MARCONI
INSTRUMENTS

EB 1020A - A/1
2 * - 3/57

OPERATING AND MAINTENANCE HANDBOOK

for

R.F. POWER METER

TYPES TF 1020A and TF 1020A/1

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

Marconi Instruments Limited, St. Albans, Hertfordshire, England. Telephone : St. Albans 59292

CONTENTS

SCHEDULE OF PARTS SUPPLIED

1. One R.F. Power Meter Type TF 1020A or TF 1020A/1, as ordered.
2. One Type N coaxial free plug, either 75-ohm or 50-ohm fitting, as appropriate.
3. One Operating and Maintenance Handbook No. EB 1020A -A/1.

1. DESCRIPTION

1.1. GENERAL

The Marconi R.F. Power Meters Types TF 1020A and TF 1020A/1 are direct-reading absorption instruments for use at any frequency up to 250 Mc/s. Each model 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 from 100 to 250 Mc/s the accuracy is 7½% of full scale. The TF 1020A has an input impedance of 75 ohms and the TF 1020A/1 an input impedance of 50 ohms. For both models, the v.s.w.r. is less than 1.1. from d.c. to 100 Mc/s and less than 1.25 from 100 to 250 Mc/s.

1.2. DESIGN DETAILS

The dissipative element in the TF 1020A and TF 1020A/1 consists of a heavy-duty high-stability resistor (R1) 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.

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.

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.

2. OPERATION

2.1. GENERAL

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 because, of course, the output from the thermocouple is dependent on the level of power dissipated in its heater, the meter indicates 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.

2.2. CONNECTIONS

Connection is made to the R.F. Power Meter by means of a type N coaxial socket mounted on the front panel; a suitable type N free plug to mate with this socket is supplied with each instrument. The type numbers of coaxial cables suitable for use with the plugs are as follows:-

TF 1020A (75 ohms)

Great Britain:	Joint-Service types UR57 or UR60.
United States:	Military Nos. RG-11/U, RG-12/U, or RG-13/U.

TF 1020A/1 (50 ohms)

Great Britain:	Joint-Service type UR67.
United States:	Military Nos. RG-8/U, RG-9/U, or RG-10/U.

2.3. MAKING A MEASUREMENT

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.

2.3 (Continued)

To make a power measurement, connect the source under test to the socket on the front panel of the R.F. Power Meter; the mean power input to the instrument is read directly on the meter.

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.

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

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

(4) Due to the time lag in 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.

