

Power Meters Voltmeters



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POWER METERS

Audio Frequency	Frequency Range	Model	Power Range & Impedance	Features	Page
TF 1347	50 c/s to 20 kc/s	TF 1347 A.F. Power Meter	10 μ W to 6 W 2.5 Ω to 20 k Ω	High-discrimination measurement	115
TF 893A	20 c/s to 35 kc/s	TF 893A A.F. Power Meter	20 μ W to 10 W 2.5 Ω to 20 k Ω	Balanced or unbalanced inputs	116
A.F. and R.F.	Frequency Range	Model	Power Range & Impedance	Features	Page
TF 1065 & /1	A.F.: 250 c/s to 10 kc/s R.F.: 50 c/s to 500 Mc/s	TF 1065 & /1 Transmitter and Receiver Output Test Set	A.F.: 0 to 3 W, 3 and 600 Ω R.F.: 0 to 25 W, 50 Ω or 75 Ω	Also measures f.m. deviation and d.c. volts and amps. Transistorized. Internal battery supply	117
R.F.	Frequency Range	Model	Power Range & Impedance	Features	Page
TF 1152A & A/1	D.C. to 500 Mc/s	TF 1152A & A/1 R.F. Power Meter	0.5 to 25 W 50 Ω or 75 Ω	Indicates mean power of c.w., a.m., or pulsed outputs	119
TF 1020A & A/1	D.C. to 250 Mc/s	TF 1020A & A/1 R.F. Power Meter	1 to 100 W 50 Ω or 75 Ω	Indicates mean power of c.w., a.m., or pulsed outputs	120
TF 1020A/2 & A/3		TF 1020A/2 & A/3 R.F. Power Meter	5 to 300 W 50 Ω or 75 Ω	TF 1020A/2 & A/3 are forced-air cooled models	
TF 1205	D.C. to 500 Mc/s	TF 1205 R.F. Power Meter	10 to 500 W 50 Ω	Oil cooled Suitable for pulsed outputs up to 5 kW peak	121
TF 1341	170 to 230 Mc/s	TF 1341 R.F. Power Meter	20 to 1,000 W 50 Ω	Oil cooled Suitable for pulsed outputs up to 1 MW peak	122
U.H.F. and S.H.F.	Frequency Range	Model	Power Range	Features	Page
TF 1202A	500 to 5,000 Mc/s	TF 1202A U.H.F./S.H.F. Power Meter	Basic: 0.05 mW to 5 mW 50 Ω Up to 20 W in selected bands using accessories	Specially designed for multi-channel link measurements	123

VOLTMETERS

Microvoltmeters	Frequency Range	Model	Measurement Range	Features	Page
TF 1375	50 c/s to 1 Mc/s	TF 1375 A.C. Microvoltmeter	5 μ V to 15 V a.c.	Fully transistorized; battery supply Switch selected i.f. rejection	124
Millivoltmeters	Frequency Range	Model	Measurement Range	Features	Page
TF 1100	10 c/s to 10 Mc/s	TF 1100 Sensitive Valve Voltmeter	100 μ V to 300 V a.c.	Can be used as wide-band amplifier	125
TF 1371	30 c/s to 30 Mc/s	TF 1371 Wide-Band Millivoltmeter	100 μ V to 300 mV a.c. $\times 10$ and $\times 100$ multipliers available	High-stability indication	126
TF 899A	50 c/s to 100 Mc/s	TF 899A Valve Millivoltmeter	20 mV to 2 V a.c.	Detected output for modulation monitoring.	127
TF 1262	1 to 500 Mc/s	TF 1262 U.H.F. Millivoltmeter	50 mV to 1 V a.c.	75-ohm coaxial input No power supplies required	128
Voltmeters	Frequency Range	Model	Measurement Range	Features	Page
TF 1300	20 c/s to 300 Mc/s	TF 1300 Vacuum Tube Voltmeter	50 mV to 100 V a.c. 100 mV to 300 V d.c. 50 Ω to 5 M Ω	Economically priced general-purpose instrument	129
TF 1300/1	20 c/s to 200 Mc/s	TF 1300/1 Vacuum Tube Voltmeter		Balanced a.c. probe	
TF 1041B	20 c/s to 1,500 Mc/s	TF 1041B Vacuum Tube Voltmeter	25 mV to 300 V a.c. 10 mV to 1,000 V d.c. 0.02 Ω to 500 M Ω	Inputs isolated from chassis Centre-zero facility Accessories available to extend performance	131
Special Models	Performance	Model	Features	Page	
TF 1377	Measures up to 500 volts d.c. and small changes down to 1 mV in 100 volts	TF 1377 Suppressed-Zero Voltmeter	Combined voltage-measuring potentiometer and differential voltmeter	133	
TF 1325	Measures 0 to 0.999 V d.c. with accuracy of ± 1 mV. Sampling time: 20 msec	TF 1325 Digitizer	Binary coded decimal output Facilities for use in automatic systems	134	

MARCONI
 INSTRUMENTS

6-Watt A.F. Power Meter

Type TF 1347


R6973

- ▶ **Frequency range: 50 c/s to 20 kc/s**
- ▶ **Power range: 10 μ W to 6 W**
- ▶ **Impedance: 2.5 Ω to 20 k Ω in 11 steps**
- ▶ **Direct calibration in watts and dBm**

HERE is a sensitive, accurate power meter for audio measurements over a wide range of impedance. Its frequency characteristic is substantially flat from 50 c/s to 20 kc/s and its ten power ranges and 5½-inch meter provide excellent discrimination.

APPLICATIONS

The TF 1347 is suitable for a wide variety of audio power measurements in the laboratory, production line, or field. Its bottom range of 200 μ W full-scale makes it particularly suitable for low-signal tests, including measurements of noise or quieting in f.m. receivers.

IMPEDANCE AND POWER SELECTION

Functionally, the Power Meter may be considered as a variable attenuator whose input impedance is adjustable in steps and whose output is applied to a voltmeter calibrated in terms of power input to the attenuator.

Subdivided then, the circuit of the instrument consists of three parts providing impedance selection, attenuation, and indication respectively. Impedance is selected by means of a tapped matching transformer which is

connected to the input terminals of the instrument via an eleven-position switch; it is the design of this transformer which largely contributes to the level response of the Power Meter over so wide a frequency range. A ten-step resistive attenuator forms the power range multiplier and presents a constant impedance to the secondary winding of the matching transformer. The attenuator is terminated by the indicator circuit which consists of a moving-coil meter and bridge-connected rectifier; the sensitivity and input impedance of the indicator circuit are standardized by the addition of shunt and series resistors preceding the rectifier.

POWER AND dB CALIBRATION

By means of the multiplier switch and the meter calibration, the output from an audio frequency system may be read directly in units of power. In addition, the multiplier switch positions are marked in 5-dB steps from -5 to +35 dB, and the meter is calibrated from -5 to +3 dB, so that decibel levels relative to 1 mW may be read directly. The lowest range, 10 μ W to 200 μ W, has a separate scale on the meter to which the decibel calibration does not refer.

SPECIFICATION

Range

POWER: 10 μ W to 6 watts in ten ranges. Full-scale deflections: 200 and 600 μ W; 2, 6, 20, 60, 200, and 600 mW; 2 and 6 watts. There is an additional calibration from -10 to +38 dB relative to 1 mW. IMPEDANCE: 2.5 ohms to 20 k Ω in eleven steps: 2.5, 5, 10, 50, 100, 150, 300, and 600 ohms; 4, 8, and 20 k Ω .

Accuracy (at 1 kc/s and 20°C)

POWER: For powers of 200 μ W and greater: $\pm 5\%$ of the reading, from full-scale to half-scale; $\pm 2\frac{1}{2}\%$ of f.s.d., from half-scale to 1/10th full-scale.

For powers of less than 200 μ W: $\pm 10\%$. IMPEDANCE: With the power range switch set to 20 mW: $\pm 3\%$ for impedance selector settings of 50 ohms and greater; $\pm 5\%$ for impedance selector settings of less than 50 ohms.

Frequency characteristic

Measured at 20°C on the 2 mW power range, the frequency characteristic relative to 1 kc/s is flat to within ± 1 dB from 100 c/s to 10 kc/s, and to within ± 2 dB from 50 c/s to 20 kc/s, for all settings of the impedance selector. For the higher settings of the power range switch, the frequency characteristic is improved.

Dimensions and weight

Height	Width	Depth	Weight
11 in	7½ in	6¾ in	9 lb
(28 cm)	(19 cm)	(17 cm)	(4.1 kg)

Marconi Instruments Ltd.
 St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

10-Watt A.F. Power Meter

Type TF 893A


6805

- ▶ Frequency range: 20 c/s to 35 kc/s
- ▶ Power range; 20 μ W to 10 W
- ▶ Impedance: 2.5 ohms to 20 k Ω in 48 steps
- ▶ Balanced or unbalanced inputs
- ▶ Direct calibration in watts and dBm

THIS AUDIO POWER METER covers an exceptionally wide range of power and maintains its accuracy at both very high and very low frequencies.

Power is measured by a temperature-compensated constant-resistance multi-range rectifier voltmeter, the required input impedance being obtained by the use of a tapped transformer and by a switched resistance-changing pad. Provision is made for measuring either balanced or unbalanced inputs.

The instrument is contained in a compact portable case, with the input terminals fitted in a recess in the case top; this protects the terminals from accidental mechanical damage. The lid of the recess may be swung back to support the instrument at a convenient viewing angle, while the sloping front panel hinges upwards for ease of servicing.

APPLICATIONS

The TF 893A is a versatile general-purpose power meter. It is suitable for measurements on audio amplifiers and receivers, transmission, studio and recording apparatus. Output impedance of audio equipment can be

rapidly measured by switching the 48-step impedance selector for maximum power transfer.

IMPEDANCE SELECTION

The Meter measures the power delivered by an audio-frequency source into a load provided by the instrument itself, and its excellence of performance over so wide a range of power, impedance and frequency is due primarily to two important points of design. Firstly, the patented feature—the use of a resistance network, forming an impedance-changing pad, to select the significant figures of the value of the input impedance; secondly, the use, for the decade multiplication of impedance, of a transformer using an English Electric wound-strip core of anisotropic magnetic alloy.

CENTRE-TAPPED INPUT

There are five power measurement ranges, with calibration directly in watts or milliwatts and in decibels relative to 1 mW. The overall impedance range of 2.5 to 20,000 ohms is in forty-eight steps arranged in two groups identified by the use of engraving in contrasting colours. The primary of the input (impedance-matching) transformer is of low d.c. resistance, is isolated from the case and is provided with a centre tap for push-pull working; the centre tap also allows impedances down to 0.625 ohm to be correctly terminated, but with some falling off in measurement accuracy.

SPECIFICATION

Range

POWER: 20 μ W to 10 watts in five ranges. Full-scale deflections are: 1, 10 and 100 mW, 1 and 10 watts.

IMPEDANCE: 2.5 to 20,000 ohms thus:

2.5, 3, 4, 5, 6, 8, } with
 6.25, 7.5, 10, 12.5, 15, 20 } multipliers
 { $\times 1$, $\times 10$,
 { $\times 100$, $\times 1,000$.

Impedances of one-quarter the above—extending the range down to 0.625 ohm—can be obtained by using the input centre tap, but with reduced accuracy.

The impedance of the Power Meter falls when it is connected into a circuit carrying d.c. At 50 c/s, a drop of approximately 5% is produced by 60 mA at the 100-ohm setting or 4 mA at the 20-k Ω setting.

Accuracy (at 1 kc/s and 20°C)

POWER: 2½% of f.s.d. up to half-scale deflection. 5% of the reading from half-scale to full-scale deflection.

IMPEDANCE: 5%.

Frequency characteristic

With all controls at approximately mid-setting the response of a typical Power Meter is, relative to indication at 1 kc/s, flat to within -0.5 dB from 50 c/s to 10 kc/s; at 20 kc/s the response is approx. 1 dB down. At other control settings, the maximum variation from the above is ± 1 dB at 50 c/s and ± 1.5 dB at 20 kc/s. The instrument can be used over the extended frequency range, 20 c/s to 35 kc/s, with reduced accuracy.

Dimensions and weight

Height	Width	Depth	Weight
11 in	7½ in	6¾ in	9 lb
(28 cm)	(19 cm)	(17 cm)	(4.1 kg)

Marconi Instruments Ltd.
St. Albans, Hertfordshire, England

**MARCONI
INSTRUMENTS**

Transmitter and Receiver Output Test Set

**Types TF 1065
and TF 1065/1**


R5107

- ▶ **Comprises r.f. and a.f. power meters, deviation monitor, and d.c. volt/ammeter**
- ▶ **Complete output testing facilities for f.m. and a.m. transmitters and receivers in all mobile bands**
- ▶ **Transistorized: no external power supplies required**

THE TF 1065 is a combined a.f. power meter, r.f. power meter, f.m. deviation indicator, and d.c. volt/ammeter.

