Instruction Manual
No. EB 995B/2
for

F.M./A.M. Signal Generator
TF995B/2

mi Technical Publications

ST. ALBANS HERTFORDSHIRE ENGLAND

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General information

1.1 INTRODUCTION

The Marconi F.M./A.M. Signal Generator TF 995B/2 covers the frequency range of 0·2–220 MHz in five bands. Its output can be unmodulated, frequency modulated or amplitude modulated. If required both frequency and amplitude modulation can be applied simultaneously. The modulation obtained either from an internal 1000 cycle oscillator or from an external source is variable to maximum deviations ranging from 25 to 600 kHz for F.M. or to depth up to 50% for A.M.

The open circuit output voltage is variable by means of resistive step attenuators from 1 μV to 100 mV at 52 Ω, and 1 μV to 200 mV at 75 Ω. A plug-in 20 dB attenuator pad, available as an optional accessory, extends the range down to a nominal 0·1 μV at both impedances.

This generator provides comprehensive test and alignment facilities for a.m. and f.m. receivers in the v.h.f. and h.f. bands. It has crystal check points for accurate calibration of tuning dials, slow motion drive and direct reading incremental tuning for precise bandwidth measurements and monitored f.m. deviation and a.m. depth for signal/noise measurement.

The inclusion of a carrier ON/OFF switch makes it possible for the generator output to be temporarily interrupted without affecting the output impedance. This facilitates a number of two signal receiver tests such as intermodulation and blocking which involves the simultaneous use of two signal generators.

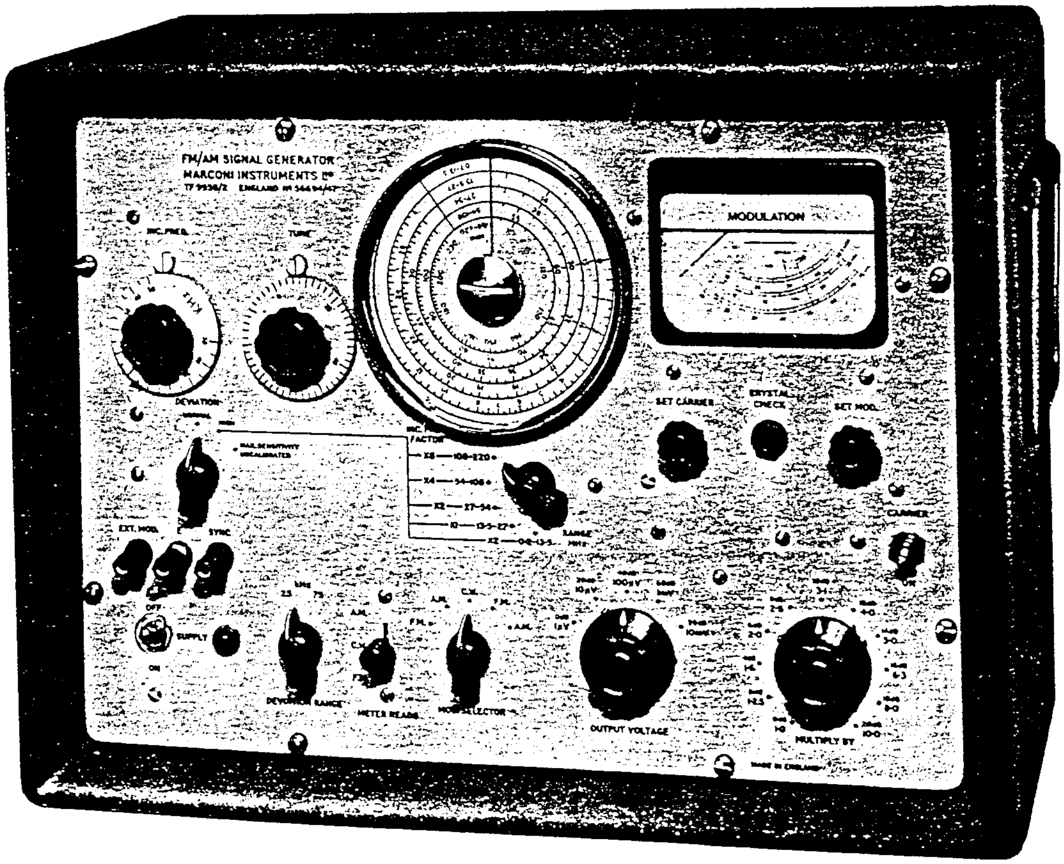

Fig. 1.1 F.M./A.M. Signal Generator TF 995B/2

1.2 DATA SUMMARY

Frequency

RANGE: 0·2 to 220 MHz in five bands:
0·2 to 13·5 MHz, 13·5 to 27·5 MHz, 27 to 55 MHz, 54 to 110 MHz, 108 to 220 MHz.

CALIBRATION ACCURACY: From 13·5 to 220 MHz the calibration of the main frequency dial is accurate to within ±1%. In addition, the built-in crystal calibrator provides 14 check points to an accuracy of 2 parts in 10^4, on each of the four higher-frequency bands. From 0·2 to 13·5 MHz, the accuracy is within ± 3% ± 10 kHz using the crystal calibrator.

STABILITY: After warm-up the frequency drift is not greater than ± 0.005%, but typically 0.002%, in a ten minute period on all except the lowest frequency band.

On Band 1 after a 45-minute warm-up, the frequency drift is not greater than ±3 kHz or 0·1%, whichever is the greater, in a 15-minute period.

INCREMENTAL CONTROL: The cover of this control is as follows:—
± 50 kHz on band 2,
± 100 kHz on band 3 and band 1 above 300 kHz,†
± 200 kHz on band 4,
± 400 kHz on band 5.
The calibration is accurate to within ±10 %.

Output

VOLTAGE: Built-in coarse and fine 75-ohm attenuators connected in cascade provide—in conjunction with the 6-dB Terminating Unit—a source e.m.f. variable in 2-dB steps from 1 μV to 100 mV. Interpolation between the 2-dB steps is by means of a ± 1 dB calibration on the r.f. level meter.

HIGH OUTPUTS: Source e.m.f.'s up to 200 mV at an impedance of 75 ohms are obtained direct from the Generator output cable.

LOW OUTPUTS: Source e.m.f.'s down to a nominal 0·1 μV at impedances of 75 and 52 ohms are obtained by inserting 20-dB Attenuator Pad TM 5552 between the Generator output cable and the Terminating Unit.

ACCURACY: The accuracy of the joint indication of the attenuators and level meter is within 1 dB ± 0·25 μV up to 100 MHz, and within 2 dB ± 0·25 μV up to 220 MHz.

Modulation

F.M.: Normal deviation continuously variable in two ranges ± 25 kHz and ± 75 kHz on all carrier bands above 300 kHz.† Accuracy at maximum deviation on bands 2, 3, 4, 5* at 1 kHz is ± 5% of f.s.d. with a possible additional variation of ± 10% due to valve ageing or random replacement.
High deviation of ×2 normal is also available on bands 1 (above 300 kHz†) and 3, ×4 normal on band 4 and ×8 normal on band 5.

* The wide frequency coverage on band 1 (0·2 to 13·5 MHz) is achieved by heterodyning the normal band 2 signal with a fixed oscillator. At some frequencies on band 1, spurious F.M. in excess of the figure quoted for the other bands may occur. At these frequencies the deviation accuracy will also be affected.

† Below 300 kHz the frequency shift and deviation should be such that the instantaneous frequency never goes below 200 kHz.

INTERNAL F.M.:	At 1 kHz, the modulation distortion does not exceed 2% at maximum deviation. External modulation characteristic flat within 1 dB 50 Hz to 15 kHz, with respect to 1 kHz.
EXTERNAL F.M.:	External modulation characteristic is flat within ± 1 dB, 50 Hz to 15 kHz with respect to 1 kHz. Maximum sensitivity, uncalibrated deviation—between 54 and 110 MHz sensitivity is such that ± 75 kHz deviation is produced by not more than 5 volts r.m.s. and the frequency response is suitable for stereo multiplex signals.
SPURIOUS F.M. ON C.W.:	Deviation less than ± 50 Hz between 13·5 and 100 MHz and less than ± 100 Hz between 100 and 220 MHz.*
A.M.:	Internal at 1 kHz to a depth variable up to 50%, with distortion not exceeding 6% at 30% depth. External modulation characteristic flat to within ± 1 dB, 50 Hz to 10 kHz (with input adjusted for constant modulation meter reading).
SYNCHRONIZING SIGNAL:	A nominal 100-volt high-impedance output from the internal 1 kHz oscillator is available at the front panel.

Power Supply: 200 to 250 volts, or 100 to 150 volts after adjusting internal link, 40 to 65 Hz; 65 watts. Both the mains and h.t. circuits are fused.

Dimensions and Weight:

Height	*Width*	*Depth*	*Weight*
330 mm	440 mm	220 mm	17·2 kg
(13 in)	(17½ in)	(8½ in)	(38 lb)

1.3 ACCESSORIES

Supplied

One Terminating Unit Type TM 5551; 75 ohms in, 52 and 75 ohms out.

Two Coaxial Free Plugs, Type BNC; one 50-ohm, one 75-ohm; for Terminating Unit outlets.

One Telephone Plug, Igranic Type P40; for Crystal Check jack.

Available

20-dB Attenuator Pad Type TM 5552; for use between output cable and Terminating Unit.

Section
2

Operation

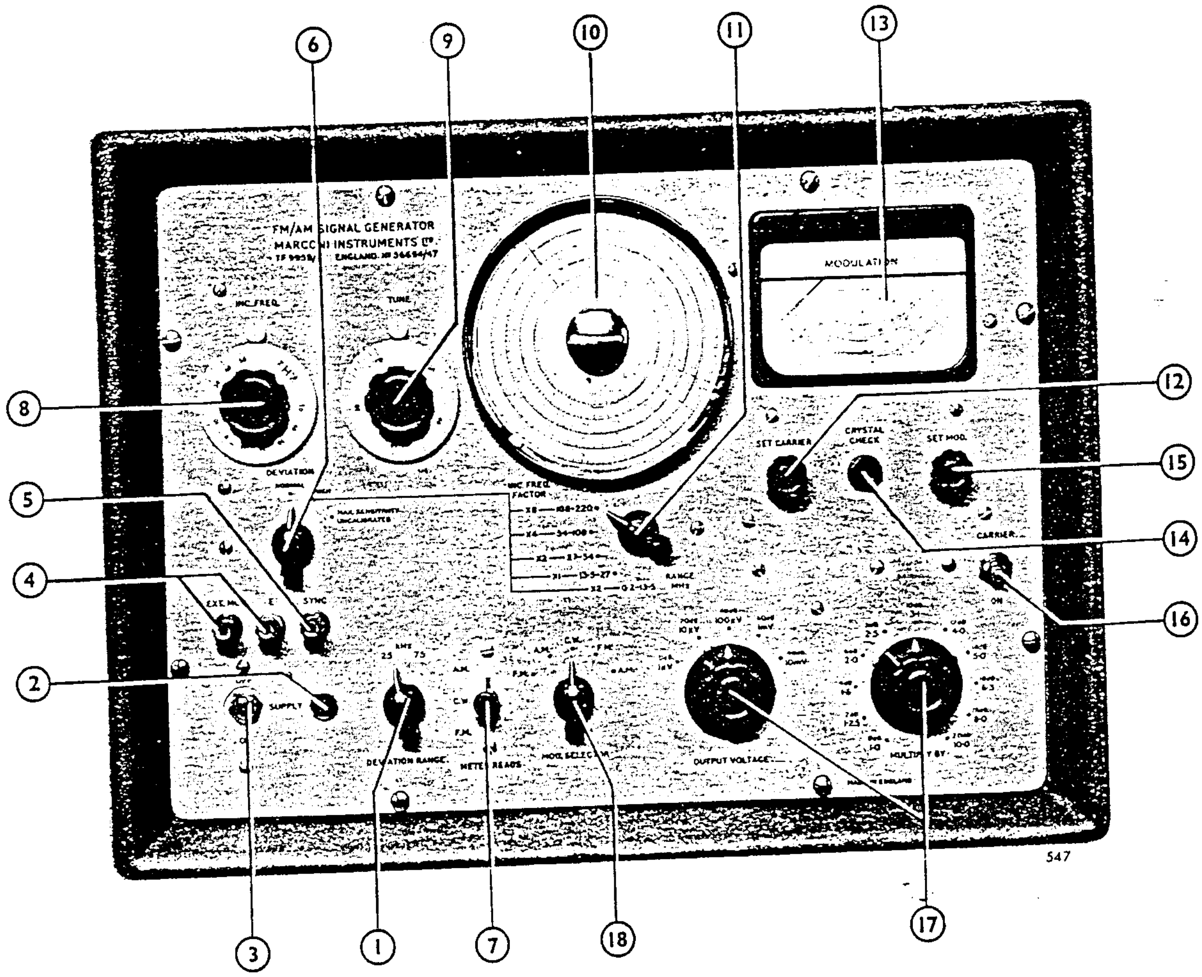

Fig. 2.1 Controls

2.1 INSTALLATION

Unless otherwise specified, the Signal Generator is normally dispatched with its valves in position and with its mains input circuit adjusted for immediate use with a 240-volt, 40- to 65-Hz mains supply. The instrument can be adjusted for operation from any other 40- to 65-Hz supply voltage in the ranges 200 to 250 and 100 to 150 volts. To check or alter the settings of the mains transformer tappings, refer to MAINTENANCE, Section 5.3.

2.2 SWITCHING ON AND WARMING UP

Before switching on, be quite sure that the instrument is correctly adjusted to suit the particular mains supply to which it is to be connected. Then proceed as follows:—

(1) Connect the mains lead—stowed in the left-hand case-handle recess—to the mains supply socket.

(2) Switch ON by means of the SUPPLY switch; the red pilot lamp should now glow.

(3) Before proceeding further, allow a short time —say five minutes—to elapse for the internal circuits to warm up. If a particularly high standard of frequency stability is required, this time should be increased to about one hour.

2.3 CONTROLS

1. **Deviation Range Selector**
   Read deviation from corresponding scale on meter.
2. **Pilot Lamp**
3. **Mains Supply Switch**
4. **External Modulation Input**
   For f.m. or a.m.
5. **Sync Output**
   From internal modulation oscillator.
6. **Deviation Multiplier**
   Normal: deviation is as shown on meter.
   High: multiply meter reading by factor on RANGE switch.
   Max Sensitivity: disregard meter reading, use external modulation meter to find deviation.
7. **Meter Function Selector**
8. **Incremental Tuning Control**
   Carrier shift is given by dial reading multiplied by factor on RANGE switch.
9. **Main Tuning Control**
10. **Main Tuning Dial**
    Knurled boss adjusts cursor to standardize scale against crystal check points.
11. **Range Selector**
12. **Set Carrier Control**
    For adjusting unmodulated carrier to SET R.F. mark on meter.
13. **Meter**
    Indicates carrier level, f.m. deviation, or a.m. depth depending on setting of METER READS switch.
14. **Crystal Check Jack**
    Plug in headphones here to switch on crystal check oscillator.
15. **Set Mod Control**
    Adjusts f.m. deviation or a.m. depth.
16. **Interrupts Output**
    without switching off filaments.
17. **Output Attenuators**
    Direct reading in source e.m.f. at output of Terminating Unit when carrier is adjusted to SET R.F. mark on meter.
18. **Modulation Selector**

2.4 OUTPUT CONNECTIONS

The r.f. output from the Signal Generator is derived, at a source impedance of 75 ohms, via a permanently attached coaxial lead fitted with a BNC free socket; the lead is stowed in the right-hand case-handle recess.

The TERMINATING UNIT, which will normally be plugged on to the output lead, has two outlets, one of 75 ohms impedance and the other of 52 ohms. Two free plugs are supplied for making connection to the Terminating Unit outlets.

The 20-dB ATTENUATOR PAD, available as an optional accessory, can be inserted between the Generator output socket and the Terminating Unit input plug when low outputs are required.

Details on the use of the Terminating Unit and Attenuator Pad are given in Section 2.7, R.F. OUTPUT ARRANGEMENTS.

Equivalents to the free plugs supplied, and illustrated in Fig. 2.2, are as follows:—

	75 ohm	*50 ohm*
Great Britain,		
Air Ministry:	10H/20946	10H/20935
Films and Equipment:	UG-260/U	UG-88/U
Transradio Ltd.:	BN. 1/7	BN. 1/5
Belling and Lee:		L. 1331/FP
United States,		
Military No.:	UG-260/U	UG-88/U

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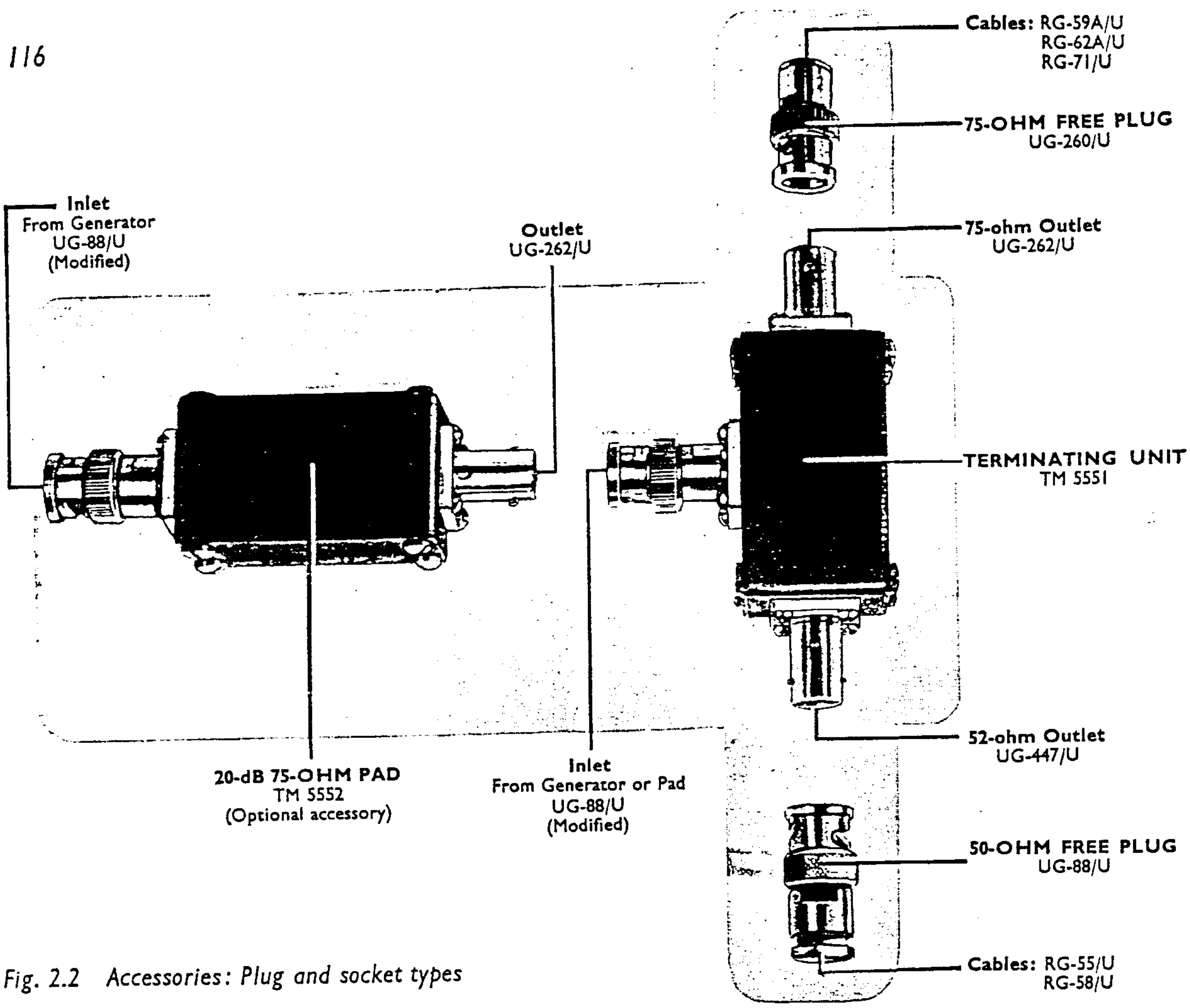


Fig. 2.2 Accessories: Plug and socket types

2.5 TUNING

The various aspects of tuning the Generator are dealt with in the following sections.

General tuning: Section 2.5.1.
Standardizing frequency against crystal oscillator: Section 2.5.2.
Use of incremental frequency controls: Section 2.5.3.
Interpolation of main frequency scales: Section 2.5.4.

2.5.1 GENERAL TUNING

The T.F. 995B/2 covers the range 0·2 to 220 MHz in five bands as follows:

0·2 to 13·5 MHz
13·5 to 27·5 MHz
27 to 54 MHz
54 to 110 MHz
108 to 220 MHz

The particular band required is selected by means of the RANGE switch. Rotation of the TUNE control varies the output frequency within the limits of the band selected, and moves the main dial relative to its cursor.

The Signal Generator has a built-in crystal calibrator, and the cursor of the main tuning dial is mounted so that its angular position relative to that of the dial is variable over a small arc by movement of a milled boss at the centre of the dial. This movable cursor enables the operator to standardize the frequency scale of the Signal Generator at any time; the cursor is used in conjunction with the crystal calibrator in the manner described in Section 2.5.2.

