10 kHz-120 MHz AM/FM Signal Generator TF 2016A

Code No. 52016-910C

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

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CONTENTS

Note ...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ▶ .... ◀ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

NOTES AND CAUTIONS

SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

Radio frequency interference

This equipment conforms with the requirements of IEC Directive 76/889 as to limits of r.f. interference.

WARNING : Handling hazards

This equipment is formed from metal pressings and although every endeavour has been made to remove sharp points and edges, care should be taken, particularly when servicing the equipment, to avoid minor cuts.

WARNING : Toxic hazard

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

Chapter 1

GENERAL INFORMATION

CONTENTS

INTRODUCTION

1. TF 2016A is a general purpose a.m./f.m. signal generator covering the frequency range 10 kHz to 120 MHz in twelve switched bands. Fundamental frequency generation is by voltage tuned oscillators which, in conjunction with the panel mounted controls, enable easy tuning to narrow band communication receivers up to the highest carrier frequencies. This 'A' version has a number of improvements including reverse power protection, an increased attenuation range and a modulation on/off switch.

2. Outputs up to 2 V e.m.f. can be obtained with up to 100% a.m. or up to 4 V e.m.f. for c.w. or f.m. Output is maintained constant over the whole frequency range by an automatic level control loop and is adjustable by coarse and fine attenuators calibrated in voltage. An auxiliary output is available for driving a counter or digital synchronizer.

Fig. 1 AM/FM Signal Generator TF 2016A.

3. Amplitude modulation and frequency modulation are both derived from an internal oscillator. AM depth is variable up to 100% by a directly calibrated control. FM is directly calibrated in three full-scale ranges of 5 kHz, 25 kHz and 75 kHz peak deviation. External modulation may also be applied and a mixed a.m. and f.m. facility is available.

4. The instrument, which is compact and portable, can be operated from a.c. supplies or from an external battery.

PERFORMANCE DATA

5. Frequency

Range :	10 kHz to 120 MHz in 12 bands : (1) 10 to 22 kHz (2) 22 to 48 kHz (3) 48 to 105 kHz (4) 105 to 230 kHz (5) 230 to 500 kHz (6) 0.5 to 1.1 MHz (7) 1.1 to 2.4 MHz (8) 2.4 to 5.2 MHz (9) 5.2 to 11.4 MHz (10) 10 to 23 MHz (11) 23 to 53 MHz (12) 53 to 120 MHz
Discrimination :	Suitable for tuning into a narrow band receiver (tuning discrimination better than 1 in 10^5).
Scale accuracy :	±2% with EXTRA FINE TUNE control centred.
Stability :	At a constant ambient temperature in the range 10°C to 35°C and after 2 hours from switch on, the drift does not exceed 25 Hz in 5 minutes up to 200 kHz and 20 p.p.m. + 100 Hz in 5 minutes above 200 kHz.

6. RF output

Level :	0.2 µV to 2 V e.m.f. with up to 100% a.m. Up to 4 V e.m.f. in c.w. and f.m. modes.
Attenuators :	Coarse : 13 steps of 10 dB. Fine : 0 to 10 dB continuously variable.
Total level accuracy :	With the CARRIER switch in the ON position, the output level is within ±1 dB of the indicated value for all attenuator settings above 2 µV e.m.f.
Calibration :	Output calibrated in µV, mV and V e.m.f.
Source impedance :	50 Ω. VSWR better than 1.2:1 with 10 dB or more coarse attenuation. BNC socket.
Counter output :	Greater than 50 mV into 50 Ω. TNC socket.

Leakage : Less than 0.5 μV in a 2 turn, 25 mm diameter loop 25 mm or more from the instrument. This permits measurements on receivers with sensitivities down to 0.1 μV.

Reverse power protection : **Protects signal generator output from accidental r.f. power application up to 100 W from 10 kHz to 120 MHz and d.c. voltages up to ±50 V. LED indication and reset push-button are provided.**

7. Amplitude modulation

Carrier frequency range : 100 kHz to 120 MHz. Usable down to 10 kHz.

Depth : Continuously variable up to an indicated 100% by directly calibrated control.

Accuracy and distortion at 1 kHz :

Carrier frequency range (MHz)	AM Depth			
	30%		80%	
	Acc.	Dist.	Acc.	Dist.
0.1 - 30	±3.5%	1.5%	±4%	3%
30 - 90	±4.5%	3%	±6%	6%
90 - 120	±5.5%	3%	±8%	6%

Internal frequency : Switch selected 400 Hz or 1 kHz ±5%.

AF output : Fixed level greater than 1 V r.m.s. into 10 kΩ. Rear panel BNC outlet.

External frequency characteristic : 100 Hz to 10 kHz within 0.5 dB of the response at 1 kHz.

External input requirement : Less than 1.5 V r.m.s. into 1 kΩ.

8. Frequency modulation

Carrier frequency range : 1.1 MHz to 120 MHz.

Deviation : Continuously variable in three ranges with full-scale settings of 5 kHz, 25 kHz and 75 kHz.

Accuracy : ±15% f.s.d. at 1 kHz modulation frequency.

Internal frequency : Switch selected 400 Hz or 1 kHz ±5%.

AF output : Fixed level greater than 1 V r.m.s. into 10 kΩ. Rear panel BNC outlet.

External input requirement : Less than 1.5 V r.m.s. into 1 kΩ.

External frequency characteristic : With f.m. deviation up to the maximum shown in the table below, 50 Hz to 10 kHz within 1 dB of the response at 1 kHz; usable to 100 kHz at carrier frequencies above 30 MHz.

FM stereo performance : (88 to 108 MHz and 10.7 MHz on range 9 only). Channel separation better than 30 dB at 1 kHz modulation frequency.

FM distortion at 1 kHz :

Carrier frequency range (MHz)	Maximum deviation obtainable for t.h.d. of	
	2%	4%
1.1 - 2.4	-	5 kHz
2.4 - 5.2	5 kHz	25 kHz
5.2 - 11.4	25 kHz	75 kHz
10 - 120	75 kHz	-

9. Spurious signals

Carrier harmonics : At least 26 dB below carrier at carrier levels up to 2 V e.m.f.

Non-harmonically related coherent components : None. Fundamental frequency generation produces no non-harmonically related coherent components.

FM on c.w. : With telephone weighting (CCITT P53) less than 10 Hz deviation up to 53 MHz and 20 Hz above.

AM on c.w. : With telephone weighting (CCITT P53) less than 0.05% modulation depth.

10. IF probe supply

A rear panel socket provides +20 V d.c. behind 470 Ω as power supply for optional i.f. probes.

11. Power requirements

AC supply : Any voltage within the limits 190 to 264 V or 95 to 132 V, at any frequency between 45 and 65 Hz (usable to 500 Hz).
40 VA (32 W) maximum.

External d.c. : 23 V to 32 V, negative earth, 0.7 A maximum.

12. Dimensions and weight

Height	Width	Depth	Weight
140 mm	286 mm	311 mm	7 kg
$5\frac{1}{2}$ in	$11\frac{1}{4}$ in	$12\frac{1}{4}$ in	15.4 lb

13. Environmental

Limit range of operation :

Temperature :	0°C to 55°C.
Conditions of storage and transport :	
Temperature :	-40°C to +70°C.
Humidity :	Up to 90% r.h.
Altitude :	Up to 2500 m, i.e. pressurized freight at 27 kPa (3.9 lbf/in^2) differential.

14. Safety : Complies with IEC 348 and BS 4743.

15. Radio frequency interference : Conforms to the requirements of EEC directive 76/889 as to limits of r.f. interference.

ACCESSORIES

16. Supplied accessories

43129-071D	Mains cable, 2 m.
41690-102S	Protective front panel cover.

17. Optional accessories

43126-012S	RF connecting cable, 50 Ω, BNC to BNC, 1.5 m.
41690-044B	Carrying case.
44411-001M	Matching Unit TM 5569, a series 25 Ω resistor that converts the effective source impedance of the generator from 50 Ω to 75 Ω. BNC socket to Belling-Lee type L734/P plug.
44411-019G	Matching Pad TM 5573/3, for matching to 75 Ω loads. Input/output voltage ratio 2:1. BNC plug to BNC socket.
54451-121B	455 kHz i.f. probe.) Each provides a crystal
54451-061Y	470 kHz i.f. probe.) controlled signal at a) standard i.f. for use in
54451-071S	10.7 MHz i.f. probe.) receiver alignment.
54311-071Z	Adapter, BNC to TNC.
	Reversible conversion plates for output attenuator calibration :-
35902-255P	dB relative to 1 mW and μV p.d.
35902-256X	dBμV e.m.f. and dBμV p.d.
54127-231P	Rack mounting shelf for TF 2016A.
54127-241A	Rack mounting shelf for TF 2016A with TF 2173 Digital Synchronizer.

18. Associated equipment

52173-900M	TF 2173 Digital Synchronizer with ±1 in 10^7 frequency stability.
52169-900J	TF 2169 Pulse Modulator for use above 10 MHz.

ALERNATIVE VERSIONS

19. The instrument is also available with a preset frequency modulation facility which enables receivers fitted with 150 Hz calling tone circuits to be tested without separate signal injection. In this version the 400 Hz internal modulation oscillator is replaced by a 150 Hz fixed deviation pilot tone. (For details see Supplement H 52016-302E).

Chapter 2

INSTALLATION

CONTENTS

UNPACKING AND REPACKING

1. Retain the packing materials and the packing instruction note (if included) in case it is necessary to reship the instrument.

2. If the instrument is to be returned for servicing attach a label indicating the service required, type or model number (on rear label), serial number and your return address. Pack the instrument in accordance with the general instructions below or with the more detailed information in the packing instruction note.

(1) Place a pad in the bottom of the container.

(2) Place pads in the front and rear ends of the container with the load spreader(s) facing inwards.

(3) Put the polythene cover over the instrument and place it in the container with the front handles and rear projections (where applicable) against the load spreaders.

(4) Place pads in the two sides of the container with cushioning facing inwards.

(5) Place the top pad in position.

(6) Wrap the container in waterproof paper and secure with adhesive tape.

(7) Mark the package FRAGILE to encourage careful handling.

Note ...

If the original container or materials are not available, use a strong double-wall carton packed with a 7 to 10 cm layer of shock absorbing material around all sides of the instrument to hold it firmly. Protect the front panel controls with a plywood or cardboard load spreader; if the rear panel has guard plates or other projections a rear load spreader it also advisable.

AC MAINS OPERATION

3. Before connecting the instrument to the supply check the position of the voltage selector on the rear panel. The instrument is normally despatched with the selector set to 230 V.

4. For supplies in the range 95 to 132 V, remove the locking plate, set the switch to 115 V, reverse the plate and refit. Note that the a.c. supply fuses must also be changed to a rating of 500 mA, slow-blow.

5. The free a.c. supply cable is fitted at one end with a female plug which mates with the a.c. connector at the rear of the instrument. When fitting a supply plug ensure that conductors are connected as follows :

Earth	-	Green/Yellow
Neutral	-	Blue
Live	-	Brown

When attaching the mains lead to a non-soldered plug it is recommended that the tinned ends of the lead are first cut off owing to the danger of cold flow resulting in intermittent connections.

BATTERY OPERATION

6. For battery operation it is only required to connect a nominal 24 V d.c. supply to the appropriate terminals on the rear of the instrument. Check that a 1 A fast-blow fuse is fitted in the BATT holder.

Note ...

> There is no mains/battery switch. AC and d.c. supplies may safely be applied simultaneously, in which case the a.c. input will automatically override the d.c. This feature can be used for emergency standby battery operation since the battery supply will automatically take over in the event of a mains supply failure.

RACK MOUNTING ARRANGEMENTS

7. Two rack mounting shelves are available for fitting the TF 2016A into a standard 19-inch rack. A single version, 54127-231P, accommodates the TF 2016A on its own and a double version takes both the TF 2016A and the TF 2173 Digital Synchronizer, one above the other.

Chapter 3

OPERATION

CONTENTS

CONTROLS AND CONNECTORS

1. Front panel

(1) AC SUPPLY switch. Positioned up to switch ON.

(2) PILOT LAMP. Lit when a.c. supply is switched on or when external battery is connected.

(3) CARRIER switch. Set at ON for normal c.w., f.m. or a.m. operation. The +6 dB position provides a high output for c.w. or f.m. only. The OFF position allows the carrier to be switched off without switching the instrument off.

(4) CARRIER RANGE switch. Selects the required frequency range and exposes the appropriate tuning scale.

(5) TUNE control. This is a nineteen position switch to set the generator approximately to the required frequency.

(6) FINE TUNE control. Provides continuous tuning between each of the nineteen positions of (5) above.

(7) EXTRA FINE TUNE control. An uncalibrated fine tuning control which allows very precise setting of the carrier frequency.

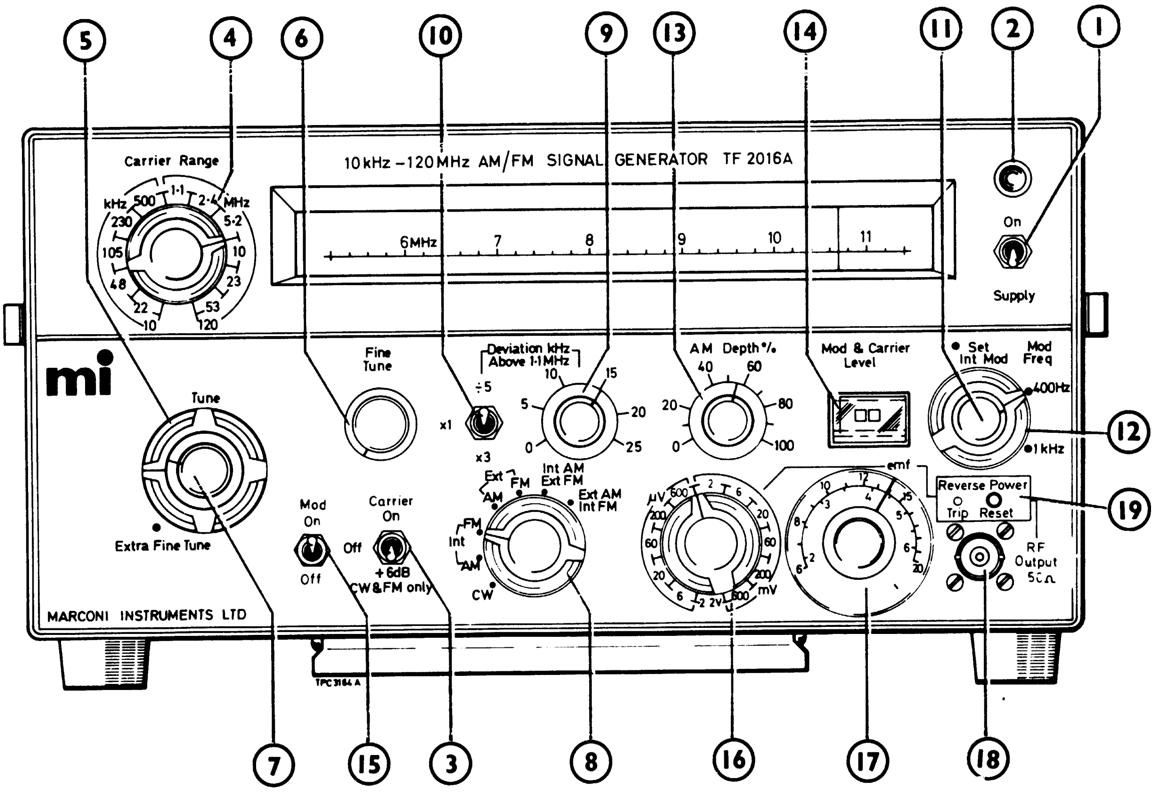


Fig. 1 Front panel controls.

(8) FUNCTION switch. Selects c.w., internal or external a.m. or f.m. or simultaneous f.m. and a.m.

(9) DEVIATION control. Full-scale value is 5 kHz, 25 kHz or 75 kHz depending on setting of deviation multiplier.

(10) DEVIATION ÷ 5, x1, x3. Multiplier for use with DEVIATION control.

(11) SET MOD control. Adjusted to set the pointer of the MOD & CARRIER LEVEL meter to the reference mark for f.m. or a.m.

(12) MOD FREQUENCY switch. Selects the internal modulation frequency, 400 Hz or 1 kHz.

(13) AM DEPTH. Adjusted to provide the desired a.m. depth from 0 to 100%.

(14) MOD & CARRIER LEVEL meter. Indicates correct reference level for a.m. and f.m. and also correct a.l.c. operation in the c.w. mode.

(15) MOD ON/OFF switch. Enables internal or external modulation to be interrupted so as to allow fast signal-to-noise measurements to be made.

(16) RF OUTPUT (coarse). Stepped attenuator providing increments of 10 dB from 0.2 μV to 2 V e.m.f.

(17) RF OUTPUT (fine). Continuously variable to interpolate between coarse steps of item (16).

(18) RF OUTPUT connector. BNC 50 Ω. Output in voltage given by combination of coarse and fine RF OUTPUT control settings. Multiply readings by 2 when CARRIER switch is in +6 dB position.

(19) REVERSE POWER TRIP & RESET. Provides protection against r.f. power or d.c. voltage externally applied to the RF OUTPUT socket.

2. Rear panel

(1) MAINS INPUT connector. Bulgin P580. The a.c. supply is connected through this plug which mates with the connector fitted to the supplied mains cable.

(2) VOLTAGE SELECTOR switch. Selects either 95 to 132 V or 190 to 264 V range to suit local a.c. supply.

(3) AC FUSES. Mains input fuses rated at 250 mA (slow-blow) for 190 to 264 V or 500 mA (slow-blow) for 95 to 132 V.

(4) BATTERY FUSE. Battery input fuse rated at 1 A (fast-blow).

(5) BATTERY TERMINALS. Battery input terminals (negative is connected to chassis).

(6) EXT MOD IN connector. BNC 50 Ω. High impedance input for external modulation.

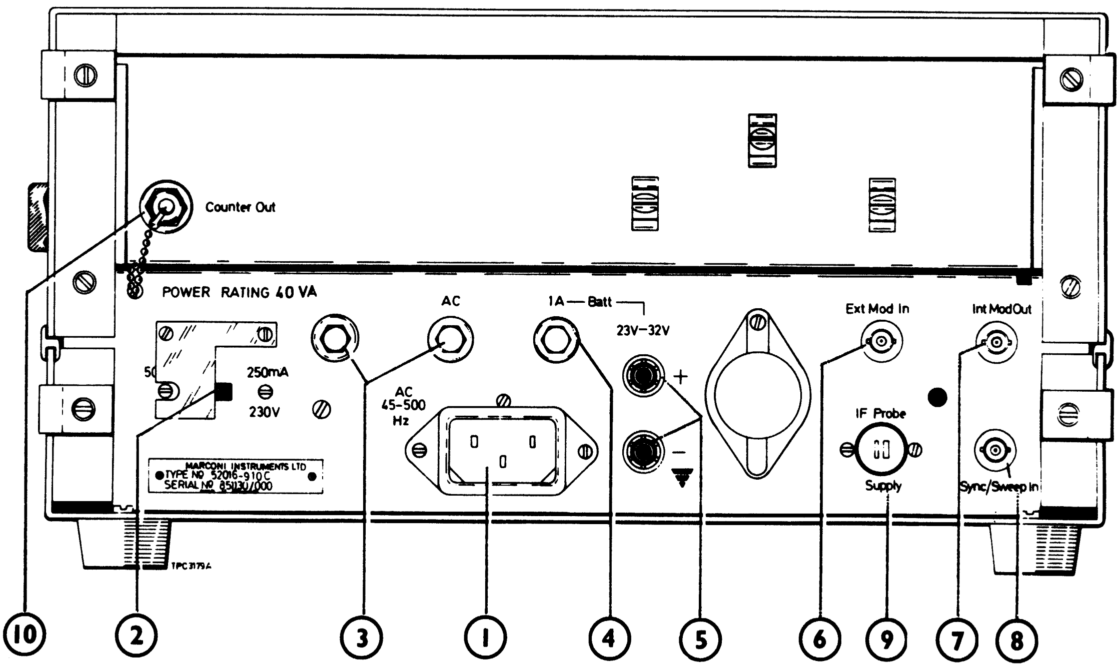


Fig. 2 Rear panel controls.

(7) INT MOD OUT connector. BNC 50 Ω. Internal modulation oscillator, 1 kHz or 400 Hz, output when FUNCTION switch is set at INT AM or FM.

(8) SYNC/SWEEP IN connector. BNC 50 Ω. Accepts a frequency sweep voltage or the control voltage from a digital synchronizer, such as TF 2173.

(9) IF PROBE SUPPLY connector. DIN loudspeaker socket provides +20 V for external i.f. probe.

(10) COUNTER OUT. TNC 50 Ω. For connection to an external counter or digital synchronizer (see para. 20).

SETTING FREQUENCY

3. (1) Set SUPPLY switch at ON and check that the pilot lamp is lit.

(2) Connect TF 2016A to the equipment under test.

(3) Set FUNCTION switch at CW and the CARRIER RANGE switch to select the desired frequency range.

(4) Set CARRIER switch at ON and check that the meter pointer is within the white box.

(5) Rotate the stepped TUNE control to position the pointer of the tuning scale as close as possible to the desired frequency. Then adjust the FINE TUNE control to position the pointer correctly. For final precise adjustment use the EXTRA FINE TUNE control.

OPERATION WITH DIGITAL SYNCHRONIZER

4. TF 2016A can be used with digital synchronizer TF 2173 for a high degree of frequency stability. The synchronizer is driven from the COUNTER OUTPUT socket (rear of instrument) and its control voltage is applied to SYNC/SWEEP connector.

SWEEP FACILITY

5. A voltage swing of 0 to +19 V applied to the SYNC/SWEEP IN connector will vary the carrier frequency over the frequency coverage of any one range. If a linear sweep is required a suitable non-linear waveform must be used. To maintain the r.f. levelling accuracy, slow sweep speeds are necessary.

SETTING MODULATION

6. AM or f.m. may be applied from the internal modulation oscillator or from an external source as described below.

7. Internal a.m.

(1) Select desired modulating frequency by means of MOD FREQUENCY switch.

(2) Set FUNCTION switch at INT AM, CARRIER switch at ON and MOD switch at ON.

Note ...

Amplitude modulation is not possible when CARRIER switch is at +6 dB.

(3) Adjust SET MOD control to position the meter pointer at the centre of the white box.

(4) Adjust AM DEPTH control to provide desired modulation.

8. Internal f.m.

(1) Select desired modulating frequency by means of MOD FREQUENCY switch.

(2) Set FUNCTION switch at INT FM, CARRIER switch at ON and MOD switch at ON. For extra output set CARRIER switch at +6 dB.

(3) Adjust SET MOD control to position the meter pointer at the centre of the white box.

(4) Adjust DEVIATION control to provide a deviation from 0 - 5 kHz (DEVIATION multiplier in ÷ 5 position), 0-25 kHz (x1) or 0-75 kHz (x3).

9. External a.m. or f.m.

(1) Set FUNCTION switch to appropriate position i.e. : EXT AM or EXT FM and CARRIER switch at ON.

Note ...

External a.m. is not possible when CARRIER switch is at +6 dB.

(2) Connect the external modulation source to EXT MOD IN (on rear panel); then adjust its level to position the meter pointer at the centre of the white box.

(3) The desired modulation depth or deviation is then obtained by adjusting the relevant controls i.e. : AM DEPTH or DEVIATION.

10. Internal a.m. with external f.m.

(1) Set FUNCTION switch at INT AM, CARRIER switch at ON and MOD switch at ON.

Note ...

Amplitude modulation is not possible when CARRIER switch is at +6 dB.

(2) Select desired internal modulating frequency by MOD FREQUENCY switch.

(3) Adjust SET MOD control to position the meter pointer at the centre of the white box.

