Instruction Manual
No. EB 2303
for

FM/AM Modulation Meter
TF 2303

mi
Technical Publications

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

Contents

Chapter 1 General information

1.1 INTRODUCTION

The F.M./A.M. Modulation Meter type TF 2303 has been specifically designed for production testing and servicing narrow band mobile radio transmitters. It covers the frequency bands most commonly used for fixed and mobile communications and particular attention has been paid to the provision of facilities and accessories required for the field testing of mobile equipments.

Measurements can be made on f.m. transmitters with carrier frequencies in the range 25 to 225 MHz and 380 to 520 MHz. The carrier frequency range from 225 to 380 MHz, although not calibrated, is in fact available if required by using the fifth harmonic of the oscillator. Three narrow deviation ranges are provided for f.m. deviations of 1.5 kHz, 5 kHz and 15 kHz full-scale at modulation frequencies of 50 Hz to 9 kHz. (TF 2303 is, therefore, not suitable for use on f.m. broadcast transmitters, stereo receivers or telemetry equipment.)

Measurements on a.m. mobile transmitters can also be made up to 225 MHz: a.m. depth can be measured up to 95% at modulation frequencies between 50 Hz and 4 kHz.

The instrument is easy to use and has a simple tuning system not requiring crystal control. It uses as its local oscillator a low noise, high stability, varactor tuned oscillator, which eliminates complicated tuning and drive systems. A.F.C. can be switched in if required for long term monitoring.

With the service engineer in mind, the modulation meter has been made small and portable. It can operate from a mains supply or from a rechargeable nickel cadmium battery pack which can be mounted inside the instrument case. The modulation meter can be operated from batteries all day (the continuous operational life of the battery pack is about 8 hours) then charged up overnight using the built-in charger. A carrying case, for carrying the modulation meter, and any accessories that might be needed with it, is available.

Accessories which may be required for mobile servicing are listed in Sect. 1.3. Several of these are designed to couple the output signal from the mobile transmitter to the modulation meter's input socket.

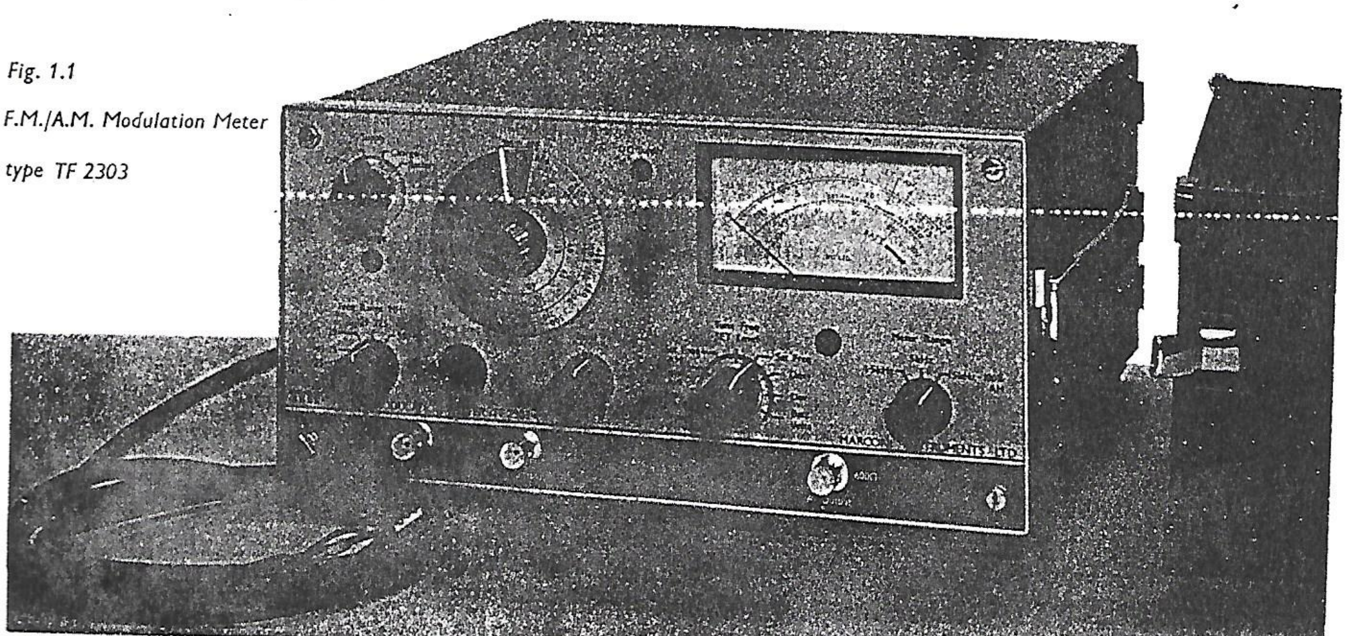


Fig. 1.1

F.M./A.M. Modulation Meter type TF 2303

1.2 DATA SUMMARY

Characteristic	Performance	Supplementary information
R.F. INPUT		
Carrier frequency range :	25 to 225 MHz f.m. and a.m. 380 to 520 MHz f.m. only.	
Local oscillator calibration :	25 to 43 MHz. 43 to 75 MHz. 75 to 129 MHz. 129 to 225 MHz. 380 to 520 MHz.	Local oscillator set to 500 kHz above carrier.
Local oscillator scale accuracy :	±5%.	
Sensitivity :	Better than : 50 mV r.m.s. 25 - 225 MHz. 100 mV r.m.s. 380 - 520 MHz.	Recommended input : 6.5 mV to 150 mV increasing to 65 to 700 mV.
Maximum safe input :	1 watt	Overloads the instrument but causes no damage.
R.F. level control :		At least 20 dB at 520 MHz.
Input impedance :	Nominally 50 Ω.	
F.M. MEASUREMENT		
Deviation ranges :	Three ranges with full-scale indications of 1.5 kHz, 5 kHz and 15 kHz. Positive or negative deviation indication is selected by a switch.	
Scale accuracy :	±3% of f.s.d. at 1 kHz modulation frequency.	±5% of f.s.d. at extremes of operating temperature.
Modulation frequency range :	Over the range 50 Hz to 9 kHz, deviation measurements are within 0.5 dB with respect to 1 kHz.	
Inherent noise :	Deviation due to noise is less than 50 Hz at the highest carrier frequency and in a nominal bandwidth 10 Hz to 14 kHz (-3 dB).	
A.M. rejection :	Additional deviation error is at least 26 dB below the reading for 5 kHz deviation when a.m. depth is 30% at 1 kHz modulation frequency.	

Characteristic	Performance	Supplementary information
A.M. MEASUREMENT		
Modulation depth range :	Full-scale indication 100%. Usable up to 95%.	
Accuracy :	±3% modulation depth for depths up to 80% and modulation frequency of 1 kHz.	±5% modulation depth at extremes of operating temperature.
Modulation frequency range :	Over the range 50 Hz to 4 kHz, modulation depth measurements are within 0.5 dB with respect to 1 kHz.	
Noise :	-50 dB with respect to 100% modulation in a nominal bandwidth 10 Hz to 24 kHz (-3 dB).	
I.F. OUTPUT		
Frequency :	500 kHz.	
Level :	100 mV nominal e. m. f.	
Output impedance :	Nominally 1 kΩ.	
A.F. OUTPUT		
Output level :	1 mW nominal into 600 Ω with meter at f. s. d.	
Distortion :	Less than 1% for f. m. deviations up to 15 kHz. Less than 3% for a. m. depths up to 80%.	
POWER REQUIREMENTS		
Mains operation :	Absolute limits 95 V to 130 V or 190 V to 264 V } 45 to 500 Hz. Consumption 5 VA approx.	
Battery operation :	Rechargeable Battery 54463-011 can be fitted.	
DIMENSIONS AND WEIGHT		

Dimensions :

Width	*Depth*	*Depth with Lid*	*Height*
280 mm (11 in)	255 mm (10 in)	305 mm (12 in)	140 mm (5.5 in)

Weight :

Without battery	*With battery*
4.75 kg (10.5 lb)	5.7 kg (13 lb)

CONNECTORS

BNC sockets for r.f. inputs, i.f. output and a.f. output.

1.3 ACCESSORIES

Supplied accessories : Mains Lead TM 7052.
Lid.
Instruction card.
Instruction Manual EB 2303.

Optional accessories :

(a) 750 μs De-emphasis Unit, 54412-011

Provides de-emphasis network for connection to TF 2303 a.f. output socket. The unit should work into 600 Ω or an internal 600 Ω load can be switched in when working into high impedance.

Connectors : BNC plug to BNC socket (may be connected either way round).

Dimensions : 94 mm x 25 mm x 25 mm (3.7 in x 1 in x 1 in).

(b) Signal Sniffer, 54452-011

T connector for insertion between transmitter and load with pick-up to give a small signal from the T branch to TF 2303.

Attenuation : Dependent upon frequency. Approximate range is -50 dB at 25 MHz reducing to -24 dB at 500 MHz when terminated by 50 Ω.

Dimensions : 66 mm x 66 mm x 15 mm (2.6 in x 2.6 in x 0.6 in).

(c) 20 W, 50 Ω, 20 dB Attenuator, 54431-021

Attenuator for use with signal sniffer where additional attenuation and/or termination is required with transmitters up to 30 W.

Attenuation : 20 dB nominal.

Frequency range : D.C. to 1 GHz.

Impedance : 50 Ω nominal.

Rating : 20 W continuous. 30 W for up to 5 minutes with off periods of at least 5 minutes.

Connectors : 50 Ω, BNC plug to BNC socket.

Dimensions : 66.4 mm long x 38 mm dia. nominal (2.625 in x 1.5 in nominal).

(d) 1 W, 50 Ω, 20 dB Attenuator, 54431-011

	Attenuator for use with signal sniffer or where termination is required with transmitters up to 1 W.
Attenuation :	20 dB nominal.
Frequency range :	D.C. to 1 GHz.
Impedance :	50 Ω nominal.
Rating :	1 W continuous.
Connectors :	50 Ω, BNC plug to BNC socket.
Dimensions :	66 mm long x 16.5 mm dia. nominal (2.6 in x 0.65 in nominal).

(e) 12 W, 50 Ω Termination, 54422-011

	Termination for use as a good non-radiating termination for transmitters up to 15 W.
Impedance :	50 Ω.
Frequency range :	D.C. to 1 GHz.
Rating :	12 W continuous. 15 W for up to 5 minutes, with off periods of at least 5 minutes.
Connector :	50 Ω, BNC plug.
Dimensions :	50 mm x 25 mm nominal (2 in x 1 in nominal).

(f) R.F. Fuse Unit, 50 Ω, TM 9884

	Fuse for protection against accidental overload.
V.S.W.R. :	Better than 1.4:1 up to 500 MHz.
Insertion loss :	Better than 0.75 dB at 300 MHz. Better than 1.25 dB at 500 MHz.
Rating :	0.4 W.
Connectors :	50 Ω, BNC plug to BNC socket.
Dimensions :	88 mm x 14 mm (3.5 in x 0.55 in).

(g) Coaxial Lead, 50 Ω, TM 4969

Length :	1520 mm (5 ft).
Connectors :	50 Ω BNC plugs.

(h) Rechargeable Battery, 54463-011

21 V nickel cadmium battery which fits into a space provided inside the TF 2303. It has a lead with a polarized connector to mate with the connector inside the TF 2303. A fuse supplied with the instrument, must be fitted for battery operation.

Continuous operational life is approximately 8 hours. Recharging time, from fully discharged, is approximately 14 hours. Battery voltage monitored on meter.

Weight :	0.92 kg (2 lb)

(i) Carrying Case, 54112-031

Case for carrying the TF 2303 and accessories. There is space for stowage of the complete range of external accessories, the handbook and instruction card.

Material :	Fibre with felt lining and finished in leather. Base is plywood reinforced and fitted with a retaining screw which secures the instrument.
Dimensions :	340 mm x 300 mm x 160 mm (13.4 in x 11.8 in x 7 in).
Weight :	With instrument, accessories and battery:- 8.2 kg (18 lb). Case only:- 1.8 kg (4 lb)

WARNING

54431-021 20 W, 50 Ω 20 dB ATTENUATOR
54422-011 12 W, 50 Ω TERMINATION

Beryllia is used in the internal construction of these accessories. This material when in the form of fine dust or vapour and inhaled into the lungs can cause a respiratory disease. Because of this hazard, you are strongly advised not to open the accessory. If a fault is suspected the accessory must be returned for repair to Marconi Instruments Service Division, or disposed of in such a manner that no health hazard will result.

Chapter 2 Operation

2.1 PREPARATION FOR USE

2.1.1 Unpacking

Unpack the instrument and any accessories ordered and check the goods received against the packing note. Sect. 1.3 lists the accessories supplied with the instrument and optional accessories available. The instruction card should be taped to the instrument lid or kept in the carrying case. The modulation meter can operate from an a.c. mains supply only or, when rechargeable batteries are fitted from a.c. mains or batteries.

2.1.2 Mains operation

The mains lead supplied must be fitted with a mains plug by the user. The colour coding is as follows:

Connection	*Colour*	*Sleeve*
Line	Brown	
Neutral	Blue	N
Earth	Yellow/Green	⏚

Before connecting to the mains supply, check the fuses and mains voltage setting. For mains voltages around 230 V, a 50 mA fuse is fitted; for 110 V this must be changed to 100 mA. To change the mains voltage setting reverse the L-shaped plate on the rear panel, switching the slide switch to the other position.

Plug into the mains supply and turn the supply switch to ∼ . If the instrument has no batteries proceed to Sect. 2.2.

2.1.3 Battery installation

Battery pack, M.I. code 54463-011, consists of sealed nickel cadmium rechargeable cells. The battery pack is normally packed seperately and must first be fitted as follows:

1) Ensure that the instrument is switched to OFF and disconnected from the mains supply.

2) Insert the battery fuse in the battery fuse holder. (This fuse can be found in a small bag inside the instrument.)

3) Remove the front battery clamp and slacken the rear clamp.

4) Slide battery into rear clamp; replace front clamp and tighten rear clamp.

5) Insert connector on battery lead into the chassis receptacle on the front edge of the main chassis.

6) Set the FUNCTION switch to BATTERY VOLTS and check the meter reading. If the meter reads backwards the battery connections are reversed; this must be corrected <u>before</u> the instrument is switched on.

7) If the meter reads on the black arc, this indicates that the batteries are charged (18 to 21 V) and the instrument is ready for use. If the meter reads below the black arc, the battery is discharged and must be charged (Sect. 2.1.4).

2.1.4 Charging a new battery

Nickel cadmium cells are normally stored and despatched in the discharged state. They can be charged using the modulation meter's built-in charger which provides an approximately constant current.

CAUTION

The correct procedure must be followed for charging a completely discharged battery. Always disconnect the instrument from the mains before switching to CHARGE, otherwise the lamps in the charger circuit may be overloaded with a consequent reduction of life.

The sequence for charging a new battery or a deeply discharged battery is as follows:

1) Ensure that the instrument is disconnected from the mains then switch the SUPPLY switch to OFF.

2) Connect the instrument to the mains supply.

3) Switch the SUPPLY switch to ~ . In this condition the battery is trickle charged at about 25 mA. Switch the FUNCTION switch to BATTERY VOLTS. For a fully discharged battery, this low charge rate enables the battery voltage to rise without an initial excessively high voltage across the voltage regulator lamps. The rising battery volts will be indicated by the meter. When the meter reads about 2/3 of f.s.d. (this normally takes 5 to 10 minutes) turn the SUPPLY switch to CHARGE. The full charge current of about 140 mA is now fed to the battery.

4) Continue charging for 14 to 16 hours. The battery will then be ready for 8 hours discharge i.e. 8 hours use on battery operation. The battery will not be harmed even if charging is continued long after it is fully charged. The battery voltage is 21 V when fully charged.

NOTE: A new battery may require several charge/discharge cycles before full capacity is obtained.

If battery operation is only required for brief intermittent periods and if the instrument is switched off after each measurement, a full week's service can be obtained from one full battery charging.

5) When the battery is charged, continue to use the instrument as in Sect. 2.1.7.

2.1.5 Recharging the battery

1) With the instrument connected to the mains supply, set the SUPPLY switch to CHARGE for the full charging current of about 140 mA. A rough guide for charging time is that it is twice the period required for use on battery operation.

2) Check the battery voltage by setting the SUPPLY switch to BATTERY and the FUNCTION switch to BATTERY VOLTS. The meter indication should be at the top of the black arc when the battery is fully charged to 21 V.

During normal mains operation, i.e. when the SUPPLY switch is set to ~ , the battery is trickle-charged at about 25 mA.

The battery may be removed from the instrument and charged at a higher rate using an external charger. This rate must not exceed 1 A and must be stopped when approximately 85% of charge has been replaced or when the temperature rise of the battery exceeds 10 °C.

2.1.6 Battery storage

If a battery is stored for periods in excess of one month, it should be stored in the discharged condition to preserve its cell life. The battery can be discharged by switching the modulation meter's SUPPLY switch to BATTERY and the FUNCTION switch to BATTERY VOLTS, and leaving it until the battery voltage is 16.5 V (meter indication approximately at the SET mark). This can take about 10 hours for a fully charged battery or about 3 hours if the battery is three-quarters discharged.

When the battery is removed from the modulation meter, the battery fuse should also be removed, otherwise the meter can indicate the charging voltage.

2.1.7 Battery operation

Having installed and charged the battery as in Sect. 2.1.3 and 2.1.4, set the SUPPLY switch to BATTERY and the FUNCTION switch to BATTERY VOLTS. Check that the meter indication is within the black arc, i.e. that the battery voltage is 18 to 21 V. (If the battery is below 18 V the voltage regulator goes out of regulation.)

To ensure that your nickel cadmium battery has the longest possible life, observe the following rules.

(a) Keep the battery charged when in regular use.

(b) Do not discharge too rapidly. (Operation of the TF 2303 when switched to BATTERY gives a suitable discharge rate of C/10 as recommended by the battery manufacturer.)

(c) Do not deeply discharge i.e. do not discharge below 16.5 V (the SET A.M. mark on the meter).

(d) Store in the discharged state.

(e) If the battery is deeply discharged, use the sequence of operations for charging a new battery as given in Sect. 2.1.4.

2.2 PRINCIPLE OF OPERATION

The modulation meter is basically a heterodyne a.m./f.m. receiver with a peak reading voltmeter. The r.f. input is heterodyned with the local oscillator signal producing a 500 kHz i.f. output from the mixer.

With FUNCTION switch at TUNE FREQ. SET LEVEL, the frequency controls are tuned so that the local oscillator frequency is 500 kHz above the signal frequency, and the LEVEL control is used to set the r.f. input to the mixer to a suitable level. When the instrument is switched to SET FREQUENCY, an output, whose level is proportional to the intermediate frequency, is monitored by the meter and the instrument can be finely tuned so that the i.f. output from the mixer is accurately set to 500 kHz.

For f.m. deviation measurements, a discriminator produces an a.c. output proportional to deviation; this output is measured by the peak voltmeter circuit and the meter reads deviation directly. For a.m. depth measurements, the signal from the i.f. amplifier is passed to a diode detector. The average carrier level is first set to a known level by monitoring the d.c. component from the diode and re-setting the r.f. input level. Then, with the FUNCTION switch set to A.M. PEAK, the modulating waveform is detected by the peak voltmeter which measures its peak amplitude and the meter reads modulation depth directly.

When the instrument is tuned so that the local oscillator is 500 kHz above the carrier frequency, the DEV+ reading is the peak deviation above the carrier and DEV− is the peak frequency deviation below the carrier.

The modulation depth measured is defined as the ratio (expressed as a percentage) of peak modulation amplitude to mean envelope amplitude of a signal with no distortion. Thus, when even harmonic distortion of the modulating signal is present, the modulating envelope will be asymmetrical and the instrument will indicate different depths when switched to A.M. PEAK or A.M. TROUGH as indeed it should.

2.3 CONTROLS

The following controls and connectors are listed for reference purposes. To use the controls, follow the operating procedures given in later sections.