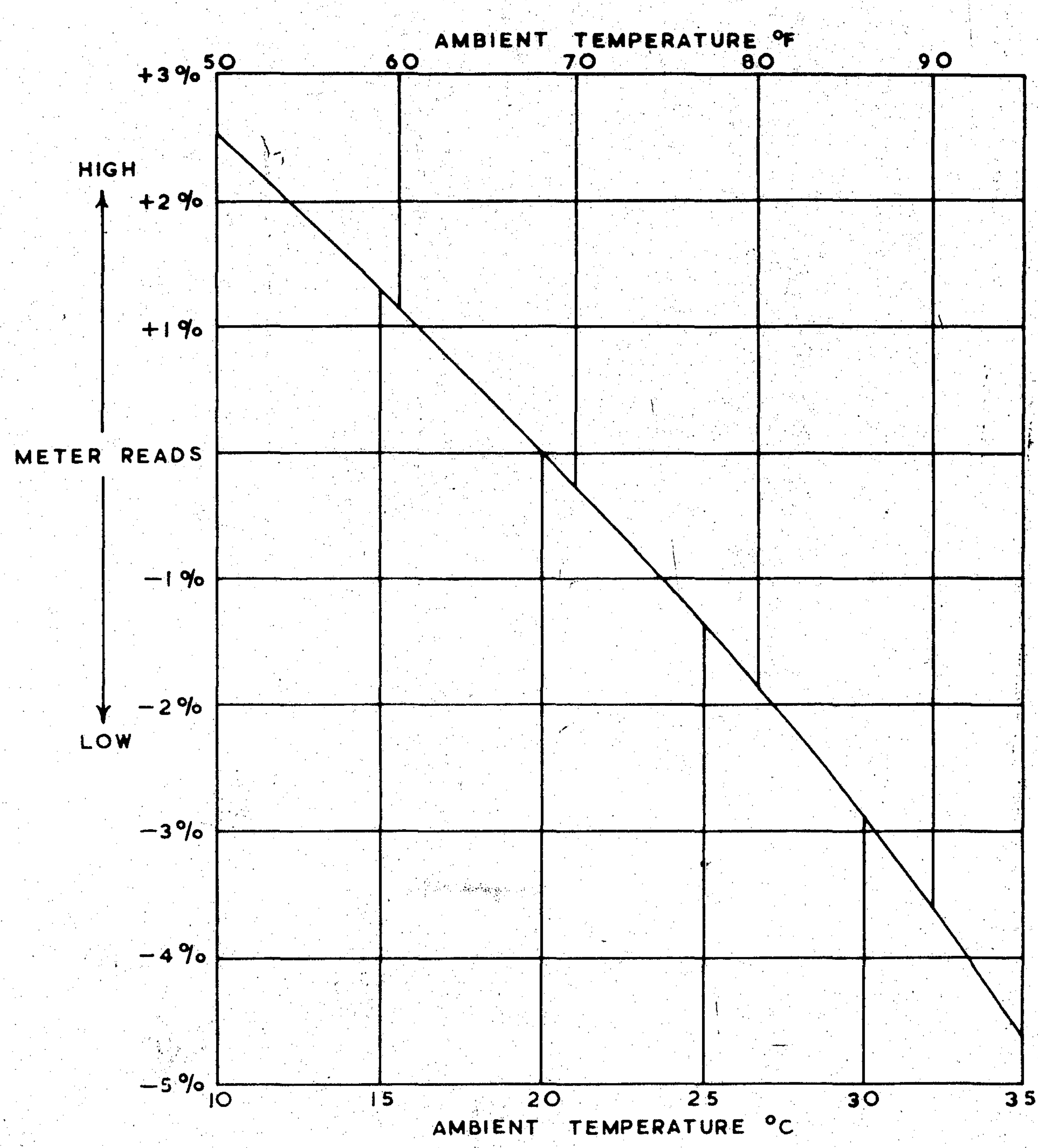
(5) If the instrument is run at a fairly high power for some time and then a lower power is applied, a suitable period should be allowed for the instrument to attain thermal stability. The time interval will depend on the change in power levels, the degree of accuracy required and the duration of the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

TEMPERATURE CORRECTION

R.F. Power Meters of the TF 1020A Series are calibrated in such a manner that optimum accuracy is obtained when the ambient temperature is 20°C (68°F). The typical temperature/accuracy curve, shown below, may be used to obtain greater accuracy at other ambient temperatures.

Protracted power measurements 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 greatest accuracy, time should be allowed between measurements for the Power Meter to revert to ambient temperature, as described in Section 2.3. of the handbook.



2.3. (Continued)

(6) The peak voltage that can be applied to the R.F. Power Meter 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-ohm TF 1020A is accordingly of the order of 3 kW and, for the 50-ohm TF 1020A/1, 5 kW.

2.4. 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

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

Transposing and simplifying, equation (1) gives

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

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

Hence, from equation (2),

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

$$= 85.5\%.$$

3.2.1 Removal of Case

To detach the case, remove the four coin-slotted screws from the rear panel. The instrument may then be withdrawn from the case giving full access to all components.

NOTE: On some instruments the case was secured by means of four chromed-headed screws around the front edge of the instrument case rear section.

3.2.2 The Thermocouple (X1)

To detach the thermocouple, first remove L1 and L2 from their respective thermocouple leads. Then detach the two screws holding the retainer strip in position and remove this strip; finally disconnect the two thermocouple leads from the chassis and L3. When fitting a replacement thermocouple, the reverse procedure should be followed.

The heater wires emerge from the glass seal diametrically opposite to each other; the couple leads emerge close together the positive lead being identified by a red dot on the glass seal. When connecting the components to the thermocouple leads, do not solder the wires closer than about 0.5 cm. from the glass seal; if it is found necessary to bend the leads, the bend should not be made closer than about 2 mm from the glas seal.

