Instruction Manual

No. EB 2502

for

R.F. Power Meter TF 2502

mi Technical Publications

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

R.P. 1c
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EB 2502
1b - 11/74

Contents

Chapter 1

General information

1.1 INTRODUCTION

TF 2502 is a 50 Ω absorption power meter for measurements from d.c. to 1 GHz in ranges of 3 W and 10 W full-scale. It is one of a series of similar instruments having different power ranges.

The design is based on thin-film and microwave techniques and employs a thermocouple detector in series with a terminating load. Incident power is sampled by the detector and the resultant e.m.f. is displayed on a meter calibrated in terms of total incident power. This method gives a reading of true mean power irrespective of waveform and makes the instrument particularly suitable for measuring the output of a.m. or pulse transmitters. A socket is provided to allow the demodulated signal to be monitored on headphones or an oscilloscope.

The disadvantage of the long time constant inherent in a thermocouple meter is overcome by the provision of an auxiliary fast response diode detector with a separate small meter. This allows you to quickly tune a source under test for maximum output before measuring its power level on the main meter.

Fig. 1.1

R.F. Power Meter TF 2502

The instrument consists of three separable items - a detector unit, a monitor unit and a terminating load - and requires neither batteries nor mains supply.

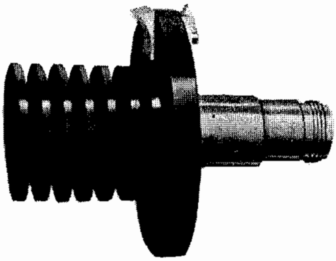

Fig. 1.2 Terminating Load TM 8544

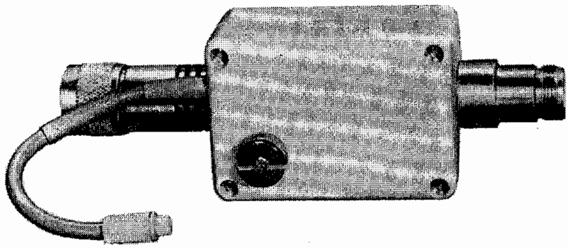

Fig. 1.3 Detector Unit TM 8723/2

1.2 DATA SUMMARY

Frequency range:	D. C. to 1 GHz.
Power ranges:	3 W and 10 W full-scale.
Accuracy:	±5% of full-scale.
Input impedance:	50 Ω via type N socket.
V. S. W. R.:	Better than 1.1:1.
Overload capacity:	20% continuously. Up to 50% for periods up to 30 s.
Detector characteristics:	(1) Calibrated thermocouple giving an approximately linear power scale. (2) Uncalibrated fast response diode detector operating down to 5 MHz.
Output facility:	Jack provided for monitoring modulation.
Temperature range:	+10 °C to +35 °C.

Dimensions and weight:	*Height*	*Width*	*Depth*	*Weight*
	5 1/8 in	8 5/8 in	4 3/4 in	3 lb
	(130 mm)	(219 mm)	(121 mm)	(1.4 kg)

1.3 ACCESSORIES

Supplied

Type N free plug, M.I. code 23443-708; for r.f. input.

Telephone plug, M.I. code 23421-610; for modulation output.

Knurled retaining ring, M.I. code 33265-309R, for securing r.f. input connector during transit.

Chapter 2

Operation

2.1 GENERAL

The power meter has dual readout facilities - a large meter directly calibrated in mean power and a small meter with an arbitrary calibration for use as a fast response tuning indicator.

2.2 CONTROLS

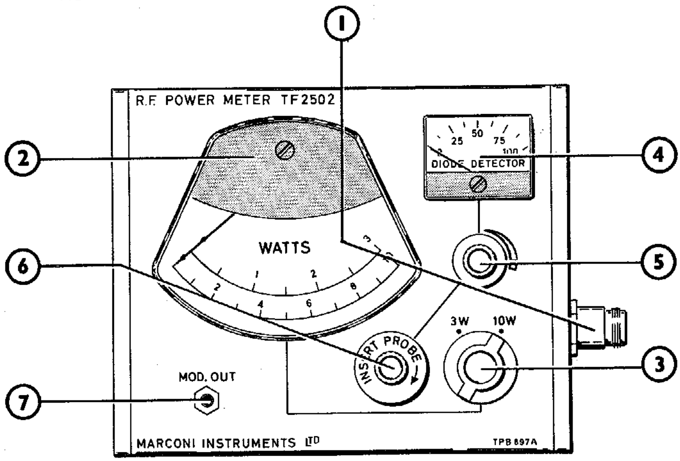

Fig. 2.1 Layout of controls

(1) Type N input socket accepts inputs up to 60 V peak.

