MAINTENANCE MANUAL

9300

TRUE RMS VOLTMETER

RACAL-DANA

RACAL

The Electronics Group

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9300

TRUE RMS VOLTMETER

RACAL-DANA

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RACAL

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LETHAL VOLTAGE WARNING

VOLTAGES WITHIN THIS EQUIPMENT ARE SUFFICIENTLY HIGH TO ENDANGER LIFE.

COVERS MUST NOT BE REMOVED EXCEPT BY PERSONS QUALIFIED AND AUTHORISED TO DO SO AND THESE PERSONS SHOULD ALWAYS TAKE EXTREME CARE ONCE THE COVERS HAVE BEEN REMOVED.

RESUSCITATION

TREATMENT OF THE NON-BREATHING CASUALTY

1 SHOUT FOR HELP. TURN OFF WATER, GAS OR SWITCH OFF ELECTRICITY IF POSSIBLE

Do this immediately. If not possible don't waste time searching for a tap or switch.

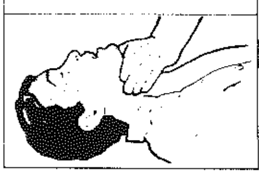
2 REMOVE FROM DANGER: WATER, GAS, ELECTRICITY, FUMES, ETC.

Safeguard yourself when removing casualty from hazard. If casualty still in contact with electricity, and the supply cannot be isolated, stand on dry non-conducting material (rubber mat, wood, linoleum). Use rubber gloves, dry clothing, length of dry rope or wood to pull or push casualty away from the hazard.

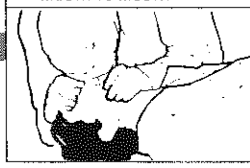
3 REMOVE OBVIOUS OBSTRUCTION TO BREATHING

If casualty is not breathing start ventilation at once.

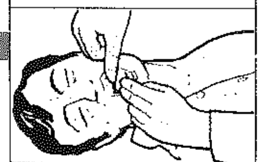
LOOSEN NECKWEAR
TILT HEAD BACKWARDS
AND PUSH CHIN UPWARDS



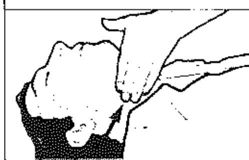
PINCH THE NOSE
COMMENCE VENTILATION
FOUR GOOD INFLATIONS
MOUTH-TO-MOUTH



IF CHEST DOES NOT RISE
RE-CHECK AIRWAY, REMOVE
OBSTRUCTION AND RE-INFLATE



CHECK PULSE



POSITION OF PULSE

PULSE PRESENT

CONTINUE INFLATIONS UNTIL RECOVERY OF NORMAL BREATHING

PULSE ABSENT

HEART HAS STOPPED BEATING
LAY ON BACK ON FIRM SURFACE (eg FLOOR).
COMMENCE EXTERNAL CHEST COMPRESSION AND CONTINUE MOUTH-TO-MOUTH VENTILATION

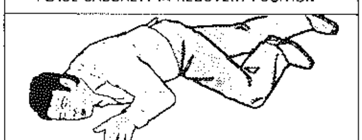
ONE FIRST AIDER
15 Compressions at 80 per minute followed by 2 Inflations

TWO FIRST AIDERS
One conducts chest compressions, without pause at 60 per minute. The other administers mouth-to-mouth ventilation – after each 5th compression.

Check heart beat after first minute and then after every three minutes. Continue external chest compression and mouth-to-mouth ventilation until a normal pulse is felt and colour improves.

CONTINUE INFLATIONS UNTIL RECOVERY OF NORMAL BREATHING

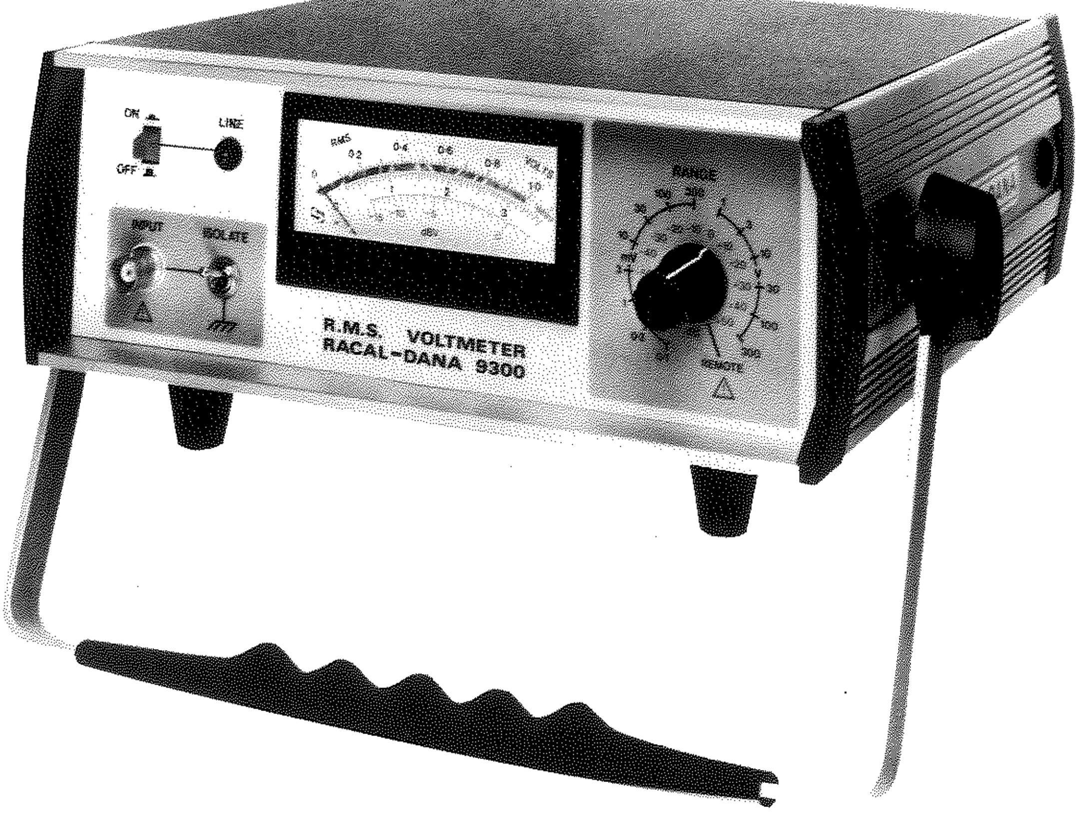
WHEN NORMAL BREATHING COMMENCES
PLACE CASUALTY IN RECOVERY POSITION



Keep casualty at rest. Remove on a stretcher. Watch closely, particularly for difficulty in breathing. Lightly cover with blankets or other materials.

SEND FOR DOCTOR AND AMBULANCE

DOCTOR	AMBULANCE	HOSPITAL	Nearest First Aid Post
TELEPHONE	TELEPHONE	TELEPHONE	



True RMS Voltmeter 9300

'POZIDRIV' SCREWS

The metric thread cross-head screws fitted to RACAL equipment are of the 'Pozidriv' type. Phillips and 'Pozidriv' screwdrivers are not interchangeable, and use of wrong type of screwdriver may cause damage. POZIDRIV is a registered trade mark of G.K.N. Screws and Fasteners Ltd. 'Pozidriv' screwdrivers are Manufactured by Stanley Tools Ltd.

MOS ELECTRONIC DEVICES

This unit contains MOS devices, and care should be taken to avoid static discharge damage.

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IN TEXT ILLUSTRATIONS

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PART 1

TECHNICAL SPECIFICATION

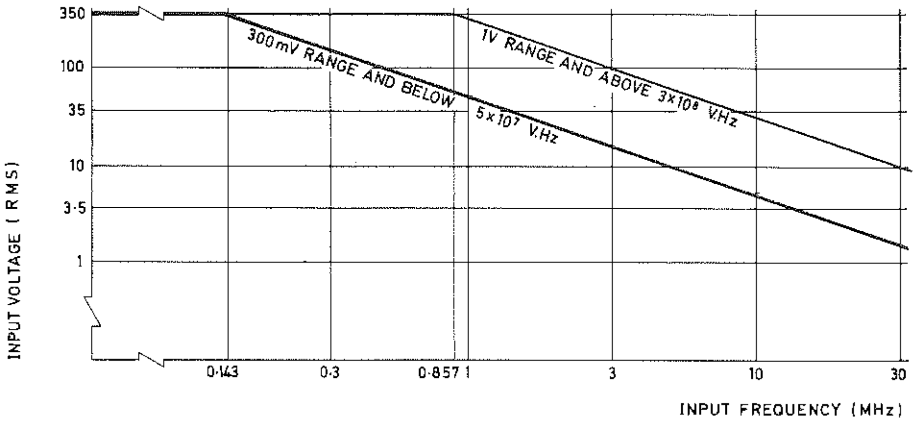
TECHNICAL SPECIFICATION

1. OPERATIONAL MODE

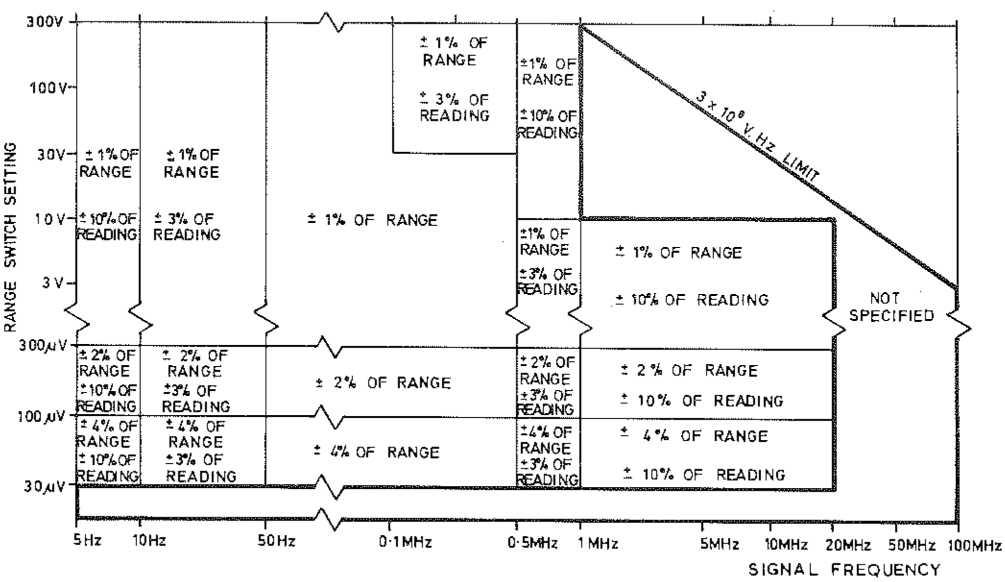
Measurement Function:	True r.m.s. voltage measurement.

2. ELECTRICAL CHARACTERISTICS

Measurement Range:	30μV to 316V in 14 half-decade, switchable ranges.
Frequency Range:	5 Hz to 20 MHz.
Input Impedance:	1 V range and above: 1 MΩ in parallel with approximately 30 pF. 300 mV range and below: 1MΩ in parallel with approximately 40 pF. The fitting of the REMOTE INPUT socket as part of the remote control interface option adds approximately 45 pF to the above figures.
Input Isolation:	The input socket shell (common terminal) is isolated from chassis earth by a pair of back-to-back diodes. The permissible voltage difference is approximately 0.5 V. The maximum current between the common terminal and chassis earth must not exceed 5 A. A switch is provided to allow the common terminal to be held at chassis earth.
Maximum Permitted Input Levels:	The d.c. level + peak signal level must not exceed 500 V on any range. The maximum r.m.s. input must not exceed the values indicated in Fig. T.S.1.
Accuracy:	Fig. T.S.2 shows the accuracy of the d.c. output, within the limits of 10% to 110% of the selected range, for a calibrated sinusoidal input within the ambient temperature range from 18°C to 28°C. At the break points the better figures apply.



Maximum RMS Input Levels Fig.TS.1



Accuracy of DC Output Fig.TS.2

Temperature Coefficient:	An additional error of 0.04% of range per $^{\circ}C$ must be added to the figures obtained from Fig. TS2 when the instrument is operated in an environment outside the temperature range from $18^{\circ}C$ to $28^{\circ}C$.
Crest Factor:	When making measurements on rectangular waveforms with crest factors exceeding 4:1 an additional error of 0.5% of reading must be added to the figures obtained from Fig. TS2. At a signal level giving full scale deflection of the meter the maximum acceptable crest factor is 7. The maximum acceptable crest factor is inversely proportional to the meter deflection. When measuring complex waveforms having high harmonic content, further errors may arise due to harmonics carrying a significant proportion of the energy of the signal falling outside the instrument's measurement bandwidth.
Residual Noise:	With the input terminals short circuited, the residual noise is less than 10 µV.
Meter Non-linearity:	The meter non-linearity is a maximum at mid scale, and reduces to zero at zero and f.s.d. The maximum non-linearity will not exceed ±1% f.s.d.
Meter Scales:	Two voltage scales (black) are provided. These are numbered 0.1 to 1 and 0.3 to 3, but indicate to 1.1 and 3.5. The highest numbered mark corresponds to an input level equal to the RANGE switch setting in use. A dBm scale (red) is provided. This is graduated from +3 dBm to -12 dBm in 600Ω. The total reading is obtained by adding the scale reading algebraically to the RANGE switch dBm setting in use.
Measurement Response Time:	The instrument will indicate to the specified accuracy within two seconds of the application of the signal to be measured.
DC Output:	A d.c. output suitable for driving an electronic voltmeter is available via a rear panel BNC socket.
DC Output Sensitivity:	1 V corresponds to an input signal level giving a scale reading of 1 or 3.16 according to the scale in use.
Output Impedance:	1 kΩ ± 2%.

Output Isolation:	The output socket shell (common terminal) is connected to the input socket shell. The output isolation is controlled by the front panel ISOLATE switch. The permissible voltage difference between the common terminal and chassis earth is approximately 0.5 V. The maximum current between the common terminal and chassis earth must not exceed 5 A.