In addition to the RANGE switch and the TUNE control, the instrument is fitted with a directly calibrated incremental frequency control; the method of using this control is described fully in Section 2.5.3. Section 2.5.4 deals with the method of interpolating between main dial markings by means of the linearly calibrated dial on the TUNE control.

2.5.2 USE OF THE CRYSTAL CALIBRATOR

(a) Introduction

The calibrator, or crystal oscillator, has a fundamental frequency of 333·3 kHz, with an accuracy of 2 parts in 10^4, and is coupled to the basic 4·5- to 9·16-MHz r.f. oscillator which feeds the multiplier chain. Plugging a pair of high-resistance head telephones into the CRYSTAL CHECK jack socket automatically brings the calibrator circuit into use; with the aid of the headphones, the difference frequency between the basic oscillator and the harmonic multiples of the calibrator's 333·3 kHz can be monitored aurally.

Because the outputs on the four higher-frequency bands are all derived directiy from the multiplier chain, their frequencies have an exact integral relationship to the frequency of the basic oscillator. It follows, therefore, that setting the TUNE control to bring the basic-oscillator frequency to that of a crystal harmonic will also bring the frequency of the outputs from the multiplier chain to a known relationship with the crystal harmonic, and allow the frequency dial to be standardized with a high degree of accuracy.

Outputs on the lowest-frequency, 0·2- to 13·5-MHz, band are not derived directly from the multiplier chain; their generation involves a heterodyne action between the 27- to 54-MHz multiplier and a 30-MHz fixed oscillator which is not locked to the basic oscillator. For this reason, although use is made of the crystal calibrator when setting up for 0·2- to 13·5-MHz outputs, the accuracy of standardization is of a lower order than that obtained on the four higher-frequency ranges.

(b) Check-Point Frequencies

The calibrator provides a total of 56 check points between 13·5 and 220 MHz; these check points occur as follows:—

13·5–27 MHz band: At 14, 15, and 16 MHz, and every calibration point which is a multiple of 1 MHz, to 27 MHz.

27–54 MHz band: At 28, 30, and 32 MHz, and every calibration point which is a multiple of 2 MHz, to 54 MHz.

54–108 MHz band: At 56, 60, and 64 MHz, and every calibration point which is a multiple of 4 MHz, to 108 MHz.

108–220 MHz band: At 112, 120, and 128 MHz and every calibration point which is a multiple of 8 MHz, to 216 MHz.

(c) Standardization Procedure

As shown above, the calibrator allows the frequency scale to be checked at 14 different points on each of the above bands, and the adjustable cursor can be set to correspond exactly with any one of these points.

When the Signal Generator is to be used above 13·5 MHz to provide an output at a single spot frequency, or over a narrow band of frequencies, the cursor should be set up at the nearest crystal check point.

When the Signal Generator is to be used over a wide range of frequencies, and it is inconvenient to reset the cursor for each material frequency change, or, alternatively, when using the 0·2- to 13·5-MHz band, the procedure is varied to reduce the mean error to a minimum. The method of standardizing the frequency scale for subsequent general use is as follows:—

(1) Set the INC. FREQ. control to zero.

(2) Set the RANGE switch to 13·5–27 MHz.

(3) Using the headphones plugged into the CRYSTAL CHECK jack, tune the main dial to a crystal check point near the centre of the band; e.g. 20 MHz.

When using the calibrator, the MOD SELECTOR must be set to a position other than INT MOD—F.M. or EXT MOD—F.M. This ensures that the variable oscillator is not being frequency modulated—a condition which prevents precise setting of the TUNE control for the lowest-frequency beat note in the headphones, since it gives rise to a fluctuating tone.

After using the calibrator, the Signal Generator can, of course, be subsequently set up for f.m. without invalidating any frequency calibration previously given by use of the calibrator.

(4) Adjust the milled boss in the centre of the dial to bring the cursor exactly in line with the calibration mark corresponding to the crystal check point.

If the Signal Generator has been out of use for some time, it may be necessary to use a coin in the slot provided in order to rotate the milled boss.

(5) Check the calibration accuracy at several crystal check points both above and below the check point at which the cursor was set in (4) above.

(6) Readjust the cursor setting to equalize the errors over the band; e.g. it might be found that, with the frequency scale indication correct at 20 MHz, the indication was high at both 15 and 25 MHz—in such a case, the errors would be equalized by making the indication a little low at 20 MHz, and thus not so high at 15 and 25 MHz.

It will be noted that, in the above procedure, the frequency scale is standardized on the 13·5- to 27-MHz band. This band is specified since its corresponding scale calibrations occupy the longest arc on the dial. The dial can therefore be read with a high degree of discrimination on this band and the correct cursor setting most easily determined. Once the frequency scale has been standardized on the 13·5- to 27-MHz band, the cursor is correctly set to give the minimum mean error on the other three direct-multiple bands. It is also correctly set for the 0·2- to 13·5-MHz band.

When standardized in this way, the main tuning dial indication for frequencies above 13·5 MHz is accurate to at least 1%, and will generally be within 0·5%; for frequencies below 13·5 MHz, the average error does not exceed 3% ± 10 kHz.

2.5.3 THE INCREMENTAL FREQUENCY CONTROL

This control provides a convenient means of producing small, accurately known changes in carrier frequency. Since it is not connected directly to the r.f. oscillator, either mechanically or electrically, but operates by varying the d.c. voltage at the grid of the reactor valve, the control is completely free from any sort of backlash. This attribute, together with the directly calibrated scale, renders the control very suitable for bandwidth or similar measurements.

To use the control proceed as follows:—

(1) With the INC. FREQ. dial set to its centre zero position, tune the Signal Generator to the centre frequency of the equipment under test by means of the TUNE control.

(2) Rotate the INC. FREQ. control by the amount necessary to produce the required frequency shift or the required change in response depending on the method of measurement.

The scale of the INC. FREQ. dial is direct-reading on the 13·5- to 27-MHz band. For each of the other bands, a multiplying factor must be applied; the appropriate factor for each frequency band is engraved on the front panel adjacent to the RANGE switch marking. The multiplying factors are also given below in Table 1.

TABLE 1

RANGE switch setting (MHz)	*Total coverage of INC. FREQ. control (kHz)*	*Multiply INC. FREQ. dial readings by*
0·2–13·5	±100	2
13·5–27	±50	1
27–54	±100	2
54–108	±200	4
108–220	±400	8

2.5.4 THE INTERPOLATING DIAL

The TUNE control knob is fitted with a small dial calibrated linearly from 0 to 100 over its total circumference and makes approximately 17 revolutions as the main dial is turned through its complete angle of rotation.

This dial may be used to subdivide linearly any portion of the frequency coverage on any band in order to tune accurately to a frequency above 13·5 MHz which does not coincide with a crystal check point. The method of using the dial for this purpose is described in the following instructions:—

(1) Set the INC. FREQ. control to zero.

(2) Set the RANGE switch to whichever of the four higher-frequency bands includes the required frequency.

(3) Tune the Signal Generator to the nearest crystal check point *below* the required frequency, identify the point with the aid of the CRYSTAL CHECK oscillator and note the interpolating dial reading.

(4) Tune the Signal Generator to the nearest crystal check point above the required frequency and note the change of reading of the interpolating dial. It is important that the *total* change is noted when the dial is turned through more than one revolution.

The relationship should be determined between the crystal check points which embrace the particular section of the frequency band over which incremental variations are to be made. Also, the relationship should be redetermined for each different section of the frequency band, since it varies, not only from band to band, but also for different sections of any one band.

(5) From the difference in frequency between the two crystal check points, and the total interpolating dial divisions traversed, calculate the frequency change per interpolating dial division.

(6) With the aid of the headphones, reset the main tuning dial to the crystal check point below the required frequency.

(7) Rotate the TUNE control so that the interpolating dial traverses the correct number of divisions to give the required frequency.

It is recommended that the required frequency should always be approached from the low-frequency side in order to eliminate the possibility of error due to backlash.

The following example illustrates the use of the interpolating dial to obtain an output from the instrument at an accurate frequency of 74·25 MHz.

Example: With the TUNE control set to the crystal check point at 72 MHz, the interpolating dial reading was 17. With the TUNE control set to the crystal check point at 76 MHz the new reading on the auxiliary dial was 40. The total number of interpolating dial divisions traversed was 123, the dial having rotated through slightly more than one revolution for the frequency change of 4 MHz, i.e. 4,000 kHz. In this case, a change of 1 division on the interpolating dial corresponded, between 72 *and* 76 MHz, to a nominal frequency change of

$$\frac{4000}{123} = 32{\cdot}5 \text{ kHz}$$

Therefore, by starting from the original auxiliary dial setting at 72 MHz (72,000 kHz) the required frequency of 74·25 MHz (74,250 kHz) was obtained by rotating the auxiliary dial through

$$\frac{74{,}250-72{,}000}{32{\cdot}5} = \frac{2250}{32{\cdot}5} = 69 \text{ divisions.}$$

The interpolating dial can also, of course, be calibrated in kHz per division for any portion of the 0·2- to 13·5-MHz band. Crystal check points cannot be used on this band, but the movement of the auxiliary dial for any frequency interval can be determined against the appropriate main dial calibration markings, and accurate interpolation between these marks carried out as previously described for the higher-frequency ranges.

2.6 SETTING UP FOR C.W., A.M. OR F.M.

The Signal Generator includes facilities which allow the following types of r.f. output to be obtained:—

(1) Continuous wave (see Section 2.6.1).

(2) Amplitude modulated (see Section 2.6.2), variable to 50% depth,
 (a) from the internal a.f. oscillator at 1,000 Hz,
 (b) from an external sine-wave source, within the range 50 Hz to 10 kHz.

(3) Frequency modulated (see Section 2.6.3), variable to maximum frequency deviations ranging from 25 kHz to 600 kHz,
 (a) from the internal a.f. oscillator at 1,000 Hz,
 (b) from an external sine-wave source, within the range 50 Hz to 15 kHz.

(4) Simultaneously frequency and amplitude modulated (see Section 2.6.4), the amplitude modulation being obtained from the internal a.f. oscillator, and the frequency modulation from an external source as (3) (b) above.

When setting up for amplitude or frequency modulation as described in Sections 2.6.2 and 2.6.3, it may be observed that, with the METER READS key held to either A.M. or F.M., as applies, the apparent modulation as measured on external apparatus is less than that indicated on the meter. This is quite in order; the meter indicates the modulation which will be obtained when the switch is returned to its central position and the meter reverts to its normal function of monitoring the r.f. level.

2.6.1 CONTINUOUS WAVE

(1) Set the MOD SELECTOR switch to C.W.

(2) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.

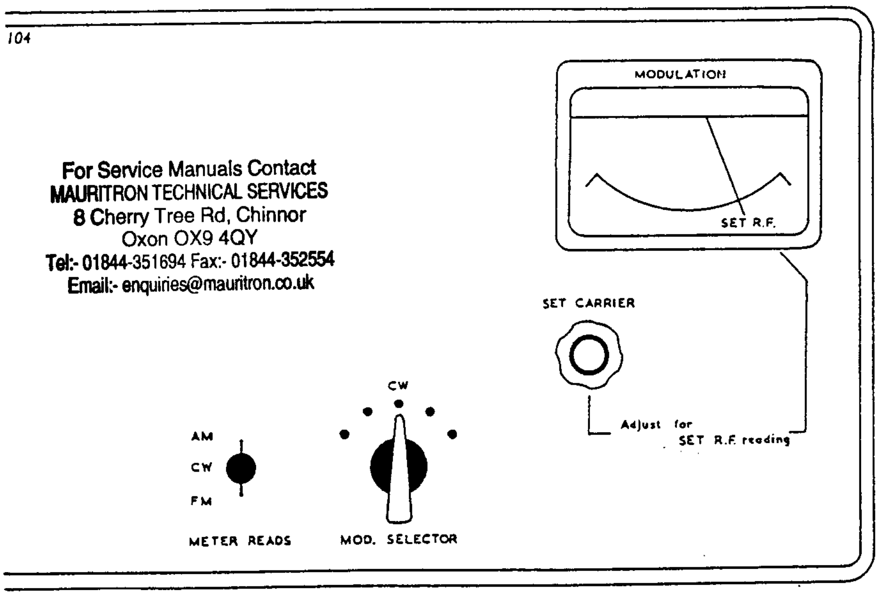


Fig. 2.3 C.W. operation

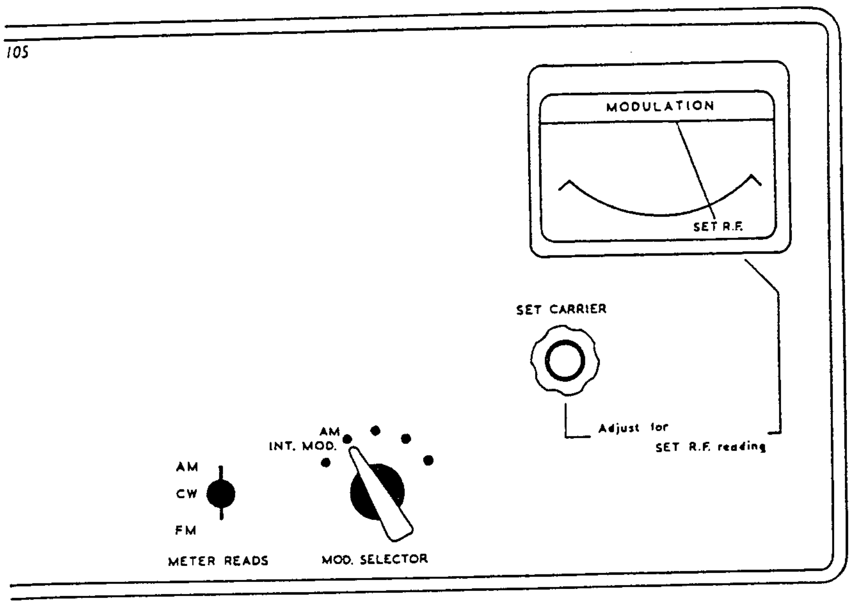


Fig. 2.4
Internal a.m. operation
(i) Setting carrier level

2.6.2 AMPLITUDE MODULATION

(a) From the internal oscillator

(1) Set the MOD SELECTOR switch to INT MOD—A.M.

(2) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.

(3) With the METER READS key switch held in the A.M. position, adjust the SET MOD control to the required modulation depth, as indicated on the top scale of the panel meter. Amplitude modulation is variable to a maximum depth of 50%.

(4) Release the METER READS key switch and, if necessary, repeat (2) above.

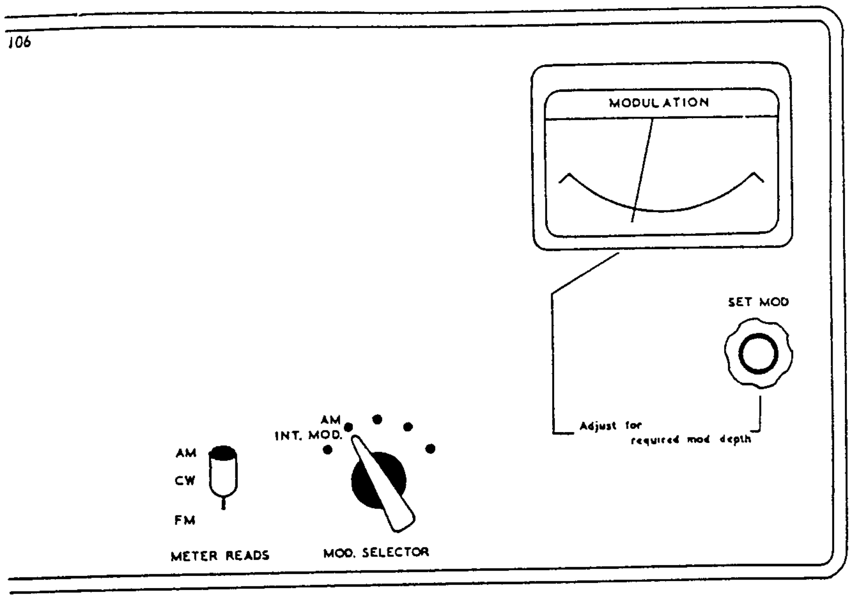
(b) From an external a.f. source

(1) Set the MOD SELECTOR switch to EXT MOD—A.M.

(2) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.

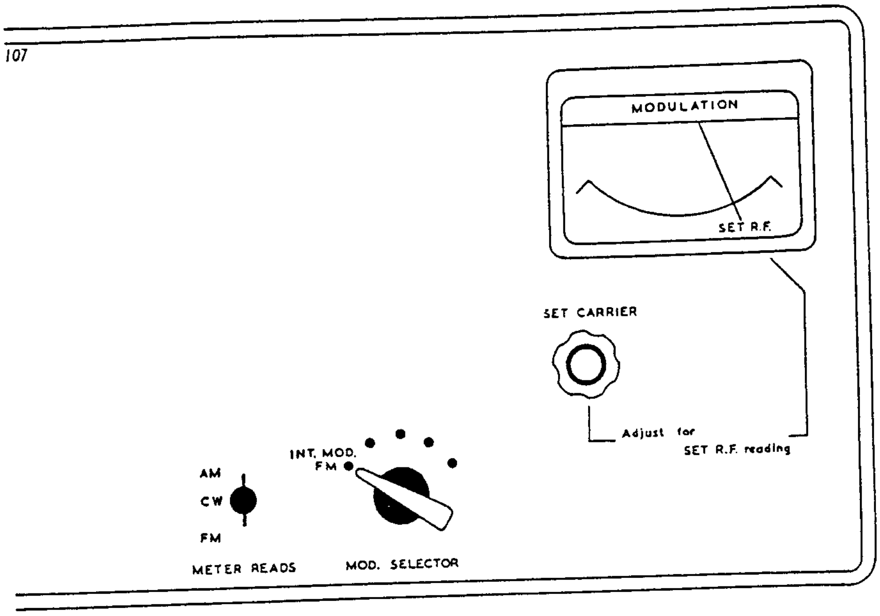
(3) Connect the external modulation source to the EXT MOD and E terminals.

(4) With the METER READS key switch held in the A.M. position, adjust the SET MOD control to



(ii) Setting modulation depth

Fig. 2.5
Internal f.m. operation
(i) Setting carrier level



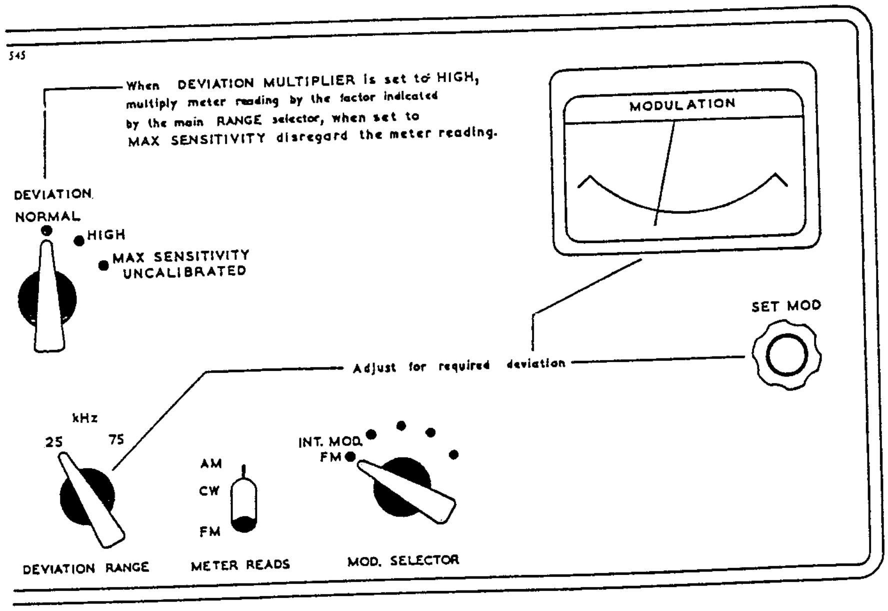
the required modulation depth, as indicated on the top scale of the panel meter. With the SET MOD control at maximum, an input of approximately 15 volts r.m.s. is required at the EXT MOD and E TERMINALS to produce 30% modulation depth within the modulation frequency range 50 Hz to 10 kHz.

(5) Release the METER READS key switch and, if necessary, repeat (2) above.

2.6.3 FREQUENCY MODULATION

In addition to the MOD SELECTOR switch, there are three other controls concerned in setting up the carrier deviation when the output from the Signal Generator is to be frequency modulated. These controls are the continuously-variable SET MOD potentiometer, the DEVIATION RANGE switch, and the DEVIATION MULTIPLIER switch. When the METER READS key switch is held to F.M., the panel meter indicates deviation. The meter has two deviation scales: one calibrated from 0 to 25 kHz, and the other from 0 to 75 kHz.

With the DEVIATION MULTIPLIER switch set to NORMAL, the meter scale appropriate to the setting of the DEVIATION RANGE switch is used and the deviation is as indicated by the meter for all settings of the carrier-frequency range switch.



