an input between +4.5V and +4.3V. Increase the supply voltage to +4.6V and check that the indication disappears.

k. Note the voltage on B1. Increase the supply voltage to +5.5V and check that the voltage on B1 changes by not more than 200 mV.

l. Remove the test leads from TP1 and TP2.

m. Disconnect the power unit and re-fit batteries.

2.2 **REFERENCE ZENER** The following test should be carried out before setting-up if the reference zener, D36 has been changed.

a. Switch multimeter POWER selector "on" and select V⎓ mode.

b. Connect a +1000V dc supply to V/kΩ Hi and Lo input terminals.

c. Set RV10 fully anti-clockwise and note the reading on the display.

d. Refer to Tabel 3.8 and link the split-pads appropriate to the reading obtained.

TABLE 3.8 ; ZENER TOLERANCES

READING	SP1	SP2	SP3
0.8840 to 0.8960	Link	Link	Link
0.8960 to 0.9120	Link	Link	
0.9120 to 0.9330	Link		Link
0.9330 to 0.9460	Link		
0.9460 to 0.9590		Link	Link
0.9590 to 0.9730		Link	
0.9730 to 0.9850			Link
0.9850 to 1.0000			

3 **CALIBRATION PROCEDURE** Table 3.9 gives the final calibration check which should be carried out after the setting-up procedures have been completed. Before commencing the tests, the Thermocouple Probe should be connected to the °C input socket and the probe end securely taped to the thermometer bulb. This will avoid settling delays on reaching test 34 in the table.

Paragraph 3.1 describes the procedure for checking Interference Rejection. The test arrangement shown in Figure 3.2 (DC Common Mode check) can be made-up locally. Series Mode rejection can be assumed to be satisfactory providing the integration time is correct. This can be ascertained by measuring the clock frequency as per paragraph 3.1.2.

3.1 **INTERFERENCE REJECTION**

3.1.1 **DC Common Mode Check** Connect up the multimeter as shown in the test circuit diagram. Switch multimeter POWER switch "on" and select V⎓/auto-range. Set dc output to 1000V and check that the multimeter reading < 0.500 mV.

