SIGNAL GENERATOR
AM/FM 10 kHz-120 MHz
(MARCONI INSTRUMENTS TF 2016 & 2016A)
AND
DIGITAL SYNCHRONIZER
(MARCONI INSTRUMENTS TF 2173)

BY COMMAND OF THE DEFENCE COUNCIL

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Prepared by Marconi Instruments Ltd., St. Albans
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SIGNAL GENERATOR
AM/FM 10 kHz-120 MHz
(MARCONI INSTRUMENTS TF 2016 & 2016A)

AND

DIGITAL SYNCHRONIZER
(MARCONI INSTRUMENTS TF 2173)

GENERAL AND TECHNICAL INFORMATION

Prepared by Marconi Instruments Ltd., St. Albans

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ILLUSTRATIONS

INTRODUCTION

1. TF 2016 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.

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.

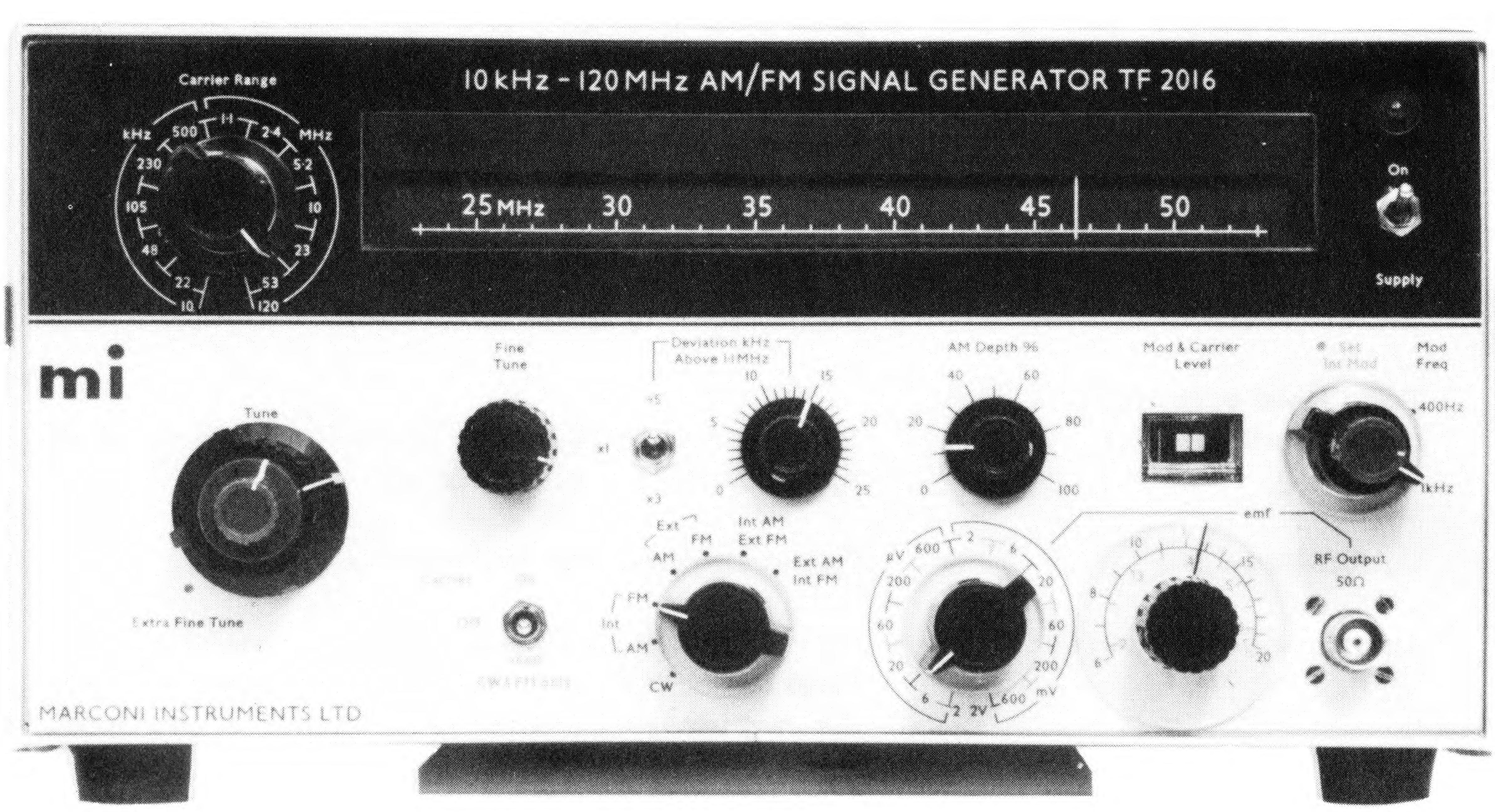

Fig. 1.1 AM/FM Signal Generator TF 2016

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 2 parts in 10^5 + 100 Hz in 5 minutes.

6. RF output

Level :	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 : 11 steps of 10 dB Fine : 0 to 10 dB continuously variable.
Total level accuracy : (above 2 μV e.m.f.)	With the CARRIER switch in the ON position, ±1 dB including the a.l.c. loop response.
Calibration :	Output calibrated in μV, mV and V e.m.f.
Automatic level control :	With the output terminated, a.l.c. maintains the level meter indication substantially constant. No set carrier level control is necessary or provided.
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.

7. Amplitude modulation

Carrier frequency range : 10 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%	
	Accy.	Dist.	Accy.	Dist.
0.1 - 30	±5%	1.5%	±5%	3%
30 - 90	±5%	3%	+5% -10%	6%
90 - 120	+0% -7.5%	4%	+0% -15%	8%

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

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

External frequency characteristic : 100 Hz to 10 kHz within 0.5 dB of the response at 1 kHz. Usable to 100 kHz at carrier frequencies above 30 MHz.

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. BNC rear outlet.

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

External frequency characteristic : 50 Hz to 10 kHz within 1 dB of the response at 1 kHz; usable to 100 kHz at carrier frequencies above 10 MHz.

FM stereo performance : (88 to 108 MHz and 10.7 MHz 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 coherence components : None. Fundamental frequency generation produces no non-harmonically related coherent components.

FM on c.w. : With telephone weighting (CCITT P53) less than 20 Hz deviation up to 53 MHz and 40 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 V to 264 V or 95 to 132 V; 45 Hz to 65 Hz (usable to 500 Hz). 24 VA maximum (at 50 Hz).

External d.c. : 23 V to 32 V, negative earth, 0.55 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

ACCESSORIES

13. Supplied accessories

43129-071D	Mains cable, 2 m.
41690-102S	Protective front panel cover.
44429-018B	20 dB pad, BNC to BNC.

14. 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 T-pad TM 5573/3, for matching to 75 Ω loads. Input/output voltage ratio 2:1.BNC plug to BNC socket.
43281-007C	RF Fuse Unit TM 9884; for protecting attenuator resistors when connecting to active loads. 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.
54431-021B	20 W 20 dB pad for use at end of cable to transceiver to provide reverse power protection.
	Reversible conversion plates for output attenuator calibration:-
35901-869Y	dB relative to 1 mW and μV p.d.
35901-870E	dB μV e.m.f. and dBμV p.d.

15. Associated equipment

52173-900M	TF 2173 Digital Synchronizer giving 1 in 10^6 frequency stability.
52169-900J	TF 2169 Pulse Modulator for use above 10 MHz.

ALTERNATIVE VERSIONS

16. 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 52016-301H).

Chapter 1

GENERAL INFORMATION

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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.

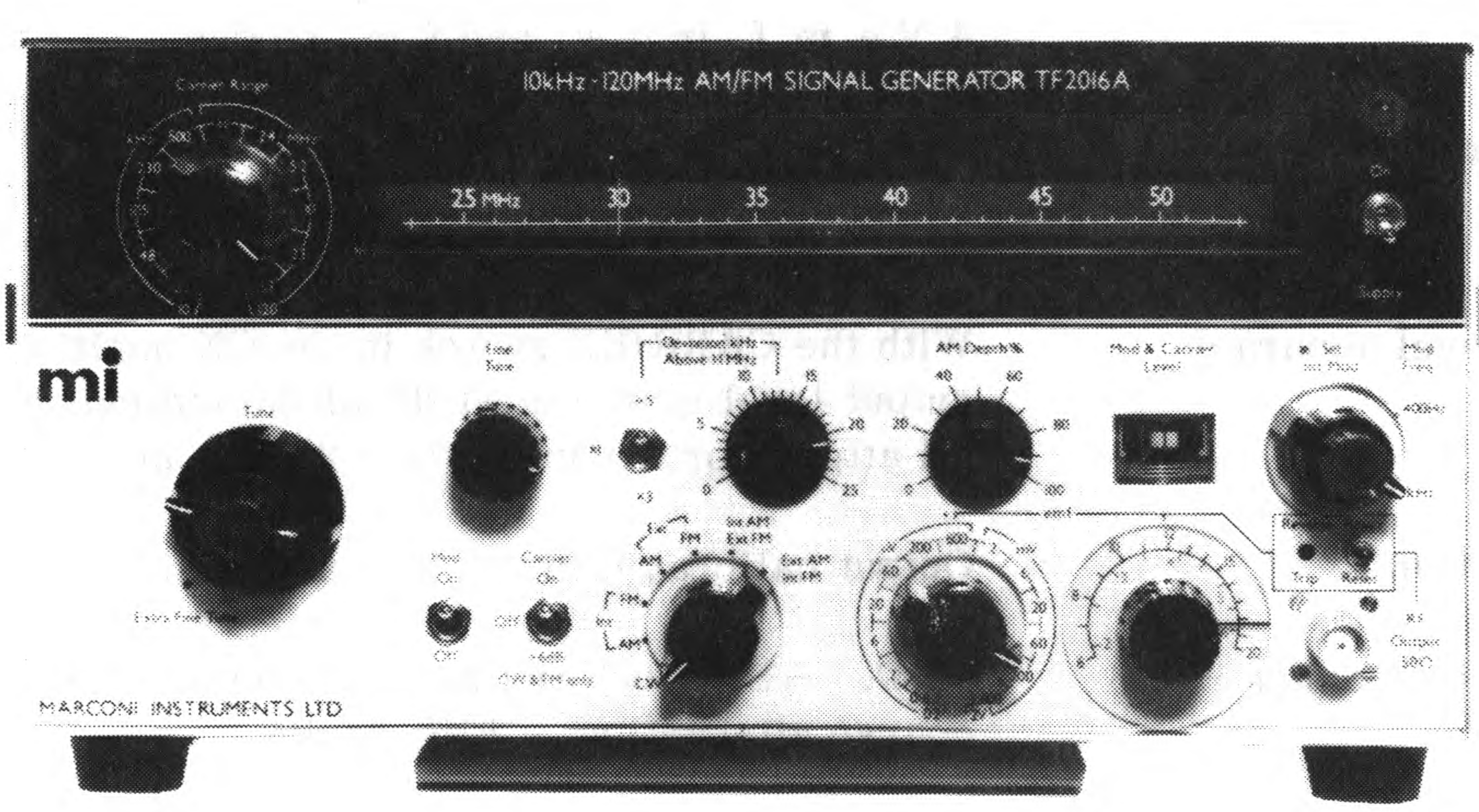

Fig. 1 AM/FM Signal Generator TF 2016A.