(2) Thermocouple meter shows mean power in 50 Ω load. Near linear scales of 0 to 3 W and 0 to 10 W are selected by Range switch.

(3) Power range switch selects 3 W or 10 W full-scale on WATTS meter.

(4) DIODE DETECTOR meter provides fast response tuning indication for the source under test. Operates down to 5 MHz. Scale arbitrarily engraved from 0 to 100.

(5) Sensitivity control adjusts the gain of the diode detector. The crescent symbol indicates that sensitivity increases clockwise.

(6) INSERT PROBE control adjusts the input to the diode detector.

(7) MOD OUT jack accepts 2-pole telephone plug for connection to oscilloscope or high impedance headphones to monitor amplitude modulation.

2.3 CONNECTIONS

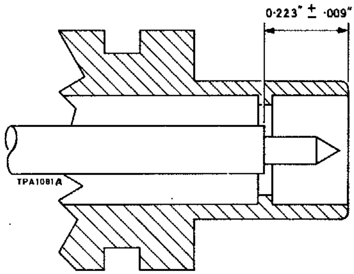

Fig. 2.2 Cross section of type N connector (male) showing critical dimension

A knurled retaining ring is fitted to the type N connector to prevent movement of the detector unit during transit. Before using the power meter, unscrew this ring and pull off the plastic cap from the connector. Keep both these items for re-use if the instrument has to be transported.

CAUTION When making connection to the input socket it is important to use the free type N connector supplied as an accessory. If another type N connector is used then it is essential to ensure good reliable mating. To achieve this the inner contact depth, i.e. the distance from the shoulder on the pin to the interface as shown in Fig. 2.2, must be 0.223 in ±0.009 in (5.92 mm ±0.23 mm) conforming to US Spec. MIL-C-71B.

Type numbers of coaxial cables suitable for use with the plug are as follows:

United Kingdom:	Amphenol No. 82-312 Joint Services 5935-99-943-4155.
United States:	Military No. UG-1185/U.

NOTE: To prevent accidental interchange of parts with those of other instruments in the series, the following items of the R. F. Power Meter TF 2502 are colour coded YELLOW. In addition identification labels, bearing the same serial number, are fitted on each of the units which make up the complete instrument.

(a) The plastic cover of the detector unit.

(b) The catch on the terminating load.

(c) The plug and socket of the cable joining the detector unit and the monitor.

2.4 MEASUREMENT PRECAUTIONS

When making a measurement, the following points should be borne in mind:

1) Ideally, the impedance presented by the power meter to a transmitter under test should be purely resistive. In practice, the power meter impedance will, inevitably, include a small reactive component which will be reflected back into the transmitter tuned output circuit, partially detuning it. In order to obtain a true measure of the power output capabilities of a transmitter, its output stage should always be tuned to produce maximum indication on the power meter.

2) In circumstances where the power meter is required for use merely as a terminating device, it is better to make connection directly to the terminating load as this presents a particularly high quality resistive termination having a v. s. w. r. of about 1.04. To remove the load for this purpose see Sect. 2.6.

3) Because of the time lag in thermocouple heating, and the low resistance of the meter circuit, wait a few seconds before reading the power.

4) The peak voltage that can be applied to the power meter is limited by the in-line detector insulation; this is rated to withstand 60 V peak, which exceeds the peak voltage of a 100% sine wave amplitude modulated signal of 10 W mean power.

5) In the event of long-term storage in conditions of extreme humidity, check 50 Hz calibration before use (refer to Sect. 5.4). If necessary, dry out by placing the power meter in an oven (+50 ^{o}C to +70 ^{o}C) for at least one hour.

2.5 MAKING POWER MEASUREMENTS

To make a power measurement proceed as follows:

1) Set the Range switch to suit the expected power level of the source. If this is unknown, use the 10 W position as a precaution.