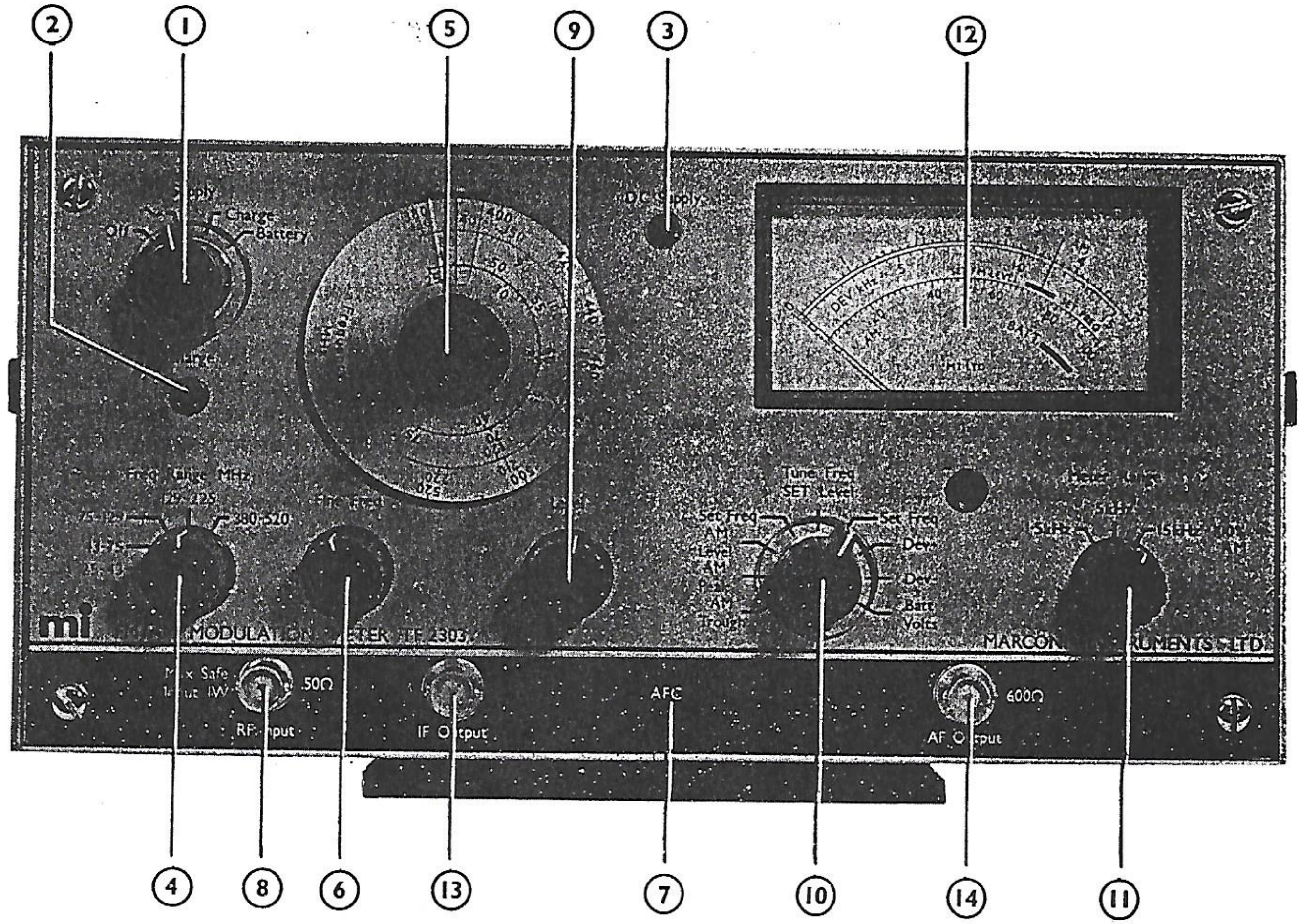


Fig. 2.1   Controls

(1) SUPPLY switch.   Four positions.

OFF.   Mains supply disconnected.

∼.   Mains supply connected to instrument, for normal mains use and for trickle charging the battery.

CHARGE.   Mains supply connected and charging current fed to batteries.

BATTERY.   Internal batteries connected to voltage regulator.   For normal battery use.

(2) CHARGE indicator.   Lights up when battery is being charged, becoming dim when battery is fully charged.

(3) D.C. SUPPLY light.   Indicates that the instrument's regulated 15 V supply is on for normal mains or battery use.

(4) FREQ. RANGE switch.   Selects r.f. input frequency range by selecting the appropriate range of the internal local oscillator.

(5) FREQUENCY control.   Main tuning dial. Should be set to 500 kHz above frequency of input signal.

(6) FINE FREQ. control.   Used in conjunction with (4).

(7) A.F.C. switch.   Press to apply automatic frequency control to the local oscillator when the input signal is not stable.   The instrument is normally operated with A.F.C. off.

(8) R.F. INPUT socket.   Type BNC.   50 Ω impedance.   Accepts signal under test.

(9) LEVEL control.   Sets the attenuation applied to the signal at the R.F. INPUT socket.

(10) FUNCTION selector. Selects the setting and measuring conditions. For a.m. start with the centre position and turn counter-clockwise; for f.m. start with the centre position and turn clockwise.

TUNE FREQ. SET LEVEL. The carrier level is detected and indicated on the meter when the FREQUENCY dial is set 500 kHz from the frequency of the incoming signal. Used to coarsely tune to the r.f. signal and adjust the level to the mixer.

SET FREQ. Two positions. An output from the discriminator , proportional to intermediate frequency is measured by the meter. When the meter indicates SET FREQ. the i.f. is set to the centre frequency of the 500 kHz i.f. amplifier.

A.M. LEVEL. The average carrier envelope is detected and indicated on the meter. Used to standardize the meter before measuring a.m. depth.

A.M. PEAK and A.M. TROUGH. The peak and trough amplitudes of the modulating waveform are indicated. The meter reads a.m. depth directly, after the standardizing on A.M. LEVEL.

DEV+ and DEV-. Frequency deviation above and below the carrier respectively, are indicated on the meter. Note that the correct sense of deviation and modulation depth are dependent on the local oscillator being tuned above the signal.

BATTERY VOLTS. The internal batteries (if fitted) are connected to the meter. The SUPPLY switch should be set to BATTERY to check battery volts. Note that a meter reading is obtained even if the SUPPLY switch is set to OFF.

(11) METER RANGE switch. Selects the attenuation applied to the a.f. signal fed to the peak voltmeter. Three meter ranges for deviation, one for a.m. depth.

(12) METER. Three calibrated scales for deviation and one, in red, for a.m. depth. A black arc (SET F.M. LEVEL and SET FREQUENCY) and a mark (SET A.M.) are used for setting up. Another black arc is used to check battery volts.

(13) I.F. OUTPUT. BNC socket provides 500 kHz i.f. signal.

(14) A.F. OUTPUT. BNC socket provides demodulated output for connection to extra sensitive meter, wave analyser etc.

The following controls and connections are on the rear panel.

(15) A.C. MAINS plug. Accepts mains lead for connection to a.c. mains.

(16) 230 V/115 V selector. Set for the required mains voltage.

(17) MAINS FUSE. 50 mA fuse for 230 V; 100 mA for 115 V.

(18) BATTERY FUSE. 160 mA time delay fuse for use when internal nickel cadmium battery pack is fitted.

2.4 MEASURING F.M. DEVIATION OR A.M. DEPTH

After ensuring that the mains or battery supply is satisfactory as in Sect. 2.1.2 or 2.1.7 proceed as follows.

Setting up

(1) Set the SUPPLY switch to ~ or BATTERY as required. The D.C. SUPPLY light should come on.

(2) Set A.F.C. to off i.e. switch in released position.

(3) Set the FREQ. RANGE to the required range and the FREQUENCY dial to the carrier frequency of the signal to be measured. Set the FINE FREQ. control to mid-position.

NOTE : For the uncalibrated band 225-380 MHz select range 43-75 MHz and set FREQUENCY dial to one quarter the required frequency from 225-300 MHz or one sixth the frequency from 300-380 MHz.

(4) Turn the LEVEL control fully clockwise.

(5) Connect to the R.F. INPUT socket the signal to be measured; it should be 7 mV to 150 mV for the bottom frequency range increasing to 65 mV to 700 mV on the top range. Above these levels an external attenuator should be used (Sect. 2.6 gives details on how to couple the signal to the R.F. INPUT socket). The maximum input that can be applied without damage is 7 V r.m.s. If a counter is used to monitor the carrier frequency, isolate the counter from the modulation meter as described in Sect. 2.7.

(6) Set the FUNCTION selector to TUNE FREQ. SET LEVEL.

(7) Swing the main FREQUENCY control to find the response on the meter and if necessary adjust the LEVEL control to avoid meter readings which are greater than f.s.d. Two peaks should be found on the meter. Tune to the higher frequency peak using the FREQUENCY dial and if required the FINE FREQ. control. The higher frequency peak is the one with the FINE FREQ. control in the more counter-clockwise position. (If it is not required to make + or - deviation measurements or to use a.f.c., either peak may be used.)

(8) Adjust the LEVEL control for a meter reading on the black arc (marked SET F.M. LEVEL and SET FREQUENCY).

(9) Turn the FUNCTION selector to SET FREQ. slightly adjust the FINE FREQ. control to reset the meter reading to the black arc.

NOTE : Check that when switched to SET FREQ. clockwise rotation of the FINE FREQ. control increases the meter reading. If it does not the instrument is incorrectly tuned to the lower frequency peak - see Fig. 2.2. Any difficulty experienced when setting frequency indicates that the instrument is tuned to the wrong peak.

For F.M. measurements, omit steps (12) and (13).

For A.M. measurements, omit steps (10) and (11).

F.M.

(10) For frequency deviation measurement, return the FUNCTION selector to TUNE FREQ. SET LEVEL, check that the meter reading is still on the black arc and slightly adjust LEVEL control if required. (If the reading has fallen right off, go back and retune.)

(11) Set the METER RANGE switch to the required deviation range and select DEV+ or DEV-. Deviation can now be read from the appropriate meter scale.

A.M.

(12) For a.m. depth measurement, select A.M. LEVEL. Use LEVEL control to set meter indication to the SET A.M. mark exactly. (If it will not set, go back and retune.)

(13) Set the METER RANGE switch to 100% A.M. and select A.M. PEAK or A.M. TROUGH. Modulation depth can now be read from the red meter scale.

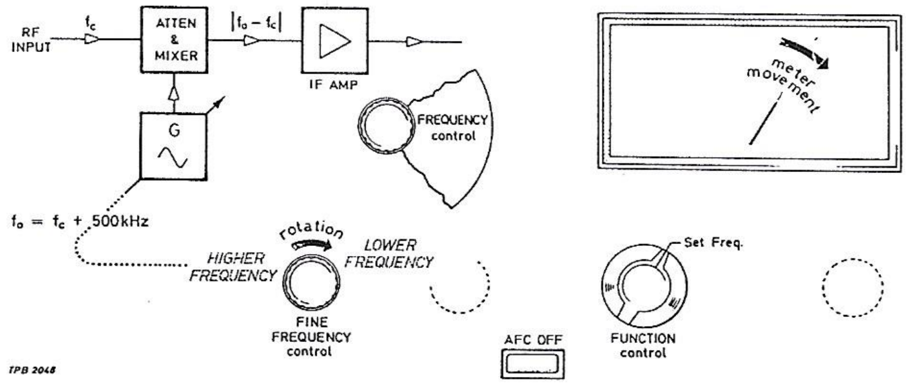


Fig. 2.2 Setting frequency

Asymmetric modulation

(14) If unequal meter readings are obtained as the FUNCTION switch is turned between DEV+ and DEV- or between A. M. PEAK and A. M. TROUGH, this indicates distortion in the equipment under test. For deviation measurements, make sure that this asymmetry is not introduced by the instrument itself by retuning to the lower peak (local oscillator frequency 500 kHz below the carrier frequency). If the unequal deviation readings are now reversed, the asymmetric modulation can be attributed to the input signal.

Switching off

(15) After use, switch to SUPPLY OFF.

(16) If the instrument has been on battery operation, the battery can be recharged (CHARGE position) or trickle charged (∼ position) see Sect. 2.1 for details.

2.5 USING A.F.C.

Automatic frequency control is not normally required. However if the signal source is not stable or if long term monitoring is required a. f. c. can be switched in after manual tuning. The instrument cannot be tuned with a. f. c. on since the control voltage is too high when there is no i. f. signal, i. e. when the instrument is off-tune.

Use the following sequence for measurements with a. f. c.

(1) With A. F. C. off, i. e. switch released, tune the modulation meter to the incoming signal, set level and set frequency in the usual way (Sect. 2.4 steps (1) and (9)).

(2) With the FUNCTION switch at SET FREQ. and the meter reading on the black arc, press the A. F. C. switch. The reading should remain within the black arc.

NOTE : Check that a. f. c. is being applied by varying the FINE FREQ. control; the meter should appear less sensitive.

(3) For frequency deviation measurement, switch to TUNE FREQ. SET LEVEL, check that the meter still reads on the black arc and slightly adjust the LEVEL control if necessary. Set the METER RANGE switch to the required range, switch to DEV+ or DEV- and read deviation.

(4) For a. m. depth measurement, switch to A. M. LEVEL and adjust LEVEL control to set meter to the SET A. M. mark exactly. Set the METER RANGE switch to 100% A. M. Switch to A. M. PEAK or A. M. TROUGH, and read modulation depth.

If the input signal is momentarily removed when a. f. c. is being used, it will be necessary to switch off a. f. c. in order to restore the correct tuning conditions. Restore tuning as in step (5).

(5) Switch A. F. C. off (switch released), set FUNCTION switch to SET FREQ. and check that the instrument is still tuned (reading within the black arc). Switch A. F. C. on, return FUNCTION switch to deviation or a. m. depth position and continue measurements.

With a. f. c. applied the modulation meter should typically follow an input signal which drifts up to 1% off frequency. When the signal drifts too far, the meter reading will suddenly fall and the instrument must be manually tuned again. To retune proceed as follows :

(6) Switch A. F. C. off (switch released).

(7) Set FUNCTION switch to SET FREQ. and set frequency by adjusting the FINE FREQ. control checking that clockwise rotation increases the meter reading. If the frequency will not set or if the instrument tuning has jumped to the wrong peak, retune to the upper frequency peak and set level, then set frequency again.

(8) Switch A. F. C. on and check that the meter still reads within the black arc. Continue measuring frequency deviation or a. m. depth as in steps (3) or (4).

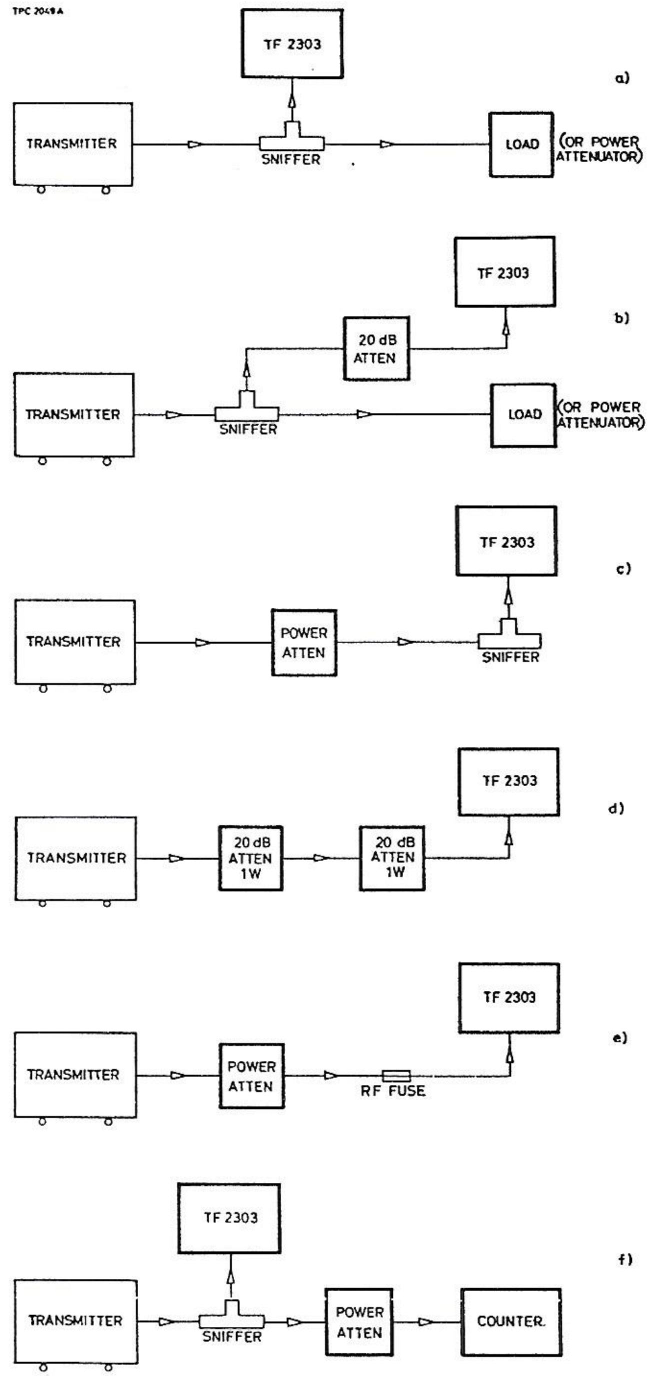


Fig. 2.3 Coupling the r.f. signal to the TF 2303

2.6 COUPLING THE R.F. SIGNAL TO THE R.F. INPUT

A high sensitivity modulation meter can easily be damaged if precautions are not taken when coupling the transmitter signal to the instrument input. The use of a pick-up loop placed near the transmitter is not recommended. For a. m. measurements, reflections from people in the vicinity of the transmitter can produce a varying signal level at the modulation meter. Furthermore it is often undesirable to radiate from a transmitter located in a factory or workshop.

It is recommended that the transmitter power is fed to a screened dummy load and that the signal

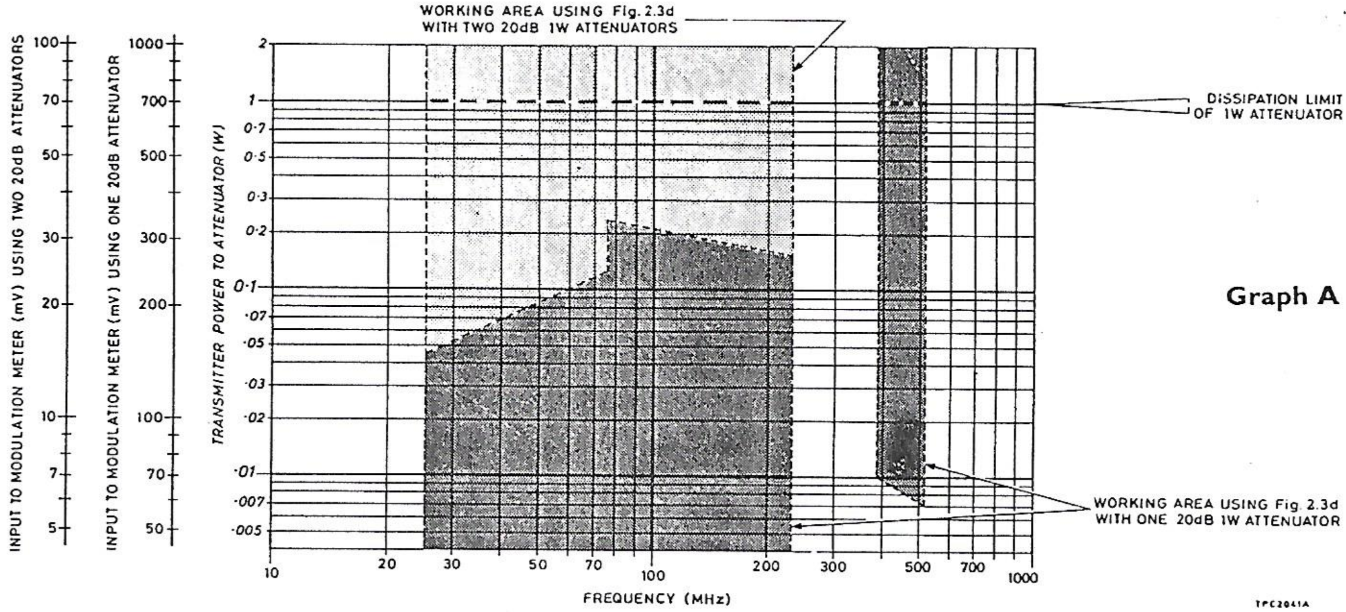


Fig. 2.4 Power/frequency graph with 40 dB attenuation

is coupled to the modulation meter using an attenuator pad or sampling device, e.g. Signal Sniffer 54452-011. The range of accessories (see Sect. 1.3) available for use with TF 2303 will handle transmitter powers of 0.1 W to 30 W. Several suggested methods of coupling to the transmitter are illustrated in Fig. 2.3 but great care must be taken to choose the correct combination.