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 50 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

OPERATION

CONTENTS

ILLUSTRATIONS

PREPARATION FOR USE

Note ...

1. Retain the container, packing materials and the packing instruction note (if included) in case it is necessary to reship the instrument. Repacking instructions are given in Chap. 4.

AC mains operation

2. The a.c. supply cable is fitted at one end with a 3-pin socket which connects with the instrument. When connecting a supply plug to the other end ensure that the wires are connected as follows :-

Earth - Green/yellow
Neutral - Blue
Live - Brown

3. Before connecting the instrument to the a.c. supply check that the voltage selector switch on the rear panel is set to accept the local supply, i.e. set to 230 V for the 190 to 264 V range or 110 V for the 95 to 132 V range. To change the range, remove the locking plate, set the switch correctly, reverse the plate and refit.

4. Check that a slow-blow a.c. fuse is fitted having the correct rating as indicated by the position of the range switch locking plate.

Battery operation

5. 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.

Note ...

6. 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.

7. Check that a 1 A slow-blow fuse is fitted in the BATT holder.

Output circuit protection

8. To avoid damage to the resistors in the coarse RF OUTPUT attenuator RF Fuse Unit TM 9884 (43281-007C) should be used when testing transceivers; alternatively, the 20 W 20 dB pad (54431-021B) may be used - see para. 27.

CONTROLS AND CONNECTORS

9. 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.

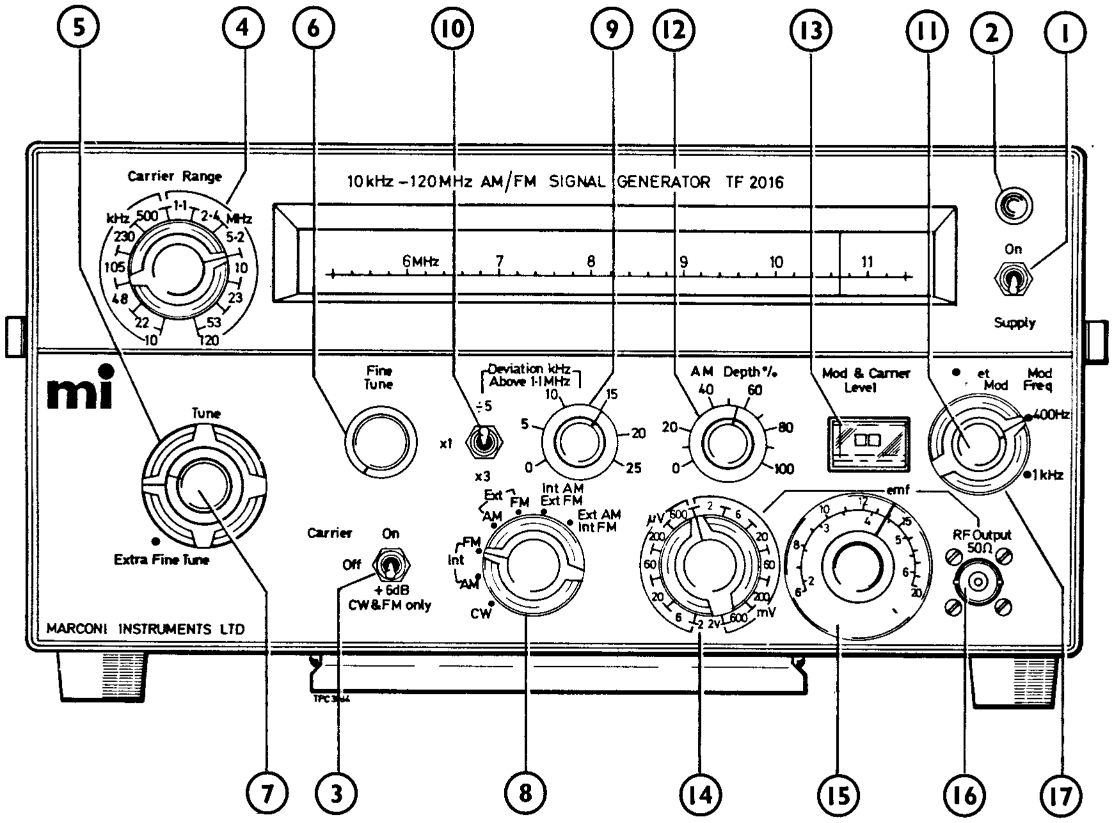

Fig. 1 Front panel controls

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

(13) 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.

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

(15) RF OUTPUT (fine). Continuously variable to interpolate between coarse steps of item (14).

(16) 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.

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

10. 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 to suit local a.c. supply.

(3) AC FUSE. Mains input fuse 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 (slow-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.

(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. 29).

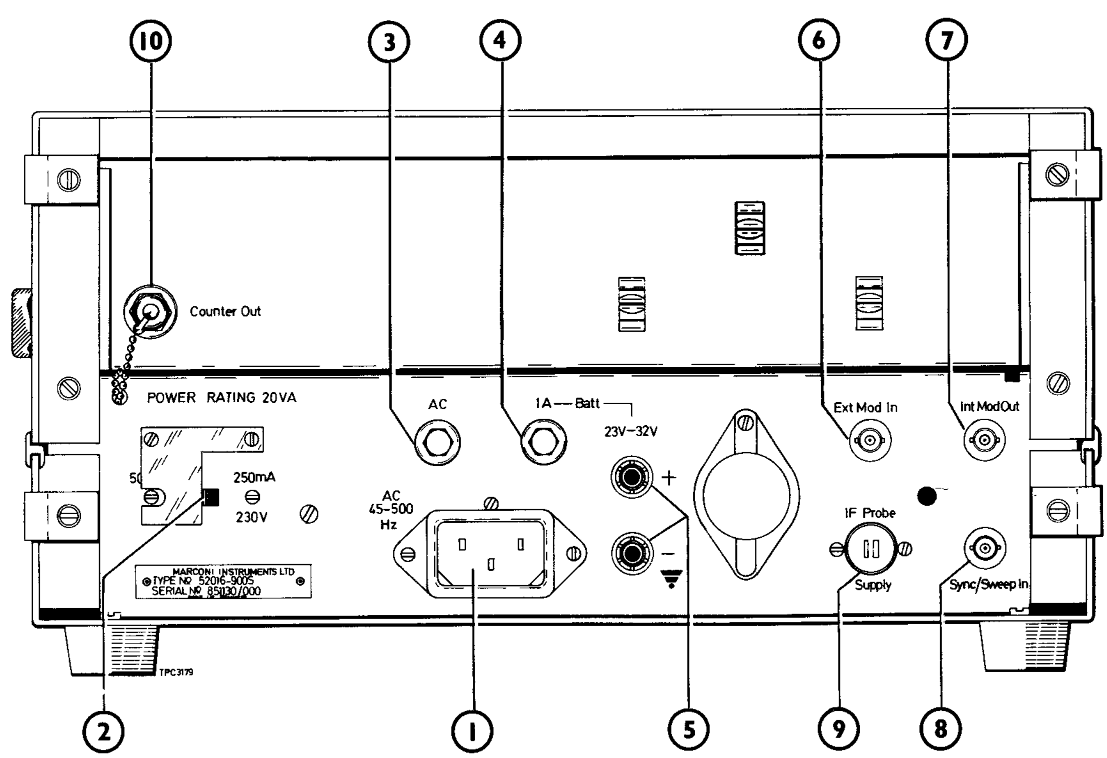

Fig. 2 Rear panel connectors

SETTING FREQUENCY

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

(2) Using the output cable supplied connect TF 2016 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

12. TF 2016 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 the SYNC/SWEEP connector.

SWEEP FACILITY

13. 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

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

15. Internal a.m.

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

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

16. Internal f.m.

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

(2) Set FUNCTION switch at INT FM and CARRIER 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).

17. 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.

18. Internal a.m. with external f.m.

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

19. Internal f.m. with external a.m.

(1) Set FUNCTION switch at INT FM and CARRIER 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

20. 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

21. 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

22. The RF OUTPUT controls (coarse and fine attenuators) are calibrated in V e.m.f. Where dBμV or dBm levels are to be used reference should be made to the conversion scale on the top of the instrument. The scale is as shown in Fig. 3.

