# OPERATING INSTRUCTIONS

for

# R.F. POWER METER

## TYPES TF 1205 and TF 1205/S

(TF 1205/S only: Joint-Services Designation, Wattmeter Absorption (R.F.) Type CT 401; A.M. Ref. No. 10S/16846)

## WARNING

Be careful to avoid touching the oil used in this Power Meter as it may have harmful effect on sensitive skins. The use of rubber gloves is recommended when carrying out the procedures in Sections 3.1.1 and 3.1.3.

## NOTE

This handbook is issued for use with Instrument Serial No. A735/32. The correction graphs at the end of this handbook apply only to this particular instrument.

AMENDMENTS, if any, are included at the end of the handbook.

CONTENTS

# SCHEDULE OF PARTS SUPPLIED

## TF 1205

1. One R.F. Power Meter Type TF 1205, complete with attached Indicator Unit Lead.
2. One Indicator Unit Type TM 5568.
3. One Signal Input Plug, Coaxial, Type N. Missing
4. One 3/16" A/F Hexagonal Socket Wrench, in linen bag.
5. One Instruction Book No. EB 1205 -/S.

## TF 1205/S

1. One R.F. Power Meter Type TF 1205/S, complete with attached Indicator Unit Lead.
2. One Indicator Unit Type TM 5568/1.
3. One Coaxial Input Lead Type TM 5581.
4. One Elbow Adapter, Coaxial, Type N.
5. One Wavemeter 'T' Connector Type TM 5656.
6. One 3/16" A/F Hexagonal Socket Wrench, in linen bag.
7. One Instruction Book No. EB 1205 -/S.

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## 1.1 GENERAL

The Marconi TF 1205 is a direct-reading absorption-type R.F. Power Meter, for use at any frequency from d.c. to 500 Mc/s. It measures true mean power, irrespective of waveform, up to 500 watts.

Intended for direct connection to a coaxial cable, the instrument has an input impedance of 50 ohms. Its v.s.w.r. is less than 1.15 up to 150 Mc/s, 1.25 up to 300 Mc/s, and 1.35 up to 450 Mc/s. With the use of the correction graph at the end of the handbook, the indication is accurate to within 5% of meter f.s.d. from d.c. to 150 Mc/s, and 7½% of f.s.d. 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 satisfactoril up to 500 Mc/s.

The indicating section of the instrument is a small separate unit, connected by a six-foot length of cable to the main unit. The Indicator Unit may thus be used a short distance away from the main body of the instrument.

The load element is oil-immersed, and the finned outer casing is cooled by free air convection. The instrument is completely self-contained and transportable.

The TF 1205/S, which is identical to TF 1205 except for accessories, has the Joint-Service designation CT 401, and Air Ministry Reference No. 10S/16846.

## 1.2 DESIGN DETAILS

A simplified representation of the electrical circuit and mechanical construction is given in the Functional Diagram, Drawing No. TLC 27640. The Circuit Diagram, Drawing No. TC 27528, gives all the electrical components, and Component List XC 27528 gives values and tolerances etc.

The above drawings, which are at the end of this handbook, are intended to be used in conjunction with the information given below.

The dissipative element consists of a heavy-duty high-stability resistor, R1, which forms the central conductor of a 'slab' transmission line.

1.2 (continued)

Connection from the source of power is made to a type N coaxial socket, the input being fed to the 'live' end of the load resistor by an outward-taper, constant-impedance section of slab-line. From a point in line with the 'live' end of the resistor, the broad cast metal plates which form the outer ('earthy') conductor of the slab line gradually converge down the length of the resistor, and are clamped to its far end. This specially-shaped convergent section matches the transmission line to the resistor throughout its length, decreasing the impedance of the line along the length of the resistor coincidently with the decrease in resistance along the resistor towards earth; this results in an almost reflection-free resistive termination.

Efficient cooling of the load resistor is obtained by immersing the complete slab-line assembly in a tank of transformer oil. The tank is heavily finned for good heat-dissipation. This cooling arrangement allows continuous rating of the instrument at its highest power without the need for further cooling assistance. Special compensators are fitted, to allow expansion of the oil when hot. The compensators consist of blocks of 'Rubazote' (non-absorbent neoprene foam); these are immersed in the coolant and are compressed by the oil pressure as the temperature inside the tank increases. A spring-loaded pressure-relief valve is also fitted, so that any excessive expansion which cannot be handled by the compensators may be relieved.

Power level is indicated by means of a vacuum thermocouple and a moving-coil meter. The heater of the thermocouple is fed from a tap near the 'earthy' end of the load resistor. To compensate for the sensitivity/temperature characteristic of the thermocouple, a thermistor is included in its output lead; this offsets the effect of a decrease in the thermocouple output as the oil temperature rises during measurements, and maintains a constant meter reading for a given power input.

The Indicator Unit, which includes the meter, a preset sensitivity control, and a thermistor-shunting resistor (R5), is a separate unit, and may be clipped on or detached from the main body of the instrument; connection between the main body and the Indicator Unit is made via a six-foot length of screened cable.

The meter has a full-scale deflection of 1 mA, and is calibrated from 0 to 500 watts. The front face of the Indicator Unit is covered by a hinged transparent 'Perspex' plate which protects the meter face.

## 2. OPERATION

### 2.1. GENERAL

The output from the thermocouple is directly proportional to the power in the 50-ohm load. Therefore, the meter deflection is proportional to true mean power, irrespective of waveform. Thus, power contained in harmonics of the input is correctly summed with the fundamental; furthermore, since the meter will indicate the correct increase in power when a.m. is applied to a previously unmodulated input signal, modulation depth can be calculated - see Section 2.5.