(4) Connect the external modulation source to EXT MOD IN (on rear panel).

(5) Set FUNCTION switch at EXT FM. Then adjust the level of the external modulation to position the meter pointer at the centre of the white box.

(6) Set FUNCTION switch at INT AM/EXT FM. Then adjust AM DEPTH and DEVIATION controls to provide the required levels of modulation.

11. Internal f.m. with external a.m.

(1) Set FUNCTION switch at INT FM, CARRIER switch at ON and MOD switch at ON.

Note ...

Amplitude modulation is not possible when CARRIER switch is at +6 dB.

(2) Select desired internal modulating frequency by MOD FREQUENCY switch.

(3) Adjust the SET MOD control to position the meter pointer at the centre of the white box.

(4) Connect the external modulation source to EXT MOD IN (rear panel).

(5) Set FUNCTION switch at EXT AM. Then adjust the level of the external modulation to position the meter pointer at the centre of the white box.

(6) Set FUNCTION switch at EXT AM/INT FM. Then adjust AM DEPTH and DEVIATION controls to provide the required levels of modulation.

Internal modulation output

12. When FUNCTION switch is at INT AM, INT FM, INT AM/EXT FM or EXT AM/INT FM, the modulating signal at a nominal 1 V (into a high impedance load), is available at the INT MOD OUT connector on the rear panel. This signal may be used, for example, to trigger an oscilloscope at the modulating frequency or for a.f. tests.

SETTING OUTPUT

13. For an unmodulated c.w. output proceed as follows :

(1) Set FUNCTION switch at CW.

(2) For normal operation set CARRIER switch at ON and check that the meter pointer is within the white box.

(3) Set RF OUTPUT controls as required. (For extra output set CARRIER switch at +6 dB).

Attenuator calibration

14. The RF OUTPUT controls (coarse and fine attenuators) are calibrated in V e.m.f. Where dBμV or dBm levels are to be used refer to the conversion scale shown in Fig. 3.

15. Alternatively, a permanent change of scale can be made by fitting, as follows, one or other of the attenuator scale conversion plates listed under 'Optional Accessories' in Chap. 1.

(1) Remove the lower section of the case.

(2) Tune to a convenient carrier frequency, e.g. 10 MHz, and with a suitable r.f. voltmeter connected to the RF OUTPUT note the reading with the attenuator set to 2 V e.m.f. Then switch off the instrument.

(3) Remove the coarse and fine attenuator knobs and potentiometer securing nuts and fit the new cover plate, securing the nuts and the coarse attenuator knob.

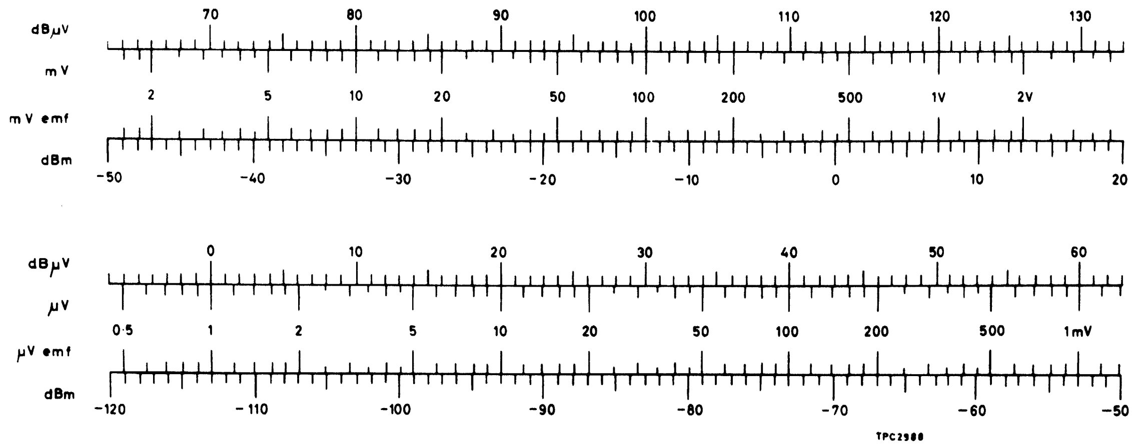


Fig. 3 Output conversion scale.

(4) Rotate the fine attenuator spindle to obtain the same voltmeter reading as in (2) above.

(5) Fix the fine attenuator knob so that it indicates the equivalent of 2 V e.m.f. (1 V p.d., +13 dBm, 126 dBµV e.m.f. etc.).

(6) Repeat steps (4) and (5).

(7) • Refit the lower section of the case.

Matching to high impedance loads

16. To match a load that is greater than 50 Ω to the output of TF 2016A a resistor R_s is required to be added in series with the generator output as in Fig. 4. The value of R_s is given by the difference between the load and the generator impedances, i.e.

$$R_s = R_L - R_o$$

in which case the voltage across the load, V_L, is given by

$$V_L = \frac{E}{2}$$

where E is the output voltage e.m.f.

17. When a series resistor is employed to match a receiver input impedance of 75 Ω the output impedance of the signal generator will be mismatched. Therefore it is preferable to use Matching Pad type TM 5573/3 giving a convenient 2 : 1 attenuation. Using this pad both the output impedance of the generator and the input impedance of the receiver are correctly matched.

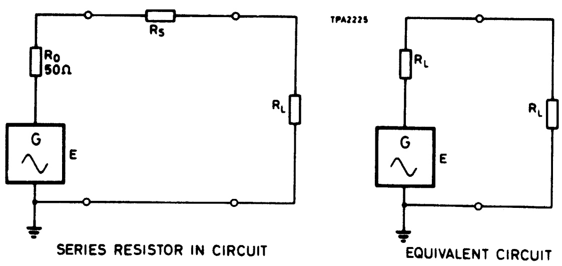


Fig. 4 High impedance matching.

USE OF IF PROBES

18. The i.f. probes generate crystal controlled signals at customary receiver i.f's of 455 kHz, 470 kHz and 10.7 MHz. They are powered from the IF PROBE SUPPLY socket on the generator.

19. The probes provide an auxiliary test signal for use in conjunction with the normal r.f. signal from the generator in receiver testing. In operation, the probe is positioned close to the receiver so that its signal is inductively coupled into the receiver i.f. circuit while the r.f. output from the generator is connected in the normal way to the receiver input. This facilitates a number of receiver tests such as the following :-

(1) Checking receiver i.f. When the signal generator is tuned to the nominal frequency of a receiver channel, any difference between the receiver i.f. and the probe frequency will produce a beat note in the receiver output. Readjusting the signal generator for zero beat, using the EXTRA FINE TUNE control, ensures that the generator is correctly tuned to the r.f. circuits in the receiver.

(2) Overriding receiver de-sensitization. It is often difficult to tune a signal generator to a receiver incorporating some forms of de-sensitization, such as squelch or a battery enonomizer, which respond to the presence of an i.f. signal. This is because the varying r.f. signal may traverse the receiver pass band too quickly, so that an i.f. signal is not present for long enough to sensitize the squelch or economizer circuit. By using the i.f. probe to inject an i.f. signal the receiver can be held in the sensitive condition while the r.f. generator is tuned into the pass band.

USE OF EXTERNAL COUNTER

20. For greater accuracy, the frequency of the signal generator may be measured on a counter connected to the COUNTER OUT socket on the rear panel. At carrier frequencies below 100 kHz, if a wide band counter is used, noise in the signal may cause spurious readings on the counter. If so, connect a 100 kHz low-pass filter between the signal generator and the counter.

REVERSE POWER PROTECTION

21. This facility prevents internal damage due to r.f. power accidentally applied to the RF OUTPUT socket. The r.f. level is monitored and when a given threshold is exceeded a relay in series with the RF OUTPUT socket is caused to open, thereby isolating the generator output stage and attenuator from the output socket. Visual indication of this state is given by illumination of the REVERSE POWER TRIP lamp. The circuit latches in this protected state with the relay open until reset manually following removal of the offending overload. Reset is easily achieved by pressing the REVERSE POWER RESET button; alternatively the mains supply may be switched OFF and ON.

22. The circuit protects against continuous or long term overloads and also responds whenever a pulsed or transient overload is present whose peak power exceeds the threshold. Transients as short as 10 μs will operate the trip. Protection at low frequencies and d.c. is afforded by an internal 1 μF blocking capacitor, which enables the RF OUTPUT socket to be connected to external equipment with d.c. potentials within ±50 V; connection to higher d.c. potentials is possible using a suitable external blocking capacitor.

23. It should be noted that in connecting the RF OUTPUT socket to a positive d.c. voltage exceeding 8 V the transient voltage step transmitted through the blocking capacitor will trip the protection circuit. This state is evident by illumination of the TRIP lamp and the generator output can be restored immediately by pressing the RESET button.

24. Another condition that may cause a false trip is operation of the CARRIER switch when the RF OUTPUT socket is unterminated and the coarse step attenuator is set to maximum output. Again, the output may be restored by pressing the RESET button to extinguish the TRIP lamp.

Chapter 4

TECHNICAL DESCRIPTION

CONTENTS

INTRODUCTION

1. All printed boards and other sub-assemblies in the instrument are allocated a unit identification code in the sequence A1 to A7 and, where practical, the sub-assembly is marked with this code. The main frame and interconnecting material is coded A0.

2. The complete circuit reference for a component carries its unit identification code as a prefix, e.g. A1C2. For convenience in this chapter and elsewhere the circuit reference is abbreviated by dropping the prefix, except where there is a risk of ambiguity.

OVERALL FUNCTION

Block diagram : see Fig. 1

3. Two voltage tuned oscillators are used to cover the twelve ranges, one oscillator covering ranges 1 to 9, the other ranges 10 to 12. The two outputs are routed by buffer amplifiers, and held at a constant level by the first automatic level control (a.l.c.) loop. The output is fed to a phase splitter, and also to the counter amplifier.

4. The frequency of each oscillator is controlled by means of a set of variable capacitance diodes across the tuned circuit, the l.f. oscillator having two pairs of diodes, the h.f. circuit one pair of diodes. The capacitance of the diodes, and hence the resonant frequency of the tuned circuit, is determined by the control voltage applied to the diodes. This arrangement provides for both tuning and frequency modulation, a variable d.c. control voltage being applied for tuning purposes and an a.f. modulating signal for f.m.

5. The output from the phase splitter is fed to the modulator circuit. The r.f. output from the modulator is passed to a wide band amplifier incorporating an interstage voltage controlled amplifier. For f.m. and c.w., the modulator is bypassed by a change-over relay, to reduce noise in the circuits. The output from the modulator is approximately 12 mV.

6. Output from the amplifier is applied to the input of the coarse RF OUTPUT attenuator and also to a detector circuit. This controls a second a.l.c. loop which, operating in conjunction with the fine RF OUTPUT attenuator, sets and then maintains the level of the r.f. input to the coarse attenuator.

7. The r.f. carrier can be amplitude or frequency modulated using either the internal modulation oscillator or an external signal. For a.m. the a.f. signal is applied to the modulator through an emitter follower (a.m. driver) and for f.m. to the tuning circuits. To ensure that deviation is acceptably constant over each frequency range, tracking circuits are employed.

8. A Wien bridge oscillator operating at 1 kHz or 400 Hz is used for internal modulation and to provide an a.f. output. For both a.m. and f.m. the internal a.f. signal is routed through the SET MOD control which is adjusted to obtain a modulation reference level. The desired a.m. depth or f.m. deviation is then obtained by adjustment of the appropriate controls.

9. Inputs are provided for connection of an external modulating signal and for application of a suitable sweep waveform. A 20 V d.c. output is available as a supply for certain associated equipments, e.g. i.f. probes, and an output is provided for connection to a frequency counter.

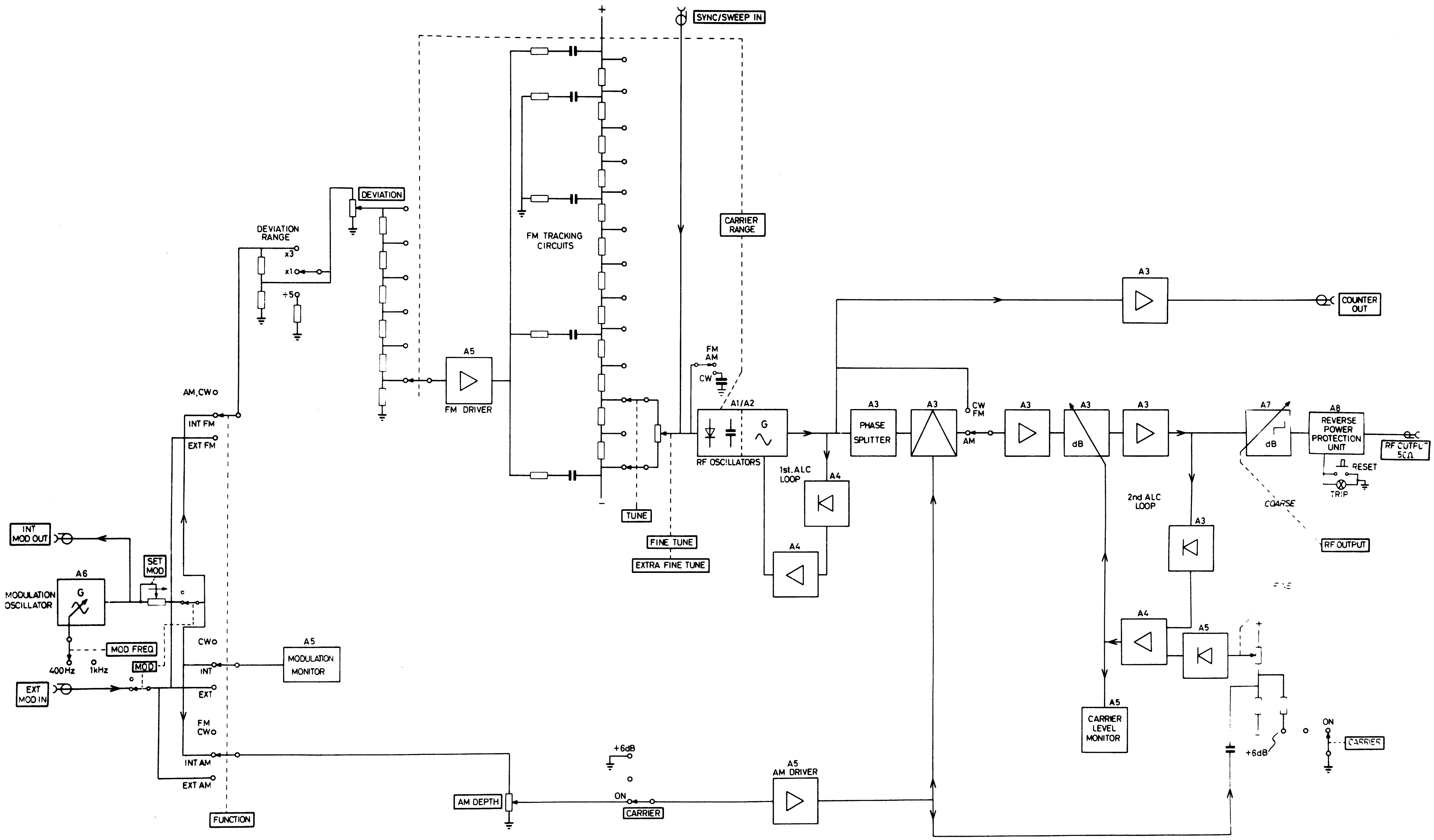
10. In c.w. operation the MOD & CARRIER LEVEL meter indicates correct operation of the a.l.c. In the modulated modes it monitors the a.f. reference level.

RF OSCILLATORS

Circuit diagram : Chap. 7,Fig. 4 (A1 & A2)

11. The two r.f. oscillators use a Colpitts arrangement and both employ bipolar maintaining transistors. Feedback is obtained from the centre tap of the variable capacitance diodes D2, D3 and D11, the back-to-back configuration contributing to reduced distortion. The oscillators are built around TR1 and TR16, their driving currents being controlled by the a.l.c. transistors TR2 and TR13 respectively. The oscillator not in use is turned off by diverting the a.l.c. current into a dummy load, TR3 or TR12. The dummy load transistor shares its heat with its maintaining transistor, to maintain the oscillating device temperature and reduce range change drift.

12. Diodes D2, D3 and D11 act as variable capacitors to tune the appropriate range coil. There is one coil for each range of frequencies; the lowest nine ranges are independently selected by reed relays, A2RL1 to RL8 and A1RL1. Ranges 10 to 12 have their coils connected in series and the appropriate sections connected to earth by switching diodes D8 and D9 (e.g. when switched to range 11, L10 is shorted out by D9, and L11 and L12 combine to give the required tuning inductance). For ranges 1 to 9, the appropriate coil core sets the bottom of the range and the corresponding trimmer capacitor the top of the range. To adjust ranges 10 to 12, range 12 is set first by means of the adjuster inside the printed coil and the corresponding trimmer, then range 11 is set, then finally range 10.



Block diagram.

power available is determined by the current through the output pair and the supply voltage. The output level detector D2, D3 is mounted beside the output transistors. The output impedance is defined by A0R84 which is fitted inside the mounting pillar of the connector SKG.

FINE RF OUTPUT CONTROL

Circuit diagram : Chap. 7, Fig. 2 (A5)

28. The fine RF OUTPUT control dictates the level of the reference voltage to be compared with the voltage developed across the second detector. To compensate for an a.m. envelope, an audio component is added into the fine output control. This feature is essential to the operation of a low frequency a.m. signal generator, since the detector time constants for a carrier frequency of 10 kHz mean that the a.l.c. action reduces the peaks of the envelope to the mean carrier. Hence the a.l.c. has to be compensated by feeding the modulation signal into the fine attenuator and rectifying the output at D7.

+6 dB OUTPUT

Circuit diagram : Chap. 7, Fig. 2 (A5)

29. To increase the level of the r.f. output by +6 dB, the reference level to the second a.l.c. via the fine RF OUTPUT control is increased by shunt resistor A5R25. Amplitude modulation is not possible in this mode, so that when the CARRIER switch is in the +6 dB position, the a.m. modulating signal is routed to earth.

COARSE RF OUTPUT CONTROL

Circuit diagram : Chap. 7, Fig. 6 (A7)

30. This provides a loss of 130 dB in steps of 10 dB. The pad sections consist of resistive networks with a characteristic impedance of 50 Ω. The unit is divided into compartments to ensure maximum shielding between pads. Pads are connected into circuit by microswitches housed in screened compartments and operated in pairs by leaf springs actuated by cams on the control spindle.

REVERSE POWER PROTECTION

Circuit diagram : Chap. 7, Fig. 7 (A8)

31. The r.f. path from input to output consists of a coaxial protection relay and d.c. blocking capacitor. The r.f. signal at the input socket is detected and fed to the first stage of the trip circuit, a comparator. With normal operating signal levels the comparator threshold is not exceeded and the relay remains energized, i.e. contacts closed. With overload the comparator output changes state and de-energizes the relay opening the contacts. A latching circuit breaks the h.t. supply to the relay and illuminates the l.e.d. overload indicator. The circuit will remain in this tripped state even with the overload removed until such time as the reset button is actuated.

32. Comparator. IC1 is a d.i.l. comparator with threshold level set to about 2.3 V d.c. by preset potentiometer R4. This level corresponds to an overload threshold of 6.4 V r.m.s. at 1 MHz and is such that a continuous r.f. overload of 3/4 W is possible without trip-out. IC1 output is high when r.f. level is below threshold (normal operation) and is low when r.f. level initially exceeds threshold during overload.

33. Relay switch. TR1 is a switching transistor controlled by the comparator, TR1 being normally on.

34. Latch. In normal operation TR2, TR3 are on and pin 5 is held low through D7 so that the

l.e.d., D2 on Fig. 6, is off. Following initial overload TR1 turns off and the voltage across RLA coil falls to zero, turning TR3 off. TR3 collector rises to +20 V turning TR2 off and at the same time pin 5 is released and the l.e.d. illuminates with current limited by R13. The relay opens after a de-actuate period removing the overload, consequently TR1 turns on again but since TR2 is off the relay remains de-energized and the l.e.d. remains on.

35. Reset. The front panel push-button shorts pin 5 to chassis thereby generating a negative-going voltage edge of about 2 V amplitude. This is transmitted via C9 and C7 to TR2 base turning TR2 on and energizing the relay. Should an overload still be connected when the reset is actuated the comparator output will turn TR1 off as soon as the relay closes and the sequence of para. 34 will repeat.

36. Starter. This ensures the latch circuit settles in the reset mode whenever the instrument is switched on. C8 charges through R11 and D6 when the h.t. supply exceeds 3 V rising to 20 V. The period that TR2 is held on is thereby extended until after TR1 has turned on, forcing the latch into the reset mode.

37. DC protection. C1 protects the generator for up to ±50 V applied d.c. Transient pulses occur whenever the generator output socket is connected to a different voltage level, and it is inevitable that voltage levels exceeding +7.5 V d.c. cause transients that trip the protection circuit. R17 provides a charging path for C1 so that the circuit can be reset without further tripping. R16 and R17 provide a discharge path for C1.

38. Pulse protection. The circuit provides protection from pulse trains by responding to pulses whose peak power exceed the threshold for widths less than 10 μs. TR1 is turned off by the initial overload pulse, thereby operating the latch and de-energizing the relay.

MODULATION OSCILLATOR AND CIRCUITS

Circuit diagram : Chap. 7, Fig. 2 (A6)

39. A Wien bridge circuit is employed for internal modulation of the r.f. signal and to provide an a.f. output at the INT MOD OUT connector. The circuit is switchable between 1 kHz and 400 Hz, the 400 Hz position switching in extra capacitors to lower the oscillator frequency.

Note ...

> It is possible to obtain alternative modulation frequencies in the range 400 Hz to 4 kHz. For frequencies up to 1 kHz change the '400 Hz' capacitors C9 and C11 to a new value given by (1900/f - 1.9)nF, where f = frequency required in Hz. Above 1 kHz, where the formula gives a negative result, change (i.e. reduce) the value of the '1 kHz' capacitors C2 and C3 by this amount.

40. The amplitude stabilization of the oscillator is provided by an f.e.t. feedback stage. The output voltage is detected by diodes D1 and D2 and fed to the gate of the f.e.t., which acts as a voltage controlled resistor to vary the gain of the amplifier to sustain oscillation. This f.e.t. configuration eliminates switch-on 'bounce'.

41. For amplitude modulation, the signal from the modulation oscillator is routed through the SET MOD and AM DEPTH controls to the emitter follower A5TR2 in the a.m. driver circuit.

42. For frequency modulation the internal modulating signal is routed through the SET MOD and DEVIATION controls and driver TR6 to the switched f.m. scaling resistors A0R6 to R11 (ganged to the CARRIER RANGE switch) and then through the f.m. driver A5TR7, TR8 and TR9, to the tuning circuits.

43. The MOD ON/OFF switch, SK, enables both internal and external modulation to be interrupted.

MONITOR CIRCUITS

Circuit diagram : Chap. 7, Fig. 2 (A5)

44. When the FUNCTION selector is set for a.m. or f.m. modulation the output from the internal or external modulation oscillator is routed to the monitor circuits on A5.

45. The a.f. is rectified by the circuit D1 and D2 and the positive d.c. output is applied to the meter ME1 through the emitter follower TR1 and diode D3. To obtain the desired sensitivity the meter is backed off by a set d.c. level from the network R10, R11 and R12 and by preset adjustment of R2 which sets a reference level to the detector circuit D1 and D2. Thermistor R9 provides the necessary temperature compensation to the network R10, R11 and R12 while D3 prevents the application of reverse currents to TR1.