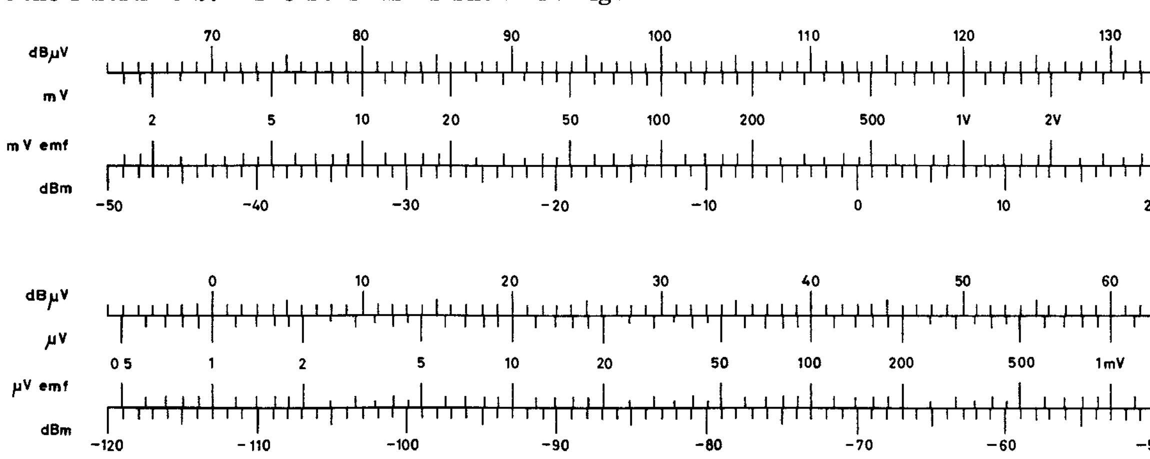

Fig. 3 Output conversion scale

23. 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 fine attenuator knob and potentiometer securing nut and fit the new cover plate.

(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

24. To match a load that is greater than 50 Ω to the output of TF 2016 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.

25. 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.

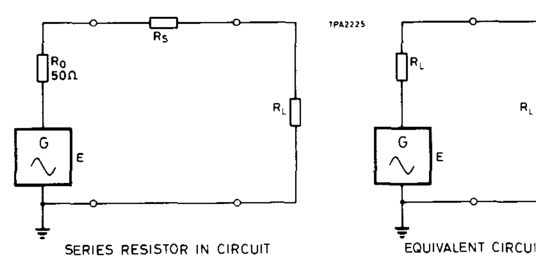

Fig. 4 High impedance matching

USE OF IF PROBES

26. 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.

27. 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 economizer, 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 RF FUSE OR 20 dB 20 W PAD

28. To prevent accidental damage to the signal generator when testing transceivers the r.f. fuse or 20 W 20 dB pad may be used at the equipment end of the cable from the generator. The 20 W pad has a 5 minute duration capability of 30 W and its attenuation of 20 dB must be allowed for in measurements on the receiver.

USE OF EXTERNAL COUNTER

29. 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.

Chapter 2

OPERATION

CONTENTS

AC MAINS OPERATION

1. 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.

2. 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.

3. 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

BATTERY OPERATION

4. 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

5. 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.

CONTROLS AND CONNECTORS

6. 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.

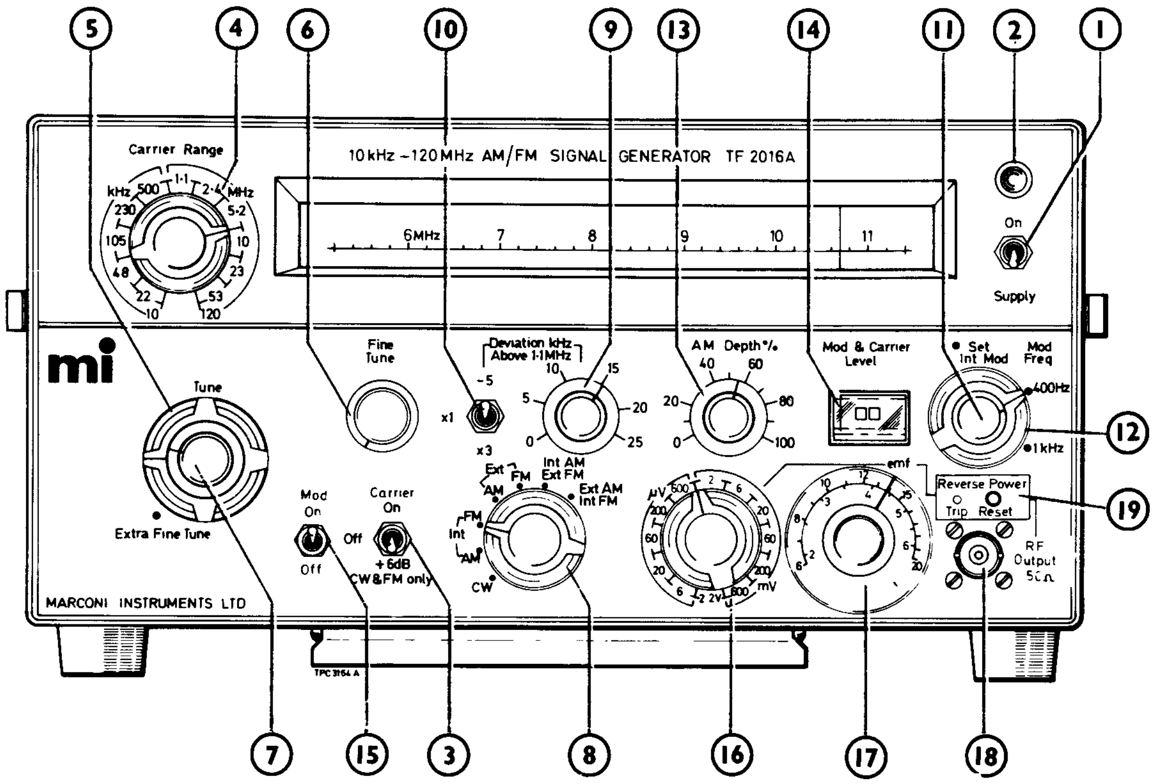

Fig. 1 Front panel controls.

(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.

7. 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.

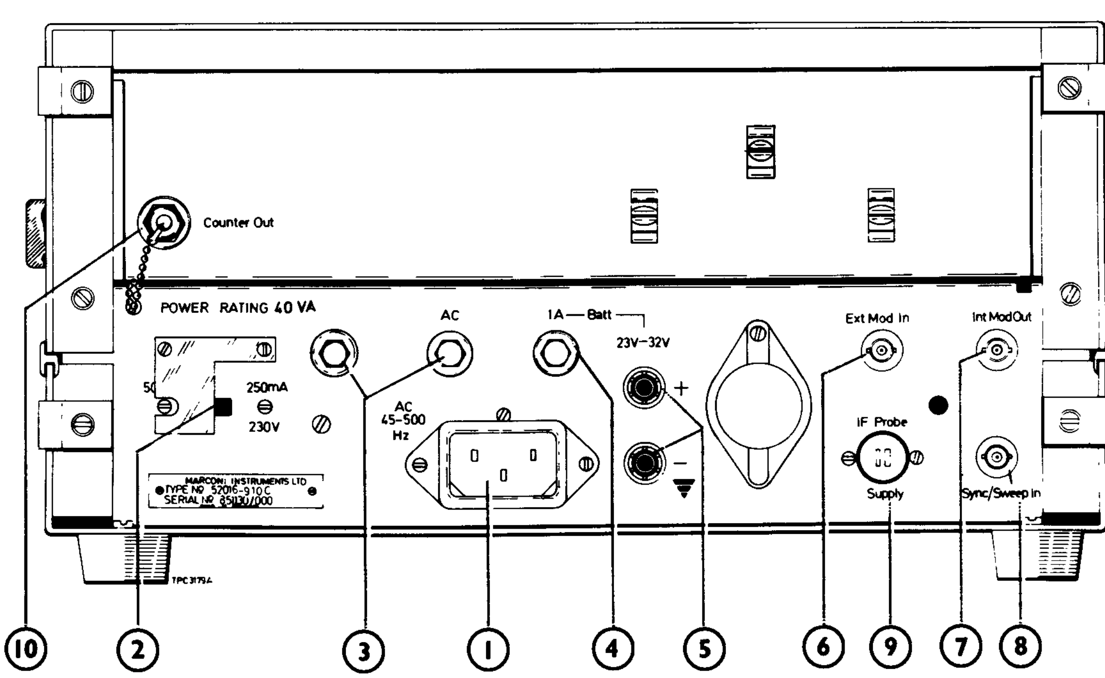

Fig. 2 Rear panel controls.

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(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. 25).

SETTING FREQUENCY

8. (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

9. 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

10. 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

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

12. 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.

13. 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).

14. 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.

15. 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.

16. 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

17. 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

18. 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

19. 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.

20. 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.

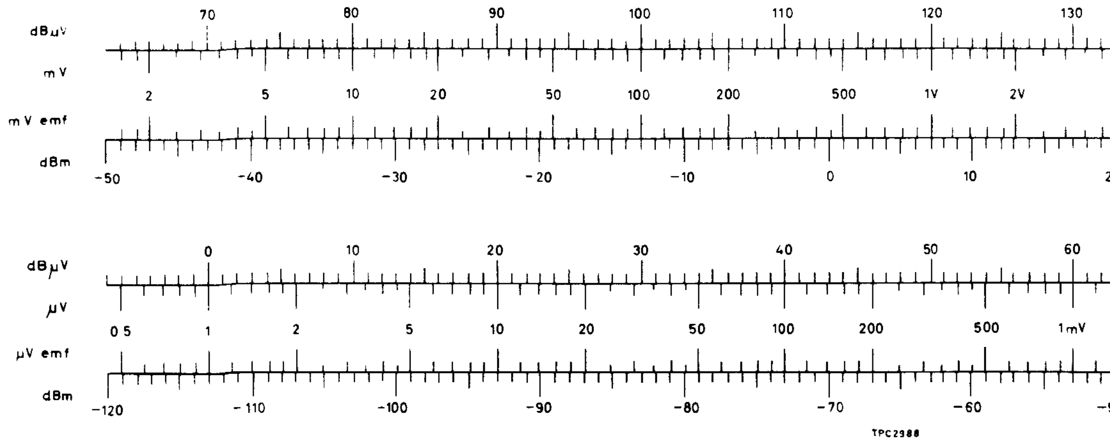


Fig. 3 Output conversion scale.

