

True RMS Voltmeter

9300

Operators Handbook

RACAL

The Electronics Group

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9300

TRUE RMS VOLTMETER

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True RMS Voltmeter 9300

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TECHNICAL SPECIFICATION

1. OPERATIONAL MODE

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

2. ELECTRICAL CHARACTERISTICS

Measurement Range: 30 μ V to 316V in 14 half-decade, switchable ranges.

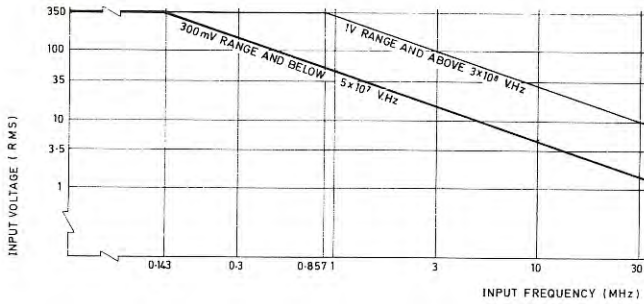
Frequency Range: 5 Hz to 20 MHz.

Input Impedance: 1V range and above: 1 M Ω in parallel with approximately 30 pF.
300mV range and below: 1 M Ω 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 0.5V. The maximum current between the common terminal and chassis earth must not exceed 5A.
A switch is provided to allow the common terminal to be held at chassis earth.

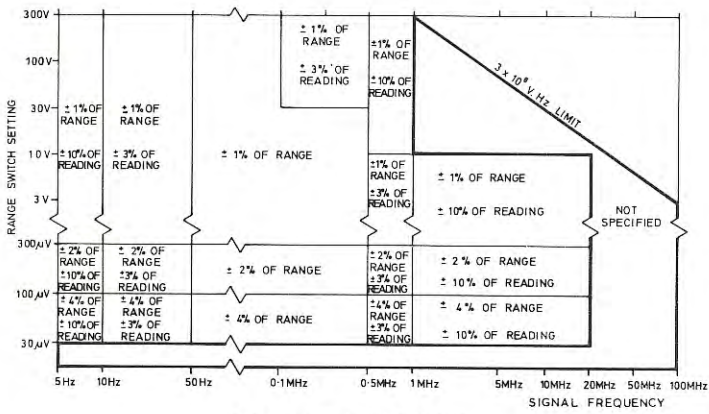
Maximum Permitted Input Levels: The d.c. level + peak signal level must not exceed 500V on any range. The maximum r.m.s. input must not exceed the values indicated in Fig. 1.

Accuracy: Fig. 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 temperature range from 18°C to 28°C. At the break points the better figures apply.



Maximum RMS Input Levels

Fig. 1



Accuracy of DC Output

Fig. 2

14 1534

Temperature Coefficient:	An additional error of 0.04% of range per °C must be added to the figures obtained from Fig. 2 when the instrument is operated in an environment outside the temperature range from 18°C to 28°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. 2. 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 10µV.
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% of 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:	1V corresponds to an input signal level giving a scale reading of 1 or 3.16 according to the scale is use.
Output Impedance:	1 k Ω \pm 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 0.5V. The maximum current between the common terminal and chassis earth must not exceed 5A.

3. MECHANICAL CHARACTERISTICS

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

4. POWER SUPPLIES

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

5. ENVIRONMENTAL SPECIFICATION

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

6. ACCESSORIES PROVIDED

Power Lead: Part number 23-3227
Fuse for 90/132V 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 -15V and +0.8V
Logic '1' between +2.4V and +15V

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 30 μ V r.m.s.
2. The equipment is light and portable. It operates from a.c. supplies in the ranges 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 ± 0.5 V. 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 measurement 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. For customers wishing to carry out their own servicing a comprehensive maintenance manual is available from Racal-Dana Instruments Ltd. at the address on the title page of this manual. When ordering the serial number of the instrument should be quoted.

CHAPTER 2

DESCRIPTION OF CONTROLS

INDICATORS AND CONNECTORS

1. FRONT PANEL ITEMS

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	<p>A taut band meter, providing an analogue indication of the r.m.s. value of the measured signal. The meter has three scales.</p> <p>Two voltage scales (black) are provided, numbered to agree with the voltage markings of the range selection switch.</p> <p>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.</p>
RANGE Switch	<p>This allows selection of one of the 14 half octave ranges or the remote control mode.</p> <p>If the REMOTE position is selected when the remote control interface option is not fitted the instrument will be switched to the 300V range.</p>
ISOLATE Switch:	<p>This switch is open in the ISOLATE position, when the INPUT and DC OUTPUT BNC socket shells (common line) are isolated from chassis earth.</p> <p>When the switch is closed the common line is connected to chassis earth.</p> <p>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.</p>

INPUT Socket:

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

- 1) $1\text{ M}\Omega$ in parallel with 30 pF for the 1 V range and above.
- 2) $1\text{ M}\Omega$ in parallel with 40 pF for the 300 mV range and below.

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

NOTE: When the remote interface option is fitted, high frequency signals to be 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 .

2. REAR PANEL ITEMS

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. The 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 proportional 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

PREPARATION FOR USE

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.