46. When the FUNCTION switch is set for c.w. operation, the meter only indicates correct a.l.c. operation, since the calibration accuracy of the fine r.f. output control is largely dependent upon the performance of the a.l.c. loop A4. The circuit A5R10 to R16 forms a limits bridge with R13 preset to position the pointer of the meter at the centre of the white box on the meter scale.

47. Provided the output from the second a.l.c. remains within certain limits, diodes D4 and D5 are non-conducting. Should the a.l.c. loop operate incorrectly due to malfunction of the r.f. circuits, the operational amplifier A4IC1 will produce an output that is out of limits. The appropriate diode then conducts, causing the bridge condition to change such that the meter pointer will be positioned at zero or f.s.d.

POWER UNIT

Circuit diagram : Chap. 7, Fig. 2 (A6)

48. The power unit, which operates by switch selection from a.c. supplies of 95 to 132 V or 190 to 264 V, 45 to 500 Hz, is driven from a double secondary mains transformer A0T1. The transformer is torroidal, with a mumetal screen, both factors contributing to low hum radiation.

49. The higher voltage secondary winding, which gives 27 V r.m.s. is fed to a full-wave rectifier bridge D9, D10, D11 and D12, and a conventional regulator circuit, giving a +20 V stabilized output. This regulator supplies all the circuits except the tuning circuits, r.f. oscillators and 1st a.l.c., which are driven from a +21 V regulator. The second secondary of the transformer (10 V r.m.s.) is full-wave rectified by D5, D6, D7 and D8, and is fed to a monolithic 5 V regulator IC1, which takes its 'common' terminal from the +20 V supply. It therefore supplies +5 V +20 V = +25 V to the +21 V regulator, which is a high performance circuit giving the low ripple and high regulation needed for the r.f. oscillator control. The 21 V regulator sampling lines maintain the voltage across the tuning network, although some drift compensation is introduced by the thermistor R36, mounted in the filter box.

CAUTION

> Both voltage supplies are short-circuit proof when the instrument is mains supplied. However, if a short circuit fault occurs, the instrument must be switched off to allow the circuits to recover for a few minutes. The pilot lamp is extinguished when the instrument recovers.

50. Short circuit protection is provided by a two-transistor equivalent of an s.c.r. TR18, 19 but with complementary gates, one of which can be triggered by a positive-going pulse, the other by a negative-going pulse.

SUPPLY FILTERS

51. Filters are incorporated in supply lines to various units to ensure that spurious r.f. signals are not introduced into the circuits. All the filters are contained in a separately screened box which consists of two screen divided sections. Each filter employs two series connected chokes and lead-through type shunt capacitors.

Chapter 5

MAINTENANCE

CONTENTS

INTRODUCTION

1. This chapter contains information for keeping the equipment in good working order, for checking its overall performance and for tracing faults. Before attempting any maintenance on the equipment you are advised to read the preceding Technical Description chapter.

ACCESS TO SUB-ASSEMBLIES

Screw fasteners

2. The majority of screw threads used in the instrument are metric of various sizes but in some positions BA threads are used. Ensure that screws removed are refitted in original positions.

Removal of case

3. The case is in two sections. Remove the six screws at the rear of the instrument and then slide off the top and bottom sections.

Units A1 and A2

4. A1 and A2 form the r.f. oscillator mother board, which is contained within the r.f. box. To obtain access, remove the cover of the r.f. box by removing the four fixing screws. Unit A1/A2 is hinged to provide access to the underside of A1 and to A2 as shown in Fig. 1. A1 is retained by five M3 screws, one of which is in the middle of the board. The hinge pivot bolts must be loosened before hinging the board out for access.

CAUTION

Touching tuned circuits on the oscillator board A1/A2 may stop oscillation, giving the false impression of circuit failure. To restore the normal a.l.c. working conditions switch the instrument momentarily off and on.

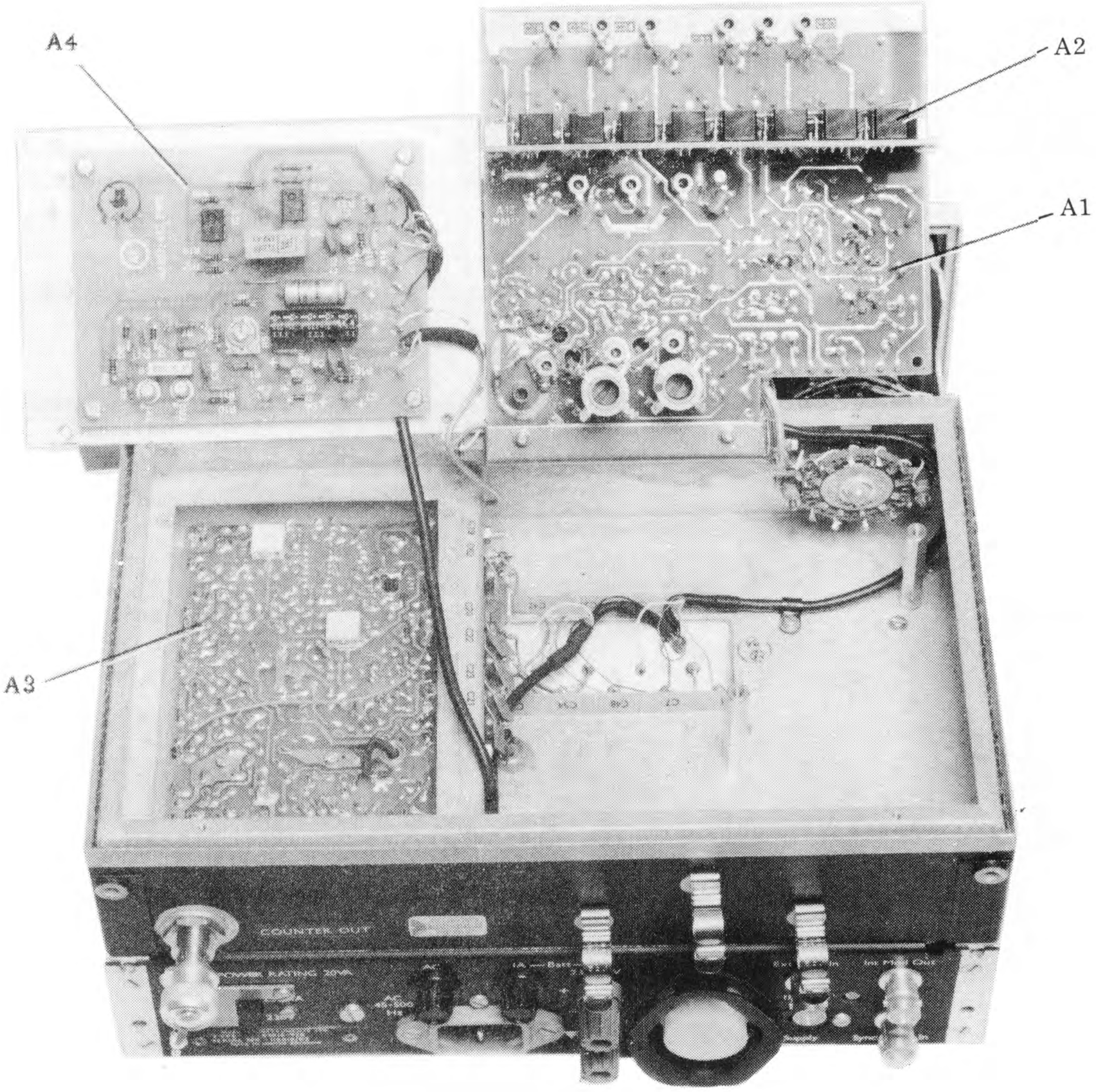


Fig. 1 Top view showing boards A1 to A4

Units A3 and A4

5. The position of these units is shown in Fig. 1. Access to A3 is obtained by removing the four screws holding the screening plate and then by carefully folding this back with A4 attached. A3 is retained by four M2 screws and the nut of the output socket mounting pillar - this special nut is 2BA across flats. A4 is retained by four M3 screws.

Units A5 and A6

6. The position of these units is shown in Fig. 2 and both are directly accessible from the underside of the instrument. A5 is retained by the two M2.5 screws, one of which is near the middle of the board, and one M3 screw which fixes the mounting block to the side frame of the instrument. The pivot bolts must be loosened before hinging A5 back. (To retain A5 in the open position while servicing, one pivot may be tightened). A6 is retained by six M2.5 screws and also the support pillar for A5 which is 5.5 mm across flats.

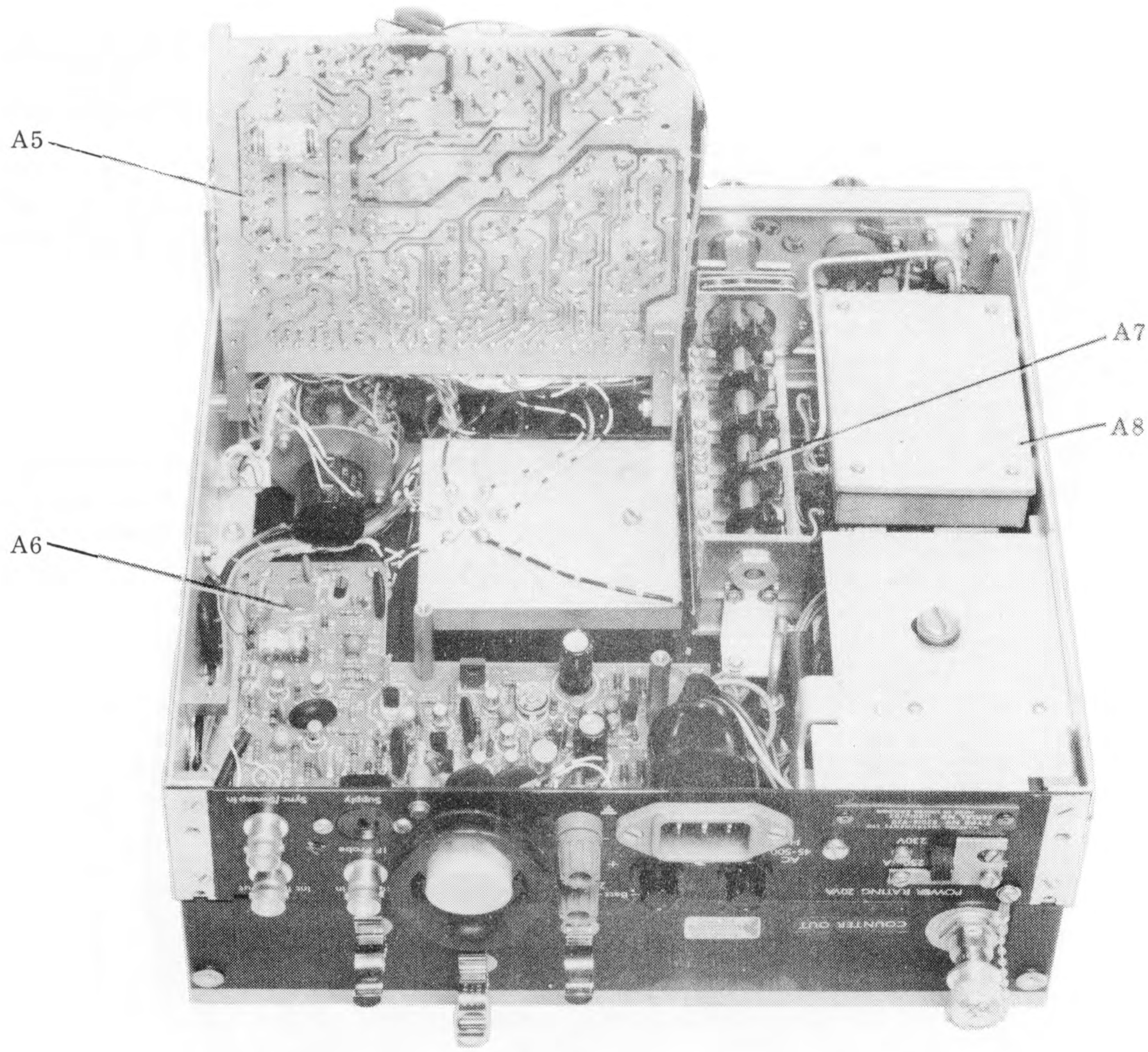


Fig. 2 Bottom view showing boards A5 to A7

Supply filters

7. These are contained in a separately screened compartment. Inputs and outputs can be accessed through the associated capacitors which are accessible by carefully folding A5 upwards and folding A1 back as shown in Fig. 1.

Unit A7

8. To remove the attenuator, carefully disconnect the two semi-rigid coaxial cables, remove the control knob and nut holding the unit to the panel; remove the bracket screw then lift the unit from the chassis.

Unit A8

9. To remove this screened unit, first take out the four screws retaining the RF OUTPUT socket SKH and then disconnect plug PLJ. Remove the three retaining screws from the side of the instrument and lift out the unit.

PERFORMANCE CHECKS

10. Many of the methods in this section are simplified and of restricted range compared with those which would be needed to demonstrate complete compliance with the specification. They should be regarded only as providing a check procedure, for use during routine maintenance, to determine whether adjustment or repair is necessary. Any figures given are for guidance only and should not be taken as guaranteed performance figures unless they are quoted in the Performance Data in Chap. 1.

Note ...

If the results quoted in the following sections are not obtainable, refer to the related section in Chap. 5.

Test equipment

11. The test equipment required for maintenance and repair of the instrument is listed in Table 1.

Note ...

When making tests to verify that the instrument meets the stated performance limits, allowance must always be made for the uncertainty of the test equipment used.

TABLE 1 TEST EQUIPMENT

Item	Description	Recommended model (Marconi Instruments unless otherwise stated)
a	200 MHz counter	2431A
b	Variable voltage transformer	Variac
c	'N' type 50 Ω load	TM 7967
d	Digital voltmeter, up to 50 V with resolution of 1 in 10^3	
e	100 MHz oscilloscope	
f	Wave analyser	TF 2330A
g	RF millivoltmeter	TF 2603
h	'T' connector	TM 7948
i	Distortion factor meter	TF 2331A
j	AM/FM modulation meter	TF 2300B
k	AF oscillator	TF 2000
l	Psophometer	Hatfield Instruments MBC 1000 with A4/1000 filter
m	RF detector	TM 9650
n	Spectrum analyser	TF 2370 with Extender Unit TK 2373
o	Multimeter	GEC Selectest
p	Video oscillator, 1 MHz at 6.5 V	Krohn-Hite 4200

Power supply : A6

Test equipment : items b, d, f.

12. The power supply output lines are checked as follows :-

(1) With TF 2016A connected to the a.c. supply and switched on, connect the digital voltmeter between tag 28 (positive) and tag 23 (negative) and check that the meter indicates 20 V ±100 mV. If necessary, adjust R39 to obtain this requirement.

(2) Connect the digital voltmeter between tag 24 (positive) and tag 27 (negative) and check that the meter indicates 21 V ±100 mV when the instrument is at normal room temperature, i.e. not yet warmed up. If necessary, select values for R49 and R150 to obtain this requirement.

(3) Apply the a.c. input through a variable voltage transformer and check, using the digital voltmeter, that with inputs to the power supply of between 190 and 264 V the voltage between tag 24 and tag 27 is maintained to within ±2 mV of that obtained in (2).

(4) Disconnect the digital voltmeter and with the a.c. input at 230 V connect the wave analyser set for battery operation, in turn to the 20 V and 21 V outputs. The 100 Hz ripple should not be greater than 250 μV r.m.s. and 2 μV r.m.s. at the respective outputs.

(5) Disconnect the a.c. supply and connect a 23 V d.c. supply to the battery terminals and check that the 21 V output at tag 24 is within ±400 mV.

(6) Disconnect the d.c. supply and re-connect TF 2016A directly to the a.c. supply.

Frequency calibration : A1

Test equipment : items a, b.

13. The following procedure describes how to check and readjust the carrier frequency scale calibration.

(1) Set the FUNCTION selector at CW and CARRIER switch at ON then ensure that the pointer of the MOD/CARRIER meter is within the white box.

(2) Connect the counter to the RF OUTPUT socket on the front panel. Set the CARRIER RANGE selector in turn to ranges 1 to 12 and check, using the TUNE, FINE TUNE and EXTRA FINE TUNE controls, that the scale calibrations at three points on each range, i.e. low and high frequency ends and at a centre frequency, are within ±2% of counter indication.

(3) If necessary, for ranges 1 to 9 inclusive, adjust the appropriate tuning coil core for low frequency correction and the appropriate trimming capacitor for high frequency correction. Since the coil and trimmer capacitor are interdependent ensure that after the second adjustment the first adjustment remains correct.

(4) For ranges 10 to 12, range 12 should be adjusted first. Coarse adjustment is carried out by repositioning the wire loop (three alternative positions are shown illustrated in Chap. 7, Fig. 3) or if necessary by altering the length of loop. Fine adjustment is carried out by means of a small coil former inside the printed coil L12 and its associated trimming capacitor; then adjust range 11, and then range 10. This is because the coils for ranges 10 to 12 are connectedin series.

Note ...

Coil former replacements are supplied with four fixing pins attached to the base. These should be removed and the new former affixed instead to the printed circuit board using a suitable adhesive.

RF output (normal)

Test equipment : items g, h

14. The following procedure verifies the action of the a.l.c. at the normal maximum c.w. output.

(1) With the FUNCTION selector and CARRIER switch set as in para. 13 (1) connect the millivoltmeter to the output of TF 2016A.

(2) Set the RF OUTPUT controls to maximum positions; that is, the COARSE output control fully clockwise (600 mV, -2 V position) and the FINE output control on the 2 V mark.

(3) Verify that the pointer of the MOD/CARRIER LEVEL meter is within the white box. Using the TUNE control to step through each frequency range, verify that the output level is held at 2 V e.m.f. (1 V p.d.) ±0.25 dB (± voltmeter response) up to 120 MHz.

(4) Ensure that when making each check the pointer of the MOD/CARRIER meter remains within the white box.

RF output (+6 dB)

Test equipment : items g, h

15. The following procedure checks the action of the +6 dB switch.

(1) With the FUNCTION selector, CARRIER switch, RF OUTPUT controls, set as in para. 14, and with the millivoltmeter connected to the RF OUTPUT SOCKET, set the frequency of TF 2016A at 1 MHz.

(2) Note the indicated output then set the CARRIER switch at +6 dB and check that the output level has been increased by +6 dB ±0.5 dB.

(3) Repeat the check with TF 2016A tuned to 120 MHz and check that with the CARRIER switch at ±6 dB the output level has been increased by 6 dB ±0.5 dB.

VSWR

Test equipment : items c, g, h

16. The following procedure can be used to check the v.s.w.r. at any frequency from 10 kHz to 120 MHz.

(1) With the TF 2016A controls set as in para. 14, with 10 dB or more in the coarse attenuator, connect the voltmeter to the RF OUTPUT of TF 2016A using the T connector and note the indicated output level.

(2) Connect the 50 Ω load to the T connector and again note the indicated output level.

(3) Compute the impedance Z using the following formula :

$$Z = \frac{50E}{V} - 50$$

where E = the open circuit output level

and V = the output across the 50 Ω load.

From the above,

$$\text{v.s.w.r.} = \frac{Z}{50}$$

The v.s.w.r. should be better than 1.2:1

Modulation oscillator performance

Test equipment : items a, i.

17. To test the frequency, distortion and output of the modulation oscillator proceed as follows :-

(1) Set the FUNCTION selector at INT MOD and the CARRIER switch at OFF.

(2) Connect the counter to the INT MOD OUT socket (rear of instrument) and check that the indicated frequency, selected by the MOD FREQUENCY switch, is between (i) 900 Hz and 110 Hz (for 1 kHz) or (ii) 360 Hz and 440 Hz (for 400 Hz).

(3) Disconnect the counter and connect the distortion factor meter (d.f.m.) to the INT MOD OUT socket. The measured distortion should not be greater than 0.25%.

(4) Set the d.f.m. to measure voltage and check that the measured voltage approximates 1.3 V r.m.s. into a high resistance load.

FM deviation

Test equipment : item j.

18. To check and readjust the deviation accuracy proceed as follows :-

(1) Set the FUNCTION switch at INT FM, the CARRIER switch at ON and the MOD switch at ON. Set the frequency of TF 2016A at 20 MHz and then adjust the SET MOD control to centre the pointer of the MOD/CARRIER meter.

(2) Connect the modulation meter tuned to 20 MHz to the RF OUTPUT on TF 2016A.

(3) Set the DEVIATION controls at x3 and 25 kHz respectively. The measured deviation should be within ±15% of 75 kHz. If necessary, adjust SET MOD to obtain this requirement and then reset A5R2 to centre the pointer of the meter.

Note ...

If this adjustment is made the a.m. should be checked.

(4) Set the DEVIATION multiplier at x1. The measured deviation should now be within ±15% of 25 kHz. If necessary, adjust A5R43 to obtain this requirement.

(5) Set the DEVIATION multiplier at ÷ 5. The measured deviation should now be within ±15% of 5 kHz. If necessary, adjust A5R46 to obtain this requirement.

FM tracking

Test equipment : item j.

19. To check the f.m. tracking proceed as follows :-

(1) Connect the modulation meter to the RF OUTPUT of TF 2016A.

(2) Set the FUNCTION selector at INT FM, the CARRIER switch at ON and the MOD switch at ON.

(3) Adjust the SET MOD control to centre the pointer of the MOD/CARRIER meter. Then set the DEVIATION multiplier at x3 and the deviation control at 25 kHz.

(4) Set the CARRIER RANGE selector at 10 - 23 MHz and check that at frequencies 10, 17 and 23 MHz the measured deviation is 75 kHz ±15%.

AM depth

Test equipment : item j or e.

20. To check and readjust the a.m. depth accuracy, proceed as follows :-

(1) Set the FUNCTION selector at INT AM, set the CARRIER switch at ON and the MOD switch at ON. Set the frequency of TF 2016A at 20 MHz then adjust the SET MOD control to centre the pointer of the MOD/CARRIER meter.

(2) Set the AM DEPTH control at 80%.

(3) Connect the modulation meter to the RF OUTPUT on TF 2016A. Set the RF OUTPUT controls to provide a suitable input to the modulation meter then tune the modulation meter to TF 2016A.

(4) Check that the measured a.m. depth (average of peak and trough readings) is between 76% and 84%.

(5) Repeat with the AM DEPTH control at 30% and check that the measured a.m. depth is between 26.5% and 33.5%. If necessary, adjust A5R19 to obtain the best results for both 80% and 30% depths.

Note ...

If a modulation meter is not available the a.m. depth can be assessed by using the oscilloscope to measure the peak and trough values of the modulation envelope. The a.m. depth is then determined by

$$\text{AM depth } \% = \frac{Vp - Vt}{Vp + Vt} \times 100$$

where V_p and Vt are the measured peak-to-peak and trough-to-trough amplitudes respectively.

ALC system

21. Correct operation of the a.l.c. system can be quickly proved as follows :-

(1) Set the FUNCTION selector at CW and the CARRIER switch at ON. Then check that the pointer of the MOD/CARRIER meter is within the white box.

(2) Switch to each CARRIER RANGE in turn and use the TUNE control to check that over each frequency range the pointer of the MOD/CARRIER meter remains within the white box.

(3) Repeat with output set to the low end of the fine attenuator and then in the +6 dB position with the fine attenuator at maximum (with a 50 Ω load).

Counter output level

Test equipment : items g, h.

22. To check the counter output level proceed as follows :-

(1) Set the FUNCTION selector at CW and the CARRIER switch at ON.

(2) Connect the voltmeter with 50 Ω 'T' piece to COUNTER OUT socket (rear of instrument) then check that with TF 2016A tuned to 120 MHz the output level is not less than 50 mV p.d.

External modulation sensitivity

Test equipment : item k.

23. To check the external modulation input level required proceed as follows :-

(1) Set the FUNCTION selector at EXT AM, the CARRIER switch at ON and the MOD switch at ON.