(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

21. 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.

22. 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.

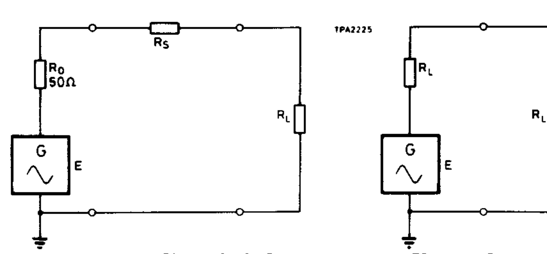


Fig. 4 High impedance matching.

USE OF IF PROBES

23. 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.

24. 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

25. 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

26. 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.

27. 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.

28. 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.

29. 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 3

TECHNICAL DESCRIPTION

CONTENTS

ILLUSTRATIONS

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 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.

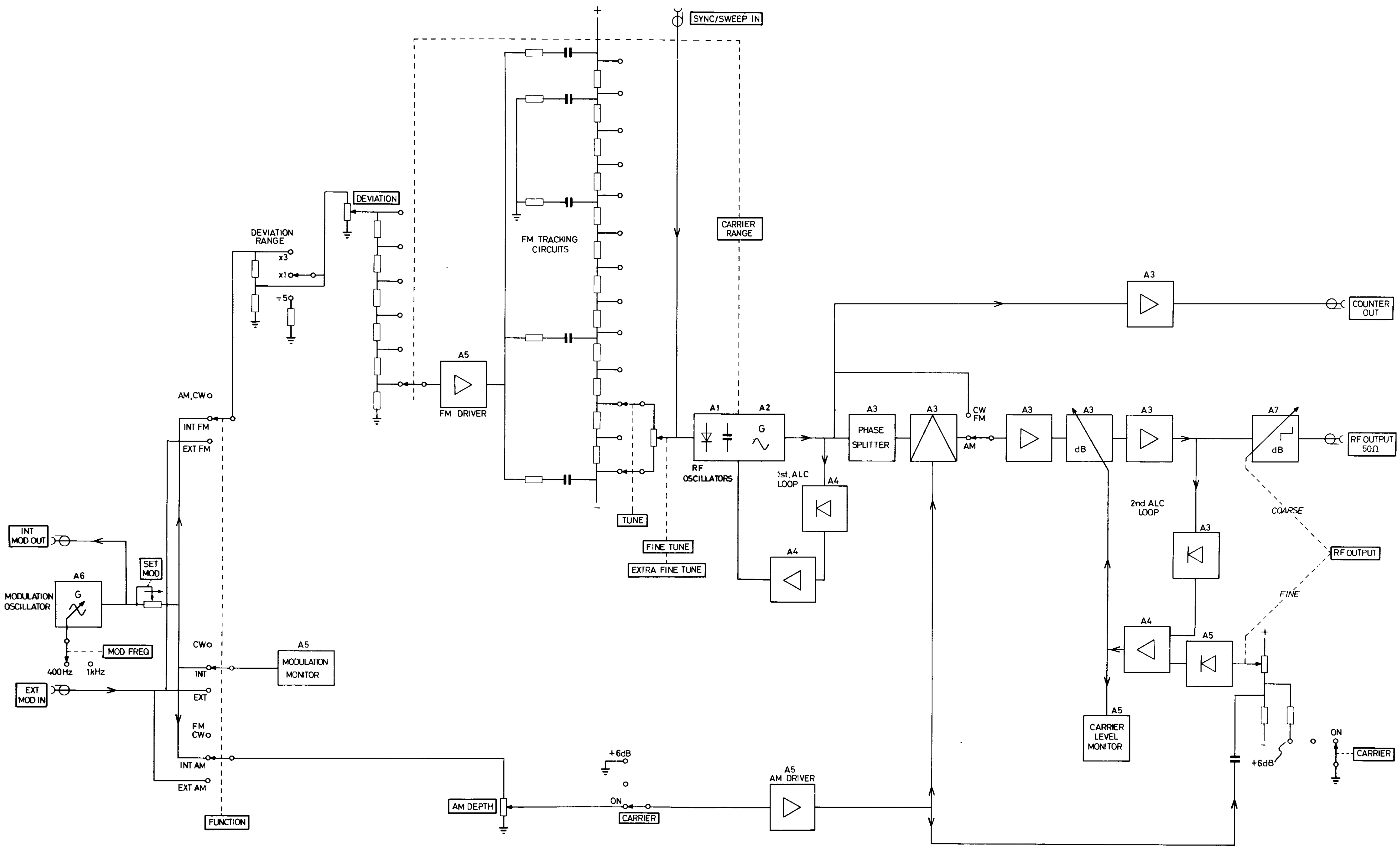


Fig. 1

Block diagram

Fig. 1

13. Frequency is stabilized by compensation for the instrument's rise in temperature after switch on. This is achieved by compensation of the 21 V supply by thermistor A0R36, also by thermistor A0R37 and nickel resistor A5R65.

14. The required oscillator is selected by the range switch, and its output is taken through a common buffer, TR18, to the first a.l.c. loop.

TUNING AND FREQUENCY MODULATION

Circuit diagram : Chap. 7, Fig. 2 (A5 & A6)

15. Because the varactors used for tuning have a non-linear capacitance/voltage characteristic, a 19-position switch A0SG with a chain of various resistors is used to provide a stepped linear change of frequency. Potentiometer A0R34 interpolates between switch positions. The additional potentiometer A0R33 enables TF 2016 to be precisely tuned to a receiver under test.

16. For a frequency modulated output the a.f. signal is routed to the varactors through the f.m. controls, scaling resistors A0R6 to R11, amplifier TR7, TR8 and TR9, tracking resistors A5R56 to R62, and the tuning control circuits. The tracking resistors are automatically selected by the carrier range switch. A5TR10 forms a low impedance source for the f.m. drive filter.

FIRST ALC LOOP

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

17. The output from the oscillators is maintained at a nominal level of 70 mV by the first automatic level control (a.l.c.) loop. The oscillator output is applied to a detector circuit, D1 and D4, which is referenced by the set voltage at the junction of R1 and R2.

18. Output from the detector is applied to one input of a differential pair TR1, TR2, where it is compared with a level preset by network R4, R5, R6 and R7. Any difference in the level of the signals either towards positive or negative appropriately varies the bias to the a.l.c. transistors TR3, TR12 on the oscillator board A1, which re-establishes the required output level.

19. Diodes A4D2 and D3 compensate for the temperature changes of the detectors D1 and D4. Capacitors C14 and C15 ensure that the lower frequency ranges cannot be cut off by switching surges, and also minimize a.l.c. noise (spurious f.m.).

PHASE SPLITTER

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

20. The controlled output level from the oscillators is applied to a low noise phase-splitter TR1, after being attenuated by pad R2 and R3. This drives the modulator in a balanced mode.

COUNTER AMPLIFIER

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

21. The attenuated signal fed to the phase splitter is also fed to the counter amplifier circuit, IC2, which provides an auxiliary output of greater than 50 mV into 50 Ω, to drive an external frequency counter, or synchronizer.

MODULATOR AND AMPLITUDE MODULATION

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

22. The modulator, IC1, is a long-tailed pair with current steering. Its operation may be described as follows.

The sum of the two output currents equals the tail current and, from considerations of symmetry, if either $V_1 = V_2$ or $V_3 = V_4$ then $I_1 = I_2$. Also if $R \gg r_e$ (the inherent emitter resistance) the collector currents of A and B will differ by an amount proportional to the difference between V_1 and V_2. If, therefore, a small input at frequency f_1 is applied between V_1 and V_2 and a large signal at f_2 is applied between V_3 and V_4, sufficient to turn the transistors C, F, D and E fully on and off, it is evident that switching modulation, similar to that of a diode ring will occur and frequencies $f_1 \pm f_2$ will occur at the output (as will sums and differences of f_1 and the odd harmonics of f_2 i.e., $f_1 \pm 3f_2$, $f_1 \pm 5f_2$, etc.).

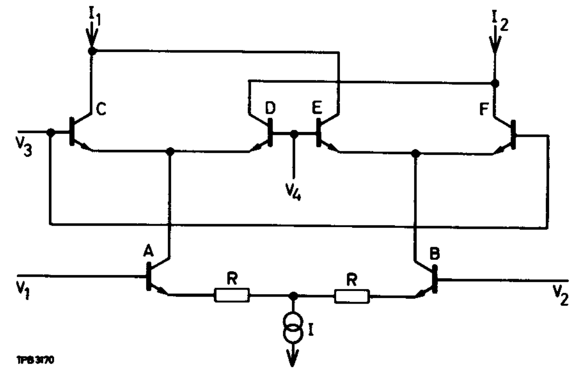


Fig. 2 Simplified diagram of amplitude modulator

23. The a.m. modulating signal is applied to the modulator in an unbalanced mode, and so needs no special driving circuits. For correct results, the modulator has to be set up to provide 6 dB of carrier suppression at 120 MHz, below maximum output.

24. In c.w. and f.m. modes, the modulator is bypassed by a change-over relay, A3RL1, to further reduce the amplifier noise floor.

RF AMPLIFIER - LEVELLING STAGES

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

25. There are two identical levelling stages in the main r.f. amplifier circuit, formed around stages A3TR4 and TR6. Maximum stage gain is determined by the drain-source 'on' resistance of the f.e.t., TR5 and TR12, which varies with the a.l.c. control voltage from A4IC1, pin 6. The minimum gain is determined for each stage by A3R48 and R58 respectively.