2) Turn the INSERT PROBE and Sensitivity controls fully counter-clockwise.

3) Connect the source under test to the Input socket and note the reading on the DETECTOR meter. Bring this reading to about half scale by turning up the Sensitivity control. If this is insufficient, turn the INSERT PROBE control clockwise.

NOTE: If the probe is inserted too far, the v. s. w. r. of the instrument may increase. Do not insert it until the Sensitivity control is at maximum.

4) Tune the source under test for maximum reading on the DETECTOR meter.

5) If the probe was inserted in (3) above, turn the INSERT PROBE control back to its fully counter-clockwise position. Then read the power of the source on the WATTS meter.

2.6 REMOTE OPERATION

If the power meter has to be connected directly to the power source it may be inconvenient to read or operate the instrument. If so, it may be better to use it with the detector unit and load detached from the monitor unit.

To do this, pull out the INSERT PROBE knob to disengage the dog clutch, depress the catch on the terminating load and withdraw the load and detector assembly as far as the interconnecting lead will allow.

Operation is the same as in Sect. 2.5 except that probe insertion is controlled directly by the slotted knob on the detector unit.

2.7 DETERMINATION OF MODULATION DEPTH

The depth of amplitude modulation of an r.f. signal having a sinusoidal envelope can be determined as follows:

1) Measure the output power of the source under test with the signal unmodulated. Let this reading be P_c watts.

2) Modulate the signal and again measure the output power. Let this reading be P_m watts.

3) Calculate the modulation depth. This can be evaluated since P_c, P_m, and the % modulation, m, are related by

$$P_m = P_c \left(1 + \frac{m^2}{2}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Transposing and simplifying, equation (1) gives

$$m = \sqrt{\frac{2\ (P_m - P_c)}{P_c}} \times 100\% \ \ldots\ldots\ (2)$$

Example: From measurements, it is found that $P_c = 1.1$ W and $P_m = 1.5$ W

Hence from equation (2)

$$m = \sqrt{\frac{2\ (1.5 - 1.1)}{1.1}} \times 100\%$$

$$= 85.5\%$$

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	**0**	1·0	1·0
·9886	·9772	**·1**	1·012	1·023
·9772	·9550	**·2**	1·023	1·047
·9661	·9333	**·3**	1·035	1·072
·9550	·9120	**·4**	1·047	1·096
·9441	·8913	**·5**	1·059	1·122
·9333	·8710	**·6**	1·072	1·148
·9226	·8511	**·7**	1·084	1·175
·9120	·8318	**·8**	1·096	1·202
·9016	·8128	**·9**	1·109	1·230
·8913	·7943	**1·0**	1·122	1·259
·8710	·7586	**1·2**	1·148	1·318
·8511	·7244	**1·4**	1·175	1·380
·8318	·6918	**1·6**	1·202	1·445
·8128	·6607	**1·8**	1·230	1·514
·7943	·6310	**2·0**	1·259	1·585
·7762	·6026	**2·2**	1·288	1·660
·7586	·5754	**2·4**	1·318	1·738
·7413	·5495	**2·6**	1·349	1·820
·7244	·5248	**2·8**	1·380	1·905
·7079	·5012	**3·0**	1·413	1·995
·6683	·4467	**3·5**	1·496	2·239
·6310	·3981	**4·0**	1·585	2·512
·5957	·3548	**4·5**	1·679	2·818
·5623	·3162	**5·0**	1·778	3·162
·5309	·2818	**5·5**	1·884	3·548
·5012	·2512	**6**	1·995	3·981
·4467	·1995	**7**	2·239	5·012
·3981	·1585	**8**	2·512	6·310
·3548	·1259	**9**	2·818	7·943
·3162	·1000	**10**	3·162	10·000
·2818	·07943	**11**	3·548	12·59
·2512	·06310	**12**	3·981	15·85
·2239	·05012	**13**	4·467	19·95
·1995	·03981	**14**	5·012	25·12
·1778	·03162	**15**	5·623	31·62

DECIBEL CONVERSION TABLE (continued)