(ii) Setting modulation depth

TABLE 2

Carrier frequency RANGE switch setting (MHz)	*DEVIATION RANGE switch setting (kHz)*	*DEVIATION MULTIPLIER switch is set to HIGH* — *Multiply meter reading by*	*Maximum deviation obtainable (kHz)*
0·2–13·5	25	2	50
	75	2	150
13·5–27	25	1	25
	75	1	75
27–54	25	2	50
	75	2	150
54–108	25	4	100
	75	4	300
108–220	25	8	200
	75	8	600

With the DEVIATION MULTIPLIER switch set to HIGH, the deviation obtained on the 13·5- to 27-MHz band is the same as with the switch set to NORMAL. For all other carrier-frequency bands the deviation is increased and the meter readings—again taken on the scale appropriate to the settings of the DEVIATION RANGE switch—must be multiplied in accordance with Table 2 above.

The example given below shows the method of determining the meter reading for a required deviation which is greater than 75 kHz and thus necessitates setting the DEVIATION MULTIPLIER switch to HIGH.

Example: A deviation of 160 kHz is required at a carrier frequency of 80 MHz. The carrier frequency lies within the 54- to 110-MHz band. The meter multiplying factor for this band is 4; therefore, for 160 kHz deviation, the meter should be set (by means of the SET MOD control) to read

$$\frac{160}{4} = 40 \text{ kHz}.$$

Do this on the bottom scale of the meter with the DEVIATION RANGE switch set to 75 kHz.

The third position of the DEVIATION MULTIPLIER switch, MAX SENSITIVITY-UNCALIBRATED, is intended for use when modulating from an external source and there is no advantage in selecting this position when using internal modulation.

(a) F.M. from the internal oscillator

(1) Set the MOD SELECTOR switch to INT MOD—F.M.

(2) Set the DEVIATION RANGE switch as required. If, at carrier frequencies, less than 13·5 MHz, or greater than 27 MHz, more than 75 kHz deviation is required, set the DEVIATION MULTIPLIER switch to HIGH. (Deviations greater than 75 kHz are not obtainable on the 13·5- to 27-MHz carrier-frequency band, the maximum deviations obtainable on the other carrier-frequency bands are given earlier in Table 2.)

(3) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.

(4) With the METER READS key switch held to F.M. adjust the SET MOD control until the required deviation is indicated on the panel meter; read the meter on its middle scale when the DEVIATION range switch is set to 25 kHz, and read on the lower scale when the switch is set to 75 kHz. If the DEVIATION MULTIPLIER switch is set to HIGH, the meter readings must be multiplied by the appropriate factor given in Table 2.

(5) Release the METER READS key switch and, if necessary, repeat (3) above.

(b) F.M. from an external source

(1) Set the MOD SELECTOR switch to EXT MOD—F.M.

(2) Set the DEVIATION RANGE switch as required. If at carrier frequencies less than 13·5 MHz, or greater than 27 MHz, more than 75 kHz deviation is required, set the DEVIATION MULTIPLIER switch to HIGH. (Deviations greater than 75 kHz are not obtainable on the 13·5- to 27-MHz carrier-frequency band; the maximum deviations obtainable on the other carrier-frequency bands are given earlier in Table 2.)

(3) Adjust the SET CARRIER control to bring the meter pointer to the SET R.F. mark.

(4) Couple the external modulation source to the EXT MOD and E terminals.

(5) With the METER READS key switch held to F.M., adjust the SET MOD control until the required deviation is indicated on the panel meter; read the meter on its middle scale when the DEVIATION RANGE switch is set to 25 kHz, and read on the lower scale when the switch is set to 75 kHz. If the DEVIATION MULTIPLIER switch is set to HIGH, the meter readings must be multiplied by the appropriate factor given in Table 2.

For any setting of the DEVIATION RANGE switch, with the DEVIATION MULTIPLIER at NORMAL or HIGH and within the modulation frequency range 50 Hz to 15 kHz, approximately 25 volts r.m.s. is required between the EXT MOD and E terminals for full deviation.

When the DEVIATION MULTIPLIER is set to MAX SENSITIVITY, the frequency response is extended to make it suitable for handling stereo multiplex signals and the sensitivity is increased so that at least

75 kHz deviation is provided by 5 volts r.m.s. Although the modulation meter responds when the METER READS switch is pressed to F.M., the MAX SENSITIVITY position of the DEVIATION MULTIPLIER is uncalibrated and the meter reading should be disregarded. To measure the deviation a separate deviation meter, such as Marconi Instruments TF 2300, must be used.

2.6.4 SIMULTANEOUS FREQUENCY AND AMPLITUDE MODULATION

(1) Set up the required depth of amplitude modulation as detailed in Section 2.6.2 (a).

(2) Leaving the MOD SELECTOR switch at INT MOD—A.M., and without altering the setting of the SET MOD control, set up the required deviation in a similar manner to that detailed in Section 2.6.3 (b); in this case, adjust the amount of deviation by variation of the audio input from the external modulation source.

2.7 R.F. OUTPUT ARRANGEMENTS

Five factors affect the output level from the Signal Generator; these factors are:

(a) The SET CARRIER control whose setting determines the input level to the attenuator cascade.

(b) The ' coarse ' or OUTPUT VOLTAGE attenuator.

(c) The ' fine ' or MULTIPLY BY attenuator.

(d) The TERMINATING UNIT which plugs on the end of the output cable from the fine attenuator.

(e) ATTENUATOR PAD Type TM 5552, which is an optional accessory designed for insertion between the output cable and TERMINATING UNIT when especially low output levels are required.

The SET CARRIER control is adjusted in conjunction with the panel meter; with the METER READS key switch in its central position, the panel meter forms part of a crystal voltmeter which monitors the input to the coarse attenuator. The panel meter has three main marks on its scale; these marks are minus 1 dB, SET R.F., and plus 1 dB, respectively. Normally, the SET CARRIER control should be adjusted to bring the meter pointer to the SET R.F. mark.

Four 20-dB steps give the coarse or OUTPUT VOLTAGE attenuator a total range of 80 dB; each setting of the attenuator control has markings in yellow (or red on earlier models) and in black. The yellow (or red) markings are in terms of decibels relative to 1 μV; the black markings are directly in units of voltage.

Ten 2-dB steps give the fine or MULTIPLY BY attenuator a total range of 20 dB; each setting of the attenuator control has markings in yellow (or red) and black, the yellow (or red) markings being in terms of decibels relative to 1 μV, and the black markings, multiplying factors for the black voltage markings on the coarse attenuator.

Both attenuators have a characteristic impedance of 75 ohms and, ' looking into ' the coaxial socket at the end of the output cable, the instrument appears as a generator with a source impedance of 75 ohms.

The TERMINATING UNIT is, essentially, a 6-dB attenuator pad; ' looking into ' its input socket, the TERMINATING UNIT presents an impedance of 75 ohms, while the two outlets present impedances of 52 and 75 ohms respectively.

The ATTENUATOR PAD has a characteristic impedance of 75 ohms and provides an optional, additional, 20-dB attenuation of the output signal.

It should be noted particularly that the r.f. output controls on the Signal Generator are calibrated in terms of source e.m.f. or open-circuit output voltage. The significance of quoting the output of a signal generator in this way will be apparent when it is remembered that one of the primary functions of a signal generator is to simulate a received signal as it would come from an aerial.

To take a simple case—that in which a 75-ohm receiver is fed from a 75-ohm dipole, the e.m.f. induced in the aerial is shared between its inherent 75-ohm radiation resistance and the matched 75-ohm receiver input. Clearly, when the same receiver is fed from a signal generator, the corresponding signal strength is given by the source e.m.f. of the signal generator, and not by the on-load p.d. at the receiver terminals.

2.7.1 OUTPUTS FROM 1 μV TO 100 mV AT 52 AND 75 OHMS

It is intended that the Signal Generator should normally be used with the SET CARRIER control adjusted to bring the meter pointer to the SET R.F. mark; with the TERMINATING UNIT coupled directly to the output cable; and without the ATTENUATOR PAD Type TM 5552.

Used in this way, the Signal Generator should be regarded as a source of zero impedance in series with a resistance of either 75 ohms or 52 ohms, the open-circuit output level, or source e.m.f., being variable in 2-dB steps from 1 μV to 100 mV and being given:

(a) *directly in terms of decibels relative to* 1 μV, by the sum of the ' yellow ' (or red) settings of the OUTPUT VOLTAGE and MULTIPLY BY attenuators;

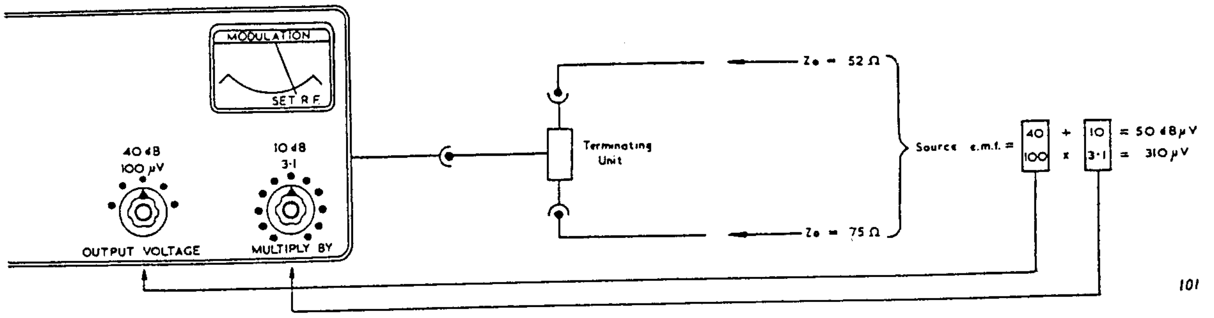


Fig. 2.6 Outputs via terminating unit

(b) *directly in voltage*, by the product of the 'black' settings of the OUTPUT VOLTAGE and MULTIPLY BY attenuators.

The plus 1-dB and minus 1-dB marks on the panel meter allow interpolation between the 2-dB steps of the MULTIPLY BY attenuator. Setting the meter pointer to either the plus 1-dB or minus 1-dB mark increases or decreases the input to the attenuator cascade by 1 decibel. Thus, using the SET CARRIER control and panel meter in conjunction with the OUTPUT VOLTAGE and MULTIPLY BY attenuators, the output level from the Signal Generator can be varied in 1-dB steps over the range 0 to +100 dB relative to 1 µV.

It should be noted that the 'black' voltage indication given by the attenuator controls is not directly applicable when the meter is set to other than the SET R.F. mark; with the meter at minus 1 dB, the source e.m.f. at the TERMINATING UNIT outlets is 0·89 of the indicated voltage; with the meter at plus 1 dB, the source e.m.f. is 1·12 of the indicated voltage.

2.7.2 OUTPUTS FROM 2 µV TO 200 mV AT 75 OHMS ONLY

With the TERMINATING UNIT detached and with the meter at the SET R.F. mark, the output level obtained directly from the plug at the end of the r.f. output cable is variable in the range 2 µV to 200 mV and is derived via a source impedance of 75 ohms.

Under these conditions, the open-circuit level, or source e.m.f., in terms of decibels relative to 1 µV is obtained by adding 6 dB to the sum of the meter reading and the 'yellow' (or red) indications of the OUTPUT VOLTAGE and MULTIPLY BY attenuators; the source e.m.f. is given directly in voltage by doubling the product of the 'black' indications of the OUTPUT VOLTAGE and MULTIPLY BY attenuators.

2.7.3 OUTPUTS FROM 0.1 µV TO 10 mV AT 52 AND 75 OHMS

With the TERMINATING UNIT coupled to the r.f. output cable via the optional 20-dB ATTENUATOR PAD and with the meter at the SET R.F. mark, the output level from the TERMINATING UNIT is variable in the range 0·1 µV (nominal) to 10 mV.

In this case, the source e.m.f. in terms of decibels relative to 1 µV is obtained by subtracting 20 dB from the sum of the meter reading and the 'yellow' (or red) indications of the OUTPUT VOLTAGE and MULTIPLY BY attenuators; the source e.m.f. is given directly in voltage by dividing the product of the 'black' indications of the OUTPUT VOLTAGE and MULTIPLY BY attenuators by 10.

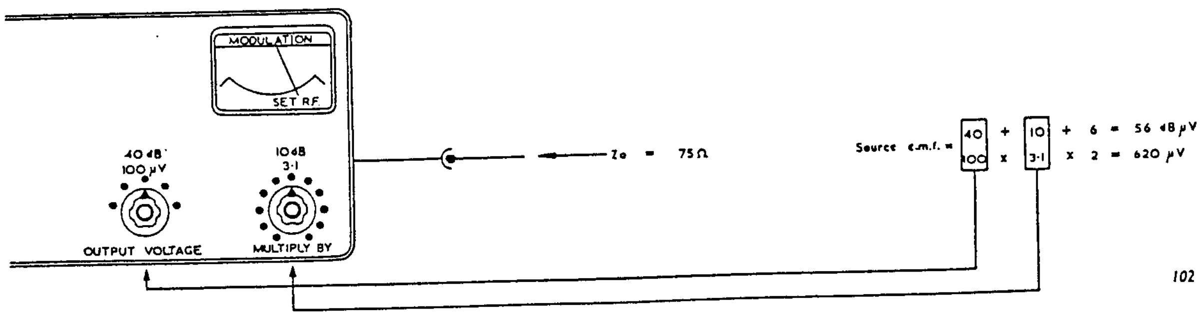


Fig. 2.7 Output direct from output lead

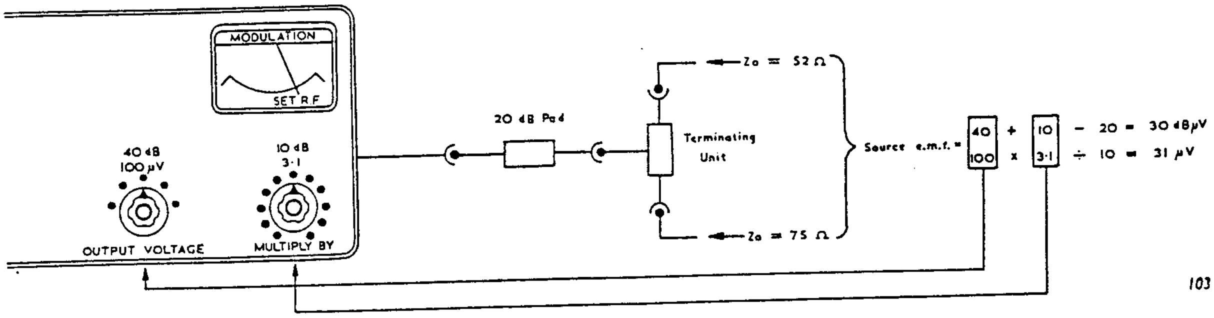


Fig. 2.8 Outputs via 20-dB pad and terminating unit

2.7.4 OUTPUT IN TERMS OF VOLTAGE DEVELOPED ACROSS AN EXTERNAL LOAD

For some particular applications, it may be desired to work not in terms of source e.m.f. as indicated by the meter and attenuator controls, but in terms of actual voltage developed across the external load. This on-load, or terminal voltage, is given by the expression

$$V_L = E \times \frac{Z_L}{Z_0 + Z_L} \quad \text{........ (1)}$$

where V_L = actual voltage developed across the external load.

E = the source e.m.f. of the Signal Generator.

Z_L = the impedance of the external load.

Z_0 = the source impedance of the Signal Generator; (with the TERMINATING UNIT in use, $Z_0 = 75$ or $52\,\Omega$; with the TERMINATING UNIT removed, $Z_0 = 75\,\Omega$).

The expression is based on the assumption that the external load impedance Z_L is essentially resistive. Where Z_L is not essentially resistive, it may be necessary for the user to revise the expression to take account of the reactive component of the load.

A series of multiplying factors, which can be used to convert from source e.m.f. to actual voltage developed across an external resistive load, and which have been derived with the aid of the above expression, are given in Table 3 for a selection of typical load values.

2.7.5 MATCHING TO EXTERNAL LOADS OTHER THAN 52 OR 75 OHMS

The TERMINATING UNIT supplied with the Signal Generator allows r.f. outputs to be obtained from a source impedance of either 52 or 75 ohms.

If the equipment under test has an input impedance of other than 52 or 75 ohms, and if it is required to present the equipment with a signal derived from a matched source, then it is necessary to modify the output arrangements of the Signal Generator. The simple modifications required are described in sub-sections (a) and (b) which follow.

In these sub-sections it is assumed that the TERMINATING UNIT is in circuit, and that the 20-dB ATTENUATOR PAD is out of circuit.

(a) External load less than that of the TERMINATING UNIT outlet in use.

The impedance presented to the load can be made equal to the load impedance by shunting the TERMINATING UNIT outlet with a single resistor, R_p, where

$$R_p = \frac{Z_0 \times Z_L}{Z_0 - Z_L} \quad \text{.........(2)}$$

TABLE 3

External load impedance in ohms	*Approximate multiplying factor to convert from source e.m.f. to actual voltage developed across an external resistive load*	
	Z_0 75Ω	Z_0 52Ω
10	0·12	0·16
20	0·21	0·28
30	0·29	0·36
40	0·35	0·43
50	0·4	0·49
52	0·41	0·5
60	0·44	0·53
70	0·48	0·57
75	0·5	0·59
80	0·51	0·61
100	0·57	0·65
150	0·67	0·74
200	0·73	0·79
300	0·8	0·85
600	0·89	0·92

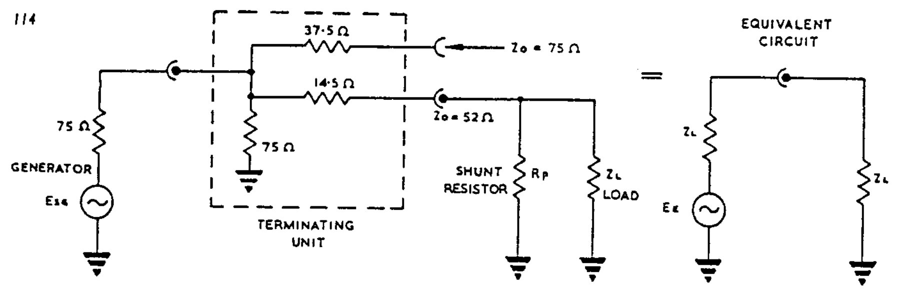


Fig. 2.9
Matching to low-impedance loads

and where Z_0 = the source impedance of the Signal Generator at the TERMINATING UNIT outlet in use;

Z_L = the impedance of the external load.

Under these conditions, the relationship between E_{SG}, the e.m.f. indicated by the attenuator controls on the Signal Generator, and E_E, the effective source e.m.f. presented to the external load, is given by the expression

$$E_{SG} = E_E \times \frac{R_p + Z_0}{R_p} \quad \text{.........(3)}$$

Example: It is required to provide a signal of 25 μV effective source e.m.f. at a source impedance of 20 ohms.

Since the new source impedance is to be 20 ohms, the output is taken from the 52-ohm outlet on the TERMINATING UNIT, the 52-ohm outlet being chosen in preference to the 75-ohm outlet to obtain the minimum reduction from E_{SG} to E_E.

From expression (2), the value of R_p to be connected in parallel with the 52-ohm outlet of the TERMINATING UNIT is

$$\frac{52 \times 20}{52 - 20} = 32{\cdot}5\,\Omega.$$

From expression (3), the attenuator controls on the Signal Generator should be set to indicate

$$25 \times \frac{32{\cdot}5 + 52}{32{\cdot}5} = 65\ \mu\text{V}.$$

The attenuators cannot be set to indicate exactly 65 μV and they should therefore be set to 63 μV—the setting nearest to the required value for E_{SG}. 63 μV is approximately −0·3 dB relative to 65 μV and, if desired, the user may obtain an E_{SG} nearer to 65 μV by adjustment of the SET CARRIER control to bring the meter pointer to an estimated +0·3 dB.

As a result of shunting the output of the TERMINATING UNIT with 32·5 ohms and setting the attenuator controls in the manner described, the equipment under test is fed from a source whose effective output impedance is 20 ohms and whose effective source e.m.f. is 25 μV; the actual voltage developed across the input impedance of the equipment under test is, of course, 12·5 μV.

(b) External load greater than that of the TERMINATING UNIT outlet in use.

The impedance presented to the load can be made equal to the load impedance by connecting a single resistor, R_S, in series with the Signal Generator output. The value of R_S is given by the expression

$$R_S = Z_L - Z_0 \quad \text{.........(4)}$$

where Z_L = the impedance of the external load.

Z_0 = the source impedance of the Signal Generator at the TERMINATING UNIT outlet in use.

Under these conditions, the effective source e.m.f. (E_E) of the Signal Generator and series resistor combined, equals the source e.m.f. (E_{SG}) of the Signal Generator alone,

$$\text{i.e. } E_{SG} = E_E \quad \text{.........(5)}$$

Example: It is required to provide a signal of 10 μV effective source e.m.f. at a source impedance of 300 ohms.