(2) Using the external a.f. generator connected to the EXT MOD IN socket (rear of instrument) check that, with an input signal of less than 1.5 V r.m.s. at frequencies of 30 Hz, 1.5 kHz, 10 kHz and 50 kHz, the pointer of the MOD/ CARRIER meter can be centred.

(3) Repeat the above with FUNCTION selector at EXT FM.

Note ...

The TF 2016A meter can be overloaded if the applied a.f. input exceeds 10 V.

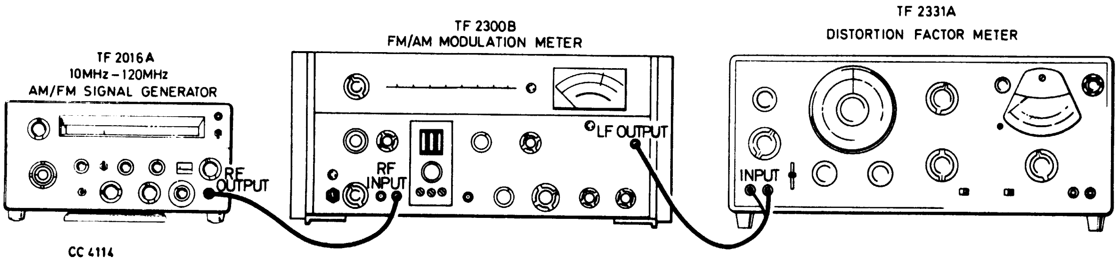


Fig. 3 Checking f.m. and a.m. distortion.

AM distortion

Test equipment : items i, j.

24. To check the internal and external a.m. distortion proceed as follows :-

(1) Connect the test equipment as shown in Fig. 3.

(2) Set the FUNCTION selector at CW, the CARRIER switch at ON, the MOD switch at ON and the frequency of TF 2016A at 30 MHz. Then check that the pointer of the MOD/CARRIER meter is within the white box.

(3) Set the FUNCTION selector at INT AM. Then adjust the SET MOD control to centre the pointer of the MOD/CARRIER meter.

(4) Set the AM DEPTH control at 30%. Then tune the modulation meter to TF 2016A and check that the distortion indicated on the distortion factor meter is not greater than 1.5%.

(5) If required, repeat the check using the external a.f. generator for modulation frequencies at 100 Hz and 10 kHz.

FM distortion

Test equipment : items i, j.

25. To check the internal and external f.m. distortion proceed as follows :-

(1) With the test equipment connected as in Fig. 3 repeat para. 24 (2). Then

set the FUNCTION selector at INT FM and the SET MOD control to centre the pointer of the MOD/CARRIER meter.

(2) Set the DEVIATION multiplier at x1 and the DEVIATION control at 25 kHz.

(3) Ensure that the modulation meter is tuned to TF 2016A. Then check that the distortion indicated on the distortion factor meter is not greater than 2%.

(4) If desired, repeat the check using the external a.f. generator for modulation frequencies at 100 Hz and 20 kHz.

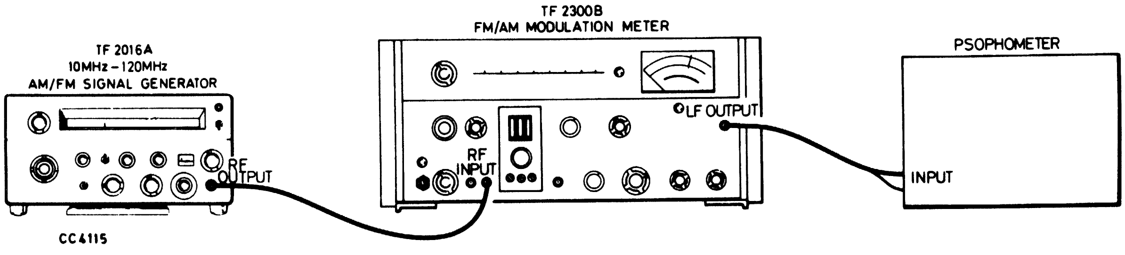


Fig. 4 Checking spurious f.m. on c.w.

Spurious f.m. on c.w.

Test equipment : items j, l.

26. To check the unwanted f.m. deviation on a c.w. output proceed as follows :-

(1) Connect the test equipment as in Fig. 4.

(2) Set the FUNCTION selector at CW, the CARRIER switch at ON and the MOD switch at ON. Then tune TF 2016A to 120 MHz and ensure that the pointer of the MOD/CARRIER meter is within the white box.

(3) Set the FUNCTION selector at INT FM. Then adjust the SET MOD control to centre the pointer of the MOD/CARRIER meter.

(4) Set the DEVIATION multiplier at x1 and the DEVIATION control at 20 kHz.

(5) Set the psophometer controls as follows :

INPUT SELECTOR	:	Terminated
WEIGHTING	:	FILTER NO.1 (telephone)
ATTENUATOR	:	0 dB

(6) Tune the modulation meter to TF 2016A. Then set the ADJUST CALIBRATION control on the psophometer for a meter indication of 0 dB.

(7) Set the FUNCTION selector at CW. Then adjust the psophometer attenuator to restore the meter pointer at 0 dB, and check that the change is greater than 60 dB (deviation less than 20 Hz).

Spurious a.m. on c.w.

Test equipment : items m, l.

27. To check the depth of unwanted a.m. on a c.w. output proceed as follows :-

(1) Connect the test equipment as shown in Fig. 5. Then with the FUNCTION selector at CW, the CARRIER switch at ON, the MOD switch at ON and TF 2016A tuned to 100 MHz check that the pointer of the MOD/CARRIER meter is within the white box.

(2) Set the FUNCTION selector at INT AM. Then adjust the SET MOD control to centre the pointer of the MOD/CARRIER meter.

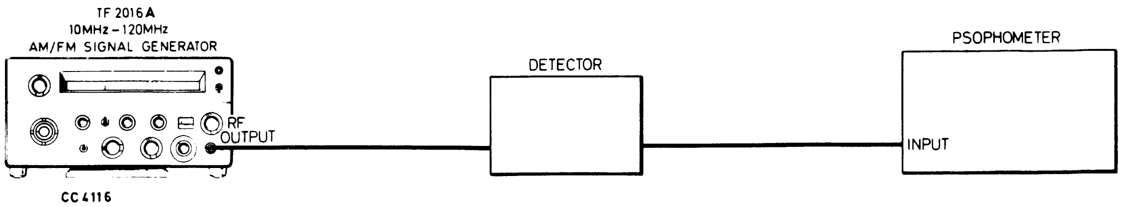


Fig. 5 Checking spurious a.m. on c.w.

(3) Set the AM DEPTH control at 30% and the TF 2016A output at maximum.

(4) Set the psophometer controls as follows :-

INPUT SELECTOR	:	THRO
WEIGHTING	:	FILTER NO. 1 (telephone)
VOLTAGE/dBm RANGE	:	to suit detector output

(5) Switch the psophometer to INTERNAL SUPPLY. Then adjust the VOLTAGE/dBm RANGE switch and the ADJUST CALIBRATION control for a convenient indication on the meter. Note the setting of the VOLTAGE/dBm RANGE switch and the meter indication.

(6) Set the TF 2016A FUNCTION selector at CW. Then increase the VOLTAGE/dBm RANGE switch on psophometer by 50 dB. The meter should indicate a level which is at least 56 dB less than that noted in (5).

Carrier harmonics

Test equipment : item n.

28. To check the level of harmonics of the carrier frequency in a c.w. output proceed as follows :-

(1) Connect the RF OUTPUT of TF 2016A to the r.f. input of the spectrum analyser.

(2) Set the FUNCTION selector at CW, the CARRIER switch at ON and the RF OUTPUT controls to maximum indication. Then ensure that the pointer of the MOD/ CARRIER meter is within the white box.

(3) Tune TF 2016A through each r.f. range and check that the amplitude of any harmonic is greater than 26 dB down on the fundamental.

Coarse r.f. output control

Test equipment : item f, or g and h, or n.

29. Provided the protection level given by the reverse power protection unit is not exceeded, it should not be possible to damage the attenuator resistors by accidental misuse of the TF 2016A. The attenuator microswitch action may be checked in the following manner.

(1) With the SUPPLY switch at ON, and the CARRIER switch at ON, connect the millivoltmeter (or alternative) to the RF OUTPUT socket.

(2) Position the COARSE control in turn to each dB setting and check that, within the range of the test equipment, attenuation at each setting changes by 10 dB.

Fine r.f. output control

Test equipment : item g.

30. To check the accuracy of the fine r.f. output control proceed as follows :-

(1) Connect the voltmeter to the RF OUTPUT socket.

(2) Set the SUPPLY switch at ON, the FUNCTION selection at CW and the CARRIER switch at ON. Tune TF 2016A to 100 MHz and check that the pointer of the MOD/CARRIER meter is within the white box.

(3) Set the COARSE control at maximum and the FINE control at 2 V; then note the reading obtained on the voltmeter.

(4) Repeat check (3) with the FINE control in turn at 1.7 V, 1.4 V, 1 V, 800 mV, 600 mV. Voltmeter readings should be within ±3% of fine attenuator settings ± voltmeter error).

Reverse power protection

Test equipment : items g and p.

31. To check the operation of the trip circuit under d.c. conditions proceed as follows :-

(1) Set the coarse attenuator fully clockwise. Set SUPPLY switch to ON. Connect a 1 μF (or larger value) capacitor across the IF PROBE socket on the back panel (+ve pin is off centre).

(2) Connect the +20 V terminal of the i.f. probe socket on the back panel to the centre pin of the RF OUTPUT connector on the front panel. Although this socket is a.c. coupled, the transient produced will confirm the operation of the reverse power protection unit. The exact sensitivity may be confirmed if required by using the r.f. millivoltmeter and high level video oscillator at 1 MHz applied to the RF OUTPUT socket, (factory set to 6.4 V r.m.s.).

FAULT LOCATION

32. Some aid to fault finding is provided by the typical d.c. voltage and signal levels given in Tables 1 and 2 and by the fault tables included in each of the following sections. The tables are not extensive but are intended as a pointer to further investigation. It is to be emphasized that each fault table should be studied having regard for the others since incorrect operation of a circuit may be caused by malfunction of an associated circuit.

DC voltages

Test equipment : item o.

33. Voltages given on the circuit diagrams are indicative of those which can be expected using a 20 kΩ/V meter on a typical TF 2016A connected to an a.c. supply of 240 V, 50 Hz.

34. Unless stated otherwise the voltages were measured with the controls of TF 2016A positioned as follows :-

CARRIER FREQUENCY	:	10 MHz on range 9 or 10 as appropriate
CARRIER switch	:	ON
FUNCTION selector	:	INT AM
RF OUTPUT controls	:	600 mV - 2 V (coarse) and 20 (fine)

35. Before making measurements ensure that screws on Unit A1/A2 are tight.

RF signal levels

Test equipment : item g.

36. The r.f. signal levels listed in Table 2 are indicative of those which can be expected using the specified meter on a typical TF 2016A. Unless otherwise stated, measurements were made with the TF 2016A controls set as follows : -

FUNCTION selector	:	INT AM
AM DEPTH control	:	0%
RF OUTPUT controls	:	60-200 mV (coarse) and 20 (fine)
CARRIER switch	:	ON

and with the earth probe of the voltmeter connected to a position on the earth track on the printed board close to the test point. These figures are given as a guide to relative stage gains; actual levels may vary by 25% at some intermediate stages but the levels at TR10 emitter should always be close to the specified value.

TABLE 2 RF SIGNAL LEVELS

Test point (on A3)	Carrier frequency : 1 MHz		Carrier frequency : 120 MHz	
Pin 1	44 mV		29 mV	
TR1 e	7.1 mV		4.2 mV	
c	7.3 mV		4.8 mV	
IC1 pin 13	9.0 mV		3.5 mV	
TR2 c	22 mV		3.8 mV	
TR3 c	57 mV		26 mV	
	RF OUTPUT (with 50 Ω load)		RF OUTPUT (with 50 Ω load)	
	2 V	† 4 V	2 V	† 4 V
TR4 c	64 mV	85 mV	31 mV	49 mV
TR6 c	40 mV	89 mV	48 mV	100 mV
TR7 c	460 V	920 V	205 mV	440 V
TR8 e	455 V	210 V	245 mV	510 V
*TR9 c	2.1 V	4.2 V	1.95 V	3.7 V
e	4.3 mV	825 mV	280 mV	595 mV
*TR10 e	2.13 V	4.2 V	2.12 V	4.15 V
TP1	9.8 mV	9.0 mV	2.7 mV	2.75 mV
TP2	56 mV	56 mV	13.8 mV	11 mV
TP3	43 mV	88 mV	27 mV	60 mV
TP4	450 V	905 mV	160 mV	350 mV

† With CARRIER switch at +6 dB
* Measurements using 100 : 1 Adapter TM 7947 on TF 2603

AF signal levels

Test equipment : item c.

37. The a.f. signal levels listed in Table 3 are indicative of those which can be expected on

a typical TF 2016A. Unless stated otherwise, measurements were made with TF 2016A set as follows :-

CARRIER RANGE	:	10
TUNE	:	10 MHz
CARRIER switch	:	ON
FUNCTION selector	:	INT AM
AM DEPTH control	:	0%

TABLE 3 AF SIGNAL LEVELS

Test point	Reading	Control settings	
A6 pin 8	1.4 V - 1.8 V		
A5 pin 2	1.1 - 1.15 V	CARRIER & MOD METER centred	
A5 pin 15	810 mV	AM DEPTH : 80%	
A5 pin 23	1 V		CARRIER RANGE : 7 FUNCTION : INT FM DEVIATION kHz : 25 x 3
A5 TR8 e	4.95 V		
A5 pin 41	3.2 V	TUNE to max.	
	310 mV	TUNE to min.	

Power supply

Circuit diagram : Chap. 7, Fig. 2 (A6)

38. Typical power supply fault conditions are listed in Table 4.

TABLE 4 POWER SUPPLY FAULTS

Fault	Probable cause
Fuse FS1 blows when instrument is switched on.	Check for short circuit in a.c. input wiring. Check reservoir capacitors A0C60 or C61 for short or partial short circuit.
No 20 V output.	Instrument short circuit supply protection operative - allow instrument to recover (see Chap. 4, para. 49). Check A0TR1 for open circuit. Check A0C60, C61 or A6C23 for short or partial short circuit.
No 21 V output.	Power supply may be tripped (short circuit or overload). Check for short circuit on 21 V line. A6TR9 may be open circuit.
20 V line cannot be set to ±100 mV.	Check TR11 or TR12. Check resistors for value or continuity. Check A6C25 or C26 for short or partial short circuit. Check A6IC1 and D17 for faults.
21 V line is not correct to ±100 mV.	Check TR10, TR13 or TR15. Check resistors, especially R44, R49 or R50. Thermistor A0R36 may be short circuit.
100 Hz ripple on the 20 V supply is greater than 250 μV r.m.s.	A0C61, A6C24 or C25 may be open circuit or low capacitance. D9 - D12 faulty. TR11 or TR12 may be faulty.

TABLE 4 POWER SUPPLY FAULTS (continued)

Fault	Probable cause
100 Hz ripple on 21 V supply is greater than 2 μV r.m.s.	A0C60 may be open circuit or low capacitance, similarly A6C29. TR14 or TR15 may be faulty.

Frequency calibration

Circuit diagram : Chap. 7, Fig. 4 (A1 & A2)

39. Typical frequency calibration fault conditions are listed in Table 5.

TABLE 5 FREQUENCY CALIBRATION FAULTS*

Fault	Probable cause
Calibrations incorrect all ranges.	Incorrect d.c. voltage at A5 pin 41. Check d.c. path to switch SG.
Inability to set scale calibrations on either ranges 1 to 9 or 10 to 12.	Incorrect d.c. voltage to A1R14 (ranges 1 to 9) or R44 (ranges 10 to 12). Check output A5 pin 41, D2/3 or D11 faulty.

*See CAUTION on p.2, para. 4, of this chapter.

RF output

Circuit diagram : Chap. 7, Fig. 2 (A5) and Fig. 6 (A3).

40. Typical r.f. output fault conditions are listed in Table 6.

TABLE 6 RF OUTPUT FAULTS*

Fault	Probable cause
Low counter output	Low r.f. oscillator level.
Meter pointer not within white box on c.w.	Incorrect d.c. outputs A5 pins 14 or 15. Check circuit A5TR3. Faulty resistor or diode in circuit A5R10 to R16, D4 or D5. Incorrect operation of circuit A4R1 to R7 and TR1 and TR2. Fault in amplifier levelling stages TR5 and TR12. D2 or D3 faulty. Fault in second a.l.c. loop. Check A4IC1 and IC2.
No output but meter within white box on c.w.	Suspect attenuator or reverse power protection unit - see Table 11.
+6 dB output not obtainable	Faulty carrier switch SB. Faulty diode A5D6 or R25. Recheck operation of circuit A4IC1 and IC2 for increased d.c. level to amplifier levelling stages. A3TR5 or 12 faulty.

*See CAUTION on p. 2, para. 4, of this chapter.

VSWR

41. Check that A3R84 is 50 Ω ±1% and recheck A7 as given in Chap. 5, para. 29.

Modulation oscillator

Circuit diagram : Chap. 7, Fig. 2 (A6)

42. Typical modulation oscillator faults are listed in Table 7.

TABLE 7 MODULATION OSCILLATOR FAULTS

Fault	Probable cause
No output or incorrect output.	No 20 V at pin 1 : check switch SA1F. TR1 or TR2 faulty.
Frequency incorrect.	R1, R2, R6, C2, C3, C9 or C11 may be faulty : check values. Faulty switch SH.
Distortion greater than 0.25%.	Faulty transistor TR3. Check C13.

Amplitude modulation

Circuit diagram : Chap. 7, Figs. 2 & 6 (A5 & A3)

43. Typical amplitude modulation faults are listed in Table 8.

TABLE 8 AMPLITUDE MODULATION FAULTS

Fault	Probable cause
Inability to set meter pointer at centre of white box by adjusting SET MOD control.	A0R4 faulty. Fault in monitor circuit A5TR1.
Inability to obtain required modulation depth.	Fault in a.m. circuit A5TR2. Incorrect operation of modulator. Check a.f. path from SET MOD control to modulator.
Envelope distortion.	Fault in modulation oscillator. Fault in A5TR2 circuit. A3IC1 (R18) maladjusted. Fault in amplifier output stage A3TR8 to TR11.

Frequency modulation

Circuit diagram : Chap. 7, Fig. 2 (A5)

44. Typical frequency modulation faults are listed in Table 9.

TABLE 9 FREQUENCY MODULATION FAULTS*

Fault	Probable cause
No frequency modulation.	Check a.f. path from SET MOD control to TR7. Incorrect operation of A5TR6 to TR10. Switch SG or switch SD faulty.
Incorrect deviation.	Faulty resistor A0R6 to R11 or A5R56 to R62.
FM distortion.	Incorrect operation of A5TR6 to TR10 or modulation oscillator or r.f. oscillator.

*See CAUTION on p.2, para. 4, of this chapter.

ALC system

Circuit diagrams : Chap. 7, Figs. 2 & 6 (A3, A4 & A5)

45. Typical a.l.c. faults are listed in Table 10.

TABLE 10 ALC FAULTS

Fault	Probable cause
Meter pointer at zero or full-scale - all ranges.	Fault in r.f. signal path. Check outputs from circuits on A4 and A3. Fault in circuit A4IC1 and IC2 : check outputs. Check diodes A3D2 and D3.
- On one range only.	No input to A4 pin 1 : suspect appropriate oscillator range switching circuit.

Reverse power protection

Circuit diagram : Chap. 7, Fig. 8

46. Typical reverse power protection faults are listed in Table 11.

TABLE 11 REVERSE POWER PROTECTION FAULTS

Fault	Probable cause
No r.f. output.	Relay A8RLA sticking open. RESET switch or control circuit faulty.

Carrier harmonics

Circuit diagram : Chap. 7, Fig. 6 (A3 & A4)

47. If harmonics are too high on all ranges, suspect incorrect operation of first a.l.c. loop causing high oscillator outputs to overload amplifier or modulator not set up correctly. For

amplifier distortion check circuits A3TR2 to TR4, TR6 to TR11.

Spurious modulation

48. If spurious f.m. or a.m. are too high check for excess ripple on 21 V or 20 V d.c. supplies. If noise on the tuning line is suspected try decoupling with a 100 μF capacitor. Check for oscillator faults by measuring the d.c. and r.f. operating voltages on A1.

CLEANING ROTARY SWITCHES

49. If it is necessary to clean the contacts of any rotary switches, this should be done with benzine or white spirit (not carbon tetrachloride) and the contacts should afterwards be wiped with a suitable lubricant such as a 1% solution of petroleum jelly in white spirit. Avoid lubricants containing soap or solid materials.

REPLACING TUNING DRIVE CORD

50. The procedure for fitting a new drive cord is given below. A drive cord consists of 1 metre of nylon cord (Part no. 16410-604V). A new tension spring (Part no. 31119-017X) may also be required.

(1) Remove the case from the instrument and remove the attenuator unit (see Chap. 5 para. 8) and the reverse power protection unit.

(2) Remove the scale plates for the three highest frequency ranges.

(3) Set the RANGE switch to the 22 - 48 kHz position.

(4) Stand the instrument upside-down on the bench.

(5) Referring to Fig. 6, slacken the grub screws and unscrew the nut to pull aside R33.

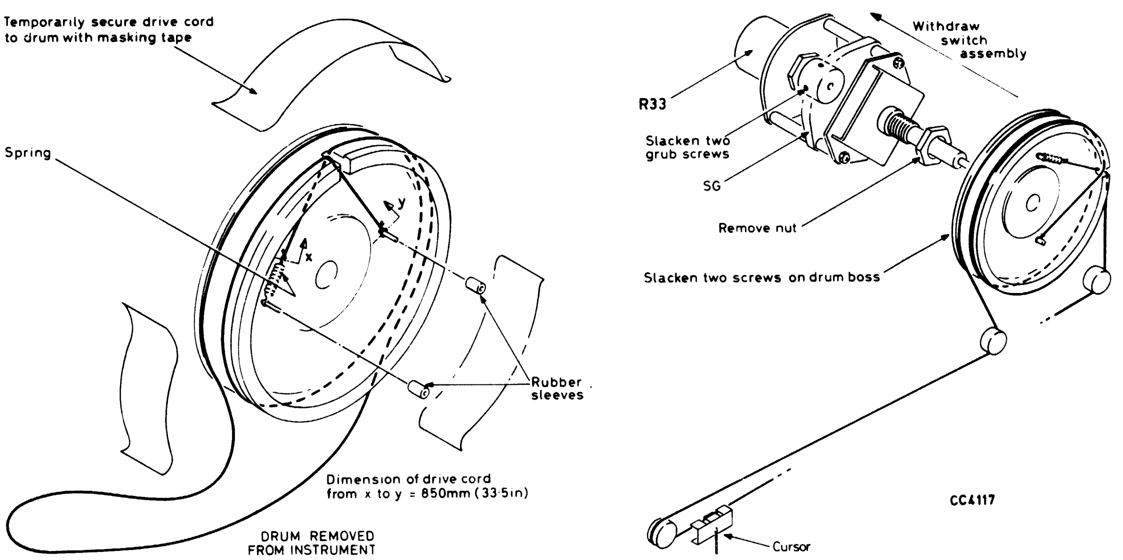


Fig. 6 Replacing drive cord.

With the TUNE control three steps away from the fully counter-clockwise position, slacken one of the grub screws in the cord-drum boss. Turn the TUNE control fully clockwise and slacken the other grub screw. Remove the TUNE and EXTRA FINE TUNE knobs. Unscrew the nut and pull away the switch assembly SG from the drum.