3. MECHANICAL CHARACTERISTICS

Dimensions:	Height:	97 mm
	Width:	240 mm
	Depth:	268 mm
Weight	Approximately 2.5 kg.	

4. POWER SUPPLIES

Voltage:	A four range supply voltage selector is provided to accept 100 V, 120 V, 220 V or 240 V a.c. ±10%.
Frequency:	45 Hz to 440 Hz.
Consumption:	Approximately 5 VA.

5. ENVIRONMENTAL SPECIFICATION

Operating Temperature:	0°C to +55°C (Operable to -10°C with reduced specification)
Storage Temperature:	-40°C to +70°C.
Electromagnetic Compatibility:	Designed to meet TS1527, tests PCE2, PRE2, PCS2 and PRS3.3.
Humidity:	95% r.h. at +40°C.

6. ACCESSORIES PROVIDED

Power Lead:	Part number 23-3227
Fuse for 90/132 V Operation:	Part number 23-0027
Operator's Handbook	

7. OPTIONAL ACCESSORIES

Rigid Carrying Case:	Part number 15-0450
Padded Carrying Case:	Part number 15-0444
19 inch Rack Mounting Kit:	Part number 11-1126
BNC to Banana Plug Adaptor:	Part number 23-3293
Maintenance Manual	

8. REMOTE CONTROL INTERFACE OPTION

Availability:	The remote control interface option can be factory fitted, or supplied as a kit (Racal-Dana part number 11-1435) for fitting by the customer.
Facilities Provided:	Remote control of range via four control lines. A hold control, allowing the output to be held to within 1% for up to three seconds. A second d.c. output proportional to the r.m.s. value of the input signal. A rear panel mounted BNC input socket, connected in parallel to the front panel input.
Isolation:	The control lines are isolated by opto-couplers.
Supplies Required:	A d.c. supply capable of giving a continuous 20 mA at 5 V is required for the opto-couplers of the interface.
Connector:	The control lines connect to the interface via a 9-way plug on the rear panel of the instrument. A mating socket, (Cinch R43 81044, with shell R43 81960), Racal-Dana part numbers 23-3214 and 23-3216, is supplied with the kit.
Input Levels:	Logic '0' between -15 V and +0.8 V Logic '1' between +2.4 V and +15 V.

PART 2

DESCRIPTION

OPERATION & MAINTENANCE

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The 9300 is a wide band electronic voltmeter. It permits true r.m.s. voltage measurements to be made with exceptional accuracy on waveforms having high crest factors. Special automatic zeroing and noise cancellation circuits permit measurements to be made down to 30µV r.m.s.

2. The equipment is light and portable. It operates from a.c. supplies in the range 90V to 132V and 198V to 264V.

3. The input common line is isolated from chassis earth by back-to-back diodes which permit a voltage difference of ±0.5V. The common line can be connected to chassis earth, if required, via an isolation over-ride switch.

4. The instrument indication is in analogue form, but a d.c. level proportional to the applied r.m.s. level is available at a rear panel socket. This output can be used to give a true r.m.s. reading via a digital voltmeter, if required. The output is +1V relative to the output common line at an input signal level giving a scale reading of 1 or 3.16 according to the scale in use. The output common line is directly connected to the input common line, and will be isolated from chassis earth unless the isolation over-ride switch is closed.

CREST FACTOR

5. At a signal level giving full scale deflection on any range the maximum acceptable crest factor is 7. This increases in inverse proportion to the meter deflection. Errors will arise, however, if the measured waveform has a significant proportion of its energy in harmonics which lie outside the instrument's measurement bandwidth.

OPERATING PRINCIPLES

6. The circuit uses a feedback loop, containing a differential input multiplying system and an integrator, to produce a direct voltage which is equal to the r.m.s. value of the signal being measured. Signals injected into the loop are used to correct the output offset error due to the multiplier input offsets, and to cancel the zero error due to input noise and multiplier input offsets. The zero error cancelling signal is derived by automatic periodic sampling of the output with the signal to be measured disconnected.

REMOTE CONTROL

7. An optional remote control interface is available, either as a factory fitted option or as a kit for fitting by the customer. The option provides remote control of the measured range via 4 isolated lines, using binary coding. An additional, isolated, d.c. output is provided, together with a HOLD line, which allows a reading to be held for up to 3 seconds. These facilities allow the 9300 to be incorporated directly into automatic test equipment systems.

MAINTENANCE

8. The customer is recommended to take advantage of the servicing and calibration service offered by Racal-Dana Instruments Ltd. and their agents.

CHAPTER 2

PREPARATION FOR USE AND OPERATING INSTRUCTIONS

POWER SUPPLY

AC Voltage Range Setting

1. The supply voltage setting is varied by changing the position of a small drum, located under a hinged cover beside the input plug. The setting in use can be seen through a window in the cover.

2. If it is necessary to change the voltage setting, proceed as follows:

   (1) Switch Off the AC supply and remove the line power socket.

   (2) Using a 1/4 in (5mm) flat-bladed screwdriver, prise open the hinged cover.

   (3) Remove the voltage setting drum.

   (4) Withdraw the fuse carrier by pulling the end, marked with an arrow, straight out of the aperture.

   (5) Ensure that the fuse fitted is suitable for the voltage range to be used.

   (6) Replace the fuse and carrier. Ensure that the arrow on the fuse carrier points in the same direction as those on the underside of the cover.

   (7) Replace the voltage setting drum so that the required setting is outermost.

   (8) Close the hinged cover and ensure that the required setting is visible in the window.

   (9) Replace the line power socket.

Line Fuse

3. Check that the line fuse rating is correct for the local a.c. supply voltage. The fuse is a 5mm x 20mm glass cartridge, anti-surge type. The Racal-Dana part numbers for replacement fuses are:

90V to 132V supply	200 mA	23-0027
198V to 264V supply	100 mA	23-0033

Power Lead

4. The power lead must be fitted with a suitable connector in accordance with the standard colour code.

	European	American
Live	Brown	Black
Neutral	Blue	White
Earth(Ground)	Green/Yellow	Green

CONNECTION OF ADDITIONAL MEASURING INSTRUMENT

5. The 9300 produces a direct voltage proportional to the r.m.s. value of the measured signal. This is available at the rear panel DC OUTPUT socket, to which an auxiliary measuring instrument may be connected. It should be remembered that the voltage at this socket is +1V for an input signal level giving a scale reading of 1 or 3.16 according to the scale in use, and appropriate scaling must be applied to the auxiliary measuring instrument reading. If the 9300 is to be operated with the common line isolated from chassis earth the auxiliary measuring instrument must have an isolated input.

REMOVAL OF COVERS

WARNING: DANGEROUS AC VOLTAGE LEVELS ARE EXPOSED WHEN THE COVERS ARE REMOVED WITH THE AC SUPPLY CONNECTED.

6. (1) Switch off the instrument and the a.c. supply. Unplug the power lead from the instrument.

(2) Remove the blind grommet from each side trim panel. Slacken the screws revealed, which secure the rear panel, by about two turns.

(3) Ease the rear panel away from the instrument as far as possible (about 5 mm).

(4) The rear edge of the cover can now be raised, and the cover withdrawn towards the rear of the instrument.

(5) The covers are replaced in the reverse manner. Ensure that the rear panel is tightly butted up to the side panels before the securing screws are tightened. Take care not to displace or damage any r.f. gasket material fitted.

REMOTE CONTROL INTERFACE

7. The remote control interface is available as a factory fitted option, or as a kit for fitting by the customer. The Racal-Dana part number for the kit is 11-1435.

8. The kit contains the following items:-

Part Number	Description	Qty
11-1431	Support bracket assembly	1
19-1003	Printed circuit board assembly	1
23-3198	Socket, BNC	1
23-3214	Socket 9-way (mates with 23-3215)	1
23-3215	Plug 9-way	1
23-3216	Shell, for 23-3214	1
23-3217	Solid strap base assembly for 23-3215	1
23-8032	Toroid ferrite	1
24-2200	Nut, M2.5	2
24-2800	Washer, M2.5	2
24-7512	Screw, countersunk M2.5 x 10	2

NOTE: Items 11-1431, 19-1003, 23-3215 and 23-3217 will be supplied as an assembly. Items 23-3198 and 23-8032 will be supplied made into an assembly with a length of 50Ω cable.

9. The procedure for fitting the kit is as follows:

(1) Disconnect the instrument from the a.c. supply and remove both covers (see paragraph 6).

(2) Remove and retain the two screws securing the blanking plate to the rear panel. Remove and discard the plate.

(3) Mount item 23-3198 on item 11-1431 using items 24-2200, 24-2800 and 24-7512.

(4) Holding the assembly with the components on the upper side of the board, offer up the flexible connector to the connection point at the rear right hand side of the main printed circuit board. Solder the flexible connector in place.

(5) Secure item 11-1431 to the inside of the rear panel of the instrument, using the screws removed in (2).

(6) Connect the free end of the 50Ω cable to the back of the front panel INPUT socket. The braid should be connected to the socket shell.

NOTE: If it is required to connect signals at the front panel INPUT socket only, this step should be omitted. The cable should be removed entirely, or have its free end secured in a safe position within the instrument.

(7) Replace the instrument covers.

(8) Connect the remote control, hold, power supply and d.c. output lines to item 23-3214, using item 23-3216 to cover the connections. The connections to item 23-3214 are given in Table 1. The control logic is given in Table 2.

TABLE 1

Remote Control Line Connections

Pin	Function
1	Range selection D (MSB)
2	Common Line
3	Range selection A (LSB)
4	+5V external supply for opto-couplers
5	HOLD control signal
6	Range selection C
7	Range selection B
8	DC output, high
9	DC output, low

NOTE: The mating socket for the remote control option plug is a CINCH R43 81044, fitted with a shell CINCH R43 81960. Both items are supplied as part of the Racal-Dana kit 11-1435 which can be supplied for fitting by the customer.

(9) Connect the line carrying the signal to be measured. Low frequency signals may be connected at either the front panel INPUT socket or at the rear panel REMOTE INPUT socket. For high frequency measurements, the signal should be connected at the rear panel REMOTE INPUT socket and the front panel INPUT socket terminated with a 50Ω load. This gives an input impedance of 50Ω at the REMOTE INPUT socket. If the REMOTE INPUT socket has not been connected high frequency signals should be connected to the INPUT socket via a T piece, with the free end terminated with a 50Ω load.

TABLE 2

Control Line Coding

RANGE	PIN NUMBER 1	6	7	3
100μV	0	0	0	0
300μV	0	0	0	1
1mV	0	0	1	0
3mV	0	0	1	1
10mV	0	1	0	0
30mV	0	1	0	1
100mV	0	1	1	0
300mV	0	1	1	1
1V	1	0	1	0
3V	1	0	1	1
10V	1	1	0	0
30V	1	1	0	1
100V	1	1	1	0
300V	1	1	1	1

A logic '0' on pin 5 holds the reading to within 1% for up to 3 seconds.

Input Levels			
	0	:	+0.8 to −15 volts
	1	:	+2.4 to +15 volts

FITTING RACK MOUNTING KIT (OPTION) TYPE 11-1126

10. The procedure for fitting the kit is as follows:-

(1) Remove the bench type handle assembly by carefully prising off the plastic caps from the handle pivots, and then extracting the screws which secure the assembly to the unit. Store safely for possible future use.

(2) Remove the blind grommet from each side trim panel and completely remove the two screws revealed. This allows the rear panel to be drawn away from the side panels (as far as wiring permits).

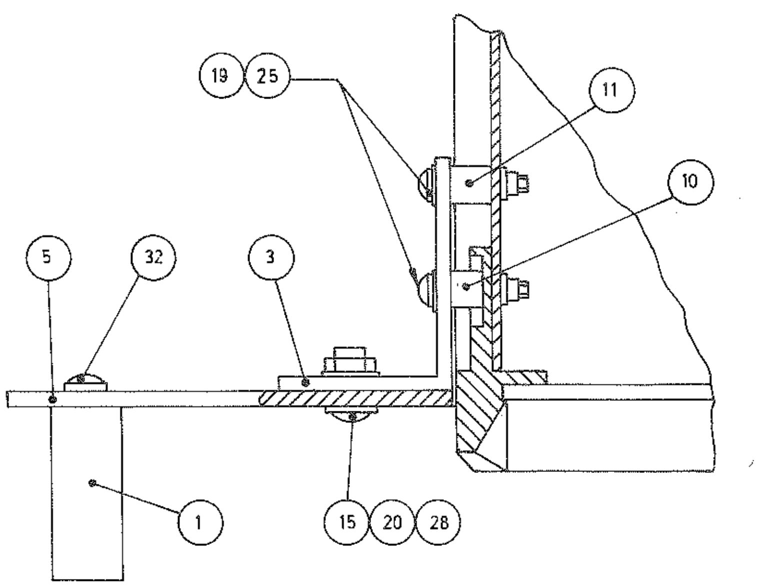
(3) With the rear panel drawn backwards, slide out the trim strips from the side panels. Store them safely for possible future use. Then refit the rear panel and secure firmly with the two screws removed in (2). Take care not to displace or damage any r.f. gasket material fitted.

(4) At the front of the instrument, remove the screw securing the front panel on one side and discard. Refer to the diagram below and fit bracket (item 3) using spacers (items 10 and 11) screws (item 25) and washers (item 19).

(5) Repeat (4) on the other side of the front panel.

(6) Fit the rack type handles (item 1) to the plates (item 5) using two Tapite screws (item 32) to each handle.

(7) Fit the plate assemblies to the brackets on the unit using two of items 15, 20 and 28 to each plate assembly.



Plan View: Rack Mounting Kit 11-1126 Fig. 2.1

OPERATING INSTRUCTIONS

Warm Up Time

11. Connect the instrument to the a.c. supply and set the ON/OFF switch to ON. Check that the LINE indicator lights. A warm up time of 10 mins should be allowed if measurements of maximum accuracy are required.

Range Selection

12. The measurement range is selected by means of the front panel RANGE switch. Voltage readings should be made on the black scale whose marking corresponds with the RANGE switch voltage setting in use. The highest numbered mark corresponds to an input level equal to the RANGE switch voltage setting in use.