Since the new output impedance is greater than

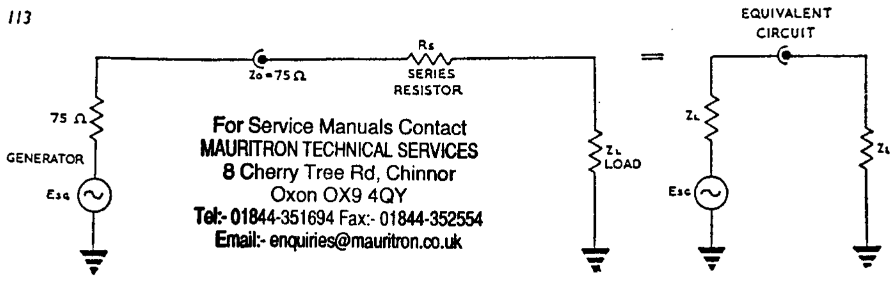
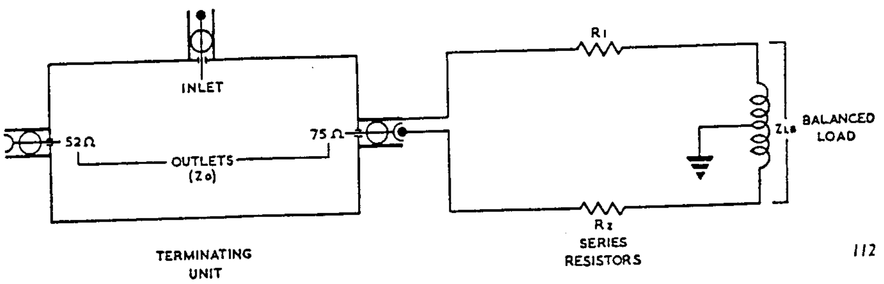


Fig. 2.10
Matching to high-impedance loads

Fig. 2.11
Matching to balanced loads



either 52 or 75 ohms, there is no advantage to be gained by using one of the TERMINATING UNIT outlets in preference to the other; in this example it is assumed that the 75-ohm outlet is used.

From expression (4) the value of R_S to be connected in series with the 'live' connection between the Signal Generator and the equipment under test, is

$$300-75 = 225\,\Omega$$

From expression (5), the attenuators on the Signal Generator should be set to indicate

$$10\ \mu V.$$

In this way, the equipment under test is fed from a source whose effective impedance is 300 ohms and whose effective source e.m.f. is 10 μV; the actual voltage developed across the input impedance of the equipment under test is, of course, 5 μV.

2.7.6 MATCHING TO BALANCED LOADS

The preceding Sections dealing with r.f. output arrangements are based on the supposition that the equipment being fed from the Signal Generator has an unbalanced input circuit.

With certain types of equipment, the input circuit is in the form of a balanced winding; such equipment can be fed from the unbalanced output of the Signal Generator by interposing two loading resistors between the TERMINATING UNIT outlet and the ends of the balanced input winding.

One resistor, R_1, is connected in series between the earth connection of the TERMINATING UNIT outlet in use and one side of the balanced winding; the other resistor, R_2, is connected in series between the 'live' connection of the TERMINATING UNIT outlet in use and the other side of the balanced winding.

Value for R_1 and R_2 may be computed from the following expressions:

$$R_1 = \frac{Z_{LB}}{2} \quad ....(6)$$

$$R_2 = \frac{Z_{LB}}{2} - Z_0 \quad ....(7)$$

where Z_{LB} = the total line-to-line impedance of the balanced winding.

Z_0 = the source impedance of the Signal Generator at the TERMINATING UNIT outlet in use.

With the equipment under test and the TERMINATING UNIT of the Signal Generator interconnected via R_1 and R_2 as described above, the source e.m.f. (E_{SG}) indicated by the Signal Generator controls is equal to the effective line-to-line source e.m.f. (E_E) seen by the equipment under test.

Example: It is required to match the 75-ohm outlet to a balanced winding whose total line-to-line impedance is 200 ohms.

From expression (6) the value of R_1 is

$$\frac{200'}{2} = 100\,\Omega.$$

From expression (7), the value of R_2 is

$$\frac{200}{2} - 75 = 25\,\Omega.$$

R_1 is connected in series with the earth connection of the TERMINATING UNIT and one side of the balanced winding; R_2 is connected in series with the 'live' connection between the TERMINATING UNIT and the other side of the balanced winding.

2.8 SYNCHRONIZING SIGNAL

A 1,000-Hz sine wave signal, derived from the internal a.f. oscillator, is available between the SYNC and E terminals of the instrument when the MOD SELECTOR switch is set at either of the INT MOD positions. This signal has an open-circuit level of the order of 100 volts and is derived via a source impedance of approximately 250 kΩ.

When an output from the equipment under test is being viewed on a cathode-ray oscilloscope, it will often be found convenient to lock the c.r.o. time base directly with the SYNC signal rather than with the actual signal being viewed.

The SYNC output can, of course, also be used when an audio frequency signal is required for the equipment under test.

Section 3 Operational summary

When the user is familiar with the principles and techniques of operation detailed in Section 2 of this manual, the following abridged operating instructions may be found convenient.

Check correctness of mains transformer tappings before use.

STANDARDIZING THE FREQUENCY SCALE

Switch mains ON and set RANGE MHz switch to 13·5–27; with MOD SELECTOR switch set to other than INT MOD—F.M. or EXT MOD—F.M., and using headphones plugged into CRYSTAL CHECK socket, tune main dial to crystal check point near centre of band. Bring movable cursor in line with dial calibration corresponding to crystal check point. Check accuracy of frequency indication above and below point to which cursor was originally set, equalize errors over band by readjusting cursor.

For further details, refer to Section 2.5.2.

TUNING

Set RANGE MHz switch to band required; rotate TUNE control until cursor indicates required frequency. For higher frequency-accuracy, compute relationship of frequency change to change in auxiliary dial setting between crystal check points or scale markings embracing required frequency. Starting from selected point below required frequency, rotate TUNE control so that incremental dial traverses calculated number of divisions.

For further details, refer to Sections 2.5.1 *and* 2.5.4.

INCREMENTAL FREQUENCY ADJUSTMENT

Make small carrier changes by means of INC. FREQ. control, using multiplying factors as shown on front panel.

For further details, refer to Section 2.5.3.

C.W. OPERATION

With MOD SELECTOR switch set to C.W., adjust SET CARRIER to bring meter pointer to SET R.F.; adjust step attenuators to obtain required output level.

For further details, refer to Section 2.6.1.

AMPLITUDE MODULATION

Internal:

With MOD SELECTOR switch at INT MOD—A.M., adjust SET CARRIER to bring meter pointer to SET R.F. With METER READS switch at A.M., adjust SET MOD to bring meter pointer to required modulation depth. Release METER READS switch and, if necessary, readjust SET CARRIER; adjust step attenuators to obtain required output level.

External:

As for internal, except that MOD SELECTOR switch is set to EXT MOD—A.M., and external signal injected between EXT MOD and E terminals. Approximately 15 volts r.m.s. (50 Hz to 10 kHz) is required to produce 30% modulation.

For further details, refer to Section 2.6.2.

FREQUENCY MODULATION

Internal:

With MOD SELECTOR switch at INT MOD—F.M., adjust SET CARRIER to bring meter pointer to SET R.F. With DEVIATION MULTIPLIER switch at NORMAL, and METER READS switch at F.M., adjust SET MOD to bring meter pointer to required deviation on meter scale appropriate to DEVIATION RANGE switch setting. (For deviations greater than 75 kHz, set DEVIATION MULTIPLIER switch to HIGH and multiply meter readings by factor given in Table 2, Section 2.6.3.) Release METER READS switch and, if necessary, readjust SET CARRIER; adjust step attenuators to obtain required output level.

External:

As for internal, except that MOD SELECTOR switch is set to EXT MOD—F.M. and external signal injected between EXT MOD and E terminals. With the DEVIATION MULTIPLIER set to NORMAL or HIGH, approximately 25 volts r.m.s. (50 Hz to 15 kHz) is required to produce full deviation; with the DEVIATION MULTIPLIER at MAX SENSITIVITY, 5 volts will produce 75 kHz deviation and the bandwidth is suitable for stereo multiplex signals.

For further details, refer to Section 2.6.3.

SIMULTANEOUS FREQUENCY AND AMPLITUDE MODULATION

Set up as for AMPLITUDE MODULATION, INTERNAL. Then, with MOD SELECTOR switch still set at INT MOD—A.M., apply external signal (50 Hz to 15 kHz) between EXT MOD and E terminals. Adjust level of external signal to produce required deviation; do not readjust SET MOD control.

For further details, refer to Section 2.6.4.

Section 4

Technical description

4.1 R.F. CIRCUITS

The r.f. oscillator itself (V3) is variable only over a fundamental frequency range of 4·5 to 9·16 MHz; the four higher frequency bands are obtained from a chain of four ganged multipliers (V6, V8, V10, and V12) of ×3, ×2, ×2, and ×2 respectively. The setting of the frequency RANGE switch determines which of the multipliers acts as the output stage. Output over the 0·2- to 13·5-MHz band is obtained by applying the 27- to 54-MHz output of the second multiplier to V7a which functions as a mixer. A 30 MHz signal from a crystal oscillator V16 is coupled via the mutual inductance of L20 into the grid circuit of the mixer stage V7a. The variable frequency is thus heterodyned with a fixed 30 MHz signal and the output from the mixer stage contains a difference frequency component which is utilised—after filtering and amplification by V7b—to provide outputs between 0·2 and 13·5 MHz.

The main tuning dial has five scales, all direct-reading in output frequency. To facilitate tuning, a slow-motion worm-and-wheel drive is incorporated; this control is fitted with a dial marked linearly from 0 to 100 to assist the operator in sub-dividing the frequency scales of the main tuning dial. In addition, there is a directly-calibrated separate incremental frequency control with a total cover of 50, 100, 200, or 400 kHz, depending on the band in use.

A carrier on/off switch (S7) is included to enable the r.f. signal to be interrupted without affecting the output circuits of the generator. This switch interrupts the h.t. supply to the r.f. oscillator valve and also the supply to the screens of the multiplier valves for the band in use.

For all the r.f. bands, the output is taken via two resistive 75-ohm ladder-network attenuators in cascade. The first attenuator has a range of 80 dB and is variable in 20-dB steps; the second has a

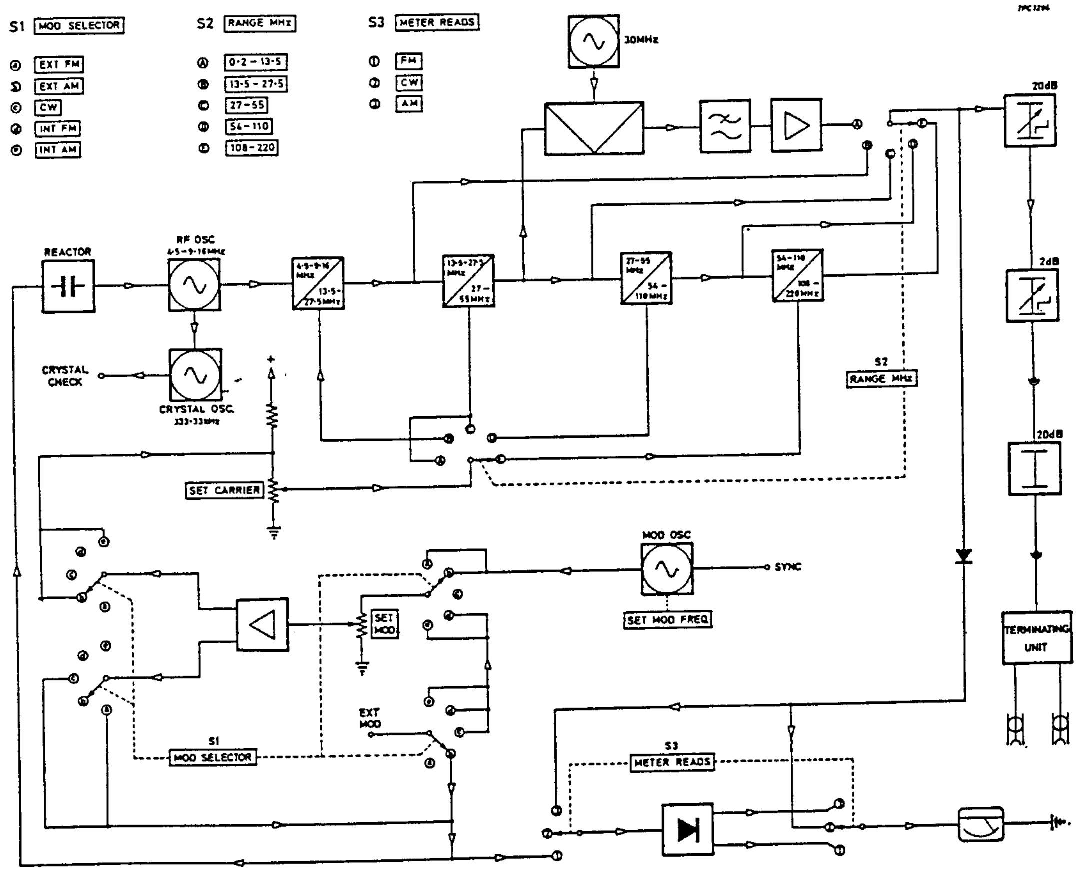


Fig. 4.1 Block schematic diagram

range of 20 dB in 2-dB steps. The input to the cascade is adjustable by means of the SET CARRIER control (R44), and is monitored by the MODULATION meter M1. The meter scale has a SET R.F. mark, and respectively above and below this mark, plus and minus 1-dB marks to allow interpolation between the 2-dB steps of the attenuator. The output from the second attenuator is applied to a coaxial cable which is permanently attached to the instrument; the direct open-circuit output obtainable from this cable is at a source impedance of 75 ohms and is variable between 2 μV and 200 mV. By using the plug-on Terminating Unit supplied, outputs 6 dB down on this range are obtainable at source impedances of both 75 and 52 ohms. With the optional Attenuator Pad interposed between the output cable and the Terminating Unit, outputs down to 0·1 μV are obtainable.

To provide for incremental carrier shift and for frequency modulation, a reactor valve (V2) is included in the tuned circuit of the r.f. oscillator. Movement of the INC. FREQ. control (R112) varies the d.c. bias applied to the grid of V2, causing a change in its mutual conductance and thus a change in the r.f. oscillator frequency. Both the d.c. shift voltage and the a.f. modulating signal are applied to the grid of the reactor valve via a tracking potentiometer (R7); this is ganged to the main tuning capacitor so that the deviation or carrier shift is kept constant as the Signal Generator is tuned over any one band.

The built-in crystal calibrator—the crystal unit of which has a fundamental frequency of 333·3 kHz—is coupled to the variable-frequency r.f. oscillator and provides 14 checking points on each of the four upper frequency bands covered by the Signal Generator. The h.t. supply to the calibrator is automatically switched on by the insertion of a telephone plug into the CRYSTAL CHECK jack on the front panel; the heterodyne beats at the checking points may then be heard in the headphones or via the receiver under test. The cursor of the tuning dial is adjustable so that it may be set to correspond exactly with the nearest crystal checking point.

4.2 MODULATION SYSTEMS

Amplitude and frequency modulation may be applied, from either an internal a.f. source or external sources. The internal source is a 1,000-Hz oscillator (V1).

For frequency modulation, the a.f. signal passes through a cathode follower (V5) and is normally fed to the reactor, not only through the variable tracking potentiometer, but also via a switched potentiometer system ganged to the RANGE switch. By this means, the ratio of a.f. input voltage to f.m. deviation is maintained constant at all frequencies on every band and is independent of the setting of either the RANGE switch or tuning control. The normal deviation ranges on all carrier bands are 0 to 25 kHz and 0 to 75 kHz, but switching (S5, the DEVIATION MULTIPLIER switch) is provided so that the switched potentiometer system can be bypassed, thus enabling the deviation to be increased.

Amplitude modulation, to a depth continuously variable up to 50%, is applied to the highest-frequency harmonic multiplier which is operating for the particular r.f. output band in use; this method helps to reduce the spurious frequency modulation often encountered when modulating an r.f. oscillator directly.

Simultaneous amplitude and frequency modulation—of use, for example, when investigating the performance of limiter stages in f.m. receivers—is obtained by setting up the instrument for internal a.m. and then applying f.m. from an external source.

4.3 MONITORING ARRANGEMENTS

A moving-coil microammeter on the front panel, used in conjunction with a crystal rectifier, continuously monitors the r.f. input to the attenuators when a spring-loaded key-switch is in the 'normal' position; the two alternative key positions are for reading f.m. deviation and a.m. depth respectively, the former by the measurement of the a.f. modulating voltage injected into the reactor valve and the latter by similarly checking the a.f. voltage being applied via the h.t. feed circuit to the screen of whichever multiplier is operating as modulator stage. The design of the modulation monitoring circuits is such that, with the Signal Generator set up for simultaneous a.m. and f.m., both percentage depth and deviation can be read independently.

4.4 POWER UNIT

A full-wave rectifier provides the positive d.c. h.t. supply; in the case of the reactor and r.f. oscillator valves, the h.t. is stabilized by means of a gas-filled stabilizer tube. A negative supply for the reactor-valve bias is drawn from a voltage-doubling circuit employing a double-diode valve and a gas-filled stabilizer. The primary of the transformer is tapped to allow for operation from 100 to 150 volts or 200 to 250 volts, and adequate r.f. filtering is introduced into the a.c. input circuit.

Section 5 Maintenance

5.1 GENERAL

Section 4, TECHNICAL DESCRIPTION, of this handbook deals with the internal circuits of the Signal Generator and it is strongly recommended that the user should familiarize himself with the principles described there before commencing the adjustment or replacement of component parts of the instrument.

The complete Circuit Diagram shows all the electrical components contained in the instrument together with their values. The full description of these components is given in the Replaceable Parts List which also lists certain selected mechanical components.

The physical location of the electrical components is shown on the Component Layout Illustrations.

5.2 REMOVAL OF CASE

To remove the Signal Generator case:—

(1) Remove the screw securing the small plate in the left-hand side pocket; the mains lead is cleated to the case by means of this plate.

(2) Extract the eight screws from around the edge of the front panel.

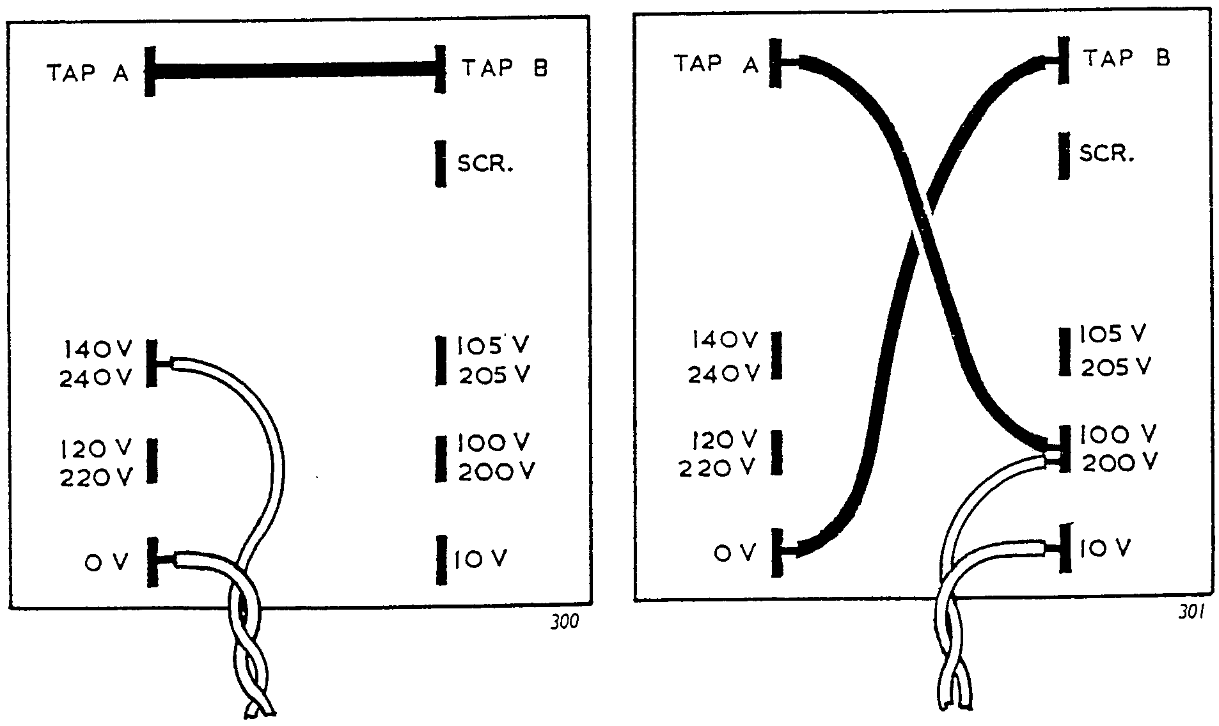
(3) Pull the instrument clear of its case and disconnect the six-way interconnecting cable from the power unit chassis.

(4) Detach the screw, from the inside of the case, which holds the cleating plate for the r.f. output cable to the right-hand side pocket.

5.3 MAINS INPUT ARRANGEMENTS

The instrument is fitted with a mains transformer which has a double-wound primary; each primary section is tapped and the two sections can be connected in series-parallel for 100- to 150-volt operation or in series for 200- to 250-volt operation.

The 100- to 150-volt or the 200- to 250-volt range is selected by links on the coil of the transformer. Selection of intermediate voltages within either range is made by means of fly leads on the transformer tags. These tags are common to both



(a) 240-volt connections *(b) 110-volt connections*

Fig. 5.1 Mains transformer tappings

ranges and are, therefore, annotated with two voltages; the applicable voltage depends on the position of the range links.

One fly lead must always be connected to either the ' 0 ' or the ' 10 ' tag; the other is connected to the tag whose voltage, added to 0 or 10 as appropriate, equals the mains supply voltage. Do not connect the fly leads to the tags marked TAP A or TAP B.