TF 2303 will tolerate an input of up to 1 W (7 V r.m.s.) without damage but it is overloaded by inputs above about 150 mV at 25 MHz or 700 mV at 500 MHz. The minimum input requirement displays a similar increase with frequency. The frequency responses of attenuators and terminations can be ignored but must be considered for the signal sniffer which has a capacitive coupling; the effective attenuation varies from 50 dB at 25 MHz to 24 dB at 500 MHz. Another factor to be considered is the dissipation rating of any termination or attenuator employed.

These factors are taken into account in Fig. 2.4 and Fig. 2.5 which relate transmitter power and frequency to the working ranges of the modulation meter used, in conjunction with accessories, in the configuration of Fig. 2.3a, 2.3b or 2.3d. Both the graphs assume a v.s.w.r. of near to unity, but if a high v.s.w.r. is expected, due allowance must be made for the greater voltage which may be presented to the modulation meter.

Use of graph A (Fig. 2.4)

This graph applies to low powered transmitters connected as in Fig. 2.3d.

Knowing the transmitter power, find the point of intersection with the frequency and decide whether the point lies within the area corresponding to the use of one attenuator or of two.

Use of graph B (Fig. 2.5)

This graph applies to transmitters connected using the signal sniffer.

Knowing the transmitter power, move along the sloping power line (scale marked 'Transmitter Power to Signal Sniffer') to find the point of intersection with the transmitter frequency line. The corresponding voltages which appear at the input to the modulation meter are given by the scales on the extreme left (Fig. 2.3a arrangement) and on the extreme right (Fig. 2.3b arrangement). If the point lies within the lower shaded area, use the signal sniffer as in Fig. 2.3a. If the point lies within the upper shaded area select the sniffer with a 20 dB attenuator as in Fig. 2.3b. Consult the list of available accessories given in Sect. 1.3. The limitations imposed by the dissipation rating of the load, shown on the graph, must be observed,

Graph B

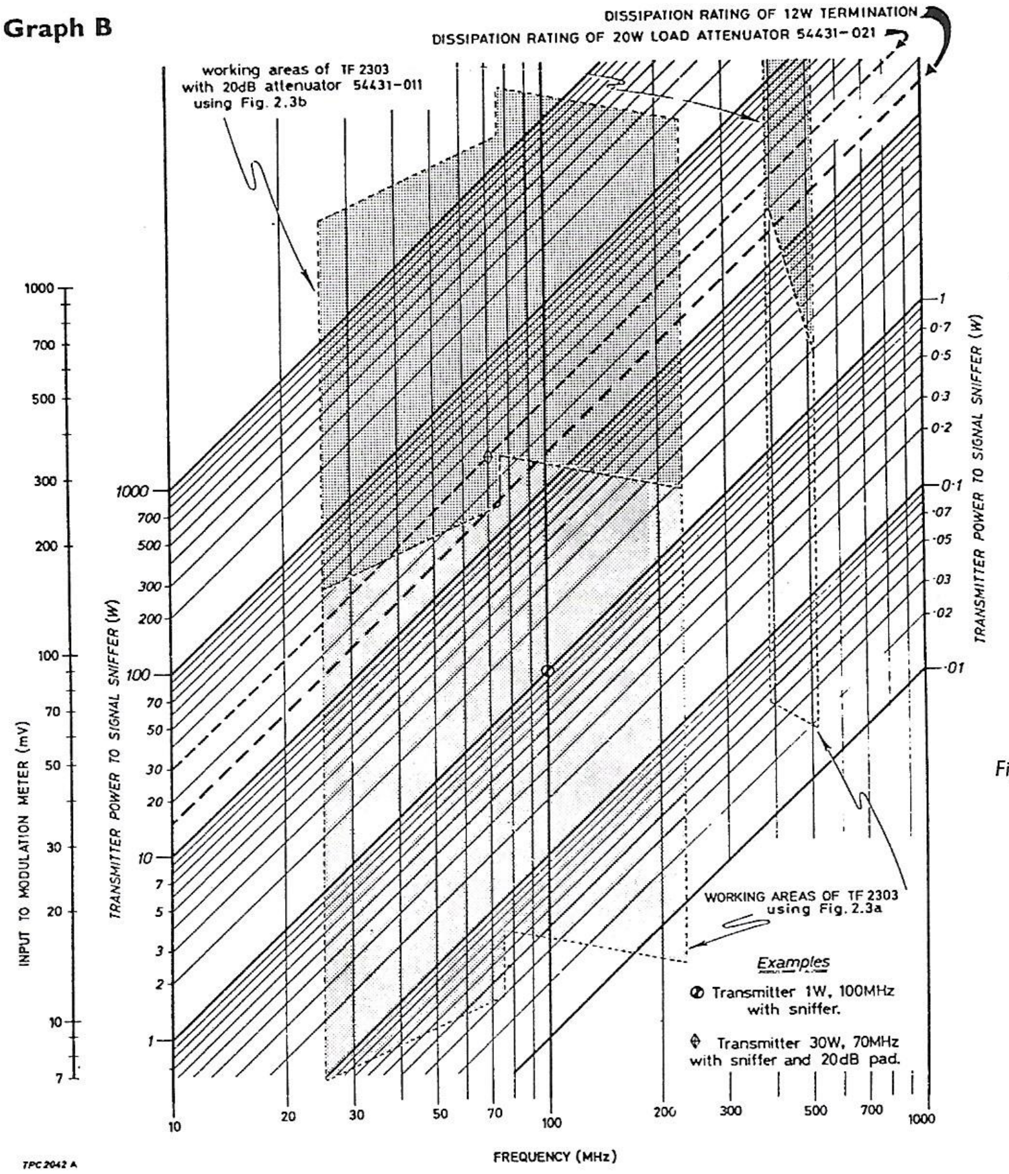


Fig. 2.5 Power/frequency graph with signal sniffer

but if a higher power termination is available operation can be extended to the upper portions of the graph.

CAUTION

The signal sniffer is a T connector; the T branch providing the attenuated signal. Do not connect it the wrong way round.

Notes on using the signal sniffer

The signal sniffer is normally used between transmitter and load as shown in Fig. 2.3(a) or 2.3(b). It can, however, be used as in Fig. 2.3(c), i.e. with the sniffer placed between the power attenuator and the TF 2303. But since the attenuator is unterminated, its attenuation will be reduced from 20 dB to about 13 dB.

As can be seen from Graph B, the signal sniffer with or without a 20 dB attenuator covers most mobile applications. The only case where the sniffer may not be useable is with 0.1 W transmitters working near 25 MHz. In this application use two 20 dB, 1 W attenuators in series (Fig. 2.3(d)).

Loading and overloading

The accessory chosen to terminate the transmitter must be capable of handling the maximum power output. A 20 dB attenuator can be used as a load. It will provide a satisfactory load, even if it is not terminated, since the attenuation ratio is so high that the input impedance is hardly affected by whatever is connected to the attenuator output.

In cases where the modulation meter may be required to handle a wide range of power levels, an R. F. Fuse Unit TM 9884 can be connected, as in Fig. 2. 3(e), to prevent accidental damage to the instrument input circuitry. If TF 2303 is overloaded, the two 100 Ω terminating resistors in the attenuator/mixer unit may burn out - see Sect. 5.4 for replacement details.

Measurements at u.h.f.

Since the transmitter is not usually a 50 Ω source, the v. s. w. r. is large for the 380-520 MHz frequency band, and the signal level at the TF 2303 input becomes rather unpredictable. It will depend on carrier frequency, length of cable, couplings etc. If necessary, the signal level can be optimized using different lengths of cable. Because measurements on the top band are restricted to f. m., the exact signal level is not critical and it is quite permissible to operate with the level, as indicated on the meter, above or below the black arc by an amount equal to the arc length. The only effect of this will be a possible increase by 1 or 2 dB in the instrument's internal noise but this will have no appreciable effect on normal measurements.

2.7 USING A COUNTER WITH TF 2303

When a counter is used to monitor the carrier frequency, ensure that the counter input socket is not connected directly to the modulation meter input socket, otherwise the counter could measure the local oscillator frequency appearing at the R. F. INPUT socket. If this happens spurious readings result on the counter. The counter and modulation meter should be connected to the transmitter as shown in Fig. 2. 3(f). Alternatively, disconnect the modulation meter when a frequency measurement is required.

2.8 USE OF I.F. OUTPUT SOCKET

This socket provides the 500 kHz i. f. signal.

Carrier shift

The I. F. OUTPUT socket can be used to measure carrier shift by connecting a counter to it. Tune the modulation meter to the incoming r. f. signal and set the level in the normal way (Sect. 2. 4). Turn to SET FREQ. and readjust the FINE FREQ. control to bring the meter reading to the SET mark. The i. f. is now centred on 500 kHz. But if carrier shift is present the meter reading will fluctuate and the extent of the shift can be measured on the counter. In cases of severe carrier shift, the modulation meter may be set up with modulation off.

2.9 USE OF A.F. OUTPUT SOCKET

The A. F. OUTPUT socket provides the demodulated signal which can be measured by a sensitive voltmeter or wave analyser for low deviations and low modulation depths. The output level is approximately 0. 775 V p. d. into 600 Ω when the meter indicates f. s. d. The socket is fed by an independent buffer stage so the meter is unaffected by the load connected. Only earthy circuits should be connected to the socket since an electrolytic coupling capacitor is used.

Noise in f.m. measurements

When measuring f. m. noise and f. m. on a. m., the internally generated noise from the modulation meter must be kept to a minimum. Optimum internal noise conditions are usually achieved with the signal level set to the black arc, but depending on carrier frequency the optimum may be at a level slightly above or below the black arc.

The a. f. signal at the A. F. OUTPUT socket can be monitored using a true r. m. s. or average reading voltmeter. The LEVEL control can then be adjusted for minimum voltmeter reading (corresponding to minimum internal noise level) and f. m. deviation measured with the internal noise kept to a minimum.

De-emphasis network

Modulation Meter TF 2303 has no internal de-emphasis network but a 750 µs De-emphasis Unit 54412-011 is available as an optional accessory. This is an R-C network which can be connected to the A. F. OUTPUT socket to restore a modulation signal that has had pre-emphasis applied. The response is only correct when the network is terminated in 600 Ω so a switched internal load is provided for working into high impedances.

If the signal is being monitored using high impedance headphones (approximately 2 kΩ) the response will not be quite correct. However, since the source resistance of the instrument is 600 Ω, the error will not be great and the response will normally be sufficiently accurate for a listening test.

Restricted bandwidth measurements

For measurements where the effect of internally generated noise must be minimized, the bandwidth of the a. f. output signal can be reduced using the arrangement of Fig. 2.6.

For a bandwidth, at 3 dB points, of 9 kHz use a value for C of 0.055 µF, which will give a noise improvement of about 3 dB for f. m. measurements.

For a bandwidth, at 3 dB points, of 4 kHz use a value for C of 0.13 µF. The noise improvement, then, for f. m. measurements is about 6 dB; for a. m. measurements the internal noise falls to about 0.03% modulation depth.

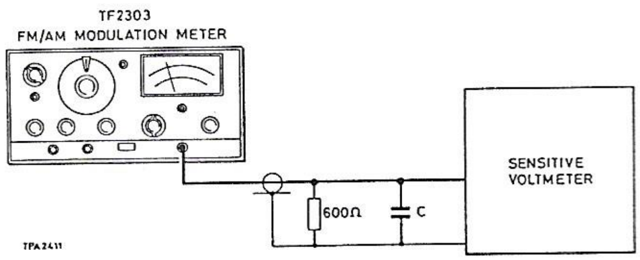
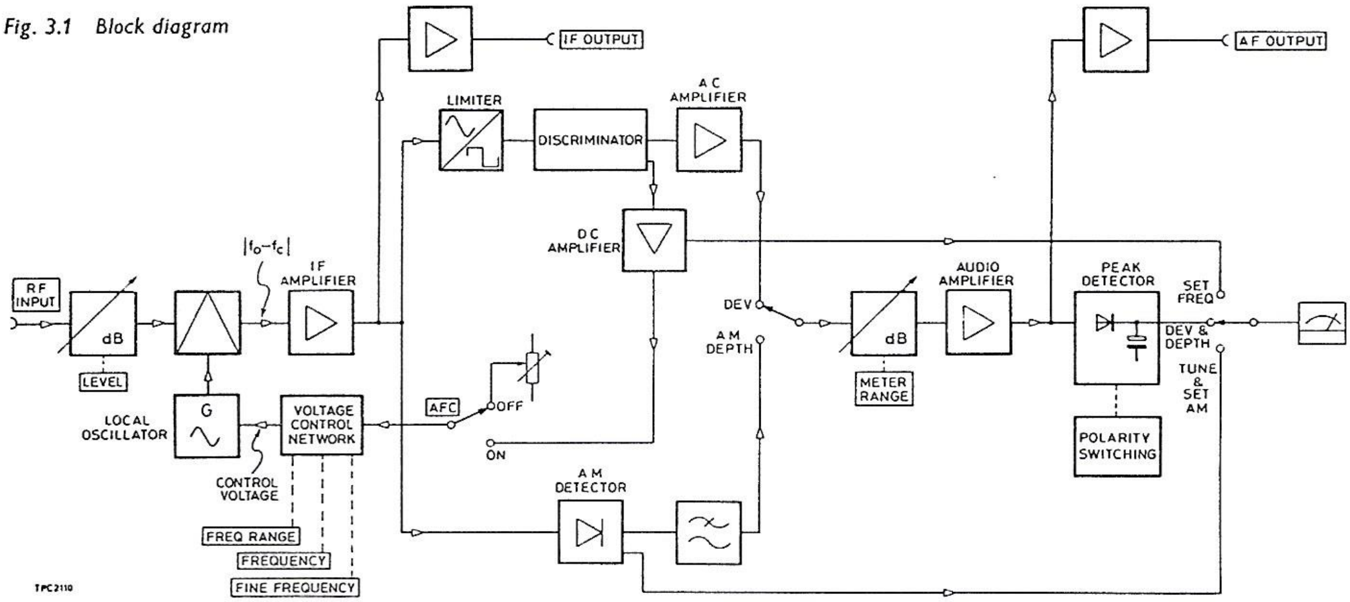


Fig. 2.6 A.F. output with restricted bandwidth

Chapter 3 Technical description

Fig. 3.1 Block diagram



3.1 OVERALL SYSTEM

F.M./A.M. Modulation Meter TF 2303 is a superheterodyne f.m./a.m. receiver with discriminator and a.m. detector, and a peak voltmeter to measure the demodulated signal. General operation of the instrument can be understood by referring to Fig. 3.1; detailed circuits will be given in Figs. 7.1 and 7.2.

The r.f. signal takes two paths: the limiter and discriminator for setting frequency and for deviation measurement, and the a.m. detector for tuning, setting a.m. level and a.m. depth measurement.

The action of the limiter and discriminator are illustrated in Fig. 3.2. To provide good a.m. rejection when measuring deviation, the limiter must eliminate all amplitude changes and produce a rectangular waveform (Fig. 3.2b). This limited i.f. signal triggers the pulse counter type of discriminator. A monostable pulse generator produces a pulse of fixed width and amplitude every time the i.f. signal passes through zero in the positive-going sense (Fig. 3.2b and c). Vm, the

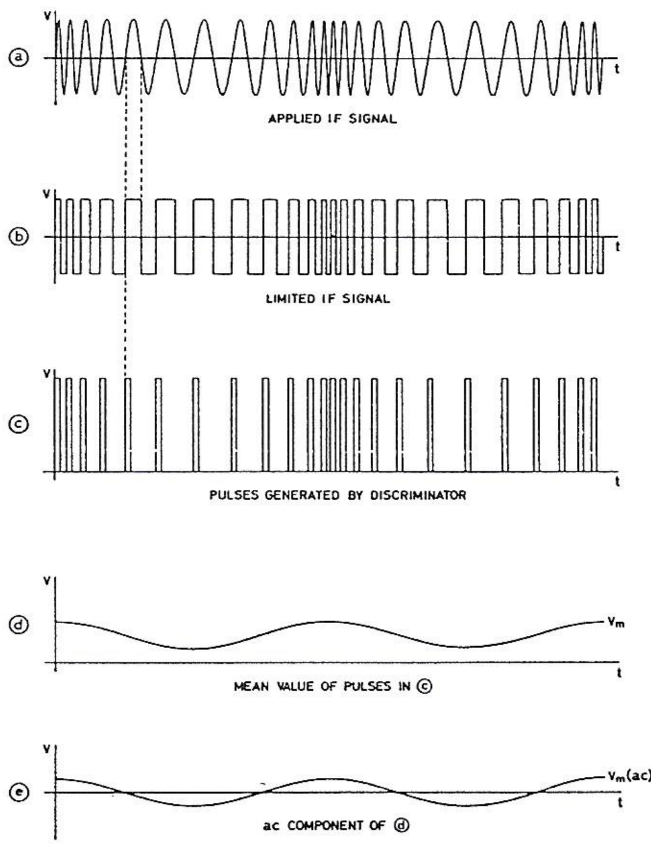


Fig. 3.2 Operation of discriminator

mean amplitude of these pulses varies with the p.r.f. of the input signal so, when f.m. is present, Vm varies directly with deviation frequency. This is illustrated in (c) and (d).

The d.c. component of the discriminator output, which is proportional to carrier frequency, is used for setting frequency precisely or, amplified, for automatic frequency control. The a.c. component, whose amplitude is proportional to deviation, is fed for measurement to the peak detector.

The a.m. detector, equally, has two components of its output. The d.c. component of the detected signal is proportional to mean carrier envelope level; it is used to indicate correct setting for preliminary tuning and as an indication of correct signal levels. The a.c. component, whose amplitude is proportional to modulation depth, is fed for measurement to the peak detector.

The peak detector is merely a diode and a capacitor. But to cope with a.m. peak and trough measurements and with positive and negative deviation, the FUNCTION switch is used to reverse the polarity of the diode and to reverse the connections to the capacitor.

The nine positions of the FUNCTION switch can be understood by studying Fig. 3.1 and, for further detail, Fig. 7.1. The TUNE FREQ. SET LEVEL and the A.M. LEVEL positions are both exactly the same: the d.c. component from the a.m. detector is fed to the meter. In the SET FREQ. positions, a direct voltage which is proportional to intermediate frequency, is taken from the discriminator, amplified and passed to the meter. When deviation is measured (DEV+ and DEV- positions) the a.c. component passes to an a.c. amplifier then to a buffer and an l.f. amplifier before being fed to the peak voltmeter. When a.m. depth is measured (A.M. PEAK and A.M. TROUGH positions) the modulation signal from the a.m. detector is switched, via the buffer and l.f. amplifier, to the peak voltmeter. In the BATTERY VOLTS position the meter with a resistor in series is connected across the battery terminals.

3.2 ATTENUATOR AND MIXER A1

The attenuator and mixer are contained in the screened unit 46771-008.

At the R.F. INPUT socket the input impedance is 50 Ω. R1 and R2 provide a 50 Ω terminating resistance. Overloads up to 1 W should cause no damage, but above this, R1 and R2 could burn out.