3.2.3 The Load Resistor (R1)

The simplest method of removing the load resistor is as follows :

(1) Unsolder R2 from the tapping band on R1.

(2) Loosen the band which secures the outward-taper section to the "live end" of the load resistor. The screw and nut holding the band are accessible through two small holes in the side plates. Pull the band clear of the resistor towards the input socket.

3.2.3. (Continued)

(3) Slacken the four 2-BA screws clamping the "earthy" end of the resistor to the side plates. The resistor can now be pulled towards the front panel and removed from the instrument.

To replace the load resistor reverse the above procedure. A replacement resistor is supplied already tested in accordance with the procedure detailed in Section 3.3.2.

3.2.4. The Outward-Taper Constant-Impedance Section

If it is desired to remove the outward-taper section, release the clamping band as described in (2) of Section 3.2.3., and then remove the cylindrical, slotted-head nut securing the input end of the section to the coaxial socket on the front panel.

3.3. SCHEDULE OF TESTS

The following information, based on abstracts from the internal Factory Test Schedule TS 1020A -A/1, is included to enable the user to carry out a series of tests by which the main points of performance of the instrument can be checked; it also gives details concerning adjustment to preset components and the choice of value for individually selected components.

3.3.1. Apparatus Required

(a) Wheatstone Bridge.

(b) Variable D.C. Source; 0 to 30 volts.

(c) D.C. Voltmeter; 0 to 30 volts.

(d) Signal Generator; 100 to 250 Mc/s; Marconi Types TF 801B (Series) or TF 1066 (Series) - both 50-ohm output; for 75-ohm output, use these instruments in conjunction with 50-ohm to 75-ohm Matching Unit Type TM 4918.

3.3.1. (Continued)

(e) V.S.W.R. Measuring Device, characteristic impedance to suit Power Meter under test; operating range 100 to 250 Mc/s; preferably a slotted line or standing wave meter, but an impedance bridge can be used and the v.s.w.r. calculated from measured susceptance and conductance values.

(f) Variable A.C. Source; capable of delivering 100 watts at normal power-supply frequency.

(g) Dynamometer Wattmeter; 0 to 100 watts.

(h) Standardized R.F. Power Meter; Marconi Types TF 1020A or TF 1020A/1 (as appropriate).) See Section 3.3.5.

(i) Stable R.F. Power Oscillator; 100 to 250 Mc/s, Variable output, 100 watts or greater.) See Section 3.3.5.

3.3.2. <u>Preliminary Checks</u> (Apparatus Required: Items a, b and c)

The three checks described in this sub-section are carried out on all replacement resistance units before despatch. Therefore, if a replacement unit has been fitted, these checks can be omitted.

(1) Measure the cold d.c. resistance of R1 between the centre conductor of the input socket and chassis. The actual resistance should be within ±5% of the nominal value.

(2) Apply a voltage of 27.4 volts (TF 1020A) or 22.36 volts (TF 1020A/1) to the input socket. Check that the voltage developed between the tapping band and the "earthy" end of the load resistor is 4 volts ±10%.

(3) Measure the linearity of the resistor by means of a d.c. potential-divider method. The simplest way of doing this is to apply a known voltage across the whole resistance and then to measure the voltage developed across (i) a quarter, (ii) a half, and (iii) three-quarters of the resistance length.

3.3.2. (Continued)

When making contact to the body of the resistor, do not use a sliding connection as this will tend to scrape the carbon surface off the resistor. The resistance/length characteristic should be linear to within ±10%.

3.3.3. Standing Wave Ratio (Apparatus Required: Items d and e)

For the Power Meter to act as a good match to a transmission line, its v.s.w.r. must be as close to unity as possible. In the TF 1020A series of Power Meters, v.s.w.r. is a function of the general configuration and spacing of the slab line side plates. This spacing can be varied by means of the screws marked "P" and "Q" on illustration MP 1020A -1. The following paragraphs give the method of adjusting these screws. Normally, this adjustment is best made at 250 Mc/s because, characteristically, the ratio progressively improves with decrease in frequency. However, it is advisable to check the v.s.w.r. at lower frequencies as well.