APPLICATIONS

It is designed primarily as a companion instrument to the TF 1064 or TF 995 series of Signal Generators. Together, Test Set and Generator provide comprehensive facilities for testing f.m. and a.m. mobile transmitter-receiver equipments; by itself the Test Set is a completely self-contained unit, used for measuring the r.f. output of transmitters and a.f. output of receivers, for indicating the deviation of f.m. signals, and for checking valve feed currents and electrode voltages. Lightweight, compact, and entirely independent of external power supplies, it is ideally suited for measurements in the field.

MEASUREMENT RANGES

As an a.f. power meter, it has a range of 10 μ W to 3 watts—a total coverage of 55 dB.

Measurement can be made either at the normal loud-speaker impedance of 3 ohms or at the standard 600-ohm line impedance.

The r.f. power meter section has an input impedance of 50 ohms and measures up to 25 watts in the frequency range 50 c/s to 500 Mc/s. Between 150 and 185 Mc/s, the power range may be extended to 125 watts by means of an external attenuator, which is available as an optional accessory.

Used in conjunction with TF 1064A, or any other equivalent signal generator, the Test Set gives direct-reading indication of deviation up to 15 kc/s at carrier frequencies up to 500 Mc/s.

A.f. power, r.f. power, and deviation, as well as d.c. voltages and currents, are all indicated on a single multi-scale panel meter.

The TF 1065/1 is an alternative version of the Test Set; it differs from the basic model only in that the input impedance of its r.f. power meter and deviation indicator sections is 75 ohms instead of 50 ohms. An external r.f. attenuator is not available for the TF 1065/1.

A.F. AND R.F. POWER METERS

The a.f. power meter has five 3-ohm and five 600-ohm ranges, each group having full-scale deflection values of 300 μ W, 3 mW, 30 mW, 300 mW, and 3 watts. As well as providing direct power indication, the a.f. power meter facilitates receiver noise measurement. Connection to the a.f. power meter section is made via screw terminals.

The r.f. power meter section employs a heavy-duty high-stability resistor as the dissipative element; this resistor is mounted so as to form the central conductor of a slab or parallel-plate line. The indicating meter is fed, via a silicon diode, from a tap on the load resistor. A Type N coaxial socket is used as the input connector to the r.f. power meter section. The slab-line unit is similar to that employed in the well-known TF 1020A and TF 1152 series of r.f. power meters; it results in an extremely pure input impedance over an exceptionally wide frequency range and possesses inherently rugged mechanical characteristics.

The optional accessory that can be supplied to extend the r.f. power measurement range of the TF 1065 is Attenuator TM 5280. A completely separate unit, it is fitted with Type N 50-ohm connectors to allow insertion between the transmitter under test and the r.f. power inlet on the TF 1065. The Attenuator is intended for use between the frequency limits 150 and 185 Mc/s and over this band its insertion loss remains close to the 7 dB which is necessary to give the required $\times 5$ multiplication of the basic 0- to 25-watt measurement capability of the TF 1065. The dissipative element of the Attenuator consists of an 80-foot length of coaxial cable; this is mounted in a small instrument case fitted with a carrying handle.

DEVIATION INDICATOR

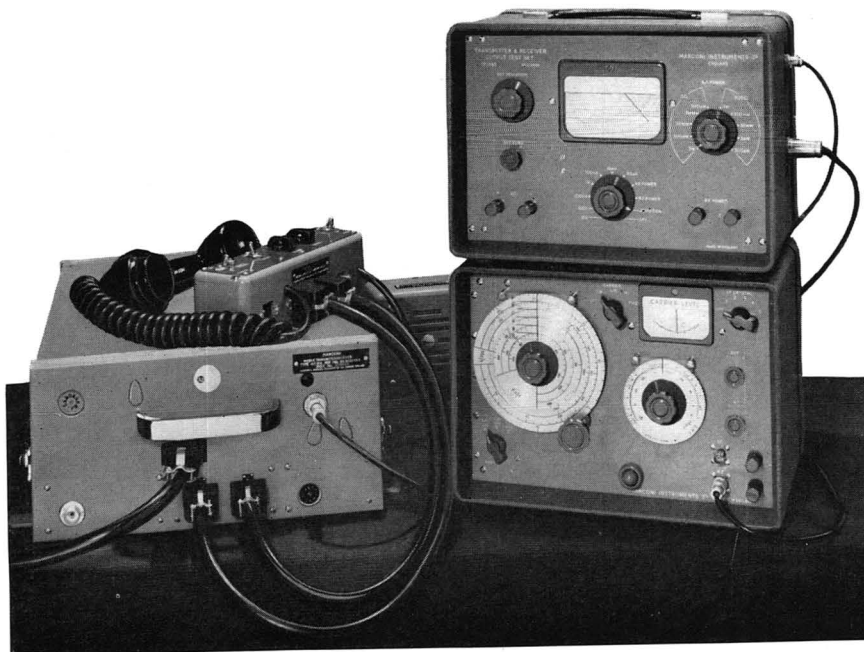
With an f.m. transmitter coupled to the r.f. power input socket, the degree of modula-

tion can be checked by switching the Test Set to DEVIATION. In the deviation monitor a portion of the frequency-modulated r.f. signal obtained from a tapping on the load resistor of the r.f. power meter section is heterodyned to an i.f. centred on 130 kc/s. To avoid circuit complexity, a local oscillator is not included in the Test Set; instead, a separate BNC inlet is provided so that an externally-derived c.w. signal can be fed into the mixer. Whilst Signal Generators of the TF 1064 or TF 995 series are admirably suited to play the temporary role of local oscillator to the deviation monitor, any other suitable signal source can be employed for this purpose. The i.f. signal is applied to a 130-kc/s tuned circuit across which it develops a voltage that varies inversely with the width of deviation. After amplification in a push-pull transistor circuit powered by a mercury battery, the output from the deviation monitor is displayed on the panel meter; for this function, one of the meter scales is calibrated with 5-, 10-, and 15-kc/s points. The use of a transistor amplifier is an important design feature of the Test Set, allowing it to preserve its complete independence from external power supplies. With the low current drain of the transistors a very long battery life can be expected, even under conditions of prolonged intermittent usage.

MULTI-RANGE TEST METER

The basic element of the multi-range test meter section of the Test Set is the 50- μ A panel meter. This can be switched direct to a separate pair of panel terminals for external use. At six other switch settings it is associated with either shunts or multipliers so that full-scale values of 10 mA, 100 mA, 1 amp, 10 volts, 100 volts, or 1,000 volts are obtained.

Supplied as an optional accessory, Probe Unit TM 5302 enables the Test Set to be used as a signal tracer when the multi-range test meter section is switched to its 50- μ A range. The Probe Unit can be used at any frequency between 50 kc/s and 500 Mc/s and within these limits the input required for full-scale deflection varies between 1 volt and 100 mV. The dimensions of the Probe, which contains a silicon diode rectifier, have been kept to a minimum to facilitate use in a confined space. Connection to the point under test is made by means of the tip of the Probe and an earthing clip; the rectified output is fed via a 4-foot cable to the Test Set.



5140

The TF 1065 with its companion Signal Generator, Type TF 1064A, form a compact yet comprehensive test rig for the Marconi V.H.F. F.M. Telephone Equipment, Type HP 81A

SPECIFICATION FOR TF 1065 AND TF 1065/1

A.F. power meter

POWER RANGE: 0 to 3 watts. Full-scale deflection values: 300 μ W, 3 mW, 30 mW, 300 mW, and 3 watts. The meter scale has an auxiliary calibration in decibels.
 FREQUENCY RANGE: 250 c/s to 10 kc/s.
 MEASUREMENT ACCURACY (at 1 kc/s): Within $\pm 15\%$ of reading above $\frac{1}{3}$ full-scale.
 INPUT IMPEDANCE: 3 ohms and 600 ohms.

R.F. power meter

POWER RANGE: 0 to 25 watts.
 FREQUENCY RANGE: 50 c/s to 500 Mc/s.
 MEASUREMENT ACCURACY: Within $\pm 15\%$ of full-scale from 50 c/s to 500 Mc/s.
 INPUT IMPEDANCE: TF 1065: 50 ohms.
 TF 1065/1: 75 ohms.
 V.S.W.R.: Better than 1.2 up to 250 Mc/s and better than 1.4 from 250 to 500 Mc/s.

Deviation monitor

RANGE: 0 to 15 kc/s deviation.
 ACCURACY: Better than 15% for 15 kc/s deviation at 1 kc/s sinewave modulation frequency.
 MAXIMUM CARRIER FREQUENCY: 500 Mc/s.
 INPUT REQUIREMENTS: With 4 watts transmitter power applied to the r.f. power inlet, approximately 100 mV c.w. is required at the signal generator inlet.

Multi-range test meter

CURRENT RANGES: 50 μ A, 10 mA, 100 mA, and 1 amp d.c. full-scale.
 VOLTAGE RANGES: 10, 100, and 1,000 volts d.c. full-scale at 20 k Ω /volt.
 ACCURACY (at 20 $^{\circ}$ C): 5% of f.s.d.

Power supply

Internal long-life mercury cells.

Dimensions and weight

Height	Width	Depth	Weight
8 $\frac{1}{2}$ in	12 in	8 $\frac{1}{2}$ in	13 $\frac{1}{2}$ lb
(21.5 cm)	(31 cm)	(21.5 cm)	(6 kg)

Accessories supplied

Coaxial Free Plug, Type N, for use with r.f. power input socket; 50-ohm plug for TF 1065; 75-ohm plug for TF 1065/1.
 Coaxial Free Plug, Type BNC, 50-ohm; for use with local oscillator input socket.

Accessories available

Probe Unit, TM 5302.
 7-dB Attenuator Unit, TM 5280; for TF 1065 only.
 Full information on the above two items is given in the text.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

25-Watt R.F. Power Meter

Types TF 1152A and TF 1152A/1



7343

SPECIFICATION

Types TF 1152A and 1152A/1

Power ranges

0.5 to 10 watts and 5 to 25 watts.

Frequency range

D.C. to 500 Mc/s.

Accuracy of power measurement

Within 5% of full scale from d.c. to 250 Mc/s and within 10% of full scale from 250 to 500 Mc/s.

Input impedance

TF 1152A: 75 ohms.

TF 1152A/1: 50 ohms.

V.S.W.R.

Better than 1.2 from d.c. to 500 Mc/s.

Dimensions and weight

Height	Width	Depth	Weight
11 in	7 in	12 in	6½ lb
(28 cm)	(17 cm)	(31 cm)	(1.45 kg)

Accessories supplied

Coaxial Free Plug, Type N; for r.f. input socket. 75-ohm plug with TF 1152A; 50-ohm plug with TF 1152A/1.

- ▶ **Frequency range: D.C. to 500 Mc/s**
- ▶ **Power range: 0.5 to 25 W**
- ▶ **Impedance: 50 or 75 Ω**
- ▶ **Meter shows true mean power irrespective of waveform**

PORTABLE and entirely self-contained, these direct-reading absorption wattmeters have two measurement ranges of 10 and 25 watts full scale. From d.c. to 250 Mc/s, readings are accurate to within 5% of full scale and at 500 Mc/s the accuracy is 10% of full scale. The TF 1152A has an input impedance of 75 ohms; the TF 1152A/1, an input impedance of 50 ohms.

The TF 1152A and A/1 are electrically the same as the TF 1152 and /1 models which they supersede, and differ from them only in having a new-style case with a protective front-panel surround.

APPLICATIONS

The TF 1152A Power Meters will measure the power output of small transmitters operating at any frequency up to 500 Mc/s. Waveform errors are eliminated and the power contained in harmonics of the input

is correctly summed with the fundamental; also, since the meter will indicate the correct increase in power when amplitude modulation is applied to a c.w. input, percentage modulation depth can be calculated.

Another useful application is the measurement of the mean power output of pulse transmitters or modulators. The insulation of the input circuit is rated at 500 volts and this allows the application of peak powers of up to 3.3 kW for the 75-ohm version and 5 kW for the 50-ohm version.

The instruments are ideally suited for mobile use. They are small and compact, and each model weighs only 6½ lb. No internal batteries or external power supplies are required.

DISSIPATIVE ELEMENT

The dissipative element in the TF 1152A Power Meters consists of a heavy-duty, high-stability resistor mounted so that it forms the central conductor of a slab or parallel-plate line.

Connection of the power source is made to a Type N coaxial socket, the input being fed to the 'live' end of the resistor by an outward-tapering section which preserves a

constant impedance between the connector and the relatively large-diameter resistor. From 'live' to 'earthy' end of the resistor, the broad metal plates which form the outer conductor have an inward taper so that continuous matching is maintained along the whole length of the resistor.

The system is similar to that used in the Marconi Type TF 1020 series of Power Meters; it presents a remarkably pure input impedance over a very wide frequency range, while the simple rugged circuitry ensures both reliability and long-term calibration stability.

INDICATION

Indication is by means of a moving-coil meter and robust vacuum thermocouple fed from a tap on the load resistor. Changing the power range is done by altering meter sensitivity and not by altering the proportion of input power applied to the thermocouple heater; it is thus impossible to damage the thermocouple by inadvertently switching to the wrong power range.