### 2.2. CONNECTIONS

The power input connector is a Type N jack, and mates with a Type N (50 ohm) free plug, one of which is supplied with the instrument; in the TF 1205/S version, the plug is supplied complete with a coaxial lead terminated with a free socket, Joint Service ref. No. Z560044 (Burndept Part No. 45945) at the other end. The TF 1205/S is also supplied with a Type N Elbow Adaptor (plug/socket).

A special 'T' connector is supplied with the TF 1205/S; this may be interposed between the power input jack and the incoming plug to allow connection to a wavemeter. The outlet for the wavemeter is a Type BNC jack and mates with a Type BNC (50 ohm) free plug.

The type numbers of the jacks and mating plugs, and of cables for use with the plugs, are as follows:-

| | |
|---|---|
| Input Jack: | Type N; Transradio Ltd. Code No. BEa 071/50. U.S. Military No. UG-23 B/ |
| Mating Plug: | Type N (50 ohm); Transradio GE 071/50, (UG-21 B/U). |
| Cable: | Uniradio 67, (RG-8AU). |
| Elbow Adaptor (Plug/Socket): | Type N (50 ohm); Transradio LEa 071/50, (UG-27A/U). |
| Wavemeter Jack: | Type BNC; Transradio Ltd. Code No. BN 1/5. U.S. Military No. UG-89/U. |

2.2. (continued)

Mating Plug: Type BNC (50 ohm); Transradio BN 1/5, (UG-88/U).

Cable: Uniradio 43, (RG-55/U).

Connection between the main body of the instrument and the Indicator Unit is made by means of a six-foot cable permanently connected to the main unit, and terminated in a telephone plug which is inserted into a jack mounted on the side of the Indicator Unit case.

2.2.1. Adjustment of Signal Level to Wavemeter

The wavemeter outlet on the special T-connector supplied with the TF 1205/S is fed via an internal movable pick-up probe, whose position can be adjusted so that a convenient signal-level is fed to the wavemeter. To adjust the signal level, rotate the knurled nut on the wavemeter outlet arm; rotate the nut in a clockwise direction to increase the signal level to the wavemeter.

2.3. INDICATOR UNIT FIXING

In operation, the Indicator Unit may be separated from the main unit to the extent of the cable, or it may be fixed to the lifting bridge which spans the top of the main body casting of the instrument; this latter position is used when transporting the Power Meter. The Indicator Unit is fixed to the lifting bridge by fitting the slot in the rear of its case over the upper edge of the lifting bridge, and inserting the securing peg which clicks into position. The peg is connected to the main unit by a short length of stranded wire to prevent its loss when not in use. The Indicator Unit can be fixed to either side of the bridge as convenient; the unit is adequately protected from heat rising from the cooling fins. Two spring clips are provided on the side of one of the end cooling fins in order that the Indicator Unit connecting cable may be conveniently coiled onto the main unit. The meter movement of the Indicator Unit is protected during transit by removal of the telephone plug. Contacts, which form part of the jack socket, close and apply a short-circuit across the meter.

2.4. MAKING A POWER MEASUREMENT

Connect the telephone-plug lead on the main unit to the jack on the Indicator Unit.

2.4 Connect the source under test to the coaxial socket at the base of the instrument; the mean power input can then be read directly on the meter.

Due to manufacturing tolerances, the calibration accuracy of the instrument tends to decrease slightly with increasing frequency. The correction graph at the end of the handbook gives factors applicable to the instrument with which this handbook is issued. To apply the correction, first read from the graph the correction factor - for the frequency at which measurement is being made - and multiply the TF 1205 meter reading by it to obtain the true power measurement in watts.

Included in the handbook issued with our earlier models was AMENDMENT No. 1 which gave CORRECTION FOR SCALE SHAPE multiplying factors. Improved design features make this correction no longer necessary.

When using the Power Meter, the following points should be borne in mind: -

1) Although there will be no loss of oil if the instrument is put into a position other than vertical, it must be in a vertical position when power is being measured, in order to allow proper air-convection round all the cooling fins; otherwise overheating may occur.

2) It must be emphasized that the meter indication always corresponds to the power being dissipated within the Power Meter. However, this does not imply that an accurate power measurement is achieved unless the power source accurately matches the load. For optimum measurement accuracy, the power source should be adjusted for maximum power transfer.

3) There is, unavoidably, a small time-lag between the application of power and the meter indication becoming steady. This is due partly to the heating time of the thermocouple, and partly to meter damping caused by the low-resistance meter circuit. After the initial application of power or any change in power level, therefore, it is good practice to wait two or three seconds for the meter reading to stabilize.

4) The peak voltage which may safely be applied to the Power Meter is limited by the insulation of the coaxial connecting plug; this is rated to withstand a maximum of 500 volts. The maximum peak power that may be applied is accordingly of the order of 5 kW. The thermocouple will withstand overloads equivalent to 750 watts mean power input to the instrument (i.e., 50% overload).

2.4 (continued)

5) Although the instrument may safely be operated at maximum power dissipation for extended periods, the attendant overall temperature rise may cause indication errors.

With the instrument operating at full power for 2 hours, indication may change by about ±2% of full scale. Since this error is dependent upon the temperature rise, it will be of a lower order after prolonged operation at powers less than 500 watts. Normal accuracy will be regained when the instrument is allowed to cool.

