# WATTMETERS CT 403 AND CT 417

## 6625-99-943-5565 AND 6625-99-943-5566

### (MARCONI INSTRUMENTS TF 1020A/1 AND TF 1020A)

## GENERAL AND TECHNICAL INFORMATION AND SCALE OF SERVICING SPARES

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## LEADING PARTICULARS

Ref. No. ... ... ... ... CT403 : 6625-99-943-5565.
CT417 : 6625-99-943-5566.

Purpose — Portable direct-indication absorption type power meter with linear scale indicating true mean power irrespective of waveform. Neither external power supplies nor internal batteries required.

Power range — 1 to 50 W and 2 to 100 W.

Frequency range — DC to 250 MHz.

Frequency accuracy — Up to 100 MHz ±5% of f.s.d. 100 to 250 MHz ±7.5% of f.s.d.

VSWR — Better than 1.1 from d.c. to 100 MHz. Better than 1.25 from 100 to 250 MHz.

Input impedance — CT 403 : 50 Ω. CT417 : 75 Ω.

Dimensions and weight

| | Height (mm) | Width (mm) | Depth (mm) | Weight (kg) |
|---|---|---|---|---|
| CT403 ... ... ... | 311 | 208 | 433 | 5.2 |
| CT417 ... ... ... | 311 | 208 | 433 | 5.2 |

| | |
|---|---|
| Accessories required | Coaxial plug, Type N for r.f. input socket. 50 Ω for CT403 and 75 Ω for CT417. |
| Commercial equivalent | Marconi Instruments Ltd. TF 1020A/1 (CT403) and TF 1020A (CT417). |

## GENERAL INFORMATION

### Introduction

1. The wattmeters CT417 and CT403 are direct-reading absorption instruments for use at any frequency up to 250 MHz. Each model has two measurement ranges of 50 and 100 watts full-scale- from d.c. to 100 MHz the accuracy of measurement is 5% of full-scale and from 100 to 250 MHz the accuracy is $7\frac{1}{2}$% of full-scale. The CT417 has an input impedance of 75 Ω and the CT403 has an input impedance of 50 Ω. For both models the v.s.w.r. is less than 1.1 from d.c. to 100 MHz and less than 1.25 from 100 to 250 MHz.


Fig. 1 Wattmeter CT417

### Design details

2. The dissipative element in the CT417 and CT403 consists of a heavy-duty high-stability resistor R1 (Fig. 4) which has a tubular ceramic former with a conducting outer coating of cracked carbon. The resistor is mounted in an upward slanting position to assist cooling by convection and forms the central conductor of a slab line of relatively large dimensions. Suitable air vents are provided in the case to allow free air flow; also the interior of the case

and certain parts are sprayed black to assist in heat dispersion.

3. Connection of the power source is made to a type N coaxial socket SK1 on the front panel, the input being fed to the "live" end of the load resistor by an outward taper constant impedance section. From the "earthy" end of the resistor, connection is made back to the input socket through broad metal sheets which serve as the outer conductor to complete the slab line.

4. Indication of power level is achieved by means of a vacuum thermocouple X1 and a moving coil meter M1; the thermocouple heater is fed from a tap near the "earthy" end of the main load resistor. The meter sensitivity is adjusted by two preset series resistors RV1 and RV2, one for each power range; the appropriate preset resistor is brought into circuit by operation of the range switch SW1 mounted on the front panel.

5. Instruments with serial numbers prefixed 826 and above have a thermistor, TH1, with a shunt resistor, R3, added in series with RV1 (Fig. 5) to improve the temperature characteristic of the 100 W range.

## Operation

6. There is a constant ratio between power in the main load and power in the heater of the thermocouple feeding the panel meter. Because of this and the fact that the output from the thermocouple is dependent on the level of power dissipated in its heater, the meter indicates a 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 previously unmodulated input has a.m. applied, modulation depth can be calculated.

## Connections

7. External connection to the wattmeter is effected by type N coaxial socket mounted on the front panel. A suitable type N free plug is supplied with each instrument. Recommended coaxial cables suitable for use with these plugs are as follows :-

CAUTION...