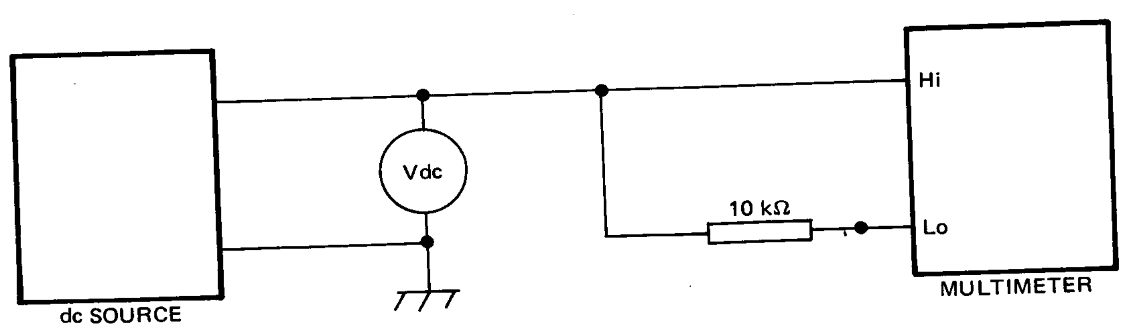


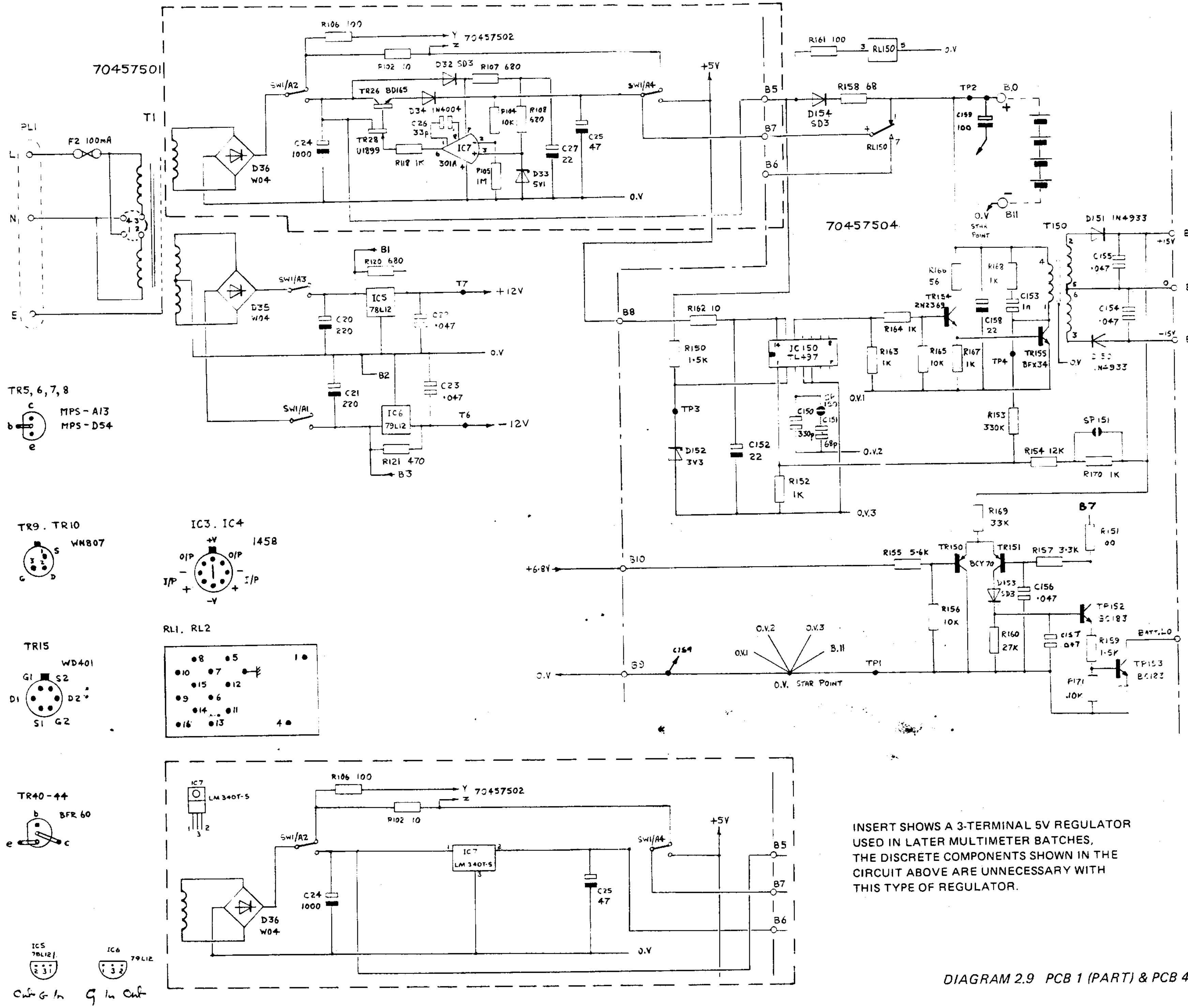
Fig. 3.2 *Test Circuit*

3.1.2 **DC Series Mode Check** Measure the clock frequency at pin 39 of IC8 with a frequency meter and check that the reading is 960 kHz ± 0.1 kHz.

TABLE 3.9 ; CALIBRATION CHECK

TEST	INPUT	FREQ.	ACTION	POT	READING	TOL. (DIGITS)	REMARKS
	V⎓						
*	S/C		Adjust	RV5	±0.00mV		Set zero
1	+1.7000V		Adjust	RV10	+1.7000	±1	Cal
2	−1.7000V		Check		−1.7000	±2	Cal balance
3	−.2000V		Check		−.2000	±1	Linearity
4	+17.000mV		Adjust	RV8	+17.000mV	±2	Set × 100
5	−17.000mV		Check		−17.000mV	±2	Cal balance
6	−10.000mV		Check		−10.000mV	±2	× 100 linearity
7	+170.00mV		Adjust	RV9	+170.00mV	±1	Set × 10
8	+170.00V		Adjust	RV12	+170.00	±1	Set ÷ 100
9	+1000.0V		Check		+1000.0	±1	Check ÷ 1000
10	+17.000V		Check		+17.000	±1	
							Change mode
	KΩ						
11	10.500KΩ		Adjust	RV4	10.500	±1	Set test current
12	10.000MΩ		Check		10.000MΩ	±20	
13	1.0500MΩ		Check		1.0500MΩ	±2	
14	105.00KΩ		Check		105.00	±2	
15	1.0500KΩ		Check		1.0500	±3	