Marconi Instruments Ltd.
St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

100-Watt R.F. Power Meter

**Types TF 1020A
(Series)**


R 4576

- ▶ **Frequency range: D.C. to 250 Mc/s**
- ▶ **Power range: 1 to 100 W, or 5 to 300 W in forced-air cooled models**
- ▶ **Impedance: 50 or 75Ω**
- ▶ **Meter shows true mean power irrespective of waveform**

THESE DIRECT-READING absorption wattmeters are for use at all frequencies up to 250 Mc/s. Portable, and entirely self-contained, each instrument has two measurement ranges of 50 and 100 watts full scale. From d.c. to 100 Mc/s, the accuracy of measurement is 5% of full scale and at 250 Mc/s the accuracy is 7.5% of full scale. The TF 1020A has an input impedance of 75 ohms; the TF 1020A/1, an input impedance of 50 ohms.

The TF 1020A and A/1 have the Joint-Service Reference Nos. CT 417 and CT 403 respectively.

300-WATT MODELS

The TF 1020A/2 and A/3 are high-power versions of the TF 1020A and A/1. Each has measurement ranges of 150 and 300 watts full-scale, representing a three-fold increase in power over the basic models; this has been achieved by the inclusion of a compact forced-air cooling unit. In other respects, their performance is identical to the TF 1020A and A/1.

Either instrument may be used for measurements up to 100 watts without the need for a mains supply.

APPLICATIONS

The meter indicates mean power irrespective of waveform, and, because of this, power contained in harmonics of the input is correctly summed with the fundamental;

further, since the meter will indicate the correct increase in power when amplitude modulation is applied, percentage modulation depth can be calculated.

Other important results of its unique design are that the instruments can be used to measure the mean power output of pulse transmitters or modulators and that the calibration of the instruments can be accurately and easily checked and standardized at either d.c. or power supply frequencies.

SLAB-LINE ELEMENT

The dissipative element in the TF 1020A wattmeters consists of a heavy-duty, tubular high-stability resistor. This resistor is mounted in an upward slanting position to assist cooling by convection and forms the central conductor of a relatively large dimensioned slab line. Connection of the power source is made to a type N coaxial socket on the front panel, the input being fed to the live end of the load resistor by an outward-taper constant-impedance section. From live to earthy end of the resistor, the broad metal plates which form the outer conductor have an inward taper so that continuous matching is maintained along the whole length of the resistor.

It is to this simple construction, based on classical line theory, experience, and persistent careful development, that the TF 1020A wattmeters owe their consistency and their relative purity of input impedance.

SPECIFICATION for TF 1020A and TF 1020A/1

Power ranges

1 to 50 watts and 2 to 100 watts.

Frequency range

D.C. to 250 Mc/s.

Accuracy of power measurement

Within 5% of full scale from d.c. to 100 Mc/s and within 7.5% of full scale from 100 to 250 Mc/s.

Input impedance

TF 1020A: 75 ohms.
TF 1020A/1: 50 ohms.

V.S.W.R.

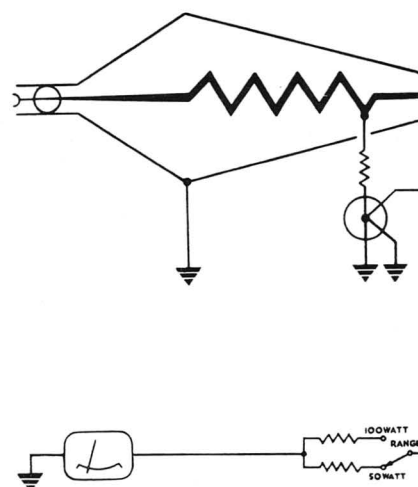
Better than 1.1 from d.c. to 100 Mc/s, and better than 1.25 from 100 to 250 Mc/s.

Dimensions and weight

Height	Width	Depth	Weight
12½ in (31 cm)	8 in (20.5 cm)	17 in (43 cm)	11½ lb (5.25 kg)

Accessories supplied

Coaxial Free Plug, Type N; for r.f. input socket. 75-ohm plug with TF 1020A; 50-ohm plug with TF 1020A/1.



Functional Diagram of TF 1020A and A/1

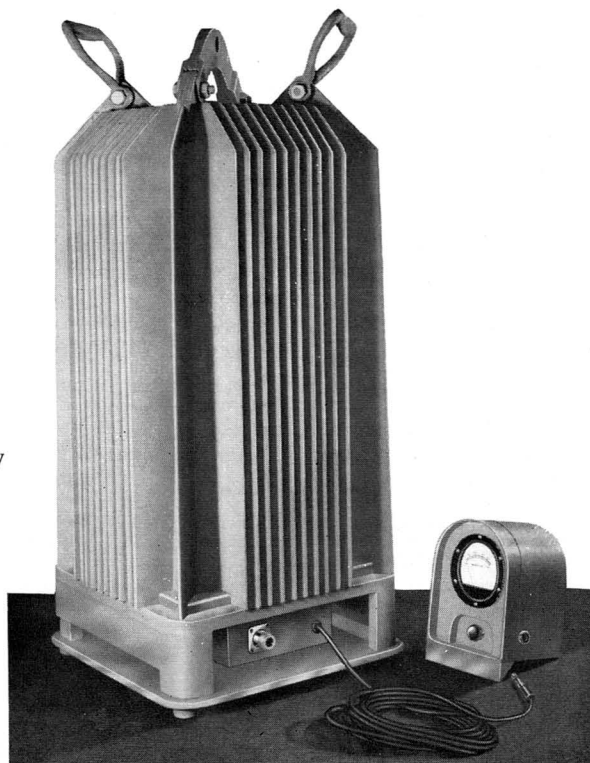
Marconi Instruments Ltd.
St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

500-Watt R.F. Power Meter

Type TF 1205

- ▶ **Frequency range:**
D.C. to 500 Mc/s
- ▶ **Power range:** 10 to 500 W
- ▶ **Impedance:** 50Ω
- ▶ **Compact, self-cooling,
oil-filled unit**



R 5597

DIRECT MEASUREMENT of powers up to 500 watts may be made at any frequency from d.c. to 500 Mc/s using the Marconi R.F. Power Meter Type TF 1205; an absorption-type instrument, it is completely self-contained and fully transportable.

The dissipative element is oil immersed and cooling of the finned outer casing is by free air convection. The design obviates the need for water or forced-air cooling and yet retains the advantages of compactness and a sealed construction.

The directly-calibrated meter indicates true mean power, irrespective of waveform. Intended for direct connection to a coaxial cable, the Power Meter has an input impedance of 50 ohms.

The TF 1205/S, a military version of this Power Meter, differing only in accessories, has the Joint-Service Reference No. CT 401.

APPLICATIONS

Power outputs of c.w., a.m., or pulse transmitters can be measured with the TF 1205. Its input socket has a peak voltage rating of 500 volts, making the instrument suitable for measurements on pulsed outputs with peak powers up to 5 kW. Since it correctly

indicates the increase in mean power when amplitude modulation is applied to a c.w. carrier, modulation depth can be calculated.

SLAB LINE ASSEMBLY

The dissipative element in the TF 1205 Power Meter consists of a heavy-duty, high-stability resistor. This resistor has a tubular ceramic former with a conducting outer coating of cracked carbon and is mounted so that it forms the central conductor of a slab or parallel-plate line.

Efficient cooling of the load resistor is obtained by immersing the complete slab-line assembly in a tank of transformer oil. Cooling fins, forming an integral part of the tank casting, provide a total surface area of over 20 square feet. By this means the overall temperature rise of the oil is restricted to approximately 30°C. Normal expansion of the oil is accommodated by means of a pair of neoprene rubber compensators, but, in the interests of safety, a spring-loaded pressure-relief valve is also fitted.

INDICATOR UNIT

The power-level measuring circuit comprises

a vacuum thermocouple, fed from a tap on the load resistor, and a moving-coil meter mounted in a separate indicator unit connected via a cable to the main assembly. The indicator unit can be attached by means of a clip to the top of the main assembly so that the meter is inclined at a convenient viewing angle; alternatively, it can be used remote from the main assembly up to the full 6 feet allowed by the connecting cable.

The thermocouple is well protected mechanically and is very robust electrically; it will, in fact, withstand overloads equivalent to 750 watts.

SPECIFICATION

Power range

10 to 500 watts.

Frequency range

D.C. to 500 Mc/s.

Accuracy of power measurement

Within 5% of full-scale from d.c. to 150 Mc/s and within 7.5% of full-scale from 150 to at least 300 Mc/s; there is no abrupt change in performance above 300 Mc/s and the instrument can be used up to 500 Mc/s.

Input impedance

50 ohms.

V.S.W.R.

Better than 1.15 up to 250 Mc/s, and better than 1.35 up to 450 Mc/s.

Coolant

Shell 'Diala B' transformer oil; approx. 1.7 gallons.

Dimensions

	Height	Width	Depth
MAIN UNIT:	22½ in (57 cm)	13½ in (34.5 cm)	15¼ in (38.5 cm)
INDICATOR UNIT:	5½ in (14 cm)	3¾ in (9.5 cm)	3¾ in (9.5 cm)

Weight

Combined weight of main and indicator units is approximately 65 lb (30 kg).

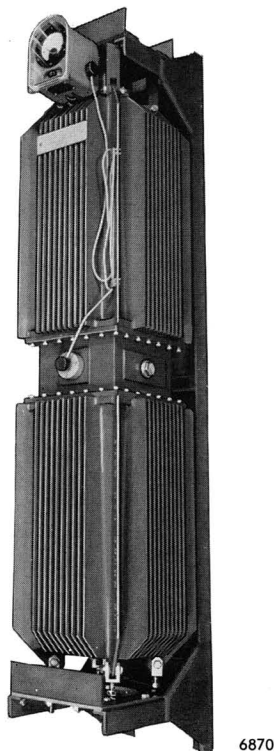
Accessories supplied

Coaxial Free Plug, Type N; for r.f. input socket.

Marconi Instruments Ltd.
 St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

1,000-Watt R.F. Power Meter

Type TF 1341


6870

- ▶ **Frequency range: 170 to 230 Mc/s**
- ▶ **Power range: 20 to 1,000 W**
- ▶ **Impedance: 50Ω**
- ▶ **Alternative mounting arrangements**

DIRECT MEASUREMENT of mean powers up to 1 kilowatt may be made within the frequency range 170 to 230 Mc/s using this absorption-type Marconi power meter. Like the 500-watt TF 1205, but on a larger scale, the TF 1341 has an oil-immersed dissipative element in a finned case cooled by free air convection. It is completely self-contained without the need for forced-air or water cooling and has a fully sealed rugged construction.

The directly-calibrated meter indicates mean power, irrespective of modulating waveform. Intended for direct connection to a coaxial cable, the Power Meter has an input impedance of 50 ohms and a v.s.w.r. better than 1·2:1.

APPLICATIONS

The TF 1341 can be used for c.w., a.m., and pulsed power measurements on v.h.f. Band III transmitters. Its input voltage rating of

7 kV makes it particularly suitable for measurements on pulsed outputs with peak powers up to 1 megawatt. Since it indicates mean power, the increase in reading when amplitude modulation is applied to a carrier is readily convertible into modulation depth.

MOUNTING ARRANGEMENTS

The Power Meter is normally supplied complete with a circular cast-iron plinth for standing it on the floor, but, where specially ordered, a tubular steel upright trolley can be supplied instead. An alternative version—Type TF 1341/1S, as illustrated—is fitted with a bulkhead mounting attachment, and forms an extremely rugged assembly suitable for military use.

DISSIPATIVE ELEMENT

The dissipative element in the TF 1341 consists of a heavy-duty, high-stability resistor. This resistor has a tubular ceramic former with a conducting outer coating of cracked carbon, and is mounted so that it forms the central conductor of a slab or parallel-plate transmission line.

Connection of the power source is made to a Type LC coaxial socket, the input being fed to the live end of the resistor by an outward-tapering section of line which preserves a constant impedance between the connector and the relatively large-diameter resistor. From the live to the earthy end of the resistor, the broad metal plates which form the outer conductor have an inward taper so that continuous matching is maintained along the whole length of the resistor.

Efficient cooling of the load resistor is obtained by immersing the complete slab-line assembly in a tank of transformer oil. Cooling fins, forming an integral part of the tank casting, provide a total surface area of over 40 square feet. Normal expansion of the oil is accommodated by an air-filled space above the oil in the tank but in the interests of safety, a spring-loaded pressure-relief valve is fitted.

INDICATOR

The power-level measuring circuit comprises a vacuum thermocouple fed from a tap on the load resistor, and a moving-coil meter mounted in a separate indicator unit connected via a 6-ft length of cable to the main assembly; the indicator unit can also be attached to the main assembly.

A mean power input of 1 kW can be applied to the instrument continuously, and a mean power of 1·2 kW can be applied for periods of up to 30 minutes.

The thermocouple is well protected mechanically and is very robust electrically; it will, for short periods, withstand over-loads equivalent to 1,500 watts mean power input to the instrument.

PROVISIONAL SPECIFICATION

Power range

20 to 1,000 watts, continuous rating.