Connect the v.s.w.r. measuring device to the Power Meter input socket and set its operating frequency to 250 Mc/s, or as near 250 Mc/s as is convenient. Determine the v.s.w.r. of the Power Meter; it should be less than 1.25. If the v.s.w.r. is greater than this adjust screws "P" and "Q". The spacing between the slab plates can be increased or decreased as necessary in order to obtain minimum v.s.w.r., but the plates should always be kept parallel. During the original factory calibration procedure, fine adjustment of the v.s.w.r. is made by means of screws "P" and "Q"; and coarse adjustment by the addition of 30-thou shims between the inside front end of the slab plates and the mounting block to which the plates are secured. If R1 has not been replaced, any adjustment that may be necessary can normally be made with "P" and "Q". If R1 has been replaced and if the v.s.w.r. requirements cannot be met by reasonable adjustment of "P" and "Q", it will then also be necessary to remove some of the shims or, alternatively, add to those already in position.

Complete the test by checking the v.s.w.r. at a selection of frequencies down to 100 Mc/s; the v.s.w.r. should be less than 1.25. Below 100 Mc/s the v.s.w.r. should be less than 1.1.

3.3.4. Calibration Accuracy at L. F. (Apparatus Required: Items f and g)

The power-reading accuracy is best checked at a low frequency - usually the frequency of the local power supply - and then compared with that of a standardized mean-reading power meter near the upper limit of the frequency range. This section deals with the l.f. tests and Section 3.3.5. which follows describes the r.f. tests.

(1) Connect the dynamometer wattmeter between the l.f. supply and the Power Meter under test. The current and voltage coil connections should be arranged for minimum error due to internal losses, and allowance should be made for the error if appreciable.

(2) Set the RANGE switch to 100 WATTS and apply a known power of 75 watts.

(3) Adjust RV1 so that the meter indicates 75 watts.

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

(5) Increase the applied power in known increments and check the scale shape of the 100-watt range. It should be such that readings are accurate to within about 2% of full scale; if the accuracy is less than this it will not normally be possible to attain the specified power measurement accuracy of ±5% of full scale in the high-frequency tests detailed in Section 3.3.5. If the scale shape is not satisfactory at the top end of the scale, it can be corrected by moving the tapping band on R1 slightly towards the "earthy" end. When moving the band, take care that the carbon surface of the resistor does not get scratched and damaged. As the correct setting for RV1 is dependent on the position of the tapping band, if the tapping band is adjusted it will be necessary to readjust RV1 as described in (2) and (3) above. If the tapping band is moved too far, then the coverage of RV1 will be insufficient. The band should then be moved back slightly until a position is found where both the coverage and scale-shape requirements are met.

(6) Set the RANGE switch to 50 WATTS and apply a known power of 40 watts.

3.3.4. (Continued)

(7) Adjust RV2 so that the meter indicates 40 watts.

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

(9) Increase the applied power in known increments and check the scale shape of the 50-watt range. The actual power indicated at any level, should be within ±2% of full-scale deflection.

3.3.5. Calibration Accuracy at R.F. (Apparatus Required: Items h and i)

After the calibration accuracy has been checked at l.f. as described in Section 3.3.4., the Power Meter should, if possible, be compared with a TF 1020A or TF 1020A/1 of established accuracy. The comparison should be carried out at a frequency above 100 Mc/s; preferably as near 250 Mc/s as is convenient.

A stable oscillator should be used as the source of r.f. power. The oscillator output coupling must be set to a matching condition; also, if the available oscillator power is sufficient, the output should be fed to the standard instrument via a length of coaxial cable (75-ohm or 50-ohm as appropriate) having a loss of 3 dB, or greater if possible, to assist in obtaining correctness and constancy of source impedance. The oscillator power should be adjusted so that the standard wattmeter reads at or near full scale on the 100-watt range. The R.F. Power Meter under test can then be substituted for the standard and the oscillator output coupling retuned for maximum deflection on the meter. If the indication differs from that obtained on the standard the spacing between the turns of L3 should be adjusted until the correct reading is obtained.