Measurement errors may be incurred if a 75 Ω type plug is inserted in a 50 Ω socket.
Mechanical damage may be done if a 50 Ω type plug is inserted in a 75 Ω socket.
For typical caution label see Fig. 2.

(1) Wattmeter CT417 (75 Ω) :
Great Britain : Joint Service types UR57 or UR60.
United States : Military Nos. RG-11/U, RG-12/U or RG-13/U.

(2) Wattmeter CT403 (50 Ω) :
Great Britain : Joint Service type UR67.
United States : Military Nos. RG-8/U, RG-9/U or RG-10/U.

## Making a measurement

8. Before connecting the instrument to the equipment under test, set the RANGE switch to the position appropriate to the expected power level. If the order of the power level is not known, set the RANGE switch initially to 100 watts. To make a power measurement, connect the source under test to the socket in the front panel of the wattmeter; the mean power to the instrument is read directly on the meter.

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

(1) Air vents are provided, in the case, to assist in the cooling of the load resistor; care should be taken to see that these air vents are not obstructed in any way when the

instrument is in use.

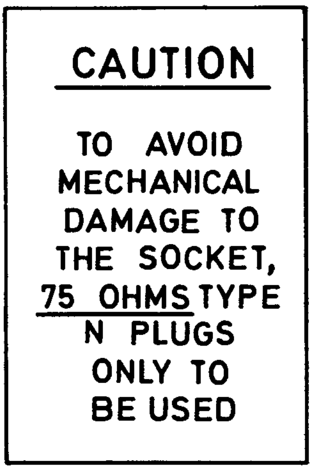


Fig. 2 Caution label (for CT417)

(2) Before making a measurement check that the mechanical-zero adjustment on the meter is correctly set.

(3) Ideally, the impedance presented by the wattmeter to a transmitter under test should be purely resistive. In practice, the wattmeter impedance will, inevitably, include a small reactive component which will be reflected back into the transmitter tuned output circuit. This will have the effect of partially detuning the transmitter output stage. To obtain a true measurement of the lower output capabilities of a transmitter, its output stage should always be tuned to produce maximum indication on the wattmeter. This also applies when substituting one power meter for another.

(4) Due to the time lag in the thermocouple heating and also to the low-resistance meter circuit, a slight delay, of the order of two or three seconds, should be allowed before reading the actual power value.

(5) If the instrument is run at a fairly high power for some time and then a lower power is applied, a suitable period should be allowed for the instrument to attain thermal stability. The time interval will depend on the change in power levels, the degree of accuracy required and the duration of the high-power measurement; in general, sufficient time should be allowed for the residual reading to fall to zero after each measurement.

(6) The peak voltage that can be applied to the wattmeter is limited by the input socket insulation; this is rated to withstand a maximum of 500 volts. The peak power that can be applied to the 75 Ω CT417 is accordingly of the order of 3 kW and, for the 50 Ω CT403, 5 kW.

Temperature correction (Fig. 3)

10. Wattmeters of this type are calibrated in such a manner that optimum accuracy is obtained when the ambient temperature is 20°C (68°F). A typical temperature/accuracy chart, Fig. 3, may be used to obtain greater accuracy at other ambient temperatures. Protected power measurement will cause an air-temperature increase within the instrument, leading to long-term drift. All measurements should, therefore, be made as rapidly as possible. For greater accuracy time should be allowed between measurements for the meter to revert to ambient temperature, as described in para. 9.