In order to examine the connections to the transformer and, if necessary, make adjustments, the instrument must be removed from its case in the manner described in Section 5.2. With the instrument out of its case, the transformer (Reference T4 on the Circuit Diagram, and on Component Layout Illustration, Fig. 5.6) is immediately accessible.

For Supply Voltages within the range 200 to 250 volts, the tags on the transformer *must* be linked in the following manner:—

' TAP A ' to ' TAP B '

For Supply Voltages within the range 100 to 150 volts, the tags on the mains transformer *must* be linked in the following manner:—

' 0 ' to ' TAP B '
' 100/200 ' to ' TAP A '

On earlier models the mains transformer is of slightly different mechanical construction. It is identified by having a mains-tapping plate fixed to its rear edge. Attached to this panel is a pierced reference plate which is reversible and marked with a selection of voltages. On one side of the plate, the voltages are applicable to the 100- to 150-volt range; on the other side, to the 200- to 250-volt range.

The two sections of the primary are connected together by means of links soldered between tags, numbered 1-2-3-4, on an insulated strip at the front of the transformer.

For 200- to 250-volt operation, link tag 2 to tag 3.

For 100- to 150-volt operation, link tag 1 to tag 2 and tag 3 to tag 4.

5.4 ACCESS TO ENCLOSED SUB-ASSEMBLIES

General tests or some peculiarity in the performance of the Signal Generator may suggest the desirability of inspecting the interior of one of the enclosed sub-assemblies which form part of the instrument. Any of these sub-assemblies can be dismantled by the appropriate procedure as detailed in the following sections.

5.4.1 R.F. UNIT

To remove the screening cover from the r.f. unit:—

(1) With the instrument removed from its case, lay it on its face.

(2) Extract the two screws which secure the screening cover of the r.f. unit.

(3) Grip the sides of the screening cover and draw it off; the cover is held by earthing contact springs and will consequently offer some resistance to removal.

5.4.2 'MULTIPLY BY' ATTENUATOR

To dismantle the attenuator:—

(1) Remove the attenuator screening cover after extracting the single securing screw.

(2) Remove the front-panel control knob after slackening the two grub screws which secure it to its associated spindle.

(3) Detach the main body of the attenuator from the front panel by extracting five screws; three of these screws are visible on removal of the control knob as in (2) above; the two remaining screws are located immediately above the 8-dB and 12-dB panel markings respectively.

With the attenuator thus detached, it remains coupled to the body of the instrument by two coaxial leads; these leads are normally long enough to permit inspection and, if necessary, replacement of the attenuator resistors without completely disconnecting the attenuator.

Reassemble the attenuator in the reverse order to that detailed above.

5.4.3 'OUTPUT VOLTAGE' ATTENUATOR AND MONITOR CRYSTAL XL2

In addition to the actual attenuator components, the r.f. monitor crystal, XL2, and its associated filter components are mounted in the OUTPUT VOLTAGE attenuator casing. Access to the crystal, XL2, resistors R71 and R72, and capacitors C88, C89, and C90 can be obtained by removing the cover of the attenuator in the following manner:

(1) Disconnect R70 from the small insulated spigot projecting through the cover of the attenuator.

(2) Remove the central securing screw and lift the screening cover clear of the attenuator body.

To obtain access to the attenuator resistors, R73 to R82, detach the attenuator from the front panel of the Signal Generator in the following manner:—

(3) Remove the control knob by slackening the two grub screws securing it to its spindle.

(4) Extract the five fixing screws securing the attenuator to the front panel; three of these screws are immediately visible on removing the control knob as in (3) above; the two remaining screws are located immediately above and to the right of the coarse-attenuator panel markings.

With the attenuator detached as in (4) above, it remains coupled to the body of the instrument by two coaxial cables. These cables are, however, long enough to permit inspection and, if necessary, replacement of the attenuator-resistors without completely disconnecting the attenuator.

Reassemble the attenuator in the reverse order to that detailed above.

5.4.4 MAINS INPUT FILTER UNIT

To gain access to the components comprising the mains input filter:—

(1) Remove the nut and screw which secure, at the open end, the two halves of the mains filter unit screening cover.

(2) Separate the push-fit screening channel from the fixed half of the screening cover.

Reassemble the screening cover in the reverse order to that detailed above.

5.4.5. POWER UNIT

To remove the power unit from the instrument case:—

(1) Remove, from the underside of the instrument case, the five screws which engage with nuts along the front and left-hand flanges of the power unit chassis.

(2) Holding the power unit with one hand, remove the remaining two screws which engage with the tapped bushes on the right-hand flange of the power unit.

Replace the power unit in the reverse order to that detailed above.

5.5 WORKING VOLTAGES

The voltages given in this section for guidance when servicing the instrument were obtained from measurements on a representative Signal Generator Type TF 995B/2; the voltmeter used had a resistance of 20,000 ohms per volt.

Mains Transformer, h.t. secondary	250–0–250 V a.c.
Mains Transformer, l.t. (rectifier)	5 V a.c.
Mains Transformer, l.t. (main)	6·3 V a.c.
Positive H.T.:—	
Rectified (V11, pin 8)	300 V d.c.
Smoothed, HT1 (across C62)	230 V d.c.
Stabilized, HT3 (V9, pin 5)	150 V d.c.
Negative H.T. (junction of R117 and R118)	85 V d.c.

Valve electrode voltages are given in Table 4.

All voltages listed are with respect to chassis and, except where alternative instructions are given, should be measured with the MOD SELECTOR switch set to INT MOD—A.M., the RANGE MHz switch to 108–220, the SET CARRIER control to maximum, and the SET MOD control to minimum.

TABLE 4

Valve No.	*Va*	*Vg2*	*Vk*
V1	245	50	1·5
V2	150	150	9·0
V3	150	75	—
V4	27	27	—
V5	250	250	3·0 40†
V6	130	160	—
V7 (amp)*	250	—	2·5
V7 (osc)*	235	—	—
V8	105	155	—
V10	150	150	—
V12	150	150	—

**When checking V7 voltages, set the RANGE MHz switch to 1·5–13·5.*

†The cathode potential of V5 increases to 40 volts when the MOD SELECTOR switch is set to INT MOD—F.M.

5.6 REPLACEMENT OF VALVES AND CRYSTALS

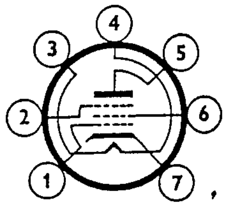
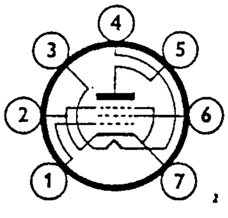
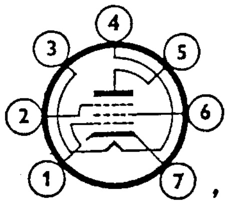
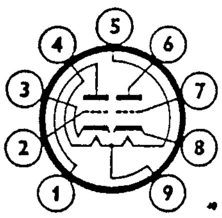
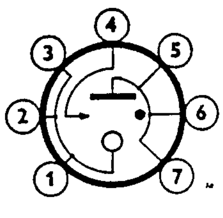
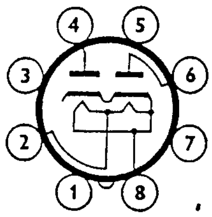
The types of valve used in the instrument, their base connections, and some guidance as to suitable alternatives if the types originally fitted are not readily available, are given in Table 5.

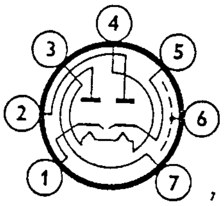
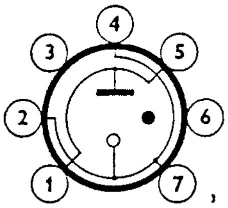
The valves and crystals may normally be replaced without special selection. Valves V1, V5, V9, V11, and V13 to V15 are immediately accessible on removing the instrument from its case. To gain access to the 333·3-kHz oscillator crystal, X1, and to the remaining valves, remove the R.F. Unit screening cover. The crystal rectifier, X2, forms part of the OUTPUT VOLTAGE attenuator assembly and can be removed by the procedure detailed in Section 5.4.3.

Replacement of valves or crystals may necessitate either the reselection of associated components or readjustment of associated preset controls; aspects of this reselection and readjustment are discussed in the following Section.

TABLE 5

Any valve which becomes faulty should preferably be replaced by a valve of the type originally supplied in the instrument and designated in the following table. If this is not possible, the additional data given by the table may be used as a guide to suitable alternatives.

Valve	*Type*	*Base*	*British Commercial Equivalent*	*British Services Equivalent*	*U.S. Equivalent*
V1, V2	Brimar 6AK6 Power Pentode	 (B7G)		CV1762	6AK6
V3, V4, V6, V8, V10, V12 V16	Mullard EF95 H.F. Pentode	 (B7G)	6AK5	CV850	6AK5
V5	Brimar 6AU6 Pentode	 (B7G)		CV2524 CV4023	6AU6
V7	Brimar 12AT7 Double Triode	 (B9A)	ECC81	CV455	12AT7
V9	Marconi QS150/15 Voltage Stabilizer	 (B7G)	OA2*	CV287 CV1832* CV4020*	OA2*
V11	Brimar 5Z4G Full-Wave Rectifier	 (IO)	R52 GZ30 52KU U50	CV1863	5Z4G

Valve	*Type*	*Base*	*British Commercial Equivalent*	*British Services Equivalent*	*U.S. Equivalent*
V13, V15	Marconi D77 Double Diode	 (B7G)	6AL5 6D2 D152 DD6 EB91	CV140	6AL5
V14	5651 Voltage Stabilizer	 (B7G)	QS1209 QS83/3 85A2	CV2573 CV449	5651 OG3

**The base connections for these voltage stabilizers are different from those of the type QS150/15 (CV287). The holder for V9 in the TF 995B/2 has been specially wired so that, without rewiring, any of the voltage stabilizers listed as alternatives can be used.*

5.7 PRESET AND SPECIALLY SELECTED COMPONENTS

During the factory calibration of the instrument, certain of its performance characteristics are brought within fine limits by means of preset components. Following the replacement or aging of certain fixed components, it may become necessary to repeat the calibration procedure by which the presets were adjusted.

The Description column of the Replaceable Parts List shows which of the components are of the preset type; components which are individually selected are distinguished in that column by a single dagger.

If, in servicing a TF 995B/2, it is necessary to replace any of these components, it is also necessary, if the performance or accuracy of the instrument is not to be impaired, to repeat the factory calibration procedure by which the components were originally selected.

Section 5.8 gives a range of tests by which the main points of the performance of the instrument can be checked; this section also deals with the adjustment of preset components and with the choice of value for individually selected components.

It will be appreciated that it may sometimes be necessary to reselect a selected component even though that component itself has not been found faulty and replaced in initial servicing operations. To take an example—the internal modulation oscillator is tuned by T1 and C6. In manufacture, C6 is selected to give an oscillator frequency of 1,000 c/s ± 5%. In servicing the instrument it might be found that T1 was faulty but that C6 was not. If T1 was replaced then it would be quite likely that with the original C6 the oscillator frequency would be outside the specified limits of

TABLE 6

Component	*Section Describing Adjustment or Selection*	*Component*	*Section Describing Adjustment or Selection*
R19	5.8.10	R140	5.8.12
R39	5.8.17	C6	5.8.9
R50	5.8.13	C35	5.8.5
R68	5.8.12	C40	5.8.7
R69	5.8.12	C47	5.8.6
R70	5.8.8	C59	5.8.7
R124	5.8.19	C66	5.8.6
R127	5.8.12	C76	5.8.6
R128	5.8.12	C83	5.8.6
R129	5.8.12	T2	5.8.5
R130	5.8.16	T3	5.8.6
R131	5.8.11	L8	5.8.4
R133	5.8.13	L18	5.8.6
R134	5.8.11	L22	5.8.6
R138	5.8.12	L23	5.8.6

± 5% and that a new value of capacitance would have to be chosen.

It therefore follows that, in all servicing involving replacement of components, the user should consider carefully the possible effects on the performance of the stage or stages involved.

Table 6 on page 29 lists the circuit reference numbers of both types of component together with the numbers of the sections in which their adjustment or selection is described.

5.8 SCHEDULE OF TESTS

The following information, based on abstracts from the internal Factory Test Schedule, 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 the adjustment to preset components and the choice of value for individually selected components.

5.8.1 APPARATUS REQUIRED

(a) 750-volt Insulation Tester.

(b) Avometer, model 8.

(c) Wave Analyser; Marconi Type TF 2330.

(d) Signal Generator, with standardized output; Marconi Types TF 801 (Series) or TF 995 (Series).

(e) Valve Voltmeter; Marconi Type TF 1041 (Series).

(f) A.M. Communications Receiver, covering the range 1·5 to 220 MHz.

(h) Audio-Frequency Oscillator; Marconi Type TF 1101.

(i) Cathode-Ray Oscilloscope; Marconi Type TF 1330 (Series) or TF 2200 (Series).

(j) Deviation Meter; Marconi Type TF 791 (Series).

(k) Counter-type Frequency Meter; Marconi Type TF 2410.

Note: *For the F.M. on C.W. check (Section* 5.8.20), *where deviations of less than* 50 *Hz have to be measured, it is essential that the deviation meter should be modified to operate from battery supplies, or incorporate facilities allowing its local oscillator to be brought under crystal control.*

5.8.2 INSULATION

(Apparatus required: Item a)

Test the insulation between each pin of the supply plug and chassis with SK1 engaged with PL1. The reading should not normally be less than 40 MΩ.

5.8.3 HUM LEVEL

(Apparatus required: Item c)

Measure the 100-c/s hum level using a wave analyser isolated from the TF 995B/2 by means of a suitable capacitor. The hum level should not normally exceed 20 mV as measured at the H.T.1 point.

5.8.4 CRYSTAL OSCILLATOR

(Apparatus required: Item k)

Plug headphones into the CRYSTAL CHECK socket and, by means of a loop of wire slipped over V4, take an output to the Counter-type Frequency Meter. Check the crystal frequency, it should usually lie between 333 266 Hz and 333 400 Hz.

5.8.5 BASIC OSCILLATOR

(Apparatus required: Items e and f)

Set the MOD SELECTOR switch to C.W. and the main tuning dial to 27 MHz. Using a receiver as indicator, adjust C35 until the circuit oscillates at 9·0 MHz. Set the main tuning dial to 13·5 MHz, and adjust the core of T2 until the circuit oscillates at 4·5 MHz. Repeat these two adjustments.

Measure the r.f. voltages at the grid and anode of V3 using a valve voltmeter. These should be of the following order:—

	4·5 MHz	9 MHz
Grid	2 volts	4 volts
Anode	14 volts	24 volts

Recheck the tuning adjustments against the crystal by means of high-resistance headphones plugged into the CRYSTAL CHECK socket. Fourteen check points should be heard. Check that the oscillator output is maintained when the dial is set to 27·5 MHz.

5.8.6 FREQUENCY MULTIPLIERS

(Apparatus required: Item f)

(1) 13·5- to 27-MHz band

Set the MOD SELECTOR switch to C.W., the RANGE switch to 13·5–27 MHz, and the SET CARRIER control fully clockwise.

Set the main dial to 13·5 MHz, and adjust the core of T3 for maximum deflection on the panel meter.

Set the main dial to 27 MHz, and adjust C47 for maximum deflection on the meter.

Use the receiver to check that, at these two points, the stage is operating at 13·5 and 27 MHz respectively, and that the Signal Generator tunes to 27·5 MHz at the appropriate dial reading.

(2) 27- to 54-MHz band

Set the RANGE switch to 27–54, and adjust C66 and the spacing of the turns of L18 at 54 and 27 MHz respectively for maximum deflection on the panel meter.

Use the receiver to check that, at these two points, the stage is operating at 54 and 27 MHz respectively, and that the Signal Generator tunes to 55 MHz at the appropriate dial reading.

(3) 54- to 108-MHz band

Set the RANGE switch to 54–108, and adjust C76 and the spacing of the turns on L22 at 108 and 54 MHz respectively.

Use the receiver to check that, at these two points, the stage is operating at 108 and 54 MHz respectively, and that the Signal Generator tunes to 110 MHz at the appropriate dial reading.

(4) 108- to 220-MHz band

Set the RANGE switch to 108–220, and adjust C83 and the spacing of the turns on L23 for maximum reading on the TF 995B/2 output meter at 216 and 108 MHz respectively.

Use the receiver to check that, at these two points, the stage is operating at 216 and 108 MHz respectively, and that the Signal Generator tunes to 220 MHz at the appropriate dial reading.

5.8.7 0.2- TO 13.5-MHz BAND

(Apparatus required: Item f)

This test must be made with the r.f. unit cover in position.

Set the RANGE switch to 0·2–13·5 and the MOD SELECTOR to C.W. To set the 30 MHz crystal oscillator, adjust the core of L27 so that oscillation occurs (shown by a reading on the Carrier Level meter). Adjust L20 for maximum indication on the Carrier Level meter.

Set C59 to approximately a quarter of its maximum capacitance and turn the SET CARRIER control to maximum. Adjust the TUNE control so that the main tuning dial indicates 30 MHz on band 3 and adjust C40 for minimum output (shown by a sharp fall in the reading of the Carrier Level meter).

Connect the output of the Signal Generator to a receiver, and tune the receiver to some convenient accurately-known frequency between 0·2 and 13·5 MHz.

Set the main dial of the TF 995B/2 to this frequency, and adjust C40 for maximum receiver response.

In the absence of any other frequency standard, the receiver tuning may be standardized at frequencies between 4·5 and 9 MHz by loosely coupling its input to the basic oscillator of the TF 995B/2. This oscillator should first be standardized against the internal crystal calibrator, the basic-oscillator frequency being given by dividing by three the indication on the 13·5–27 scale.

5.8.8 R.F. OUTPUT VOLTAGE ACCURACY

(Apparatus required: Items d, e, and f)

This test should be carried out with the instrument in its case.

Using a receiver as indicator, compare the output voltage with that of a standardized signal generator. If a constant error exists, it is probably due to a faulty monitor diode X2. This diode should have a backward resistance of 8 kΩ or greater when checked with a sensitive multi-range test meter, e.g. Avometer Model 8. If X2 is replaced, it will be necessary to select a new value for R70 in order to bring the output level within the limits of 0·89 to 1·12 of nominal up to 100 MHz, and 0·795 to 1·25 of nominal up to 220 MHz.

Check at the following frequencies and levels: 25 MHz, 100 MHz, and 220 MHz; 100 mV and 10 μV.

5.8.9 MODULATION OSCILLATOR

(Apparatus required: Items e, h and i)

Set the MOD SELECTOR switch to INT MOD—A.M., connect the output from the slider of the SET MOD potentiometer to the Y plates of a cathode-ray oscilloscope and the output of an a.f. oscillator to the X plates. Check the frequency of oscillation by the lissajous-figure method, and, if outside the limits of 950 to 1,050 Hz, select a new value for the tuning capacitor C6.

Measure the output voltage at the SYNC terminal with a valve voltmeter. It should not be less than 100 volts.

5.8.10 F.M. DISTORTION

(Apparatus required: Items c and j)

Set the DEVIATION MULTIPLIER switch to NORMAL, the DEVIATION RANGE switch to 75 kHz, the MOD SELECTOR switch to INT MOD—F.M., and the RANGE switch to 13·5–27; then adjust the SET CARRIER control to give a convenient deflection on the TF 995B/2 panel meter.

Connect the output cable directly to a carrier deviation meter, tune both instruments to 20 MHz, and adjust the TF 995B/2 attenuators for maximum output.

Adjust the SET MOD control to produce 75 kHz deviation, and check that the positive and negative deviations as indicated on the deviation meter are equal. If they are unequal, select a value for R19 to produce equal positive and negative deviations.

Apply the demodulated f.m. signal from the deviation meter to a wave analyser, and measure the total distortion at carrier frequencies of 13·5, 27, 90, and 220 MHz. The total f.m. distortion should not exceed 2%.

5.8.11 F.M. TRACKING AND RANGE 2 SENSITIVITY

(Apparatus required: Items h and j)

Set the MOD SELECTOR switch to EXT MOD—F.M., the DEVIATION RANGE switch to 75 kHz, and adjust the SET CARRIER control to bring the meter pointer to SET R.F. Set the OUTPUT VOLTAGE and MULTIPLY BY attenuators to 100 dB, connect the output cable directly to a deviation meter and tune both instruments to 13·5 Mc/s (range 2).

Connect the audio oscillator to the EXT MOD terminals and feed in a 26 V, 1 kHz signal. Turn the SET MOD control fully clockwise and check that the deviation indicated on the external deviation meter is at least 80 kc/s adjusting R131, if necessary, to obtain this figure.

Turn the MOD SELECTOR switch to INT MOD F.M. and adjust the SET MOD control until the external deviation meter indicates a deviation of 75 kHz.

Tune both the TF 995B/2 and the deviation meter to 27 MHz (range 2). Note the deviation and, if necessary, adjust R134, so that the deviation is maintained at 75 kHz.

5.8.12 DEVIATION MONITOR

(Apparatus required: Item j)

Put the MOD SELECTOR switch to INT MOD—F.M. the DEVIATION MULTIPLIER switch to NORMAL.