## 2.5 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 factor, m, are related by

$$P_M = P_C (1 + m^2/2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Transposing and simplifying, Equation (1) gives

$$\text{Modulation Depth} = \sqrt{\frac{2 (P_M - P_C)}{P_C}} \times 100\% \quad \ldots\ldots\ldots (2)$$

Example: From measurements, it is found that $P_C$ = 55 watts, and $P_M$ = 75 watts.

From Equation (2),

$$\text{Modulation Depth} = \sqrt{\frac{2 (75 - 55)}{55}} \times 100\%$$

$$= \underline{85.5\%}$$

2.5 (continued)

In this method it is assumed that no change in carrier level occurs in the source under test when modulation is applied. If this effect is present, the result obtained from equation (2) will be lower than the actual depth of modulation.

# 3 MAINTENANCE

## 3.1 GENERAL

Owing to the robustness and inherent simplicity of the instrument, very little maintenance is likely to be required. If, however, it is considered necessary to check the calibration of the instrument, or replace or top-up the oil in the tank, the procedures given below should be adopted.

### 3.1.1 Replacement of Oil

To replenish or change the oil in the instrument, proceed as follows:-

NOTE: Do not attempt to remove the oil filler plug unless the instrument is cool.

(1) If the Indicator Unit is clipped to the main body of the Power Meter, remove it and put it aside.

(2) Invert the main body and, using a 9/16" Whitworth spanner or equivalent, unscrew and remove the filler-plug, being careful not to damage the special washer.

(3) Fill with oil, well up to the screw threads, using Shell 'Diala B' transformer oil. The oil must be clean, and should be filtered and freed from moisture-content before use. Transformer oils other than Shell 'Diala B' may be used, providing their electrical and physical properties are the same.

Filling can best be accomplished using a syringe or funnel.

To drain the instrument of oil, a length of thin plastic tubing should be inserted well into the tank through the filler hole, before the instrument is reverted over a suitable receptacle. This will prevent the formation of air-locks, and ensure smooth pouring.

The tank holds approximately 1.7 imperial gallons (7.7 litres) of oil.

3.1.2 Checking the Calibration of the Instrument

The accuracy of calibration may be checked, or the instrument may be restandardized, by feeding in measured power at d.c. or at mains frequency. If necessary, the meter sensitivity may be adjusted by means of the preset control, RV1, on the front face of the Indicator Unit. This control is accessible when the hinged plastic protective plate over the front face of the Indicator Unit is hinged down, and the small dome in the recess below the meter face is unscrewed and removed. The procedure for making an adjustment to RV1 is described in Section 3.2.2.

3.1.3 Replacement of Thermocouple and Thermistor

To gain access to the thermocouple and the thermistor, it will be necessary to remove the complete load assembly from the oil-filled tank; for a clean operation, the oil should be drained off (see Sect. 3.1.1) and the instrument should then be inverted and left for a few minutes to drain oil off the load assembly into the top of the oil tank.

To remove the load assembly, proceed as follows:-

(1) With the instrument still inverted, remove the screws which secure the rubber feet to the body. This will release the feet and the cut-out square plate beneath, which should be removed.

(2) Using a 3/16 in. A.F. socket wrench, remove all 24 screws and washers from the periphery of the base plate. The base-plate with the load assembly can now be withdrawn from the oil tank, and should be placed on a clean surface.

The thermocouple assembly is mounted on a machined aluminium block attached to one side of the flat cast slab-line, near the 'earthy' end of the load resistor. To obtain access to the thermocouple assembly, proceed as follows:-

(1) Take out the seven screws and unscrew the two nuts, which secure the cover to the machined block.

(2) Remove this cover and the piece of screening gauge beneath it.

(3) Withdraw the machined block, which may now be placed on a working surface beside the load assembly.

3.1.3 (continued)

To remove the thermocouple unsolder its four lead-out wires. When fitting a replacement thermocouple make sure that, when soldering it into position, it is suspended clear of the sides of the cavity inside which it fits. The black identification spot on the glass envelope denotes the negative lead, which should be connected to the earth tag.

The thermistor is mounted between the two stand-off capacitors C1 and C5 that are with the r.f. filter inductors on one side of the aluminium block.

To remove the thermistor simply unsolder it from the two stand-off capacitors to which it is connected.

NOTE: If the thermistor or the thermocouple are replaced, it may be necessary to change the shunting resistor R5, which is mounted in the Indicator Unit, to a resistor of different value, since this resistor is selected to suit the individual thermistor and thermocouple. The resistor modifies the effect of the thermistor, and its value is chosen so that the net resistance/temperature characteristics exactly compensates for the effect of oil temperature on the thermocouple; that is, so that the meter reading for a given power input does not change as the oil warms up. Section 3.2.1 includes the procedure for selecting the value of this resistor.

To gain access to the thermistor shunt resistor, remove the three small self-threading screws from the periphery of the rear panel on the Indicator Unit. Remove the panel to expose the shunt resistor, which is secured by means of a 4-BA screw and nut - only the nut need be unscrewed in order to extract the resistor.

Reassembly Note:

In order to ensure an oil-tight seal between the base plate and main casting, it is essential that both surfaces are absolutely clean, and that the gasket is in good condition.

Insert the 24 fixing screws and, having made sure that washers are fitted beneath the screw heads, tighten them by an equal amount with the fingers. The socket wrench should then be employed in a manner similar to that used for tightening the cylinder-head bolts of a car engine - the diametrically-opposite screws should be tightened, a small amount at a time, in order to avoid the possibility of distortion.