The input level is controlled by C2, a variable differential capacitor which attenuates, by up to 24 to 30 dB, the signal coupled to the mixer. A conventional diode mixer is used with a point contact germanium diode. The local oscillator voltage is developed across R4. The mixer output is filtered by the low-pass filter formed by a 10 μH inductor and the input capacity of the i.f. amplifier. This keeps the local oscillator signal out of the i.f. amplifier.

3.3 LOCAL OSCILLATOR A3

The local oscillator covers 25-225 MHz and 380-520 MHz and when the instrument is correctly tuned, the local oscillator frequency is 500 kHz above the carrier frequency.

The oscillator unit 44456-119 is screened and is mounted in the top of the instrument; its voltage control circuitry is on the main printed circuit board.

Oscillator

Two oscillators with fundamental frequency ranges of 25 to 43 MHz and 43 to 75 MHz are used. The basic oscillator circuit is a derivation of a conventional L-C tuned amplifier circuit and uses several varactor diodes, a printed coil with high Q and an f.e.t. as the active device. Fig. 3.3 shows the basic circuit.

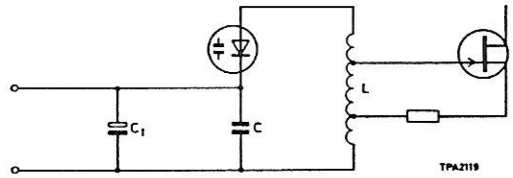


Fig. 3.3 Oscillator circuit

To obtain as large a capacitance as possible, hence lowest possible noise, several varactor diodes are used. The varactor diode bias voltage is varied between 0 and approximately 15 V, the

10 μF capacitor (C in Fig. 3.3) removing low frequency noise from the control voltage. In these oscillators the field effect transistors have source resistance biasing.

The buffer amplifier TR3 distorts the signal from the oscillator to improve the operation of the mixer when the seventh harmonic is used. Transformer T1 is a wide bandwidth transmission line transformer with a 4:1 impedance ratio. The buffer output works into 75 Ω approximately.

Frequency coverage

Two oscillators and their harmonics cover the required frequency ranges. On fundamental frequencies oscillator 'A' covers 25 - 43 MHz; oscillator 'B' covers 43 - 75 MHz. The third harmonic of oscillator 'A' gives the range 75-129 129 MHz; the third harmonic of oscillator 'B' gives 129-225 MHz and the seventh harmonic of 'B' gives the top range 380-520 MHz. The top range has an expanded scale. Frequencies between 225 and 380 MHz are also covered by using the fourth or sixth harmonics of oscillator 'B', but are not directly calibrated.

Table 3.1

Range	Oscillator	Harmonic used	Oscillator Frequency MHz	Carrier Frequency MHz
1	'A'	1st	25 - 43	24.5 to 219.5
2	'B'	1st	43 - 75	
3	'A'	3rd	75 - 129	
4	'B'	3rd	129 - 225	
5	'B'	7th	380 - 520	379.5 to 519.5

The required oscillator is selected by supply switching; the unused oscillator is earthed and is thereby also isolated by the reverse bias applied to the diode D9 or D10.

Frequency control

A control voltage of between 0 and 15 V is derived from a potentiometric network. The main tuning control is R3 and trimming potentiometers R12, R14, R16, R17 and R18 (on the main board) are used to set the oscillator ranges to fit the frequency tuning dial. A fine frequency tuning voltage is obtained from potentiometer R1 and is combined with the voltage from the main frequency control (see Fig. 7.1) so that

$$V_{out} = V_m \frac{R_{11}}{R_{11} + R_{15}} + V_f \frac{R_{15}}{R_{11} + R_{15}}$$

where V_m and V_f are the main and fine tuning control voltages. The control voltage V_{out} is fed to the local oscillator via pin 4 of the oscillator unit.

An automatic frequency control voltage is added to the tuning control voltage when a.f.c. is switched in, this a.f.c. voltage being derived from the discriminator. In addition to the varying a.f.c. voltage a standing d.c. voltage is present from the discriminator and is also added to the timing control voltage when a.f.c. is switched in. When a.f.c. is switched out, a voltage from R22 (which should be set to equal the discriminator standing d.c. voltage) is added so that as a.f.c. is switched in and out the frequency does not shift up and down. The a.f.c. only works when the modulation meter is tuned to the upper frequency peak.

3.4 I.F. AMPLIFIER

The signal from the mixer enters the i.f. amplifier on the main printed circuit board at pin 1.

The main function of the i.f. amplifier is to operate as a filter to pass to the limiter only the signals in the wanted pass band 300 kHz to 700 kHz. The i.f. amplifier comprises coupling capacitor C1, amplifier TR1, a low-pass i.f. filter, an emitter follower and a resistive attenuator.

The i.f. filter must attenuate signals above the pass band very sharply to prevent wrong triggering of the discriminator. (This can happen at frequencies at which the discriminator pulse approaches or exceeds 100% mark/space ratio when the discriminator will operate in a 'divide by two' mode.) The filter, therefore, has an attenuation slope such that the output level from the limiter falls below the triggering level of the discriminator before the 'divide-by-two' frequency is reached: this frequency is 1.5 MHz. Characteristic of the low-pass i.f. filter is flat from d.c. to the cut-off frequency (700 kHz) and cuts off sharply at higher frequencies. A two section filter is used in which each section has a design attenuation of 21 dB at twice the cut-off frequency.

To obtain the required pass band, the low-pass filter is combined with coupling capacitor C1 which attenuates frequencies below about 200 kHz and a pass band 200 kHz to 700 kHz results. This wide bandwidth makes the instrument easy to tune.

The output from the filter is coupled by emitter follower TR2 and a 21 dB resistive attenuator R9, R13 to the limiter. The emitter follower also feeds the a.m. detector and the i.f. buffer amplifier TR3 which provides an i.f. output of 100 mV r.m.s. nominal from a 1 kΩ source.

3.5 LIMITER, DISCRIMINATOR AND AMPLIFIERS

The operation of the limiter and discriminator was described in Sect. 3.1 and is illustrated in Fig. 3.2.

I.F. limiting amplifier IC1 provides high gain (60 dB) and has good limiting characteristics so that any a.m. on the input signal does not produce spurious f.m. The integrated circuit used for limiting does in fact include an f.m. detector but only the three-stage amplifier is used.

A rectangular waveform (Fig. 3.2b) with a standing d.c. level is provided by the limiter and is directly coupled to the discriminator via emitter follower TR4 for impedance matching.

The discriminator IC2 is a TTL monostable. Pin 5 is a positive edge Schmitt trigger input and triggers the one shot when pin 5 goes high and both NAND inputs (pins 3 and 4) are low. The output of the monostable pulse generator (from pin 6) is a positive-going pulse of amplitude at least 2 V.

This pulse train has a repetition rate, which is proportional to the signal frequency from the i.f. amplifier, and a pulse duration of 700 ns, determined by C14, R29. At 500 kHz the mark/space ratio is 1:2 but the discriminator can operate well above 500 kHz i.e. with mark/space approaching 1:1. However, if the mark/space ratio approaches 100% (due to signals at too high a frequency from the i.f. filter or to the monostable pulse duration being too long) then the discriminator will operate in a 'divide by two' mode and the slope of the output voltage versus frequency will be halved.

From IC2 the pulse output is integrated by a low-pass π filter C16, L3, C18 and the mean value of the pulses (Fig. 3.2) is amplified by a high gain d.c. amplifier, TR5, whose output is proportional to the frequency of the signal to the discriminator. The forward voltage of diode D2 provides bias and temperature compensation and final optimization of bias is obtained by the slightly positive bias of the negative terminal (pin 7) of the discriminator IC2 adjusted by R26. The output from the d.c. amplifier is smoothed and fed directly to the meter (via pin 21 and switch SD) for setting frequency, and to the a.f.c. switch for automatic frequency control.

The a.f. component of the integrated pulse output is the modulation frequency component and this is amplified by TR6, an a.c. amplifier with a Zener diode D4 to obtain correct biasing. Switch SD2f routes the a.f. signal to the f.e.t. buffer stage.

3.6 AUTOMATIC FREQUENCY CONTROL

The mean d.c. level of the discriminator output is proportional to carrier frequency. This direct voltage is amplified and inverted by d.c. amplifier TR5, so that when a.f.c. is switched in, it is added to the control voltage applied to the local oscillator. R21, R22 and R23 supply a fixed control voltage to replace the a.f.c. voltage when a.f.c. is switched off.

With no signal to the discriminator, the a.f.c. voltage approaches +15 V, consequently the instrument must always be tuned manually before switching the a.f.c. on. If the signal is momentarily removed when a.f.c. is in use, the voltage may push the local oscillator further off-tune; so the instrument should be retuned manually before applying a.f.c. again.

Fig. 3.4b shows the output voltage from the d.c. amplifier with varying signal frequency and the direction of a.f.c. control.

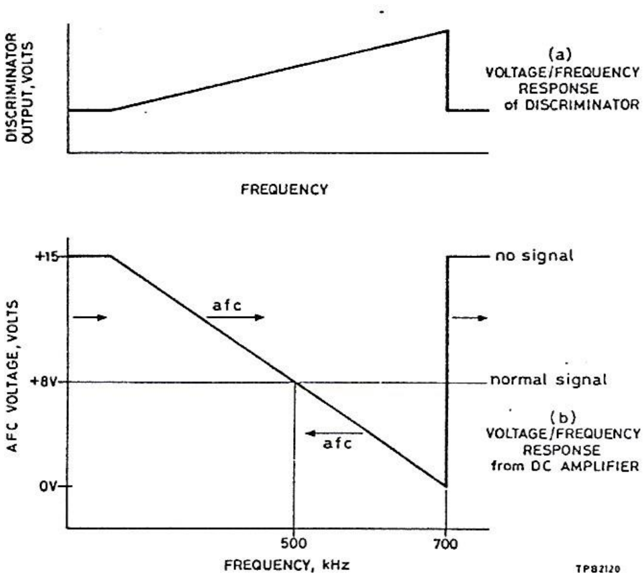


Fig. 3.4 Voltage/frequency characteristic of a.f.c.

3.7 A.M. DETECTOR

The a.m. detector uses a diode in the feedback loop of an operational amplifier. The diode characteristic is linearized by employing a large amount of feedback. The rectified output from diode D5 is therefore proportional to the modulated carrier level.

The rectified output is fed into resistive load R48, R49, in the set a.m. and tune positions, and a proportion of the output is directly coupled to the meter to indicate mean carrier envelope level. Thus the d.c. component is used for level standardization.

For measuring a.m. depth, the rectified output feeds resistive load R64, R65 and R54 and a proportion of the output is passed to a two stage R-C filter. This removes carrier ripple so the resulting modulation frequency signal is passed to SD2f and coupled to the f.e.t. buffer stage for modulation depth measurement.

3.8 BUFFER AND A.F. AMPLIFIER

A signal from the discriminator or from the a.m. detector is selected by SD2f and coupled to the potentiometric network R52 and R53 where R52 is set for the 1.5 kHz meter range. Since there is no d.c. in this attenuator and since a high input impedance is required, an f.e.t. amplifier is used to couple the signal to the next stage. The attenuation applied to the signal is selected by SE and passed to the class AB audio amplifier IC4. Its output is loaded by R76 and R77 in parallel with the peak voltmeter is connected across R77. C39 and C40 provide feedback to prevent oscillation. C41 is a d.c. blocking capacitor and the amplified a.f. signal is coupled via C42 to switch SD6f.

3.9 PEAK VOLTMETER AND METER SWITCHING

The a.f. signal fed to the peak voltmeter for deviation and a.m. depth measurement, has been inverted by previous amplifying stages. Thus negative deviations and a.m. troughs correspond to positive peak amplitudes of the a.f. signal.

The peak detector consists of diode D6 and capacitor C43 both components being mounted on the FUNCTION switch. The capacitor is charged via the diode to the peak voltage of the a.f. waveform, then the capacitor is discharged through the meter and a 33 kΩ resistor in series with it. Charging time is short and discharging time is as long as possible; the meter, therefore, reads peak voltage. So that positive or negative peak amplitudes can be measured, the diode polarity is reversed by switch wafers SD6f and SD7f. C43 is an electrolytic capacitor so its polarity must also be reversed (Fig. 3.5). The switch wafers SD4f and SD5f are concerned only with function selection i.e. selecting the required setting up or measurement signal for the meter.

3.10 POWER SUPPLY

The power supply consists of a mains transformer, a full-wave rectifier, a charging circuit and a voltage regulator. The transformer (TM 6944) and the voltage regulator board A4 (44825-222) are mounted under the top cover on the left-hand side. For battery operation, the battery pack and battery fuse are fitted.

SUPPLY switch SA connects the transformer to the mains input plug when the switch is set to ~ or to CHARGE. It is also used to connect the rectified mains or the battery to the regulator and to switch the charging current to the battery.

Switch SC, on the rear panel, selects the transformer taps for 115 V or 230 V mains voltage.

The two primary halves of the transformer are in series for 230 V and in parallel for 115 V. The full-wave rectifier produces +21 V, at least, at pin 6 of board A4. When switched to ∼, this is fed via SA1 to the regulator circuit. A precision voltage regulator of the μA723C type is used: IC1 consists of reference amplifier, error amplifier, series stabilizer and current limit circuitry. The voltage output from IC1 pin 6 drives the series control transistor TR1 and the final +15 V supply is sampled at R3 and is taken to the error amplifier of IC1.

For battery operation, the battery voltage of 18 to 21 V passes to the regulator board producing a +15 V regulated supply. If the battery voltage falls below 18 V, the regulator ceases to function.

The charging circuit is very simple. Two lamps in series are connected to the rectified mains supply, which is about 27 V, and the current through the lamps is used to charge the battery. The resistance of the filaments depends on the filament voltage and as the battery voltage increases the charging current decreases slightly. When the battery is deeply discharged, e.g. 10 V, the charging rate will be very high for a few seconds if the instrument is switched to CHARGE. But as the battery voltage rises the charging current will decrease. As the battery voltage rises from 18 V to 21 V, the current decreases slightly from about 140 mA to 120 mA thus, at high battery volts, the charge rate is almost constant.

When the charge rate is high, the lamps will glow brightly and can be viewed through perspex on the instrument front panel. For a fully charged battery the lamp is only just visible.

To trickle charge the battery, the charging current is reduced by R7 to about 25 mA.

Chapter 4

Maintenance

4.1 INTRODUCTION

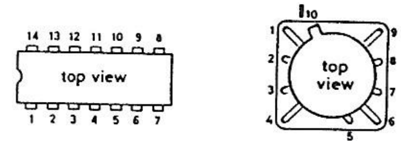
This chapter contains the information required for keeping the instrument in good working order, checking its overall performance and making those preset adjustments necessary for regular maintenance.

CAUTION Integrated circuits and discrete semiconductor devices are used throughout the instrument. Although they have inherent long term reliability and mechanical ruggedness, they are easily damaged by overloading, reversed polarity, heat and electromagnetic radiation. Prolonged soldering, strong r.f. fields, short circuits and the use of insulation testers should therefore be avoided.

Mains voltage setting, battery installation and battery charging are dealt with in Chapter 2. Note that if the battery is removed the battery fuse should also be removed and kept in a plastic bag tied to the battery clamp.

Fig. 4.1

IC pin numbering



It may be desirable occasionally to clean and lubricate the contacts of the rotary switches using white spirit (but neither carbon tetrachloride nor trichlorethylene) and to lubricate them with a suitable lubricant such as a 1% solution of petroleum jelly in white spirit.

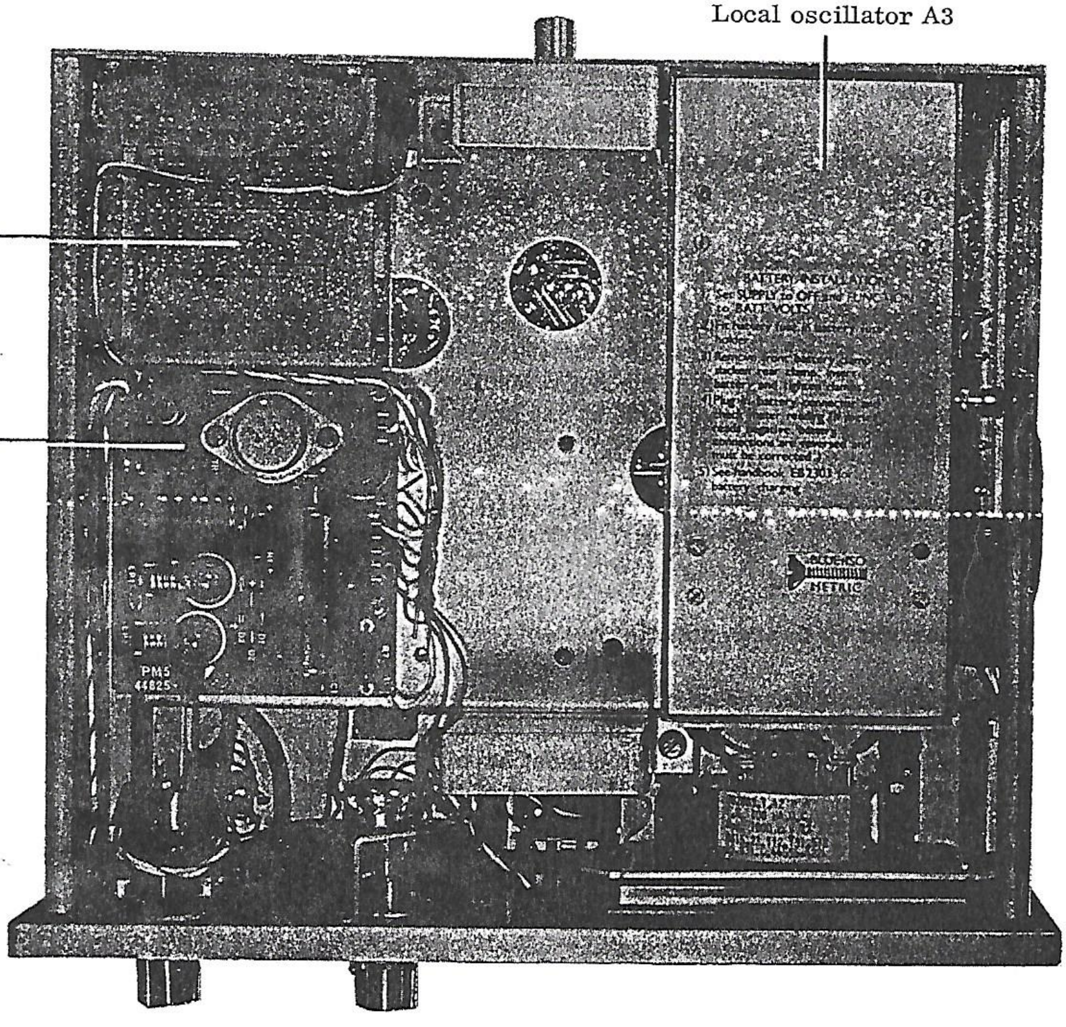


Fig. 4.2

Top view with covers removed

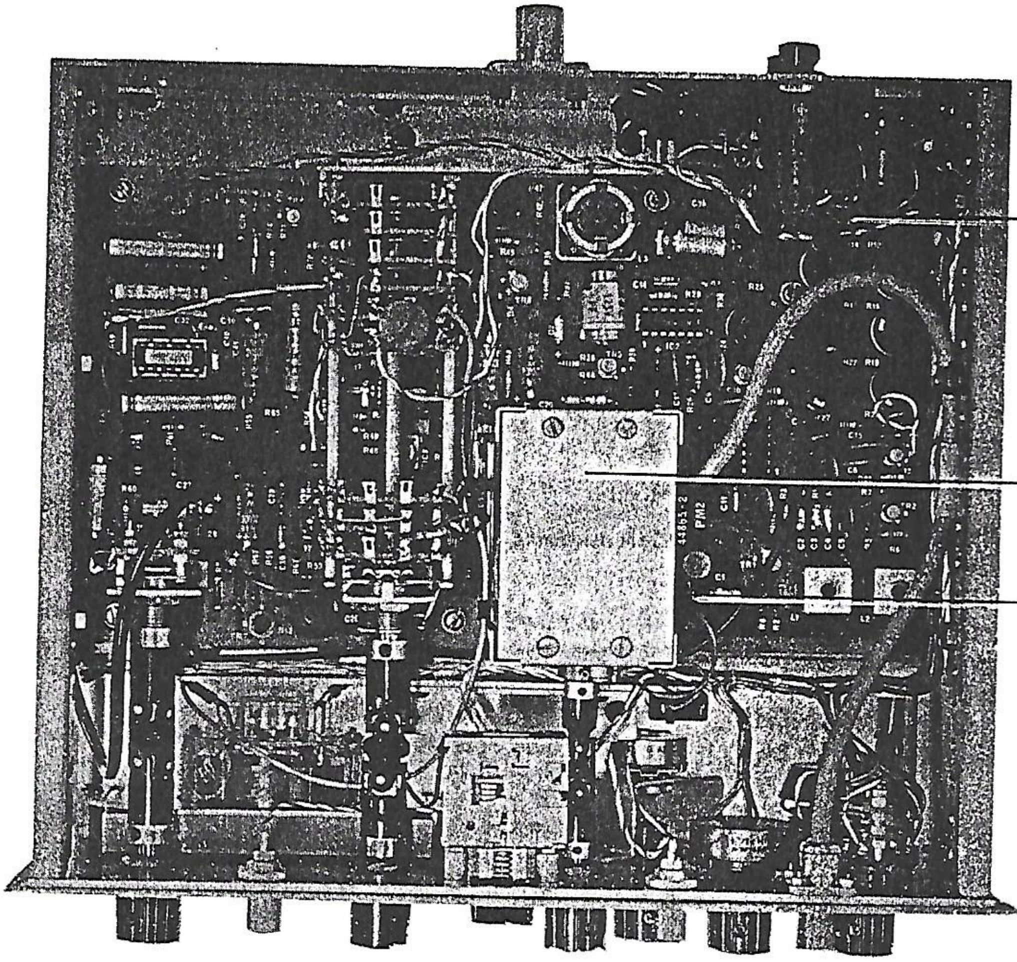


Fig. 4.3
Bottom view with covers removed

4.2 ACCESS TO MONITORING POINTS AND PRESETS

4.2.1 Removal of case

The case is in two sections. The upper half is secured by four M4 screws and the lower half by two M4 screws in the back of the instrument. When replacing a screw, carefully line up the holes before inserting it.