Frequency range

170 to 230 Mc/s.

Accuracy of power measurement

Within 10% of full-scale.

Input impedance

50 ohms.

V.S.W.R.

Better than 1·2:1.

Coolant

Shell 'Diala B' transformer oil; approximately 3 gallons.

Dimensions

MAIN UNIT (excluding plinth):

Height	Width	Depth
45 in	10½ in	10½ in
(114 cm)	(26·7 cm)	(26·7 cm)

INDICATOR UNIT

Height	Width	Depth
5½ in	3¾ in	3¾ in
(14 cm)	(9·5 cm)	(9·5 cm)

PLINTH: 24 in (61 cm) dia.

4 in (10 cm) high.

Weight

162 lb (73·5 kg) including plinth.

Accessories supplied

One *Coaxial Free Plug*, Type LC; for power input socket.

Accessories available (to special order)

Trolley; tubular steel, upright, with two wheels.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

U.H.F./S.H.F. Power Meter Type TF 1202A



- ▶ **Frequency range: 500 to 5,000 Mc/s**
- ▶ **Basic power range: 0.05 to 5 mW**
- ▶ **Impedance: 50Ω**
- ▶ **Indicates true mean power**
- ▶ **Plug-on units give additional ranges up to 20 W within u.h.f. radio link bands**

THE TF 1202A is a high-sensitivity bolometer-type power meter for measurements down to 50 μ W in the frequency range 500 to 5,000 Mc/s. Essentially a d.c. energized bridge employing thermistors as the power-sensitive elements, it has two measurement ranges of 1 and 5 mW full-scale, and presents an input impedance of 50 ohms.

Range extension units are available as optional accessories for higher power measurements up to 20 watts.

APPLICATIONS

Primarily designed for use on the r.f. stages of u.h.f. multi-channel link transmitters and repeaters, this power meter will measure the output of mixers, and travelling-wave tube intermediate or power amplifiers. Lightweight, portable and free from external power supplies, it is ideally suited for use in the field.

THERMISTOR HEAD

The thermistor head is a coaxial assembly terminated by a twin thermistor element which forms a 50-ohm resistive load to r.f. inputs. It is fully screened, and insulated against heat transfer from the hand of the

user. Compensating thermistors, linked to a second arm of the bridge, are also situated in the head.

RANGE EXTENSION UNITS

Three range extension units are available for use between 1,700 and 2,300 Mc/s. Used in conjunction with the 1-mW range, these provide additional ranges of 1, 10, and 20 watts full-scale. The 1-watt unit may also be used with the 5-mW range to give a further range of 5 watts full-scale. Corresponding extension units, except for the 20-watt range, are available for use between 3,600 and 4,200 Mc/s, and between 4,200 and 5,000 Mc/s.

SPECIFICATION

Power ranges

50 μ W to 1 mW and 0.25 mW to 5 mW. Additional ranges up to 20 watts are provided by extension units—see Accessories Available.

Frequency range

500 to 5,000 Mc/s on basic power ranges.

Accuracy of power measurement

1,700 to 2,300 Mc/s:

1-mW range: within $\pm 5\%$ of reading ± 0.05 mW.

5-mW range: within $\pm 10\%$ of reading ± 0.25 mW.

500 to 1,700 Mc/s and 2,300 to 5,000 Mc/s:

1-mW range: within $\pm 10\%$ of reading ± 0.05 mW.

5-mW range: within $\pm 15\%$ of reading ± 0.25 mW.

Input impedance: 50 ohms.

V.S.W.R.

1,700 to 2,300 Mc/s: Better than 1.3 on the 1-mW range, and 1.6 on the 5-mW range. (Better than 1.2 using extension units.)

500 to 1,700 Mc/s and 2,300 to 5,000 Mc/s: Better than 1.6 on the 1-mW range, and 1.8 on the 5-mW range. (Better than 1.3 using extension units.)

Dimensions

BRIDGE AND METER UNIT:

Height	Width	Depth
12 in	6 in	8½ in
(31 cm)	(15.5 cm)	(22 cm)

THERMISTOR HEAD:

Diameter, 2¼ in (5.7 cm); length, 3½ in (9 cm); length of lead, 36 in (92 cm).

Weight (including thermistor head and batteries): 8¼ lb (3.7 kg).

Accessories supplied

Coaxial Free Connector, Marconi u.h.f. pattern, Type H1.

Accessories available

30-dB Attenuators:

Type TM 5682 (1,700 to 2,300 Mc/s).

Type TM 6215 (3,600 to 4,200 Mc/s).

Type TM 6231 (4,200 to 5,000 Mc/s).

These units extend the power ranges of the TF 1202A to 1 watt and 5 watts; a fitted chart permits stub adjustment for attenuation accuracy of ± 0.5 dB.

40-dB Attenuators:

Type TM 5683/1 (1,700 to 2,300 Mc/s).

Type TM 6156 (3,600 to 4,200 Mc/s).

Type TM 6230 (4,200 to 5,000 Mc/s).

These units extend the power range of the TF 1202A to 10 watts; a fitted chart of meter multipliers gives an accuracy of ± 0.5 dB.

43-dB Attenuator:

Type TM 5683 (1,700 to 2,300 Mc/s).

This unit extends the power range of the TF 1202A to 20 watts (for 10 minutes at 20°C ambient temperature); a fitted chart of meter multipliers gives an accuracy of ± 0.5 dB.

Carrying Case, polished hardwood, TM 5947; will house the bridge and meter unit, the thermistor head, a 30-dB attenuator, and either a 40-dB or the 43-dB attenuator.

Mallory Mercury Batteries, 6.75-volt, type SKB 639; for use in place of the Drydex type H1177 batteries normally supplied.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

A.C. Microvoltmeter

Type TF 1375



R7478

- ▶ **Voltage range:** 5 μ V to 15 volts r.m.s.
- ▶ **Frequency range:** 50 c/s to 1 Mc/s with switch-selected l.f. rejection
- ▶ **Completely portable, with self-contained battery supply**
- ▶ **May be used as amplifier with greater than 60 dB gain**
- ▶ **Permits a.c. measurement down to 10^{-10} ampere**

SELF-CONTAINED and fully transistorized this compact A.C. Microvoltmeter offers unparalleled sensitivity in audio, video, and r.f. measurements. Its 4-inch meter has an overload-protected 50- μ A movement with clear high-discrimination voltage and decibel scales.

APPLICATIONS

The high gain and freedom from hum which characterize this instrument enable it to be used for a variety of purposes. It can be used, for example, as an oscilloscope pre-amplifier, as a sensitive measuring-bridge detector, or for field strength and aerial tests.

In conjunction with a suitable pick-up loop direct measurement may be made of leakage flux emanating from mains transformers and electric motors.

The input impedance and sensitivity of the TF 1375 are such that, when measuring the voltage drop in an external circuit,

accurate measurements may be made with currents as low as 10^{-10} ampere.

TRANSISTOR AMPLIFIER

Basically, the instrument consists of a frequency-compensated input attenuator with decade steps, and a seven-transistor frequency-compensated amplifier having a voltage gain of approximately $\times 5,000$. Output from this amplifier is rectified in a full-wave bridge circuit before application to the meter; in addition, the output from the penultimate stage is available at a front-panel outlet.

For use in situations where externally-generated mains hum is giving rise to spurious readings, provision is made for the low-frequency response to be attenuated by some 20 dB at 50 c/s; under these conditions the response from 1 kc/s to 1 Mc/s remains unimpaired.

Only one type of transistor is employed throughout the instrument—Type OC 44. These are entirely standard and the performance of the instrument is not dependent upon special selection of transistors for particular stages.

HIGH OVERLOAD CAPACITY

Overload protection is applied to the meter movement only. This takes the form of a forward-connected diode, shunted across the meter terminals. The amplifier itself will not be damaged by peak overloads of up to 100 volts on the upper ranges. On the lower ranges it will withstand overloads equivalent to f.s.d. $\times 10^4$.

BATTERY POWER SUPPLY

Two 4½-volt batteries are housed within the instrument case. These are of a type which is readily available throughout the world, and were chosen with a view to their long working life. A battery-check position is provided on the main selector switch, enabling the user to ascertain the state of the batteries, under their normal load conditions.

SPECIFICATION

Voltage ranges

5 μ V to 15 volts in twelve ranges: six direct ranges with full-scale deflections from 50 μ V to 5 volts in 10:1 steps; internal 10-dB attenuator gives six additional ranges from 150 μ V to 15 volts full-scale.

Measurement accuracy

$\pm 10\%$ of full-scale.

Frequency response

Within ± 2 dB from 50 c/s to 1 M c/s.

Typical characteristic, relative to response at 1 kc/s, is flat to within ± 0.5 dB from 50 c/s to 200 kc/s, rising to within +2 dB at 600 kc/s, and within ± 2 dB at 1 Mc/s. L.F. CUT position: as above but falling below 1 kc/s to -20 dB at 50 c/s.

Input resistance

25 k Ω on 50-, 150-, 500- and 1,500- μ V ranges.

100 k Ω on 5- and 15-mV range.

1 M Ω on other ranges.

Input capacitance

80 μ F on 50- and 150- μ V range.

40 μ F on higher ranges.

Temperature range

0° to 40°C.

Noise level

Approximately 2 μ V equivalent input.

Amplifier output

250 mV maximum at approximately 3 k Ω source impedance.

Amplifier gain

Greater than 60 dB.

Power supply

Two 4½-volt batteries. Ever-Ready Type AD 28 (U.S., Burgess Type F3).

Dimensions and weight

Height	Width	Depth	Weight*
6 in	8½ in	5½ in	4½ lb
(15.25 cm)	(21.6 cm)	(13 cm)	(2 kg)

Accessories supplied

One Coaxial Free Plug, Belling-Lee Type L 734/P.

*Including batteries.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

Sensitive Valve Voltmeter

Type TF 1100



5170

- ▶ **Voltage range: 100 μ V to 300 volts a.c.**
- ▶ **Frequency range: 10 c/s to 10 Mc/s**
- ▶ **5-inch meter scale; direct calibration for both voltage and dBm**
- ▶ **Can also be used as wide-band amplifier**

A.C. VOLTAGES between 100 μ V and 300 volts and at any frequency in the range 10 c/s to 10 Mc/s can be measured by the Marconi TF 1100.

An amplifier-rectifier type instrument, it maintains good accuracy with moderately distorted waveforms; it is free from turn-over effect and has a large overload capacity. The meter, which responds to the average value of the voltage under test, is calibrated in terms of the r.m.s. value of a sinusoidal input.

APPLICATIONS

The sensitivity and high discrimination of the TF 1100 make it suitable for many applications in audio, video, and r.f. work; and, in particular, for measurement of noise and hum, filter response, field strength when used with a pick-up loop, or as a balance indicator for bridges. Its scale of decibels relative to a milliwatt in 600 ohms may be used in level measurement on telephone line equipment.

The instrument is provided with a pair of output terminals to enable it to be used as a wide-band amplifier as well as a voltmeter;

this useful feature is well suited to applications such as increasing the sensitivity of cathode-ray oscilloscopes and other test equipment.

FEEDBACK AMPLIFIERS

The Voltmeter has a cathode follower input circuit; this, with its characteristically high input impedance, is followed by a four-stage video amplifier whose output is applied to the meter via a full-wave rectifier. The four amplifier stages are grouped in pairs, feedback being applied individually over each pair.

The overall frequency characteristic of the Voltmeter is remarkably level and allows a measurement accuracy of 5% of full-scale to be maintained up to at least 5 Mc/s. Above 5 Mc/s, there are no abrupt changes and, for many applications, the instrument is suitable for use up to 10 Mc/s.

A further cathode-follower stage, fed from the meter amplifier, provides a 75-ohm output which is available at a pair of front-panel terminals. This enables the instrument to be used as a wide-band amplifier with a voltage gain of 400, a maximum output of 3 volts and a frequency response comparable with that of the voltmeter.

LINEAR CALIBRATION

The two linear voltage scales on the large meter ensure easy readability. There is also a decibel scale calibrated relative to 1 mW in 600 ohms, which can be used in conjunction with the range switches to measure levels from -72 to $+52$ dBm.

SPECIFICATION

Voltage range

0 to 300 volts a.c. in twelve ranges with full-scale deflections of 1, 3, 10, 30, 100, and 300 mV, and 1, 3, 10, 30, 100, and 300 volts. The instrument is also calibrated in decibels relative to 1 mW in 600 ohms.

Frequency range

10 c/s to 10 Mc/s.

Measurement accuracy

$\pm 5\%$ of full-scale from 10 c/s to at least 5 Mc/s.

Input resistance

10 M Ω on all ranges.

Input capacitance

15 μ F on the 1- to 300-volt ranges.
25 μ F on the 1- to 300-mV ranges.

Amplifier output

3 volts maximum.

Amplifier voltage gain

Of the order of 400.

Power supply

200 to 250 volts, or 100 to 150 volts after adjusting internal link, 40 to 60 c/s; 65 watts. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering. Fuses in both mains and h.t. circuits.