3.1.3 (continued)

Gradually increase the loading on the screws until they are just sufficiently tight to give an oil-tight seal. Do not overtighten - this could lead to stripped threads in the tapped holes of the magnesium alloy casting.

## 3.2 THERMAL COMPENSATION AND SCALE SHAPE

If the thermocouple or the thermistor are replaced, it may be necessary to change the value of R5 and to make an adjustment to the preset control RV1. It is recommended that, in these circumstances, you carry out the checks and/or adjustments described in Sections 3.2.1, and 3.2.2. When making these checks or adjustments it is recommended that the Indicator Unit be clipped to the main body of the Power Meter.

### 3.2.1 Thermal Compensation

The value of the thermal shunting resistor R5 may be calculated, as follows :-

(1) Feed into the TF 1205 a 50 c/s input of 400 watts, monitored by a standardized dynamometer-wattmeter.

(2) With the Indicator Unit disconnected, measure the thermocouple e.m.f. at the jack plug with a high-impedance instrument (e.g. d.c. potentiometer).

(3) Short circuit the thermistor shunt resistor R5 and reconnect the Indicator Unit.

(4) Allow the instrument to cool to ambient temperature, repeat (1), and adjust RV1 to give an Indicator Unit reading of 400 watts.

(5) Keeping the input power to the instrument constant, note the peak Indicator Unit reading; this peak reading usually occurs within 5 to 30 minutes after the power is first applied.

(6) Note the Indicator Unit reading after the power has been applied for a total period of two hours from the commencement in (4).

3.2.1 (continued)

(7) Calculate the required value of the resistor R5 from the following:-

$$R5 = 1.6\,E\,(P/P1 - 1)$$

Where, E = the e.m.f. measured in (2) expressed in millivolts.
P = the peak value observed in (5)
P1 = the power reading obtained in (6)

(8) Fit the value of resistor calculated in (7) in place of R5 in the the Indicator Unit, if necessary, and remove the short circuit in (3).

3.2.2 Scale Shape and Setting RV1

The preset control RV1 in the Indicator Unit may be adjusted and the scale shape of the meter checked, as follows:-

(1) Feed into the TF 1205 a 50 c/s input of 400 watts, monitored by a standardized dynamometer-wattmeter.

(2) After applying input power for 5 minutes, adjust RV1 to give an Indicator Unit meter reading of 400 watts.

(3) Continue to apply input power for a period of two hours and note the maximum and minimum Indicator Unit meter readings during this time.

(4) From the maximum reading obtained in (3) subtract 400 and record this as the 'positive error'.

(5) From 400 subtract the minimum reading obtained in (3) and record this as the 'negative error'.

(6) From the 'positive error' recorded in (4) subtract the 'negative error' recorded in (5) and divide by two. This resultant figure is the correction to be applied in (8).

(7) Remove the source of input power and allow the TF 1205 to cool to ambient temperature.

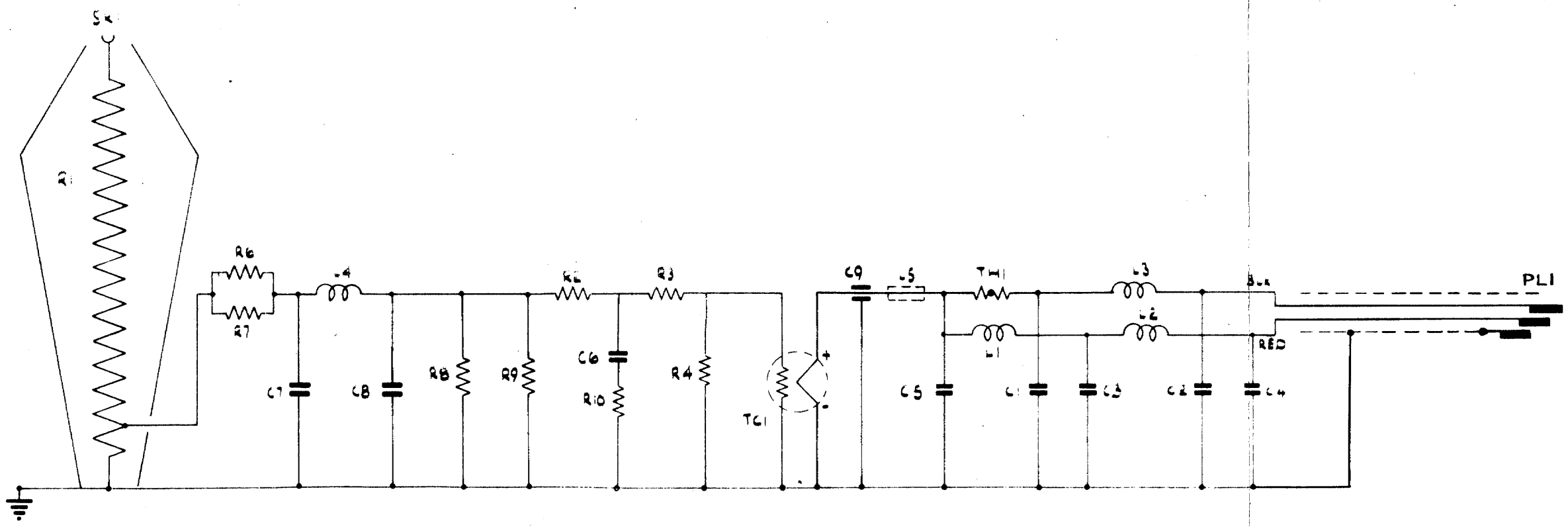
(8) Apply the input power to the instrument as in (1) and, after 5 minutes, adjust RV1 to obtain an Indicator Unit meter reading of 400 less the resultant correction figure obtained in (6).