SECOND ALC LOOP

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

26. The a.l.c. control voltage is derived as follows :-

The voltage across the second detector (A3D2 and D3) is compared by A4IC1 with a level dictated by the setting of the fine RF OUTPUT control A0R3. Any difference in the signals causes the output of A4IC1 to change, thus instructing the f.e.t. levelling stages to increase or reduce amplifier gain as necessary. The function of the second operational amplifier, A4IC2, is to invert the control signal to the integrating capacitor, C10, to preserve the sense of integration.

RF AMPLIFIER - OUTPUT STAGES

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

27. The class A output pair, A3TR10 and TR11, is driven by a phase splitter TR9, whose gain, and hence the gain of the triplet, is determined by the ratio of R75 and R77. The output 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. 6 (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 110 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.

MODULATION OSCILLATOR AND CIRCUITS

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

31. 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 Hz. 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.

32. 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'.

33. 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.

34. 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.

MONITOR CIRCUITS

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

35. 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.

36. 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.

37. 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.

38. 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)

39. 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.

40. 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.

41. 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.

42. 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

43. 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 3

TECHNICAL DESCRIPTION

CONTENTS

INTRODUCTION

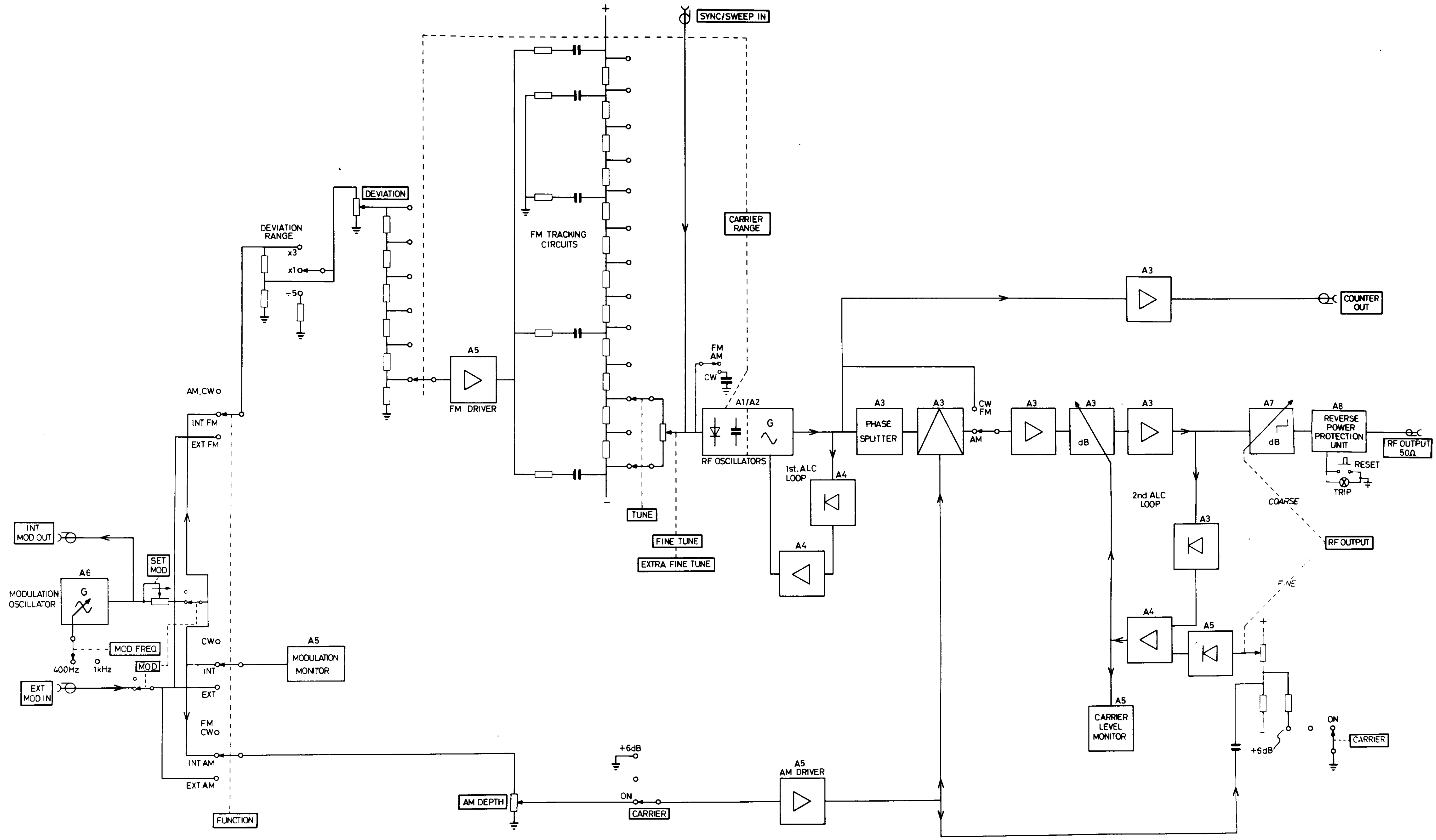
1. All printed boards and other sub-assemblies in the instrument are allocated a unit identification code in the sequence A1 to A7 and, where practical, the sub-assembly is marked with this code. The main frame and interconnecting material is coded A0.

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.



Block diagram.

13. Frequency is stabilized by compensation for the instrument's rise in temperature after switch on. This is achieved by compensation of the 21 V supply by thermistor A0R36, also by thermistor A0R37 and nickel resistor A5R65.

14. The required oscillator is selected by the range switch, and its output is taken through a common buffer, TR18, to the first a.l.c. loop.

TUNING AND FREQUENCY MODULATION

Circuit diagram : Chap. 5, Fig. 2 (A5 & A6)

15. Because the varactors used for tuning have a non-linear capacitance/voltage characteristic, a 19-position switch A0SG with a chain of various resistors is used to provide a stepped linear change of frequency. Potentiometer A0R34 interpolates between switch positions. The additional potentiometer A0R33 enables TF 2016 to be precisely tuned to a receiver under test.

16. For a frequency modulated output the a.f. signal is routed to the varactors through the f.m. controls, scaling resistors A0R6 to R11, amplifier TR7, TR8 and TR9, tracking resistors A5R56 to R62, and the tuning control circuits. The tracking resistors are automatically selected by the carrier range switch. A5TR10 forms a low impedance source for the f.m. drive filter. In c.w. operation capacitors A0C73/74 are switched in to reduce the f.m. noise level.

FIRST ALC LOOP

Circuit diagram : Chap. 5, Fig. 6 (A4)

17. The output from the oscillators is maintained at a nominal level of 44 mV by the first automatic level control (a.l.c.) loop. The oscillator output is applied to a detector circuit, D1 and D4, which is referenced by the set voltage at the junction of R1 and R2.

18. Output from the detector is applied to one input of a differential pair TR1, TR2, where it is compared with a level preset by network R4, R5, R6 and R7. Any difference in the level of the signals either towards positive or negative appropriately varies the bias to the a.l.c. transistors TR3, TR12 on the oscillator board A1, which re-establishes the required output level.

19. Diodes A4D2 and D3 compensate for the temperature changes of the detectors D1 and D4. Capacitors C14 and C15 ensure that the lower frequency ranges cannot be cut off by switching surges, and also minimize a.l.c. noise (spurious f.m.).

PHASE SPLITTER

Circuit diagram : Chap. 5, Fig. 6 (A3)

20. The controlled output level from the oscillators is applied to a low noise phase-splitter TR1, after being attenuated by pad R2 and R3. This drives the modulator in a balanced mode.

COUNTER AMPLIFIER

Circuit diagram : Chap. 5, Fig. 6 (A3)

21. The attenuated signal fed to the phase splitter is also fed to the counter amplifier circuit, IC2, which provides an auxiliary output of greater than 50 mV into 50 Ω, to drive an external frequency counter, or synchronizer.

MODULATOR AND AMPLITUDE MODULATION

Circuit diagram : Chap. 5, Fig. 6 (A3)

22. The modulator, IC1, is a long-tailed pair with current steering. Its operation may be described as follows.

The sum of the two output currents equals the tail current and, from considerations of symmetry, if either $V_1 = V_2$ or $V_3 = V_4$ then $I_1 = I_2$. Also if $R >> r_e$ (the inherent emitter resistance) the collector currents of A and B will differ by an amount proportional to the difference between V_1 and V_2. If, therefore, a small input at frequency f_1 is applied between V_1 and V_2 and a large signal at f_2 is applied between V_3 and V_4, sufficient to turn the transistors C, F, D and E fully on and off, it is evident that switching modulation, similar to that of a diode ring will occur and frequencies $f_1 \pm f_2$ will occur at the output (as will sums and differences of f_1 and the odd harmonics of f_2 i.e. $f_1 \pm 3f_2$, $f_1 \pm 5f_2$, etc.).

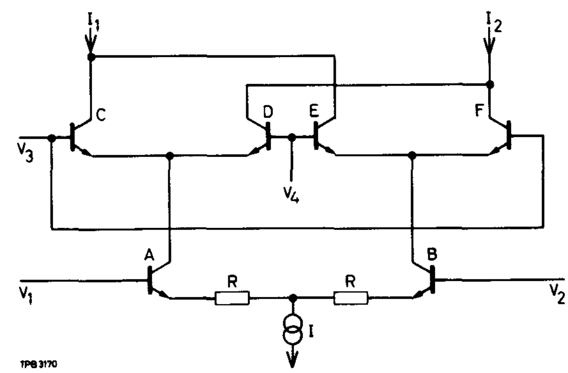


Fig. 2 Simplified diagram of amplitude modulator.

23. The a.m. modulating signal is applied to the modulator in an unbalanced mode, and so needs no special driving circuits. For correct results, the modulator has to be set up to provide 6 dB of carrier suppression at 120 MHz, below maximum output.

24. In c.w. and f.m. modes, the modulator is bypassed by a change-over relay, A3RL1, to further reduce the amplifier noise floor.