The positions of the boards and sub-units are shown in Fig. 4.2 and Fig. 4.3.

4.2.2. Access to boards and components

All the boards are wired-in. The attenuator/mixer unit (on the underside of the instrument) and the local oscillator unit (on the top side) have screening covers. To remove the cover of the attenuator/mixer unscrew the 4 screws and pull off the cover. To remove the cover of the local oscillator, simply lever off the top plate with a screwdriver. Do not unscrew the 8 screws in the plate.

The six preset potentiometers, used to set up the voltage control for the local oscillator, are located on the main printed circuit board and are near the mains input connector. All the other presets (except for the power supply) are also l located on this board.

4.3 TEST EQUIPMENT

Test equipment required to check the performance of a TF 2303 is listed in Table 4.1.

4.4 PERFORMANCE CHECK

Before attempting to check and set up the instrument it is advisable to read the description of the overall system in Sect. 3.1 and to study the block diagram Fig. 3.1.

Performance limits quoted are for guidance only and should not be taken as guaranteed performance specifications unless also quoted in the Data Summary, Sect. 1.2.

Table 4.1 Test equipment

Item	Minimum specification	Model
a	A.M./F.M. Signal Generator covering h.f. and v.h.f. mobile bands, low noise for f.m.	TF 995B/5
b	Signal Generator 25 MHz - 470 MHz, 500 mV p.d.	TF 801D
c	F.M. Signal Generator 400 - 520 MHz, low noise.	TF 2012
d	A.M. Signal Generator, 25 MHz, low distortion.	TF 2002AS or TF 867
e	R.F. Millivoltmeter 25 - 520 MHz, with probe.	TF 2603
f	Coaxial T connector, 50 Ω.	TM 7948
g	Counter 25 - 75 MHz.	TF 2424 or TF 2410
h	Lead with miniature Belling plug.	
i	General purpose oscilloscope.	
j	1 kΩ resistor.	
k	Standard A.M./F.M. Modulation Meter.	TF 2300A or standardized TF 2303
l	Distortion Factor Meter.	TF 2331
m	Sensitive Voltmeter 1 kHz - 500 kHz, 10 mV full-scale.	TF 2600

4.4.1 Functional check

Test equipment : items a, c.

Use a signal generator to check that the modulation meter will measure frequency deviation and a.m. depth and check that it will tune on each frequency range. Proceed as follows :

(1) Set the f.m./a.m. signal generator (TF 995B/5) to a convenient frequency, say 80 MHz, and set its output to 100 mV p.d. into 50 Ω.

(2) Connect the generator output to the R.F. INPUT socket of the TF 2303 and set the generator to provide f.m., (modulation frequency 1 kHz and frequency deviation 15 kHz, say).

(3) Tune the modulation meter and measure f.m. deviation as given in Sect. 2.4 steps (1) to (11).

(4) Set the generator to provide a.m. (modulation frequency 1 kHz, modulation depth 50%, say) and then measure a.m. depth as in steps (9), (12) and (13) of Sect. 2.4.

(5) Check that the modulation meter will tune to a frequency on each of its four lower frequency ranges.

(6) Change the signal source to a u.h.f. generator with 100 mV p.d. and check that the modulation meter will tune to a frequency on its top range.

(7) Finally, if battery operation is required, set the FUNCTION switch to BATT. VOLTS and the SUPPLY switch to BATTERY and check that the meter indicates within the arc marked BATT. If it is below this arc, switch to CHARGE; the CHARGE indicator should glow.

4.4.2 Input sensitivity

Test equipment : items b, e, f.

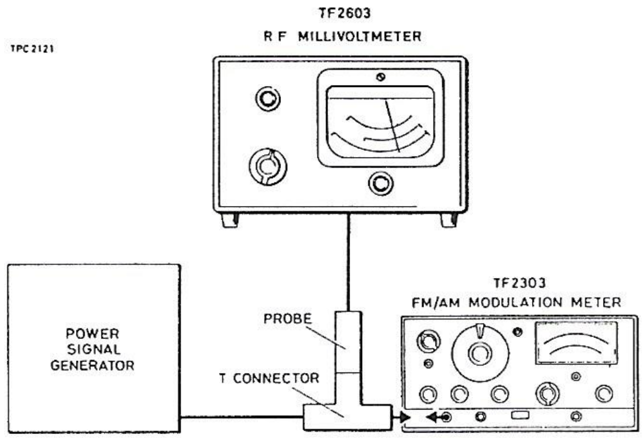


Fig. 4.4 Checking input sensitivity

(1) Connect the signal generator set to provide about 100 mV p.d., to the TF 2303 via a T connector and connect the millivoltmeter probe to the T junction of the connector.

NOTE. The T connector must be connected directly to the TF 2303 input socket for good v.s.w.r. at the input.

(2) Set signal generator to 25 MHz. On TF 2303 select TUNE FREQ. SET LEVEL and tune to the peak at 25.5 MHz.

(3) Set TF 2303 LEVEL control to maximum (fully clockwise) and reduce signal generator output until TF 2303 meter indicates to the lower end of SET FM LEVEL arc.

(4) Switch off TF 2303 for a moment and check that the millivoltmeter reading is less than 50 mV. If the sensitivity of the TF 2303 is too low, there could be a fault in the audio amplifier, a.m. detector, i.f. amplifier, local oscillator or mixer. If the sensitivity varies considerably with frequency, i.e. poor v.s.w.r., the terminating resistors in the mixer/attenuator could be burnt out.

(5) Repeat steps (1) to (4) but for 225 MHz.

(6) Repeat for 470 MHz, except that the millivoltmeter reading in step (4) should be less than 100 mV.

NOTE. If it is required to use the TF 2303 up to 520 MHz, the previous check should be carried out at 520 MHz. The check which follows should also ideally, be carried out at 520 MHz.

(7) Remove the millivoltmeter and connect the signal generator direct to the input of the TF 2303. With the signal at 470 MHz and the TF 2303 LEVEL control at maximum, tune the modulation meter and adjust the generator output for a reference reading on TF 2303 (say, 30% A.M. on meter). Turn the LEVEL control to minimum (counter-clockwise) then increase the generator output to restore the meter reading. The increase should be at least 20 dB.

4.4.3 Frequency range

Test equipment : items g, h.

The dial is calibrated in local oscillator frequency. Scales 25–43 MHz and 43-75 MHz are fundamental oscillator frequency ranges; the next two scales (in red) are third harmonics and the top range is the seventh harmonic of 43-75 MHz but has an expanded scale.

The local oscillator (with its cover still fitted) can be monitored by connecting a counter to the miniature socket on the side of the oscillator box. Only the fundamental frequency is measured by the counter. Preset potentiometers on the main printed circuit board can be adjusted if required.

(1) Connect the counter to the local oscillator output.

(2) Set TF 2303 FREQ. RANGE to 25–43 MHz, FINE FREQ. to mid-position and A.F.C. to off (released).

(3) Check the counter frequency at the 25 MHz and 43 MHz dial marks. Adjust the FINE FREQ. slightly so the counter reads 25 MHz and 43 MHz at each end of the scale. Check the scale between 25 and 43 MHz. If necessary, adjust R12 for 24 MHz at the left-hand end stop and R14 for 44 MHz at the right-hand stop, recheck and repeat adjustments. Check the scale calibration which should be within ±5% of frequency.

(4) Note that, with the TF 2303 still set to the 25–43 MHz range, the frequency markings on the 75–129 MHz scale are three times the counter frequency.

(5) Change to the 43-75 MHz range and check the dial marks at 43 and 75 MHz. If necessary, adjust R16 for 43 MHz and R17 for 75 MHz. Check that the frequency at the end stop is at least 77 MHz, if it is not, set R17 for 77 MHz at the end stop then check that the scale calibration is within ±5%.

(6) Note that the frequency markings on the 129-225 MHz scale are three times the counter frequency.

(7) Change to the 380-520 MHz range, set the dial to the 380 MHz mark, check that the counter frequency is 54.29 MHz and if necessary adjust R18. Set the dial to 520 MHz and check that the counter frequency is 74.29 MHz approximately.

4.4.4 I.F. output

Test equipment : items d, i, j, m.

(1) Connect the signal generator, set to 30 MHz and 50 mV p.d. output, to the R.F. INPUT socket of the modulation meter and connect the oscilloscope, terminated in 1 kΩ, to the I.F. OUTPUT socket.

(2) Set TF 2303 to 30.5 MHz and tune in the usual way for maximum meter indication (this adjusts the local oscillator frequency so that the intermediate frequency is set to the peak of the i.f. amplifier response). The frequency, as measured by the oscilloscope, should be approximately 500 kHz. Select SET FREQ. and check that the meter reads in the SET FREQ. band. If it does not, set up as in Sect. 5.4.7.

(3) Adjust the LEVEL control so that the peak reading is at the SET A.M. mark. The level at the I.F. OUTPUT socket, measured by the voltmeter terminated in 1 kΩ, should be at least 45 mV r.m.s.

4.4.5 A.F.C.

Test equipment : item b.

(1) Connect signal generator, set to 450 MHz and 100 mV p.d. output level, to TF 2303 R.F. INPUT socket. With A.F.C. set to off, tune for a peak on the meter at 450.5 MHz. Select SET FREQ. and check that as FINE FREQ. is turned clockwise, the meter reading increases, i.e. check that instrument is tuned to the higher frequency peak.

(2) Select TUNE FREQ. SET LEVEL and adjust FINE FREQ. for meter reading on SET A.M. mark. Switch A.F.C. to on then check that the meter reading does not change between A.F.C. on and A.F.C. off. If reading changes, use tuning controls to bring meter to SET A.M. mark with A.F.C. on. Switch A.F.C. to off and adjust R22 (on main board) for SET A.M. reading. With A.F.C. off, adjust FINE FREQ. for a reading on the edge of the black segment, switch A.F.C. on and check that the needle swings back to the SET mark.

4.4.6 F.M. deviation

Test equipment : items a, c, k, l.

Once the TF 2303 has been set up, the i.f. amplifier, limiter and discriminator should operate correctly unless a fault condition occurs (Chapter 5). However, should the audio amplifier gain change slightly, resulting in a slight change in deviation sensitivity, the meter range potentiometers can be adjusted.

(1) Connect F.M./A.M. Signal Generator TF 995B/5 to the r.f. input of the TF 2300A (or

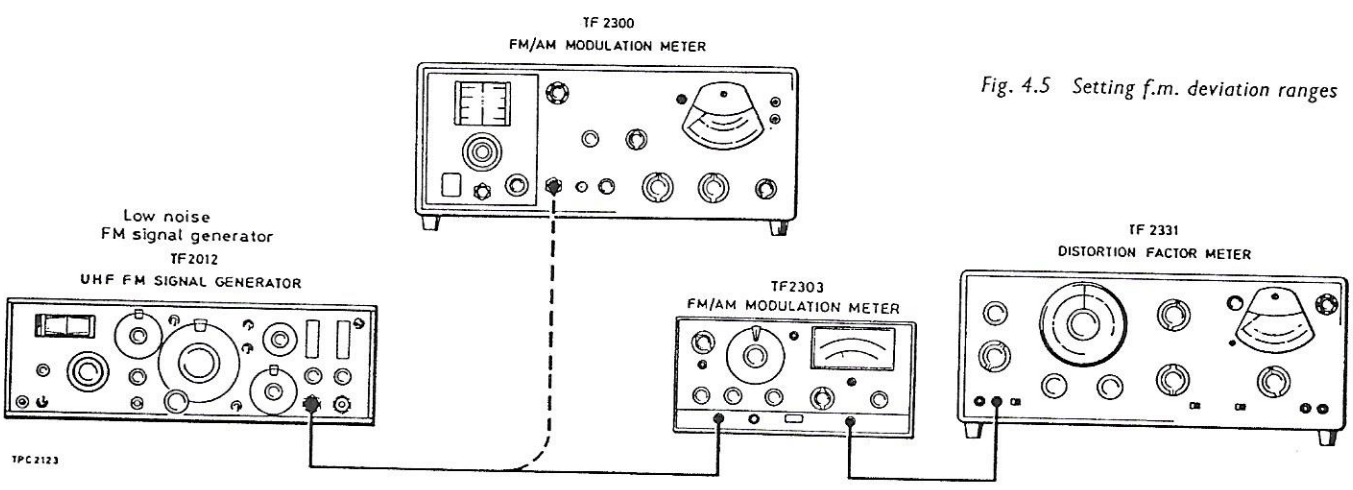


Fig. 4.5 Setting f.m. deviation ranges

standardized TF 2303). With 30 MHz, 50 mV r.f. signal and 1 kHz modulation frequency, set up the generator for 1.5 kHz deviation as indicated by TF 2300A. Disconnect from TF 2300A and connect generator to TF 2303.

NOTE. TF 2300A and TF 2303 must not be connected in parallel.

(2) On TF 2303 select TUNE FREQ. SET LEVEL, tune to peak at 30.5 MHz and adjust LEVEL for a reading near the centre of the black arc.

(3) Select SET FREQ. and adjust FINE TUNE for a reading near the centre of the black arc.

NOTE. The deviation readings obtained in steps (4), (5) and (6) will depend on the errors of the test gear. The TF 2303 is set up in the factory against a standardized modulation meter so that its deviation accuracy is within $\pm 2\frac{1}{2}\%$ of f.s.d.

(4) Select DEV+, set METER RANGE to 1.5 kHz and check that meter reads 1.5 kHz deviation. (For this check the instrument should be or oriented in the plane in which it is normally used). Adjust R52, if required, for 1.5 kHz reading. Select DEV- and check that the reading is the same.

(5) Repeat steps (1) and (4) but with 5 kHz deviation and adjust R60 if required.

(6) Repeat steps (1) to (4) but with 15 kHz deviation and adjust R62 if required. (Alternatively, the reference deviation may be set up by the Bessel zero method using first carrier disappearance at 624 Hz, 2079 Hz and 6237 Hz modulation frequency.)

(7) Connect Distortion Factor Meter TF 2331 to A.F. OUTPUT of TF 2303 and set TF 2331 input impedance to 600 Ω. (If a TF 2330 Wave Analyser is used connect 600 Ω across its input.)

(8) Set the generator for 15 kHz deviation at 1 kHz modulation frequency, and with TF 2303 measuring deviation so that its meter reads f.s.d., measure the a.f. output level using the distortion factor meter set to VOLTMETER. It should be between 620 and 920 mV.

(9) Use the distortion factor meter to measure the distortion. It should be less than 1% i.e. more than 40 dB down.

(10) Change the modulation frequency to 50 Hz and reset up using the standardized modulation meter so that 15 kHz deviation is again measured. The a.f. output should not change by more than 0.5 dB compared with that measured at 1 kHz (step 8).

(11) Repeat step (10) but at 9 kHz modulation frequency.

(12) For u.h.f. operation, repeat the tests in this section using a low noise f.m. generator, e.g. TF 2012, set to 470 MHz.

4.4.7 F.M. noise

Test equipment : items c, m.

(1) Using an unmodulated low noise source connected to the R.F. INPUT, tune the TF 2303 to the carrier and set up for deviation measurement on the 5 kHz range. Select DEV+, and measure the a.f. output with the voltmeter. It should be more than 40 dB down on the reading obtained for f.s.d. in Sect. 4.4.6 (step 8).

4.4.8 A.M. depth

Test equipment : items d, k, l.

The accuracy of a.m. depth measurement can be checked using an accurately calibrated a.m. signal as in Sect. 5.4.9 or by using a standard modulation meter and a low distortion a.m. signal generator. Proceed as follows :

(1) Set the signal generator to carrier 30 MHz, level 100 mV, modulation frequency 1 kHz, depth 80% and connect it to a standard modulation meter e.g. TF 2300A.

NOTE. Do not connect the TF 2303 and TF 2300A in parallel.

(2) Set the signal generator so that its modulation depth is exactly 80% according to the TF 2300A.

(3) Connect the TF 2303 to the signal generator and set it up so that it measures modulation depth. (The TF 2303 should preferably be positioned in the plane in which it will eventually be used.) Check the meter reading.

(4) The meter should read 80%; adjust R65, if necessary, then switch between A.M. PEAK and A.M. TROUGH and readjust R65 for a compromise between peak and trough.

NOTE. TF 2303 modulation depth calibration was set in the factory to be within ±3% of f.s.d. for depths up to 80%. Readings obtained will depend on the accuracy of the TF 2300A.

(5) With the TF 2303 measuring 80% modulation depth, 1 kHz modulation frequency, connect a distortion factor meter or voltmeter to the A.F. OUTPUT socket and set it for 0 dB reading.

(6) Repeat measurement at 50 Hz modulation frequency and check that the distortion factor meter reading does not change by more than ±0.5 dB.

(7) Repeat for 4 kHz modulation frequency.

Chapter 5

Repair

5.1 INTRODUCTION

This chapter contains information for the localization and repair of faults and, in conjunction with chapter 4, gives a complete realignment procedure.

CAUTION. See Sect. 4.1 for precautions in handling semiconductors. When removing an integrated circuit use wither a special soldering iron or an iron with facilities for removing solder by suction.

Most of the screws used are ISO metric M2, M3 and M4 and are tinted blue.

5.2 FAULT LOCATION

Methodical fault location can be carried out at three levels :

(i) Front panel functional checks.

(ii) Internal checks and waveform monitoring.

(iii) Full realignment to locate a fault when (i) and (ii) are inadequate.

5.2.1 Front panel checks

The following ten checks will verify that most of the circuits in the modulation meter are functioning. An f.m./a.m. signal generator e.g. M.I. TF 995B/5 is the only test equipment needed.

(1) With no input signal to the TF 2303 set SUPPLY switch to ~ or BATTERY and select SET FREQ. The DC SUPPLY light should come on and a meter deflection which is greater than full-scale should be obtained. This checks the presence of the regulated voltage supply and checks that the meter is in circuit.