13. For readings in dBm use the red scale. The input level in dBm is the algebraic sum of the scale reading and the RANGE switch dBm setting in use. 0 dBm represents a level of 0.775V r.m.s.

14. It should be remembered that the permissible crest factor of the measured waveform increases as the meter deflection decreases. With signals of high crest factor the highest RANGE switch setting which will permit accurate reading of the scale should be used.

Connection of Signals

15. If the instrument is fitted with the complete remote control interface option, low frequency signals to be measured may be connected at either the front panel INPUT socket or at the rear panel REMOTE INPUT socket. The input impedance is 1 MΩ in parallel with approximately 95pF. For measurements at high frequency signals should be connected at the REMOTE INPUT socket, and the front panel INPUT socket should be terminated with a 50Ω load. The input impedance at the REMOTE INPUT socket will then be 50Ω. This applies even when the instrument is not being remotely controlled.

16. If the remote control interface is not fitted, or if the REMOTE INPUT socket has not been connected (see paragraph 9 (6)) the signal to be measured is connected at the front panel INPUT socket. The input impedance is 1 MΩ in parallel with approximately 40pF. For measurement of high frequency signals the connection to the INPUT socket should be made via a T piece, with the free end terminated with a 50Ω load.

Common Line Isolation

17. The instrument may be operated with the input and output common line isolated from chassis earth by putting the ISOLATE switch to ISOLATE. The permissible voltage difference is ± 0.5V.

NOTE: It must be remembered that only isolated connections may be made to the front panel INPUT socket, the rear panel REMOTE INPUT socket (if fitted), the DC OUTPUT socket and the d.c. output via the 9-way plug (if fitted) if common line isolation is to be maintained.

Remote Control

18. For operation under remote control set the ON/OFF switch to ON and the RANGE switch to REMOTE.

DESCRIPTION OF CONTROLS, INDICATORS AND CONNECTORS

Front Panel Items

19. ON/OFF Switch: This switch controls the a.c. supply to the instrument.

LINE Indicator: This LED lights when the instrument is connected to the a.c. supply and switched on.

Meter: A taut band meter, providing an analogue indication of the r.m.s. value of the measured signal. The meter has three scales.
Two voltage scales (black) are provided, numbered to agree with the voltage markings of the range selection switch.
A dBm scale (red) is provided, scaled from +3 dBm to -12 dBm into 600Ω. The total dBm reading is obtained by adding the meter reading algebraically to the dBm setting of the range selection switch.

RANGE Switch: This allows selection of one of the 14 half octave ranges or the remote control mode. If the REMOTE position is selected when the remote control interface option is not fitted the instrument will be switched to the 300V range.

ISOLATE Switch: This switch is open in the ISOLATE position, when the INPUT and DC OUTPUT BNC socket shells (common line) are isolated from chassis earth.
When the switch is closed the common line is connected to chassis earth.
The switch also controls the isolation of the REMOTE INPUT socket and the d.c output via the 9-way plug when the remote control interface option is fitted.

INPUT Socket: A BNC socket at which the signal to be measured is connected. The input impedance is:

(1) 1MΩ in parallel with 30pF for the 1V range and above.

(2) 1 MΩ in parallel with 40pF for the 300mV range and below.

The fitting of the REMOTE INPUT socket as part of the remote control interface option adds approximately 45pF to these figures.

NOTE: When the remote interface option is fitted, high frequency signals to measured should be connected at the rear panel REMOTE INPUT socket. The front panel input should be terminated with a 50Ω load. The input impedance will then be 50Ω.

Rear Panel Items

20. REMOTE INPUT Socket: This BNC socket is only fitted when the remote control interface is fitted. It is connected in parallel with the front panel INPUT socket.

NOTE: When this socket is fitted it should be used in preference to the front panel INPUT socket for high frequency measurements. The front panel INPUT socket should be terminated with a 50Ω load. This input impedance will then be 50Ω.

Remote Control Plug:	This 9-way plug is only fitted when the remote control interface option is fitted. It allows connection of the four range control lines, the HOLD command line and the common return line. An additional line is provided to carry the positive side of the 5V supply for the opto-couplers. Two lines, connected in parallel with the DC OUTPUT socket, carry a d.c. output proportional to the r.m.s. level of the measured signal.
Line Fuse:	The fuse is a 5mm x 20mm glass cartridge pattern and should be of the anti-surge type.
Line Voltage Selector:	This allows the selection of one of four line voltage ranges. The range selected can be read on the selecting plate through the clear plastic cover.
Line Power Plug:	The power input plug incorporates a filter, and external supply filtering should be unnecessary.
DC OUTPUT Socket:	A d.c. level proprotional to the r.m.s. value of the signal being measured, is available at this socket. The d.c. level is +1V for an input signal level giving a scale reading of 1 or 3.16 according to the scale in use.

CHAPTER 3

PRINCIPLES OF OPERATION

INTRODUCTION

1. The explanation of the principles of operation of the 9300 in this chapter is made with reference to the block diagram Fig. 3.1. Detailed descriptions of the circuits employed are given in Chapter 4. Circuits, component layouts and parts lists are to be found in Part 3 of this manual.

RANGE SWITCHING

2. A series of relay switched attenuators in the instrument signal input path provides control over the voltage applied to the multiplier input. Attenuators of 60 dB, 40 dB, 20 dB and 10 dB are provided, giving attenuation from 0 dB to 130 dB in 10 dB steps. The insertion of the attenuators is controlled by means of the RANGE switch, or by signals via the remote control interface, if this is fitted. With no attenuators in circuit the instrument gives a full scale indication for a level of 100 μV at the INPUT socket. The range of input levels for full scale indication is therefore from 100 μV to 316 V.

OPERATION OF FEEDBACK LOOP

3. The basic components of the feedback loop are the differential multiplier, the integrator, the amplifier and the inverter. If the input offset signals, Vox and Voy, the noise signal, Vn, and the correction signals injected into the loop are neglected, the inputs to the multiplier are $V_S + V_R$ and $V_S - V_R$, where V_S is the signal to be measured and V_R is the d.c. output of the instrument.

The output of the multiplier, Vo, is given by

$$Vo = (V_S + V_R)(V_S - V_R)$$

$$= V_S^2 - V_R^2$$

4. The multiplier output is applied to the integrator, the output of which is the mean level of the input, $\overline{V_S^2 - V_R^2}$. If the amplifier has a gain A the amplifier output is $A(\overline{V_S^2 - V_R^2})$.

$$\therefore \quad V_R = A\ (\overline{V_S^2 - V_R^2})$$

and

$$\frac{V_R}{A} = \overline{V_S^2 - V_R^2}$$

5. If the gain of the amplifier is large $\frac{V_R}{A}$ approximates to zero once the loop has settled, when

$$\overline{V_S^2} = \overline{V_R^2}$$

Since V_R is a direct voltage $\overline{V_R^2} = V_R^2$ and

$$V_R = \sqrt{\overline{V_S^2}}\text{ , the r.m.s. value of } V_S \text{ .}$$

6. If V_S is represented by $V_S = V \sin wt$, the multiplier output

$$V_S^2 - V_R^2 = V^2 \sin^2 wt - V_R^2$$

$$= \frac{V^2(1 - \cos 2\ wt)}{2} - V_R^2 \qquad (1)$$

The mean value of $V^2 \cos 2\ wt$ is zero, so the integrator output

$$\overline{V_S^2 - V_R^2} = \overline{\frac{V^2}{2} - V_R^2}$$

whence $V_R = \frac{\sqrt{V^2}}{\sqrt{2}}$ as shown above, if A is large.

Expression (1) shows that for every sinusoidal component of the input waveform there will be a double frequency component in the multiplier output.

7. A more complete analysis of the loop operation, taking account of noise and multiplier input offsets is given in the appendix to this chapter.

NOISE AND OFFSET CANCELLATION

8. The system noise, referred to the multiplier input, will cause a zero error at the amplifier output. This can be corrected by injecting a signal of suitable amplitude into the loop. The required level of signal for this is found by periodically disconnecting the signal being measured, and sampling the residual amplifier output with an integrating sample and hold circuit. During the sampling period the output of this circuit is injected into the loop, the system stabilising when the amplifier output, and therefore the sample and hold circuit input, is driven to zero. The input to the sample and hold circuit is disconnected from the amplifier output before the signal to be measured is reconnected, but the output remains connected to the loop to cancel the zero error during the following measurement period.

9. The multiplier input offsets will contribute towards the zero error at the amplifier output, and will also give an offset, the magnitude of which is independant of the range in use. These two effects can be corrected by injecting suitable signals into the loop. The zero error due to multiplier input offsets is corrected by the same circuit that corrects for zero error due to noise, since it is the combined zero error which is applied to the sample and hold circuit during the output sampling period. The output offset due to the multiplier input offsets is corrected by a permanently injected signal, derived from a potentiometer, which is adjusted during calibration of the 9300.

SAMPLING PERIOD

10. The sampling period for the zero offset correction system is controlled by an astable circuit, and lasts for approximately 1 ms in every second.

11. At the start of the sampling period the following actions occur:

(1) The d.c. output of the loop is held by a sample and hold circuit, to maintain the output during the sampling period.

(2) The signal being measured is disconnected from the measuring circuit input. To allow switching to occur at a low level when high level signals are being measured, the disconnection of the signal occurs after the 60 dB input attenuator. Part of the instrument input circuit is therefore disconnected during sampling, and a circuit which simulates the noise contribution from this part of the circuit is introduced.

(3) The operation of the loop integrator is suspended.

(4) The residual output from the amplifier is connected to the sample and hold circuit of the zero offset correction system.

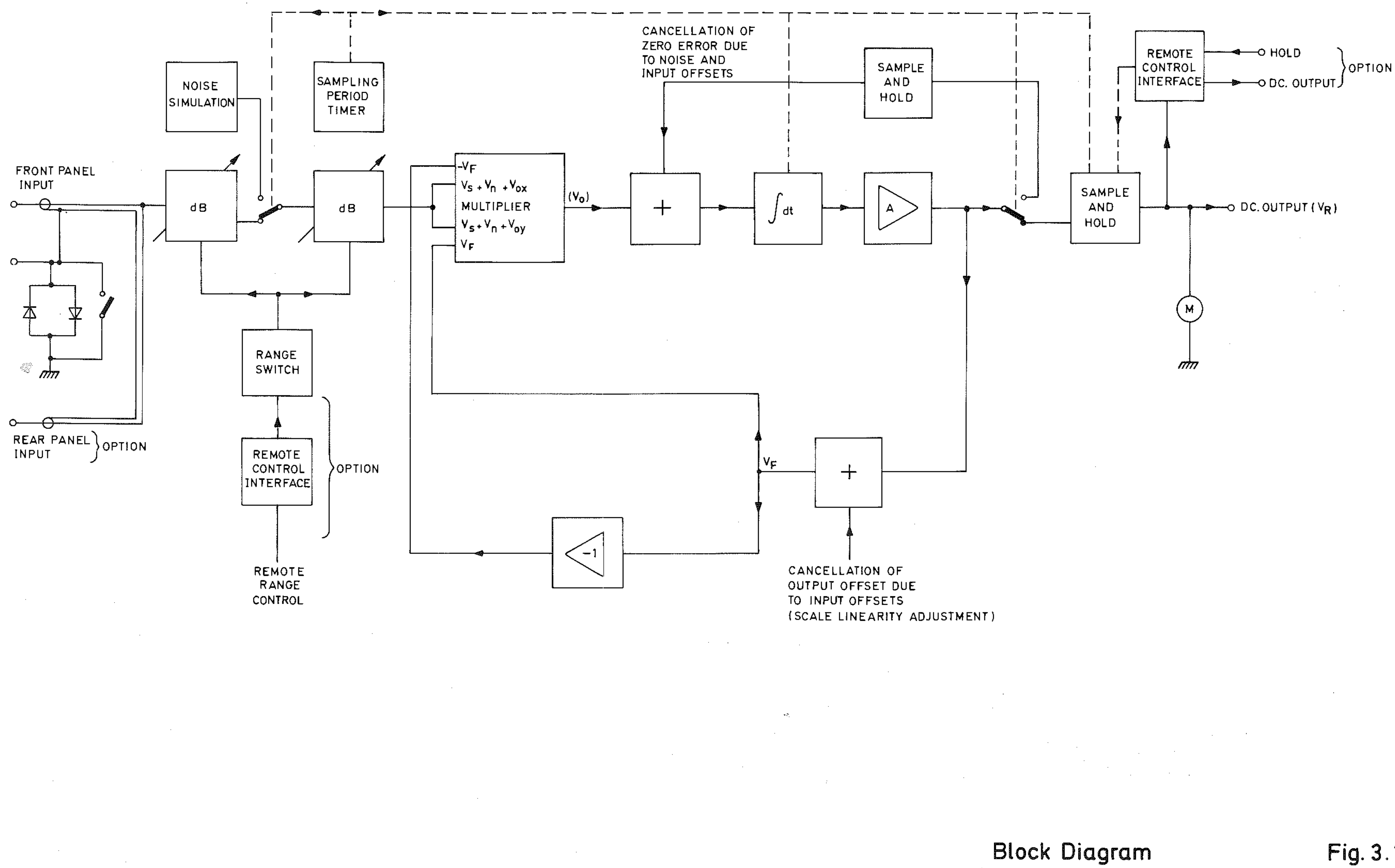
12. At the end of the sampling period the instrument reverts to the measurement mode.

REMOTE CONTROL INTERFACE

13. The remote control interface provides facilities for remote control of the instrument range via four opto-coupler isolated control lines. The opto-coupler outputs are fed to the input attenuator control circuits via the front panel RANGE switch, which must be in the REMOTE position if remote control is required.

14. A hold facility is also provided. Application of a logic '1' level at the appropriate input will hold the d.c. output constant, to within 1%, for up to 3 seconds. This facility is available when the interface is fitted even if the instrument is not switched to REMOTE. The hold facility input is isolated by an opto-coupler on the remote control interface.