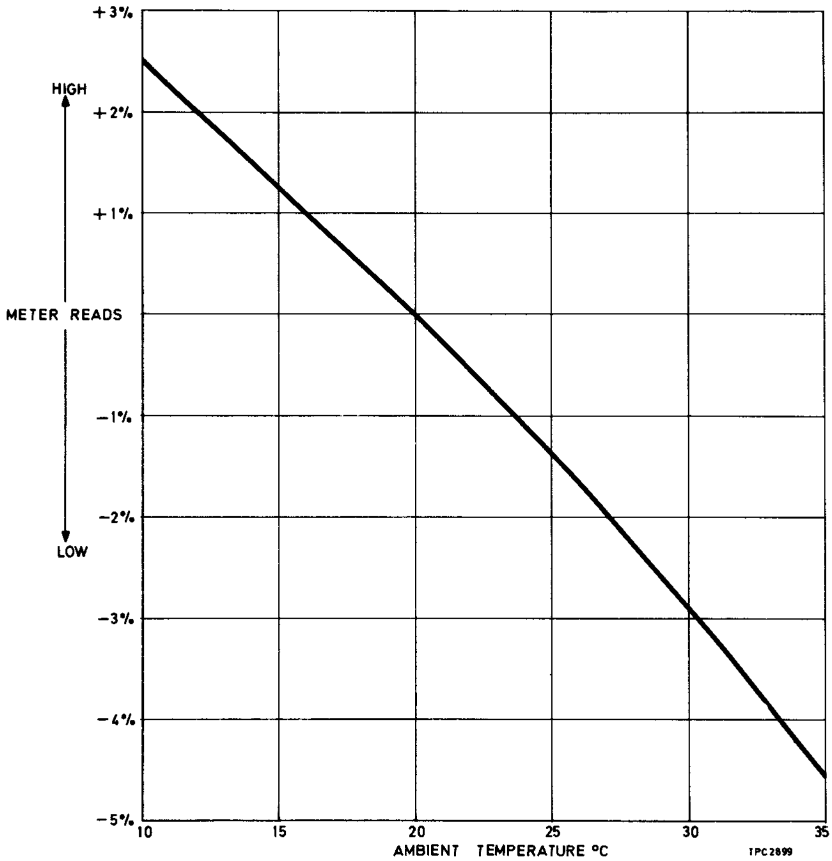


Fig. 3 Temperature correction chart

Determination of modulation depth

11. 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

$$P_M = P_C \left(1 + \frac{m^2}{2}\right)$$

Transposing and simplifying this equation becomes

$$\text{Modulation depth} = \sqrt{2\left(\frac{P_M - P_C}{P_C}\right)} \times 100\%$$

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

$$\text{Hence, modulation depth} = \sqrt{2\left(\frac{75 - 55}{55}\right)} \times 100 = 85.3\%.$$

CAUTION...

Component parts of this power meter must not be dismantled nor rearranged except by authorized personnel.