Ratio Down			*Ratio Up*	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	$6·310 \times 10^{-3}$	**22**	12·59	158·5
·06310	$3·981 \times 10^{-3}$	**24**	15·85	251·2
·05012	$2·512 \times 10^{-3}$	**26**	19·95	398·1
·03981	$1·585 \times 10^{-3}$	**28**	25·12	631·0
·03162	$1·000 \times 10^{-3}$	**30**	31·62	1,000
·02512	$6·310 \times 10^{-4}$	**32**	39·81	$1·585 \times 10^{3}$
·01995	$3·981 \times 10^{-4}$	**34**	50·12	$2·512 \times 10^{3}$
·01585	$2·512 \times 10^{-4}$	**36**	63·10	$3·981 \times 10^{3}$
·01259	$1·585 \times 10^{-4}$	**38**	79·43	$6·310 \times 10^{3}$
·01000	$1·000 \times 10^{-4}$	**40**	100·00	$1·000 \times 10^{4}$
$7·943 \times 10^{-3}$	$6·310 \times 10^{-5}$	**42**	125·9	$1·585 \times 10^{4}$
$6·310 \times 10^{-3}$	$3·981 \times 10^{-5}$	**44**	158·5	$2·512 \times 10^{4}$
$5·012 \times 10^{-3}$	$2·512 \times 10^{-5}$	**46**	199·5	$3·981 \times 10^{4}$
$3·981 \times 10^{-3}$	$1·585 \times 10^{-5}$	**48**	251·2	$6·310 \times 10^{4}$
$3·162 \times 10^{-3}$	$1·000 \times 10^{-5}$	**50**	316·2	$1·000 \times 10^{5}$
$2·512 \times 10^{-3}$	$6·310 \times 10^{-6}$	**52**	398·1	$1·585 \times 10^{5}$
$1·995 \times 10^{-3}$	$3·981 \times 10^{-6}$	**54**	501·2	$2·512 \times 10^{5}$
$1·585 \times 10^{-3}$	$2·512 \times 10^{-6}$	**56**	631·0	$3·981 \times 10^{5}$
$1·259 \times 10^{-3}$	$1·585 \times 10^{-6}$	**58**	794·3	$6·310 \times 10^{5}$
$1·000 \times 10^{-3}$	$1·000 \times 10^{-6}$	**60**	1,000	$1·000 \times 10^{6}$
$5·623 \times 10^{-4}$	$3·162 \times 10^{-7}$	**65**	$1·778 \times 10^{3}$	$3·162 \times 10^{6}$
$3·162 \times 10^{-4}$	$1·000 \times 10^{-7}$	**70**	$3·162 \times 10^{3}$	$1·000 \times 10^{7}$
$1·778 \times 10^{-4}$	$3·162 \times 10^{-8}$	**75**	$5·623 \times 10^{3}$	$3·162 \times 10^{7}$
$1·000 \times 10^{-4}$	$1·000 \times 10^{-8}$	**80**	$1·000 \times 10^{4}$	$1·000 \times 10^{8}$
$5·623 \times 10^{-5}$	$3·162 \times 10^{-9}$	**85**	$1·778 \times 10^{4}$	$3·162 \times 10^{8}$
$3·162 \times 10^{-5}$	$1·000 \times 10^{-9}$	**90**	$3·162 \times 10^{4}$	$1·000 \times 10^{9}$
$1·000 \times 10^{-5}$	$1·000 \times 10^{-10}$	**100**	$1·000 \times 10^{5}$	$1·000 \times 10^{10}$
$3·162 \times 10^{-6}$	$1·000 \times 10^{-11}$	**110**	$3·162 \times 10^{5}$	$1·000 \times 10^{11}$
$1·000 \times 10^{-6}$	$1·000 \times 10^{-12}$	**120**	$1·000 \times 10^{6}$	$1·000 \times 10^{12}$
$3·162 \times 10^{-7}$	$1·000 \times 10^{-13}$	**130**	$3·162 \times 10^{6}$	$1·000 \times 10^{13}$
$1·000 \times 10^{-7}$	$1·000 \times 10^{-14}$	**140**	$1·000 \times 10^{7}$	$1·000 \times 10^{14}$

2502 (1)

Chapter 3

Technical description

3.1 CIRCUIT ANALYSIS

R. F. Power Meter TF 2502 consists of an in-line thermocouple detector, a diode detector and a terminating load as shown in Fig. 3.1.