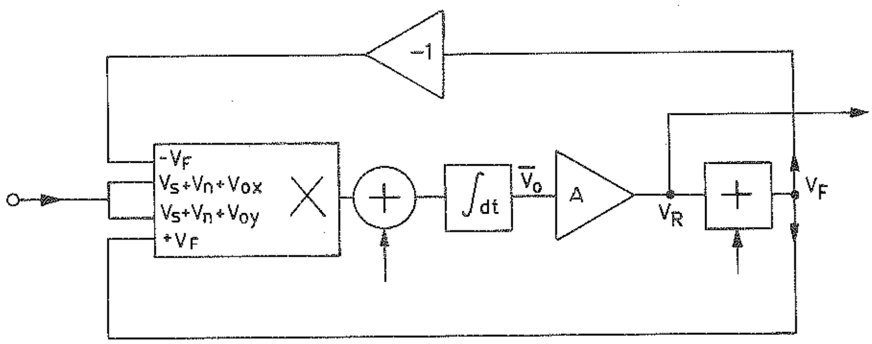
15. Additional input and output sockets are provided with the remote control interface. The additional input is connected in parallel with the front panel INPUT socket, while the additional output is connected in parallel with the rear panel DC OUTPUT socket.



Block Diagram Fig. 3.1

APPENDIX 1

OPERATION OF FEEDBACK LOOP



Loop Block Diagram Fig. 3.2

1. From Fig. 3.2 it can be seen that:

$$V_o = [V_s + V_n + V_{ox} + V_F]\,[V_s + V_n + V_{oy} - V_F]$$

$$= [V_s + V_n + V_{ox}]\,[V_s + V_n + V_{oy}] - V_F[V_s + V_n + V_{ox}] + V_F[V_s + V_n + V_{oy}] - V_F^2$$

$$= [V_s + V_n]^2 + [V_s + V_n]\,[V_{ox} + V_{oy}] + V_{ox}V_{oy} - V_F[V_{ox} - V_{oy}] - V_F^2$$

$$\therefore \overline{V_o} = \overline{V_s^2 + V_n^2 + 2V_sV_n + [V_s + V_n]\,[V_{ox} + V_{oy}] + V_{ox}V_{oy} - V_F[V_{ox} - V_{oy}] - V_F^2}$$

V_s and V_n are a.c. quantities, with mean values of zero

$$\therefore \quad \overline{V_o} = \overline{V_s^2 + V_n^2 + V_{ox}V_{oy} - V_F[V_{ox} - V_{oy}] - V_F^2}$$

From this point on mean values will be assumed without the bar.

$V_F = AV_o$, and if A is large $V_o \triangleq 0$

$$\therefore \quad V_F^2 + V_F[V_{ox} - V_{oy}] - [V_s^2 + V_n^2 + V_{ox}V_{oy}] = 0$$

$$\therefore \quad V_F = \frac{-[V_{ox} - V_{oy}] \pm \sqrt{[V_{ox} - V_{oy}]^2 + 4[V_s^2 + V_n^2 + V_{ox}V_{oy}]}}{2}$$

$$= -\frac{V_{ox} - V_{oy}}{2}$$

$$\pm \frac{1}{2}\sqrt{4V_s^2 + 4V_n^2 + 4V_{ox}V_{oy} + V_{ox}^2 - 2V_{ox}V_{oy} + V_{oy}^2}$$

$$= -\frac{V_{ox} - V_{oy}}{2}$$

$$\pm \frac{1}{2}\sqrt{4V_s^2 + 4V_n^2 + V_{ox}^2 + 2V_{ox}V_{oy} + V_{oy}^2}$$

$$= -\frac{V_{ox} - V_{oy}}{2} \pm \frac{1}{2}\sqrt{4V_s^2 + 4V_n^2 + [V_{ox} + V_{oy}]^2}$$

$$= -\frac{V_{ox} - V_{oy}}{2} \pm \frac{1}{2}\sqrt{4\left[V_s^2 + V_n^2 + \left[\frac{V_{ox} + V_{oy}}{2}\right]^2\right]}$$

$$= -\frac{V_{ox} - V_{oy}}{2} \pm \sqrt{V_s^2 + V_n^2 + \left[\frac{V_{ox} + V_{oy}}{2}\right]^2}$$

It is required that $V_R = \sqrt{V_s^2}$, a result which can be obtained by adding two correction signals.

2. The first of these is an offset correction, $-\frac{V_{ox} - V_{oy}}{2}$, which is injected into the loop such that the value of V_R is increased while V_F, the signal fed back to the multiplier, remains the same. A suitable injection point is shown in Fig. 3 as a rectangular box marked +. Injection of the correcting signal here affects both feedback inputs equally, but it is also possible to apply the correction to one feedback path only, as this will produce the required offset between the feedback inputs to the multiplier.

3. With the loop offset corrected

$$V_R = \sqrt{V_s^2 + V_n^2 + \left[\frac{V_{ox} + V_{oy}}{2}\right]^2}$$

The expression $\sqrt{V_n^2 + \left[\frac{V_{ox} + V_{oy}}{2}\right]^2}$ represents a zero error which exists when V_s is zero. This too can be corrected by means of a signal injected into the loop. An automatic system is used to disconnect V_s and generate the required correction signal from the residual value of V_R. This correction signal is injected into the loop at the point indicated by ⊕.

CHAPTER 4

TECHNICAL DESCRIPTION

INTRODUCTION

1. This chapter provides a detailed explanation of the operation of the circuits used in the voltmeter model 9300. The principles of operation of the instrument are given in Chapter 3. These principles should be understood before any study of the circuit details is made.

2. The majority of the instrument circuitry is mounted on one printed circuit board (PCB) 19-0980. An additional PCB, 19-1003, is used if the remote control interface option is fitted. The circuit diagrams, component layouts and parts lists are to be found in Part 3 of this manual.

INPUT CIRCUIT

3. The instrument INPUT socket is mounted on the front panel. The signal is carried to pin 7 of the main PCB by a coaxial lead. The body of the socket is connected to the PCB earth plane (signal earth) but is isolated from chassis earth by two sets of back-to-back diodes contained in the diode bridge D2. The signal earth can be held at chassis earth, if required, by closure of the ISOLATE switch S2.

4. An additional INPUT socket may be provided on the rear panel when the remote control option is fitted. This is connected in parallel with the front panel socket.

VARIABLE GAIN AMPLIFIER SYSTEM

5. The instrument's sensitivity is varied by means of a variable gain amplifier system. This consists of an attenuator and buffer amplifier, followed by four attenuators separated by feedback amplifiers. The attenuators are inserted in the signal path as required by means of control signals derived from the RANGE switch, or from the remote control interface, if in use. The control lines are pulled to 0V to remove an attenuator from the circuit.

60 dB Attenuator

6. The switching of the 60dB attenuator is controlled by relays RLA, RLB and RLC. With the instrument switched off all the relay contacts are in the open position and the signal path is open circuited. With the instrument switched on and the 60dB control line pulled towards +15V via R16, Q1 is switched on, holding Q2 cut off. This energises RLA and RLC but leaves RLB de-energised, and the signal to be

measured is passed through the attenuator. When the control line is pulled to 0V, RLA and RLC are de-energised and the attenuator is completely isolated from the signal path, which is now via RLB, R6, R7 and C8.

7. The attenuator value at high frequencies can be varied by adjustment of C3.

8. The signal to be measured is applied to the buffer amplifier containing Q5 and Q6 via the opto-coupler IC1. During the measurement period IC1 will be conducting, The voltage variation at the opto-coupler input is limited by the base/emitter junctions of Q3 and Q4, which act as low capacity zener diodes, connected back-to-back between the signal line and 0V.. Fine adjustment of the instrument calibration at high frequencies on the more sensitive ranges is made by adjustment of C10.

40 dB Attenuator

9. The 40dB attenuator consists of two 20dB current attenuators, which are switched in simultaneously. Each attenuator is followed by a feedback amplifier stage.

10. The attenuator switching is effected by RLD and RLE. With the 40dB control line pulled towards +15V via R16, the three transistors in IC5 which control the relays are all in the conducting state. The relays are energised and the attenuators are inserted in the signal path. The transistors are cut off, and the system put to the high gain state, when the control line is pulled to 0V.

11. The variable resistor R19 in the first attenuator allows adjustment of the attenuator value. The variable resistor R29 in the feedback path of the second amplifier allows adjustment of the total signal path gain for instrument calibration.

20 dB Attenuator

12. The 20dB attenuator is similar in operation to one stage of the 40dB attenuator. The attenuator switching is performed by RLF, which is controlled by two transistors in IC8. The frequency response of the amplifier feedback path is adjustable by means of C34. This provides a means of adjusting the signal path gain at high frequencies for instrument calibration purposes.

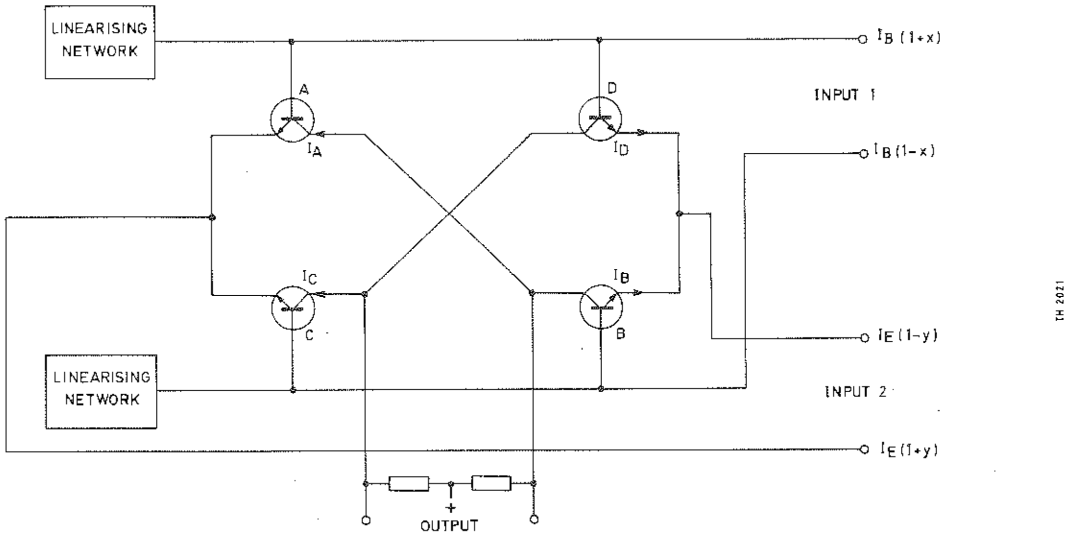
10 dB Attenuator

13. The 10db attenuator is formed by R62 and R63 at the input to the multiplier stage. The attenuator switching is performed by RLG, which is controlled by two transistors in IC12.

FEEDBACK LOOP

The Multiplier

14. The multiplier used is of the linearised transconductance type, a schematic circuit diagram being shown in Fig. 4.1.



Multiplier Operation Fig. 4.1

The inputs are the differential currents at inputs 1 and 2. It is a property of this circuit that the ratio of the collector currents in A and C and the ratio of the collector currents in B and D are both the same as the ratio of the currents in the linearising networks. (Proof of this property is unnecessary for the purpose of this manual).

15. If the currents at input 1 with zero signal are I_B, the currents with a signal of 2x will be $I_B\ (1 + x)$ and $I_B\ (1 - x)$. These currents have a difference, the signal, of 2x and a ratio $1 + x\ /\ 1 - x$. Similarly the currents at input 2 with a signal of 2y will be $I_E\ (1 + y)$ and $I_E\ (1 - y)$.

16. The collector currents of the multiplier transistors will be:

$$I_A = \tfrac{1}{2}I_E\,(1+y)(1+x)$$
$$I_C = \tfrac{1}{2}I_E\,(1+y)(1-x)$$

Two currents having a total of $I_E\ (1+y)$ and a ratio of $1+x\ /\ 1-x$

$$I_D = \tfrac{1}{2}I_E\,(1-y)(1+x)$$
$$I_B = \tfrac{1}{2}I_E\,(1-y)(1-x)$$

Two currents having a total of $I_E\ (1-y)$ and a ratio of $1+x\ /\ 1-x$

17. The output of the multiplier is the differential current at the output, given by $(I_A + I_B) - (I_C + I_D)$, and equals

$$\tfrac{1}{2}I_E\left[(1+y)(1+x)+(1-y)(1-x)-(1+y)(1-x)-(1-y)(1+x)\right]$$
$$= \tfrac{1}{2}I_E\left[1+x+y+xy+1-x-y+xy-1+x-y+xy-1+y-x+xy\right]$$
$$= \tfrac{1}{2}I_E\ 4\ x\ y$$
$$= \tfrac{1}{2}I_E\ 2x.\ 2y$$

The differential output current is therefore the product of the input signals, scaled by the no-signal value of the current at input 2.

18. The transistors of the multiplier are contained in IC10. The use of the transistor array rather than discrete components affords close matching of the transistor characteristics. IC10 is specially selected to obtain the degree of matching required. The multiplier linearising networks are formed by the transistors in IC9. This array is also specially selected to obtain the required degree of matching. The base/emitter diodes of these transistors form the loads for the input currents from IC11 pins 8 and 14. They provide an exponential relationship between the input currents and the voltages applied at IC10 pins 4, 9, 2 and 6 which offset similar non-linearities in the transistors of IC10.

19. The multiplier inputs are driven by the transistors in IC11, which are connected to form two long-tailed-pair differential amplifiers. Good matching of these transistors is essential, and IC11 is specially selected to achieve this. When measuring signals of high crest factor the differential signal at the amplifier inputs becomes large, and the transistors may be driven close to cut off at the signal peaks. This results in non-linearity. The effect is overcome by means of D8 and D9, which conduct when the differential signal is large, reducing the emitter coupling resistor value and increasing the amplifier gain.

Averager and Loop Feedback Path

20. The multiplier output is fed to the operational amplifier IC6b. During the measurement period Q9 is held in the high impedance state, and the feedback path via IC6a is not effective. However, Q10 is in the low impedance state, providing a feedback path via C41, so that IC6b acts as an integrator, its output being the mean value of the input from the multiplier.