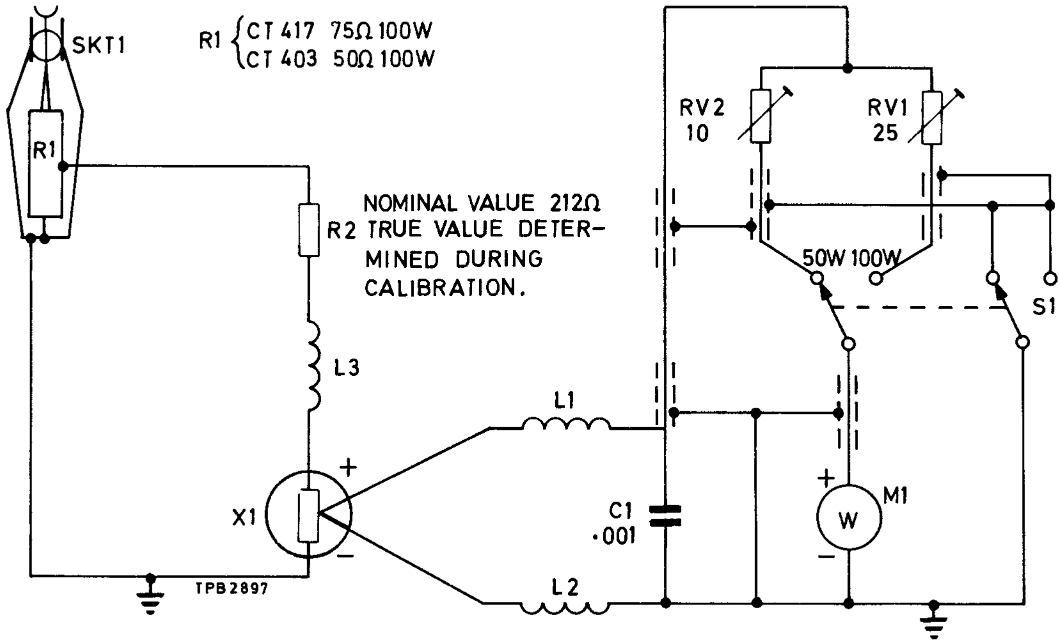


Fig. 4 Wattmeter CT403 and CT417 - old circuit

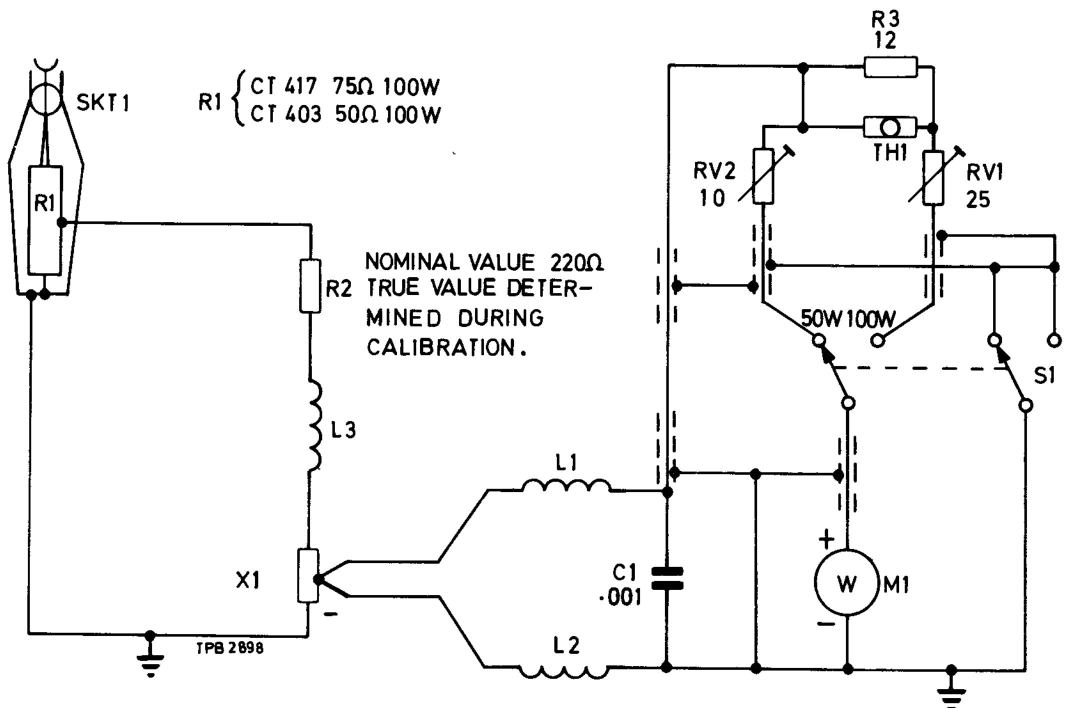


Fig. 5 Wattmeter CT403 and CT417 - modified circuit

TOPIC 3D

# SCALE OF SERVICING SPARES

FOR

6625-99-943-5565
6625-99-943-5566

# WATTMETERS CT403 and CT417

This Scale of Servicing Spares is based on the most up-to-date information available at the time of printing. Any aspect of the scale thought to be unsatisfactory is to be reported in accordance with AP 3158 Vol 2 (2nd Edition) Leaflet D6 (as amended) to Ministry of Defence (ADSM 25) RAF Via Command Headquarters.

## COLUMN HEADINGS AND SPECIAL NOTES

Col. 1 - Section and reference number.

Col. 2 - Nomenclature.

Col. 3 - Qty off per equipment.

Col. 4 - 4 months station holding to support one equipment.

Col. 5 - 4 months station holding to support two equipments.

Col. 6 - 4 months station holding to support three equipments.

Note (1) Quantities scaled in Cols. 4, 5 and 6 are maximum station holdings.

Note (2) Items marked with an asterisk (*) in Col. 4 may be demanded on a one-for-one basis by user units.

Col. 7 - 6 months 3rd line test equipment repair unit holding. Items marked with an asterisk (*) are to be demanded on a one-for-one basis as required.

Col. 8 - Items marked Ø affect calibration of the equipment.

Col. 9 - Circuit reference, part number or other reference.