16	O/C		Check		1- ---MΩ		Check flashing O/L
*	S/C		Check		0.00Ω	+10 −0	
							Change mode
	V∿						
*	S/C		Check		0.00mV	+8 −0	Zero check
17	1.7000V	1KHz	Adjust	RV1	1.7000	±1	Cal
18	170.00mV	1KHz	Check	RV11	170.00mV	±4	
19	170.00V	1KHz	Adjust	RV2	170.00	±2	Set ÷ 100
20	17.000V	1KHz	Check		17.000	±4	
21	750.0V	1KHz	Adjust	RV3	750.0	±1	Set ÷ 1000
22	1.7000V	40Hz	Check		1.7000	±10	Check L.F.
23	1mV	40Hz	Check		1.00mV	±10	Check linearity
24	1.7000V	20KHz	Check		1.7000	±15	Check H.F.
25	1mV	20KHz	Check		1.00mV	±10	Check linearity
26	170.00mV	20KHz	Check		170.00mV	±15	Check H.F.
27	17.000V	20KHz	Check		17.000	±30	Check H.F.
28	170.00V	20KHz	Check		170.00	±30	Check H.F.
29	500.0V	20KHz	Check		500.0	±15	Check H.F.
30	100.00V	50KHz	Check		100.00	±100	Check H.F.
31	1.7000V	50KHz	Check		1.7000	±100	Check H.F.
32	170.00mV	100KHz	Check		170.000mV	±300	Check H.F.
33	1.7000V	100KHz	Check		1.7000mV	±300	Check H.F.
34	17.000V	100KHz	Check		17.000	±600	Check H.F.
35	170.00V	100KHz	Check		170.000	±600	Check H.F.
36	°C		Adjust	RV6	Ambient	±2°C	Set to thermometer reading