21. The output of IC6b is fed back to the multiplier inputs at IC11 pin 2 and, after inversion by IC6d, pin 12. The networks C47/R71 and C48/C75 ensure that these inputs are held at signal ground.

22. The input to the loop required to cancel the effect of the multiplier input offset is set by means of R73. The potential set is injected into the inverted feedback input only.

METER DRIVE AND DC OUTPUT

23. The output of the integrator stage, IC6b, is the r.m.s. value of the signal applied to the multiplier. The integrated output is therefore used to drive the meter and to provide a DC output proportional to the r.m.s. value of the measured signal.

24. The integrated output is passed via Q11, which is in the low impedance state during the measurement period, and charges C49. The potential on C49 is connected to the voltage follower IC6c, the output of which drives the meter via R83 and R82. Adjustment of R82 allows the meter sensitivity to be set.

25. The output of IC6c is also applied to the potential divider R84/R85. The rear panel DC OUTPUT socket is driven from the junction of these resistors. If the remote control interface option is fitted an additional DC output is made available on two pins of the remote control connector. The DC outputs are relative to signal earth. The isolation of signal earth from chassis earth is controlled by the front panel ISOLATE switch.

AUTO ZEROING

26. During a sampling period of approximately 1ms in each second the zero error in the system, due to noise and the offsets at the multiplier inputs, is used to generate a correction signal. The correction signal is held, and injected into the system during the following measurement period to cancel the zero error.

27. The timing of the sampling period is controlled by the astable clock circuit incorporating IC7a. With the output of IC7a at its high level, C36 charges slowly via R45 until pin 2 is more positive than pin 3. The output of IC7a is switched to its low level, IC7a pin 3 being driven negative with respect to pin 2. A rapid discharge path for C36 now exists via D1 and R46, and the potential at pin 2 falls towards that of pin 3. When pin 2 is more negative than pin 3 the output of IC7a and pin 3 are switched back to the high state, and the cycle is repeated.

28. The astable clock output is applied to the inverting input of IC7a and the non-inverting input of IC7d. The outputs are 1ms pulses, positive going at test point 11 and negative going at test point 5. At the commencement of the 1ms sampling period the following actions occur:

(1) The meter drive and DC outputs are disconnected from the integrator output as Q11 is put to the high impedance state. Because of the high input impedance of IC6c the charge on C49 does not change significantly during 1ms, and the meter reading and DC outputs are maintained during the sampling period.

(2) The opto-coupler IC1 is put to the high impedance state, disconnecting the signal being measured. The opto-coupler IC2 is put to the low impedance state, connecting the noise generated in C12, C11 and R11 into the circuit. This compensates for the decrease in noise due to the disconnection of the circuit between the signal input and IC1.

(3) The normal integrating action of IC6b is stopped by Q10 being put to the high impedance state.

(4) The residual signal at the output of IC6b is connected to the integrator IC6a as Q9 is switched to the low impedance state. The output of IC6a is fed back to IC6b, and provides an input offset which drives the voltage at test point 10 close to 0V. When the voltage at test point 10 reaches 0V the integrating action of IC6a ceases.

(5) The negative going pulses at the output of IC7d puts Q7 to the high impedance state, inserting C43 into the signal line. This provides a high pass filter action, passing all but the lowest frequencies of the instrument noise spectrum to the feedback loop input while ensuring that any low frequency signal voltage is reduced rapidly to zero.

29. At the end of the sampling period the circuit is reset to the measurement mode. The input of IC6a is disconnected from the signal path as Q9 reverts to its high impedance state, but the zero error correction voltage at the output of IC6a remains connected to the input of IC6b. This provides zero correction during the measurement period.

PREVENTION OF LOCK UP

30. When the instrument is operated with no input signal there may be a tendency for the output of IC6b to drift negative. The effect of this is cumulative, and if allowed to continue the feedback loop would lock up. If the output of IC6b does go negative D7 becomes back biased and the feedback path of the loop is broken. At the same time the gate/channel diode of Q8 conducts, allowing the auto zeroing circuit to function and correct the unwanted drift.

REMOTE CONTROL INTERFACE OPTION

31. The remote control interface provides the means of controlling the range setting attenuators by means of external control signals connected via a rear panel connector. The external signals are fed from the rear panel connector to an additional PCB, 19-1003, at SK5. Each line is applied to an opto-coupler, which goes to the low impedance state when the external signal is at a voltage less than TTL logic '0'. This connects the associated internal control line at SK4 to 0V, which, provided the RANGE switch is in the REMOTE position, will remove the corresponding attenuator from the signal path.

32. An additional external control connection is provided for HOLD instructions. When the external control line is at TTL logic '0', the internal control line is at -15V. This voltage level is applied to the main PCB at SK3 pin 3, and will result in Q11 being put to the high impedance state. The charge on C49, and therefore the meter indication and the DC outputs, will be held, irrespective of changes in the measured signal, to within 1% for a period of three seconds.

33. An additional DC output is taken from pins 1 and 2 of the main PCB, and is passed, via chokes mounted on assembly 19-1003, to the rear panel remote control socket.

34. An additional input socket, SK6, may be mounted on the rear panel. This is connected in parallel with the front panel input socket by means of a 50Ω coaxial cable.

CHAPTER 5

MAINTENANCE

INTRODUCTION

1. This chapter is divided into three sections, giving information on:-

   (1) The procedure for setting up the measuring circuits, which should be carried out following repair or if the instrument fails to perform to specification.

   (2) A series of performance checks which will establish whether the instrument is performing to specification.

   (3) Instructions on dismantling and assembly of the instrument to the level required for setting up and normal repair.

2. The test equipment required is listed in Table 3. Some modification to the laid down procedure may be necessary if equipment other than the preferred type listed is used.

SETTING UP PROCEDURE

Introduction

3. Ensure that the 9300 has been correctly prepared for use as instructed in Chapter 2. The checks described in paragraphs 4 to 16 should be carried out in the order given before setting up the measuring circuits as described in paragraph 17.

Isolating Circuit Check

4. Test equipment required:

Item	Table 3 Item No.
Multimeter	1

5. Disconnect the supply lead from the AC supply. Ensure that the supply lead socket is fully mated with the rear panel plug. Set the multimeter to measure resistances of approximately 50kΩ, and connect it to measure the resistance between the earth connection of the supply lead and the shell of the front panel INPUT socket.

TABLE 3

Test Equipment Required

Item	Description Preferred Type	Specification
1	Multimeter AVO model 8	Resistance measurements from 1Ω to 50kΩ.
2	Variac	Transformer ratio 0:1 to 1.5:1
3	Digital voltmeter	15V DC with resolution of 10mV. 100mV to 1.005V DC with resolution of 1mV and ± 0.05% accuracy.
4	RF Millivoltmeter Racal-Dana 9301A	True RMS reading, with probe, probe isolator and BNC socket to isolator adaptor. To read 1V over the frequency range from 30 MHz to 100MHz
5	Voltmeter Racal-Dana 9300	True RMS reading. Accuracy to be known to ± 0.1% at levels of 10V, 31.62V, 100V and 316.2V at a frequency of 50 Hz.
6	Voltmeter Fluke 8921A	True RMS reading on waveforms with crest factor of 7.
7	Signal Generator Racal-Dana 9083 and Racal Dana 9084	Frequency range from 1kHz to 100MHz. Output level from 0.3mV to 1V.
8	Oscilloscope	Bandwidth 20 MHz X Sensitivity 5μs/cm Y Sensitivity 50mV/cm
9	Pulse Generator Phillips PM 5771	Pulse width of 500μs to 20μs at a p.r.f. of 1kHz. Pulse amplitude from 200mV to 7V peak-to-peak.
10	Termination	50Ω, BNC with feedthrough for monitor.
11	Shorting Plug	BNC
12	T piece	50Ω, BNC
13	Power Supply	+5V DC

6. (1) Set the ISOLATE switch to the ISOLATE position. Check that the resistance indicated on the multimeter is not less than 50kΩ.

(2) Set the multimeter to measure resistances of approximately 1Ω. Set the ISOLATE switch to the ground position and check that the resistance indicated on the multimeter is not more than 1Ω.

(3) Repeat (1) and (2), measuring between the power lead earth connection and the rear panel INPUT socket, if fitted.

7. Disconnect the multimeter. The ISOLATE switch should remain in the ISOLATE position throughout the remainder of the setting up procedure.

Power Transformer Resistance Check

8. Test equipment required:-

Item	Table 3 Item No.
Multimeter	1

9. Set the multimeter to measure resistance in the range from 75Ω to 410Ω, and connect it to measure the resistance between the line and neutral connectors of the supply lead.

10. (1) Set the ON/OFF switch to ON.

(2) Select each supply voltage range in turn, as instructed in Chapter 2 paragraph 2. Check that the resistance indicated on the multimeter for each setting is within the limits shown in Table 4. Ensure that the resistance for the 120V setting is greater than that for the 100V setting.

(3) Reset the supply voltage range to suit the local supply. Disconnect the multimeter and set the ON/OFF switch to OFF.

TABLE 4

Power Supply Resistance Measurements

Voltage Setting	Resistance
100V	75Ω to 101Ω
120V	76Ω to 102Ω
220V	273Ω to 369Ω
240V	303Ω to 409Ω

Power Supply Rail Checks

11. Test equipment required:-

Item	Table 3 Item No.
Multimeter	1
Variac	2
Digital voltmeter	3

12. Remove the instrument covers as instructed in Chapter 2 paragraph 6.

13. Use the multimeter to check that the resistance to signal earth (the shell of the front panel INPUT socket) is not less than 1kΩ at the following points (connect the current source lead to the positive side of the measured circuit):

(1) +15V rail at test point 1 on assembly 19-0980.

(2) -15V rail at test point 2 on assembly 19-0980.

14. Connect the 9300 power lead to the variac output. Set the variac ratio to 1:1 and connect the variac input to the local AC supply.

15. (1) Set the ON/OFF switch to ON. Check that the LINE indicator lights.

(2) Set the digital voltmeter to measure 15V DC. Check that the voltage at test point 1 is between +14.25V and +15.75V, and that the voltage at test point 2 is between -14.25V and -15.75V with respect to signal ground. Note the actual voltage at each test point.

(3) Adjust the variac to increase the output by 12%. Check that the supply rail voltages have not varied by more than 150mV from the voltages noted in (2).

(4) Repeat (3) with the variac output reduced by 12%.

16. Set the ON/OFF switch to OFF and disconnect the test equipment. Disconnect the 9300 power lead from the variac, and connect it to the local AC supply.

Setting Up the Measuring Circuits

17. Test equipment required:

Item	Table 3 Item No.
Digital voltmeter	3
Signal generator	7
50Ω termination	10
T piece	12

NOTE: The setting up of the measuring circuits must be carried out at an ambient temperature between 21°C and 25°C. A warm up time of 30 minutes should be allowed before adjustments are undertaken.

18. Connect the digital voltmeter to monitor the DC OUTPUT socket of the 9300. For instruments fitted with a rear panel INPUT socket, connect the signal generator to the rear panel INPUT socket and terminate the front panel INPUT socket with the 50Ω termination. For other instruments fit the T piece to the front panel INPUT socket and connect the signal generator and the 50Ω termination to the T piece.

19. (1) Adjust the 9300 meter mechanical zeroing control to obtain a zero indication.
(2) Set the ON/OFF switch to ON, and select the 3mV range.
(3) Set the signal generator output to a frequency of 1kH at a level of 3.162mV (-50 dBV).
(4) Adjust R29 to obtain an indication of between 999mV and 1.001V on the digital voltmeter.
(5) Reset the signal generator output level to 0.3162mV (-70dBV).
(6) Adjust R73 to obtain an indication on the digital voltmeter of between 99mV and 101mV.
(7) Repeat steps (3) to (6), making the final adjustment to R29, until the digital voltmeter indication is within limits at both input levels.
(8) With a signal input level of 3.162mV (-50dBV) adjust R82 to obtain an indication of 3.162 (1.0) on the 9300 meter.
(9) Set the signal generator output to a frequency of 100kHz at a level of 3.162mV (-50dBV). Adjust C10 to obtain an indication on the digital voltmeter of between 999mV and 1.001V.
(10) Set the RANGE switch to 100mV. Set the signal generator output to a frequency of 1kHz at a level of 100mV (-20dBV). Adjust R19 to obtain an indication on the digital voltmeter of between 999mV and 1.00V.
(11) Set the RANGE switch to 1V. Set the signal generator output to a frequency of 100kHz at a level of 1V (0dBV). Adjust C3 to obtain an indication on the digital voltmeter of between 999mV and 1.00V.
(12) Set the signal generator output to a frequency of 20MHz at a level of 3.162mV (-50dBV). Set the RANGE switch to 3mV. Adjust C34 to obtain an indication on the digital voltmeter of between 998mV and 1.002V.

20. Set the ON/OFF switch to OFF and disconnect the test equipment. Replace the 9300 covers and carry out the performance tests described in paragraphs 21 to 48.

PERFORMANCE CHECKS

Residual Noise Check

21. Test equipment required:

Item	Table 3 Item No.
Shorting plug	11

22. (1) Fit the short circuited BNC plug to the front panel INPUT socket.
(2) Set the ON/OFF switch to ON and select 0.1mV on the RANGE switch.
(3) Check that the indication on the meter is not more than 10μV.
(4) Set the ON/OFF switch to OFF and disconnect the test equipment.

Scale and Meter Linearity Checks

23. Test equipment required:

Item	Table 3 Item No.
Digital voltmeter	3
Signal generator	7

24. Connect the digital voltmeter to monitor the DC OUTPUT socket of the 9300. Connect the signal generator to the front panel INPUT socket. Set the signal generator output to a frequency of 1kHz at a level of 3.162mV (-50dBV).

25. (1) Set the ON/OFF switch to ON.
(2) Check that the digital voltmeter indication is between 999mV and 1.001V.
(3) Set the signal generator output to the levels shown in Table 5, and check that the digital voltmeter indication is within the tolerance given.
(4) Set the signal generator output to the levels shown in Table 6. Finally adjust the output level to obtain the appropriate indication on the 9300 meter. Check that the digital voltmeter indication is within the tolerance given.
(5) Set the ON/OFF switch to OFF and disconnect the test equipment.