Dimensions and weight

Height	Width	Depth	Weight
12 $\frac{1}{4}$ in	8 $\frac{1}{2}$ in	8 $\frac{3}{4}$ in	12 lb
(31 cm)	(22 cm)	(22.5 cm)	(5.5 kg)

Accessories supplied

Coaxial Free Plug, Type 83, for front-panel input socket.

Accessories available

Adaptor, TM 5272; one end, Type 83 plug; other end, screw terminal; converts normal coaxial input of Voltmeter to screw terminals.

Probe Lead, TM 5269; low-capacitance coaxial-cable assembly 30 inches long; one end, Type 83 plug; other end, test prod and earth clip.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

Wide-Band Millivoltmeter

Type TF 1371



SPECIFICATION

Voltage range

100 μ V to 300 mV in five ranges with full-scale deflections of 3, 10, 30, 100, and 300 mV. Increased ranges of 0.3, 1, 3, 10, and 30 volts full-scale using $\times 100$ Multiplier. Meter reads r.m.s. value of a sinewave; also calibrated in decibels relative to 1 mW in 600 ohms.

Frequency range

30 c/s to 30 Mc/s.

Measurement accuracy (above 30% of f.s.d.)

$\pm 5\%$ of reading from 100 c/s to 10 Mc/s,
 $\pm 10\%$ of reading from 30 c/s to 30 Mc/s.
 Figures are inclusive of overall frequency characteristic of ± 0.5 dB on any range.

Input resistance

2 M Ω , decreasing to 30 k Ω at 30 Mc/s;
 10 M Ω using $\times 10$ Multiplier.

Input capacitance

11 μ F approx.;
 2 μ F using $\times 10$ Multiplier.

Short-term stability

Meter fluctuations less than $\pm 1\%$ at full-scale deflection for $\pm 2\%$ supply-voltage jitter.

Long-term stability

Gain change less than $\pm 2\%$ for $\pm 6\%$ supply-voltage variation. Internal gain standardization at 25 mV $\pm 1\%$.

Power supply

200 to 250 volts, or 100 to 150 volts after adjusting internal link; 40 to 60 c/s; 85 watts. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

Dimensions and weight

Height	Width	Depth	Weight
10½ in	10½ in	8 in	15 lb
(27 cm)	(27 cm)	(20.5 cm)	(6.8 kg)

Accessories supplied

Grounding Clip, TC 23538, for use with probe unit.

Accessories available

$\times 10$ Multiplier, Type TM 6154; increases probe input impedance to 10 M Ω with 2 μ F in shunt.

$\times 100$ Multiplier, Type TM 6154/1; increases voltage range to 30 volts.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

- ▶ **Voltage range: 100 μ V to 300 mV or up to 30 V with optional multiplier**
- ▶ **Flat response from 30 c/s to 30 Mc/s**
- ▶ **Input capacitance: 11 μ F**
- ▶ **Jitter-free reading in mV and dBm**

EXTREMELY wide frequency cover combined with stability, accuracy and sensitivity, make this a voltmeter of the broadest applicability.

APPLICATIONS

The TF 1371 will measure small a.c. voltages from power-supply frequencies to the threshold of v.h.f.; it can be used on r.f., i.f., video and audio amplifiers; and it allows measurement of signal levels throughout h.f. receivers, from aerial to loudspeaker.

HIGH-STABILITY INDICATION

Its 5½-inch meter responds to the average value of an a.c. waveform and is calibrated in the r.m.s. value of a sinewave; it has two millivolt scales, and a scale showing decibels relative to 1 mW in 600 ohms. To maintain long-term accuracy, the calibration can be easily standardized against an internal source.

In addition to the normal advantages of

the average-reading type of voltmeter—good accuracy with moderately distorted or noisy waveforms, and absence of turnover effect—particular care has been taken in the circuit design to counteract the effects of short- or long-term power-supply variations; this results in an exceptionally stable, jitter-free indication ensuring accurate, reliable measurements at all times. The meter is automatically protected against serious overloads by the characteristics of the circuit, and can be disconnected if required by switching to the 'standby' position of the range selector.

HIGH-IMPEDANCE PROBE

The cathode-follower input probe presents a low input capacitance allowing measurements to be made with little disturbance to the circuit under test. Although primarily intended for measurements of voltages with one side earthed, the 'low' connection can be made to points having a potential up to at least 100 mV relative to earth without introducing inaccuracies.

Two multipliers which plug on to the probe are available as optional accessories: one has a multiplying factor of 10 and increases the input impedance to 10 M Ω with only 2 μ F in shunt; the other has a factor of 100 and increases the voltage measuring range to 30 volts.

MARCONI
 INSTRUMENTS

Valve Millivoltmeter

Type TF 899A



SPECIFICATION

Ranges

0.02 to 2 volts in three ranges. Full-scale deflections: 150 mV, 500 mV, and 2 volts.

Accuracy

5% of full-scale calibration of the range in use.

Frequency characteristic

50 c/s to 50 Mc/s: ± 1 dB;
 50 to 100 Mc/s: ± 2 dB.

Input conditions

Capacitance, approx. 7 μ F.
 Resistance, greater than 1 M Ω at 1 Mc/s.

Power supply

100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s; 18 watts.

Dimensions and weight

Height	Width	Depth	Weight
10 $\frac{3}{4}$ in	7 $\frac{3}{4}$ in	6 $\frac{3}{4}$ in	7 $\frac{3}{4}$ lb
(26.5 cm)	(20 cm)	(17.5 cm)	(3.5 kg)

- ▶ Voltage range: 20 mV to 2 V a.c.
- ▶ Frequency range: 50 c/s to 100 Mc/s
- ▶ Detected output for modulation monitoring

THE TF 899A is a simple high-impedance millivoltmeter for measuring small a.f. and r.f. voltages up to 100 Mc/s. Its three ranges have full-scale deflections of 150 mV, 500 mV, and 2 volts, and the circuit has been designed to give maximum stability and freedom from zero drift.

A feature of the design is the probe unit fitted with input terminals and readily detachable from the main casing to enable short connecting leads to be used in high-frequency measurements.

This Voltmeter has the Joint-Service Ref. No. 6625-99-972-7776.

APPLICATIONS

In addition to its many uses in audio, video, h.f., and v.h.f. millivoltage measurement, the instrument may also be used as a simple signal rectifier for detecting the presence of amplitude modulation on r.f. carriers, or as a signal tracer for fault location; for this purpose the output of the probe detector is

available at a front-panel telephone jack for connection to headphones or an oscilloscope.

The compact form of the instrument, its light weight and simple operation, make it equally suitable for both field and test bench work, while its modern alloy case allows rapid access to all components.

MEASURING BRIDGE

The instrument essentially comprises a triode leaky-grid detector incorporated in an initially - balanced bridge measuring circuit. Subsequent application of an a.c. voltage to the grid of the detector produces a control bias which changes the anode impedance of the valve and so unbalances the bridge. The out-of-balance current in the bridge is indicated by a moving-coil meter calibrated in terms of r.m.s. value of a sinewave input. Two of the bridge arms are resistive and variable to provide a zero setting control; a third arm, consisting of the anode impedance of a pentode valve,

provides an automatic stability control such that the effects of small mains fluctuations and changes in emission leave the bridge substantially unaffected. The zero setting arrangements are such that, once set, the zero is the same for all three ranges.

Radio frequency filters remove the r.f. products of detection, while a large-value capacitor, connected between the anode and cathode of the detector valve, prevents any modulation that may be present in an r.f. voltage being measured from reaching the bridge circuit. A circuit-closing jack in one lead of the capacitor allows for the connection of head telephones in order that modulation, if present, may be monitored aurally.

Marconi Instruments Ltd.
 St. Albans, Hertfordshire, England

MARCONI
INSTRUMENTS

U.H.F. Millivoltmeter

Type TF 1262


R 6380

- ▶ **Voltage range: 50 mV to 1 volt a.c.**
- ▶ **Frequency range: 1 to 500 Mc/s**
- ▶ **75-ohm coaxial input**
- ▶ **No power supplies required**

DESIGNED FOR direct connection to coaxial systems, this crystal voltmeter has an input impedance of 75 ohms and is for use between 1 and 500 Mc/s. It has two measuring ranges, with full-scale deflections of 0.5 and 1 volt, and can be used for measurements down to 50 mV.

Over the range 1 to 300 Mc/s, response is flat to within ± 0.5 dB and, at the calibration frequency of 70 Mc/s, readings are accurate to within 5% of full scale. The v.s.w.r. at its type N inlet is better than 1.1 up to 400 Mc/s and 1.15 at 500 Mc/s.

APPLICATIONS

Simple, light and portable, the Millivoltmeter requires no external or internal power supplies. Its purity of input impedance ensures reliable measurement of the output p.d. of low-power 75-ohm signal sources. It is primarily intended for use on terminal

and repeater equipment for v.h.f. and u.h.f. multi-channel links, in applications such as the measurement of r.f. and i.f. oscillator output or amplifier gain.

SLAB LINE

To provide a matched termination having a constant 75-ohm impedance over the frequency range of the instrument, a tapered slab-line assembly is used in the input circuit. R.F. power from the source being measured is dissipated in a 75-ohm cracked-carbon resistor which forms the centre conductor. The curvature of the plates forming the outer conductor of the slab-line assembly may be varied by screw adjustment and is preset for optimum v.s.w.r.

RECTIFIER METER

A fraction of the r.f. power is tapped from the cracked-carbon resistor and detected by a crystal rectifier. The rectified output is indicated on a meter calibrated in voltage. Between the meter and rectifier, a switched series resistor alters the meter sensitivity to provide a second voltage range.

When the ON/OFF toggle switch is set to OFF, the meter is disconnected from the rectifier circuit and has a short-circuit connected across it to damp its movement and protect it from damage when not in use.

SPECIFICATION

Voltage ranges

50 mV to 1 volt r.m.s. in two ranges of 0.5 and 1 volt full-scale.

Measurement accuracy

$\pm 5\%$ of f.s.d. at calibration frequency of 70 Mc/s.

Frequency response

The frequency characteristic relative to the response at 70 Mc/s is flat within ± 0.5 dB from 1 Mc/s to 300 Mc/s, and rises to about +1.5 dB at 500 Mc/s.

Input impedance

75 ohms resistive.

V.S.W.R.

Better than 1.1 : 1 up to 400 Mc/s and better than 1.15 : 1 at 500 Mc/s.

Input connector

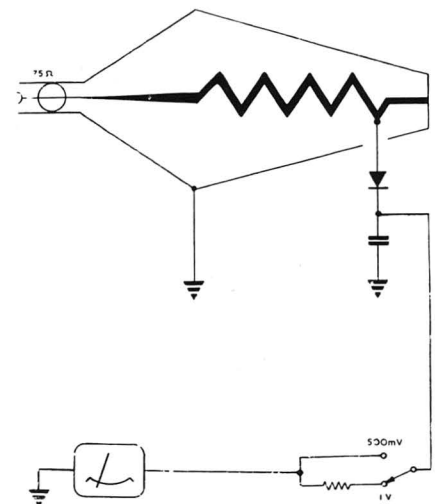
Type N coaxial socket.

Dimensions and weight

Height	Width	Depth	Weight
4½ in	5½ in	6 in	2¾ lb
(11.5 cm)	(14 cm)	(15 cm)	(1.25 kg)

Accessories supplied

Coaxial Free Plug, Type N; for input socket.



Functional Diagram

Marconi Instruments Ltd.
St. Albans, Hertfordshire, England

**MARCONI
INSTRUMENTS**

Vacuum Tube Voltmeter

**Types TF 1300
and TF 1300/1**


5921

Used in its upright position, the Voltmeter occupies less than half a square foot of bench space. Despite its small size, it includes provision for storage of all leads and attachments below its lid, which hinges back to support the instrument in a sloping position.

- ▶ Measures a.c.: 0.05 to 100 V, 20 c/s to 300 Mc/s
- ▶ Measures d.c.: 0.1 to 300 V
- ▶ Measures ohms: 50 Ω to 5 M Ω
- ▶ Economically priced
- ▶ For use on production lines, in development laboratories, and in teaching establishments

THE TF 1300 is a 300-Mc/s voltmeter of the widest general usefulness. Its a.c. measurement range is 0.05 to 100 volts, 20 c/s to 300 Mc/s. It measures d.c. up to 300 volts and resistances up to 5 M Ω . A plug-on multiplier is available to extend the a.c. measurement range to 1,000 volts at frequencies up to at least 50 Mc/s.

The indicating meter is direct-reading on a.c., d.c., and ohms ranges, and no correc-

tion factors are necessary. Zero stability is of a high order with respect to both time and mains variation, and only one zero setting is required for all a.c. or all d.c. ranges. Both a.c. and d.c. inputs are isolated from chassis.

All-in-all, the TF 1300 is an outstanding achievement; the result of skilful combination of performance and economy, it offers the highest value of any voltmeter in its class today.

APPLICATIONS

The low price of this voltmeter makes it particularly attractive to the laboratory or production engineer for whom the full 1,500-Mc/s precision performance of the TF 1041B is not essential, but who nevertheless requires a sturdy, reliable voltmeter of medium range, good accuracy and good stability.