(a) **Scale zero.** Set the SET MOD control fully counter clockwise, turn the DEVIATION RANGE switch to 75 kHz, press the METER READS switch to F.M. and check that the pointer of the deviation meter is at zero. If necessary bring the pointer to zero by selecting a new value for R68. Similarly, with the DEVIATION RANGE switch at 25 kHz, check that zero deflection is obtained, if necessary selecting a new value for R69.

(b) **Full scale.** Turn the SET CARRIER control to give a convenient deflection on the TF 995B/2 output meter. Connect the output cable directly to a carrier deviation meter; and set the TF 995B/2 attenuator controls to give maximum output and tune both instruments to 20 MHz.

With the DEVIATION RANGE switch at 75 kHz and the METER READS switch at C.W. adjust the SET MOD control until 75 kHz deviation is indicated on the external deviation meter. Press the METER READS switch to F.M. and adjust R129 so that the deviation meter (M1) reads 75 kHz.

Return the METER READS switch to C.W. and turn the DEVIATION RANGE switch to 25 kHz. Select a value for R127 to obtain 25 kHz deviation shown by the external deviation meter.

Press the METER READS switch to F.M. and adjust R128 so that the deviation meter (M1) reads 25 kHz.

Turn the RANGE switch to 27–54 MHz and turn the external deviation meter to the same frequency. Adjust the SET MOD control to give an indicated deviation of 75 kHz, with the DEVIATION RANGE switch at 75 kHz. Adjust R140 so that a true deviation of 75 kHz is obtained, as shown by the external deviation meter. Repeat this procedure on the 54–108 MHz and 108–220 MHz bands setting R138 and R136 respectively for true deviation of 75 kHz.

If a deviation meter is not available, the following method may be used to determine the frequency deviation. This method—the disappearing carrier method—depends upon the fact that the carrier, as opposed, of course, to the sidebands, disappears when the modulation index μ (the ratio of the frequency deviation δF to the modulation frequency f) has values of 2·4, 5·52, 8·65, 11·79, etc. Therefore, if the modulation frequency, f, is known, since deviation, δF, is equal to μf, deviation can be simply calculated when μ is known—i.e. at a carrier disappearance point. For example, if the applied modulation has a frequency of 10 kc/s and the deviation is progressively increased until the carrier disappears, the deviation must be $2{\cdot}4 \times 10 = 24$ kHz, and again $5{\cdot}52 \times 10 = 55{\cdot}2$ kHz.

A deviation check at 75 kHz can be obtained at the second disappearance with a modulation frequency of 13·6 kHz.

To determine these points, apply the output of the TF 995B/2 to a narrow-band (communication) a.m. receiver and tune the latter to the unmodulated output frequency of the TF 995B/2. Set the beat oscillator of the receiver to give an audio note; then frequency modulate the Signal Generator at a fairly high frequency outside the passband of the a.m. receiver—such as 10 kHz—starting from zero deviation and increasing the deviation until the beat with the carrier disappears. At this point, the actual deviation can be calculated as described above.

5.8.13 INCREMENTAL FREQUENCY

(Apparatus required: Items h and i)

Check the calibration of the INC. FREQ. dial in the following manner:—

(1) By means of a suitable jack plug, connect a pair of head telephones to the CRYSTAL CHECK socket; set the MOD SELECTOR switch to C.W.; then set the INC. FREQ. control to its centre-zero position and short-circuit the slider of its potentiometer, R112, to chassis.

(2) Adjust the TUNE control to bring the frequency of the r.f. oscillator to some convenient crystal check point near the low-frequency end of the range, and tune carefully to zero beat.

(3) Disconnect the short-circuit between the slider of R112 and chassis, and check that zero beat occurs when the INC. FREQ. control is within 2 kHz of its centre-zero position.

(4) If zero beat does not occur with the control within 2 kHz of its zero setting, check that the dial is positioned on its spindle so that the 0 coincides with the cursor when the potentiometer is at its mid-travel position; then select a value for R50 to bring the frequency to zero beat with the INC. FREQ. dial reading zero.

(5) Having obtained satisfactory operation at zero frequency-shift position, disconnect the telephones and connect in their place the Y input of a cathode-ray oscilloscope. Connect an a.f. oscillator to the X input of the oscilloscope, and adjust the frequency of this oscillator to exactly 3·33 kHz.

(6) Using the lissajous-figure method, check the accuracy of the incremental dial at each calibration point. A calibrated movement of 10 kHz on the incremental dial corresponds to an actual shift of the r.f. oscillator frequency of 3·33 kHz.

(7) If necessary, adjust R133 to bring the calibration of the INC. FREQ. dial to an accuracy of 10%.

5.8.14 HIGH DEVIATION

(Apparatus required: Item j)

Connect the output of the TF 995B/2 to a deviation meter and check that, when the TF 995B/2 is set for 9 kHz deviation with the DEVIATION MULTIPLIER switch set to NORMAL, the deviation, indicated on the deviation meter, rises to approximately the following values when the DEVIATION MULTIPLIER switch is set to HIGH.

RANGE MHz	*HIGH Deviation for 9 kHz NORMAL*
0·2–13·5	18 kHz
13·5–27	9 kHz
27–54	18 kHz
54–108	36 kHz
108–220	72 kHz

5.8.15 EXTERNAL F.M.

(Apparatus required: items h and j)

Connect the output of the a.f. oscillator, set to a frequency of 1 kHz, to the EXT MOD and E terminals. Set the MOD SELECTOR switch to EXT MOD—F.M. and the DEVIATION MULTIPLIER switch to NORMAL. Feed the output of the TF 995B/2 to the deviation meter and tune both instruments to 20 MHz.

Bring the a.f. input voltage to a convenient point on the dB scale of the a.f. oscillator output monitor and adjust the SET MOD control to give a true deviation of 60 kHz as indicated on the external deviation monitor. Press the METER READS switch to F.M. and note the meter reading.

Vary the audio input frequency from 50 Hz to 15 kHz keeping the TF 995B/2 meter (M1) reading, obtained with the METER READS switch at F.M., constant at the previously noted value. This constant reading must be achieved by adjustment of the input voltage and not by variation of the SET MOD control. Monitor the corresponding deviation indicated by the external deviation meter. Check that the total variation of the input level and the true deviation does not exceed ±1 dB.

5.8.16 INTERNAL A.M.

(Apparatus required: Items c, f, and i)

Apply the output of the TF 995B/2 to a frequency changer circuit which is followed by an i.f. amplifier and cathode ray oscilloscope; the i.f. amplifier should have a centre frequency which will allow its output to be viewed directly on the c.r.o. Set the MOD SELECTOR switch to INT MOD—A.M. and adjust the SET MOD control for 50% modulation as measured on the c.r.o. screen using the formula:

$$M(\%) = \frac{D\ max - D\ min}{D\ max + D\ min} \times 100$$

where D max = the peak-to-peak dimensions of the c.r.o. display,

D min = the trough-to-trough dimensions of the c.r.o. display.

Hold the METER READS switch to A.M. and check that the meter reading is correct. If not, adjust R130.

Using the wave analyser check that the total distortion of the detected output appearing across R70 does not, in general, exceed 6% at 30% modulation.

5.8.17 EXTERNAL A.M.

(*Apparatus required: Items f, h, and i*)

Connect the output of an a.f. oscillator to the EXT MOD and E terminals. Tune the oscillator to 1 kHz and the TF 995B/2 to 20 MHz. Set the MOD SELECTOR to EXT MOD A.M. and connect the TF 995B/2 output to a cathode ray oscilloscope to measure the modulation depth as described in Section 5.8.16.

Bring the a.f. input voltage to a convenient point on the dB scale of the a.f. oscillator monitor and adjust the SET MOD control to give a true modulation depth of 30%. Press the METER READS switch to AM and note the meter reading.

Vary the audio input frequency from 50 Hz to 10 kHz keeping the TF 995B/2 meter (M1) reading, obtained with the METER READS switch at A.M., constant at the previously noted value. This constant reading must be achieved by adjustment of the input voltage, and not by variation of the SET MOD control. Measure the corresponding modulation depth with the oscilloscope; check that the variation of true modulation depth does not exceed 1 dB and that the variation of input voltage does not exceed 1 dB. If the variations exceed these limits select a new value for R39.

5.8.18 SPURIOUS A.M.

(*Apparatus required: Item i*)

Set the TF 995B/2 for 10% a.m. at 20 MHz and measure the a.c. voltage appearing across R70. Set to 75 kHz deviation and check that the voltage across R70 is not greater than before.

5.8.19 SPURIOUS F.M. ON C.W.

(*Apparatus required: Items c and j*)

When making this check, the instrument should be removed from its case but should be bonded to the power unit by a length of copper braid or heavy-gauge wire.

(1) Connect the generator output to the deviation meter. Note that since the deviation to be measured is as low as 50 Hz, it is essential that the deviation meter itself generates negligible spurious f.m. This can be achieved either by modifying the deviation meter to operate from batteries or by using a deviation meter whose local oscillator can be brought under crystal control.

(2) In order to detect the small amount of deviation accurately, connect the Wave Analyser to the 'L.F. Output' terminals of the deviation meter.

(3) Set up the Signal Generator for, say, 10 kHz internal f.m. deviation at a carrier frequency of 12 MHz.

(4) Peak the wave analyser reading by tuning the deviation meter in the normal manner for a 12 MHz input and by tuning the Wave Analyser to the modulating frequency. From this reading, the Wave Analyser can be calibrated in terms of MV per kHz deviation.

(5) Set the modulation selector to C.W. and, with the Carrier Deviation Meter still tuned to the 12 MHz carrier frequency, tune the Wave Analyser to the frequency of the power supply.

(6) Adjust R124 until the Wave Analyser indication is at a minimum. This potentiometer is accessible through a small hole in the side of the r.f. unit cover.

(7) Measure the levels of the hum and ripple components and, from the geometric sum, calculate the deviation. The deviation should be less than 50 Hz.

(8) Repeat operations (5), (6), and (7) for a selection of frequencies up to 220 MHz. Below 100 MHz, the spurious deviation should be less than 50 Hz; between 100 and 220 MHz, the deviation should be less than 100 Hz.

Component layout illustrations

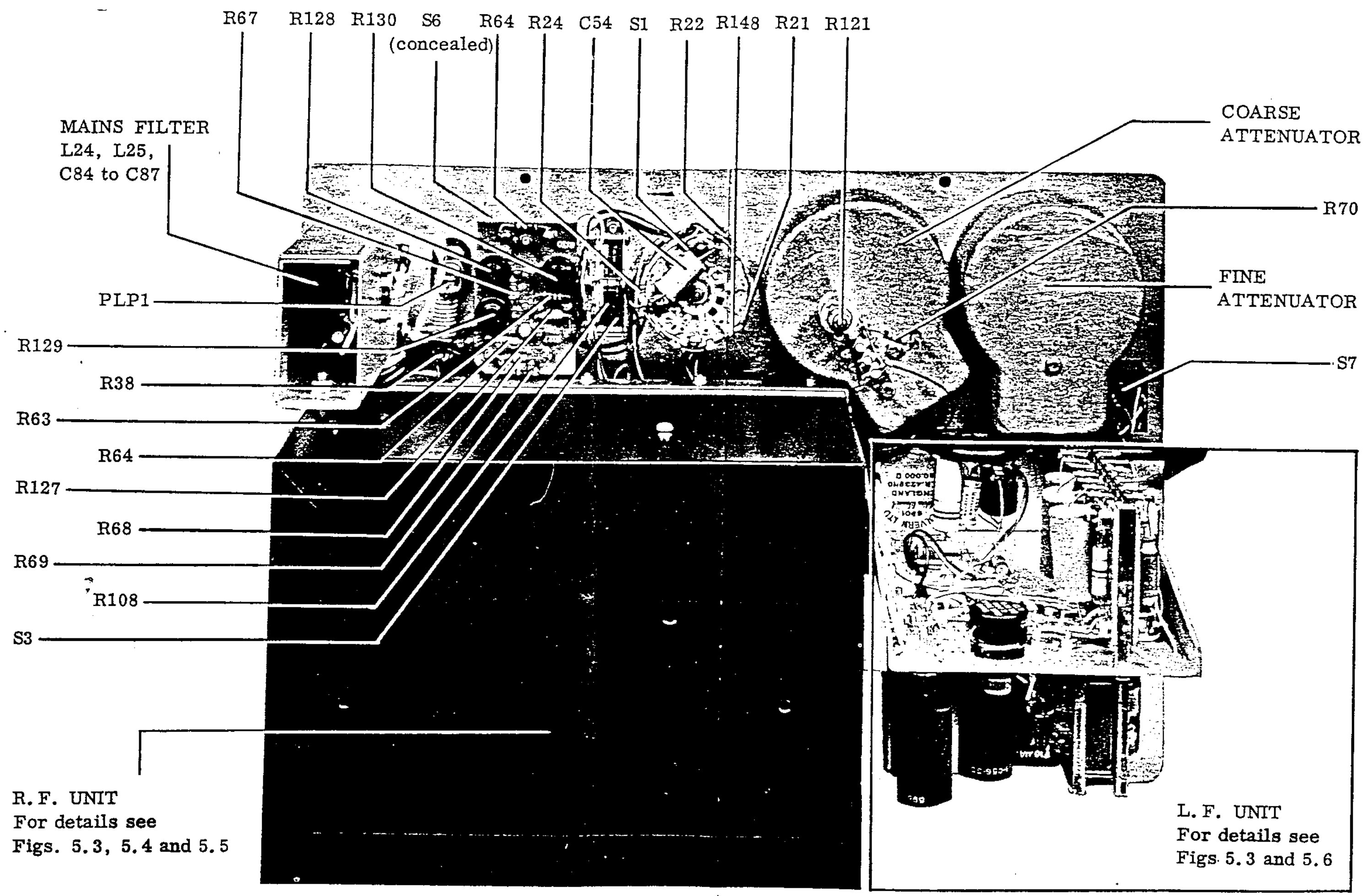
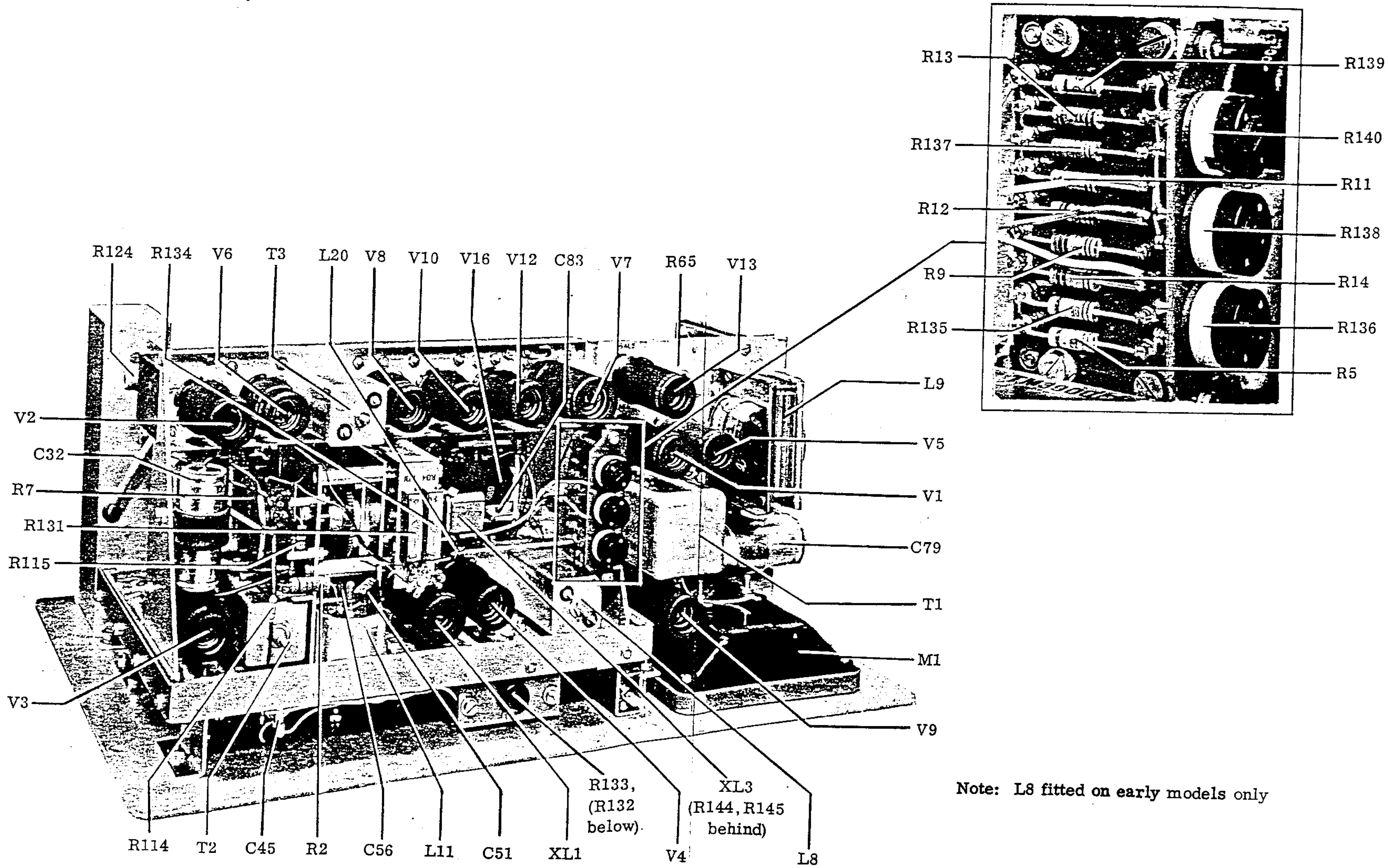


Fig. 5.2 General underside view from rear (case removed)