TABLE 5

Scale Linearity Check

Signal Generator Output	Digital Voltmeter Indication
2.846 mV	899mV to 901mV
2.529 mV	798mV to 802mV
2.213 mV	697mV to 703mV
1.897 mV	597mV to 603mV
1.581 mV	497mV to 503mV
1.265 mV	397mV to 403mV
0.949 mV	297mV to 303mV

TABLE 6

Meter Linearity Check

Signal Generator Output	9300 Meter Reading (1-10 Scale)	Digital Voltmeter Indication
2.846 mV	0.9	898mV to 902mV
2.530 mV	0.8	796mV to 804mV
2.214 mV	0.7	694mV to 706mV
1.897 mV	0.6	592mV to 608mV
1.581 mV	0.5	490mV to 510mV
1.265 mV	0.4	392mV to 408mV
0.949 mV	0.3	294mV to 306mV

Calibration Check

27. Test equipment required:

Item	Table 3 Item No.
Digital voltmeter	3
Signal generator	7

28. Connect the digital voltmeter to monitor the DC OUTPUT socket of the 9300. Connect the signal generator to the front panel INPUT socket.

29. Select each position of the 9300 RANGE switch in turn. At each position set the signal generator output to the frequencies and levels shown in Table 7. Check that the digital voltmeter indication is within the tolerance given for each step.

30. Set the ON/OFF switch to OFF and disconnect the test equipment.

Wide Band Calibration Check

31. Test equipment required:

Item	Table 3 Item No.
Digital voltmeter	3
Signal generator	7
50Ω termination	10
T piece	12

TABLE 7

Calibration Check

9300 Range	Signal Generator		Digital Voltmeter Indication
	Frequency	Output	
0.1mV	50Hz	0.0316mV	276mV to 370mV
0.1mV	50Hz 1kHz 500kHz	0.1mV	961mV to 1.044V
0.3mV	500kHz 1kHz 50Hz	0.316mV	981mV to 1.019V
1mV	50Hz 1kHz 500kHz	1mV	991mV to 1.009V
3mV	500kHz 1kHz 50Hz	3.16mV	991mV to 1.009V
10mV	50Hz 1kHz 500kHz	10mV	991mV to 1.009V
30mV	500kHz 1kHz 50Hz	31.6mV	991mV to 1.009V
100mV	50Hz 1kHz 500kHz	100mV	991mV to 1.009V
300mV	500kHz 1kHz 50Hz	316mV	991mV to 1.009V
1V	50Hz 1kHz 500kHz	1V	991mV to 1.009V
3V	500kHz 1kHz 50Hz	3.16V	991 to 1.009V

32. Connect the digital voltmeter to monitor the DC OUTPUT socket of the 9300. For instruments fitted with a rear panel INPUT socket, connect the signal generator to the rear panel INPUT socket and terminate the front panel INPUT socket with the 50Ω load. For other instruments fit the T piece to the front panel INPUT socket and connect the signal generator and the 50Ω load to the T piece.

33. Select the 9300 RANGE switch positions shown in Table 8 in turn. At each position set the signal generator output to the frequencies and levels shown. Check that the digital voltmeter indications are within the tolerances given.

TABLE 8

Wide Band Calibration Check

9300 Range	Signal Generator		Digital Voltmeter Indication
	Frequency	Output	
100mV	5Hz	100mV	900mV to 1.1V
	10Hz		964mV to 1.036V
	1MHz		964mV to 1.036V
	10MHz		900mV to 1.1V
	20MHz		900mV to 1.1V
1V	1MHz 10MHz 20MHz	1V	900mV to 1.1V

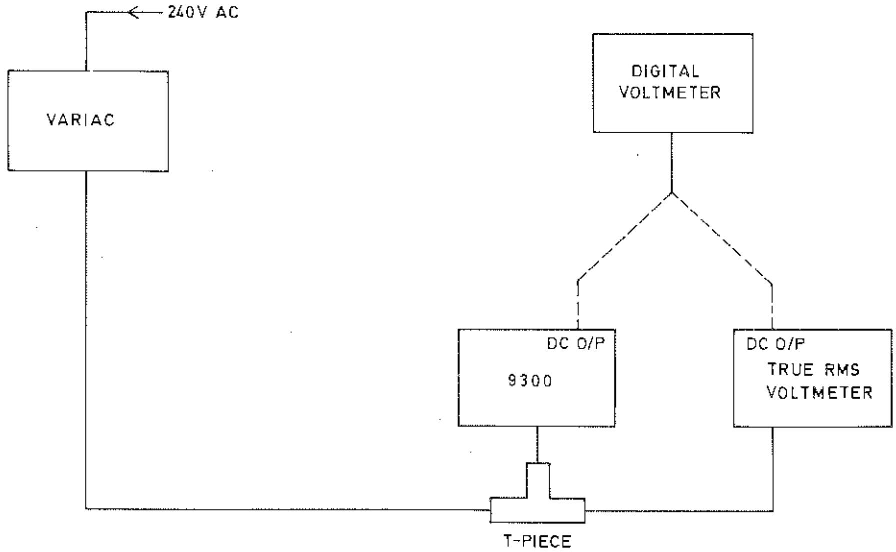
34. Set the ON/OFF switch to OFF and disconnect the test equipment.

High Voltage Calibration and Input Overload Check

35. Test equipment required:

Item	Table 3 Item No.
Variac	2
Digital Voltmeter	3
Voltmeter	5
T piece	12

36. Connect the test equipment as shown in Fig. 5.1. The digital voltmeter should be connected to monitor the DC output of the voltmeter. Set the variac output to zero. Select the 10V range on the voltmeter and on the 9300. Select the 1V range on the digital voltmeter.



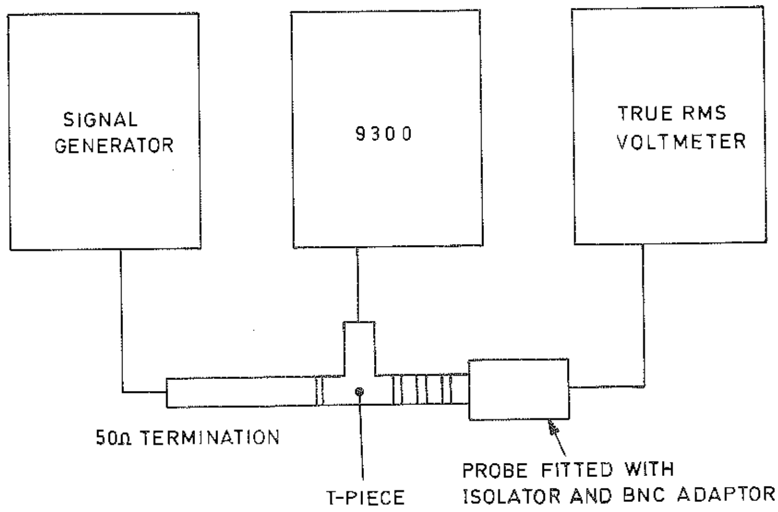
High Voltage Calibration and Input Overload Check Fig.5.1

37. (1) Set the ON/OFF switch to ON.
(2) Increase the variac output until the DC output of the digital voltmeter is 1V±3%. Note the exact indication of the digital voltmeter.
(3) Transfer the digital voltmeter to monitor the DC OUTPUT socket of the 9300. Check that the difference between the digital voltmeter indication and that noted in (2) is not more than ±10mV.
(4) Repeat the test described in (2) and (3) with the voltmeter and 9300 set to the 30V, 100V and 300V ranges in turn.
(5) Transfer the digital voltmeter to monitor the DC output from the voltmeter. Adjust the variac until an indication of 1.12V is obtained. Check that an indication of 354V is obtained on the 9300 meter.
(6) Select the 100mV range on the 9300.
(7) Reduce the variac output to zero. Set the ON/OFF switch to OFF. Disconnect the AC supply to the variac and disconnect the test equipment.
(8) Check the calibration of the 9300 1mV range, at frequencies of 50Hz and 500kHz, as instructed in paragraphs 27 to 30. Ensure that the calibration has not been affected by the application of the overload.

Frequency Response Above 20MHz

38. Test equipment required:

Item	Table 3 Item No.
Voltmeter	4
Signal generator	7
50Ω termination	10
T piece	12



Frequency Response Check (Above 20MHz) Fig.5.2

39. Connect the test equipment as shown in Fig. 5.2. Set the signal generator output to a frequency of 30MHz at a level giving an indication of 100mV on the voltmeter. Select the 100mV range on the 9300.

40.
(1) Set the ON/OFF switch to ON.
(2) Check that the indication on the 9300 meter is within the limits of +3dB and -6dB. Set the signal generator output to the other frequencies given in Table 9, maintaining a level of 100mV. Check that the indication on the 9300 meter is within the limits given for each frequency.
(3) Select the 1V range on the 9300. Set the signal generator output to a frequency of 30MHz at a level of 1V, and check that the indication on the 9300 meter is within the limits of +3dB and -6dB.
(4) Set the signal generator output to the other frequencies given in Table 9, maintaining a level of 1V. Check that the indication on the 9300 meter is within the limits given for each frequency

TABLE 9

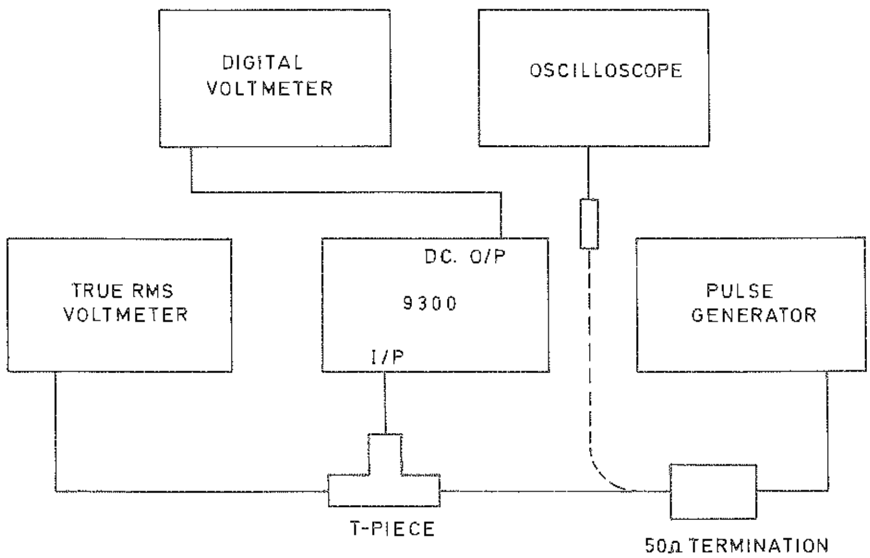
Frequency Response Above 20MHz

Frequency	Limits
30MHz	+3dB to -6dB
40MHz	+3dB to -6dB
50MHz	+3dB to -6dB
60MHz	+3dB to -6dB
70MHz	+3dB to - dB
80MHz	+3dB to - dB
90MHz	+3dB to - dB
100MHz	+3dB to - dB

Crest Factor Check

41. Test equipment required:

Item	Table 3 Item No.
Digital Voltmeter	3
Voltmeter	6
Oscilloscope	8
Pulse generator	9
50Ω termination	10
T piece	12



Crest Factor Check Fig. 5.3

42. Connect the test equipment as shown in Fig. 5.3, with the oscilloscope connected to monitor the signal across the 50Ω termination. Set the pulse generator output to give 500μs pulses, with a rise time of 2ns and a repetition frequency of 1kHz.

43. (1) Disconnect the oscilloscope and connect the signal across the 50Ω termination to the T piece. Adjust the pulse amplitude until the voltmeter indicates 1.000V.
(2) Set the 9300 ON/OFF switch to ON. Note the indication obtained on the digital voltmeter.
(3) Disconnect the 50Ω termination from the T piece and reconnect it to the oscilloscope. Set the pulse duration to 20μs.
(4) Disconnect the oscilloscope and connect the signal across the 50Ω termination to the T piece. Adjust the pulse amplitude until the voltmeter indicates 1.000V.
(5) Check that the indication on the digital voltmeter does not differ from that obtained in (2) by more than ±0.5%.
(6) Invert the pulse generator output and check that the digital voltmeter indication does not differ from that obtained in (2) by more than ±0.5%.

44. Set the ON/OFF switch to OFF and disconnect the test equipment.

Remote Control Interface Check

45. Test equipment required:

Item	Table 3 Item No.
Digital voltmeter	3
Signal generator	7
DC power supply	13

NOTE: Where signals of controlled amplitude and suitable measuring instruments are available in the remote control system the 9300 should, when possible, be checked in that system. The test equipment listed will then not be required.

46. Connect the signal generator to the rear panel INPUT socket. Connect the digital voltmeter to monitor the DC output between pin 8 (high) and pin 9 on the remote control plug. If the 9300 is being tested out of the remote control system, apply 5V DC between pin 4 (+ve) and pin 2 on the remote control plug.

47. (1) Set the ON/OFF switch to ON.
(2) Set the RANGE switch to REMOTE
(3) Select the ranges shown in Table 10 in turn. This may be done by means of the remote control system, or by short circuiting the appropriate pins to pin 2 on the remote control plug.
(4) At each step apply a signal, at a frequency of between 50Hz and 10MHz, at the level shown. Check that an indication of 1V is obtained on the digital voltmeter.

TABLE 10

Remote Control Interface Check

Range	Pins Connected to 0V	Signal Level	Attenuator Used
100µV	1,6,7 and 3	100µV	None
300µV	1,6, and 7	316µV	10dB
1mV	1,6, and 3	1mV	20dB
10mV	1,7, and 3	10mV	40dB
1V	6 and 3	1V	60dB and 20dB

(5) Apply a logic '0' to pin 5 of the remote control plug either via the remote control system or by connecting pin 5 and pin 2 on the remote control plug. Reduce the input signal to zero, and check that the indication on the digital voltmeter is held, within 1%, for at least 3 seconds.