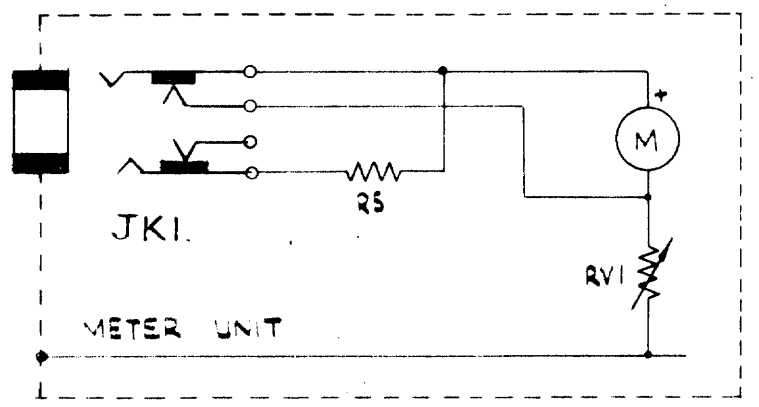
3.2.2 (continued)

NOTE: The error in power indication of the TF 1205 should now not exceed about ±4% at any time within two hours of applying input power constant at 400 watts.

(9) Remove the source of input power and allow the TF 1205 to cool to ambient temperature.

(10) Apply the input power to the instrument as in (1) and check the Indicator Unit meter readings against the dynamometer-wattmeter readings after 5 minutes, 15 minutes, and 2 hours and for inputs of 100, 200, 300, 400, and 500 watts. The difference between the indicated power and the true power measured by the dynamometer-wattmeter should not exceed about ±5% of f.s.d. (i.e. 25 watts).

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| DATE 1-2-62 | WIRING |
| CHKD. | LIST TF1205 |
| APPD. | DRG No. TC 27528 |
| TRCD | |
| MARCONI INSTRUMENTS LTD | |

ISSUE NO. 1

| CIR. REF. | DESCRIPTION | GRID | STOCK LIST REF. | CIR. REF. | DESCRIPTION | GRID | STOCK LIST REF. |
|---|---|---|---|---|---|---|---|
| | RESISTORS | | | | INDUCTORS | | |
| R1 | 50Ω ± 5% | | 13 TM 5580 | L1 | CHOKE | | 26 TM 5580 |
| R2 | 100Ω ± 5% ⅜W | | 28 TM 5580 | L2 | CHOKE | | 26 TM 5580 |
| R3 | 100Ω ± 5% ⅜W | | 28 TM 5580 | L3 | CHOKE | | 26 TM 5580 |
| R4 | 100Ω ± 5% ⅜W | | 28 TM 5580 | L4 | CHOKE | | 25 TM 5580 |
| R5 | 12Ω NOM. SIC. W/W | | 19 TM 5568 | L5 | FERRITE TUBE FX 1115A/1 | | 52 TM 5580 |
| R6 | 100Ω ± 5% ⅜W | | 28 TM 5580 | | | | |
| R7 | 100Ω ± 5% ⅜W | | 28 TM 5580 | | | | |
| R8 | 130Ω ± 5% ⅜W | | 46 TM 5580 | | | | |
| R9 | 130Ω ± 5% ⅜W | | 46 TM 5580 | | METER | | |
| R10 | S.I.C. FROM 150Ω - 2·2K | | 47 TM 5580 | M1 | METER 0 - 1MA | | 1 TM 5568 |
| | | | | | | | |
| | | | | | SOCKET | | |
| RV1 | 25Ω ± 10% ½W | | 8 TM 5568 | SK1 | SOCKET, SPECIAL | | TM 5580 |
| | | | | | | | |
| | CAPACITORS | | | | JACKS | | |
| C1 | 1000PF ± 20% | | 33 TM 5580 | JK1 | PANEL JACK | | 12 TM 5568 |
| C2 | 1000PF ± 20% | | 33 TM 5580 | | | | |
| C3 | 1000PF ± 20% | | 33 TM 5580 | | | | |
| C4 | 1000PF ± 20% | | 33 TM 5580 | | | | |
| C5 | 1000PF ± 20% | | 33 TM 5580 | TH1 | THERMISTOR | | 27 TM 5580 |
| C6 | S.I.C. FROM 2·2PF - 4·7 | | 51 TM 5580 | TC1 | THERMOCOUPLE | | 12 TM 5580 |
| C7 | 4·7PF ± 0·5PF | | 49 TM 5580 | | | | |
| C8 | 4·7PF ± 0·5PF | | 49 TM 5580 | | PLUGS | | |
| C9 | 50PF + 35% - 20% | | 50 TM 5580 | PL1 | JACK PLUG | | 30 TF 1205 |
| | | | | | | | |
| | | | | | | | |