(2) Connect a suitable signal, say 25 MHz, 100 mV to the R.F. INPUT socket. Select TUNE FREQ., SET LEVEL, set A.F.C. to off, set FREQUENCY to 25.5 MHz and tune to the incoming signal. A response should be obtained on the meter. This checks that the following are working :

(a) Mixer, local oscillator and i.f. amplifier.
(b) A.M. detector.

(3) If no response is obtained check that the level of input signal is sufficient (Sect. 1.2). Monitor the I.F. OUTPUT signal (500 kHz, 100 mV e.m.f.) to verify (a). To verify that the local oscillator is working, monitor the signal at the socket on the side of the local oscillator box, or at the R.F. INPUT socket.

(4) If a response is obtained in test (2), adjust LEVEL control. This checks the operation of :

(c) The input attenuator.

NOTE. If damage to TF 2303 input circuitry is suspected, check tuning at several other input frequencies. A wide variation of sensitivity with frequency suggests poor v.s.w.r. due to burnt out terminating resistors in the attenuator/mixer unit.

Adjust for a meter deflection on the black arc.

(5) Select SET FREQ. and adjust FINE FREQ. (or FREQUENCY) control for a meter deflection on the black arc. This checks :

(a) as above.
(d) Limiter and discriminator.
(e) D.C. amplifier.

(6) Set up the signal generator to provide suitable frequency modulation, select TUNE FREQ. SET LEVEL and, if necessary, readjust LEVEL control for a deflection on the black arc.

(7) Select DEV+; a meter reading should be obtained. This checks :

(a) and (d) as above.
(f) A.C. amplifier.
(g) Buffer, audio amplifier and peak voltmeter.

If no meter deflection is obtained, monitor the A.F. OUTPUT; this will verify (f) and (g) except for the peak voltmeter.

(8) Switch through the meter ranges 15 kHz, 5 kHz and 1.5 kHz, this checks :

(h) Switch SE and associated circuitry.

(9) Switch between DEV+ and DEV-; the reading should not change. This checks that switch SD reverses the connections to the components of the peak voltmeter.

(10) Set the signal generator to provide suitable amplitude modulation. Select A.M. PEAK; a meter reading should be obtained. This checks :

(a), (b) and (g) as above.

(11) If a battery is installed set SUPPLY to BATTERY and select BATT. VOLTS; the meter indication should be within the BATT. arc. If it is below, charge the battery as in Sect. 2.1. When the SUPPLY is set to CHARGE the CHARGE lamp should glow. This checks :

(i) the charging circuit.

5.2.2. Internal checks

Having roughly located the fault by front panel tests, it may be more accurately located by internal measurements and signal tracing using the circuit diagrams Fig. 7.1, 7.2 and 7.3.

Power supply

(1) Set SUPPLY to ~ and FUNCTION to DEV+ or DEV-. Connect standardized voltmeter to tag 33 of main function board, to measure the power supply output voltage.

CAUTION. Do not connect voltmeter to pin 1 of the power supply board since an accidental short could destroy the IC.

(2) At tag 33 the voltage should be +15 (±0.1) V. If incorrect reset as in Sect. 5.4.1. If no output, check mains supply, fuses etc., and check transformer a.c. output (regulator board pins 7 and 8, see circuit). Check rectified output (about 29 V at pin 5 and about 28 V at pin 3).

(3) For instruments with an internal battery, set SUPPLY to BATTERY and select BATT. VOLTS. If the battery voltage is less than 18 V the meter indication will be below the BATTERY arc and IC1 will stop regulating.

NOTE. The battery fuse must be fitted when the battery is fitted.

(4) To charge the battery refer to Sect. 2.1. If it does not charge, check the two filament lamps of the power supply.

Attenuator/mixer

If the attenuator/mixer unit is suspected, remove its screened cover and check the two 100 Ω resistors which could be burnt out. The layout of components in this unit is critical and could affect the v.s.w.r. if changed. The i.f. output can be monitored at tag 1 of the main board.

Local oscillator

The fundamental frequency of the local oscillator can be monitored at the miniature coaxial socket on the local oscillator box. The level, which varies with frequency, is about 600 mV p-p at 25 MHz.

I.F. signal

With the modulation meter tuned to a suitable signal (as in Sect. 5.2.1, test (2)), the 500 kHz i.f. signal can be monitored at tags 1 and 14 on the main function board. Monitor the waveforms as described in the following section.

5.2.3 Waveforms

Test equipment : items a or c, i.

Connect the signal generator, set to provide 25 MHz carrier, 50 mV output, to R.F. INPUT. Tune in the usual way to obtain a deflection to the black arc and monitor the waveforms on the main board. If the correct deflection cannot be obtained but the i.f. signal is present as in Sect. 5.2.2, tune for maximum i.f. signal level (the frequency should be about 500 kHz), then adjust the LEVEL control to give the i.f. level expected.

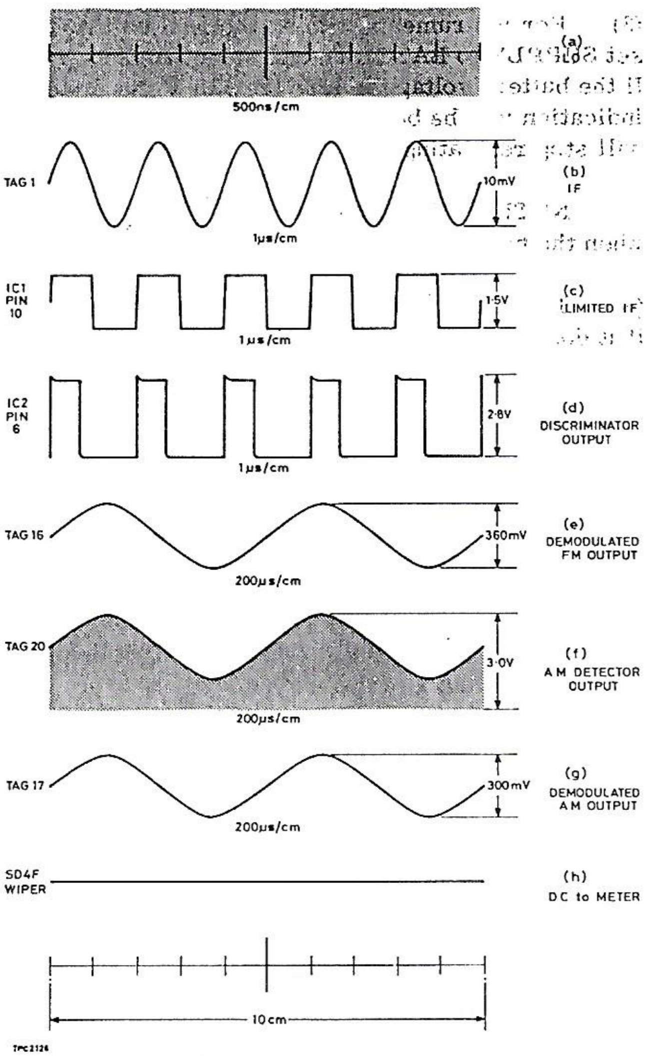


Fig. 5.1 Waveforms

With c.w. input and the TF 2303 tuned the waveforms are as follows :

Tag 1 (input to i.f. amplifier). Sine wave, 500 kHz, 10 mV p-p ... Fig. 5.1(b).

Tag 14 (i.f. buffer output). Sine wave, 500 kHz, 300 mV p-p.

Pin 4 of IC1 (input to limiter). Sine wave, 500 kHz, 10 mV p-p.

Pin 10 of IC1 (output from limiter). Square wave, 500 kHz, 1.5 V p-p ... Fig. 5.1(c).

Pin 5 of IC2 (input to discriminator). As previous waveform.

Pin 6 of IC2 (output of discriminator). Rectangular wave, 2.8 V p-p ... Fig. 5.1(d).

Tag 16 and tag 22 (smoothed output). D.C. only.

NOTE. The above waveforms are present for any position of the FUNCTION switch. If the instrument will not tune, set to tune and monitor the a.m. detector output (tag 20) and the meter input (SD4f wiper). A half-wave rectified i.f. signal should be present.

With f.m. applied, 1 kHz modulation frequency, 10 kHz deviation, and with the FUNCTION switch in any position the waveforms should be :

Tag 16 (smoothed discriminator output). Sine wave, modulation frequency 1 kHz, 360 mV p-p ... Fig. 5.1(e). (Amplitude is lower for left-hand positions of FUNCTION switch.) Amplitude varies with deviation.

Tag 23. As above (but no waveform for left-hand positions).

Tag 27. As tag 23 but 800 mV p-p.

Tag 30 (input to audio amplifier). As tag 23 but 80 mV p-p when METER RANGE set to 15 kHz.

Pins 1 or 12 of IC4 (output of audio amplifier). As above but 4.8 V p-p.

Tag 32. As above (4.8 V p-p for 10 kHz deviation, 7.5 V p-p when deviation increased to give f.s.d. on meter).

Tag 31. As above but lower amplitude (4.2 V p-p for f.s.d.).

NOTE. For tag 23 to tag 32 there will be no waveform in the left-hand positions of the FUNCTION switch.

Wiper of SD4f (output to meter). D.C. only for all positions of FUNCTION switch (except TUNE and A.M. LEVEL - distorted 500 kHz waveform) ... Fig. 5.1(h).

With a.m. applied, 1 kHz modulation frequency, 50% depth, the instrument set to tune and deflecting to the black arc, the waveforms should be :

R33 (a.m. detector input). (Monitor R33 lead near mixer box.) Amplitude modulated i.f. signal should be present.

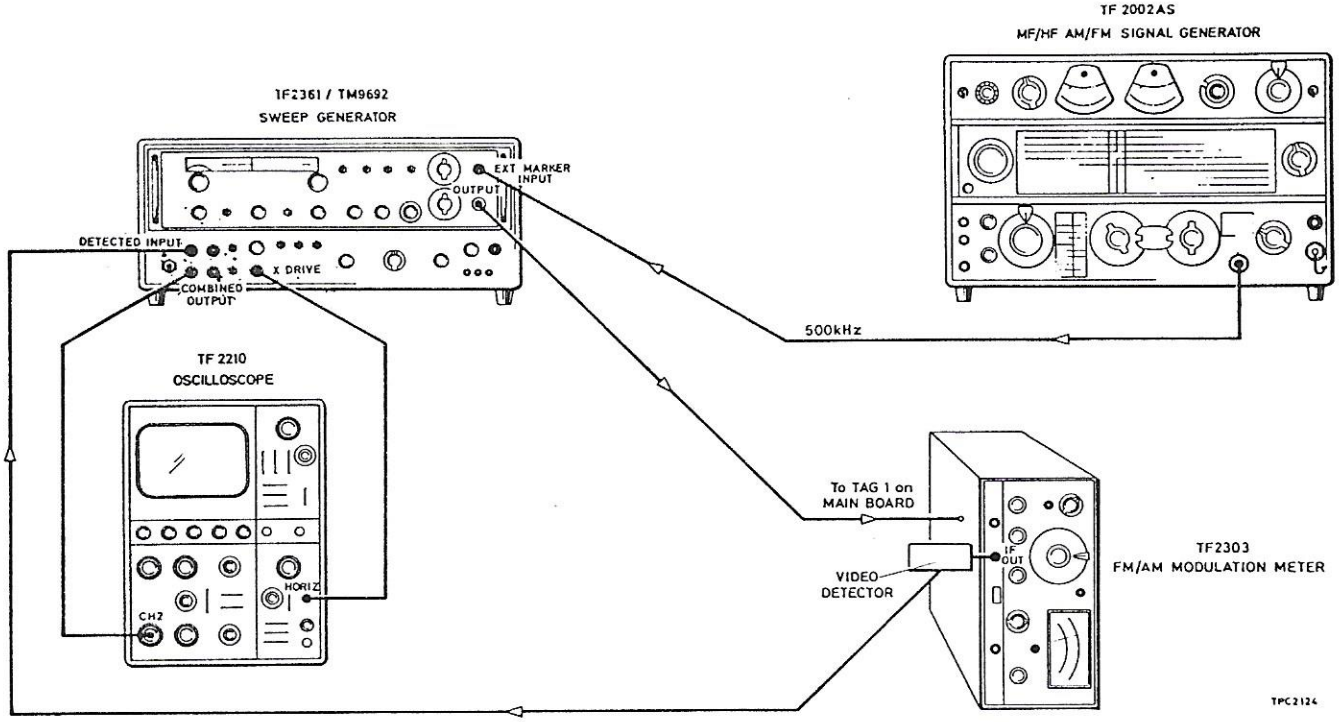


Fig. 5.2 Checking i.f. response

Tag 20 (a.m. detector output). Half-wave rectified signal, 3.0 V peak ... Fig. 5.1(f). Present for all positions of FUNCTION switch except DEV+ and DEV-.

Tag 24. As above for TUNE and A.M. LEVEL only, 0.3 V peak.

Tag 17 (filter output). D.C. + sine wave 1 kHz, 300 mV for 50% depth ... Fig. 5.1(g).

Tag 27 (f.e.t. buffer output). Sine wave 1 kHz, 650 mV.

Tag 32 (audio amplifier output). As above but 4 V p-p.

SD4f wiper (output to meter). D.C. only ... Fig. 5.1(h). (For TUNE and SET A.M. positions, a waveform as at tag 24 will be present.)

5.3 TEST EQUIPMENT

Test gear required for realignment is given in Table 4.1 (in Chapter 4) plus the following items :

(n) Standardized d.c. voltmeter, accuracy better than 0.2% at 15 V e.g. M.I. TF 2606.

(o) Oscilloscope 30 MHz, with x1 probe e.g. M.I. TF 2210.

(p) Video sweep generator, sweep with 1 MHz e.g. M.I. TF 2361 plus TM 9692.

(q) Video detector, e.g. M.I. TM 9703.

(r) 1 kHz oscillator, e.g. M.I. TF 1101.

(s) Amplitude modulator, e.g. M.I. TM 9897A.

(t) Selective level meter, 500 and 501 kHz, e.g. M.I. TF 2352.

(u) Multimeter or d.c. voltmeter.

5.4 REALIGNMENT PROCEDURE

Realignment of the modulation meter may be carried out by following this procedure; it refers back to Chapter 4 for setting up already covered under Maintenance.

5.4.1 Power supply

Test equipment : item n.

(1) Set supply to ∼ and FUNCTION to DEV+ or DEV-. Connect standardized voltmeter between tag 33 of main function board and earth. The voltage should be +15 (±0.1 V) V. If incorrect, adjust R3 on regulator board for 15 V.

5.4.2 Input sensitivity and frequency range

(1) Check the input sensitivity as in Sect. 4.4.2.

(2) Check the frequency range of the local oscillator and set, if necessary, as in Sect. 4.4.3.

5.4.3 I.F. response

Test equipment : items a, o, p, q.

(1) Connect the equipment as shown in Fig. 5.2.

(2) Set the sweeper to provide 500 kHz c.w., and adjust the sweeper output for TF 2303 meter reading on the black segment.

(3) Set the sweep rate to about 50 Hz, the sweep width to 1 MHz at approximately -50 dB output and set the signal generator to 500 kHz at approximately 50 mV.

(4) The response displayed should be similar to Fig. 5.3(a) and centred on 500 kHz.

5.4.4 Check discriminator output

(1) With the test rig used in the previous section, disconnect oscilloscope Y input from sweeper and instread connect oscilloscope Y input via x1 probe to the junction of L3, C18 (positive) on main board. Check that the response is similar to Fig. 5.3(b). (Slight bend just above 500 kHz is due to capacitive effect.)

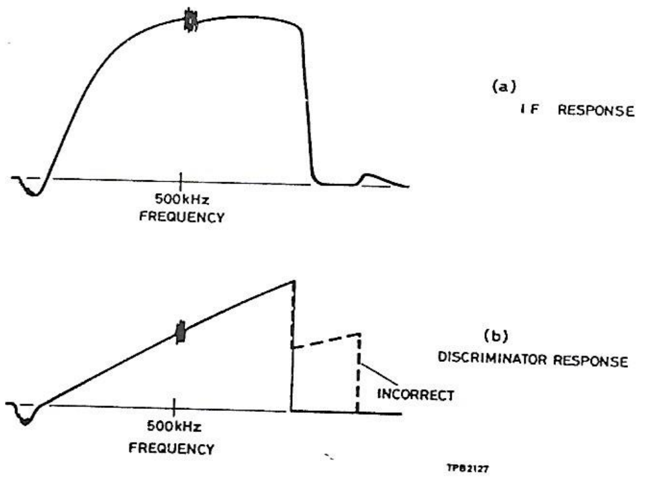


Fig. 5.3 Responses of i.f. amplifier and discriminator

NOTE. If a double saw-tooth is obtained, the discriminator is operating incorrectly in a 'divide-by-two' mode (Sect. 3.5).

(2) Disconnect the video detector from TF 2303. Measure the i.f. level at the I.F. OUTPUT socket using an oscilloscope or voltmeter; it should be 100 mV r.m.s., nominal e.m.f. from 1 kΩ source.

5.4.5 Set discriminator input trigger level

Test equipment : items d, g, o, u.

The limiter output is a square wave of about 1 V with a standing d.c. level. R20 must be set to match the limiter output to the discriminator input triggering tolerance. R20 is set so that, for a low level of signal, triggering of the discriminator is optimized.

(1) Connect the signal generator, set to 30 MHz and 50 mV, to the TF 2303 R.F. INPUT and connect the counter to the I.F. OUTPUT. Set TF 2303 LEVEL to maximum, A.F.C. to OFF and select TUNE FREQ. SET LEVEL.

(2) Tune the TF 2303 (30.5 MHz on scale) so that the counter reads 500 kHz. Connect oscilloscope probe to discriminator output (junction of R30 and IC2, pin 6); a rectangular waveform, period 2 μs and mark:space approximately 1:2 should be displayed. Turn down the signal level and the LEVEL control so that the discriminator only just triggers, then adjust R20 in conjunction with the LEVEL control, to find the two positions of R20 where the wave waveform disappears. Set R20 for a clean waveform half way between the disappearance points.

5.4.6. Set discriminator bias

R26 adjusts the bias of the discriminator and thereby sets the d.c. conditions of TR5.

(1) With the test rig as before (Sect. 5.4.5), set the r.f. input to about 50 mV and set LEVEL control for meter reading on the SET AM mark.

(2) Adjust R26 for 8.5 V at the collector of TR5.

5.4.7 Set and check SET FREQ. reading

(1) With the same test rig and conditions as in Sect. 5.4.6, step (1), retune for an i.f. (displayed by the counter) of 500 kHz and, if necessary, readjust LEVEL for reading at SET AM mark.

(2) Ensure that the instrument is horizontal or in the plane in which it is expected to be used. Select either of the SET FREQ. positions, check that meter reads to centre of SET FREQ. arc (i.e. to SET AM mark) and, if necessary, adjust R47 on main board. Select the other SET FREQ. position and check that reading has not changed.

(3) Tune to the upper frequency peak then select SET FREQ. and check that clockwise rotation of the FINE FREQ. control increases the meter reading.

5.4.8 A.F.C. deviation and noise

To set up for A.F.C., to set up f.m. deviation ranges and to check f.m. noise, use Sections 4.4.5, 4.4.6 and 4.4.7.

5.4.9 A.M. depth

Test equipment : items a, r, s, t.

If suitable test gear is available, the accuracy of a.m. depth measurement can be checked by using a selective level measuring set to measure the sidebands of an a.m. signal. A low noise source at 500 kHz, level 100 mV is modulated by a 1 kHz oscillator and an amplitude modulator and the resulting a.m. signal fed to the i.f. amplifier of TF 2303.

(1) Connect the equipment as in Fig. 5.4.

(2) Set the modulation depth to 80% by measuring the 500 kHz carrier level then setting the 501 kHz sideband to -7.96 dB relative to the carrier. Adjust TF 2303 LEVEL and set up the modulation meter so that it measures a.m. depth. The meter should read 80%. Adjust R65, if necessary, then switch between AM PEAK and AM TROUGH and readjust R65 for compromise between peak and trough.

(3) Check at 50% and 30% depth - see Table 5.1 for sideband amplitudes.