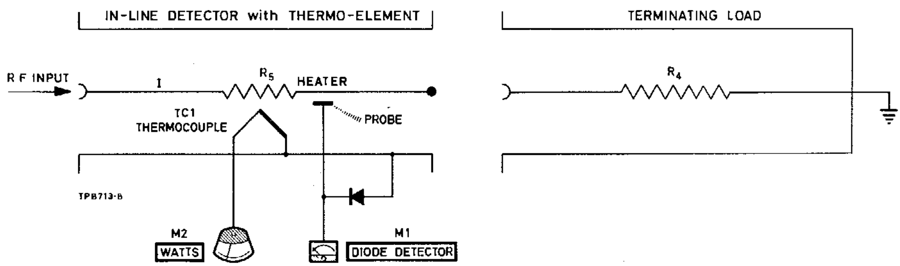

Fig. 3.1 Functional diagram of r.f. power meter

A small percentage of the incident power is absorbed by the heater of the thermocouple and the resultant rise in temperature is monitored by a series of bimetallic junctions, TC1. The thermo-electric e. m. f. thus produced is then measured by a d. c. millivoltmeter, M2, calibrated in terms of total power in watts.

Power applied to the thermo-element produces a current, I, in the heater resistance, R_5, with a resultant heat dissipation of I^2R_5. The thermocouple output voltage is consequently proportional to I^2 since its e. m. f. / temperature response is nearly linear. Hence the detector gives a d. c. output proportional to true mean power, and independent of the waveform of the power.

The input voltage is sampled by a capacitance probe, rectified by diode MR1 and monitored by meter M1 which has an arbitrary 0-100 calibration. Potentiometer RV3 adjusts the sensitivity of the meter. This circuit gives a fast-response indication and also provides a demodulated output at the MOD OUT jack, JKA, for external monitoring.

3.2 DETECTOR UNIT

The thermocouple detector is an in-line type consisting of a modified slab transmission line with a tubular thin-film resistive heater component forming part of the centre conductor. Four series connected thermocouples are mounted close to the heater surface. Beryllia* cement is used in this assembly.

3.3 3 W TERMINATING LOAD TM 8587

The terminating load - see Fig. 1.2 - is a thin-film component with a substrate made of Beryllia*. This has the high thermal conductivity of aluminium combined with excellent dielectric properties of an alumina ceramic. It is housed in a 3 W heat sink.

*See *warning in Sect. 4.2*

Chapter 4

Maintenance

4.1 GENERAL

The circuit diagram shows all the electrical components contained in the instrument. The description of these components - their type, value, rating etc. - is given in Chap. 6, and the layout of components in the monitor unit is shown in Fig. 4.1.

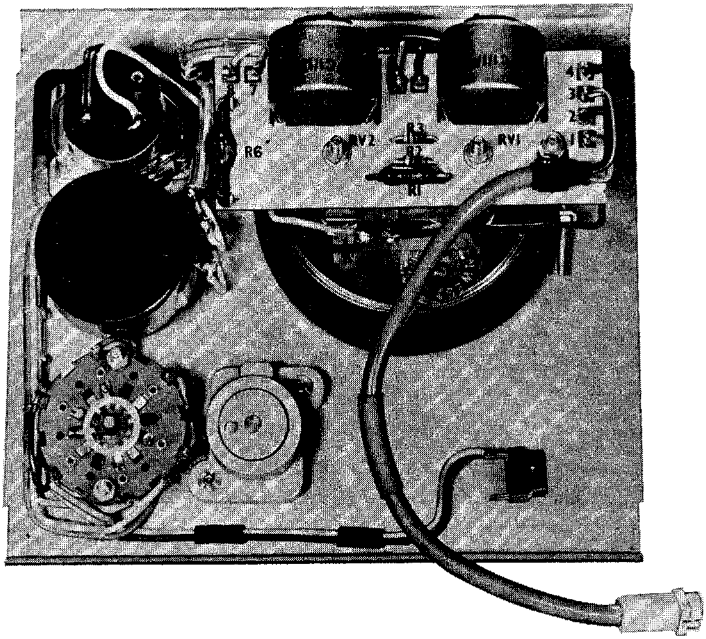

Fig. 4.1 Rear of front panel

Screw fasteners

Screw threads used on this instrument are of the following sizes: 4BA, 6BA and 8BA.