Note: **L8 fitted on early models** only

Fig. 5.3 L.F. and r.f. units. Top view with r.f. unit screening cover removed

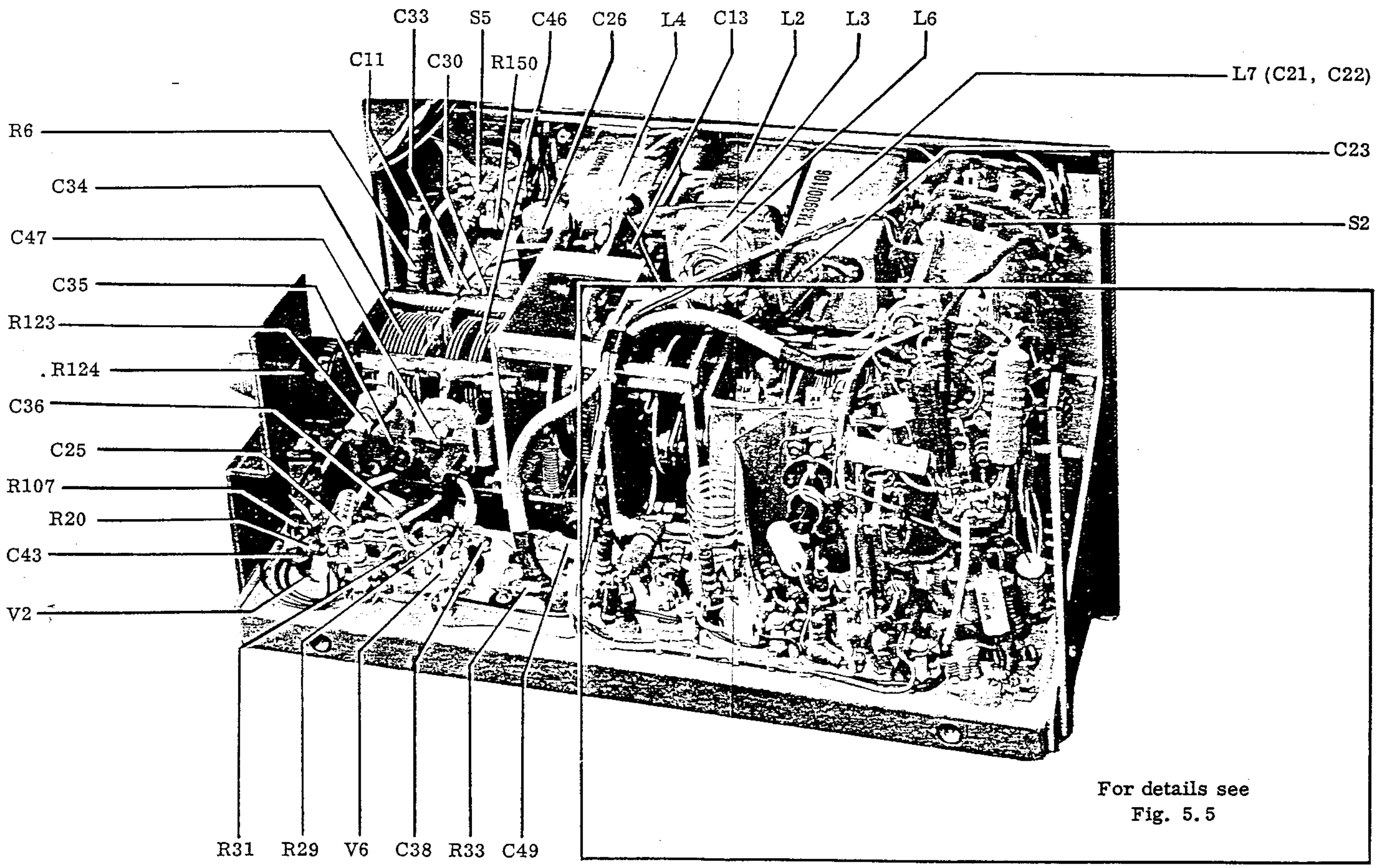


Fig. 5.4 R.F. unit, general underside view

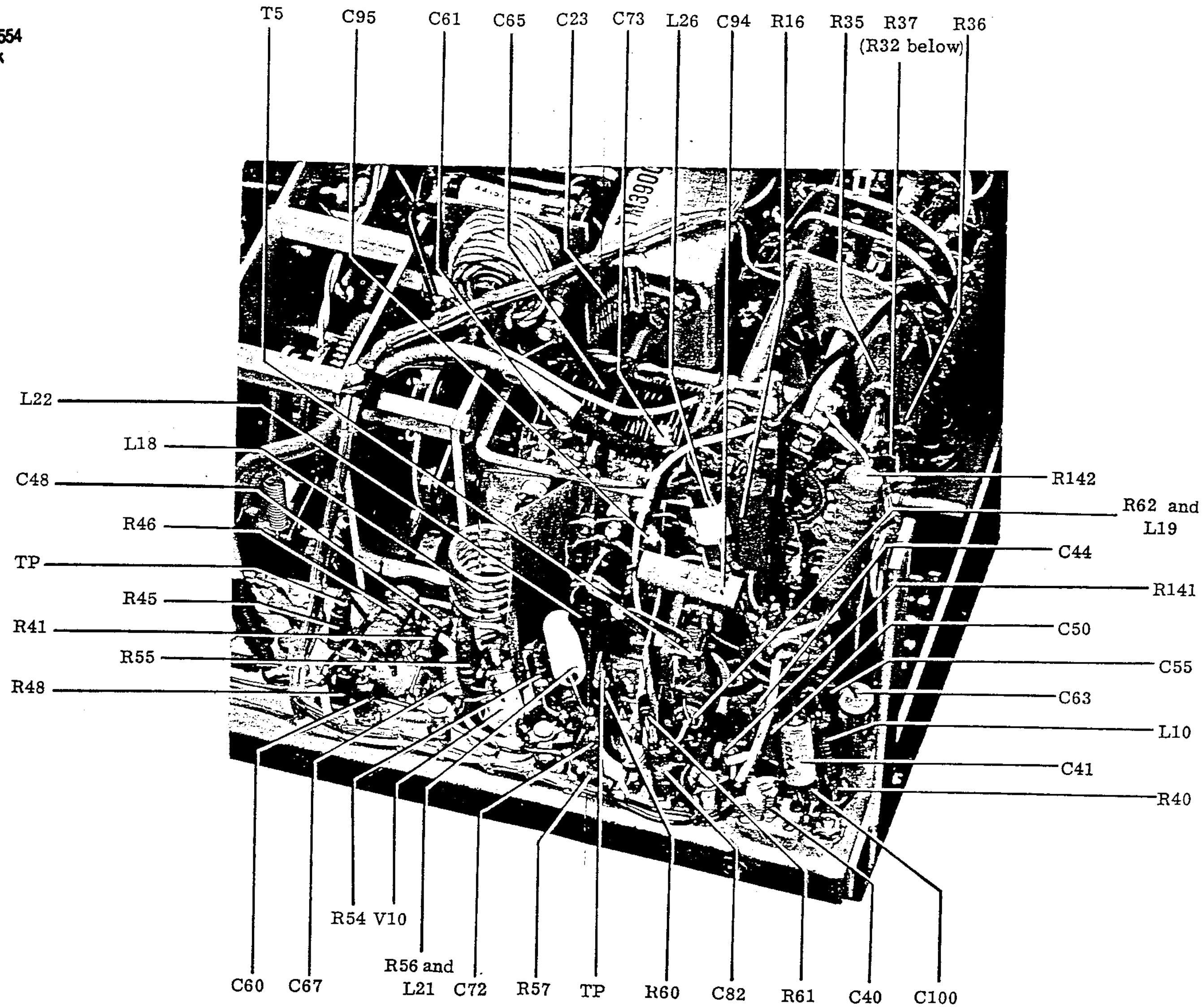


Fig. 5.5 R.F. unit, close-up of portion of underside

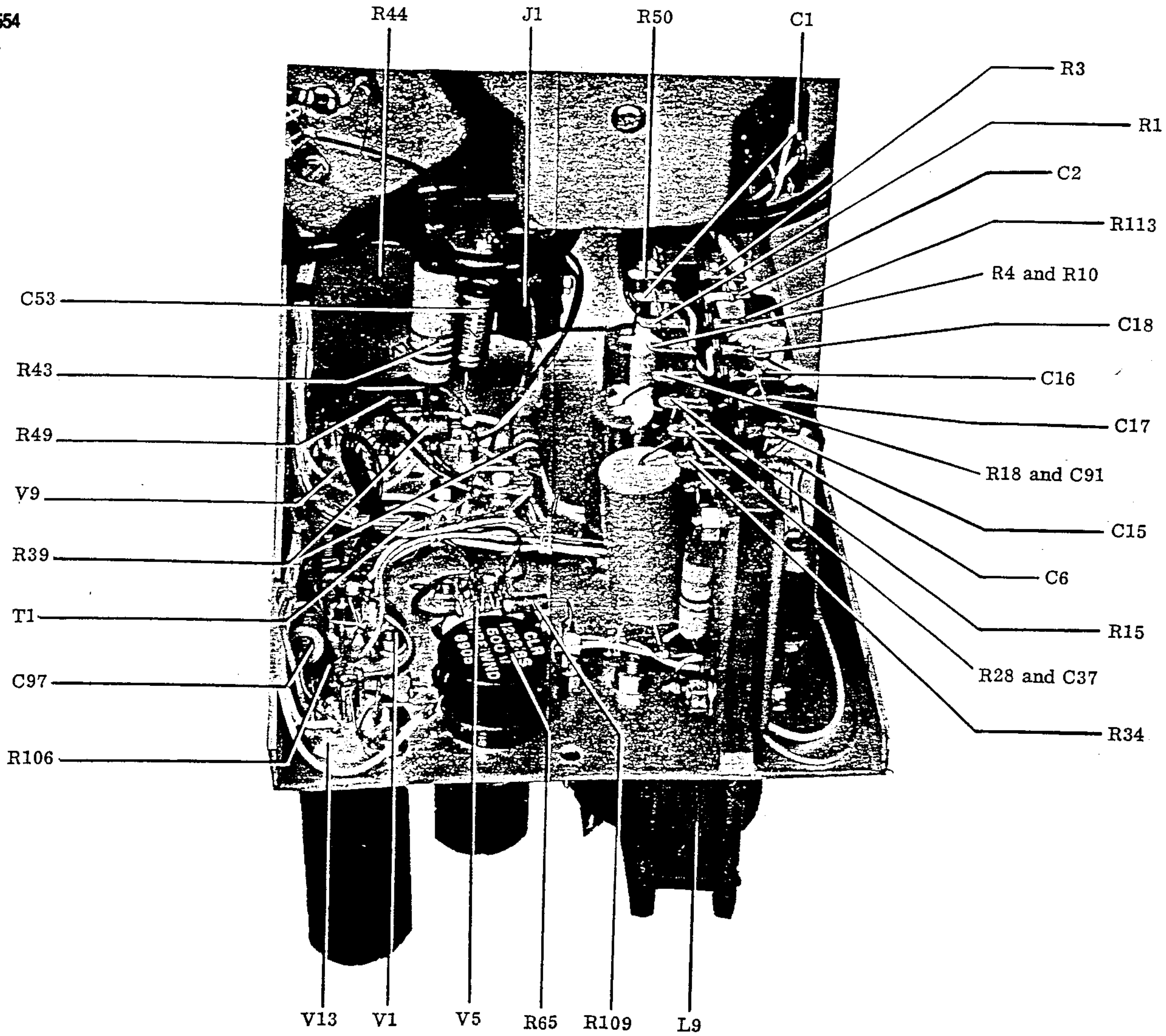
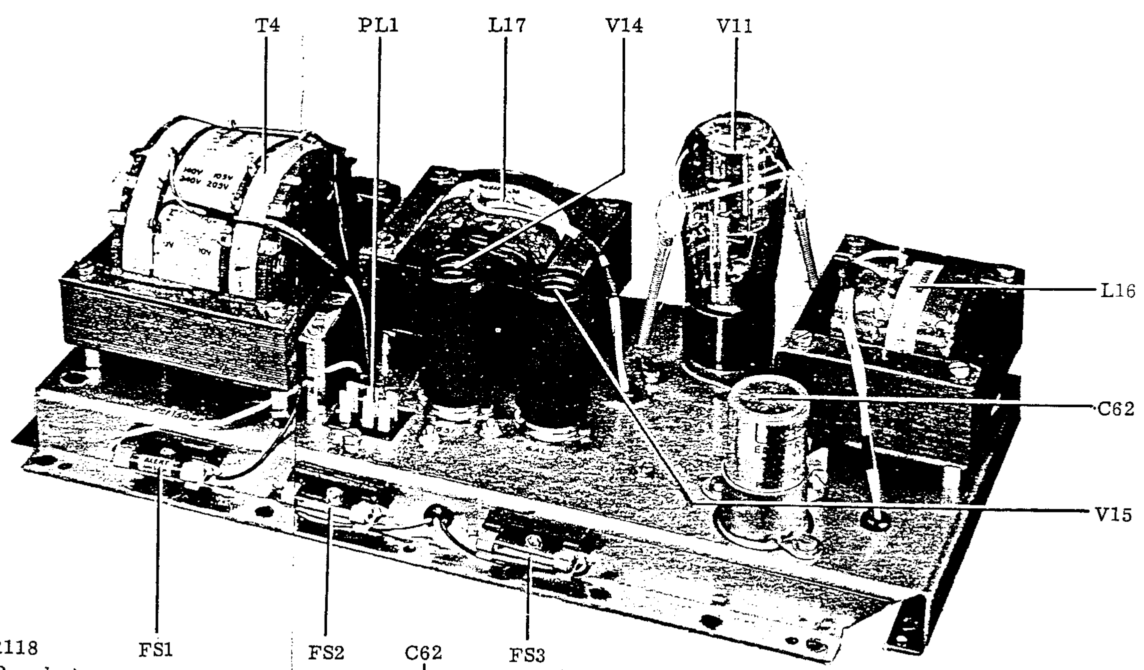


Fig. 5.6 L.F.unit, underside view



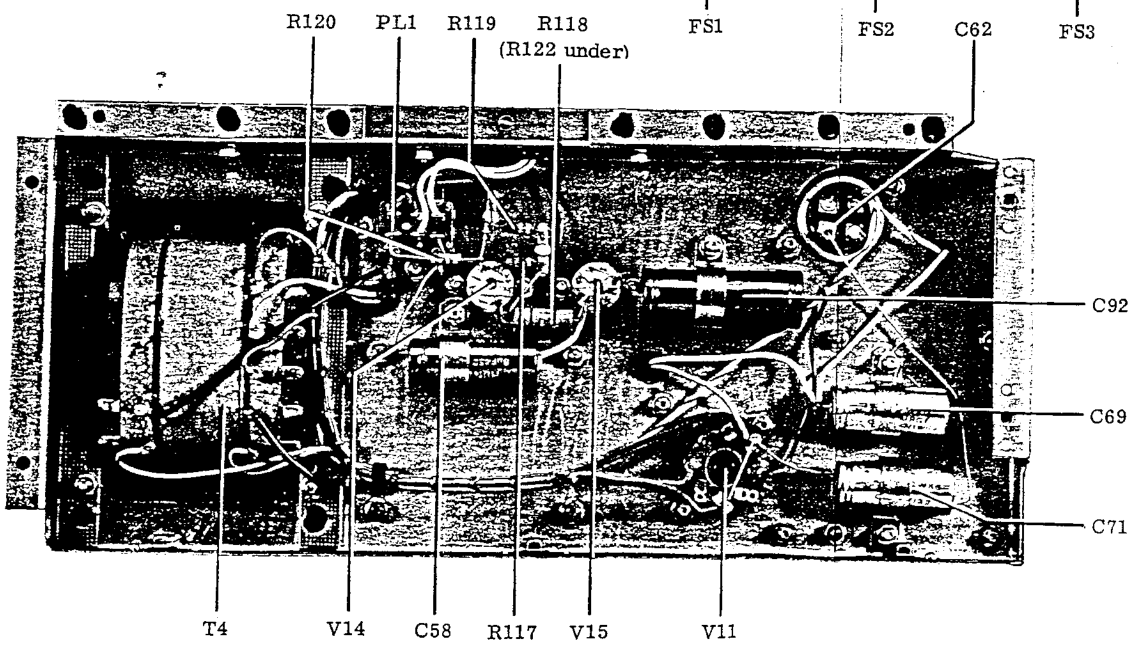


Fig. 5.7 Power unit

Section 6 Replaceable parts

INTRODUCTION

This section lists replaceable parts in alpha-numerical order of their circuit references, with miscellaneous parts at the end of the list. The following abbreviations and symbols are used:

C	: capacitor
Carb	: carbon
Cer	: ceramic
Elec	: electrolytic
FS	: fuse
J	: jack
L	: inductor
M	: meter
Met	: metal
Min	: minimum value
Ox	: oxide
PL	: plug
PLP	: pilot lamp
Plas	: plastic
R	: resistor
S	: switch
SKT	: socket
T	: transformer
V	: valve
Var	: variable
WW	: wirewound
X	: crystal
†	: value selected during test, nominal value shown

ORDERING

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

(1) Type and serial number of your instrument.

(2) Circuit reference.

(3) Description.

(4) M.I. code number or works reference.

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

Circuit reference	*Description*	*M.I. code*
C1	Paper 0·1 μF 10% 350 V	26134–455
C2	Paper 0·1 μF 10% 350 V	26134–455
C3	Mica 100 pF part of	44413–010
C4	Mica 100 pF 10% 350 V	26254–433
C5	Mica 100 pF 10% 350 V	26254–433
C6	Paper 0·02 μF 20% 350 V	26112–440
C8	Mica 100 pF 10% 350 V	26254–433
C9	Mica 100 pF 20% 350 V	26252–156
C10	Mica 100 pF part of	44414–120
C11	Elec 16 μF +100%–20% 50 V	26418–368
C12	Mica 100 pF part of	44413–010
C13	Mica 100 pF 10% 350 V	26254–433
C15	Cer 0·01 μF 25% 500 V	26383–390
C16	Cer 0·01 μF 25% 500 V	26383–390
C17	Paper 0·1 μF 10% 350 V	26134–455
C18	Paper 0·1 μF 10% 350 V	26134–455
C19	Mica 100 pF	44414–119
C20	Cer 0·01 μF +80−20% 500 V	26383–392
C22	Mica 100 pF part of	9TM3900/106
C23	Mica 100 pF 10% 350 V	26254–433
C24	Cer 0·001 μF +80−20% 500 V	26383–242
C25	Cer 56 pF 10% 750 V	26322–864
C26	Paper 0·1 μF 10% 350 V	26134–455
C27	Cer 0·001 μF +80−20% 500 V	26383–242
C28	Paper 0·01 μF 10% 400 V	26174–147
C29	Cer 47 pF 2% 750 V	26324–833
C30†	Cer 10 pF 750 V	26324–709
C31	Mica 100 pF 5% 750 V	26257–162
C32	Paper 2 μF 25% 150 V	26155–581
C33	Cer 1 pF 20% 750 V	26324–020
C34	Var 14–200 pF part of	44438–008
C35	Var 3–30 pF (trimmer) part of	44438–008
C36	Cer 47 pF 2% 500 V	26324–833
C37	Paper 0·5 μF 10% 350 V	26174–184
C38	Cer 100 pF 10% 500 V	26364–155
C39	Paper 0·01 μF 20% 350 V	26174–147
C40	Var 10 pF (trimmer)	26812–207
C41	Cer 10 pF ±0·25 pF 750 V	26324–709
C42	Cer 0·0047 μF +80%–20% 500 V	26373–665
C43	Cer 5 pF 10% 750 V	26321–060
C44	Cer 10 pF ±0·5 pF 500 V	26324–085
C45	Paper 0·5 μF 25% 150 V	26154–430
C46	Var 7–100 pF part of	44438–008
C47	Var 2–8 pF (trimmer) part of	44438–008
C48	Cer 100 pF 10% 500 V	26364–155

Circuit reference	Description	M.I. code
C49	Cer 22 pF 20% 500 V	26324–807
C50	Cer 47 pF 2% 750 V	26324–833
C51	Cer 47 pF 2% 750 V	26324–833
C52	Mica 100 pF part of	44413–010
C53	Elec 2 μF +50−20% 250 V	26412–257
C54	Paper 0·1 μF 10% 350 V	26174–173
C55	Cer 0·005 μF 20% 500 V	26367–445
C56	Mica 100 pF 10% 350 V	26254–433
C57	Mica 100 pF part of	34213–501
C58	Elec 8 μF +50−20% 450 V	26417–477
C59	Var 10 pF (trimmer)	26812–207
C60	Cer 820 pF 20% 500 V	26373–457
C61	Cer 4·7 pF ±0·25 pF 750 V	26324–017
C62	Elec 32 μF +50−20% 450 V	26427–724
C63	Paper 0·01 μF 10% 400 V	26174–147
C64	Cer 100 pF 2% 500 V	26324–897
C65	Var 7–100 pF part of	44438–011
C66	Var 2–8 pF (trimmer) part of	44438–011
C67	Cer 22 pF 20% 500 V	26324–807
C68	Paper 0·01 μF 10% 400 V	26174–147
C69	Elec 22 μF +50−20% 350 V	26417–481
C70	Cer 100 pF 10% 500 V	26364–155
C71	Elec 8 μF +50−20% 350 V	26415–320
C72	Cer 820 pF 20% 500 V	26373–457
C73	Cer 4·7 pF ±0·25 pF 750 V	26324–017
C74	Cer 0·001 μF 10% 500 V	26361–065
C75	Var 7–100 pF part of	44438–011
C76	Var 2–8 pF (trimmer) part of	44438–011
C77	Cer 10 pF 10% 750 V	26324–080
C78	Cer 100 pF 10% 500 V	26364–155
C79	Paper 6 μF 20% 150 V	26165–125
C80	Cer 100 pF 2% 500 V	26324–897
C81	Var 7–75 pF part of	44438–011
C82	Cer 820 pF 20% 500 V	26373–457
C83	Var 2–8 pF (trimmer) part of	44438–011
C84	Cer 100 pF 2% 750 V	26324–897
C85	Cer 100 pF 2% 750 V	26324–897
C86	Cer 100 pF 2% 750 V	26324–897
C87	Cer 100 pF 2% 750 V	26324–897
C88	Cer 820 pF 20% 500 V	26373–457
C89	Cer 820 pF 20% 500 V	26373–457
C90	Cer 820 pF 20% 500 V	26373–457
C91	Paper 0·1 μF 10% 350 V	26134–455
C92	Paper 0·25 μF 20% 350 V	26115–338
C93	Cer 0.001 μF +80−20% 500 V	26383–242
C94	Cer 120 pF 10% 750 V	26322–905
C95	Cer 68 pF 10% 750 V	26324–868
C96	Cer 3·3 pF 10% 750 V	26321–045
C97	Elec 25 μF +100−20% 18 V	26417–141
C98†	Cer 0·01 μF 20% 350 V	26112–515
C99	Cer 0·001 μF +40−20% 500 V	26383–242

Circuit reference	Description	M.I. code
C100	Cer 0·01 μF +80−20% 100 V	26383–055
C101	Cer 0·01 μF +80−20% 100 V	26383–055
C102	Cer 33 pF 5% 750 V	26324–822
C103	Cer 0·01 μF +80−20% 100 V	26383–055
C104	Cer 33 pF 5% 750 V	26324–822
C105	Cer 0·001 μF +80−20% 500 V	26383–242
C121	Cer 27 pF 5% 750 V	26324–812
C122†	Cer 6.8p 750V	26324–706
FSI	150 mA	23411–104
FS2	2A	23411–260
FS3	2A	23411–260
J1	Jack	23421–684
J2	Jack BNC socket	23443–375
L1	H.T. filter	44413–010
L2	H.T. filter	44414–120
L3	R.F. inductor	TB16363/27
L4	H.T. filter	44413–010
L6	Inductor (filter)	44414–120
L7	L.T. filter	44414–119
L8	R.F. inductor	44272–801
L9	Modulation inductor	44218–003
L10	Fixed osc. inductor	44226–015
L11	H.F. filter	44413–010
L14	R.F. inductor	44237–001
L15	R.F. inductor	44247–401
L16	Inductor (smoothing)	44215–005
L17	Inductor (smoothing)	44215–005
L18	Inductor	44123–001
L19	Inductor	44123–401
L20	Inductor	44232–010
L21	Inductor	44264–409
L22	Frequency range coil	44224–006
L23	Frequency range coil	35127–505
L24	Inductor	35127–102
L25	Inductor	35127–102
L26	Inductor	44227–004
L27	Inductor	44225–018