It is equally suitable for audio, video, r.f. and v.h.f. use; and it will measure power

supply voltages, resistance, and d.c. voltages in high-impedance circuits.

The TF 1300/1 is an alternative model with a balanced a.c. probe. It allows measurement of voltages between two high-impedance points and has a frequency range of 20 c/s to 200 Mc/s.

A.C. MEASUREMENTS

These are made with a lightweight probe rectifier unit. The probe houses a modern miniature diode and is coupled to the main body of the instrument by a 3-foot flexible cable. Lead errors at high frequencies are avoided, as the cable carries only the diode heater supply and the direct voltage developed across the diode load. By careful design, the size of the probe has been kept to the very minimum; it is cylindrical in form with a length of 3½ inches and a diameter of under 1 inch—features which greatly facilitate connection of its low-inductance spike contact direct to the point at which the voltage is to be measured.

BALANCED VALVE-BRIDGE

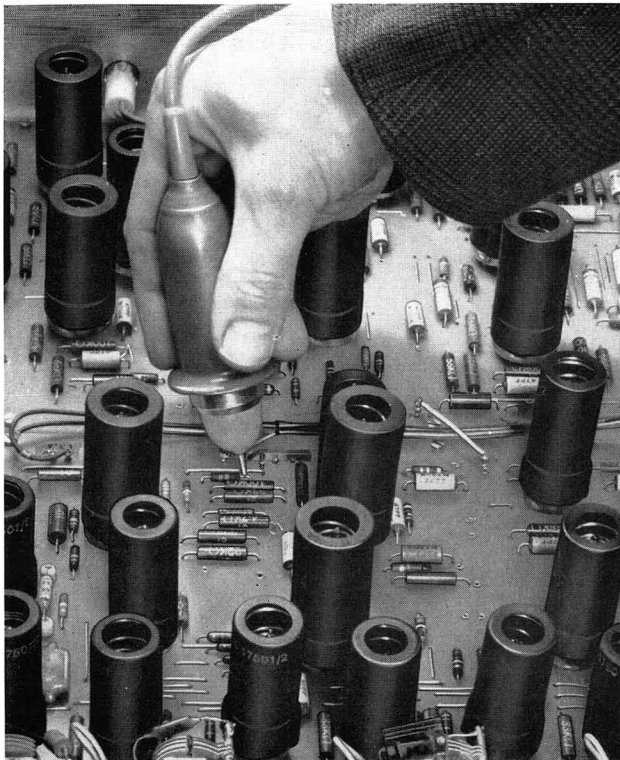
The rectified output from the probe is applied to one arm of a valve bridge comprising two double triodes; a second arm of the bridge is coupled to a splash-current balancing network including a potential divider across the h.t. supply and a 3-volt stabilizer element. The indicating meter, which is actuated by the out-of-balance bridge current caused by a voltage applied to the probe, is automatically protected from gross overload by the design of the bridge circuit.

D.C. MEASUREMENTS

The input is applied directly to the bridge via the d.c. leads, and the probe diode and splash-current network are automatically disconnected. The filament supply to the probe diode is maintained, however, to avoid thermal delays when switching between a.c. and d.c. ranges.

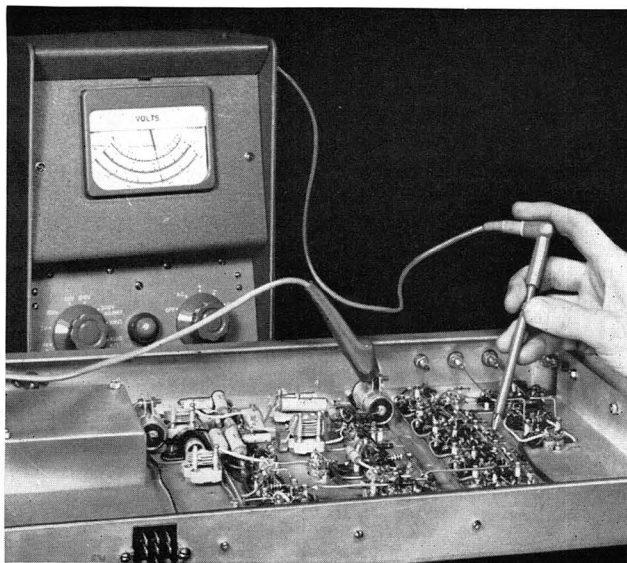
RESISTANCE MEASUREMENTS

The unknown resistor is connected, by means of the d.c. leads, in series with a standard resistor and the 3-volt stabilized supply that is used for splash-current balancing in a.c. measurement. The meter responds to the voltage developed across the unknown resistor, the deflection having been first standardized at full scale with the leads open-circuited.



6061

One of the most attractive features of the TF 1300 is its modern, up-to-the-minute a.c. probe unit. Small, compact, and fitted with a non-slip p.v.c. sheath and safety guard, the probe is ideal for use in confined spaces.



6061/5

D.C. and ohms measurements, too, can be made on the most tightly-knit circuits by means of the long-reach prod-clip. This can be used either as a sharp prod or, when its top is pressed down, as a slim clip-on connector.

SPECIFICATION for TF 1300

A.C. measurement

RANGE: 0.05 to 100 volts in five ranges.
Full-scale deflections: 1, 3, 10, 30, and 100 volts.

ACCURACY: $\pm 3\%$ of f.s.d. ± 0.02 volt.

FREQUENCY RESPONSE: Typical characteristic, relative to response at 1 kc/s, is flat to within ± 0.2 dB from 50 c/s to 200 Mc/s, falling to within -1 dB at 20 c/s, and rising to within $+1.5$ dB at 300 Mc/s.

INPUT CONDITIONS: Shunt capacitance: approx. $4 \mu\text{F}$. Resistance: approx. $5 \text{ M}\Omega$ up to 100 kc/s, $2.7 \text{ M}\Omega$ at 1 Mc/s, $0.8 \text{ M}\Omega$ at 10 Mc/s, and $50 \text{ k}\Omega$ at 100 Mc/s.

D.C. measurement

RANGE: 0.1 to 300 volts in five ranges.
Full-scale deflections: 3, 10, 30, 100, and 300 volts.

ACCURACY: $\pm 2\%$ of f.s.d.

INPUT RESISTANCE: $90 \text{ M}\Omega \pm 5\%$.

Meter zero

The meter zero is not affected by changes in the setting of the RANGE switch. A supply mains variation of 6% will cause a maximum change of 3% f.s.d. on the lowest a.c. or d.c. range; other ranges are relatively unaffected.

Overload protection

The meter is protected against serious overloads by the characteristics of the associated valve circuits.

Resistance measurement

50 ohms to $5 \text{ M}\Omega$ in two ranges centred on $1 \text{ k}\Omega$ and $100 \text{ k}\Omega$.

Power supply

200 to 250 volts, or 100 to 150 volts after adjusting internal link, 40 to 100 c/s; 30 watts. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

Dimensions and weight

Height	Width	Depth	Weight
$10\frac{3}{4}$ in	$7\frac{3}{4}$ in	$6\frac{3}{4}$ in	$9\frac{1}{2}$ lb
(27.5 cm)	(20 cm)	(17.5 cm)	(4.3 kg)

Accessories supplied

Grounding Clip, TC 23535/3; for use with a.c. probe unit.

Accessories available

A.C. Multiplier, Type TM 6067. This auxiliary probe cap, which plugs on to the normal a.c. probe, extends the a.c. measurement range to 1,000 volts r.m.s. at frequencies from 20 c/s to at least 50 Mc/s. It comprises a resistive-capacitive divider, and introduces a multiplying factor of $\times 10$ which is accurate to within $\pm 5\%$ from 40 c/s to 10 Mc/s. Its nominal input impedance is $5 \text{ M}\Omega$ with $5 \mu\text{F}$ in shunt.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

**MARCONI
INSTRUMENTS**

Vacuum Tube Voltmeter

Type TF 1041B


6134

- ▶ Measures a.c.: 25 mV to 300 V, 20 c/s to 1,500 Mc/s
- ▶ Input capacitance: 1.5 μ F
- ▶ Measures d.c.: 10 mV to 1,000 V
- ▶ Measures ohms: 0.02 Ω to 500 M Ω
- ▶ Multipliers for up to 2 kV a.c. and 30 kV d.c.

THE TF 1041B, Marconi's latest u.h.f. precision Voltmeter, advances the range of a.c. measurement up to 1,500 Mc/s. While retaining the sound basic features common to its predecessors in the well-known TF 1041 series, it brings the user important new advantages, higher all-round performance, and greater operational convenience—all at a lower price.

APPLICATIONS

This is a voltmeter for precision measurements from audio to u.h.f., for measurement of d.c. voltage and an exceptionally wide range of resistance. Its high input resistance ensures negligible loading in almost any a.c. or d.c. circuit.

Extra-low a.c. and d.c. ranges with full-scale deflections of 300 mV allow measurements down to 25 mV a.c. or 10 mV d.c. with a stability that ensures the complete suitability of these ranges for high-accuracy work. For low ohms measurement, the resistance ranges extend down to 1 ohm mid-scale.

Both a.c. and d.c. inputs are isolated from chassis. On all d.c. ranges, a centre-zero facility is available to aid the precise determination of null point in bridges or discriminators.

D.C. volts and ohms measurement is simplified by the special dual-purpose d.c. probe with its finger-tip V/Ω selector; set to V, an isolating resistor is introduced to

shield the circuit under test from the effects of probe-lead capacitance. The d.c. supply for ohms measurement is obtained without the use of batteries.

Four optional accessories still further increase the usefulness of the TF 1041B. High voltages up to 30 kV d.c. and 2 kV a.c. can be measured with plug-on d.c. and a.c. multipliers. For measuring voltages on a coaxial line, there is a plug-on T-connector for the a.c. probe; an accurately matched 50-ohm coaxial terminating load is also available.

DISK-SEAL DIODE PROBE

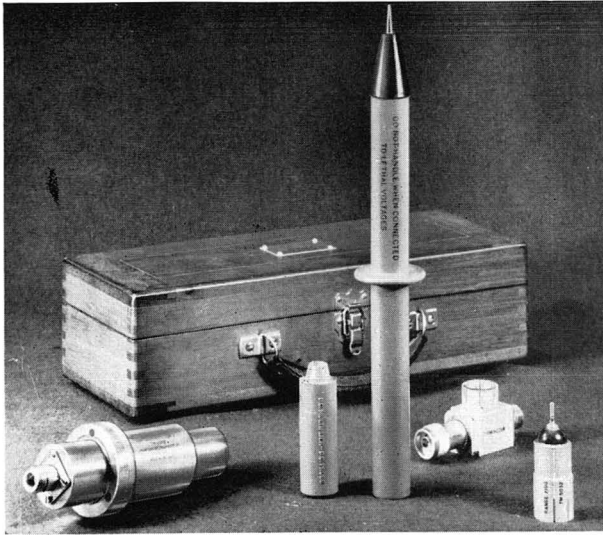
The probe unit used for a.c. measurements houses a disk-seal diode rectifier of the most advanced and up-to-date type. The low capacitance, short transit time and 3,000-Mc/s resonant frequency of this diode, together with a unique probe-head design, make possible a frequency range of up to 1,500 Mc/s. Small and cylindrical, the probe weighs only 1½ oz—a factor that makes for commendable ease of handling. A special plug-on ground connector is supplied for optional use with the probe unit; this connector facilitates the making of the ultra-short connections necessary at the higher frequencies.

HIGH-STABILITY INDICATION

The d.c. section of the Voltmeter is essentially a two-stage impedance converter. Each stage embodies two cathode followers and there is generous negative feedback between the input points and the moving-coil meter across the output. The filament supply to all valves is stabilized, and the effects of meter temperature coefficient are offset by a series thermistor. The excellent stability and freedom from drift resulting from these refinements are seen by the user as a remarkably steady zero, which needs only one setting to suit all ranges.

The meter is automatically protected from gross overload by the characteristics of the d.c. section; as a further precaution for the most sensitive ranges, meter overload rectifiers are fitted.

For d.c. measurements, the meter can be switched to give forward deflection with either positive or negative voltages; for centre-zero measurements, a standing d.c. current is applied to bias the meter to mid-scale.



6308

OPTIONAL ACCESSORIES FOR USE WITH TF 1041B

Two multipliers, a coaxial 'T' junction, and a 50-ohm coaxial dummy load are offered for use with the Voltmeter. For stowing the multipliers and 'T' junction, a polished hardwood carrying case, Type TM 4935, can also be supplied.

D.C. MULTIPLIER

Type TM 5033A (with Connector TM 5749)
This enables high voltages, such as in television receivers, to be measured with safety.

When connected to the d.c. probe of the Voltmeter, it gives a voltage reduction ratio of 30:1 and is usable up to 30 kV. The calibration of the Multiplier is accurate to within $\pm 2\%$, and its high input impedance of 3,000 M Ω causes negligible loading of the circuit under test.