Cruciform head screws are of the Pozidriv pattern; to avoid damaging them a Pozidriv screwdriver should be used.

Chapter 5 Calibration

The following information, based on abstracts from the Company Test Schedule, is intended to enable you to carry out a series of tests by which the main points of performance of the instrument can be checked; it also gives details concerning adjustment to preset components and the choice of value for individually selected components.

5.1 APPARATUS REQUIRED

(a) Resistance bridge, ±1%; e.g. mi type TF 2700.

(b) Signal generator, 400 MHz and 1 GHz, 50 Ω output; e.g. mi types TF 801 and TF 1060.

(c) V.S.W.R. measuring device, 50 Ω characteristic impedance with residual v.s.w.r. of better than 1.01 at 1 GHz.

(d) Variable a.c. source, capable of delivering 10 W; e.g. a Variac.

(e) Dynamometer wattmeter, 0 to 10 W, 0.5%.

5.2 PRELIMINARY CHECKS

(Apparatus required: item a)

NOTE: When carrying out these checks, it is advisable to set the Range switch to 10 W to avoid the possibility of overloading the meter.

1) Connect the terminating load and measure the cold d.c. resistance of the terminating load (R4) between the centre and outer conductors of the socket (SKTB). The resistance should be 49 Ω ±2%.

2) Measure the resistance of the complete power meter (i.e., in-line detector and the terminating load) between the centre conductor of the input socket SKTA and chassis. The resistance should be 53 Ω ±3%.

5.3 STANDING WAVE RATIO

(Apparatus required: items b and c)

For the power meter to act as a good match to a transmission line its v.s.w.r. must be as close to unity as possible. In the TF 2502, v.s.w.r. is a function of the general configuration and spacing of the transmission line, and no provision is made for adjustment. The validity of subsequent calibration steps is dependent on verification of good v.s.w.r. over the full frequency range. During manufacture a sweep frequency method is used to achieve this, but another method can be used if tests are made at a sufficient number of frequencies.

Connect the v.s.w.r. measuring device to the socket on the terminating load and check the v.s.w.r. at a selection of frequencies up to 1 GHz. The v.s.w.r. should be better than 1.05 over the whole frequency range.

With the INSERT PROBE control fully counter-clockwise, connect the v.s.w.r. measuring device to the power meter input socket and check the v.s.w.r. of the combined terminating load and in-line detector at a selection of frequencies up to 1 GHz. The v.s.w.r. should be better than 1.1 over the whole frequency range.

5.4 CALIBRATION ACCURACY AT L.F.

(Apparatus required: items d and e)

The power-reading accuracy is best checked at a low frequency - usually the frequency of the local power supply - and then compared with that of a standardized mean-reading power meter near the upper limit of the frequency range.

1) Connect the dynamometer wattmeter between the a.c. supply and the power meter under test. The current and voltage coil connections should be arranged for minimum error due to internal losses, and allowance should be made for the error if it is appreciable. Owing to the frequency response limitations of dynamometer wattmeters the a.c. supply must have low distortion (less than 1%).

2) Set the Range switch to 10 W and set the power input until the dynamometer indicates the input figure given on the label at the rear of the instrument.

3) Check that the TF 2502 reading is 8 W ±0.5%, if not adjust RV1 until it is correct.

4) Reduce the applied power to zero and allow sufficient time for the thermocouple to cool.

5) Set the Range switch to 3 W and set the power input until the dynamometer indicates the input figure given on the label at the rear of the instrument.

6) Check that the TF 2502 reading is 2.5 W ±0.5%, if not adjust RV2 until it is correct.

5.5 CALIBRATION ACCURACY AT R.F.

Calibration is difficult at r.f. since, unless great care is taken with impedance matching, substantial errors can be introduced. If it is essential to make checks at r.f., then connections should be made with a wide band directional coupler having a directivity of at least 35 dB and the power level monitored with a low level power meter. Such an arrangement must, of course, be calibrated by reference to a standard power meter.

NOTE : If either a terminating load or a detector unit is to be returned to Marconi Instruments for repair or recalibration, it is important to send the complete detector/load assembly. This will enable the item to be recalibrated as an assembly, which will ensure a better performance, e.g. v.s.w.r. and frequency response, than can be obtained by recalibrating the detector and load separately.