For symbols and abbreviations see introduction to this section

Circuit reference	*Description*	*M.I. code*
M1	Meter 0–100 µA	44554–425
PL1	Plug 6-way	23435–216
PL2	50 Ω plug	23443–303
PLP1	Pilot lamp 6·5 V 3A	23735–440
R1	Carb 120 kΩ 5% ¼ W	24312–937
R2†	Carb 1·5kΩ ½ W	24343–084
R3	Carb 220 kΩ 10% ½ W	24343–143
R4	Carb 270 kΩ 10% ¼ W	24342–146
R5	Met ox 56 kΩ 5% ½ W	24552–129
R6†	Carb 2·2 kΩ ½ W	24343–088
R7	WW 50 kΩ Var 2 W	25815–388
R8	Met ox 4·7 kΩ 7% ⅜ W	24552–100
R9†	Met ox 5·1 kΩ ½ W	24552–101
R10	Carb 10 kΩ 10% ½ W	24343–110
R11	Met ox 18 kΩ 7% ⅜ W	24552–116
R12†	Met ox 4·7 kΩ ½ W	24552–100
R13	Met ox 12 kΩ 7% ⅜ W	24552–112
R14†	Met ox 8·2 kΩ ⅜ W	24552–108
R15	Carb 4·7 kΩ 10% ¼ W	24342–100
R16	WW 4·7 kΩ 5% 7 W	25128–460
R17†	Carb 6·8 kΩ ¼ W	24342–306
R18	Carb 220 kΩ 10% ¼ W	24342–143
R19†	Carb 2·5 kΩ ±1% ¼ W	24134–250
R20	Carb 10 kΩ 5% ¼ W	24332–310
R21	Carb 68 kΩ 10% ¼ W	24342–131
R22	Carb 68 kΩ 10% ¼ W	24342–131
R23	Carb 56 kΩ 10% ¼ W	24342–129
R24	Met ox 36 kΩ 5% ½ W	24552–123
R25	Carb Var 25 kΩ 20% ¼ W	25615–095
R26	Carb 15 kΩ 10% ¼ W	24342–114
R27	Carb 100 kΩ 5% ¼ W	24312–935
R28	Carb 220 kΩ 10% ¼ W	24342–143
R29	Carb 6·8 kΩ 10% ¼ W	24342–106
R30	Carb 6·8 kΩ 10% ¼ W	24342–106
R31	Carb 270 kΩ 10% ¼ W	24342–146
R32	Carb 150 Ω 10% ¼ W	24342–054
R33	Carb 2·2 kΩ 10% ¼ W	24342–088
R34	Carb 390 Ω 5% ½ W	24333–465
R35	WW 15 kΩ 5% 7 W	25128–474
R36	WW 7·5 kΩ 5% 7 W	25128–467
R37	WW 5 kΩ 5% 7 W	25128–461
R38	WW 10 Ω 5% 1½ W	25123–020
R39†	Carb 220 k 10% ½ W	24343–143

Circuit reference	*Description*	*M.I. code*
R40	Carb 15 kΩ 10% ¼ W	24342–114
R41	Carb 6·8 kΩ 10% ¼ W	24342–106
R42	Carb 2·2 kΩ 10% ¼ W	24342–088
R43	Carb 10 kΩ 10% 1 W	24345–510
R44	WW var 20 kΩ 1 W	25814–358
R45	Carb 100 kΩ 10% ¼ W	24342–135
R46	Carb 6·8 kΩ 10% ½ W	24343–106
R47	Carb 10 kΩ 10% ½ W part of	44414–072
R48	Carb 2·2 kΩ 10% ¼ W	24342–088
R49	WW 4 kΩ 5% 7 W	25128–457
R50	Met ox 100 kΩ 2% ½ W	24573–121
R51	Carb 4·7 kΩ 10% ¼ W	24342–100
R52	Carb 120 kΩ 10% ¼ W	24342–137
R53	Carb 270 Ω 10% ¼ W	24342–061
R54	Carb 6·8 kΩ 10% ¼ W	24342–106
R55	Carb 68 kΩ 10% ¼ W	24342–131
R56	Carb 47 kΩ 10% ½ W part of	44264–409
R57	Carb 2·2 kΩ 10% ¼ W	24342–088
R58	Carb 100 kΩ 10% ¼ W	24342–135
R59	Carb 6·8 kΩ 10% ¼ W	24342–106
R60	Carb 100 kΩ 10% ¼ W	24342–135
R61	Carb 2·2 kΩ 10% ¼ W	24342–088
R62	Carb 33 kΩ 10% ½ W	24343–122
R63	Carb 680 kΩ 10% ¼ W	24342–158
R64	Carb 470 Ω 10% ¼ W	24342–069
R65	WW Var 500 Ω ¼ W	25813–302
R66	Met ox 120 kΩ 5% ½ W	24552–137
R67	Met ox 39 kΩ 5% ½ W	24552–124
R68	Carb 150 kΩ 10% ¼ W	24342–139
R69	Carb 47 kΩ 10% ¼ W	24342–126
R70†	Carb 3·3 kΩ ¼ W	24342–094
R71	Carb 1 kΩ 10% ¼ W	24342–080
R72	Carb 1 kΩ 10% ¼ W	24342–080
R73	Carb 82·5 Ω 1% ¼ W	24132–043
R74	Carb 742 Ω 1% ¼ W	24133–093
R75	Carb 742 Ω 1% ¼ W	24133–093
R76	Carb 742 Ω 1% ¼ W	24133–093
R77	Carb 742 Ω 1% ¼ W	24133–093
R78	Carb 220 Ω 1% ¼ W	24133–040
R79	Carb 91·6 Ω 1% ¼ W	24132–053
R80	Carb 91·6 Ω 1% ¼ W	24132–053
R81	Carb 91·6 Ω 1% ¼ W	24132–053
R82	Carb 82·5 Ω 1% ¼ W	24132–043
R83	Carb 17·9 Ω 1% ¼ W	24132–179
R84	Carb 17·9 Ω 1% ¼ W	24132–179
R85	Carb 17·9 Ω 1% ¼ W	24132–179
R86	Carb 17·9 Ω 1% ¼ W	24132–179
R87	Carb 17·9 Ω 1% ¼ W	24132–179
R88	Carb 17·9 Ω 1% ¼ W	24132–179
R89	Carb 17·9 Ω 1% ¼ W	24132–179

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
R90	Carb 17·9 Ω 1% ¼ W	24132–179
R91	Carb 17·9 Ω 1% ¼ W	24132–179
R92	Carb 17·9 kΩ 1% ¼ W	24132–179
R93	Carb 61·2 Ω 1% ¼ W	24132–612
R94	Carb 332 Ω 1% ¼ W	24133–068
R95	Carb 167 Ω 1% ¼ W	24133–025
R96	Carb 167 Ω 1% ¼ W	24133–025
R97	Carb 167 Ω 1% ¼ W	24133–025
R98	Carb 167 Ω 1% ¼ W	24133–025
R99	Carb 37·5 Ω 1% ¼ W	24132–017
R100	Carb 90 Ω 1% ¼ W	24132–900
R101	Carb 90 Ω 1% ¼ W	24132–900
R102	Carb 360 Ω 1% ¼ W	24133–360
R103	Carb 37·5 Ω 1% ¼ W	24132–017
R104	Carb 75 Ω 1% ¼ W	24132–039
R105	Carb 14·5 Ω 5% ¼ W	24232–804
R106	Carb 560 Ω 10% ¼ W	24342–072
R107	Carb 22 kΩ 10% ¼ W	24342–118
R108	Carb 1 MΩ 10% ¼ W	24342–166
R109	Carb 2·2 kΩ 10% ¼ W	24342–088
R110	Carb 100 Ω 10% ¼ W	24342–050
R111†	Met ox 100 kΩ ¼ W	24511–635
R112	WW 50 kΩ Var 2 W	25816–385
R113	Met ox 68 kΩ 2% ½ W	24573–117
R114	Met ox 47 kΩ ¼ W	24552–126
R115	Carb 1 kΩ 10% ¼ W	24342–080
R116	Met ox 180 Ω 7% ⅜ W	24552–056
R117	Carb 2·2 kΩ 10% ¼ W	24342–088
R118	Carb 22 kΩ 10% ¼ W	24343–118
R119†	Met ox 47 kΩ ½ W	24573–113
R120	Met ox 33 kΩ 2% ½ W	24573–109
R121	WW 950 Ω 10%	44364–306
R122	Carb 33 kΩ 10% ½ W	24343–122
R123	Carb 470 Ω 10% ½ W	24343–069
R124	WW 25 Ω Var ¼ W	25813–233
R125	Carb 10 kΩ 10% ¼ W	24342–110
R126	Carb 10 kΩ 10% ¼ W	24342–110
R127	Met ox 33 kΩ 7% ¼ W	24552–122
R128	Carb 10 kΩ Var ¼ W	25611–126
R129	Carb 47 kΩ Var ¼ W	25611–134
R130	Carb 220 kΩ Var ¼ W	25611–142
R131	WW 1 kΩ Var 1 W	25886–614
R132	Met ox 10 kΩ 7% ¼ W	24552–110
R133	Carb 100 kΩ Var ¼ W	25611–138
R134	WW 10 kΩ Var 1 W	25886–623
R135	Met ox 47 kΩ 7% ⅜ W	24552–126
R136	Carb 47 kΩ Var ¼ W	25611–134
R137	Met ox 22 kΩ 7% ⅜ W	24552–118
R138	Carb 47 kΩ Var ¼ W	25611–134
R139	Met ox 3·9 kΩ 7% ⅜ W	24552–096

Circuit reference	Description	M.I. code
R140	Carb 10 kΩ Var ¼ W	25611–126
R141	Carb 470 Ω ±10% ¼ W	24342–069
R142	Carb 33 kΩ ±10% 2 W	24347–722
R143	Carb 10 Ω 10% ¼ W	24342–020
R144	Carb 120 Ω 10% ¼ W	24342–052
R145	Carb 10 Ω 10% ¼ W	24342–020
R146	Carb 4·7 kΩ 10% ¼ W	24342–100
R147	Carb 100 kΩ 10% ¼ W	24342–135
R148	Met ox 12 kΩ 5% ½ W	24552–112
R149	Carb 6·8 kΩ 10% ¼ W	24342–106
R150	Carb 10 MΩ 10% ¼ W	24342–591
R151	WW var 5 kΩ 10% 1W	25815–129
R175	Carb 1 kΩ 5% ¼ W	24312–880
R176	Carb 470 kΩ 5% ¼ W	24312–952
S1	MOD SELECTOR	44324–418
S2	RANGE MHz	44324–411
S3	METER READS	44322–112
S4	SUPPLY	44334–003
S5	DEVIATION MULTIPLIER	44322–134
S6	DEVIATION RANGE	44321–126
S7	CARRIER ON/OFF	44334–003
S8	Microswitch	23483–145
SKT1	6-way	23435–260
SKT2	75 Ω socket	23443–423
SKT3	52 Ω socket	23443–414
T1	Mains transformer	43463–006
T2	Master osc. transformer	44252–210
T3	Multiplier R.F. transformer	44232–002
T4	L.F. Oscillator...	44215–007
T5	I.F. output transformer	43561–009
V1	6AK 6	28152–232
V2	6AK 6	28152–232
V3	6AK 5	28152–482
V4	6AK 5	28152–482
V5	6AU 6	28152–512
V6	6AK 5	28152–482
V7	12AT 7	28124–602
V8	6AK 5	28152–482
V9	OA 2	28213–352
V10	6AK 5	28152–482
V11	5Z4G	28113–622

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
V12	6AK 5	28152–482
V13	6AL 5	28124–727
V14	5651	28216–234
V15	6AL 5	28112–727
V16	6AK 5	28152–482
XL1	333·33 kHz crystal	28311–165
XL2	CS2A diode	28346–302
XL3	30 MHz crystal	28311–850

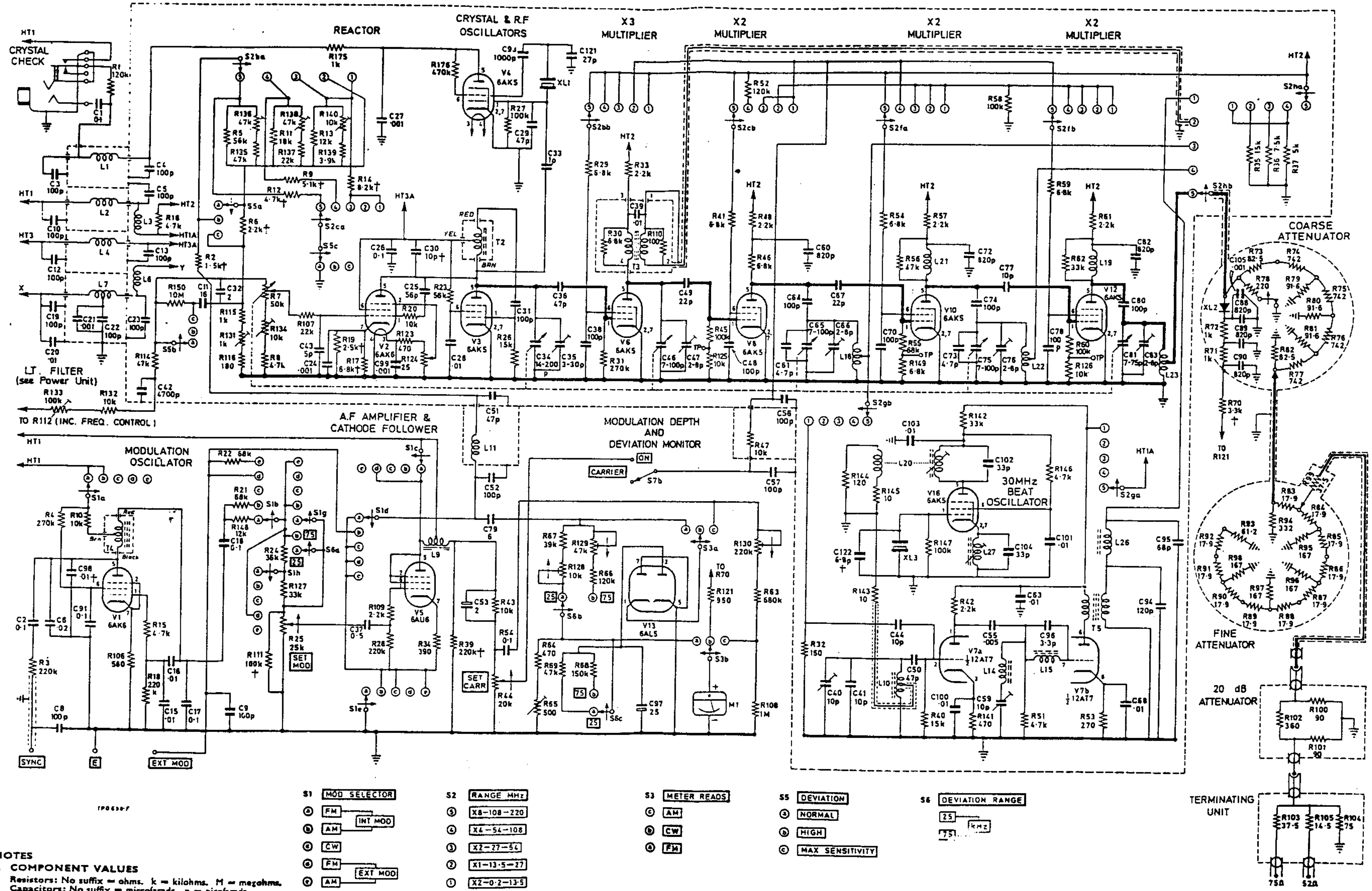
KNOBS, DRIVES AND DIALS

Description	M.I. code
Knobs, for TUNE and INC. FREQ. controls	31142–503
TUNE control dial	31761–713
INC. FREQ. control dial	31761–305
FREQUENCY DIAL. Pre-calibrated	31765–412
Dial escutcheon mounting ring	35612–311
Dial escutcheon (chromium plated) with rubber tubing	35612–320
Gasket, to fit over mounting ring	8-TM4357/2
Window, including movable cursor assembly, to fit in dial escutcheon	37445–701
Nylon drive cord	16410–602
Knob, for MOD, SELECTOR switch, S1	41144–201
Knob, for RANGE MHz switch, S2	41144–201
Knob, for DEVIATION MULTIPLIER switch, S5	41144–201
Knob, for DEVIATION RANGE switch, S6	41144–201
Knob, for OUTPUT VOLTAGE attenuator	31145–102
Knob, for MULTIPLY BY attentuator	31145–102
Knob, for SET CARRIER control, R44	31142–301
Knob, for SET MOD. control, R25	31142–301

MISCELLANEOUS

Description	M.I. code
Cover plate, for R.F. output cable exit, in right-hand handle recess	TA19721
Grommet, to fit in cover plate	TA6515/1
Cable saddle	29-TF995B/2
Front panel	34266–917
Set of eight screws, complete with black fibre washers for fixing front panel to case	TB37112–406
Terminal, EXT. MOD.	23235–176
Terminal, SYNC.	23235–176
Terminal, EARTH	23235–177
Case assembly, complete with handles and feet	41635–016
Handle escutcheon	37588–108
Case foot	35613–406
20 dB step attenuator assembly	44428–407
2 dB step attenuator assembly	44427–012
20 dB attenuator pad	44427–001
52 and 75 Ω Terminating Unit	44412–004
R.F. unit screening cover	41673–018
Contact spring for earthing R.F. unit screening cover	31118–114
Instruction Manual	EB995B/2

For symbols and abbreviations see introduction to this section



NOTES

1. **COMPONENT VALUES**
   Resistors: No suffix = ohms. k = kilohms. M = megohms.
   Capacitors: No suffix = microfarads. p = picofarads.
   † Value selected during factory testing; nominal value shown
2. **VOLTAGES** (*in italics*)
   Measured relative to earth unless otherwise stated.

Fig. 7.1 R.F. and L.F. Units

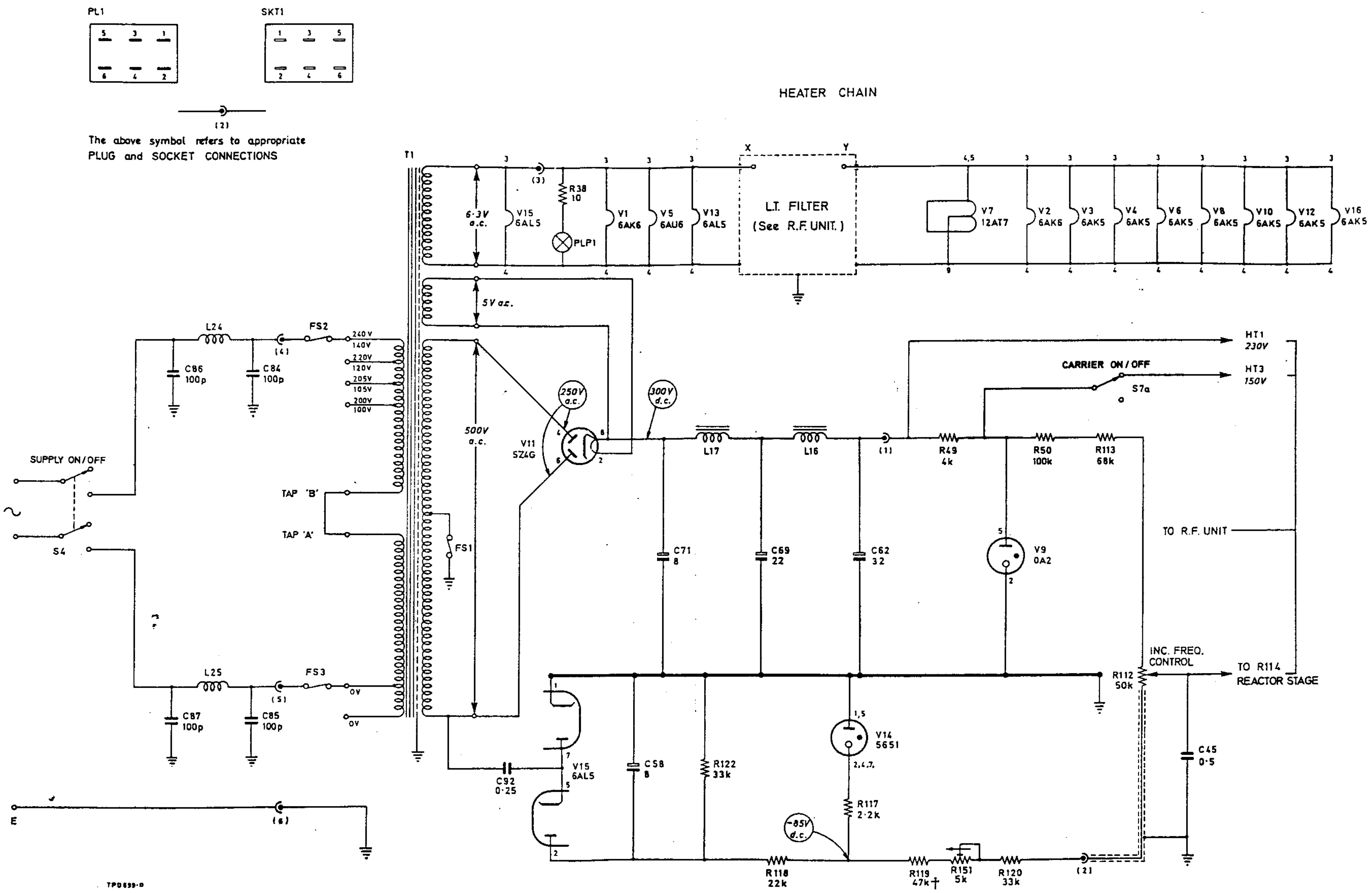


Fig. 7.2 Power unit

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

Continued ➧

DECIBEL CONVERSION TABLE (continued)

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