Table 5.1

A.M. depth	Sideband amplitude
80%	-7.96 dB
50%	-12.04 dB
30%	-16.52 dB

The modulation depth accuracy should be within ±5% f.s.d.

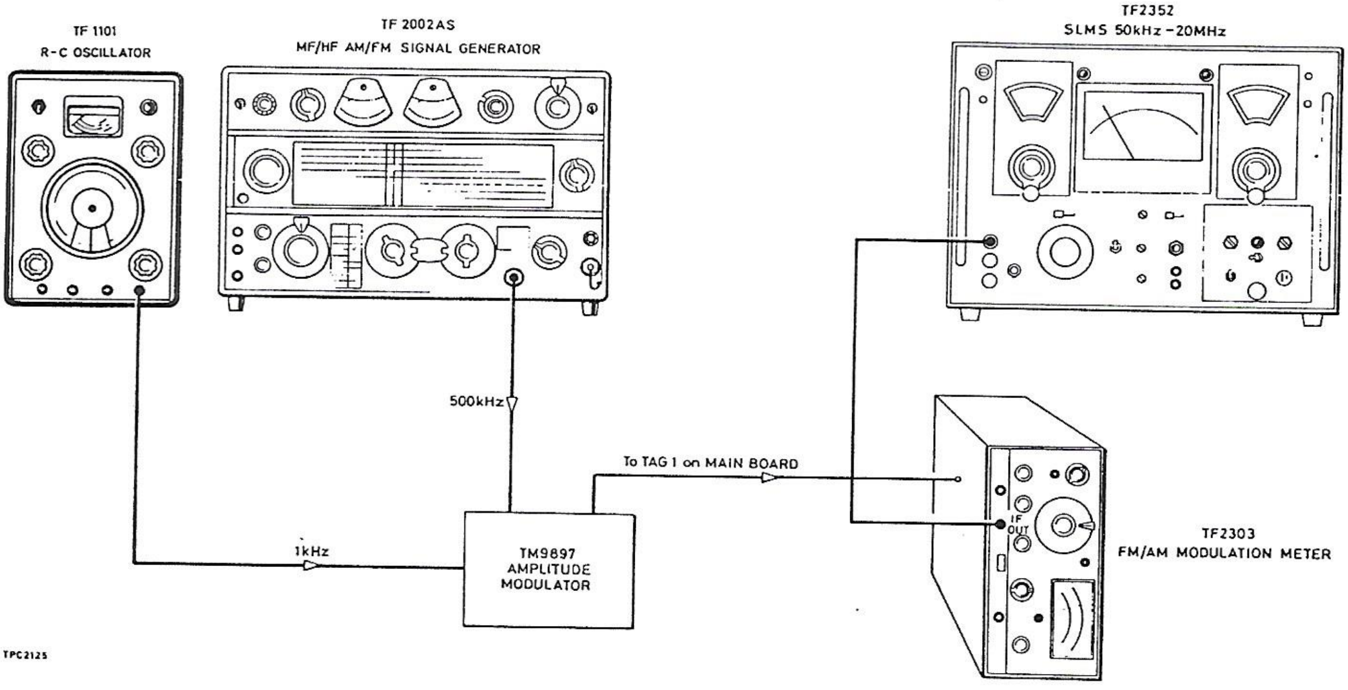


Fig. 5.4 Checking a.m. depth

5.5 REMOVAL OF SUB-ASSEMBLIES

All the printed board assemblies are wired-in and, although access to some board components may appear difficult at first sight, any board can be removed in a few minutes if the right sequence is used.

Local oscillator

Lever off the cover of the local oscillator box (do not unscrew the eight screws) to obtain access to the board.

To obtain access to the board components, unsolder the link to the coaxial connector and unscrew the eight screws.

Regulator board

This board is shown in Fig. 4.3. Remove the perspex rod before unscrewing the screws fixing this board.

Attenuator/mixer unit

Remove the four screws in the top cover and pull off the cover. This gives access to the differential capacitor, the two 100 Ω terminating resistors and the mixer components.

Disconnect the local oscillator lead by unplugging the miniature Belling connector and unsolder the wire connected to tag 1 of the main board. Remove the LEVEL knob by unscrewing the two 6 BA hexagon socket screws in the flexible coupling immediately behind the front panel then withdrawing the spindle from the coupling. Unscrew the four screws in the extreme corners of the assembly and pull the unit away from the main printed board.

To change the attenuator/mixer unit, unsolder the end of the r.f. input coaxial lead connected to the unit.

Main function board

Access to most of the transistors and integrated circuits can be obtained through holes in the chassis, if necessary after removal of the power supply or the oscillator box, but without the need to remove the whole function board.

To remove this board easily the correct sequence of operation must be followed. Avoid unnecessary dismantling.

Two small hexagon wrenches (sizes 6 BA and 4 BA) for the flexible couplings are required.

(1) Remove the three knob/spindles (LEVEL, FUNCTION and METER RANGE controls) by unscrewing the two hexagon socket screws in each of the flexible couplings behind the front panel then withdrawing the spindle from the coupling.

NOTE. Do not remove the hexagon socket screws in the ends of the couplings which are nearer to the switch wafer.

(2) Unsolder the wire connected to tag 1 of the main board.

(3) Disconnect the local oscillator lead by unplugging the miniature Belling connector.

(4) Remove the mixer cover by unscrewing the four screws and pulling off the cover.

(5) Remove the mixer assembly by unscrewing the four screws in the extreme corners of the unit. Pull the unit away and leave it to dangle.

(6) Remove the six screws holding the main board to the chassis.

(7) Tilt the board downwards on the right-hand side (R.F. INPUT side). Pull the board slightly towards the front panel and wriggle it to pull it out. The board can now be propped up vertically and further unsoldering of connections is unnecessary unless the board is to be removed completely.

(8) Any of the components on the board can now be removed, even those under the FUNCTION switch assembly, without further dismantling.

NOTE. To test the board it should be earthed and a 500 kHz signal can be fed in at tag 1.

To replace the board, pull it forwards then sideways to the right-hand side. Reverse the sequence given for removal, feeding the coaxial lead under the FUNCTION switch and not forgetting to reconnect the lead to tag 1.

Mains transformer

To remove the transformer, the rear panel must first be removed and hinged back so that the output leads of the transformer can be unsoldered.

A.F.C. switch and R.F. INPUT socket

In the unlikely event of either the A.F.C. switch or the R.F. INPUT socket requiring to be replaced, the instrument front panel must be removed to obtain access to the countersunk fixing screws.

Chapter 6

Replaceable parts

Introduction

The printed boards and screened sub-assemblies in this instrument have been allocated unit identification numbers in the sequence A1 to A4. The main chassis has been allocated A0. The complete circuit reference for a component carries its unit number as a prefix, e.g. A2R15.

For convenience in the text and on the circuit diagrams, the circuit reference is abbreviated by dropping the prefix, except where there is risk of ambiguity. When ordering spare parts or in any other correspondence, be sure to quote the complete circuit reference.

This section lists the components of each unit in alpha-numerical order of the complete circuit reference. The following abbreviations are used:-

C : capacitor
Carb : carbon
Cer : ceramic
D : semiconductor diode
Elec : Electrolytic
FS : fuse
IC : integrated circuit
L : inductor
LP : lamp
M : meter
Met : metal
Ox : oxide
PL : plug
Plas : plastic
R : resistor
S : switch
SK : socket
T : transformer
Var : variable
TR : transistor
WW : wirewound
φ : lead through
† : value selected during test; nominal value shown
W : resistor rating at 70°C
W* : resistor rating at 55°C

Ordering

When ordering replacement parts, address the order to our Service Division (for address see rear cover) or nearest Agent. Specify the following information for each part required.

(1) Type* and serial number of instrument
(2) Complete circuit reference
(3) Description
(4) MI code

* as given on the serial number at the rear of the instrument; if this is superseded by a model number label, quote the model number instead of the type number.

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

One or more of the parts fitted to the instrument may differ from those listed in this chapter for any of the following reasons

(a) Components indicated by † have their value selected during test to achieve particular performance limits.

(b) Owing to supply difficulties components may be substituted by others of different type or value provided that the overall performance of the instrument is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

Whenever there is such a difference between the component fitted and the one listed, always use a replacement the same type and value as found in the instrument.

Circuit reference	Description	M.I. code
A1	Mixer and attenuator unit	46771-008
When ordering prefix A1		
	Complete board	44823-737
C1	Cer 0.001µF +80-20% 500V	26383-242
C2	Var 3.8 -50pF	26816-299
D1	GEXM66	28345-312
L1	10µH	23642-555
R1	Met ox 100Ω 2% $\frac{1}{2}$W	24573-049
R2	Met ox 100Ω 2% $\frac{1}{2}$W	24573-049
R3	Met ox 1.1kΩ 2% $\frac{1}{4}$W	24511-581
R4	Met ox 82Ω 2% $\frac{1}{2}$W	24511-546
A2	Main function board with switches SD & SE	44865-212
When ordering prefix A2		
C1	Plas 680pF ±2pF 350V	26516-446
C2	Plas 39pF ±2pF 350V	26516-146
C3	Plas 82pF ±2pF 350V	26516-225
C4	Plas 39pF ±2pF 350V	26516-146
C5	Cer 0.1µF +50-25% 30V	26383-031
C6	Cer 0.1µF +50-25% 30V	26383-031
C7	Cer 0.1µF +50-25% 30V	26383-031
C8	Cer 0.1µF +50-25% 30V	26383-031
C9	Cer 0.1µF +50-25% 30V	26383-031
C10	Cer 0.1µF +50-25% 30V	26383-031
C11	Cer 0.1µF +50-25% 30V	26383-031
C12	Cer 0.1µF +50-25% 30V	26383-031
C13	Cer 0.1µF +50-25% 30V	26383-031
C14	Plas 22pF ±2pF 350V	26516-090
C15	Cer 0.1µF +50?25% 30V	26383-031
C16	Plas 0.0249µF 2% 160V	26516-799
C17	Elec 250µF +100-20% 6V	26417-162
C18	Plas 0.0249µF 2% 160V	26516-799
C19	Paper 0.004µF 10% 250V	26174-137
C20	Elec 2µF +100-20% 25V	26414-109
C21	Elec 100µF +100-20% 25V	26415-813
C22	Cer 0.1µF +50-25% 30V	26383-031
C23	Elec 220µF +100 -20% 10V	26415-817
C24	Cer 0.1µF +50 -25% 30V	26383-031

Circuit reference	Description	M.I. code
C25	Plas 100pF ±2pF 350V	26516-243
C26	Cer 0.1µF +50-25% 30V	26383-031
C27	Elec 100µF +100-20% 25V	26415-813
C28	Elec 100µF +100-20% 25V	26415-813
C29	Plas 100pF ±2pF 350V	26516-243
C30	Plas 100pF ±2pF 350V	26516-243
C31	Elec 10µF +100-20% 6V	26414-120
C33	Elec 470µF +100-20% 25V	26415-822
C34	Elec 100µF +100-20% 25V	26415-813
C35	Cer 0.1µF +50-25% 30V	26383-031
C36	Plas 300pF ±2pF 350V	26516-362
C37	Elec 470µF +100-20% 25V	26415-822
C38	Plas 0.1µF 10% 250V	26582-211
C39	Plas 56pF ±2pF 350V	26516-182
C40	Plas 150pF ±2pF 350V	26516-289
C41	Elec 100µF +100-20% 25V	26415-813
C42	Elec 100µF +100-20% 25V	26415-813
C43	Elec 47µF +100-20% 10V	26415-809
C44	Cer 0.1µF +50-25% 30V	26383-031
C45	Plas 47pF ±2pF 350V	26516-167
D1	Z5B 5.6	28371-434
D2	HG5004	28332-465
D3	1N4148	28336-676
D4	Z5B3	28371-203
D5	1N4148	28336-676
IC1	ULN2111A	28461-903
IC2	SN74121N	28468-402
IC3	µA702C	28461-308
IC4	TAA611B	28461-499
L1	Inductor	44267-607
L2	Inductor	44267-607
L3	Inductor	44268-810
R1	Met film 22kΩ 2% $\frac{1}{4}$W	24773-305
R2	Met film 1.1kΩ 2% $\frac{1}{4}$W	24773-274
R3	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R4	Met ox 220Ω 2% ¼W	24511-558
R5	Met film 33kΩ 2% ¼W	24773-309
R6	Met film 10kΩ 2% ¼W	24773-297
R7	Met film 560kΩ 2% ¼W	24773-267
R8	Met film 220kΩ 2% ¼W	24773-329
R9	Met film 3.3kΩ 2% ¼W	24773-285
R10	Met film 510Ω 2% ¼W	24773-266
R11	Carb 1MΩ 5% 1/8W	24311-945
R12	Var carb 1kΩ 20% ¼W	25611-072
R13	Met ox 330Ω 2% ¼W	24511-563
R14	Var carb 2.2kΩ 20% ¼W	25611-074
R15	Met film 10kΩ 2% ¼W	24773-297
R16	Var carb 1kΩ 20% ¼W	25611-072
R17	Var carb 2.2kΩ 20% ¼W	25611-074
R18	Var carb 4.7kΩ 20% ¼W	25611-076
R19	Met ox 100Ω 2% ¼W	24511-550
R20	Var carb 220Ω 20% ¼W	25611-068
R21	Met film 15kΩ 2% ¼W	24773-301
R22	Var carb 22kΩ 20% ¼W	25611-080
R23	Met film 15kΩ 2% ¼W	24773-301
R24	Met film 270Ω 2% ¼W	24773-259
R25	Met ox 270Ω 2% ½W	24573-059
R26	Var WW 33Ω 10% ½W	25811-010
R27	Met film 1kΩ 2% ¼W	24773-273
R28	Met ox 330Ω 2% ¼W	24511-563
R29	Met film 39kΩ 2% ¼W	24773-311
R30	Met film 510Ω 2% ¼W	24773-266
R31	Met film 1.8kΩ 2% ¼W	24773-279
R32	Met film 1kΩ 2% ¼W	24773-273
R33	Met film 510Ω 2% ¼W	24773-266
R34	Met ox 51Ω 2% ¼W	24511-539
R35	Met film 510Ω 2% ¼W	24773-266
R36	Met film 2.2kΩ 2% ¼W	24773-281
R37	Met film 510Ω 2% ¼W	24773-266
R38	Met film 10kΩ 2% ¼W	24773-297
R39	Met film 470Ω 2% ¼W	24773-265
R40	Met film 20kΩ 2% ¼W	24773-304
R41	Met film 20kΩ 2% ¼W	24773-304
R42	Met film 82kΩ 2% ¼W	24773-319
R43	Met film 12kΩ 2% ¼W	24773-299
R44	Met film 3.3Ω 2% ¼W	24773-285
R45	Met film 10kΩ 2% ¼W	24773-297
R46	Met film 470Ω 2% ¼W	24773-265
R47	Var carb 47kΩ 20% ¼W	25611-082
R48	Met film 910Ω 2% ¼W	24773-272
R49	Met film 120Ω 2% ¼W	24773-251
R50	Met film 5.6kΩ 2% ¼W	24773-291
R52	Var carb 100kΩ 20% ¼W	25611-084
R53	Met film 180kΩ 2% ¼W	24773-327
R54	Met ox 220Ω 2% ¼W	24511-558
R55	Met film 5.6kΩ 2% ¼W	24773-291
R56	Thermistor 15kΩ 20% ¼W	25685-485
R57	Met film 1.5kΩ 2% ¼W	24773-277
R58	Met film 1.8kΩ 2% ¼W	24773-279
R59	Met film 6.2kΩ 2% ¼W	24773-292
R60	Var carb 2.2kΩ 20% ¼W	25611-074
R61	Met film 820Ω 2% ¼W	24773-271
R62	Var carb 470Ω 20% ¼W	25611-070
R63	Met film 620Ω 2% ¼W	24773-268
R64	Met ox 220Ω 2% ¼W	24511-558
R65	Var carb 470Ω 20% ¼W	25611-070
R66	Met film 20kΩ 2% ¼W	24773-304
R67	Met film 20kΩ 2% ¼W	24773-304
R68	Met film 20kΩ 2% ¼W	24773-304
R70	Met film 18kΩ 2% ¼W	24773-303
R71	Met film 27kΩ 2% ¼W	24773-307
R72	Met film 120Ω 2% ¼W	24773-251
R73	Met film 22kΩ 2% ¼W	24773-305
R74	Met film 620Ω 2% ¼W	24773-268
R75	Met film 620Ω 2% ¼W	24773-268
R76	Met film 1kΩ 2% ¼W	24773-273
R77	Met film 1kΩ 2% ¼W	24773-273
R78	Met film 33kΩ 2% ¼W	24773-309
R79	Met ox 10Ω 2% ¼W	24511-520
R80	Met film 1kΩ 2% ¼W	24773-273
SD	FUNCTION switch	44322-160
SE	METER RANGE switch	44325-905
TR1	BC109	28452-777
TR2	BC108	28452-787
TR3	BC108	28452-787
TR4	BC108	28452-787
TR5	BC109	28452-777

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
TR6	BC109	28452-777
TR7	BF244B	28459-011
TR8	BC108	28452-787
A3	Local oscillator unit	44456-119
	L.O. board assembly	44823-191
When ordering prefix A3		
C1	Cer 0.01µF +80-20% 100V	26383-055
C2	Cer 0.01µF +80-20% 100V	26383-055
C3	Elec 10µF +100-20% 63V	26415-802
C4	Elec 50µF +100-20% 25V	26417-152
C5	Cer 1000pF +80-20% 500V	26383-242
C6	Elec 50µF +100-20% 25V	26417-152
C7	Cer 0.01µF +80-20% 100V	26383-055
C8	Cer 1000pF +80-20% 500V	26383-242
C9	Cer 1000pF +80-20% 500V	26383-242
C10	Cer 0.01µF +80-20% 100V	26383-055
C11	Cer 0.01µF +80-20% 100V	26383-055
C12	ϕ Cer 0.0047µF +80-20% 500V	26373-665
C13	ϕ Cer 0.0047µF +80-20% 500V	26373-665
C14	ϕ Cer 0.0047µF +80-20% 500V	26373-665
C15	ϕ Cer 0.0047µF +80-20% 500V	26373-665
C16	Elec 470µF +100-20% 25V	26415-822
D1	BB105	28381-096
D2	BB105	28381-096
D3	BB105	28381-096
D4	BB105	28381-096
D5	BB105	28381-096
D6	BB105	28381-096
D7	BB105	28381-096
D8	BB105	28381-096
D9	IN4148	28336-676
D10	IN4148	28336-676
R1	Met film 510Ω 2% $\frac{1}{4}$W	24773-266
R2	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R3	Met film 3.3kΩ 2% $\frac{1}{4}$W	24773-285
R4	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R5	Met film 2kΩ 2% $\frac{1}{4}$W	24773-280
R6	Met film 680Ω 2% $\frac{1}{4}$W	24773-269

Circuit reference	Description	M.I. code
R7	Met film 300Ω 2% $\frac{1}{4}$W	24773-260
R8	Met film 430Ω 2% $\frac{1}{4}$W	24773-567
R9	Met film 200Ω 2% $\frac{1}{4}$W	24773-256
SKB	Miniature Belling lee socket	23441-044
T1	Transformer	43541-014
TR1	BF244B	28459-036
TR2	BF244B	28459-036
TR3	BSX20	28452-197
X1	Ferrite bead	23635-833
A4	Voltage regulator board	44825-222
When ordering prefix A4		
C1	Elec 500µF +100-20% 100V	26417-178
C2	Elec 50µF +100-20% 25V	26417-152
C3	Plas 100pF ±2pF 350V	26516-243
C4	Elec 220µF +100-20% 25V	26415-818
D1	1N4002	28355-716
D2	1N4002	28355-716
D3	1N4002	28355-716
IC1	µA723C	28461-701
LP1	6.5V 0.3A	23735-440
LP2	6.5V 0.3A	23735-440
R1	Met film 330Ω 2% $\frac{1}{4}$W	24773-261
R2	Met film 3.3kΩ 2% $\frac{1}{4}$W	24773-285
R3	Var carb 1kΩ 20% $\frac{1}{4}$W	25611-072
R4	Met film 3kΩ 2% $\frac{1}{4}$W	24773-284
R5	Met ox 2.2kΩ 10% $\frac{1}{2}$W	24582-560
R6	Met film 1.8kΩ 2% $\frac{1}{4}$W	24773-279
R7	WW 330Ω 5% $1\frac{1}{2}$W	25123-063
TR1	2N3055	28456-567
X1	Bead insulator	23213-101
X2	Bead insulator	23213-101