Chapter 6

Replaceable parts

Introduction

This chapter lists replacement parts in alphabetical order of their circuit references, with miscellaneous parts at the end of the list. The following abbreviations are used:

C	:	capacitor	RV	:	variable resistor
Carb	:	carbon	S	:	switch
Cer	:	ceramic	SKT	:	socket
CRT	:	cathode ray tube	T	:	transformer
Elec	:	electrolytic	TE	:	total excursion
FS	:	fuse	TH	:	thermistor
ILP	:	illuminating lamp	TP	:	terminal
JK	:	jack	V	:	valve
Log	:	logarithmic law	Var	:	variable or preset
M	:	meter	VT	:	transistor
Met	:	metal	WW	:	wirewound
Min	:	minimum value	X	:	ferrite bead
MR	:	semiconductor diode	†	:	value selected during test
Ox	:	oxide	Ø	:	feed-through component
PL	:	plug	W*	:	watts at 70 °C
Plas	:	plastic	W**	:	watts at 55 °C
PLP	:	pilot lamp	W***	:	watts at 40 °C
R	:	resistor	W°	:	watts at unspecified temperature

Ordering

Send your order for replacement parts to our Service Division at the address given on the back cover. Specify the following information for each part required:

1) Type and serial number of instrument
2) Circuit reference
3) Description
4) M. I. code number

If a part is not listed, state its function, location and description when ordering.

Circuit reference	Description	M.I. code
C1	Cer 10 pF 500 V d.c.	26333-405
C2	Cer 0.001 μF 200 V d.c.	26397-205
C3	Cer 0.001 μF 200 V d.c.	26397-205
C4	Cer 0.001 μF 200 V d.c.	26397-205
C5	Cer 0.001 μF 200 V d.c.	26397-205
JKA	MOD OUT jack	23421-685
M1	DIODE DETECTOR meter, 75 μA	44556-402
M2	WATTS meter, 1 mA, 0-3 W and 0-10 W full scale	44571-030
MR1	Diode CG74H (not replaceable)	28321-321
PLB	Plug type 'N'	23443-702
PLC	Plug miniature 3-pin	23426-808
R1 †	WW 27 Ω ±5% 1½ W*	25123-031
	or 43 Ω ±5% 1½ W*	25123-036
	or 62 Ω ±5% 1½ W*	25123-041
	or 75 Ω ±5% 1½ W*	25123-044
R2	Carb 1 kΩ ±5% 1/10 W*	24331-280
R3	Carb 1 kΩ ±5% 1/10 W*	24331-280
R4	Thin film 49 Ω ±2% 10 W* (special, not replaceable)	31882-013
R5	Thin film 3 Ω ±10% (special, not replaceable)	44312-005
R6	WW 1 Ω ±5% 1½ W*	25123-001
	or 3.3 Ω ±5% 1½ W*	25123-008
	or 6.8 Ω ±5% 1½ W*	25123-014
	or 10 Ω ±5% 1½ W*	25123-020
	or 13 Ω ±5% 1½ W*	25123-023
	or 16 Ω ±5% 1½ W*	25123-025

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
RV1	WW 25 Ω ±10% 1 W	25811-512
RV2	WW 5 Ω ±10% 1 W	25811-505
RV3	Carb 22 kΩ ±20% 2 W*	25645-397
SA	POWER RANGE switch, 2-pole, 2-way	44321-135
SKTA	Socket type 'N'	23443-761
SKTB	Socket type 'N'	23443-761
SKTC	Socket miniature 3-pin	23427-808
TC1	Thermocouple (not replaceable)	44312-003
	10 W Terminating Load TM 8544	44411-016
	Catch } on terminating load	37574-519
	Slide } on terminating load	37574-521
	Spring } on terminating load	31111-422
	Detector Unit TM 8723/2	46838-003
	Chrome knob (fitted on spindle of detector)	33264-107
	Range knob and skirt assembly	41145-203
	Sensitivity knob	41141-201
	INSERT PROBE knob	41141-102
	Diode probe adjuster assembly (complete with spring, dog clutch and knob)	41321-015
	Rubber ring in right-hand side panel aperture	22412-528
	Cableform TM 4726/308 (behind front panel)	43122-076
	Bung (fitted on stretchers of monitor)	37486-113

For symbols and abbreviations see introduction to this chapter

Chapter 7

Circuit diagrams

Circuit notes

1. COMPONENT VALUES

Resistors: No suffix = ohms, k = kilohms, M = megohms.
Capacitors: No suffix = microfarads, p = picofarads.
† value selected during test, nominal value shown.