RF AMPLIFIER - LEVELLING STAGES

Circuit diagram : Chap. 5, Fig. 6 (A3)

25. There are two identical levelling stages in the main r.f. amplifier circuit, formed around stages A3TR4 and TR6. Maximum stage gain is determined by the drain-source 'on' resistance of the f.e.t., TR5 and TR12, which varies with the a.l.c. control voltage from A4IC1, pin 6. The minimum gain is determined for each stage by A3R48 and R58 respectively.

SECOND ALC LOOP

Circuit diagram : Chap. 5, Fig. 6 (A4)

26. The a.l.c. control voltage is derived as follows :-

The voltage across the second detector (A3D2 and D3) is compared by A4IC1 with a level dictated by the setting of the fine RF OUTPUT control A0R3. Any difference in the signals causes the output of A4IC1 to change, thus instructing the f.e.t. levelling stages to increase or reduce amplifier gain as necessary. The function of the second operational amplifier, A4IC2, is to invert the control signal to the integrating capacitor, C10, to preserve the sense of integration.

RF AMPLIFIER - OUTPUT STAGES

Circuit diagram : Chap. 5, Fig. 6 (A3)

27. The class A output pair, A3TR10 and TR11, is driven by a phase splitter TR9, whose gain, and hence the gain of the triplet, is determined by the ratio of R75 and R77. The output

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. 5, Fig. 6 (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. 5, 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. 5, 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. 5, 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. 5, 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. 5, 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. 5, 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 4

MAINTENANCE

CONTENTS

TABLES

ILLUSTRATIONS

INTRODUCTION

1. This chapter contains information for keeping the equipment in good working order and for checking its overall performance. 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. All chromium plated screws and all screws tinted blue are metric. 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.

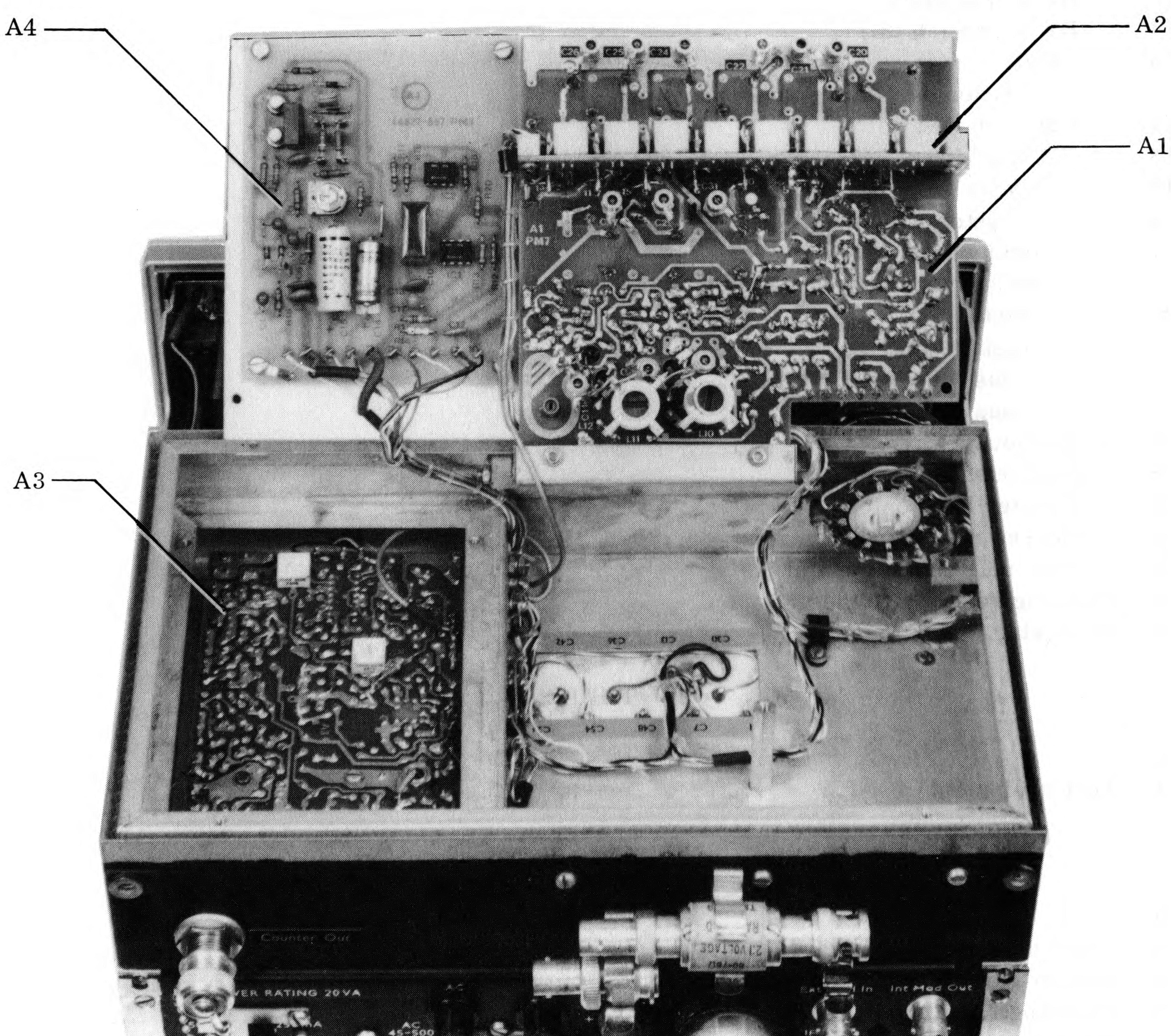


Fig. 1 Top view showing boards A1 to A4

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.

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

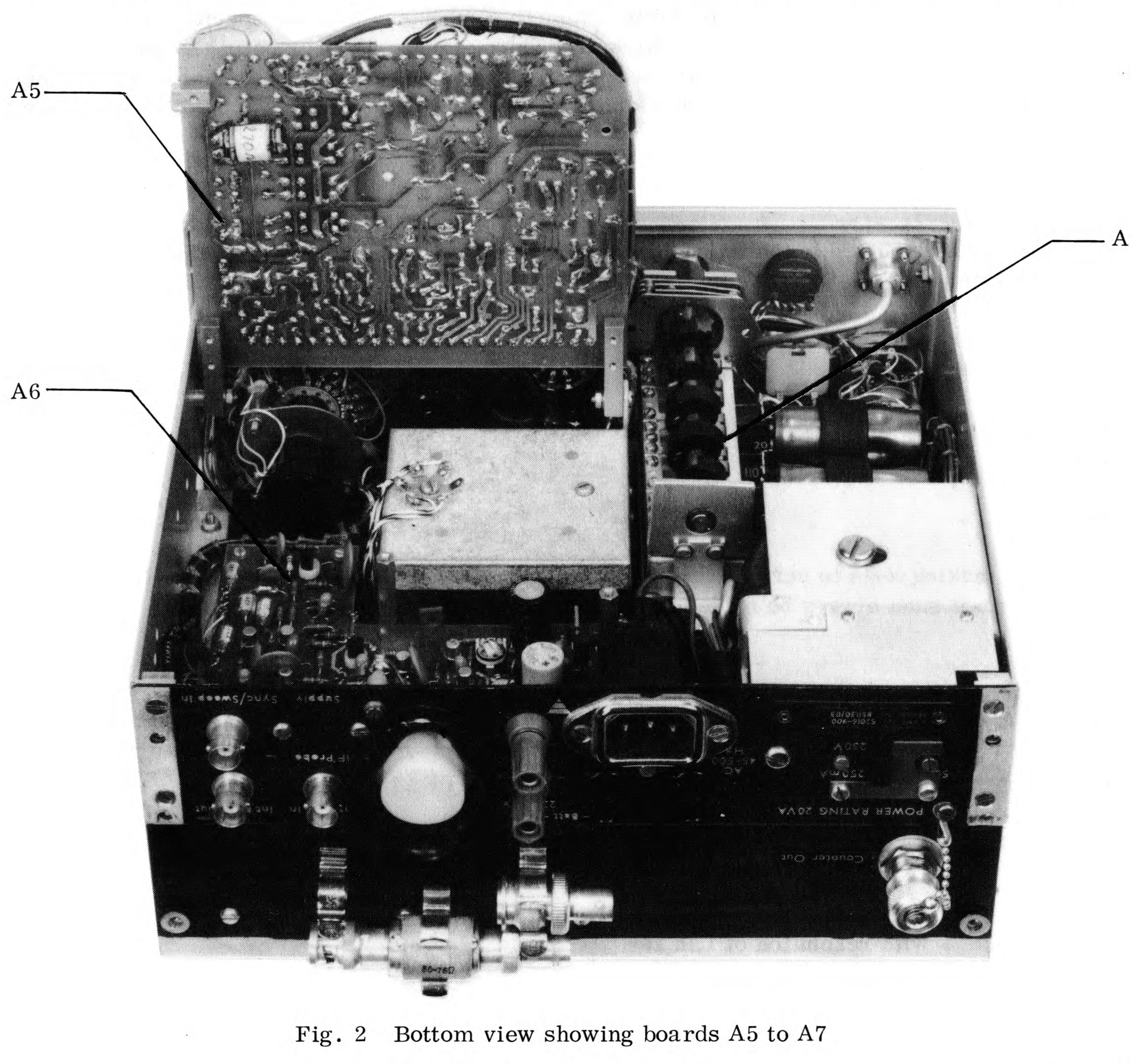


Fig. 2 Bottom view showing boards A5 to A7

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.

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.