(6) Remove the drum and attach the drive cord as shown in Fig. 6, temporarily holding it in place with adhesive tape. Seal the cord knots with bakelite varnish.

(7) Replace the drum and completely refit the switch SG and R33 assemblies.

(8) Fit the loop of cord around the three pulleys. Check that the cord spring is under tension. If the cord has been properly dimensioned, the expanded length of the spring will be about 12 mm (½ inch). Refit the knobs.

(9) Attach the pointer to the drive cord and adjust its position so that it reaches (or just passes) the calibration marks on the 53 MHz to 120 MHz range (range 12).

(a) At 53 MHz with both TUNE and FINE TUNE controls fully counter-clockwise.

(b) At 120 MHz with both TUNE and FINE TUNE controls fully clockwise.

(10) Refit scale plates, attenuator unit, reverse power protection unit and case.

ADDITIONAL INFORMATION

51. If further information is required please write or telephone Marconi Instruments Limited, Service Division - see address on back cover - or contact nearest representative, quoting the type and serial number on the data plate on rear of instrument. If the instrument is being returned for repair please indicate clearly the nature of the fault or the work you require to be done.

COMPONENTS

Unit A0 : Overall assembly

7. When ordering, prefix circuit reference with A0.

Circuit reference	Description	Part no.
C1	Cer 50pF 10% 300V	26333-229U
C4	Cer 50pF 10% 300V	26333-229U
C6	Cer 50pF 10% 300V	26333-229U
C7	Cer 0.001μF -20+80% 300V	26373-733K
C8	Tant 4.7μF 20% 35V	26486-219P
C9	Tant 4.7μF 20% 35V	26486-219P
C10	Cer 0.001μF -20+80% 300V	26373-733K
C11	Tant 4.7μF 20% 35V	26486-219P
C12	Cer 0.001μF -20+80% 300V	26373-733K
C13	Cer 0.001μF -20+80% 300V	26373-733K
C14	Tant 4.7μF 20% 35V	26486-219P
C15	Tant 4.7μF 20% 35V	26486-219P
C16	Cer 0.001μF -20+80% 300V	26373-733K
C17	Tant 4.7μF 20% 35V	26486-219P
C18	Cer 0.001μF -20+80% 300V	26373-733K
C19	Cer 500pF -20+80% 300V	26373-732B
C20	Cer 500pF -20+80% 300V	26373-732B
C21	Cer 500pF -20+80% 300V	26373-732B
C22	Cer 500pF -20+80% 300V	26373-732B
C23	Cer 500pF -20+80% 300V	26373-732B

Circuit reference	Description	Part no.
C24	Cer 0.001μF -20+80% 300V	26373-733K
C26	Cer 0.001μF -20+80% 300V	26373-733K
C27	Cer 0.0039μF, 10% 63V	26383-590R
C28	Cer 0.001μF -20+80% 500V	26383-242P
C29	Cer 0.001μF -20+80% 300V	26373-733K
C30	Cer 0.001μF -20+80% 300V	26373-733K
C31	Tant 4.7μF 20% 35V	26486-219P
C32	Cer 0.001μF -20+80% 300V	26373-733K
C33	Tant 4.7μF 20% 35V	26486-219P
C34	Tant 4.7μF 20% 35V	26486-219P
C35	Cer 0.001μF -20+80% 300V	26373-733K
C36	Cer 0.001μF -20+80% 300V	26373-733K
C37	Tant 4.7μF 20% 35V	26486-219P
C38	Cer 0.001μF -20+80% 300V	26373-733K
C39	Tant 4.7μF 20% 35V	26486-219P
C40	Tant 4.7μF 20% 35V	26486-219P
C41	Cer 0.001μF -20+80% 300V	26373-733K
C42	Cer 0.001μF -20+80% 300V	26373-733K
C43	Cer 0.0039μF 10% 63V	26383-590R
C44	Cer 0.001μF -20+80% 300V	26373-733K
C45	Cer 0.0039μF 10% 63V	26383-590R
C46	Cer 0.0039μF 10% 63V	26383-590R
C47	Cer 0.001μF -20+80% 300V	26373-733K
C48	Cer 0.001μF -20+80% 300V	26373-733K
C49	Elec 100μF -20+100% 25V	26415-813U

Unit A0 : Overall assembly (contd.)

Circuit reference	Description	Part no.
C50	Cer 0.001µF -20+80% 300V	26373-733K
C51	Elec 100µF -20+100% 25V	26415-813U
C52	Elec 100µF -20+100% 25V	26415-813U
C53	Cer 0.001µF -20+80% 300V	26373-733K
C54	Cer 0.001µF -20+80% 300V	26373-733K
C55	Tant 4.7µF 20% 35V	26486-219P
C56	Cer 0.001µF -20+80% 300V	26373-733K
C57	Tant 4.7µF 20% 35V	26486-219P
C58	Tant 4.7µF 20% 35V	26486-219P
C59	Cer 0.001µF -20+80% 300V	26373-733K
C60	Elec 1000µF -10+50% 40V	26426-080J
C61	Elec 2200µF -10+50% 40V	26426-086D
C62	Cer 500pF -20+80% 300V	26373-732B
C63	Cer 0.022µF -25+50% 18V	26383-007R
C64	Cer 0.022µF -25+50% 18V	26383-007R
C65	Cer 0.022µF -25+50% 18V	26383-007R
C66	Cer 0.047µF 20% 100V	26386-408R
C67	Cer 0.022µF -25+50% 18V	26383-007R
C68	Cer 0.022µF -25+50% 18V	26383-007R
C69	Cer 0.022µF -25+50% 18V	26383-007R
C70	Cer 0.047µF 20% 100V	26386-408R

Circuit reference	Description	Part no.
C73	Cer 0.47µF -20+80% 50V	26383-531H
C74	Cer 0.47µF -20+80% 50V	26383-531H
D1	LED MV 5053 (SUPPLY ON)	28624-104W
D2	LED LLL7 (TRIP)	28624-105D
FS1	250mA time lag (230 V)	23411-055P
	or 500 mA time lag (115 V)	23411-056X
	Holder for FS1	23416-191C
FS2	1A quick action	23411-006Y
	Holder for FS2	23416-191C
FS3	250 mA time lag (230 V)	23411-055P
	or 500 mA time lag (115 V)	23411-056X
	Holder for FS2	23416-191C
L1	Choke 1mH	23642-337H
L2	Choke 1mH	23642-337H
L3	Choke 100µH	23642-325P
L4	Choke 100µH	23642-325P
L5	Choke 100µH	23642-325P
L6	Choke 100µH	23642-325P
L7	Choke 1mH	23642-337H
L8	Choke 1mH	23642-337H
L9	Choke 100µH	23642-325P
L10	Choke 100µH	23642-325P
L11	Choke 100µH	23642-325P

Circuit reference	Description	Part no.
Unit A0 : Overall assembly (contd.)		
L12	Choke 100μH	23642-325P
L13	Choke 100mH	23642-361X
L14	Choke 100mH	23642-361X
L15	Choke 10μH	23642-314J
L16	Choke 10μH	23642-314J
L17	Choke 100μH	23642-325P
L18	Choke 100μH	23642-325P
ME1	Meter	44559-011Z
PLA	Mains input connector	23423-159P
	Cover for PLA	23423-999Y
R1	Var cermet 1kΩ 10% 2W	25737-005D
R3	Var cermet 10kΩ 10% 2W	25725-405J
R4	Var cermet 1kΩ 10% 2W	25725-403N
R5	Var cermet 1kΩ 10% 2W	25737-005D
R6	Met film 3.9kΩ 2% $\frac{1}{4}$W	24773-287V
R7	Met film 1.8kΩ 2% $\frac{1}{4}$W	24773-279N
R8	Met film 820Ω 2% $\frac{1}{4}$W	24773-271B
R9	Met film 360Ω 2% $\frac{1}{4}$W	24773-262T
R10	Met film 150Ω 2% $\frac{1}{4}$W	24773-253F
R11	Met film 120Ω 2% $\frac{1}{4}$W	24773-251L
R12	Met film 1.5kΩ 2% $\frac{1}{4}$W	24773-277U
R13	Met film 1.3kΩ 2% $\frac{1}{4}$W	24773-276E

Circuit reference	Description	Part no.
R14	Met film 1.1kΩ 2% $\frac{1}{4}$W	24773-274Z
R15	Met film 820Ω 2% $\frac{1}{4}$W	24773-271B
R16	Met film 680Ω 2% $\frac{1}{4}$W	24773-269K
R17	Met film 560Ω 2% $\frac{1}{4}$W	24773-267R
R18	Met film 470Ω 2% $\frac{1}{4}$W	24773-265M
R19	Met film 360Ω 2% $\frac{1}{4}$W	24773-262T
R20	Met film 330Ω 2% $\frac{1}{4}$W	24773-261D
R21	Met film 270Ω 2% $\frac{1}{4}$W	24773-259T
R22	Met film 240Ω 2% $\frac{1}{4}$W	24773-258D
R23	Met film 240Ω 2% $\frac{1}{4}$W	24773-258D
R24	Met film 220Ω 2% $\frac{1}{4}$W	24773-257W
R25	Met film 240Ω 2% $\frac{1}{4}$W	24773-258D
R26	Met film 220Ω 2% $\frac{1}{4}$W	24773-257W
R27	Met film 240Ω 2% $\frac{1}{4}$W	24773-258D
R28	Met film 220Ω 2% $\frac{1}{4}$W	24773-257W
R29	Met film 220Ω 2% $\frac{1}{4}$W	24773-257W
R30	Met film 240Ω 2% $\frac{1}{4}$W	24773-258D
R31	Met film 270Ω 2% $\frac{1}{4}$W	24773-259T
R32	WW 470Ω 5% 1.5W	25123-067B
R33	Var WW 100kΩ 10% 0.875W	25885-031A
R34	Var WW 10kΩ 3% 0.75W	25812-696B
R35	Met ox 3kΩ 2% $\frac{1}{2}$W	24573-084B
R36	Var thermistor 1.5kΩ 20°C	25683-644G
R37	Var thermistor 47kΩ 20% 600 MW	25685-487C
R38	Met film 27kΩ 2% $\frac{1}{4}$W	24773-307K

Circuit reference	Description	Part no.
Unit A0 : Overall assembly (contd.)		
R39	Met film 300kΩ 2% ¼W	24773-332T
R40	Met film 33Ω 2% ¼W	24773-237K
R84	Met film 50Ω 1% 1/8W	24762-558R
SA	FUNCTION	44340-022C
SB	CARRIER (4-pole 3-position)	23462-267W
SC	DEVIATION multiplier	23462-254E
SD	CARRIER RANGE	44340-097U
SE	SUPPLY	23462-258L
SF	Voltage selector (230/115V)	23467-161W
SG	TUNE	44340-015T
SH	MOD. FREQ.	44340-098Y
SJ	RESET	23465-202C
SK	MOD ON/OFF	23462-258L
SKB	BNC 50Ω (EXT. MOD. IN)	23443-443K
SKC	BNC 50Ω (INT. MOD. OUT)	23443-443K
SKD	BNC 50Ω (SYNC/SWEEP IN)	23443-443K
SKE	DIN (IF PROBE SUPPLY)	23435-252Y
SKF	TNC 50Ω (COUNTER OUT)	23444-741Z
	(Cap and chain for SKF)	23444-898M
SKG	Bulkhead receptacle 50Ω	23444-382T
SKH	BNC 50Ω (RF out) cable assy	43129-029G
T1	Mains	43490-042Z

Circuit reference	Description	Part no.
TR1	2N3055	28456-567W
X1	Ferrite bead	41372-006T
X2	Ferrite bead	41372-006T
X3	Ferrite bead	41372-006T
X4	Ferrite bead	41372-006T
X5	Ferrite bead	41372-006T
X6	Ferrite bead	41372-006T
X7	Ferrite bead	41372-006T
X8	Ferrite core	23635-910B
X9	Ferrite bead	41372-006T
X10	Ferrite bead	41372-006T
X11	Ferrite bead	41372-006T
X12	Ferrite core	23635-910B
X13	Ferrite core	23635-910B
X14	Ferrite core	23635-910B
X15	Ferrite core	23635-910B
Unit A1 : RF oscillator board		
8.	When ordering, prefix circuit reference with A1.	
	Complete assembly (A1 - A2)	44827-664H
	INTERMEDIATE ASSY (RF OSC) A1 PCB	44990-177S
C1	Tant 4.7μF 20% 35V	26486-219P
C2	Cer 0.1μF -20+50% 30V	26383-031S
C3	Cer 220pF 2% 50V	26343-481S

Circuit reference	Description	Part no.
	Unit A1 : RF oscillator board (contd.)	
C4	Cer 0.1μF -20+50% 30V	26383-031S
C5	Cer 1pF ±0.5pF 500V	26343-101J
C6	Cer 0.1μF -20+50% 30V	26383-031S
C7	Cer 0.01μF 20% 100V	26386-405X
C8	Cer 0.01μF 20% 100V	26386-405X
C9	Cer 0.01μF 20% 100V	26386-405X
C10	Cer 0.01μF 20% 100V	26386-405X
C11	Var cermet 0.5pF min 6pF swing	26843-502W
C12	Var cermet 0.5pF min 6pF swing	26843-502W
C13	Var cermet 0.5pF min 6pF swing	26843-502W
C14 †	Cer 15pF 5% 63V	26343-467U
C15 †	Cer 4.7pF ±0.5pF 63V	26343-485P
C16	Cer 8.2pF 5% 63V	26343-488C
C17	Cer 470pF -20+50% 400V	26383-139M
C18	Cer 4.7pF 10% 50V	26343-485P
C19	Tant 4.7μF 20% 35V	26486-219P
C20	Var cermet 0.5pF min 6pF swing	26843-502W
C21	Var cermet 1pF min 12pF swing	26843-503D
C22	Var cermet 1pF min 12pF swing	26843-503D
C23	Cer 4.7pF 5% 50V	26343-485P
C24	Var cermet 1pF min 12pF swing	26843-503D
C25	Var cermet 1pF min 12pF swing	26843-503D
C26	Var cermet 1pF min 12pF swing	26843-503D
C27	Var cermet 1pF min 12pF swing	26843-503D
C28	Cer 6.8pF 10% 500V	26343-039P
C29	Var cermet 1pF min 12pF swing	26843-503D
C30	Cer 6.8pF 10% 500V	26343-039P
C31	Var cermet 1pF min 12pF swing	26843-503D

Circuit reference	Description	Part no.
C32	Cer 6.8pF 10% 500V	26343-039P
C33	Cer 120pF 2% 50V	26343-478S
C34	Cer 0.01μF 20% 100V	26386-405X
C35	Cer 0.01μF -20+80% 100V	26383-055L
C36	Cer 0.01μF -20+80% 100V	26383-055L
C37	Cer 22pF 5% 63V	26343-489R
C38 †	Cer 2.7pF ±0.5pF 63V	26343-484T
C39 †	Cer 4.7pF ±0.5pF 63V	26343-485P
C40 †	Cer 4.7pF ±0.5pF 63V	26343-485P
C41 †	Cer 5.6pF ±0.5pF 63V	26343-486X
C42 †	Cer 5.6pF ±0.5pF 63V	26343-486X
C43 †	Cer 5.6pF ±0.5pF 63V	26343-486X
C44 †	Cer 6.8pF ±0.5pF 63V	26343-487M
C45 †	Cer 6.8pF ±0.5pF 63V	26343-487M
C46 †	Cer 4.7pF ±0.5pF 63V	26343-485P
D1	Z5B5.6	28371-434Y
D2, D3, D11, D4	Matched set of selected type MVAM2's	44529-046Z
D4	1N4148	28336-676J
D5	1N4148	28336-676J
D6	1N4148	28336-676J
D7	1N4148	28336-676J
D8	MPN3401	28383-992G
D9	MPN3401	28383-992G
D13	1N4148	28336-676J
D14	BAV45	28335-485J
D15	BAV45	28335-485J
D16	BB405B	28381-101V

Circuit reference	Description	Part no.
	Unit A1 : RF oscillator board (contd.)	
L1	Inductor assy (RANGE 1)	44290-531W
L2	Inductor assy (RANGE 2)	44290-532D
L3	Inductor assy (RANGE 3)	44290-533T
L4	Inductor assy (RANGE 4)	44290-534P
L5	Inductor assy (RANGE 5)	44290-535X
L6	Inductor assy (RANGE 6)	44290-536M
L7	Inductor assy (RANGE 7)	44290-537C
L8	Inductor assy (RANGE 8)	44290-538R
L9	Inductor assy (RANGE 9)	44290-539B
L10	Inductor assy (RANGE 10)	44290-540C
L11	Inductor assy (RANGE 11)	44290-541R
L12	Inductor former (RANGE 12)	23636-109E
	Inductor core (RANGE 12)	23635-111T
L14	1mH	23642-567C
R1	Met ox 2% $\frac{1}{2}$W 390Ω	24573-063N
R2	Met film 9.1kΩ 2% $\frac{1}{4}$W	24773-296X
R3	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R5	Met film 15kΩ 2% $\frac{1}{4}$W	24773-301P
R6	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R7	Met film 47kΩ 2% $\frac{1}{4}$W	24773-313H
R14	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289W
R15	Carb 1MΩ 10% 1/8W	24311-945Y
R16	Carb 10MΩ 10% 1/8W	24321-885W
R17	Met film 1.8kΩ 2% $\frac{1}{4}$W	24773-279N
R20	Met film 240Ω 2% $\frac{1}{4}$W	24773-258D

Circuit reference	Description	Part no.
R28 †	Met film 390Ω 2% $\frac{1}{4}$W	24773-263P
R29	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R34	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R35	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R36	Met film 330Ω 2% $\frac{1}{4}$W	24773-261D
R37	Met film 330Ω 2% $\frac{1}{4}$W	24773-261D
R38	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R39	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R40	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R41	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R42	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R43	Met film 68Ω 2% $\frac{1}{4}$W	24773-245U
R44	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R45	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321L
R46	Met film 470Ω 2% $\frac{1}{4}$W	24773-265M
R47	Met film 51Ω 2% $\frac{1}{4}$W	24773-242Z
R48	Met film 220Ω 2% $\frac{1}{4}$W	24773-257W
R49	Met film 270Ω 2% $\frac{1}{4}$W	24773-259T
R51	Met film 470Ω 2% $\frac{1}{4}$W	24773-265M
R52	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R53	Met film 3.3kΩ 2% $\frac{1}{4}$W	24773-285F
R54	Met film 68Ω 2% $\frac{1}{4}$W	24773-245U
R55	Met film 62kΩ 2% $\frac{1}{4}$W	24773-316Y
R56	Carb 10MΩ 10% 1/8W	24321-885W
R57	Met film 200kΩ 2% $\frac{1}{4}$W	24773-328D

Circuit reference	Description	Part no.
Unit A1 : RF oscillator board (contd.)		
R58	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321L
R59	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R60	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R61	Met film 27kΩ 2% $\frac{1}{4}$W	24773-307K
R62	Met film 300kΩ 2% $\frac{1}{4}$W	24773-332T
R63	Met film 2.7kΩ 2% $\frac{1}{4}$W	24773-283L
R64	Met film 2.7kΩ 2% $\frac{1}{4}$W	24773-283L
R65	Met film 560kΩ 2% $\frac{1}{4}$W	24773-340R
R66	Carb 100Ω 5% 1/8W	24331-997B
RL1	80-1-A-5/522	23486-441J
RL2	80-1-A-5/522	23486-441J
RL3	RS5	23486-450D
TR1	BFR99 (specially selected)	44529-038C
TR2	BFR99 (specially selected)	44529-038C
TR3	BFR99 (specially selected)	44529-038C
TR6	WN428	28459-025A
TR12	BCY71	28435-235L
TR13	BFR99 (specially selected)	44529-038C
TR14	BC108	28452-787N
TR15	BC108	28452-787N
TR16	BFR99 (specially selected)	44529-038C
TR17	WN428	28459-025A
TR18	2N5179	28451-697Y

Circuit reference	Description	Part no.
Unit A2 : RF relay board		
9.	When ordering, prefix circuit reference with A2	
	Complete assembly	44827-665E
D1	1N4148	28336-676J
D2	1N4148	28336-676J
D3	1N4148	28336-676J
D4	1N4148	28336-676J
RL1	80-1-A-5/522	23486-441J
RL2	80-1-A-5/522	23486-441J
RL3	80-1-A-5/522	23486-441J
RL4	80-1-A-5/522	23486-441J
RL5	80-1-A-5/522	23486-441J
RL6	80-1-A-5/522	23486-441J
RL7	80-1-A-5/522	23486-441J
RL8	80-1-A-5/522	23486-441J
Unit A3 : RF amplifier board		
10.	When ordering, prefix circuit reference with A3	
	Complete assembly	44828-911D
C1	Cer 0.001μF -20+80% 500V	26383-242P
C2	Tant 4.7μF 20% 35V	26486-219P
C3	Tant 4.7μF 20% 35V	26486-219P

Circuit reference	Description	Part no.
Unit A3: RF amplifier board (contd.)		
C4	Cer 8.20pF ±0.5pF 63V	28343-464Z
C5	Tant 22μF 20% 15V	26486-230B
C6	Tant 4.7μF 20% 35V	26486-219P
C7	Tant 4.7μF 20% 35V	26486-219P
C8	Elec 100μF 20% 16V	26423-242X
C9	Tant 22μF 20% 35V	26486-230B
C10	Cer 0.001μF -20+80% 500V	26383-242P
C11	Tant 22μF 20% 15V	26486-230B
C12	Tant 4.7μF 20% 35V	26486-219P
C13	Tant 4.7μF 20% 35V	26486-219P
C14	Tant 4.7μF 20% 35V	26486-219P
C15	Cer 0.01μF -20+80% 100V	26383-055L
C16	Tant 22μF 20% 15V	26486-230B
C17	Cer 0.01μF -20+80% 100V	26383-055L
C18	Elec 22μF -20+100% 25V	26415-805K
C20	Tant 4.7μF 20% 35V	26486-219P
C21	Cer 68pF 2% 50V	26343-475F
C22	Cer 0.047μF -20+80% 25V	26383-017U
C23	Tant 4.7μF 20% 35V	26486-219P
C24	Cer 33pF 5% 50V	26343-471Y
C25	Tant 10μF 20% 35V	26486-225C
C26	Cer 0.047μF -20+80% 25V	26383-017U
C27	Cer 0.047μF -20+80% 25V	26383-017U
C28	Tant 4.7μF 20% 35V	26486-219P
C29	Cer 0.047μF -20+80% 25V	26383-017U
C31	Cer 0.01μF -20+80% 100V	26383-055L
C32	Tant 4.7μF 20% 35V	26486-219P
C33	Tant 4.7μF 20% 35V	26486-219P
C34	Cer 0.047μF -20+80% 25V	26383-017U
C35	Tant 0.47μF 20% 35V	26486-207L
C36	Tant 4.7μF 20% 35V	26486-219P
C37	Cer 47pF 5% 50V	26343-473L
C38	Tant 4.7μF 20% 35V	26486-219P
C39	Tant 4.7μF 20% 35V	26486-219P
C40	Cer 22pF 5% 50V	26343-469N
C41	Tant 4.7μF 20% 35V	26486-219P
C42	Cer 0.047μF -20+80% 25V	26383-017U
C43	Tant 4.7μF 20% 35V	26486-219P
C44	Cer 0.047μF -20+80% 25V	26383-017U
C45 †	Tant 0.47μF 20% 35V	26486-207L
C46	Tant 4.7μF 20% 35V	26486-219P
C47 †	Cer 1.5pF ±0.5pF 50V	26343-106W
C48	Tant 4.7μF 20% 35V	26486-219P
C50	Tant 4.7μF 20% 35V	26486-219P
C51	Tant 4.7μF 20% 35V	26486-219P
C52	Tant 4.7μF 20% 25V	26486-219P
C53	Cer 180pF 2% 63V	26343-480V
C54	Tant 4.7μF 20% 35V	26486 219P
C55	Cer 0.01μF -20+80% 100V	26383-055L