* Short Circuit



INSERT SHOWS A 3-TERMINAL 5V REGULATOR USED IN LATER MULTIMETER BATCHES, THE DISCRETE COMPONENTS SHOWN IN THE CIRCUIT ABOVE ARE UNNECESSARY WITH THIS TYPE OF REGULATOR.

DIAGRAM 2.9 PCB 1 (PART) & PCB 4

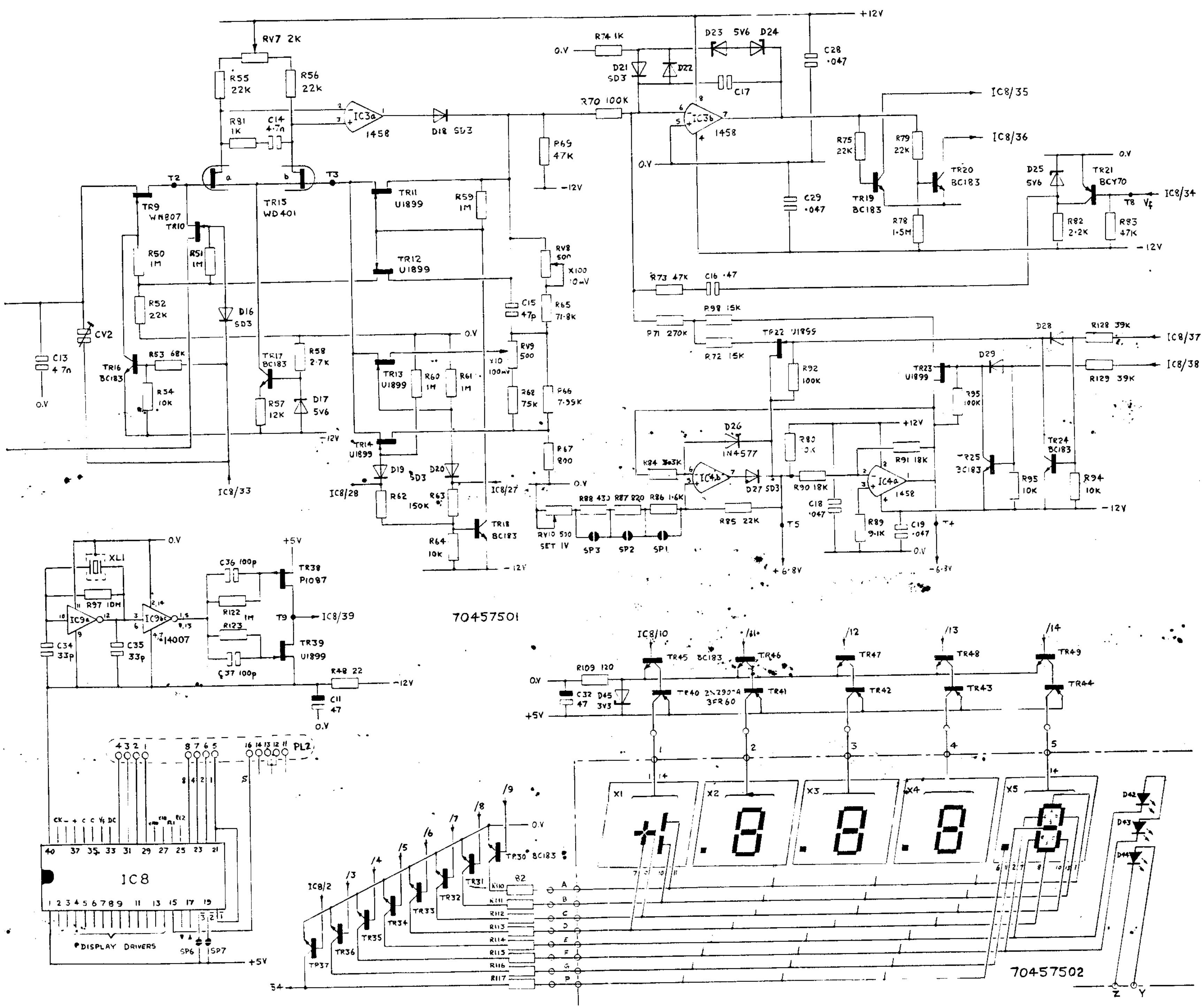


DIAGRAM 2.4 PCB 1 (PART) & PCB 2

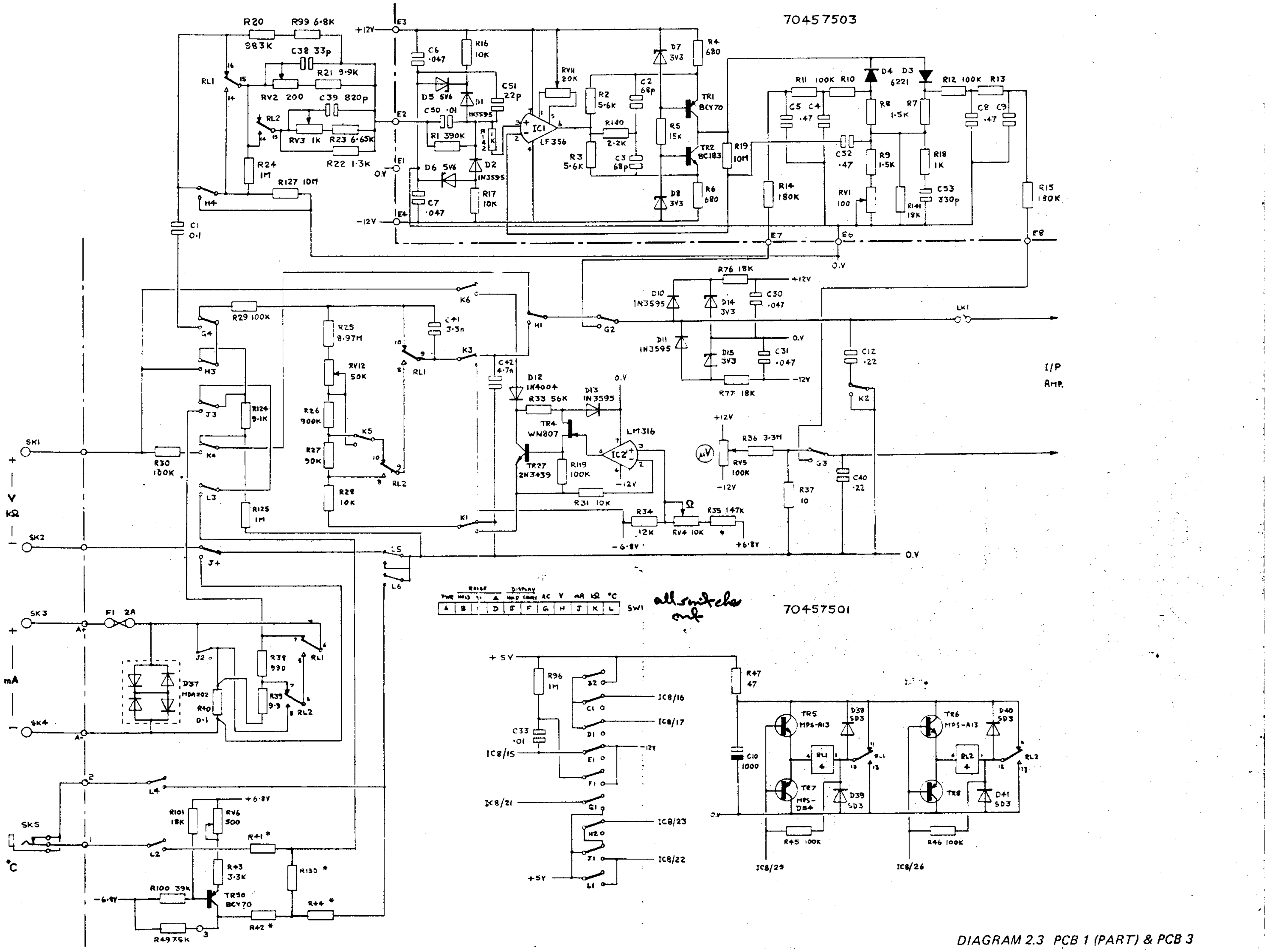


DIAGRAM 2.3 PCB 1 (PART) & PCB 3