Note (3) A scale of servicing spares is given for each of the two instruments.

| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | | WATTMETER CT403 | | | | | | | |
| 10AC | 9553549 | Nut, plain, round, 6BA | 1 | | | | * | | |
| 10AE | 9437944 | Thermocouple, heating element, 25mA, glass | 1 | | | | 1 | ø | |
| 10AR | 9118392 | Clamp, electrical, brass, 1 13/16 in. dia. of loop | 1 | | | | * | | |
| | 9403448 | Cap, spindle end | 1 | | | | * | | For Shaftlock |
| 10AS | 0120237 | Shaftlock, electronic component | 1 | | | | * | ø | For RV2 |
| | 0122985 | Shaftlock, electronic component | 1 | | | | * | ø | For RV1 |
| 10C | 1028060 | Inductor, radio frequency | 1 | | | | 1 | ø | L3 |
| | 9118390 | Inductor, radio frequency | 2 | | | | 1 | | L1,2 |
| | 9149690 | Capacitor, fixed, 0.001μF +100%-0% 500V | 1 | | | | 1 | | C1 |
| 10F | 0510504 | Switch, lever operated | 1 | * | | | 1 | | |
| 10H | 1052555 | Socket, electrical and block assay. | 1 | | | | 1 | | |
| | 9118393 | Clip, electrical, brass, 1 3/4 in. dia. of loop | 1 | | | | * | | |
| | 9401095 | Plug, electrical, free, coaxial | 1 | * | | | 1 | | |
| 10W | 0136099 | Resistor, fixed, 200Ω ±5% ½W | 1 | | | | 1 | ø | ) Select |
| | 0136100 | Resistor, fixed, 220Ω ±5% ½W | 1 | | | | 1 | ø | ) on test |
| | 0136101 | Resistor, fixed, 240Ω ±5% ½W | 1 | | | | 1 | ø | ) for R2 ) |
| | 9116609 | Resistor, variable, 25Ω ±10% 2W | 1 | | | | 1 | ø | RV1 |
| | 9116610 | Resistor, variable, 10Ω ±10% 2W | 1 | | | | 1 | ø | RV2 |
| | 9116611 | Resistor, fixed, 50Ω ±5% 100W | 1 | | | | 1 | | R1 |
| | 9559671 | Resistor, fixed, 12Ω ±1% ½W | 1 | | | | 1 | ø | R3 |
| | 9726273 | Resistor, thermal, 14Ω at 20°C 1.4V max. | 1 | | | | 1 | ø | |
| 10S | 9437943 | Wattmeter, 0-50W; 0-100W | 1 | | | | 1 | ø | |
| | | WATTMETER CT417 | | | | | | | |
| 10AC | 9110967 | Screw, machine, 6BA, 3/8 in lg. | 4 | | | | * | | |
| 10AE | 9437944 | Thermocouple, heating element | 1 | | | | 1 | ø | |
| 10AK | 9493276 | Handle, luggage | 1 | | | | * | | |
| 10AR | 9118392 | Clamp, electrical, brass, 1 13/16 in. dia. of loop | 1 | | | | * | | |
| | 9325186 | Clamp, loop, 3/16 in dia. loop | 1 | | | | * | | |
| 10B | 0560881 | Insulator, standoff | 1 | | | | * | | |
| 10C | 9408937 | Capacitor, fixed, 1000pF+100%-0% 500V | 1 | | | | 1 | | C1 |
| 10F | 9439141 | Switch, toggle | 1 | * | | | 1 | | |

| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| <u>10H</u> | 1026706 | Socket, electrical | 1 | | | | 1 | | SK1 |
| | 5803675 | Plug, electrical, 75Ω | 1 | * | | | 1 | | |
| | 9118393 | Clip, electrical, brass, 1 3/4 in dia. of loop | 1 | | | | * | | |
| <u>10W</u> | 9116609 | Resistor, variable, 25Ω ±10% 2W | 1 | | | | 1 | ø | RV1 |
| | 9116610 | Resistor, variable, 10Ω ±10% 2W | 1 | | | | 1 | ø | RV2 |
| | 9409497 | Resistor, fixed, 75Ω ±5% 100W | 1 | | | | 1 | | R1 |