2. SYMBOLS

—+► arrow indicates clockwise rotation of knob.

⊘ preset component.

—□— (2) printed board tag numbering.

FUNCTION panel marking.

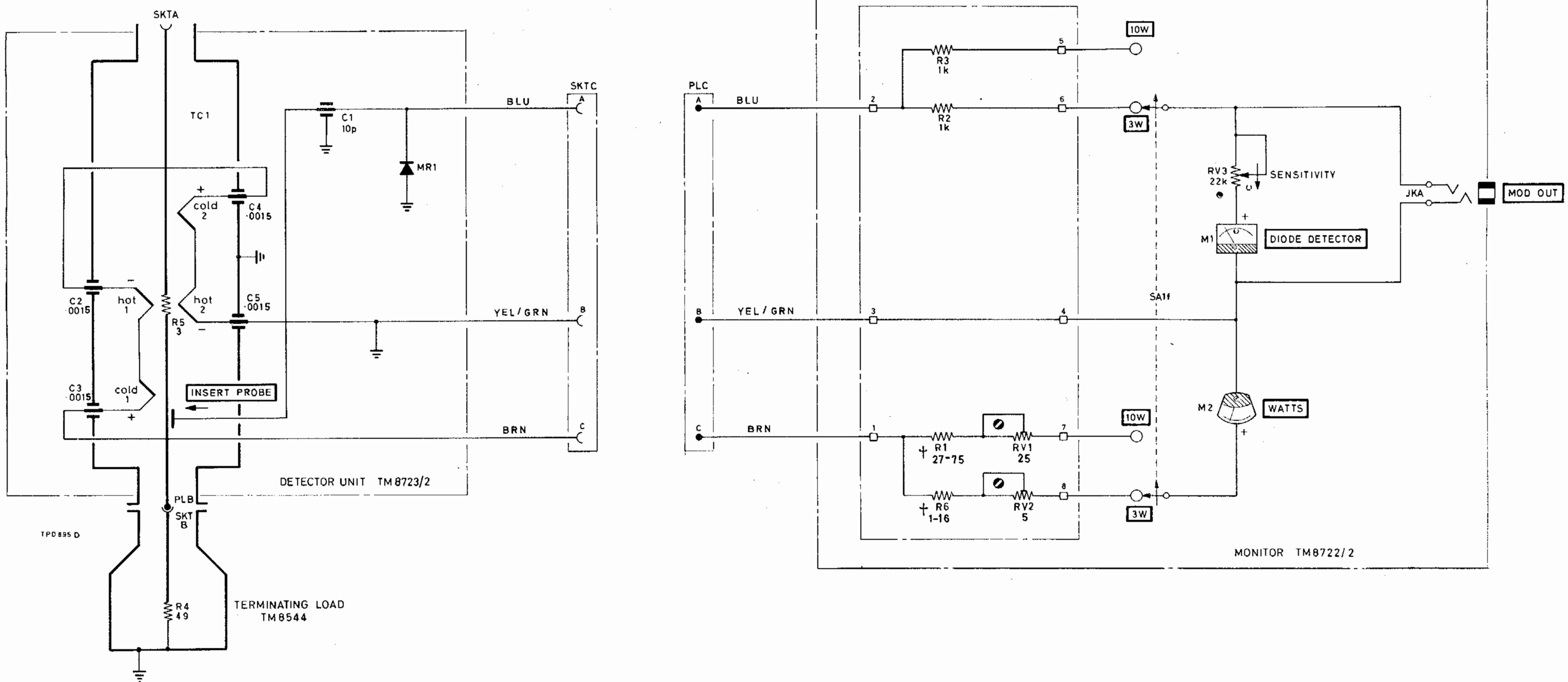

Fig. 7.1 Circuit diagram