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| DRAWN R.D.T. | CHKD [illegible] | USED ON TF 1205 | COMPONENT LIST XC 27528-- |
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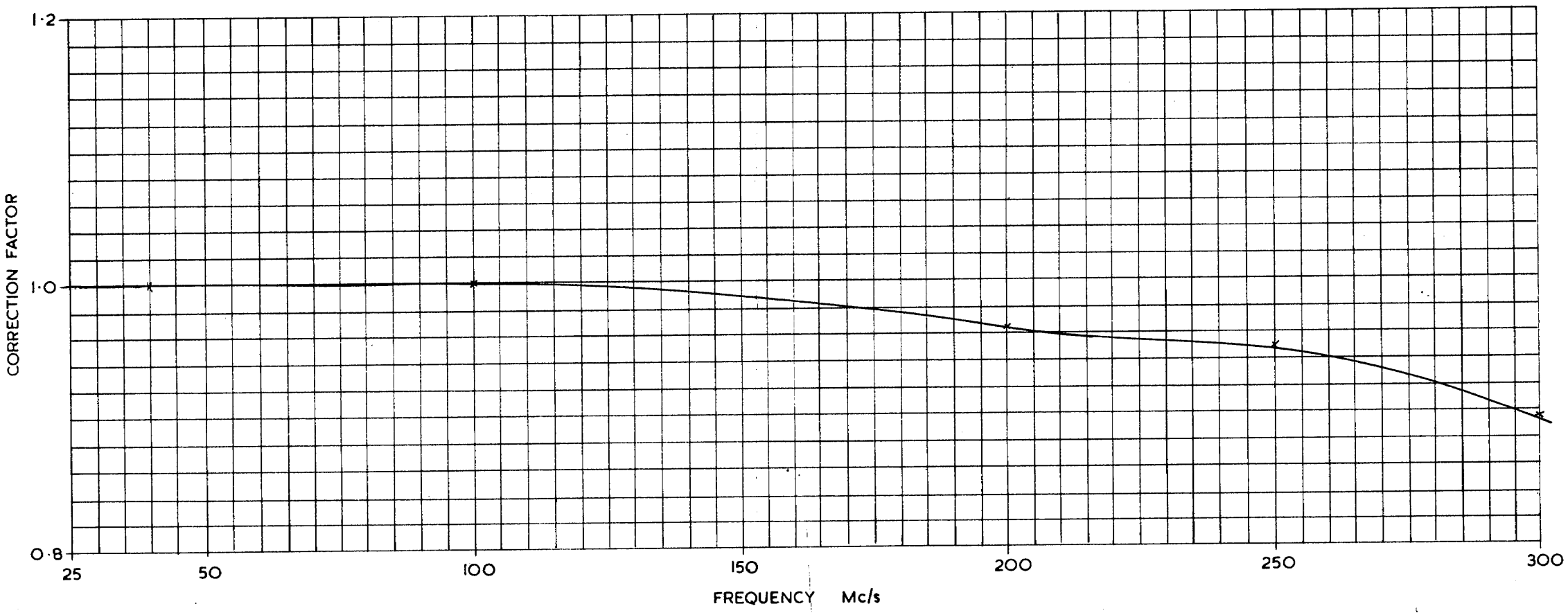


THIS CORRECTION GRAPH
APPLIES TO INSTRUMENT
SERIAL No 1A/735/32

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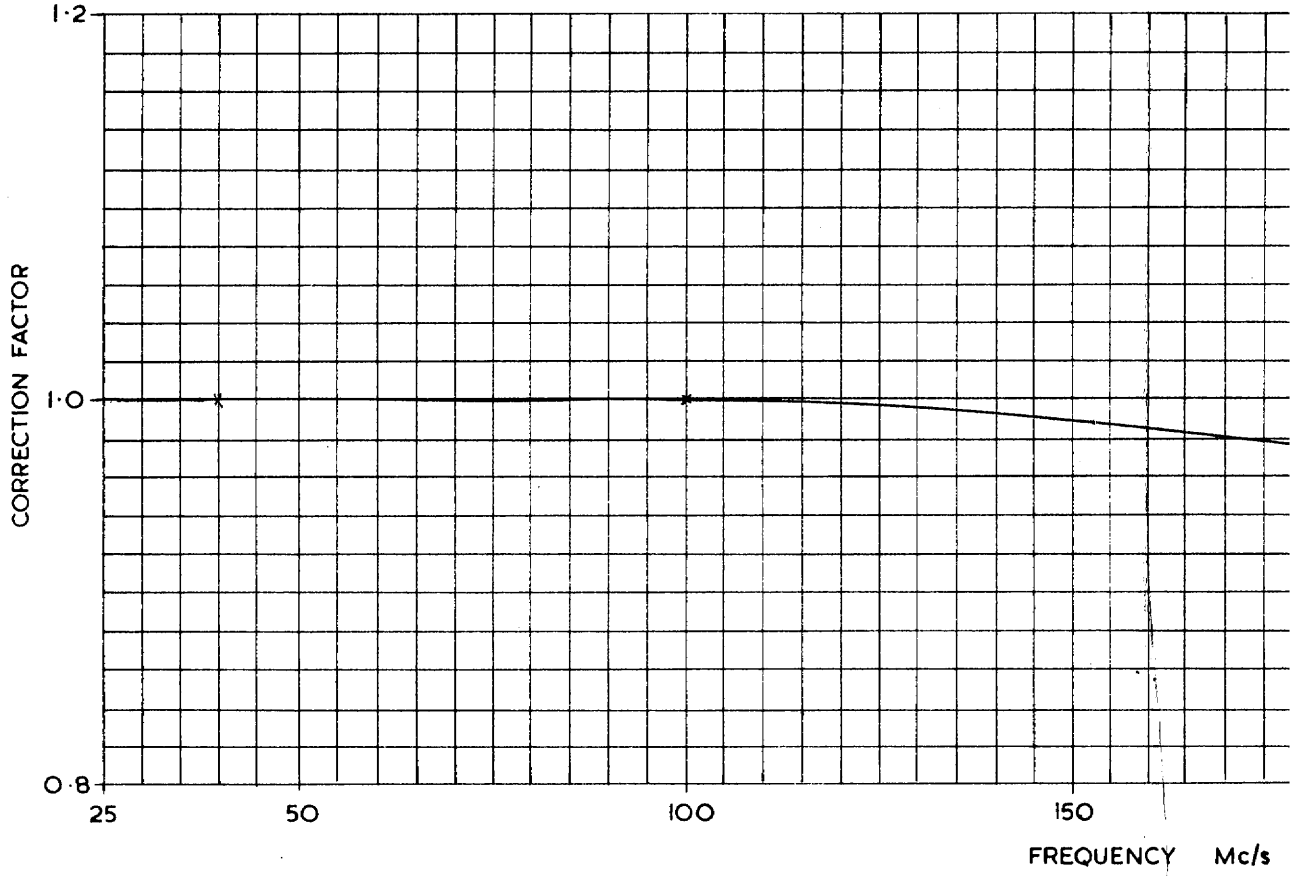
TLC38113
SHEET 1 OF 1 SHEETS