A.C. MULTIPLIER

Type TM 5032
Transmitter voltages up to 2 kV r.m.s., at frequencies of 10 kc/s and above, can be

measured with this auxiliary probe cap which fits readily over the normal a.c. probe head. It comprises a capacitive divider with a ratio of 100:1, and places a capacitance of 2 μF across the circuit under test. The unit is accurate to within $\pm 2\%$. As with the low-voltage probe, ground connection is made with the clip and the ground sleeve supplied with the Voltmeter.

COAXIAL 'T' CONNECTOR

Type TM 5031A

This device can be fitted to the a.c. probe head to facilitate voltage measurements on 50-ohm coaxial cables. For this purpose the two series arms of the 'T' are terminated in a Type N plug and socket respectively. The v.s.w.r. of the connector is of the order of 1.1 at 800 Mc/s.

5-WATT DUMMY LOAD

Type TM 5582

This 50-ohm, wide-band coaxial load is particularly useful as a well-matched termination in coaxial line measurement. It has a Type N input socket, at which the v.s.w.r. is less than 1.1 up to 500 Mc/s and less than 1.2 up to 1,200 Mc/s. It is of robust, fully enclosed construction and completely non-radiating.

SPECIFICATION

A.C. measurements

RANGES: 25 mV to 300 volts in seven ranges: 300 mV, 1, 3, 10, 30, 100, and 300 volts f.s.d.

ACCURACY: 1, 3, 30, and 100 V ranges: $\pm 2\%$ of f.s.d. ± 10 mV. Other ranges: $\pm 3\%$ of f.s.d. ± 10 mV.

FREQUENCY RESPONSE: Typical characteristic, relative to response at 1 kc/s, is flat to within:

- 0.5 dB at 20 c/s,
- ± 0.2 dB from 50 c/s to 500 Mc/s,
- +1 dB at 1,000 Mc/s,
- +3 dB at 1,500 Mc/s.

INPUT CONDITIONS: Shunt capacitance: approximately 1.5 μF . Resistance: greater than 5 M Ω at 1 kc/s, greater than 500 k Ω at 10 Mc/s, and approximately 150 k Ω at 100 Mc/s.

D.C. measurements

RANGES: 10 mV to 1,000 volts in eight ranges: 300 mV, 1, 3, 10, 30, 100, 300,

and 1,000 volts f.s.d., positive or negative. Centre-zero facility on all ranges.

ACCURACY: $\pm 2\%$ of f.s.d. ± 10 mV; above 100 volts, $\pm 3\%$ of f.s.d.

INPUT CONDITIONS: Resistance: 100 M Ω , plus 1 M Ω probe resistor. Capacitance to ground: approximately 2 μF .

Meter zero

A supply variation of 6% causes a deflection change of less than 30 mV at f.s.d. on a.c. ranges and 20 mV on d.c. ranges.

Resistance measurements

RANGE: 0.02 ohm to 500 M Ω in eight ranges: 50 ohms, 500 ohms, 5 k Ω , 50 k Ω , 500 k Ω , 5 M Ω , 50 M Ω and 500 M Ω f.s.d.

Power supply

200 to 250 volts, or 100 to 150 volts after adjusting internal link, 40 to 100 c/s; 35 watts. Models supplied ready for imme-

diately 100- to 150-volt use if specified at time of ordering.

Dimensions and weight

Height	Width	Depth	Weight
10 $\frac{3}{4}$ in	7 $\frac{3}{4}$ in	6 $\frac{3}{4}$ in	10 $\frac{1}{2}$ lb
(27.5 cm)	(20 cm)	(17.5 cm)	(4.8 kg)

Accessories supplied

Grounding Clip, TC 23535/3C; for use with a.c. probe unit.

Grounding Sleeve, TC 23533/3; for use with a.c. probe unit at u.h.f.

Accessories available

D.C. Multiplier, TM 5033A (including Connector, TM 5749).

A.C. Multiplier, TM 5032.

Coaxial 'T' Connector, TM 5031A.

Dummy Load, TM 5582.

Carrying Case, TM 4935.

For full details see above.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

**MARCONI
INSTRUMENTS**

Suppressed-Zero Voltmeter

Type TF 1377



7541

- ▶ Measures 0 to 500 volts d.c.
- ▶ Measures variations down to 1 mV in 100 volts
- ▶ Measures differential voltages from 1 mV to 50 volts
- ▶ Infinite input impedance at null
- ▶ Recorder output for stability tests

THE TF 1377 is a potentiometric slideback voltmeter for measuring absolute voltages up to 500 volts and changes as low as 1 mV in the source under test. It can also be used as a conventional differential voltmeter with a range of ± 1 mV to ± 50 volts.

In the slideback or suppressed-zero mode of operation, the source voltage is backed off against a potentiometer-controlled internal d.c. supply, with the centre-zero meter used as null indicator. The absolute voltage of the source is indicated by the digital readout of the potentiometer, and subsequent variations in voltage are shown by the meter. Small changes in large voltages can thus be measured with exceptional discrimination, accuracy and ease, avoiding the inconvenience of using complicated arrangements of external batteries for backing off the standing voltage.

In the differential mode, the potentiometer is switched out of circuit, and small unknown voltages are indicated directly on the meter.

APPLICATIONS

The instrument allows rapid, accurate measurement of a wide range of d.c. voltages in the laboratory, production line, or in the field. Its precision incremental measurement system is particularly suitable for many applications such as regulation and stability tests on d.c. voltage sources; temperature coefficient measurements on semiconductors, resistors, etc.; direct strain-gauge tests; calibration of resistance thermometers and piezoelectric transducers; and regulation of generators.

Rectifier probes are available to extend its usefulness to audio and r.f. measurement.

POTENTIOMETRIC SYSTEM

The voltmeter comprises a voltage-measuring potentiometer utilizing, as the null indicator, a sensitive differential electronic voltmeter. The potentiometer is fed from an internal d.c. source whose stability approaches that of a standard cell. It is continuously variable from 0 to 100 volts or 0 to 10 volts in two switch-selected ranges; two further positions of the range switch introduce input attenuators having factors of $\times 2$ and $\times 5$, extending the measurement range to 500 volts.

The meter—used for balance indication and differential measurements—has four switch-selected ranges in decade steps from

50-0-50 mV to 50-0-50 volts full-scale. With its ability to indicate changes of 1 mV in 100 volts, it has an effective scale length of 500 feet.

Provision is also made for applying the unknown voltage directly to the differential voltmeter section with the latter isolated from the potentiometer.

SPECIFICATION

Input voltage ranges

0 to 10 and 0 to 100 volts d.c.; switched internal attenuator gives additional ranges of 0 to 200 and 0 to 500 volts.

INDICATION: By continuously variable helical potentiometer with 3-digit in-line readout.

ACCURACY: 100-volt range: ± 100 mV.

10-volt range: ± 10 mV.

STABILITY: 100-volt range: ± 3 mV/hr; ± 1 mV short-term.

10-volt range: ± 2 mV/hr; ± 0.5 mV short-term.

Meter ranges

50-0-50 mV, 500-0-500 mV, 5-0-5 volts, and 50-0-50 volts full-scale on 10- and 100-volt input ranges. Multiplied by 2 or 5 on attenuated input ranges.

ACCURACY: $\pm 5\%$ of full-scale.

STABILITY: $\pm 1\%$ of full-scale per hour.

Input resistance

Infinite at meter null; greater than 50 M Ω off balance.

Recorder output

± 25 mV at full-scale deflection of meter; 2.5 k Ω source resistance.

Power supply

200 to 250 volts, or 100 to 150 volts after adjusting internal link, 40 to 100 c/s, 35 watts. Models supplied ready for immediate 100- to 150-volt use if specified when ordering.

10% change in supply voltage produces 2 mV change in meter indication.

Dimensions and weight

Height	Width	Depth	Weight
10 $\frac{3}{4}$ in	7 $\frac{3}{4}$ in	7 $\frac{3}{4}$ in	10 lb
(27.5 cm)	(20 cm)	(20 cm)	(4.5 kg)

Accessories available

A.F. Rectifier Probe, Type TM 6530, for a.c. voltage measurement in the range 20 c/s to 10 kc/s.

R.F. Probes are available to special order.

Marconi Instruments Ltd.

St. Albans, Hertfordshire, England

MARCONI
 INSTRUMENTS

Digitizer

Type TF 1325


7287

- ▶ Measures 0 to 0.999 V d.c.
- ▶ Accuracy: ± 1 mV
- ▶ Registers digital result in 20 millisecc
- ▶ Binary coded decimal output will feed other equipment
- ▶ Facilities for use in automatic systems

THE TF 1325 is a fully transistorized analogue to digital converter. Its digital output can be used for rapidly feeding to recording, indicating, or processing equipment, the value of an applied d.c. voltage in the range 0 to 0.999 volt. A binary coded decimal output of three digits enables the input to be read with ± 1 mV accuracy.

The sampling period occupied by a measurement is approximately 20 milliseconds, and may be initiated by remote and automatic control. In this time the input voltage is compared with twelve standardized voltages in descending order of value within the instrument, and a selection is made of those that add to produce a voltage equal to the input. The values selected, and therefore a representation of the input, are registered by the binary coded output. The Digitizer provides a signal when a result is available; the result remains registered until sampling is recommended.

APPLICATIONS

The Digitizer is primarily designed to receive a d.c. voltage as an input, sample its level, and provide the result rapidly and accurately in digital form for application to a decoder and line printer or electric typewriter, thereby enabling a record to be obtained for subsequent reference. Used in this way, it finds particular application in repeatedly monitoring the level of radiation at a number of points in a nuclear power station. Voltages derived from points to be monitored are applied in turn to the Digitizer, and need only be steady over each sampling period. The instrument may be similarly employed in systems for monitoring and recording the state of other industrial or laboratory processes.

In other applications, a voltage existing for a brief period (but over 20 milliseconds), representing a discontinuous process, may be applied to the Digitizer. The instrument,

'started' synchronously, will measure the voltage and hold the result as long as required.

The high speed capabilities of the Digitizer, which are a feature of its uses described above, also make it suitable as a converter translating an analogue voltage into digital form for application to data processing equipment.

The Digitizer is extremely accurate and can be employed, with a suitable indicator, in place of a moving-coil instrument where high accuracy is necessary. Its more rapid response may also be used to advantage where the time allowed for a measurement is short. The Digitizer can be arranged to feed a binary or decimal lamp display, or a decimal display on a bank of meters. With a suitable indicator the reading is unambiguous and no skill is required in interpreting the result; the instrument may therefore be used with advantage for production line measurements.

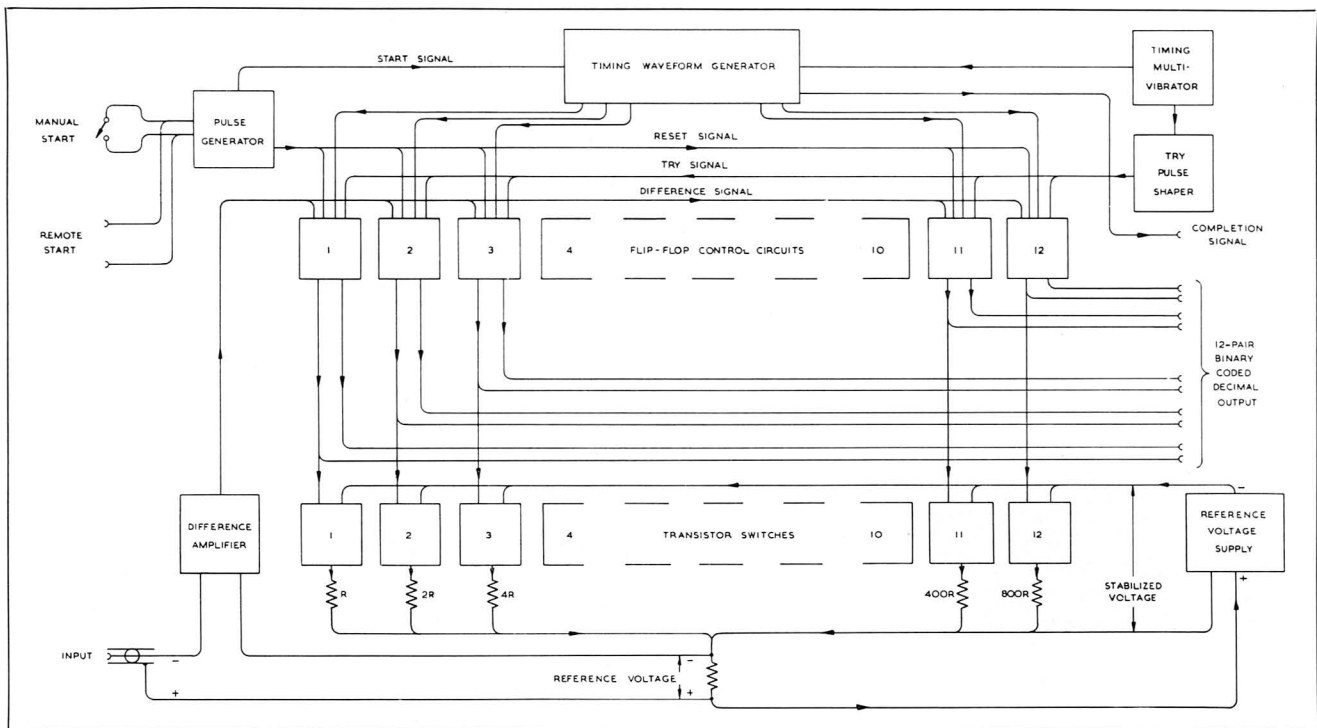
Although the binary outputs are normally in three groups giving a decimal reading of 000 to 999, the Digitizer may be supplied, to special order, modified to provide readings of four figures with a proportional decrease of resolution in the last figure.