Having adjusted L3 at about 250 Mc/s, it is not normally necessary to readjust this component when checking the power-reading accuracy at lower frequencies. Nevertheless, the Power Meter should be checked at lower frequencies in order to ascertain that the instrument is operating correctly. The accuracy should be within $\pm 7\frac{1}{2}\%$ from 250 to 100 Mc/s and within ±5% of full scale below 100 Mc/s.

This comparison of the Power Meter under test and the standard should be repeated at a convenient point on the 50-watt range. No adjustment should be made to L3 when checking this range.

EB-1020A-A/1
2 - 3/57

AMENDMENT SHEET No. 713/1

Operating and Maintenance Handbook

for

R. F. Power Meter Types TF 1020A and TF 1020A/1

In our later models, the mechanical construction is slightly different to that shown in the COMPONENT LAYOUT illustration at the end of the handbook.

If you wish to remove the thermocouple, as described in Section 3. 2. 2, you will find it convenient to first remove the centre strut on the thermocouple-side of the instrument.

M. I. Ltd. One sheet

SPARES ORDERING SCHEDULE NO. SOS/1020A -A/1

WITH CIRCUIT REFERENCES

for

R. F. POWER METERS TYPES TF 1020A AND TF 1020A/1

Applicable to Instruments
Serial Nos :-

JA 713/01 to JA 713/75
JA 737/001 to JA 737/100
JA 826/001 to JA 826/100
JA 884/001 to JA 884/100

When ordering replacement parts, ALWAYS QUOTE THE TYPE NUMBER AND SERIAL NUMBER OF THE INSTRUMENT CONCERNED.

To specify the individual parts required, STATE FOR EACH PART THE QUANTITY REQUIRED AND THE APPROPRIATE SOS ITEM NUMBER.

For example, to order replacements for the 25-Ω variable resistor, RV1, and the 1000-μμF capacitor, C1, quote as follows :-

Spares required for TF 1020A (or TF 1020A/1, as appropriate)

Serial Number 000000

1 off, SOS Item 4
1 off, SOS Item 6

It is important that the code "SOS" preceeding each item number should not be omitted.

SOS Item No.	Circuit Ref.	Description	Works Ref.
		ELECTRICAL COMPONENTS	
1	R1	Resistor, Carbon, 75 Ω ±5%, 100W (TF 1020A); complete with tapping band. This assembly is checked in respect of linearity and position of tapping band before despatch.	TB24943/2 TB24965
2	R1	Resistor, Carbon, 50 Ω ±5%, 100W (TF 1020A/1); complete with tapping band. This assembly is checked in respect of linearity and position of tapping band before despatch.	TB24943/1 TB24965
3a	R2	Resistor, Composition, 212Ω*, 1/4W.	61-TF1020A
4	RV1	Resistor, Preset, Wire-Wound, 25 Ω ±10%, 2W.	62-TF1020A
5	RV2	Resistor, Preset, Wire-Wound, 10 Ω ±10%, 2W.	63-TF1020A
6	C1	Capacitor, Ceramic, 1000 μμF, 500 V d.c.	58-TF1020A
7	L1	R.F. Inductor.	TB22722/6
8	L2	R.F. Inductor.	TB22722/6
9	L3	R.F. Inductor.	TB22722/27
10	M1	Meter, moving coil, 0 - 1 mA, 4.5 Ω ±1 Ω.	TM3970/57
11	SK1	Panel Socket Assembly, Type N, 75 Ω, complete with mounting block, spigot, and special nut to accept Item 22 (TF 1020A).	TB23527/1 TB22840/9
12		Coaxial Plug to fit Item 11.	55-TF1020A

* Nominal value; actual value determined during calibration.