DRG. No.
TLC38113
ISS. 1

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APPLIES TO INSTRUMENT
SERIAL No 1A735/32

DATE 2/62

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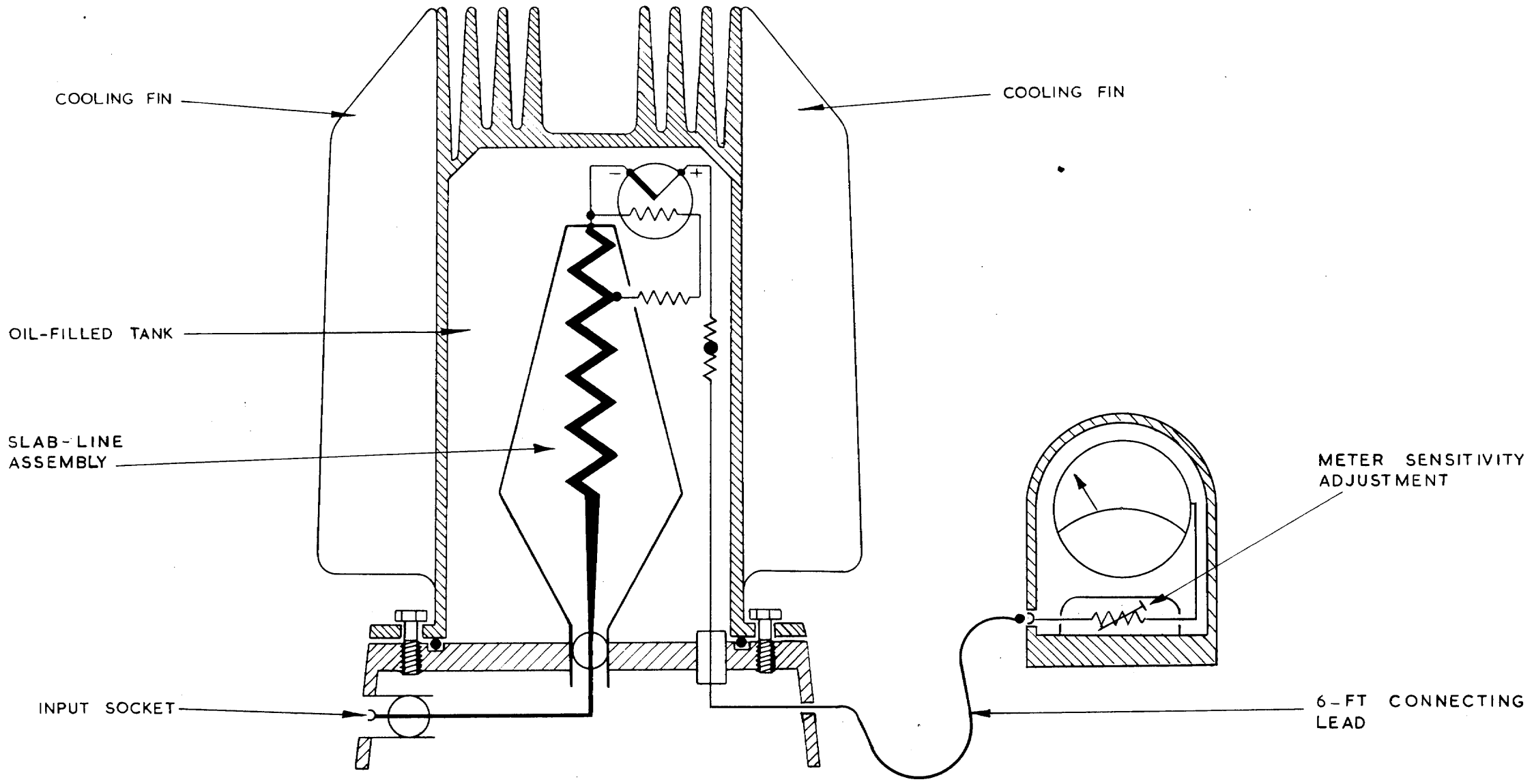