PERFORMANCE CHECKS

9. 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

10. 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
a	200 MHz counter	MI TF 2431
b	Variable voltage transformer	Variac
c	'N' type 50 Ω load	MI TM 7967
d	Digital voltmeter, up to 50 V with resolution of 1 in 10^3	
e	100 MHz oscilloscope	
f	Wave analyser	MI TF 2330A

TABLE 1 TEST EQUIPMENT (continued)

Item	Description	Recommended model
g	RF millivoltmeter	MI TF 2603
h	'T' connector	MI TM 7948
i	Distortion factor meter	MI TF 2331A
j	AM/FM modulation meter	MI TF 2300B
k	AF oscillator	MI TF 2000
l	Psophometer	Hatfield Instruments type MBC 1000 with A4/1000 filter
m	RF detector	MI TM 9650
n	Spectrum analyser	MI TF 2370
o	Multimeter	GEC Selectest

Power supply : A6

Test equipment : items b, d, f.

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

(1) With TF 2016 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 at normal room temperature. If necessary, select values for R49 and R50 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 ±40 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 100 μV r.m.s. and 1 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 ±100 mV.

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

Frequency calibration : A1

Test equipment : items a, b.

12. 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 on the meter scale.

(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, by means of the 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 connected in series. The coils are positioned as shown in Fig. 1.

RF output (normal)

Test equipment : item g.

13. 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. 12 (1) connect the millivoltmeter to the output of TF 2016.

(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.) ±0.5 dB 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 : item g.

14. 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. 13, and with the millivoltmeter connected to the RF OUTPUT SOCKET, set the frequency of TF 2016 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 2016 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.

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VSWR

Test equipment : items c, g, h.

15. 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 2016 controls set as in para. 13, with 10 dB or more in the coarse attenuator, connect the voltmeter to the RF OUTPUT of TF 2016 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.

16. 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.

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

(1) Set the FUNCTION switch at INT FM, set the CARRIER switch at ON, set the frequency of TF 2016 at 20 MHz then adjust SET MOD control to position the pointer of MOD/

CARRIER meter at centre of white box on meter scale.

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

(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 then reset A5R2 to position the pointer of the meter at centre of white box.

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.

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

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

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

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

19. 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. Set the frequency of TF 2016 at 20 MHz then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box.

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

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

(4) Check that the measured a.m. depth (average of peak and trough readings) is between 70% and 90%.

(5) Repeat with the AM DEPTH control at 30% and check that the measured a.m. depth is between 25% and 35%. 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 Vp and Vt are the measured peak-to-peak and trough-to-trough amplitudes respectively.

ALC system

20. 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 then 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 low end of fine attenuator and then in +6 dB position with fine attenuator at maximum.

Counter output level

Test equipment : items g, h.

21. 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 2016 tuned to 120 MHz the output level is not less than 50 mV p.d.

External modulation sensitivity

Test equipment : item k.

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

(1) Set the FUNCTION selector at EXT AM and the CARRIER 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 between 0.8 V and 1.4 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 positioned at the centre of the white box on scale.

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

Note . . .

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

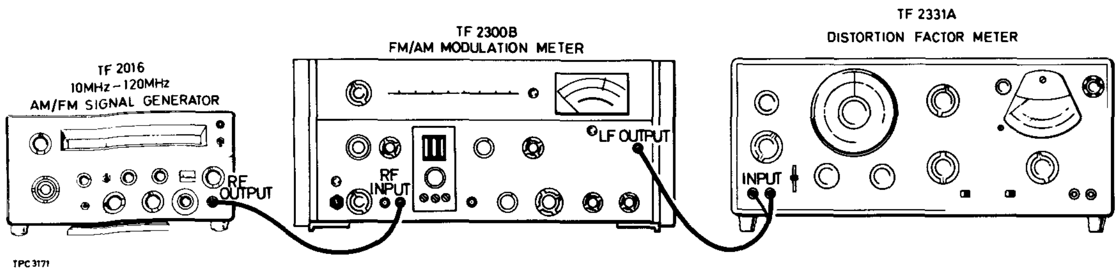

Fig. 3 Checking f.m. and a.m. distortion and f.m. on a.m.

AM distortion

Test equipment : items i, j.

23. 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 and the frequency of TF 2016 at 30 MHz. Then check that the pointer of the MOD/CARRIER meter is within the white box on meter scale.

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

(4) Set the AM DEPTH control at 30%. Then tune the modulation meter to TF 2016 and check that the distortion indicated on the distortion factor meter is not greater than 3%.

(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.

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

(1) With the test equipment connected as in Fig. 3 repeat para. 23 (2). Then set the FUNCTION selector at INT FM and the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box.

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

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

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

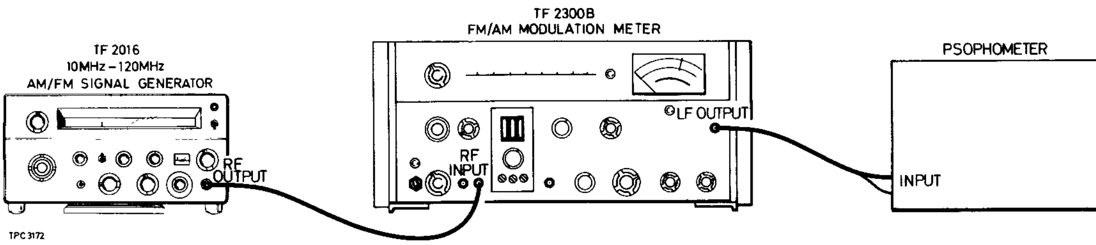

Fig. 4 Checking spurious f.m. on c.w.

Spurious f.m. on c.w.

Test equipment : items j, l.

25. 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 and the CARRIER switch at ON. Then tune TF 2016 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 position the pointer of the MOD/CARRIER meter at the centre of the white box.

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

(5) Set the psophometer controls as follows :

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

(6) Tune the modulation meter to TF 2016. 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 25 Hz).

Spurious a.m. on c.w.

Test equipment : items m, l.

26. 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 and TF 2016 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 position the pointer of the MOD/CARRIER meter at the centre of the white box on meter scale.

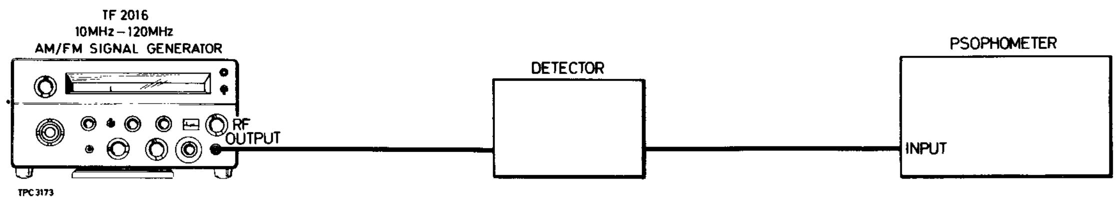

Fig. 5 Test gear arrangement to check spurious a.m. on c.w. and a.m. on f.m.

(3) Set the AM DEPTH control at 30% and the TF 2016 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 2016 FUNCTION selector at CW. Then increase the VOLTAGE/dBm RANGE switch on psophometer by $>$ 44 dB. The meter should indicate a level which is less than that noted in (5).

Spurious a.m. on f.m.

Test equipment : items l, m.

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

(1) With the test equipment connected as in Fig. 5 repeat para. 26 (1) and (2).

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

(3) Set the psophometer controls as follows :-

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

(4) 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.

(5) Set the TF 2016 FUNCTION selector at INT FM. Adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box. Then set DEVIATION multiplier at x3 and DEVIATION control at 10 (i.e. 30 kHz).

(6) Increase the VOLTAGE/dBm RANGE switch on psophometer by 20 dB. The meter should indicate a level which is not greater than that noted in (4).

Spurious f.m. on a.m.

Test equipment : items i, j.

28. To check the deviation of unwanted f.m. on an a.m. output proceed as follows :-

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

(2) Set the FUNCTION selector at INT FM, the CARRIER switch at ON, the TF 2016 frequency at 100 MHz and its output at maximum. Then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box on meter scale.

(3) Set the DEVIATION multiplier at -5 and the DEVIATION control at 5 kHz then tune the modulation meter to TF 2016 and adjust the indicated deviation to 1 kHz, if necessary.

(4) Set the FUNCTION selector on the distortion factor meter (d.f.m.) at SET REF LEVEL, the INPUT switch at HI Z, the INPUT range at 1 V - 10 V and the METER RANGE switch at 0.1 V. Then adjust the SET REF (d.f.m.) level control to give a meter indication of 0 dB.

(5) Set the TF 2016 FUNCTION selector at INT AM and adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box. Then set the AM DEPTH control at 30%.

(6) Note the difference in level shown on the d.f.m., using a more sensitive range if necessary, and ensure that it is greater than 20 dB, i.e. deviation less than 100 Hz.

$$\left(\text{Deviation in Hz} = \frac{1000}{\text{d.f.m. voltage ratio}}\right)$$

Carrier harmonics

Test equipment : item n.

29. 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 2016 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 fully clockwise. Then ensure that the pointer of the MOD/CARRIER meter is within the white box.

(3) Tune TF 2016 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 o.

30. Provided the attenuator pads have not been damaged it is only necessary to prove correct operation of the associated microswitches and this can be satisfied by making a series of resistance measurements as follows :

(1) With the SUPPLY switch at OFF, connect the multimeter set at low ohms range to the RF OUTPUT socket.

(2) Set both RF OUTPUT controls fully clockwise and check that the multimeter indicates a resistance of 50 Ω ±2%.

(3) Position the COARSE control in turn to each dB setting and check that the measured resistance at each setting below 200 mV max. output setting is 50 Ω ±2%.

(4) On the 600 mV output pad the resistance should be 60.4 Ω ±2% and on the 2 V output position, should be ∞.

Fine r.f. output control

Test equipment : item g.

31. 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, the CARRIER switch at ON. Tune TF 2016 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 ±10% of fine attenuator settings.

CLEANING ROTARY SWITCHES

32. 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.

REPACKING INSTRUCTIONS

33. 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 on 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 plywood 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 plywood 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 in 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 is also advisable.

Chapter 4

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. All chromium plated screws and all screws tinted blue are metric. 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.