SOS Item No.	Circuit Ref.	Description	Works Ref.
		ELECTRICAL COMPONENTS (Continued)	
13	SK1	Panel Socket Assembly, Type N, 50 Ω, complete with mounting block, spigot, and special nut to accept Item 22 (TF 1020A/1).	TB23537 TB22840/9
14		Coaxial Plug to fit Item 13.	55-TF1020A/1
15		Switch, Toggle, 2 position, 2 pole.	TB23903/2
16		Thermocouple: heater - 25 Ω, 25 mA; couple - 4 Ω, 16 to 18 mV.	TB27102
		MECHANICAL COMPONENTS	
17		Slab Line Side Plate, Left-Hand (TF1020A); i.e., the plate adjacent to RV1 and RV2.	TE23833/4
18		Slab Line Side Plate, Right-Hand (TF1020A).	TE23833/3
19		Slab Line Side Plate, Left-Hand (TF 1020A/1); i.e., the plate adjacent to RV1 and RV2.	TE 24528/4
20		Slab Line Side Plate, Right-Hand (TF 1020A/1)	TE24528/3
21		V.S.W.R. adjustment shims (set of two); fit between Items 17 and 18, or 19 and 20, and Mounting Block of Items 11 or 13.	TB16341/77
22		Outward-Taper Section (two plates) complete with resistor clamping band.	TD24964/1A TD24964/1B TB24965

SOS Item No.	Cir-cuit Ref.	Description	Works Ref.
		MECHANICAL COMPONENTS (Continued)	
23		U-Clamps, Set of Two; secure "earthy" end of R1 to slab line side plates.	TE23834/2A
24		Front Panel (TF 1020A).	TE23832/2D
25		Front Panel (TF 1020A/1).	TE23832/2C
26a		Instrument Case.	TE23831/2
27		Front Panel Surround and 32-inch long Rubber Fillet.	TE23832/1 TB23984
28		Anodized Edging Strip; fits between Items 25 and 27.	TD23713/1
29		Case Feet, Set of Four.	TA11420
30a		Carrying Handle.	TC 29072
		MISCELLANEOUS	
31		Operating and Maintenance Handbook.	EB1020A -A/1

DECIBEL CONVERSION TABLE

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

AP/2500/7/61

DECIBEL CONVERSION TABLE

Ratio Down			*Ratio Up*	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	·006310	**22**	12·59	158·5
·06310	·003981	**24**	15·85	251·2
·05012	·002512	**26**	19·95	398·1
·03981	·001585	**28**	25·12	631·0
·03162	·001000	**30**	31·62	1,000
·02512	·0006310	**32**	39·81	1,585
·01995	·0003981	**34**	50·12	2,512
·01585	·0002512	**36**	63·10	3,981
·01259	·0001585	**38**	79·43	6,310
·01000	·0001000	**40**	100·00	10,000
·007943	·00006310	**42**	125·9	15,850
·006310	·00003981	**44**	158·5	25,120
·005012	·00002512	**46**	199·5	39,810
·003981	·00001585	**48**	251·2	63,100
·003162	·00001000	**50**	316·2	100,000
·002512	$6{\cdot}310 \times 10^{-6}$	**52**	398·1	158,500
·001995	$3{\cdot}981 \times 10^{-6}$	**54**	501·2	251,200
·001585	$2{\cdot}512 \times 10^{-6}$	**56**	631·0	398,100
·001259	$1{\cdot}585 \times 10^{-6}$	**58**	794·3	631,000
·001000	10^{-6}	**60**	1,000	10^{6}
·0005623	$3{\cdot}162 \times 10^{-7}$	**65**	1,778	$3{\cdot}162 \times 10^{6}$
·0003162	10^{-7}	**70**	3,162	10^{7}
·0001778	$3{\cdot}162 \times 10^{-8}$	**75**	5,623	$3{\cdot}162 \times 10^{7}$
·0001000	10^{-8}	**80**	10,000	10^{8}
·00005623	$3{\cdot}162 \times 10^{-9}$	**85**	17,780	$3{\cdot}162 \times 10^{8}$
·00003162	10^{-9}	**90**	31,620	10^{9}
·00001000	10^{-10}	**100**	100,000	10^{10}
$3{\cdot}162 \times 10^{-6}$	10^{-11}	**110**	316,200	10^{11}
10^{-6}	10^{-12}	**120**	10^{6}	10^{12}
$3{\cdot}162 \times 10^{-7}$	10^{-13}	**130**	$3{\cdot}162 \times 10^{6}$	10^{13}
10^{-7}	10^{-14}	**140**	10^{7}	10^{14}

AP/2500/7/61