BENCH OR RACK MOUNTING

The Digitizer is normally supplied in a case for bench operation, but is also available with a dust cover for mounting in a standard 19-inch rack (where it occupies 10½ inches panel height).

ACCESSORIES

On the basic instrument, a blank sub-panel covers a compartment at the front of the instrument. Into this, decoding and display units can be fitted. Two such accessories, supplied to order, are Decoding Unit Type TM 6183, for feeding a line printer, and Numerical Display Unit Type TM 6184, which provides a decimal display of the measured value with illuminated numbers. Other decoding and display accessories may be supplied to special order.



Block Schematic Diagram of TF 1325

SPECIFICATION

Input

0 to 0.999 volt d.c. Input current taken at completion of sampling, less than $0.15 \mu\text{A}$. Input is floating with respect to case.

Sampling time

Approximately 20 milliseconds.

Output

REGISTER: Three decades of four binary outputs, to provide decimal readings from 000 to 999. Binary code is registered by +10 volts appearing on one or other of a pair of lines for each digit, *i.e.* twelve pairs. (The instrument may be supplied, to special order, with the binary outputs in four groups, but with the same resolution, *e.g.* to provide decimal readings from 0000 to 4995 in units of 5.)

COMPLETION SIGNAL: A negative-going step of 10 volts when sampling is completed, returning to zero when sampling is recommenced.

Accuracy

$\pm 1 \text{ mV}$, providing ambient temperature does not exceed 45°C .

Power supply

200 to 250 volts, or 100 to 125 volts after adjusting internal links, 40 to 100 c/s, 35 watts. Models supplied ready for immediate 100- to 125-volt use if specified at time of ordering.

Dimensions and weight

Height	Width	Depth	Weight
12 in	20 in	17 in	45 lb
(30.5 cm)	(51 cm)	(43 cm)	(20 kg)

Accessories supplied

One *Coaxial Free Plug*, Belling-Lee Type L734/P/A1; for use with input socket.
One *32-way Free Plug*, McMurdo Type RP32; for use with binary output and remote control socket.

Accessories available

Decoding Unit, Type TM 6183. This will fit and connect in the compartment on the front of the Digitizer. Converting the groups of binary outputs of the Digitizer, the Decoding Unit has three corresponding banks of ten outlets on which the values 0 to 9 are individually registered by the presence of an e.m.f. of -20 volts relative to a common line at $+10$ volts; outlet source impedance is approximately $10 \text{ k}\Omega$.

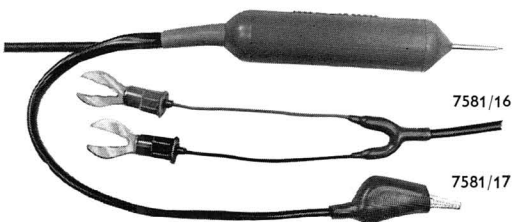
Numerical Display Unit, Type TM 6184. By means of illuminated numbers, this provides a digital display, in decimal form, of the voltage measured.

Hood, Type TD 34345. Fits over Numerical Display Unit for viewing in direct sunlight.

Marconi Instruments Ltd.
St. Albans, Hertfordshire, England

ACCESSORIES

PROBE UNIT

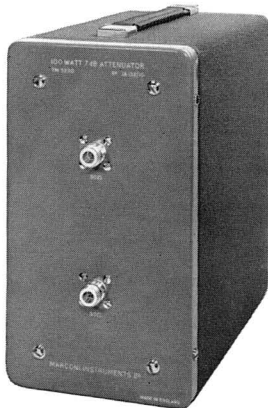


TM 5302

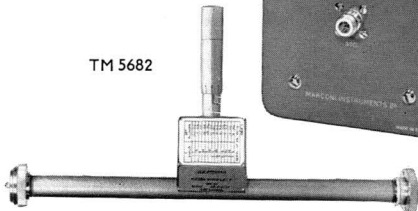
For use with TF 1065-/1. Enables the Test Set to be used as a signal tracer for frequencies between 50 kc/s and 500 Mc/s; it contains a silicon diode rectifier, the output of which is fed to the Test Set by a 4-ft cable.

ATTENUATORS

TM 5280



TM 5682



7581/18

7581/19

For extension of power measurement ranges.

TYPE	ATTENUATION AND IMPEDANCE	FREQUENCY RANGE	CONNECTORS	FOR USE WITH
TM 5280	7 dB 50Ω	150– 185 Mc/s	N	TF 1065
TM 5682	30 dB 50Ω	1,700–2,300 Mc/s	Marconi u.h.f.	TF 1202A
TM 6215	30 dB 50Ω	3,800–4,200 Mc/s	„ „	TF 1202A
TM 5683/1	40 dB 50Ω	1,700–2,300 Mc/s	„ „	TF 1202A
TM 6156	40 dB 50Ω	3,800–4,200 Mc/s	„ „	TF 1202A
TM 5683	43 dB 50Ω	1,700–2,300 Mc/s	„ „	TF 1202A

CARRYING CASE

TM 5947

For use with TF 1202A. Will house the bridge and meter unit, the thermistor head, and the extension units; made of polished hardwood.

MALLORY MERCURY BATTERIES

TYPE SKB 639

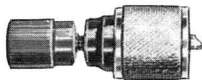
6.75-volt, for use in TF 1202A, in place of Drydex type H1177 batteries normally supplied.

TROLLEY

TM 5917

For use with TF 1341. Tubular steel, upright, with two wheels.

ADAPTOR

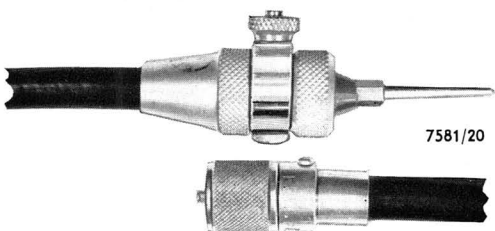


7581/14

TM 5272

For use with TF 1100. Converts normal coaxial input to screw terminals; one end Type 83 plug, other end screw terminal.

PROBE LEAD

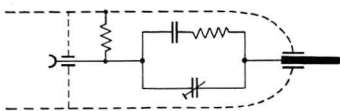


7581/20

TM 5269

For use with TF 1100. A low-capacitance 30-inch coaxial cable assembly; one end Type 83 plug, other end test prod and earth clip.

ACCESSORIES

×10 MULTIPLIER

TM 6154

For use with TF 1371. Increases probe input impedance to 10 MΩ with 2 μF in shunt.

×100 MULTIPLIER

TM 6154/1

For use with TF 1371. Increases voltage range to 30 volts.

A.C. MULTIPLIER (×10)

7289

TM 6067

For use with TF 1300. Extends a.c. measurement range to 1,000 volts r.m.s. for frequencies up to at least 50 Mc/s; nominal input impedance, 5 MΩ with 5 μF in shunt.

A.C. MULTIPLIER (×100)

TM 5032

For use with TF 1041B. Voltages up to 2 kV r.m.s. at frequencies above 10 kc/s can be measured by means of this auxiliary probe cap which comprises a 100:1 capacitive divider.

D.C. MULTIPLIER (×30)

TM 5033A (with connector TM 5749)

For use with TF 1041B. Voltages up to 30 kV can be measured by connecting this multiplier to the d.c. probe of the Voltmeter. It forms a resistive divider of 30:1 ratio, with an input impedance of 3,000 MΩ.

COAXIAL 'T' CONNECTOR

TM 5031A

For use with TF 1041B. When fitted to the a.c. probe it facilitates voltage measurements on 50-ohm coaxial cables. The two series arms of the 'T' are fitted with a Type N plug and socket respectively. It has a v.s.w.r. of the order of 1.1 at 800 Mc/s.

5-watt DUMMY LOAD

TM 5582

For use with TF 1041B. This 50-ohm coaxial load is for use as a well-matched termination in coaxial line measurements. It has a Type N input socket at which the v.s.w.r. is less than 1.1 up to 500 Mc/s and less than 1.2 up to 1,200 Mc/s.

CARRYING CASE

TM 4935

Made of polished hardwood, for stowing the TF 1041B accessories (except the Dummy Load).

DECODING UNIT

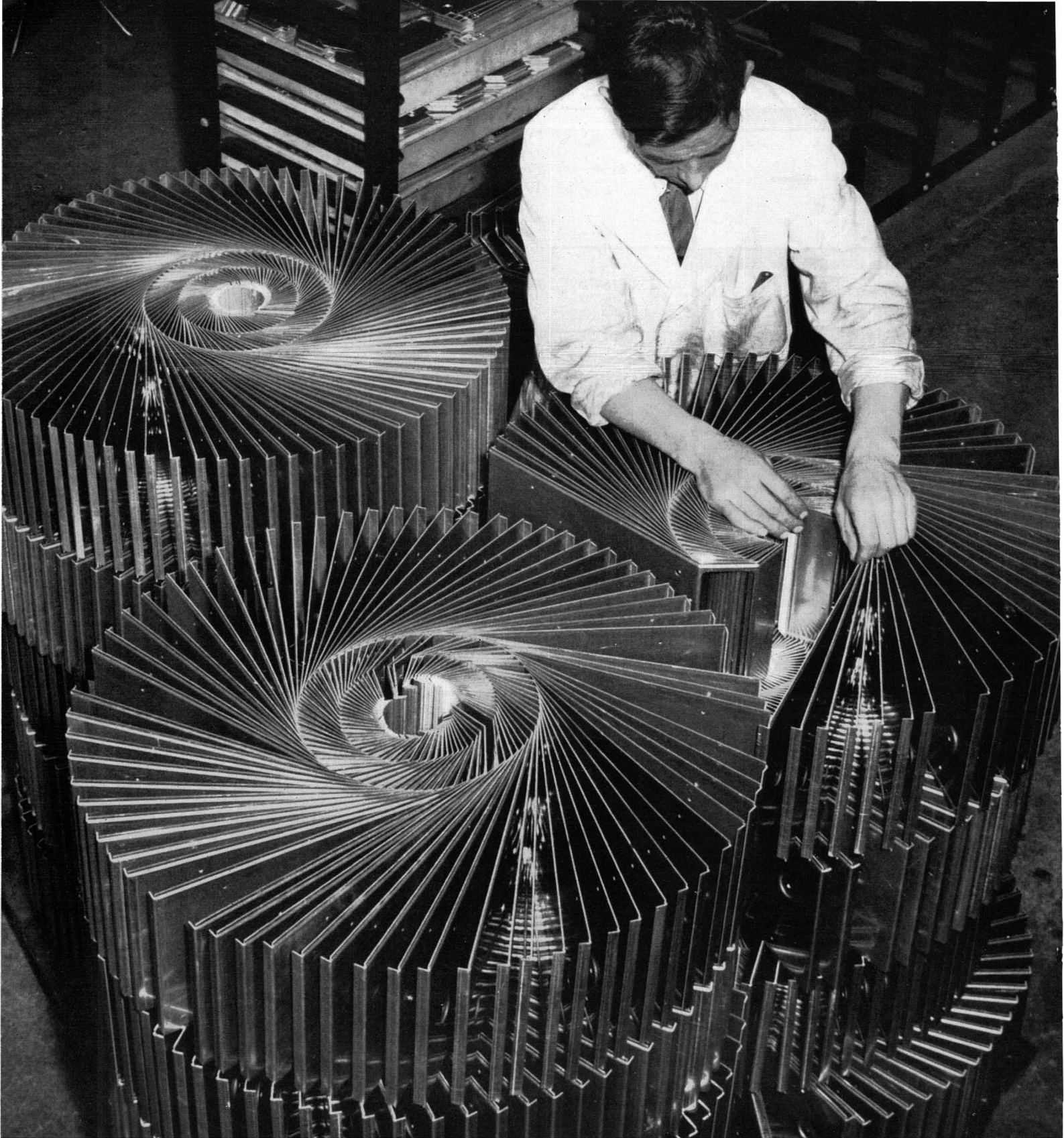
TM 6183

For use with TF 1325. Converts the groups of binary outputs of the Digitizer to three corresponding banks of ten outlets on which the values 0 to 9 are individually registered by the presence of an e.m.f. of -20 volts relative to a common line at +10 volts; outlet source impedance is approximately 10 kΩ.

NUMERICAL DISPLAY UNIT

TM 6184

For use with TF 1325. Provides a digital display, in decimal form, of the voltage measured, by means of illuminated numbers.



Marconi instruments are housed in cases which, both functionally and aesthetically, set a standard of good design. The picture shows an operator stacking centre pieces for instruments cases, after piercing cut-outs on a power press.

5490/3