FUNCTIONAL DIAGRAM OF R.F. POWER METERS TYPES TF 1205

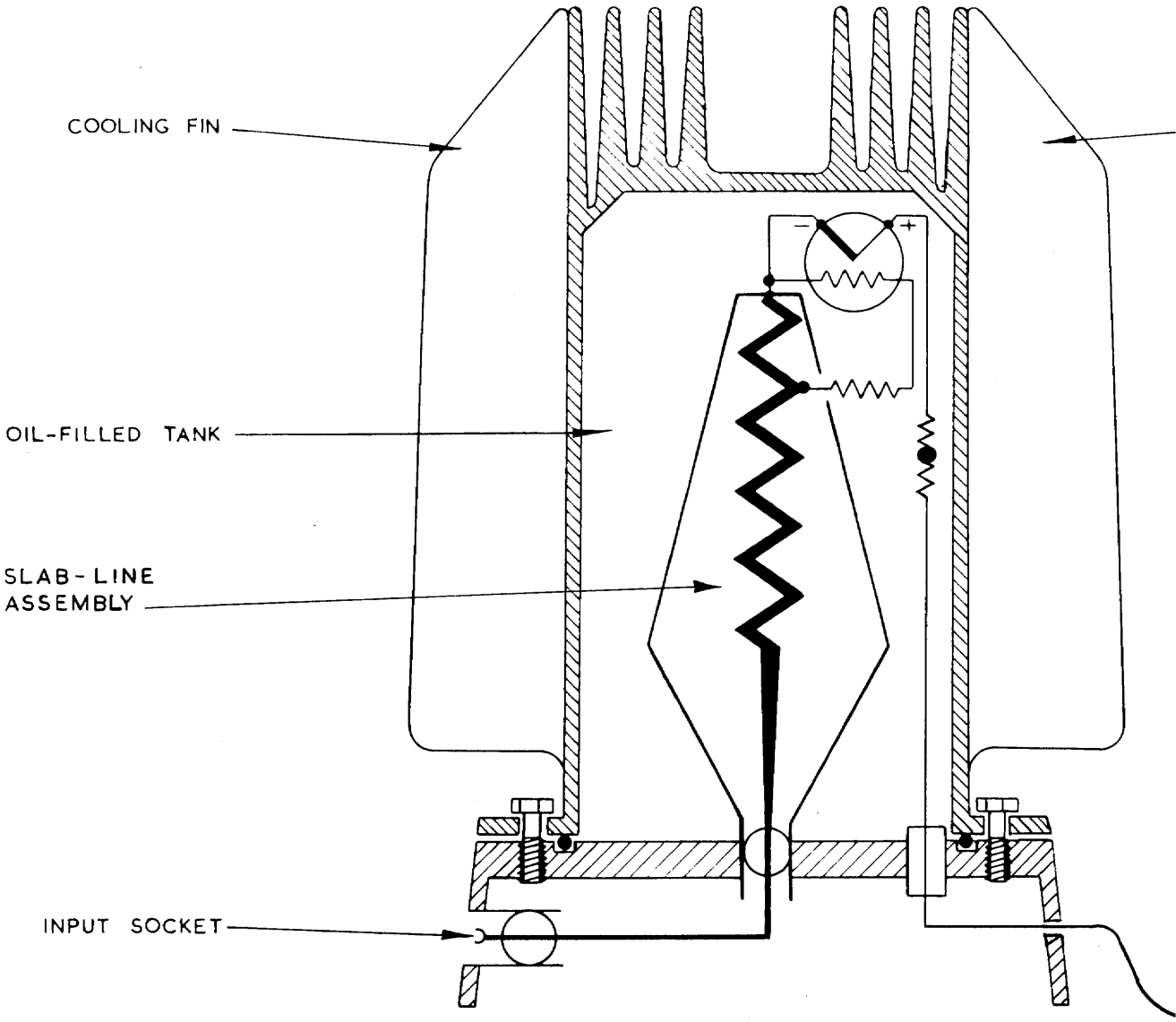
AND TF 1205/S

FUNCTIONAL DIAGRAM

OF

R.F. POWER METERS

TYPES TF 1205 AND TF 1205/S




FUNCTIONAL DIAGRAM OF R.F. POWER M

AND TF 1205/S

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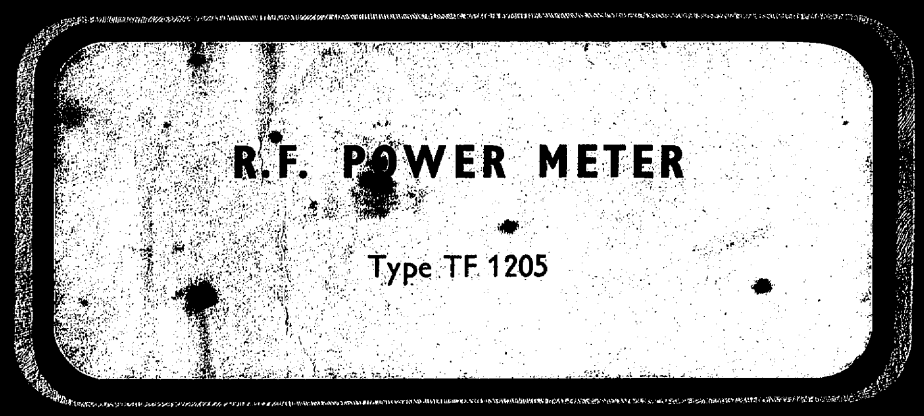
| STOCK LIST | TF1205 | | | DRG Nº | TLC 27640 | | |

# Operating Instructions




MARCONI INSTRUMENTS LIMITED, ENGLAND

Printed in England 3K 2/62 RWL

# Operating Instructions

## R.F. POWER METER

Type TF 1205

MARCONI INSTRUMENTS LIMITED, ENGLAND

Printed in England 5K 2/62 BW L