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
A0	**Main chassis**	
When ordering prefix A0		
D1	Light emitting	28624-101
FS1	160mA fuse link	23411-054
FS2	50mA fuse link for 230V	23411-051
	or 100mA fuse link for 115V	23411-052
M1	100µA meter	44555-422
PLB	Part of coaxial assembly	43122-154
PLC	Battery plug, Bulgin 503	23423-105
PLD	Mains plug	23423-151
R1	Var carb 100kΩ	25645-441
R2	Met film 390Ω 2% ¼W	24773-263
R3	Var carb 4.7kΩ	25624-208
R5	Met film 220kΩ 2% ½W	24773-329
SA	SUPPLY switch	44323-325
SB	FREQ. RANGE switch	44324-223
SC	A.F.C. switch	44333-901
SF	Mains voltage slide switch	23467-155
SKA	R.F. INPUT socket part of coaxial assembly	43123-072
SKC	I.F. OUTPUT socket, BNC	23443-443
SKD	A.F. OUTPUT socket, BNC	23443-443
T1	Transformer	43490-055
	Miscellaneous parts	
	Battery clamp rear	41116-005
	Battery clamp front	41116-006
	Fuse holder	23416-191
	Transformer terminal cover	37574-541
	Meter bezel	37555-111
	Universal coupling METER RANGE switch	22713-205
	Universal coupling FUNCTION switch	22713-205
	Universal coupling LEVEL control	22713-207
	Knob, FREQUENCY control	41141-202
	Cursor, FREQUENCY control	31185-729
	Knob, FUNCTION switch	41145-237
	Knob, METER RANGE switch	41141-206
	Knob, LEVEL control	41141-206
	Knob, FINE FREQ. control	41141-206
	Knob, oscillator FREQ. RANGE switch	41141-206
	Knob, SUPPLY switch	41145-237
	Slow motion drive for FREQUENCY control	41336-608
	Dial for FREQUENCY control	35613-917
	Carrying case fixing stud	33626-506
	Case - Bottom cover	35623-127
	Front surround	41511-018
	Protective cover	41634-065
	Top cover	41634-066
	Left hand trim	34717-420
	Right hand trim	34717-421
	Carrying handle assembly	22315-515
	Mounting foot rear	22315-663
	Lifting foot - handle	37587-925
	Handle attachment	37588-110
	Lead assembly	43121-076
	Solid state lamp and clip	28624-101
	De-emphasis unit 750µs	
C1	Plas 2.2µF 10% 63V	26582-403
C2	Plas 0.33µF 10% 63V	26582-401
PL1	BNC Plug body pack	23443-387
R1	Met film 1.2kΩ 2% ¼W	24773-275
R2	Met film 1.2kΩ 2% ¼W	24773-275
S1	Slide switch	23467-201
SK1	BNC panel socket 75Ω	23443-426

For symbols and abbreviations see introduction to this chapter

Chapter 7

Circuit diagrams

CIRCUIT NOTES

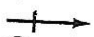
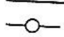
1. COMPONENT VALUES

Resistors : No suffix = ohms, k = kilohms, M = megohms.
Capacitors : No suffix = microfarads, p = picofarads.
Inductors : No suffix = henries, m = millihenries, μ = microhenries.
† : value selected during test, nominal value shown.

2. VOLTAGES

Printed in italics. Voltages are d.c. and relative to chassis unless otherwise indicated. Measured with a 20 kΩ/V meter.

3. SYMBOLS

 arrow indicates clockwise rotation of knob.
 preset component.
FUNCTION panel marking.
 tag on printed board.

4. SWITCHES

Rotary switches are drawn schematically. Numbers or letters indicate control knob setting as shown in the key diagrams. Sequence of sections reading from control knob end is as follows :-

1F = 1st section, front
1B = 1st section, back
2F = 2nd section, front
etc.

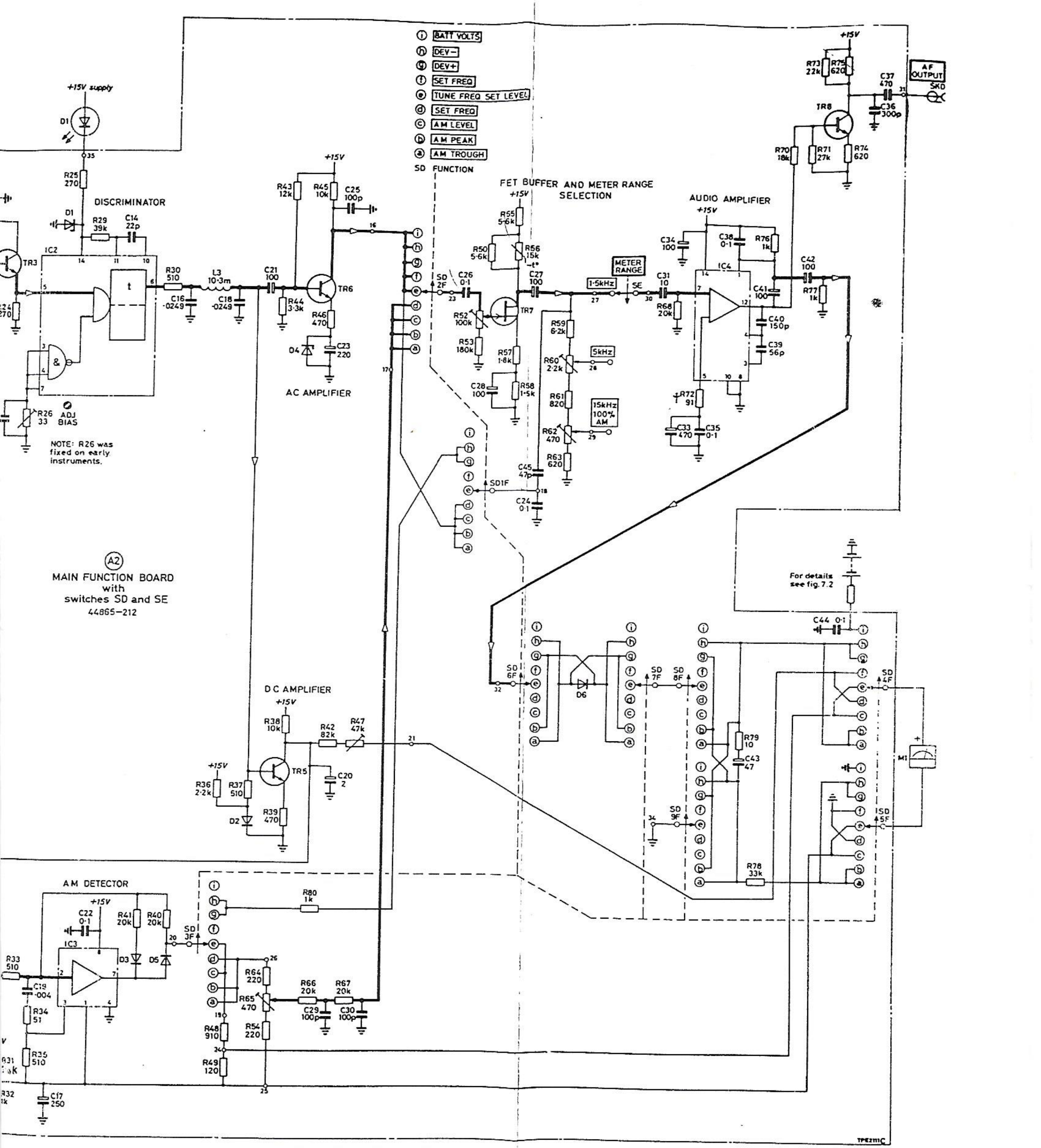
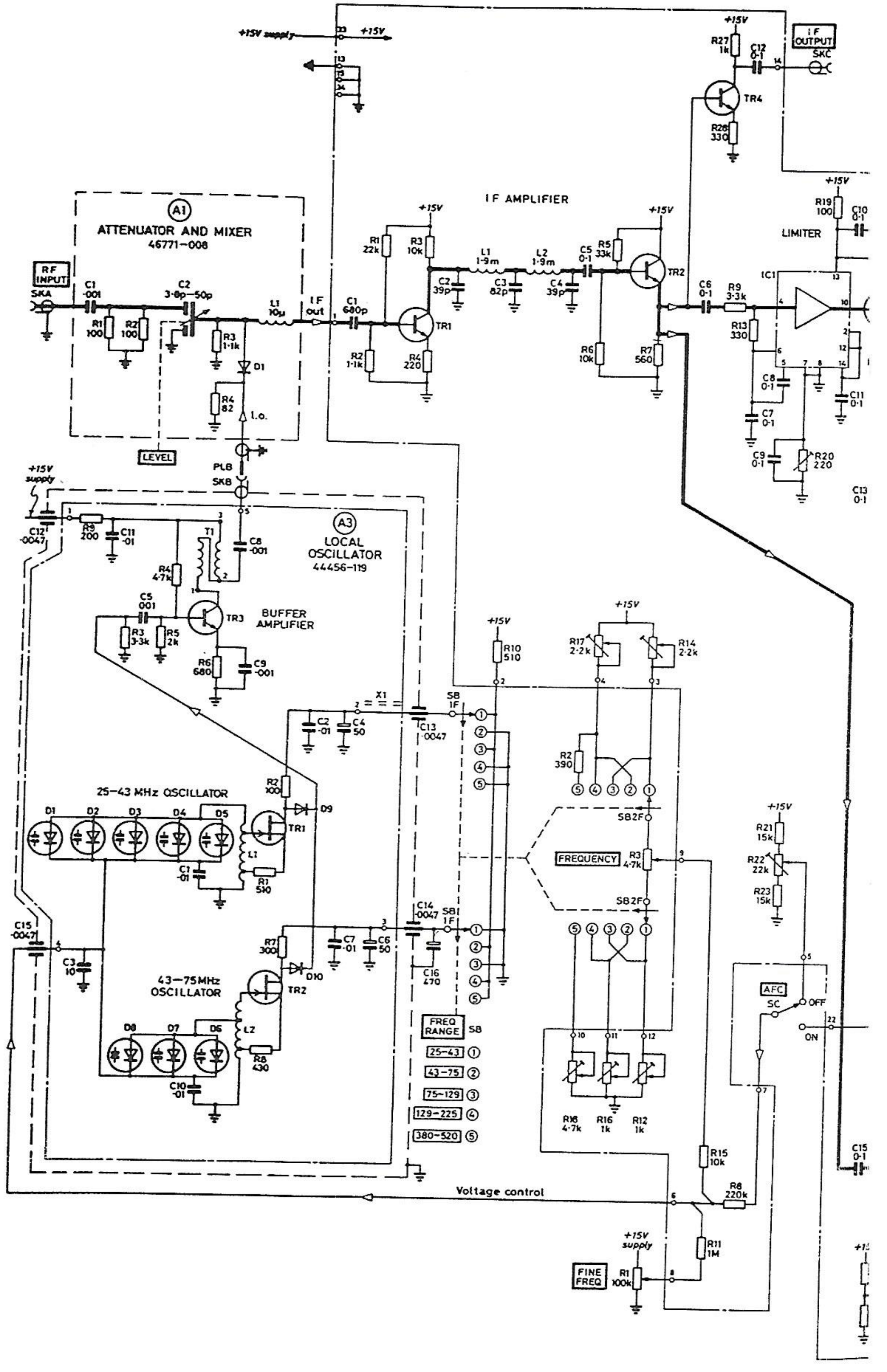
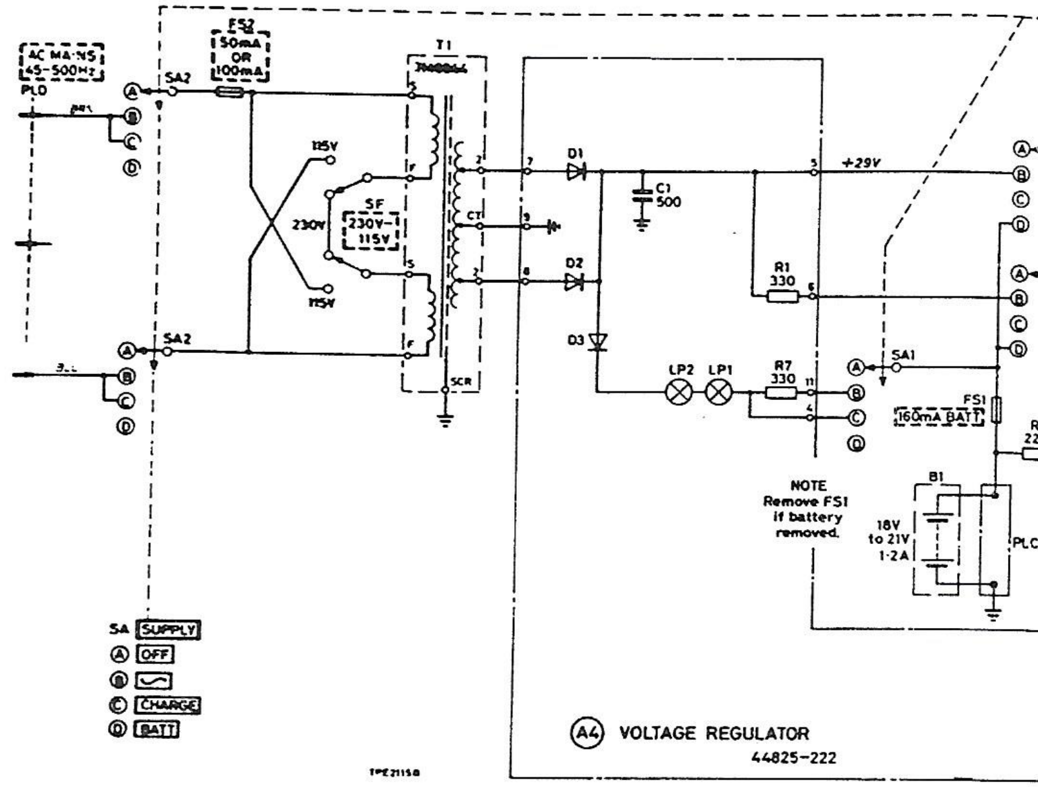
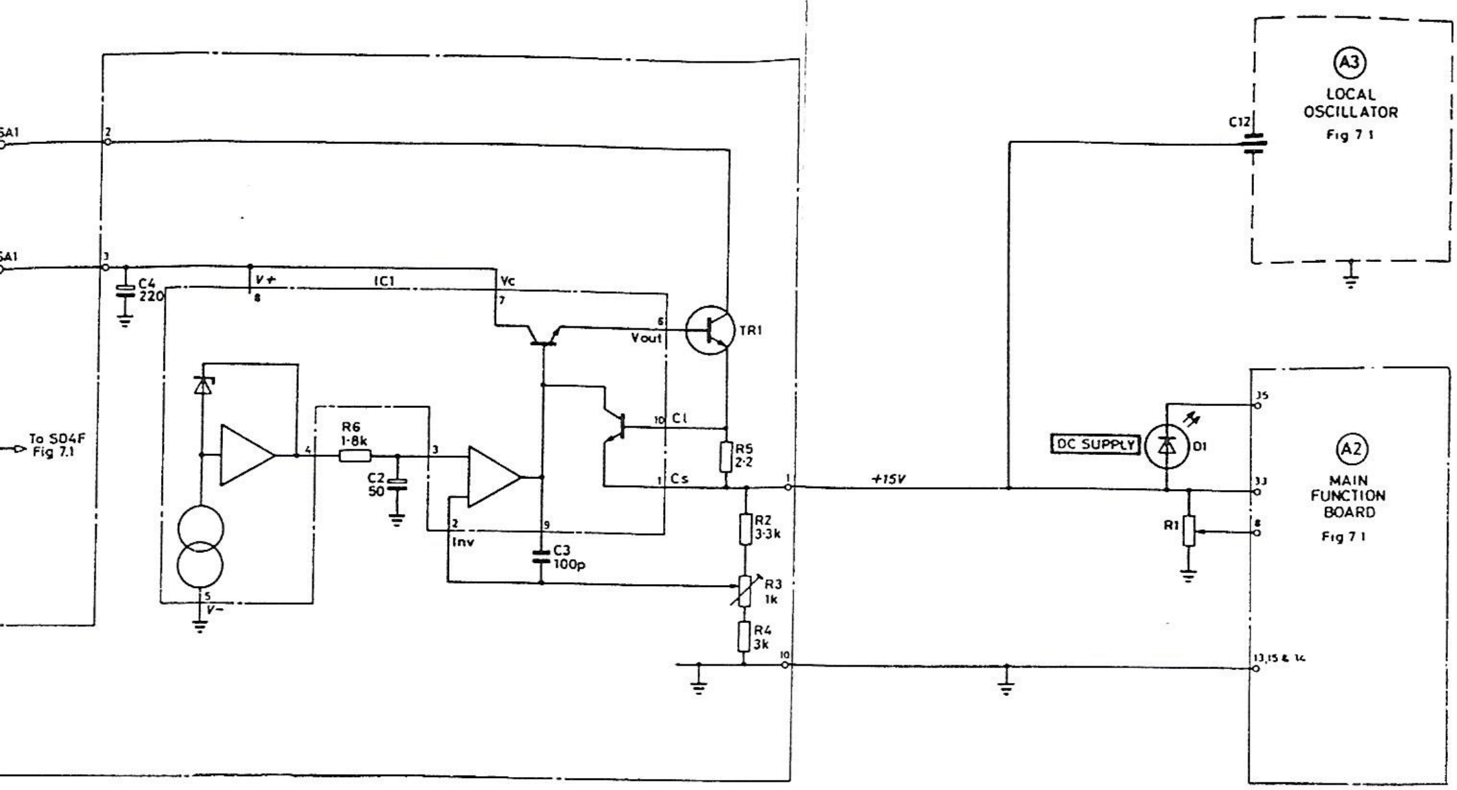


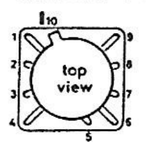
Fig. 7.1 Circuit diagram



+15V supply
+15V
I F OUTPUT
SKC
TR4
I F AMPLIFIER
A1
ATTENUATOR AND MIXER
46771-008
RF INPUT
SKA
LIMITER
TR1
TR2
IC1
LEVEL
PLB
SKB
A3
LOCAL OSCILLATOR
44456-119
BUFFER AMPLIFIER
TR3
25-43 MHz OSCILLATOR
43-75MHz OSCILLATOR
FREQUENCY
FREQ RANGE
25-43
43-75
75-129
129-225
380-520
AFC
Voltage control
FINE FREQ


AC MAINS
45-500Hz
PLO
FS2
50mA
OR
100mA
SA2
T1
115V
230V
SF
230V-
115V
CT
SCR
D1
D2
D3
C1
500
+29V
R1
330
LP2
LP1
R7
330
SA1
FS1
160mA BATT
B1
18V
to 21V
1·2A
NOTE
Remove FS1
if battery
removed.
SA SUPPLY
Ⓐ OFF
Ⓑ ∼
Ⓒ CHARGE
Ⓓ BATT
A4 VOLTAGE REGULATOR
44825-222
PL1





IC1 connections

750 µsec DE EMPHASIS UNIT

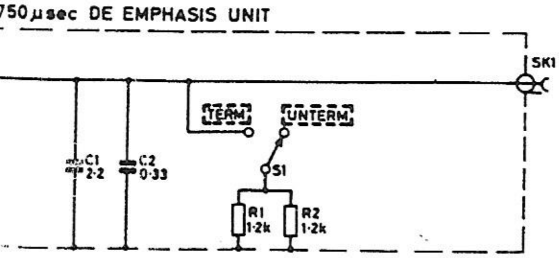


Fig. 7.2 Power supply