48. Set the ON/OFF switch to OFF and disconnect the test equipment.

DISMANTLING AND REASSEMBLY

49. Removal of the instrument covers, as described in Chapter 2 paragraph 6, will provide adequate access to the instrument interior for most repair tasks. If necessary the remote control interface can be removed by reversing the procedure given in Chapter 2 paragraphs 7 to 9.

Removal of Rear Panel

50. (1) Remove the instrument covers as instructed in Chapter 2 paragraph 6.
(2) Completely remove the two screws securing the rear panel. This will allow the rear panel to be withdrawn to be limit of the wiring.
(3) If complete removal is required it is simpler to release the remote control interface from the rear panel than to disconnect the interface from the motherboard. The remaining connections should be unsoldered.

51. The rear panel is replaced in the reverse manner. Take care not to displace or damage any RF gasket material fitted.

Removal of Front Panel

52. (1) Remove the instrument covers as instructed in Chapter 2 paragraph 6.
(2) Carefully prise off the plastic caps from the handle pivots. Remove the screws holding the assembly to the unit.
(3) Slide the short pieces of trim strip into the space previously occupied by the handle pivots.
(4) Remove the two screws securing the front panel, which can then be drawn forward to the limit of the wiring. If complete removal is required the connections must be unsoldered.

53. The front panel is replaced in the reverse manner.

PART 3

PARTS LISTS

CIRCUIT DIAGRAMS

AND

COMPONENT LAYOUTS

ORDERING OF SPARE PARTS

To be assured of satisfactory service when ordering replacement parts, the customer is requested to include the following information:

(a) Instrument type and serial number.

(b) The type reference of the Assembly in which the particular item is located (for example, '19-0834').

(c) The Racal-Dana Part number and circuit reference of each item being ordered.

It should be noted that a minimum charge of £10 sterling is applicable to all UK orders.

PARTS LIST

FRONT AND REAR PANELS

Fig. 2

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
FRONT PANEL ASSEMBLY 11-1433					
M1		Meter			17-1019
D2		Bridge Rectifier			22-1662
C52	1n	Capacitor, ceramic	500V	20	21-1532
S1		Switch, push button			23-4105
S2		Switch, toggle			23-4043
S3		Switch, rotary			17-0114
		Knob for 23-4101			24-0143
		Knob for 17-0114			16-0200
		Cap for 16-0200			16-0181
SK1		Socket, BNC			23-3198
FX1		Ferrite bead			23-8029
FX2		Ferrite bead			23-8029
FX3		Ferrite bead			23-8029
FX4		Ferrite bead			23-8029
LP1		LED, red, with mounting bush			26-5003
REAR PANEL ASSEMBLY 11-1434					
T1		Transformer			17-4093
C53	1n	Capacitor, ceramic	500V	20	21-1532
D1		Bridge rectifier			22-1662
FS1		Fuselink (90V to 132V) 200mA, anti-surge			23-0027
		Fuselink (198V to 264V) 100mA, anti-surge			23-0033
PL2		Power input plug, filter and fuse holder			23-3420
SK2		Socket, BNC			23-3198

PARTS LIST

MAIN PCB ASSEMBLY 19-0980

Fig. 2

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Resistors	Ω		W		
R1	33k	Carbon Film	¼	5	20-2333
R2	820	Carbon Film	¼	5	20-2820
R3	1M	Metal Film		0.1	20-4983
R4	825	Metal Film		0.1	20-4947
R5	22	Carbon Film	¼	5	20-2220
R6	120k	Metal Oxide	½	1	20-4463
R7	1k	Metal Oxide	¼	1	20-4035
R8	1M	Metal Film		0.1	20-4983
R9	4.7M	Carbon Film	¼	10	10-2475
R10	100	Carbon Film	¼	5	20-2101
R11	330	Carbon Film	¼	5	20-2331
R12	680	Carbon Film	¼	5	20-2681
R13	3.3k	Carbon Film	¼	5	20-2332
R14	560	Carbon Film	¼	5	20-2561
R15	7x2.2k	DIL Array			20-5518
R16	7x10k	DIL Array			20-5517
R17	3.3k	Carbon Film	¼	5	20-2332
R18	825	Metal Film		1	20-4972
R19	200	Variable			20-7061
R20	121	Metal Film		1	20-4967
R21	1.21k	Metal Film		1	20-4974
R22	470	Carbon Film	¼	5	20-2471
R23	1.82k	Metal Film		1	20-4975
R24	221	Metal Film		1	20-4968
R25	1k	Metal Film		1	20-4973
R26	121	Metal Film		1	20-4967
R27	3.3k	Carbon Film	¼	5	20-2332
R28	2.26k	Metal Film		0.25	20-4931
R29	500	Variable			20-7058
R30	1.76k	Metal Film		1	20-7516

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R31	221	Metal Film		1	20-4968
R32	1k	Metal Film		0.1	20-4883
R33	118	Metal Film		0.1	20-4966
R34	3.3k	Carbon Film	$\frac{1}{4}$	5	20-2332
R35	6.8k	Metal Film		1	20-4977
R36	3.32k	Metal Film		1	20-4976
R37	180 (AOT)	Carbon Film	$\frac{1}{4}$	5	20-2181
R38	1k	Metal Film		0.1	20-4883
R39	121	Metal Film		1	20-4967
R40	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R41	330	Carbon Film	$\frac{1}{4}$	5	20-2331
R42	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R43	1.2k	Carbon Film	$\frac{1}{4}$	5	20-2122
R44	39k	Carbon Film	$\frac{1}{4}$	5	20-2393
R45	1M	Carbon Film	$\frac{1}{4}$	5	20-2105
R46	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R47	33k	Carbon Film	$\frac{1}{4}$	5	20-2333
R48	20.3k	Metal Film		0.25	20-4934
R49	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R50	10k	Carbon Film	$\frac{1}{4}$	5	20-2103
R51	47k	Carbon Film	$\frac{1}{4}$	5	20-2473
R52	20.3k	Metal Film		0.25	20-4934
R53	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R54	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R55	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R56	1k	Carbon Film	$\frac{1}{4}$	5	20-2102
R57	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R58	220	Carbon Film	$\frac{1}{4}$	5	20-2221
R59	150k	Carbon Film	$\frac{1}{4}$	5	20-2154
R60	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R61	100k	Carbon Film	$\frac{1}{4}$	5	20-2104
R62	379	Metal Film		0.1	20-4969
R63	118	Metal Film		0.1	20-4966
R64	48.7k	Metal Film		0.5	20-4891
R65	48.7k	Metal Film		0.5	20-4891

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R66	2.4k	Carbon Film	$\frac{1}{4}$	5	20-2242
R67	2.4k	Carbon Film	$\frac{1}{4}$	5	20-2242
R68	68k	Carbon Film	$\frac{1}{4}$	5	20-2683
R69	48.7k	Metal Film		0.5	20-4891
R70	48.7k	Metal Film		0.5	20-4891
R71	1k	Metal Film		1	20-4973
R72	1M	Metal Film		0.5	20-4965
R73	50k	Variable			20-7060
R74	121k	Metal Film		1	20-4979
R75	1k	Metal Film		1	20-4973
R76	121k	Metal Film		1	20-4979
R77	100k	Metal Film		1	20-4942
R78	100k	Metal Film		1	20-4942
R79	330k	Carbon Film	$\frac{1}{4}$	5	20-2334
R80	220k	Carbon Film	$\frac{1}{4}$	5	20-2224
R81	680	Carbon Film	$\frac{1}{4}$	5	20-2681
R82	2k	Variable			20-7059
R83	8.25k	Metal Film		1	20-4978
R84	8.25k	Metal Film		1	20-4978
R85	1.15k	Metal Film		0.1	20-4903
R86	12	Carbon Film	$\frac{1}{4}$	5	20-2120
R87	33	Carbon Film	0.1	5	20-1529
R88	68k	Carbon Film	$\frac{1}{4}$	5	20-2683
R89	68k	Carbon Film	$\frac{1}{4}$	5	20-2683
Capacitors	F		V		
C1	2200μ	Electrolytic	40		21-0581
C2	2200μ	Electrolytic	40		21-0581
C3	2p-10p	Trimmer			21-6022
C4	4.7n	Chip	100	10	21-1736
C5	220n	Polyester	630	20	21-4562
C6	10n	Ceramic	25	+80-20	21-1545
C7	10n	Ceramic	25	+80-20	21-1545
C8	150p	Ceramic	500	5	21-1735
C9	10n	Ceramic	25	+80-20	21-1545
C10	2p-15p	Trimmer			21-6030

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C11	10p	Ceramic	500	10	21-1508
C12	10n	Ceramic	500	20	21-1544
C13	100n	Ceramic	25	+80-20	21-1551
C14	100n	Ceramic	25	+80-20	21-1551
C15	220μ	Tantalum	6.3	20	21-1054
C16	1p	Ceramic	63	10	21-1618
C17	680μ	Tantalum	3	20	21-1053
C18	2.2p	Ceramic	63	¼p	21-1672
C19	100n	Ceramic	25	+80-20	21-1551
C20	47μ	Tantalum	16	20	21-1045
C21	100μ	Tantalum	16	20	21-1050
C22	1n	Ceramic	500	20	21-1532
C23	100n	Ceramic	25	+80-20	21-1551
C24	220μ	Tantalum	3	20	21-1046
C25	1p	Ceramic	63	10	21-1618
C26	1n	Ceramic	500	20	21-1532
C27	100μ	Tantalum	16	20	21-1050
C28	1p	Ceramic	63	10	21-1618
C29	220μ	Tantalum	3	20	21-1046
C30	1p	Ceramic	63	10	21-1618
C31	22μ	Electrolytic	63		21-1657
C32	1n	Ceramic	500	20	21-1532
C33	4.7μ	Tantalum	35	20	21-1006
C34	10p-115p	Trimmer			21-6033
C35	100μ	Tantalum	16	20	21-1050
C36	1μ	Tantalum	35	20	21-1041
C37	100n	Ceramic	25	+80-20	21-1551
C38	1n	Ceramic	500	20	21-1532
C39	1n	Ceramic	500	20	21-1532
C40	1n	Ceramic	500	20	21-1532
C41	100n	Polyester	100	20	21-4506
C42	1μ	Polyester	100	20	21-4512
C43	47n	Ceramic	12	+80-20	21-1548
C44	33p	Ceramic	500	10	21-1514
C45	100n	Ceramic	25	+80-20	21-1551

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C46	22μ	Electrolytic	63		21-0657
C47	10n	Ceramic	25	+80-20	21-1545
C48	10n	Ceramic	25	+80-20	21-1545
C49	1μ	Polyester	100	20	21-4512
C50	120p	Ceramic	500	10	21-1521
C51	1.5μ	Tantalum	35	20	21-1029
<u>Diodes</u>					
D1		Silicon (1N4149)			22-1029
D2		Voltage regulator (BZY88C4V7)			22-1807
D3		Silicon (1N4149)			22-1029
D4		Silicon (1N4149)			22-1029
D5		Silicon (1N4149)			22-1029
D6		Silicon (1N4149)			22-1029
D7		Silicon (1N4149)			22-1029
D8		Hot carrier (5082.2811)			22-1033
D9		Hot carrier (5082.2811)			22-1033
D10		Voltage regulator (BZY88C12)			22-1817
<u>Transistors</u>					
Q1		BC109			22-6041
Q2		BC109			22-6041
Q3		2N2369			22-6017
Q4		2N2369			22-6017
Q5		BFW10			22-6092
Q6		BCY71			22-6038
Q7		J105			22-6154
Q8		BFW10			22-6092
Q9		BFW10			22-6092
Q10		BFW10			22-6092
Q11		BFW10			22-6092
<u>Integrated Circuits</u>					
IC1		H11F1) Matched pair			22-7105
IC2		H11F1)			
IC3		LM340T-15			22-4264
IC4		7915			22-4209
IC5		CA3046			22-4213