	<u>European</u>	<u>American</u>
Line	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 5mm).
- (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.
- (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 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 included in the Racal-Dana kit 11-1435, which can be supplied for fitting by the customer.

TABLE 2

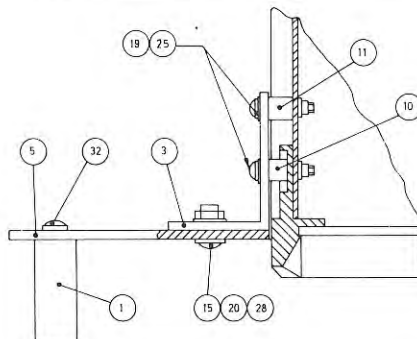
Control Line Coding

RANGE	PIN NUMBER			
	1	6	7	3
100 μ V	0	0	0	0
300 μ V	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 Taptite 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.3

CHAPTER 4

OPERATING INSTRUCTIONS

INTRODUCTION

1. Prepare the instrument for use as explained in Chapter 3. If the instrument is being used for the first time, or at a new location, pay particular attention to the setting of the a.c. supply voltage range.
2. 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

3. 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.
4. 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. 0dBm represents a level of 0.775V r.m.s.
5. 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 SIGNAL

6. 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 $1M\Omega$ 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.

7. If the remote control interface is not fitted, or if the REMOTE INPUT socket has not been connected (see Chapter 3 paragraph 9 (6)) the signal to be measured is connected at the front panel INPUT socket. The input impedance is $1M\Omega$ 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

8. 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 $\pm 0.5V$.

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

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

TRUE RMS VOLTMETER 9300

OPERATORS HANDBOOK

AMENDMENTS

The following amendments are necessary to the 9300 Vol. 1 Operators Handbook to render it suitable for use with the 9300B version of the instrument.

PAGE TECH. SPEC. 4

Para 3, Dimensions - amend Depth '268mm' to '320mm'.

PAGE TECH. SPEC. 5

Para 7, Rigid Case - amend Part No. '15-0450' to '15-0747'.
Padded Case - amend Part No. '15-0444' to '15-0746'.
Rack Mounting - amend Part No. '11-1126' to '11-1704'.
Add new item - 'Handle Option Kit, Part No. 11-1730'.

PAGE 1 - 1

Para 1 - add suffix 'B' to 9300 (1 position).

PAGE 1 - 2

Para 7 - add suffix 'B' to 9300 (1 position).

PAGE 2 - 3

Line Voltage Selector - amend 'the clear plastic cover' to read 'a window in the cover'.

PAGE 3 - 2

Para 5 - add suffix 'B' to 9300 (2 positions).
Para 6(2) - amend text to read 'Remove rear bezel which is held by 2 screws'.

June 1985

PAGE 3 - 3

Para 6(3)

(4)

(5)

- amend text to read 'Ease top cover to rear of instrument and remove'.
- amend text to read 'The bottom cover can now be withdrawn rearwards and removed'.
- amend text to read 'When replacing covers ensure that the front edges locate fully inside front bezel rim'.

PAGE 3 - 6

Remove existing Page 3 - 6 and insert new Page 3 - 6.

PAGE REFERENCES

Amend all page references to read '9300B Vol. 1'.

RECORDING

Insert this amendment sheet at the rear of the Handbook for record purposes.

FITTING RACK MOUNTING KIT (OPTION) TYPE 11-1704

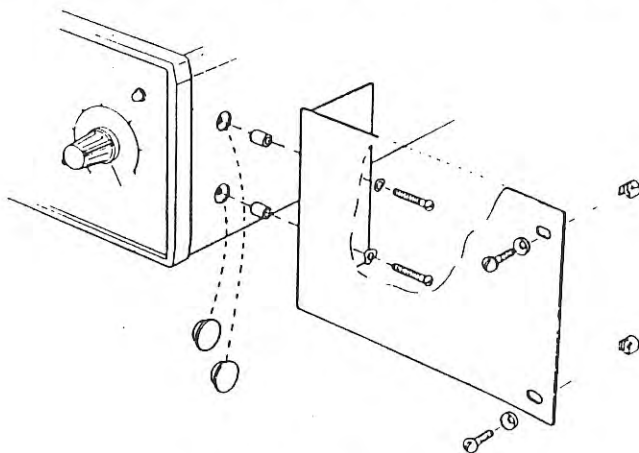
The kit comprises:

Rack Mounting ear extension	2	16-0645
M6 Captive Nut	4	24-2240
Washer Crinkle M4	4	24-2802
Washer Special M6	4	24-2809
Spacers 5mm Long	4	24-4112
Screw M4 x 16 Pan. Hd.	4	24-7733
Screw M6 x 16 Pan. Hd. Chrome	4	24-7995

Assemble the kit to the instrument as follows:-

- (1) Disconnect the AC power cord from rear panel.
- (2) Remove 4 rubber bungs from sides of instrument (2 each side)
- (3) Fit one Ear Extension to each side of the instrument using the four spacers, four Washers (24-2802), and four Screws (24-7733).
- (4) Insert the instrument into the Rack and secure the Extension ends to the Rack, using four Chrome Screws (24-7995), four Washers (24-2809) and four Captive Nuts (24-2240).

Note: Support for the rear of the instrument is not required.



Rack Mounting 11-1704 Fig. 3