Circuit reference	Description	Part no.
Unit A3 : RF amplifier board (contd.)		
C56	Cer 180pF 2% 63V	26343-480V
C57	Cer 8.2pF ±0.5pF 63V	28343-464Z
C58	Cer 220pF 10% 63V	26383-595H
C59 †	Cer 82pF 2% 63V	26343-476G
C60	Cer 0.047μF -20+80% 12V	26383-016E
C61	Tant 4.7μF 20% 35V	26486-219P
D1	Z5B5.6	28371-434Y
D2	HP5082-2800	28349-007E
D3	HP5082-2800	28349-007E
D4	Z5B6.2	28371-483P
IC1	TCA240	28461-914G
L1	100μH	23642-561W
L2	100μH	23642-561W
L3	100μH	23642-561W
L4	100μH	23642-325P
L5	0.15μH	23642-481N
L6	100μH	23642-561W
R1	Met film 470Ω 2% ¼W	24773-265M
R2	Met film 75Ω 2% ¼W	24773-246Y
R3	Met film 18Ω 2% ¼W	24773-231P
R4	Met film 4.7kΩ 2% ¼W	24773-289W
R5	Met film 560Ω 2% ¼W	24773-267R
R6	Met film 4.7Ω 2% ¼W	24773-217J
R7	Carb 12Ω 5% 1/8W	24331-986W

Circuit reference	Description	Part no.
R8	Carb 12Ω 5% 1/8W	24331-986W
R9	Met film 220Ω 2% ¼W	24773-257W
R10	Met film 1kΩ 2% ¼W	24773-273A
R11	Met film 1.2kΩ 2% ¼W	24773-275H
R12	Met film 620Ω 2% ¼W	24773-268B
R13	Met film 150Ω 2% ¼W	24773-253F
R14	Met film 51Ω 2% ¼W	24773-242Z
R15	Met film 51Ω 2% ¼W	24773-242Z
R16	Met film 470Ω 2% ¼W	24773-265M
R17	Met film 10kΩ 2% ¼W	24773-297M
R18	Var preset 10kΩ 20% ¼W	25611-078R
R19	Met film 100Ω 2% ¼W	24773-249J
R20	Var preset 470Ω 20% ¼W	25611-070S
R21	Met film 470Ω 2% ¼W	24773-265M
R22	Met film 390Ω 2% ¼W	24773-263P
R23	Met film 750Ω 2% ¼W	24773-270R
R24	Met film 51Ω 2% ¼W	24773-242Z
R25	Met film 100Ω 2% ¼W	24773-249J
R26	Met film 120Ω 2% ¼W	24773-251L
R27	Met film 470Ω 2% ¼W	24773-265M
R28	Met film 4.7kΩ 2% ¼W	24773-289W
R29	Met film 51Ω 2% ¼W	24773-242Z
R30	Met film 1.3kΩ 2% ¼W	24773-276E
R31	Met film 47Ω 2% ¼W	24773-241A
R32	Met film 15Ω 2% ¼W	24773-229X

Circuit reference	Description	Part no.
Unit A3 : RF amplifier board (contd.)		
R33	Met film 330Ω 2% $\frac{1}{4}$W	24773-261D
R34	Met film 10Ω 2% $\frac{1}{4}$W	24773-225W
R35	Met film 100Ω 2% $\frac{1}{4}$W	24773-249J
R36	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R37	Met film 47Ω 2% $\frac{1}{4}$W	24773-241A
R38	Met film 2.7kΩ 2% $\frac{1}{4}$W	24773-283L
R39	Met film 150Ω 2% $\frac{1}{4}$W	24773-253F
R40	Met film 47Ω 2% $\frac{1}{4}$W	24773-241A
R41	Met film 330Ω 2% $\frac{1}{4}$W	24773-261D
R42	Met film 22Ω 2% $\frac{1}{4}$W	24773-233M
R43	Met film 470Ω 2% $\frac{1}{4}$W	24773-265M
R44	Met film 5.6kΩ 2% $\frac{1}{4}$W	24773-291S
R45	Met film 47Ω 2% $\frac{1}{4}$W	24773-241A
R46	Met film 4.3kΩ 2% $\frac{1}{4}$W	24773-288S
R47	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R48	Met film 820Ω 2% $\frac{1}{4}$W	24773-271B
R49	Met film 100Ω 2% $\frac{1}{4}$W	24773-249J
R50	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R51	Met film 8.2kΩ 2% $\frac{1}{4}$W	24773-295P
R52	Met film 47Ω 2% $\frac{1}{4}$W	24773-241A
R53	Met film 5.1kΩ 2% $\frac{1}{4}$W	24773-290V
R54	Met film 470Ω 2% $\frac{1}{4}$W	24773-265M
R55	Met film 100Ω 2% $\frac{1}{4}$W	24773-249J
R56	Met film 2.7kΩ 2% $\frac{1}{4}$W	24773-283L

Circuit reference	Description	Part no.
R57	Met film 47Ω 2% $\frac{1}{4}$W	24773-241A
R58	Met film 820Ω 2% $\frac{1}{4}$W	24773-271B
R59	Met film 1.3kΩ 2% $\frac{1}{4}$W	24773-276E
R60	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R61	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R62	Met film 510Ω 2% $\frac{1}{4}$W	24773-266C
R63	Met film 180Ω 2% $\frac{1}{4}$W	24773-255V
R64	Met film 2kΩ 2% $\frac{1}{4}$W	24773-280U
R65	Met film 47Ω 2% $\frac{1}{4}$W	24773-241A
R66	Met film 30Ω 2% $\frac{1}{4}$W	24773-236B
R67	Met film 11Ω 2% $\frac{1}{4}$W	24773-226D
R68	Met film 330Ω 2% $\frac{1}{4}$W	24773-261D
R69	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289W
R70	Met film 330Ω 2% $\frac{1}{4}$W	24773-261D
R71	Met film 820Ω 2% $\frac{1}{4}$W	24773-271B
R72	Met film 470Ω 2% $\frac{1}{4}$W	24773-265M
R73	Met film 3.3kΩ 2% $\frac{1}{4}$W	24773-285F
R74	Met film 18Ω 2% $\frac{1}{4}$W	24773-231P
R75	Met ox 100Ω 2% $\frac{1}{2}$W	24573-049B
R76	Met film 22Ω 2% $\frac{1}{4}$W	24773-233M
R77	Met film 20Ω 2% $\frac{1}{4}$W	24773-232X
R78	Met film 18Ω 2% $\frac{1}{4}$W	24773-231P
R79	Met film 10Ω 2% $\frac{1}{4}$W	24773-225W
R80	Met film 24Ω 2% $\frac{1}{4}$W	24773-234C
R81 †	Carb 68Ω 5% 1/8W	24331-979F
R82	Met film 150kΩ 2% 1/4W	24773-325V

Circuit ref.	Description	Part no.
Unit A3 : RF amplifier board (contd.)		
R83	Met film 51kΩ 2% 1/4W	24773-314E
R85 †	Met film 130Ω 2% 1/4W	24773-252J
R86	Met film 47Ω 2% 1/4W	24773-241A
R87	Met film 16kΩ 2% 1/4W	24773-302X
R88	Met film 3.9kΩ 2% 1/4W	24773-287V
R89	Met film 47Ω 2% 1/4W	24773-241A
R90	Met film 1.3kΩ 2% 1/4W	24773-276E
R91	Carb 4.7Ω 5% 1/8W	24331-985G
R92	Met film 300Ω 2% 1/4W	24773-260W
R93	Met film 10Ω 2% 1/4W	24773-225W
R94	Met film 560Ω 2% 1/4W	24773-267R
R95	Met film 100Ω 2% 1/4W	24773-249J
R96	Met film 62Ω 2% 1/4W	24773-244E
R97 †	Met film 20kΩ 2% 1/4W	24773-304C
R98 †	Met film 47kΩ 2% 1/4W	24773-313H
R99	Met film 10Ω 2% 1/4W	24773-225W
R100	Met film 1kΩ 2% 1/4W	24773-273A
R101	Met film 470Ω 2% 1/4W	24773-265M
R102	Met film 100Ω 2% 1/4W	24773-249J
R103	Met film 510Ω 2% 1/4W	24773-266C
R104	Met film 22Ω 2% 1/4W	24773-233M
R105	Met film 150Ω 2% 1/4W	24773-253F
RL1	RS12	23486-427A
TR1	BFR90	28452-167U
TR2	2N5179	28451-697Y
TR3	2N5179	28451-697Y
TR4	2N5179	28451-697Y
TR5	J310	28459-028E
TR6	2N5179	28451-697Y

Circuit ref.	Description	Part no.
TR7	2N4179	28451-697Y
TR8	2N5109	28452-827J
TR9	2N5109	28452-827J
TR10	2N5109	28452-827J
TR11	2N5109	28452-827J
TR12	J310	28459-028E
TR13	2N5179	28451-697Y
TR14	BFY90	28452-157R
TR15	BFY90	28452-157R
	HEAT SINK TO5 (for TR9, 10, 11)	28488-428V
Unit A4 : ALC board		
11.	When ordering, prefix circuit reference with A4.	
	Complete assembly	44827-667Y
C1	Tant 0.47μF 20% 35V	26486-207L
C2	Cer 0.01μF -20+80% 100V	26383-055L
C3	Tant 0.47μF 20% 35V	26486-207L
C4	Cer 100pF 2% 50V	26343-477V
C5	Cer 100pF 2% 50V	26343-477V
C6	Cer 6.8pF 5% 50V	26343-463A
C7	Cer 0.01μF -20+80% 100V	26383-055L
C8	Tant 0.47μF 20% 35V	26486-207L
C9	Plas 0.1μF 10% 100V	26582-211B
C10	Plas 2.2μF 10% 63V	26582-418Z
C11	Tant 4.7μF 20% 35V	26486-219P
C12	Tant 0.47μF 20% 35V	26486-207L

Circuit reference	Description	Part no.
Unit A4 : ALC board (contd.)		
C13	Cer 0.01μF -20+80% 100V	26383-055L
C14	Elec 100μF -20+100% 25V	26415-813U
C15	Elec 220μF -20+100% 25V	26415-818F
C16	Cer 0.001μF -20+80% 500V	26383-242P
C17	Tant 4.7μF 20% 35V	26486-219P
C18	Cer 220pF 10% 63V	26383-595H
D1	HP5082-2811	28349-008U
D2	HP5082-2811	28349-008U
D3	HP5082-2811	28349-008U
D4	HP5082-2811	28349-008U
IC1	μA741	28461-304T
IC2	μA741	28461-304T
R1	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R2	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R3	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289W
R4	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R5	Var cermet 220Ω 10% $\frac{1}{2}$W	25711-546X
R6	Met film 510Ω 2% $\frac{1}{4}$W	24773-266C
R7 †	Met film 430Ω 2% $\frac{1}{4}$W	24773-264X
R8	Met film 270kΩ 2% $\frac{1}{4}$W	24773-331D
R9	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R10	Met film 2.7kΩ 2% $\frac{1}{4}$W	24773-283L
R11	Met film 270kΩ 2% $\frac{1}{4}$W	24773-331D
R12	Met film 7.5kΩ 2% $\frac{1}{4}$W	24773-294T
R13	Met film 7.5kΩ 2% $\frac{1}{4}$W	24773-294T
R14	Met film 470kΩ 2% $\frac{1}{4}$W	24773-337R
R15	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321L
R16	Met film 68Ω 2% $\frac{1}{4}$W	24773-245U
R17	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R18	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R19	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R20	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R21	Met film 560Ω 2% $\frac{1}{4}$W	24773-267R
TR1	BCY71	28435-235L
TR2	BCY71	28435-235L
Unit A5 : AM/FM driver board		
12.	When ordering, prefix circuit reference with A5	
	Complete assembly	44827-668N
C1	Tant 0.47μF 20% 35V	26486-207L
C2	Elec 22μF -20+100% 25V	26415-805K
C3	Tant 0.47μF 10% 63V	26582-410P
C4	Tant 4.7μF 20% 35V	26486-219P
C5	Cer 330pF 2% 50V	26343-483D
C6	Tant 4.7μF 20% 35V	26486-219P

Circuit reference	Description	Part no.
Unit A5 : AM/FM driver board (contd.)		
C7	Tant 4.7μF 20% 35V	26486-219P
C8	Tant 4.7μF 20% 35V	26486-219P
C9	Cer 330pF 2% 50V	26343-483D
C10	Tant 4.7μF 20% 35V	26486-219P
C11	Tant 4.7μF 20% 35V	26486-219P
C12	Cer 330pF 2% 50V	26343-483D
C13	Elec 22μF -20+100% 25V	26415-805K
C14	Elec 220μF -20+100% 10V	26415-817J
C16	Tant 22μF 20% 15V	26486-230B
C17	Elec 220μF -20+100% 10V	26415-817J
C18	Elec 100μF -20+100% 25V	26415-813U
C19	Tant 100μF -20+100% 10V	26486-606B
C20	Tant 22μF 20% 15V	26486-583L
C21	Tant 22μF 20% 15V	26486-583L
C22	Tant 22μF 20% 15V	26486-583L
C23	Cer 0.01μF -20+80% 100V	26383-055L
C24	Plas 0.47μF 10% 63V	26582-410P
C25	Plas 0.47μF 10% 63V	26582-410P
C26	Tant 22μF 20% 15V	26486-583L
D1	1N4148	28336-676J
D2	1N4148	28336-676J
D3	1N4148	28336-676J
D4	1N4148	28336-676J
D5	1N4148	28336-676J

Circuit reference	Description	Part no.
D6	1N4148	28336-676J
D7	1N4148	28336-676J
D8	1N4148	28336-676J
R1	Met film 3.6kΩ 2% $\frac{1}{4}$W	24773-286G
R2	Var cermet 2.2kΩ10% $\frac{1}{2}$W	25711-547M
R3	Met film 22 kΩ 2% $\frac{1}{4}$W	24773-305R
R4	Met film 220kΩ 2% $\frac{1}{4}$W	24773-307K
R5	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R6	Thermistor 1.5kΩ (CZ3)	25683-644G
R7	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R8	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R9	Met film 680Ω 2% $\frac{1}{4}$W	24773-269K
R10	Met film 3.3kΩ 2% $\frac{1}{4}$W	24773-285F
R11	Met film 4.3kΩ 2% $\frac{1}{4}$W	24773-288S
R12	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289W
R13	Var cermet 22kΩ 10% $\frac{1}{2}$W	25711-548C
R14	Met film 6.8kΩ 2% $\frac{1}{4}$W	24773-293D
R15	Met film 2.7kΩ 2% $\frac{1}{4}$W	24773-283L
R16	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R17	Met film 1.8kΩ 2% $\frac{1}{4}$W	24773-279N
R18	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R19	Var cermet 2.2kΩ 10% $\frac{1}{2}$W	25711-547M
R20	Met film 300kΩ 2% $\frac{1}{4}$W	24773-332T
R21	Met film 300kΩ 2% $\frac{1}{4}$W	24773-332T
R22	Met film 1.8kΩ 2% $\frac{1}{4}$W	24773-279N

Circuit reference	Description	Part no.
Unit A5 : AM/FM driver board (contd.)		
R23	Met film 5.6kΩ 2% $\frac{1}{4}$W	24773-291S
R24	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R25 †	Met film 3.6kΩ 2% $\frac{1}{4}$W	24773-286G
R26	Var cermet 220Ω 10% $\frac{1}{2}$W	25711-546X
R27	Var cermet 1kΩ 10% $\frac{1}{2}$W	25711-602N
R28	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289W
R30 †	Met film 150kΩ 2% $\frac{1}{4}$W	24773-325V
R31	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R32	Met film 22kΩ 2% $\frac{1}{4}$W	24773-305R
R33	Met film 10Ω 2% $\frac{1}{4}$W	24773-225W
R34	Met film 470Ω 2% $\frac{1}{4}$W	24773-265M
R36	Met film 68Ω 2% $\frac{1}{4}$W	24773-245U
R37	Met film 820Ω 2% $\frac{1}{4}$W	24773-271B
R38	Carb 330kΩ 5% $\frac{1}{4}$W	24311-933C
R39	Carb 330kΩ 5% $\frac{1}{4}$W	24311-933C
R40	Met film 220Ω 2% $\frac{1}{4}$W	24773-257W
R41	Met film 1.0kΩ 2% $\frac{1}{4}$W	24773-273A
R42	Met film 1.0kΩ 2% $\frac{1}{4}$W	24773-273A
R43	Var cermet 220Ω 10% $\frac{1}{2}$W	25711-546X
R44	Met film 1.3kΩ 2% $\frac{1}{4}$W	24773-276E
R45	Met film 62Ω 2% $\frac{1}{4}$W	24773-244E
R46	Var cermet 100Ω 10% $\frac{1}{2}$W	25711-545P
R47	Met film 270kΩ 2% $\frac{1}{4}$W	24773-331D
R48	Met film 47kΩ 2% $\frac{1}{4}$W	24773-313H
R49	Met film 8.2kΩ 2% $\frac{1}{4}$W	24773-295P
R50	Met film 1.6kΩ 2% $\frac{1}{4}$W	24773-278Y
R51	Met film 1.1kΩ 2% $\frac{1}{4}$W	24773-274Z
R52	Met film 130Ω 2% $\frac{1}{4}$W	24773-252J
R53	Met film 390Ω 2% $\frac{1}{4}$W	24773-263P
R56 †	Met film 120Ω 2% $\frac{1}{4}$W	24773-251L
R57 †	Met film 91Ω 2% $\frac{1}{4}$W	24773-248L
R58 †	Met film 1.5kΩ 2% $\frac{1}{4}$W	24773-277U
R59 †	Met film 1.3kΩ 2% $\frac{1}{4}$W	24773-276E
R60 †	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R61 †	Met film 5.1kΩ 2% $\frac{1}{4}$W	24773-290V
R62 †	Met film 1.3kΩ 2% $\frac{1}{4}$W	24773-276E
R63 †	Met film 2.0kΩ 2% $\frac{1}{4}$W	24773-280U
R65	Resistor assy	44359-017P
R66	Met film 2.0kΩ 2% $\frac{1}{4}$W	24773-280U
R67	Met film 2.0kΩ 2% $\frac{1}{4}$W	24773-280U
R68	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R69	Met film 220kΩ 2% $\frac{1}{4}$W	24773-329T
R70	Carb 1MΩ 5% $\frac{1}{4}$W	24311-945Y
R71	Carb 1MΩ 5% $\frac{1}{4}$W	24311-945Y
R72	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R73	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R74 †	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R75 †	Met film 1.5kΩ 2% $\frac{1}{4}$W	24773-277U
R76 †	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321L

Circuit reference	Description	Part no.
Unit A5 : AM/FM driver board (contd.)		
R77 †	Met film 12kΩ 2% ¼W	24773-299R
R78 †	Met film 20kΩ 2% ¼W	24773-304C
R80 †	Met film 10kΩ 2% ¼W	24773-297M
R81	Met film 180Ω 2% ¼W	24773-255V
R82 †	Met film 22kΩ 2% ¼W	24773-305R
R83 †	Met film 1kΩ 2% ¼W	24773-273A
RL1	RS12	23486-427A
RL2	RS12	23486-427A
RL3	RS12	23486-427A
RL4	RS12	23486-427A
TR1	BC108	28452-787N
TR2	BC108	28452-787N
TR3	BC109	28452-777K
TR4	BC239C	28452-771P
TR5	BCY71	28435-235L
TR6	BC239C	28452-771P
TR7	BC109	28452-777K
TR8	BC108	28452-787N
TR9	BC108	28452-787N
TR10	J310	28459-028E
Unit A6 : Power supply and mod. oscillator board		
13.	When ordering, prefix circuit reference with A6	
	Complete assembly	44827-669L

Circuit reference	Description	Part no.
C1	Tant 22μF -20+100% 25V	26415-805K
C2	Plas 0.0018μF 2% 160V	26516-543H
C3	Plas 0.0018μF 2% 160V	26516-543H
C4	Tant 4.7μF 2% 35V	26486-219P
C5	Cer 0.01μF -20+80% 100V	26383-055L
C6	Cer 0.047μF -20+80% 25V	26383-017U
C7	Cer 0.047μF -20+80% 25V	26383-017U
C8	Cer 0.1μF -20+50% 30V	26383-031S
C9	Plas 0.003μF 2% 125V	26516-597M
C10	Cer 0.01μF -20+80% 100V	26383-055L
C11	Plas 0.003μF 2% 125V	26516-597M
C12	Tant 4.7μF 20% 35V	26486-219P
C13	Cer 0.1μF -20+50% 30V	26383-031S
C21	Tant 4.7μF 20% 35V	26486-219P
C22	Tant 4.7μF 20% 35V	26486-219P
C23	Elec 100μF -20+100% 40V	26423-244C
C24	Elec 220μF -20+100% 25V	26423-254E
C25	Cer 0.01μF -20+80% 100V	26383-055L
C26	Cer 0.1μF -20+50% 30V	26383-031S
C27	Cer 0.01μF -20+80% 100V	26383-055L
C28	Tant 4.7μF 20% 35V	26486-219P
C29	Tant 4.7μF 20% 35V	26486-219P
C30	Cer 0.1μF -20+50% 30V	26383-031S
C31	Tant 4.7μF 20% 35V	26486-219P
C32	Tant 4.7μF 20% 35V	26486-219P

Circuit reference	Description	Part no.
Unit A6 : Power supply and mod. oscillator board (contd.)		
C33	Cer 0.1μF -20+50% 30V	26383-031S
C34	Cer 0.1μF -20+50% 30V	26383-031S
C35	Plas 100pF ±2pF 160V	26516-241N
C36 †	Plas 150pF 2% 350V	26516-289C
C37 †	Plas 200pF 2% 350V	26516-318W
C38	PETP 0.1μF 10% 250V	26582-208B
D1	1N4148	28336-676J
D2	1N4148	28336-676J
D5	1N4004	28357-028K
D6	1N4004	28357-028K
D7	1N4004	28357-028K
D8	1N4004	28357-028K
D9	1N4004	28357-028K
D10	1N4004	28357-028K
D11	1N4004	28357-028K
D12	1N4004	28357-028K
D13	1N4004	28357-028K
D14	1N4004	28357-028K
D15	BZX79C8V2	28371-671E
D17	1N4148	28336-676J
FET and RESISTORS KIT		46883-258T
IC1	μA7805	28461-707G
R1	Met film 160kΩ 2% $\frac{1}{4}$W	24773-326S

Circuit reference	Description	Part no.
R2	Met film 160kΩ 2% $\frac{1}{4}$W	24773-326S
R3	Met film 68Ω 2% $\frac{1}{4}$W	24773-245U
R4	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R5	Met film 220kΩ 2% $\frac{1}{4}$W	24773-329T
R6	Met film 82kΩ 2% $\frac{1}{4}$W	24773-319J
R7	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299R
R8	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R9	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299R
R10 †	Met film 3.9kΩ 2% $\frac{1}{4}$W	24773-287V
R11 †	Met film 5.6kΩ 2% $\frac{1}{4}$W	24773-291S
R12	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R13	Carb 6.8MΩ 10% 1/8W	24321-883V
R14	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321L
R15	Met film 150kΩ 2% $\frac{1}{4}$W	24773-325V
R16	Met film 20kΩ 2% $\frac{1}{4}$W	24773-304C
R17	Met film 20kΩ 2% $\frac{1}{4}$W	24773-304C
R18	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R19	Met film 560Ω 2% $\frac{1}{4}$W	24773-267R
R36	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R37	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R38	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R39	Var cer 2.2kΩ 10% $\frac{1}{2}$W	25711-547M
R40	Met film 7.5kΩ 2% $\frac{1}{4}$W	24773-294T
R41	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R42	Met film 1.5kΩ 2% $\frac{1}{4}$W	24773-277U