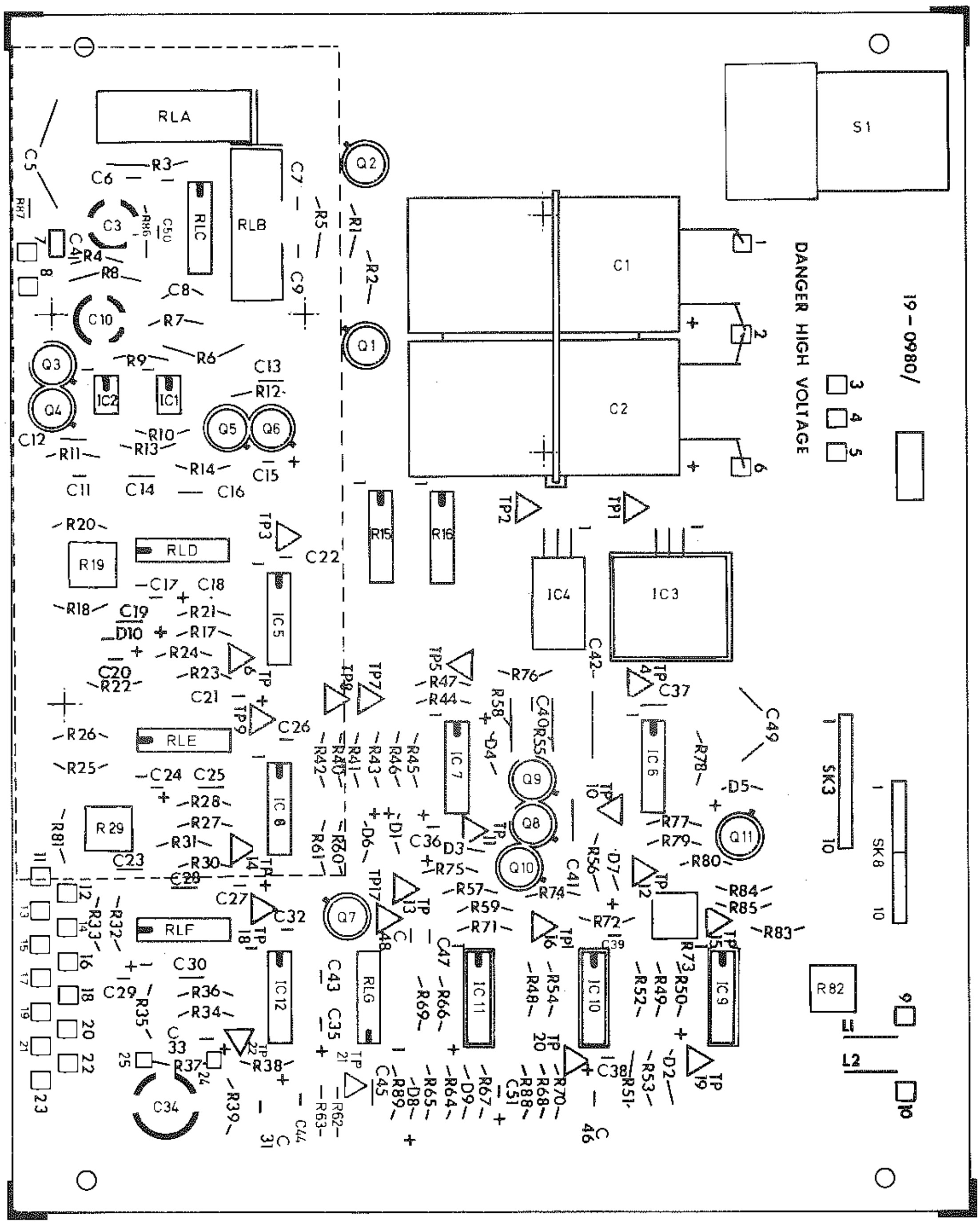
Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
IC6		TL084			22-4243
IC7		TL084			22-4243
IC8		CA3046			22-4213
IC9		CA3046 (specially selected)			22-4246
IC10		CA3046 (specially selected)			22-4246
IC11		CA3046 (specially selected)			22-4246
IC12		CA3046			22-4213
Relays					
RLA		DIL reed relay, SP (NO)			23-7520
RLB		DIL reed relay, SP (NO)			23-7520
RLC		DIL reed relay, SP (NO)			23-7521
RLD		DIL reed relay, SP (CO)			23-7522
RLE		DIL reed relay, SP (CO)			23-7522
RLF		DIL reed relay, SP (CO)			23-7522
RLG		DIL reed relay, SP (CO)			23-7522
Inductors	H				
L1	47μ	Choke, sub-miniature			23-7018
L2	47μ	Choke, sub-miniature			23-7018

PARTS LIST

REMOTE CONTROL OPTION 11-1435

Fig. 3 and Fig. 4

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
REMOTE CONTROL INTERFACE ASSEMBLY 19-1003					
Resistors Ω					
R1	7x1k	DIL Array			20-5508
R2	7x1.2k	DIL Array			20-5519
Inductors H					
L1	47μ	Choke			23-7018
L2	47μ	Choke			23-7018
Diodes					
D1		Silicon (IN4149)			22-1029
D2		Silicon (IN4149)			22-1029
D3		Silicon (IN4149)			22-1029
D4		Silicon (IN4149)			22-1029
D5		Silicon (IN4149)			22-1029
Integrated Circuits					
IC1		TIL113			22-7100
IC2		TIL113			22-7100
IC3		TIL113			22-7100
IC4		TIL113			22-7100
IC5		TIL113			22-7100
CABLE ASSEMBLY 10-2692					
		Cable 50Ω			25-2003
		Toroidal ferrite core			23-8032
CONNECTORS					
		Socket, BNC			23-3198
		Plug, 9-way			23-3215
		Solid strap base assembly for 23-3215			23-3217
		Socket to mate with 23-3215			23-3214
		Shell for 23-3214			23-3216
		Flexible connector			25-6033



Component Layout:
Motherboard Assembly 19-0980

Fig. 1

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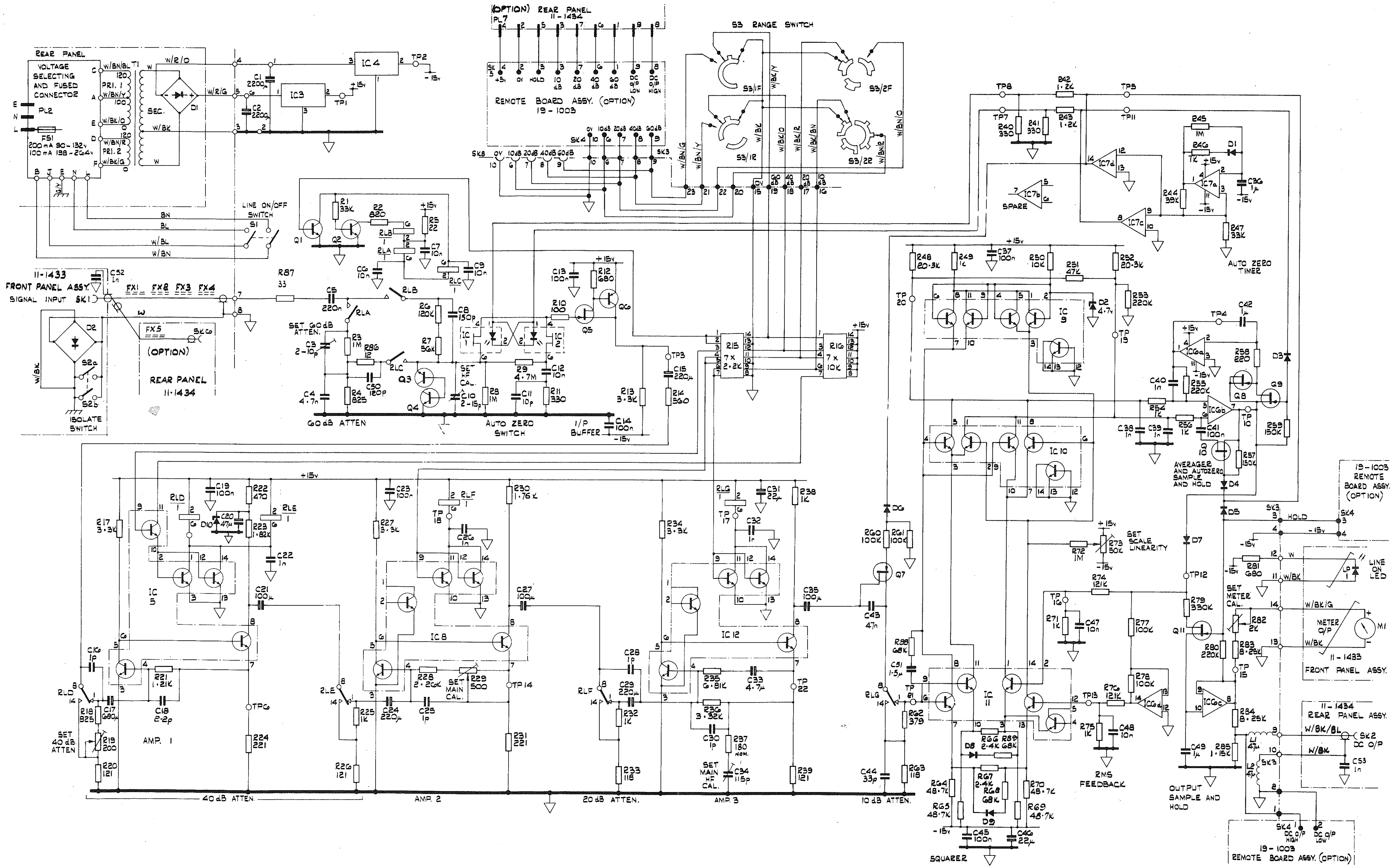

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TH 2021
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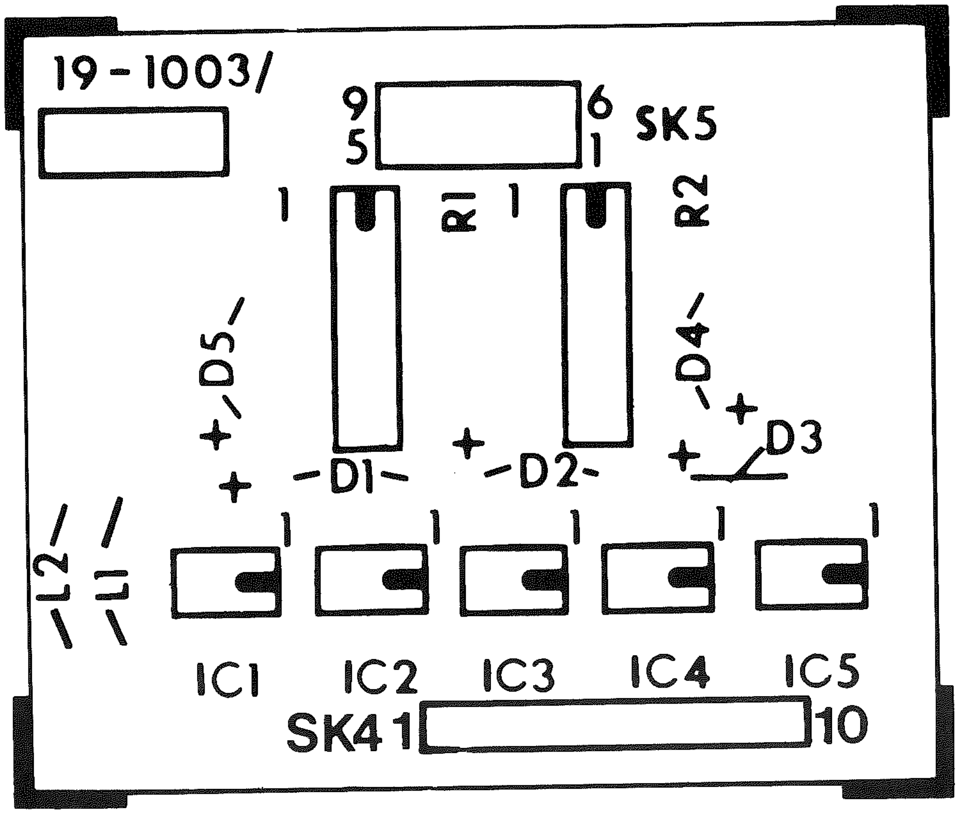
Overall Circuit: 9300 Fig.2



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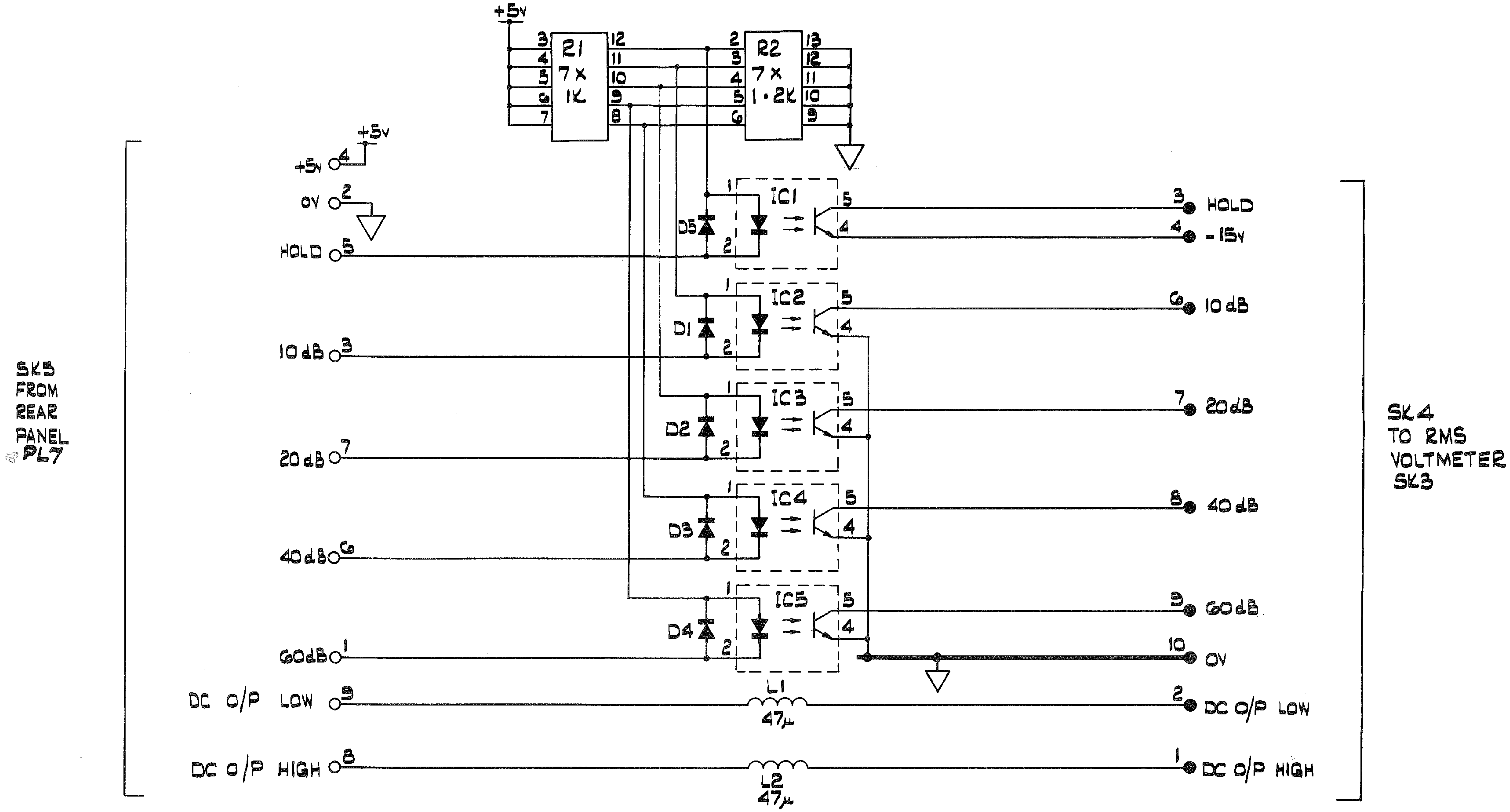
Component Layout :
Remote Control Interface 19-1003

Fig. 3



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Circuit Diagram : Remote Control Interface 19-1003

Fig. 4