Circuit reference	Description	Part no.
Unit A6 : Power supply and mod. oscillator board (continued)		
R43	Met film 24kΩ 2% $\frac{1}{4}$W	24773-306B
R44	Part of FET and RESISTORS KIT Resistor A	46883-258T
R45	Part of FET and RESISTORS KIT Resistor B	46883-258T
R46	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281Y
R47	Met film 100Ω 2% $\frac{1}{4}$W	24773-249J
R48	Met film 13kΩ 2% $\frac{1}{4}$W	24773-300T
R49 †	Met film 24kΩ 2% $\frac{1}{4}$W	24773-306B
R50 †	Met film 3.3kΩ 2% $\frac{1}{4}$W	24773-285F
R51	Met film 1.5kΩ 2% $\frac{1}{4}$W	24773-277U
R52	Met film 820Ω 2% $\frac{1}{4}$W	24773-271B
R53	Met film 3.3Ω 2% $\frac{1}{4}$W	24773-213U
R54	Met film 18kΩ 2% $\frac{1}{4}$W	24773-303M
R55	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R56	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289W
R57	WW 0.5Ω 10% 1.5W	25133-031M
R58	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297M
R59	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R60	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R61	Met film 18kΩ 2% $\frac{1}{4}$W	24773-303M
R62	Met film 6.8kΩ 2% $\frac{1}{4}$W	24773-293D
TR1	BC109	28452-777K
TR2	BCY71	28453-235L
TR3	BF244B	28459-011S
TR4	BC108	28452-787N

Circuit reference	Description	Part no.
TR9	MJE711	28435-870M
TR10	BCY71	28435-235L
TR11	BFY51	28455-827T
TR12	BC108	28452-787N
TR13	Part of FET and RESISTORS KIT	46883-258T
TR14	BC239C	28452-771P
TR15	BC239C	28452-771P
TR16	BCY71	28435-235L
TR17	BC107	28455-437L
TR18	BCY71	28435-235L
TR19	BC107	28455-437L
Unit A7 : Coarse attenuator		
14.	When ordering, prefix circuit reference with A7.	
	Complete assembly	44429-020R
CAM	10 dB	31359-024P
CAM	20/1 dB	31359-025X
CAM	20/2 dB	31359-026M
CAM	40/1 dB	31359-027C
CAM	40/2 dB	31359-028R
R1	Met film 247Ω 0.25% $\frac{1}{4}$W	24762-405Z
R2	Met film 247Ω 0.25% $\frac{1}{4}$W	24762-405Z
R3	Met film 247Ω 0.25% $\frac{1}{4}$W	24762-405Z
R4	Met film 247Ω 0.25% $\frac{1}{4}$W	24762-405Z

Circuit reference	Description	Part no.
Unit A7 : Coarse attenuator (contd.)		
R5	Met film 247Ω 0.25% $\frac{1}{4}$W	24762-405Z
R6	Met film 247Ω 0.25% $\frac{1}{4}$W	24762-405Z
R7	Met film 71.2Ω 0.25% $\frac{1}{4}$W	24762-403Y
R8	Met film 61.1Ω 0.25% $\frac{1}{4}$W	24762-402U
R9	Met film 30.5Ω 0.25% $\frac{1}{4}$W	24762-401E
R10	Met film 61.1Ω 0.25% $\frac{1}{4}$W	24762-402U
R11	Met film 61.1Ω 0.25% $\frac{1}{4}$W	24762-402U
R12	Met film 30.5Ω 0.25% $\frac{1}{4}$W	24762-401E
R13	Met film 61.1Ω 0.25% $\frac{1}{4}$W	24762-402U
R14	Met film 61.1Ω 0.25% $\frac{1}{4}$W	24762-402U
R15	Met film 61.1Ω 0.25% $\frac{1}{4}$W	24762-402U
R16	Met film 61.1Ω 0.25% $\frac{1}{4}$W	24762-402U
R17	Met film 61.1Ω 0.25% $\frac{1}{4}$W	24762-402U
R18	Met film 96.5Ω 0.25% $\frac{1}{4}$W	24762-404N
R19	Met film 96.5Ω 0.25% $\frac{1}{4}$W	24762-404N
SA	Microswitch UHF	23483-131A
SB	Microswitch UHF	23483-131A
SC	Microswitch UHF	23483-131A
SD	Microswitch UHF	23483-131A
SE	Microswitch UHF	23483-131A
SF	Microswitch UHF	23483-131A
SG	Microswitch UHF	23483-131A
SH	Microswitch UHF	23483-131A
SJ	Microswitch UHF	23483-131A

Circuit reference	Description	Part no.
SK	Microswitch UHF	23483-131A
Unit A8 : Reverse power protection unit		
15.	When ordering, prefix circuit reference with A8	
	Complete assembly	44990-255X
	Printed board assembly	44828-196K
C1	Plas 1μF 10% 63V	26582-414R
C2	Cer 4.7pF ±0.5pF 63V	26343-461B
C3	Cer 22pF 5% 63V	26343-469N
C4	Cer 0.01μF -20+80% 100V	26383-055L
C5	Cer 330pF 10% 63V	26383-597U
C6	Cer 100pF 2% 63V	26343-477V
C7	Cer 10pF ±0.5pF 63V	26343-465H
C8	Elec 100μF -20+100% 25V	26415-813U
C9	Cer 0.001μF -20%+80% 500V	26383-242P
D1	Shottky HP 5082-2800	28349-007E
D2	Shottky HP 5082-2800	28349-007E
D3	Zener Z5B10	28371-851J
D4	1N4148	28336-676J
D5	1N4148	28336-676J
D6	Zener Z5B 3.0	28371-203G
D7	1N4148	28336-676J
IC1	MLM311PI	28461-695U

Circuit reference	Description	Part no.
Unit A8 : Reverse power protection unit (contd.)		
R1	Carb 1MΩ 5% 1/8W	24311-945Y
R2	Carb 3.3MΩ 10% 1/8W	24321-879G
R3	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299R
R4	Var 2.2 kΩ 10% $\frac{1}{2}$W	25711-547M
R5	Met film 100Ω 2% $\frac{1}{4}$W	24773-249J
R6	Met film 10kΩ 2% $\frac{1}{4}$W	24773-279M
R7	Met film 39kΩ 2% $\frac{1}{4}$W	24773-311A
R8	Met film 47kΩ 2% $\frac{1}{4}$W	24773-313H
R9	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321L
R10	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321L
R11	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273A
R12	Met film 10kΩ 2% $\frac{1}{4}$W	24773-279M
R13	Met film 2kΩ 2% $\frac{1}{4}$W	24773-280U
R14	Met film 33kΩ 2% $\frac{1}{4}$W	24773-309Z
R15	Carb 560kΩ 5% 1/8W	24311-939H
R16	Carb 470kΩ 5% 1/8W	24311-937A
R17	Carb 470kΩ 5% 1/8W	24311-937A
RLA	Reed type	23486-502H
TR1	NPN 2N2219	28453-847F
TR2	PNP BCY70	28434-857Z
TR3	NPN BC208B	28452-781A

Circuit reference	Description	Part no.
MECHANICAL PARTS		
16.	Order without prefix.	
	Note ...	
	Item Nos. refer to Fig. 1 Screws, nuts and washers shown in Fig. 1 are not normally supplied with their associated components; where such fasteners are of a special type these are listed and may be ordered separately.	
Fig. 1 Item		
1	Top cover, excluding handle	41690-180R
2	Retaining clip (1 of 2), included in item 1	35418-311J
3	Protective clip (1 of 2)	37553-506Y
	Handle assembly comprising :-	
4	Plastic section	22315-575F
5	Liner (1 of 2)	22315-572N
6	End cap (1 of 2)	22315-573L
7	Special nut (1 of 2)	33900-120K
8	Bottom cover	35900-946K
9	Protective clip (1 of 2)	37553-506Y
10	Foot (1 of 4)	22315-604E
11	Special washer	33900-438J
	Handle assembly comprising :-	
12	Handle	37587-925L

Circuit reference	Description	Part no.
Fig. 1		
Item		
13	Attachment	37588-110B
14	Plate	34167-605B
15	Strip	21851-463E
16	Trim (left side)	34900-191Z
17	Trim (right side)	34900-192H
18	Protective cover, including catches	41690-102S
19	Catch (1 of 2)	22315-102V
20	Corner pad (1 of 4)	37575-123A
21	Surround	41511-018K
22	Front panel fascia	35902-254T
23	Knobs :-	
23	CARRIER RANGE	41145-407B
24	TUNE	41149-014U
25	EXTRA FINE TUNE	41149-016N
26	FINE TUNE	41141-708K
27	FUNCTION	41145-407B
28	DEVIATION	41149-002M
29	RF OUTPUT (coarse)	41145-407B
30	AM DEPTH	41149-002M
31	RF OUTPUT (fine)	41149-026W
32	MOD FREQ.	41149-027D
33	SET MOD.	41149-015Y
34	Window	37490-020W
35	Carrier range scales	
	10 to 22 kHz	31749-047T
	22 to 48 kHz	31749-048P
	48 to 105 kHz	31749-049X
	105 to 230 kHz	31749-050T

Circuit reference	Description	Part no.
	230 to 500 kHz	31749-051P
	500 kHz to 1.1 MHz	31749-052X
	1.1 to 2.4 MHz	31749-053M
	2.4 to 5.2 MHz	31749-054C
	5.2 to 10 MHz	31749-055R
	10 to 23 MHz	31749-056B*
	23 to 53 MHz	31749-057K*
	53 to 120 MHz	31749-058A*
36	RF box lid	41690-014A
37	Switch cover	37490-065A
38	Locking plate for mains selector	34444-116Y
	Tuning drive parts (see Chap. 5, Fig. 1)	
	Drive cord	16410-604V
	Tension spring	31119-017X
	Cursor assembly	41179-001R

*Quote part no. on scale if different from part no. listed above.

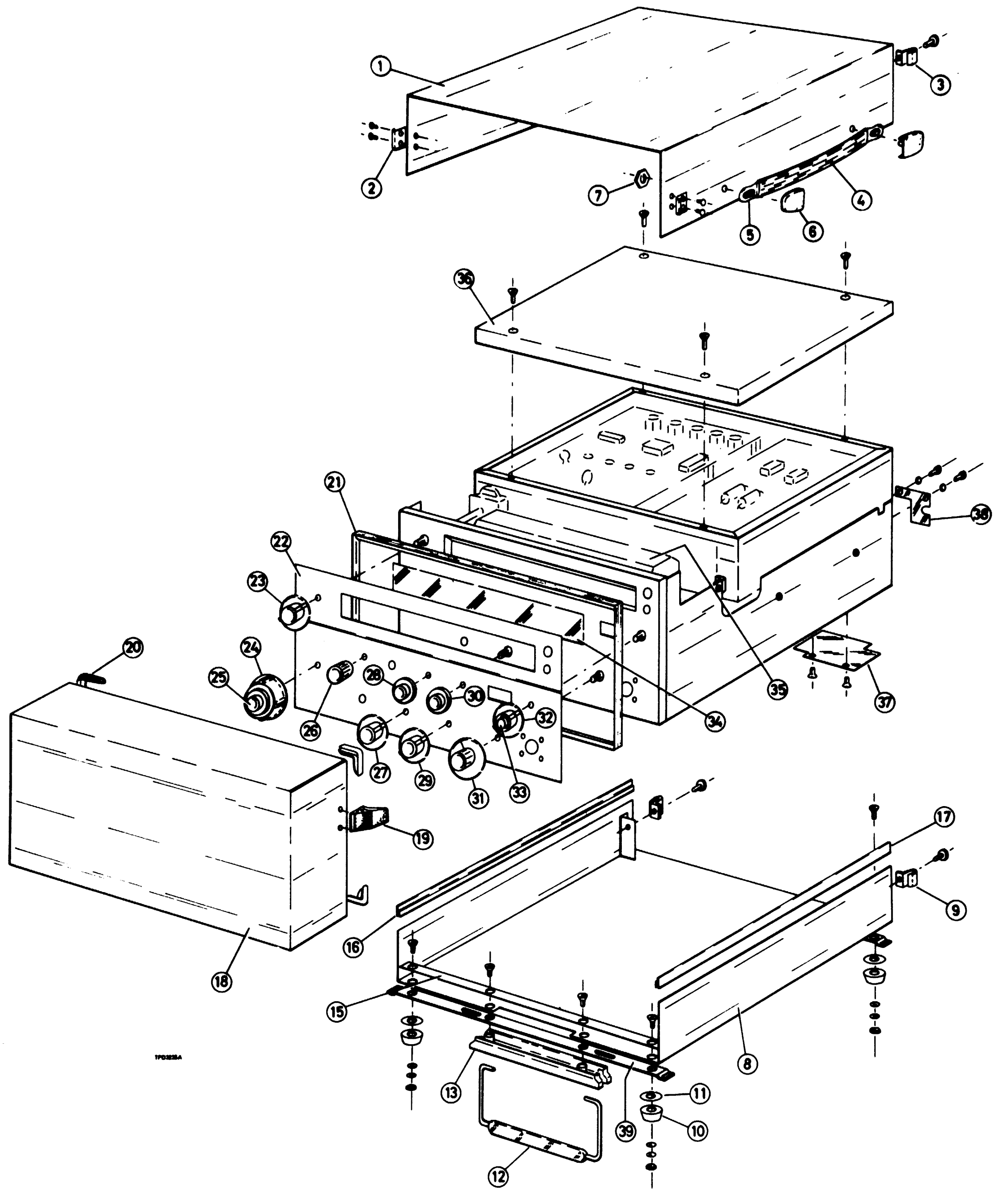


Fig. 1 TF 2016A - Mechanical parts.

Chapter 7

CIRCUIT DIAGRAMS

CONTENTS

CIRCUIT NOTES

Component values

1. Resistors : No suffix = ohms, k = kilohms, M = megohms.
   Capacitors : No suffic = microfarads, p = picofarads.
   Inductors : No suffix = henrys, m = millihenrys, μ = microhenrys
   SIC : Value selected in calibration, nominal value shown.

Switches

2. Rotary switches are drawn schematically and shown in the fully counter-clockwise position as viewed from the knob end. The active tag number is indicated at each position.

A5 DC Voltages

Test point		Reading	Test point		Reading
TR1	c	20 V	TR5	e	20 V
	b	16.6 V		b	19.4 V
	e	16.0 V		c	10.0 V
Junction D4/D5		4.5 V	TR6	c	19.5 V
TR2	c	20 V		b	*9.7 V
	b	*10 V		e	9.0 V
	e	9.4 V	TR7	c	12.0 V
TR3	c	20 V		b	2.75 V
	b	12.7 V		e	2.2 V
	e	12.3 V	TR8	c	19.2 V
TR4	c	19.4 V		b	*12.0 V
	b	11.2 V		e	11.4 V
	e	10.6 V	TR9	c	11.4 V
				b	2.2 V
				e	1.65 V

A6 DC Voltages

Test point		Reading	Test point		Reading
TR1	c	19.3 V	TR12	c	21.3 V
	b	*10 V		b	8.8 V
	e	9.3 V		e	8.2 V
TR2	e	20 V	TR13	d	21 V
	b	19.3 V		g	6 V
	c	9.5 V		s	9 V
TR4	c	20 V	TR14	c	23.7 V
	b	*12 V		b	6 V
	e	11.3 V		e	5.3 V
TR9	e	25 V	TR15	c	21 V
	b	24.4 V		b	6 V
	c	21 V		e	5.3 V
TR10	e	24.4 V	TR18	e	21.3 V
	b	23.7 V		b	20.6 V
	c	21 V		c	0 V
TR11	c	32 V	TR19	c	20.6
	b	21.3 V		b	0 V
	e	20.6 V		e	0 V
			A6 pin	22	32 V
				19	33 V
			Junction D14/D17		25 V

*Measured with a high impedance voltmeter or using the 100 V of a 20 kΩ/V meter.

Fig. 1

DC voltages : A5 and A6
(See Chap. 5 for conditions)

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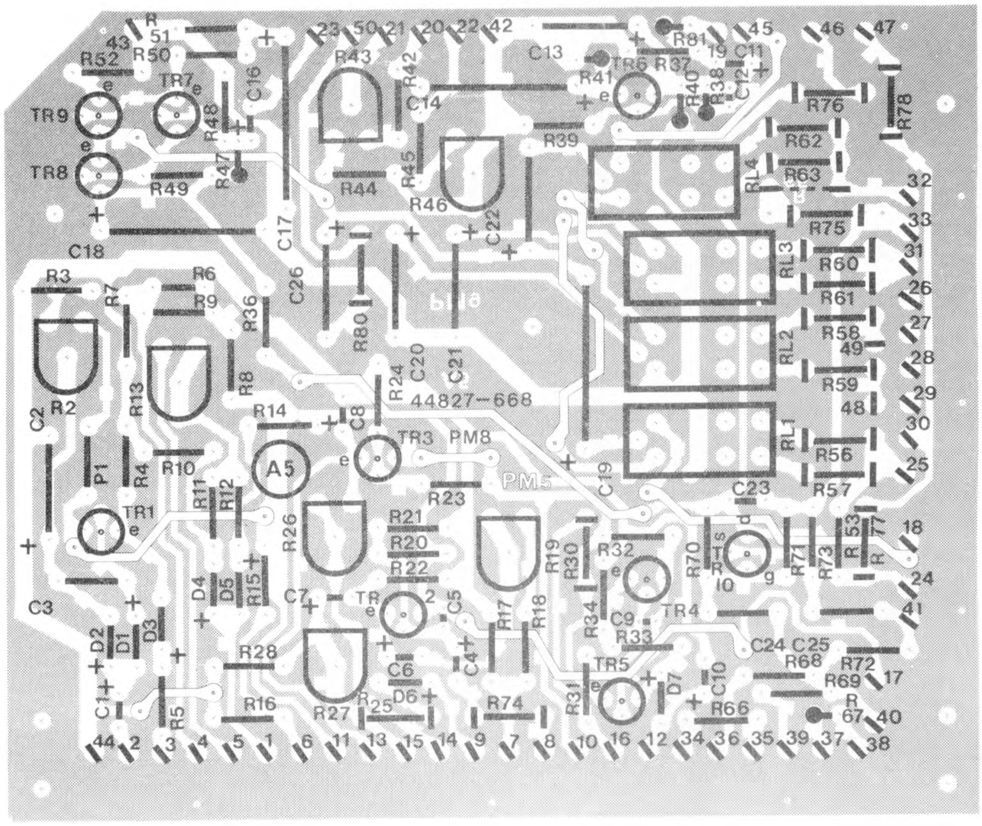

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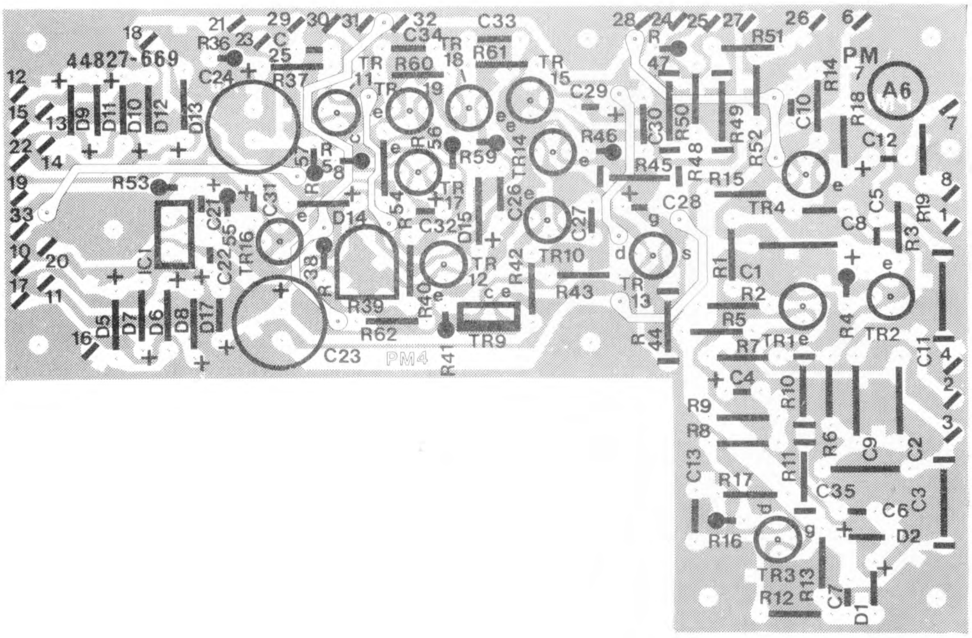
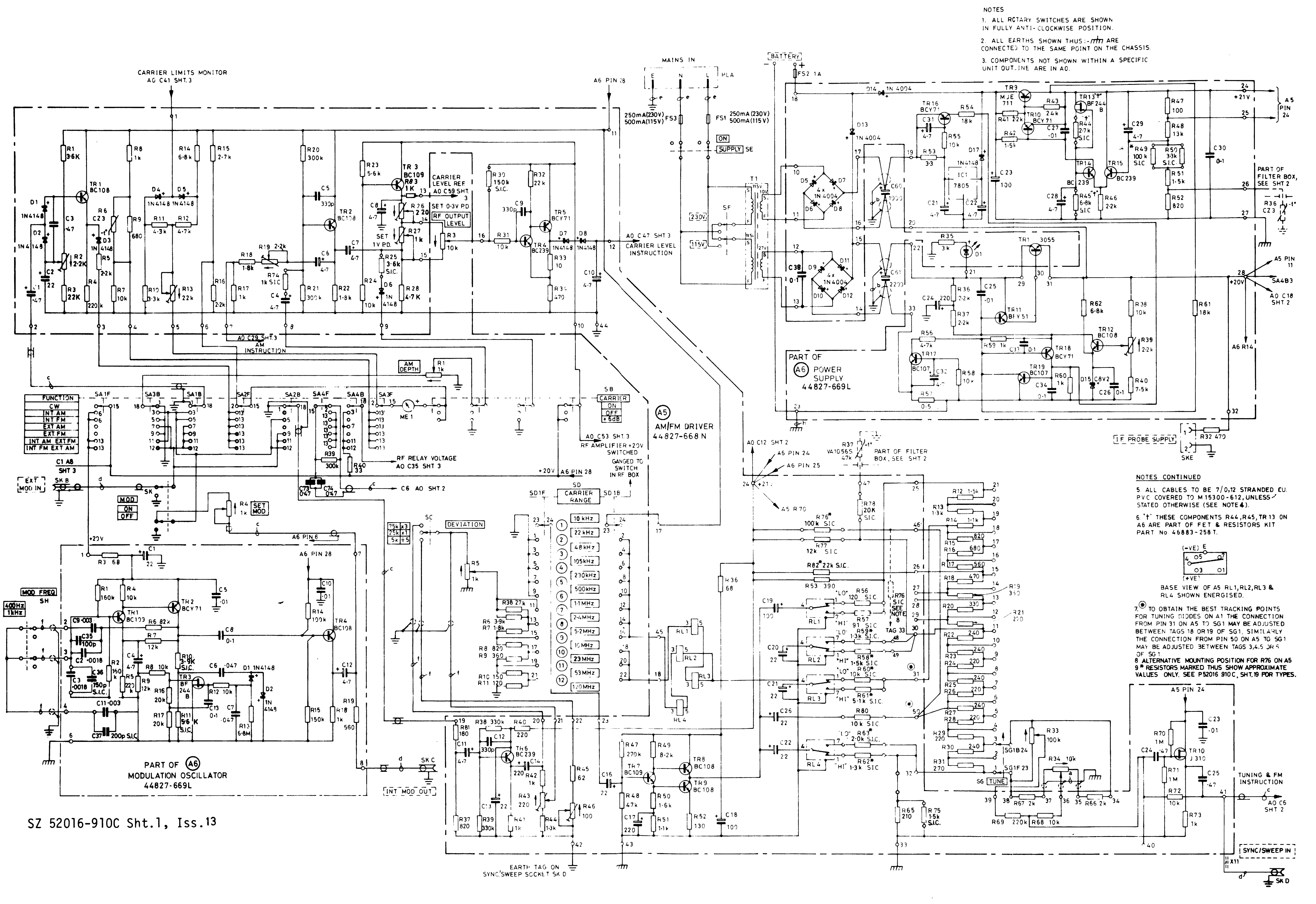


Component layout : A5 and A6

Fig. 1

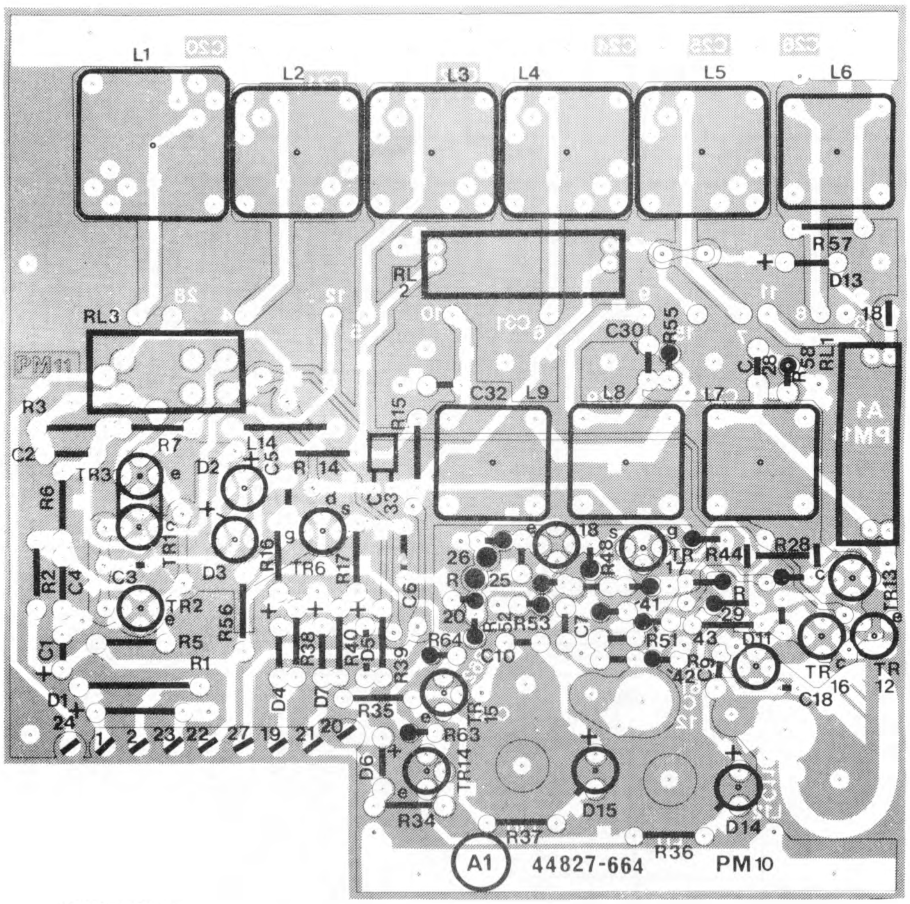


Power supply and modulation stages : A5 and A6

A1 DC Voltages

Test point		Reading	Test point		Reading
Range 9 : 5.2 MHz					
TR1	c	0 V	TR16	c	0 V
	b	10.1 V		b	11 V
	e	10.5 V		e	11.7 V
TR2	c	10.5 V	TR14	c	3.95 V
	b	12.2 V		b	4.5 V
	e	12.7 V		e	3.85 V
TR3	c	0 V	TR15	c	3.95 V
	b	12.1 V		b	4.45 V
	e	12.7 V		e	3.8 V
TR6	d	21 V	TR17	d	21 V
	g	10.5 V		g	0 V
	s	13.3 V		s	2.3 V
TR14	c	21 V	TR18	c	17.4 V
(switched off)	b	0 V		b	4.8 V
	e	0 V		e	4.2 V
TR15	c	21 V			
(switched off)	b	0 V			
	e	0 V			
Tuning voltage pin 27		1 V			
Range 12 : 53 MHz					
TR12	c	0 V	Tuning voltage		1 V
	b	13.0 V			
	e	13.7 V			
TR13	e	13.7 V			
	b	13.0 V			
	c	11.7 V			

DC voltages : A1
(See Chap. 5 for conditions)



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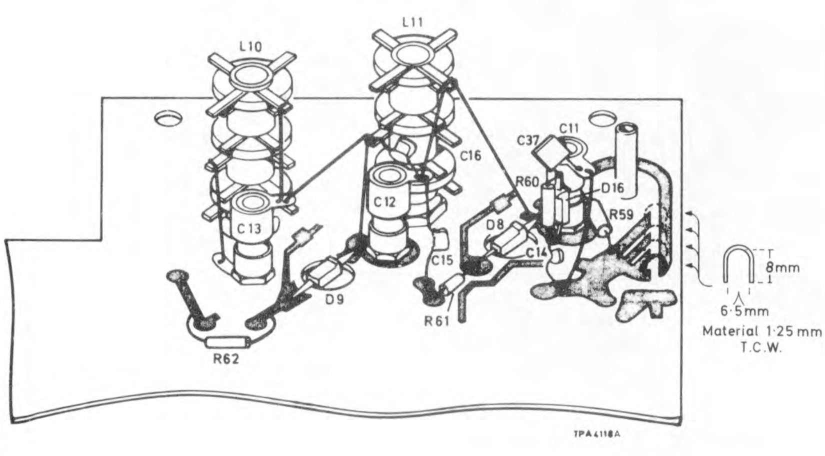
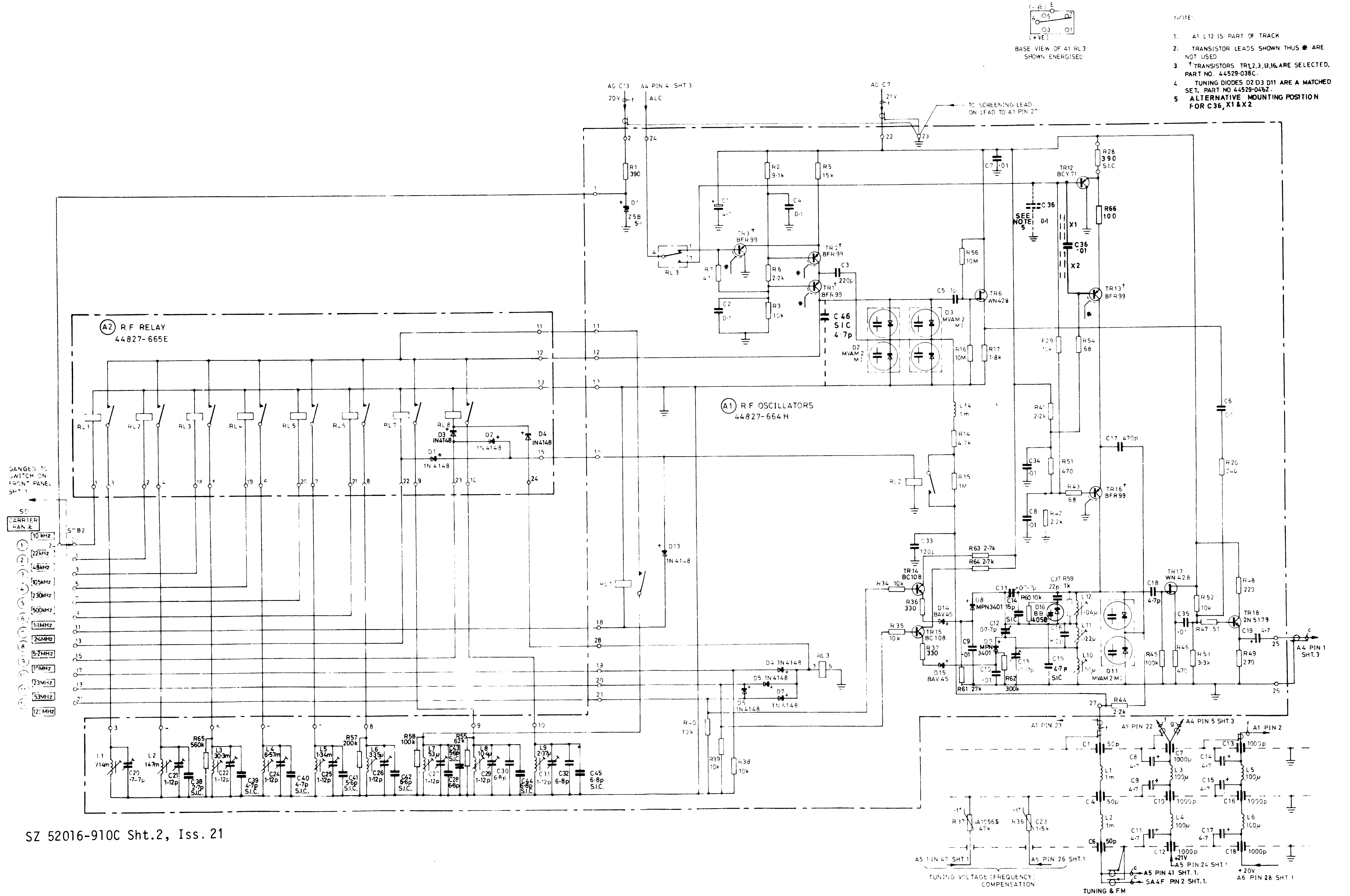


Detail of L10, L11 & L12

Component layout : A1



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Oscillators : A1 and A2

A3 DC Voltages

Test point		Reading
TR1	c	9.1 V
	b	0.93 V
	e	0.2 V
Junction R9/R7		9.3 V
Junction R9/R10		12.7 V
Junction R10/R11		5.7 V
IC1	pin 3	5.7 V
IC1	pin 4	5.7 V
IC1	pin 2	1.9 V
IC1	pin 7	1.9 V
IC1	pin 11	9.8 V
IC1	pin 13	10.0 V
IC1	pins 1, 8	1.2 V
Junction R23/R24		10.1 V
TR2	c	17.5 V
	b	3.9 V
	e	3.2 V
TR3	c	18 V
	b	3.9 V
	e	3.3 V
TR4	c	16.8 V
	b	7.5 V
	e	6.8 V
TR5	g	6.0 V
	s	6.8 V
A3 pin 5		6.0 V
TR6	c	16.9 V
	b	6.6 V
	e	6.0 V

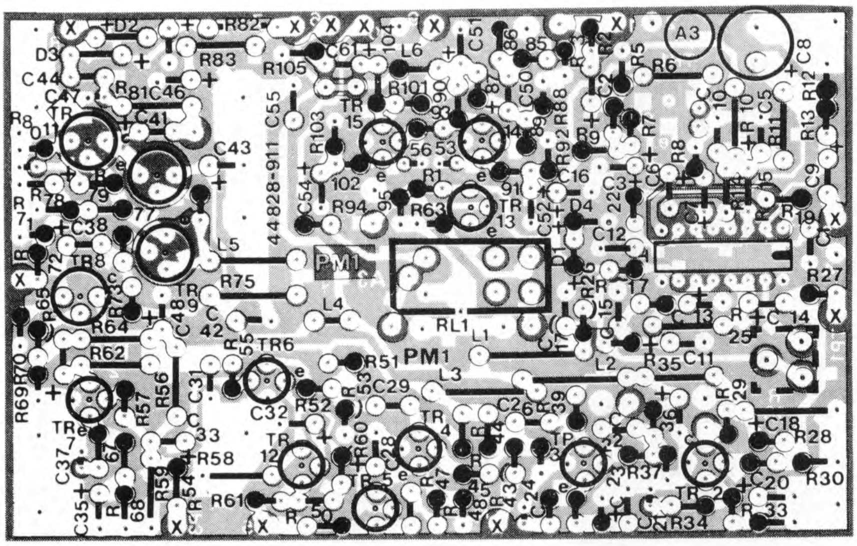
Test point		Reading
TR7	c	11 V
	b	5.7 V
	e	5.0 V
TR8	c	17.6 V
	b	12.1 V
	e	11.4 V
TR9	c	12.2 V
	b	3.5 V
	e	2.75 V
TR10	c	19.5 V
	b	12.1 V
	e	11.4 V
TR11	c	11.4 V
	b	2.75 V
	e	2.0 V
TR12	g	6.0 V
IC2	pin 1	3.7 V
	2	3.7 V
	3	3.7 V
	4	3.7 V
	5,6	0 V
	7	7.1 V
	8,9	11.6 V
	10	5.7 V

A4 DC Voltages

Test point		Reading
Range 12 : 53 MHz		
TR1	c	13.5 V
	b	14.7 V
	e	15.4 V
TR2	c	0 V
	b	14.7 V
	e	15.4 V
RF output : 2 V e.m.f. (CARRIER ON)		
IC1	pin 2	11.5 V
	3	11.8 V
	6	5.5 V
IC2	pin 2	10 V
	3	10 V
	6	14.5 V

Test point		Reading
RF output 4 V e.m.f. (CARRIER '+6 dB')		
IC1	pin 2	10.2 V
	3	10.4 V
	6	7.0 V
IC2	pin 2	10 V
	3	10 V
	6	13.3 V
Range 6 : 1 MHz		
TR1	c	11.8 V

DC voltages : A3 and A4
(See Chap. 5 for conditions)



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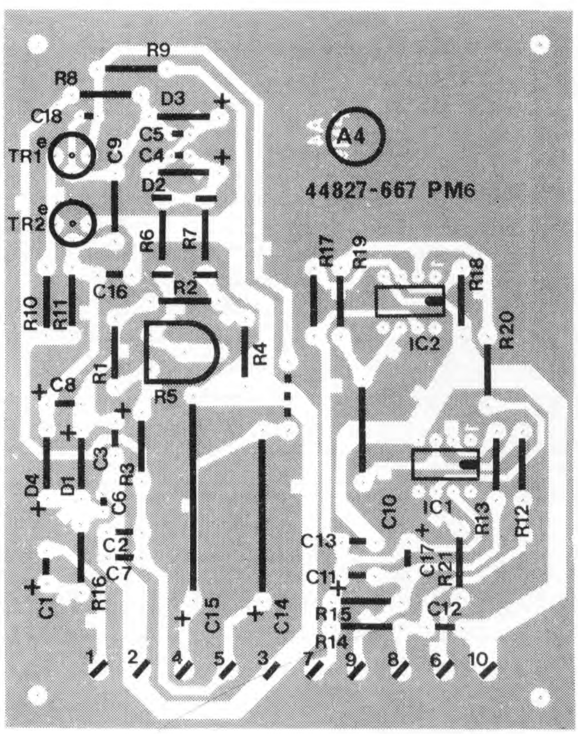

Component layout : A3 and A4

Fig. 5

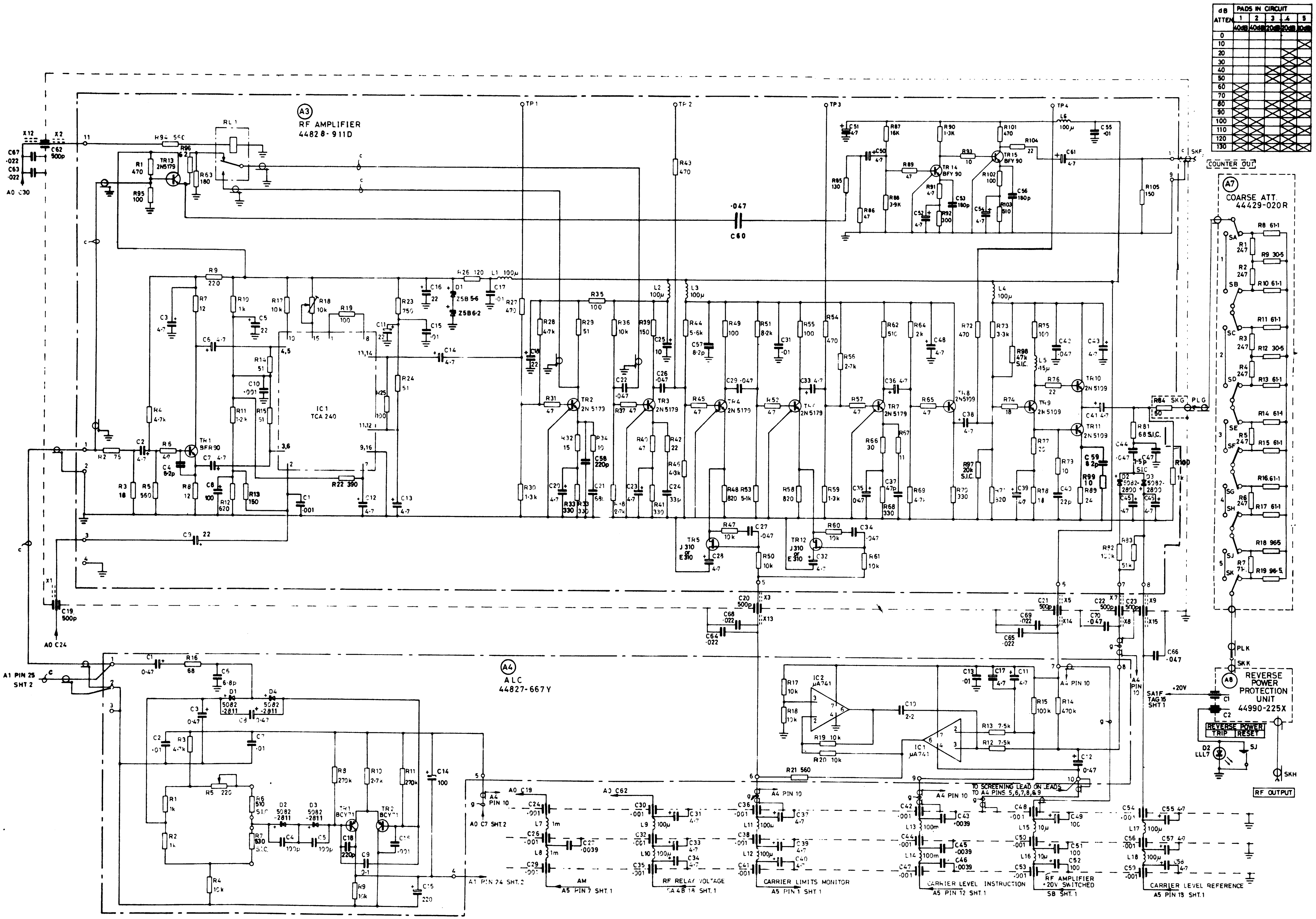

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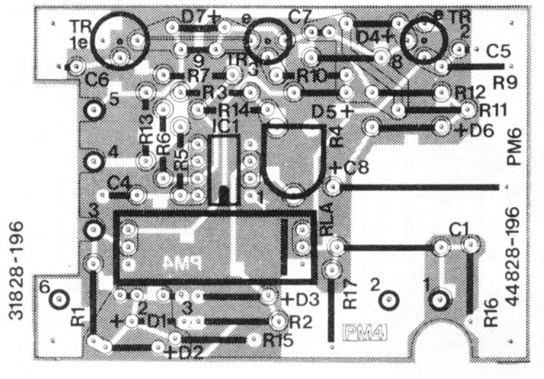
Fig. 6

Output stages : A3, A4 and A7

A8 DC Voltages

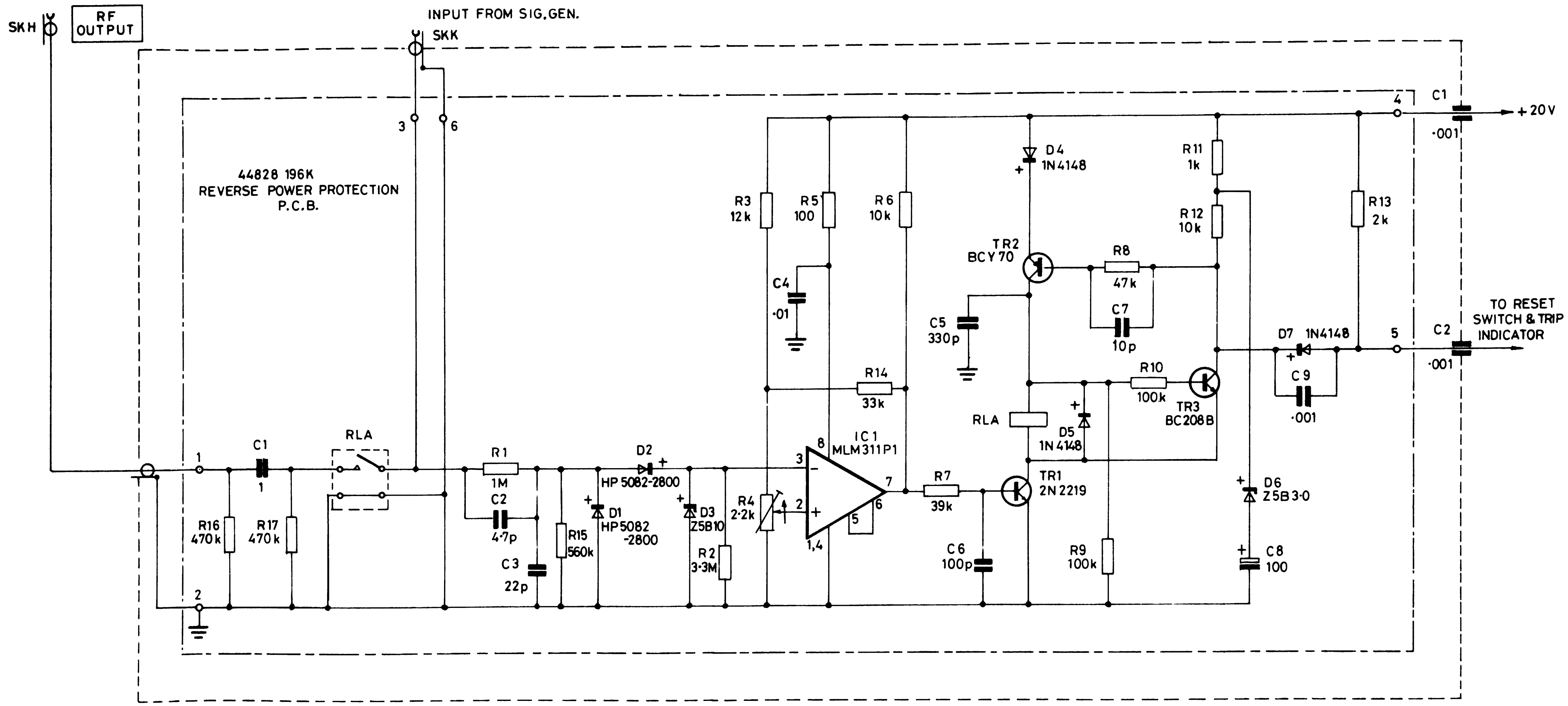
Test point		Reading
Pin 4		20.00 V
Junction R3/R4		3.69 V
IC1	pin 2	2.30 V
	pin 3	2.3 V
	pin 8	19.90 V
	pin 7	13.65 V
TR1	b	0.70 V
	c	0.10 V
TR2	e	19.3 V
	b	18.6 V
	c	19.25 V
TR3	e	0.10 V
	b	0.79 V
	c	0.18 V
Junction R11/R12		18.2 V
Pin 5		0.95 V
LED state		OFF
Volts across RLA		19.15 V
Relay state		Closed

DC voltages : A8
(See Chap. 5 for conditions)



Component layout : A8

Fig. 7



SZ 44990-255X Sht.1, Iss.2

Reverse power protection unit : A8