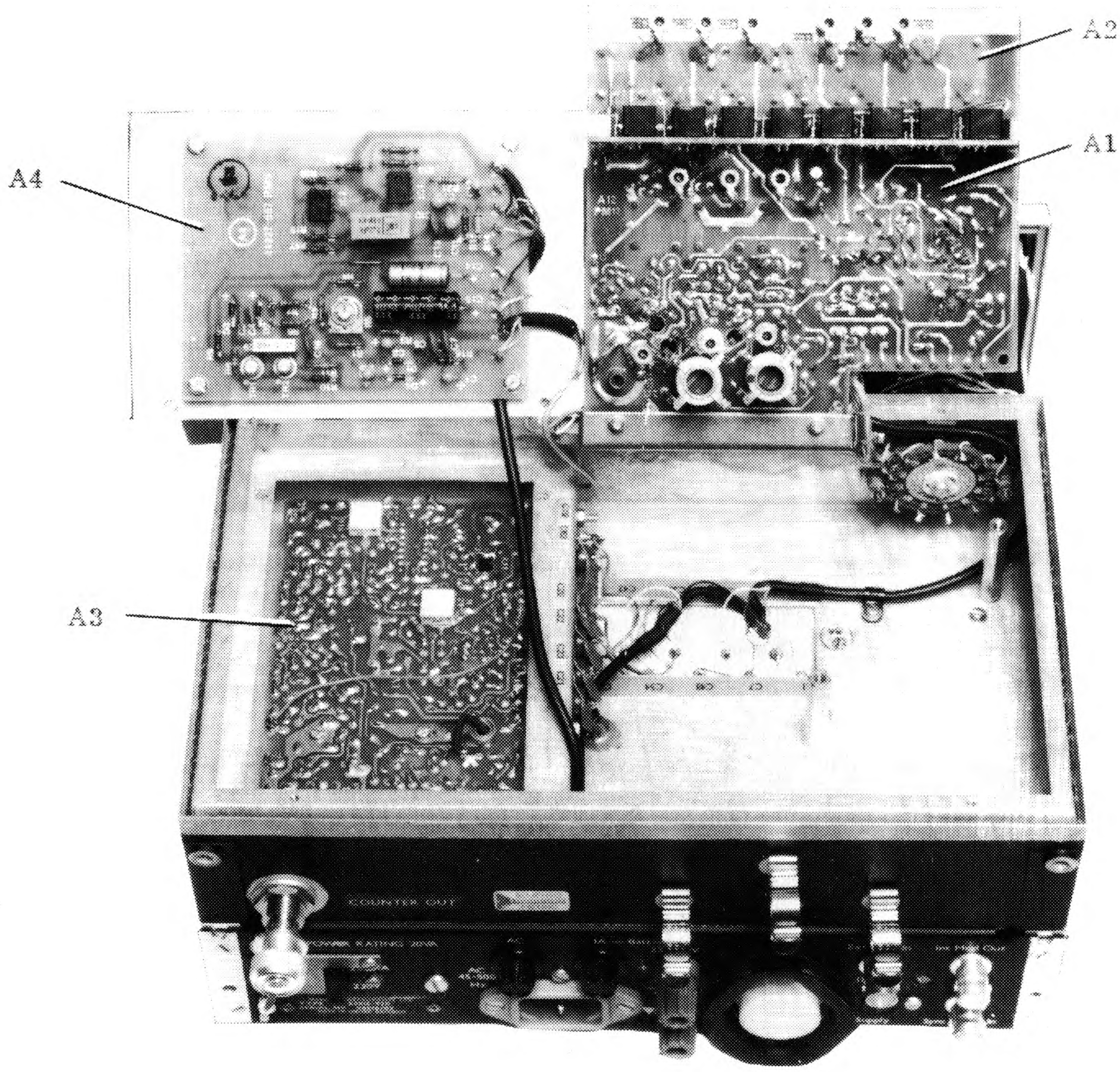

Fig. 1 Top view showing boards A1 to A4

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.

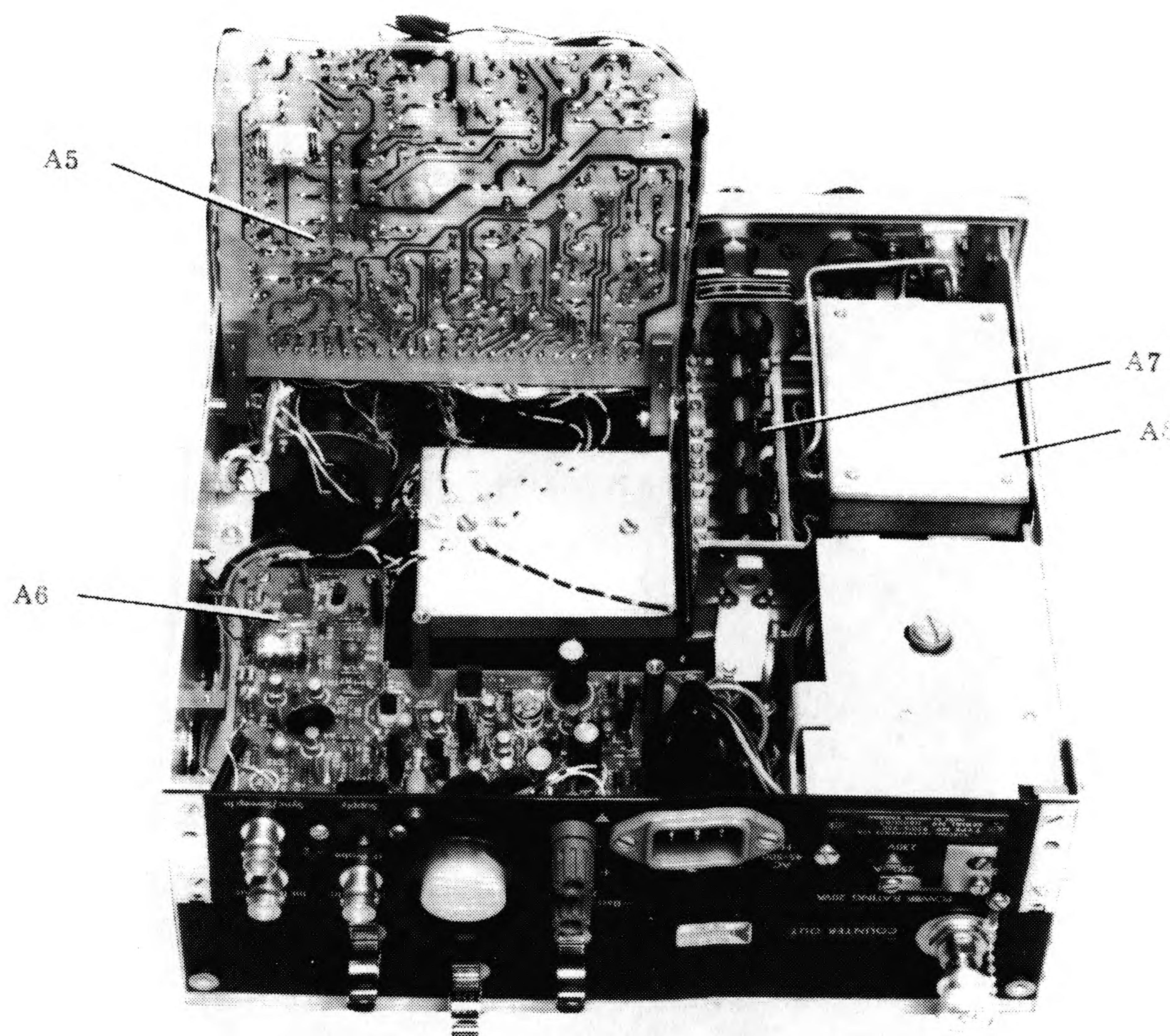

Fig. 2 Bottom view showing boards A5 to A7

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.

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. 5, 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 connected in 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 Vp 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.

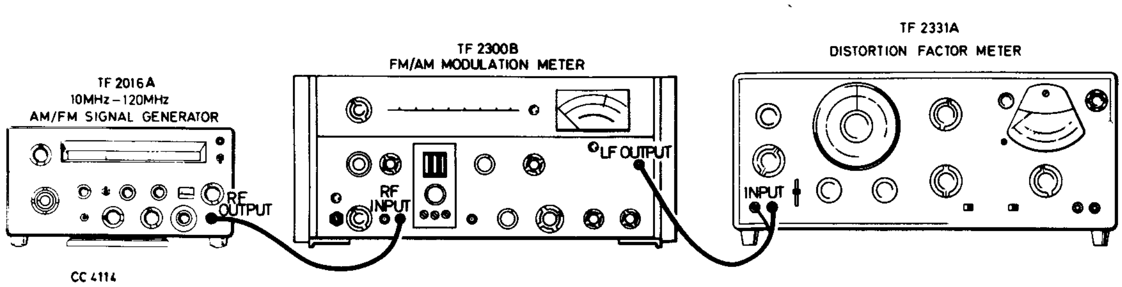

Fig. 3 Checking f.m. and a.m. distortion.

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.

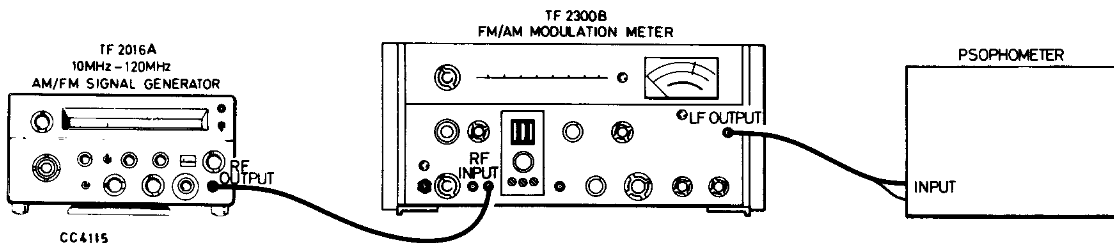

Fig. 4 Checking spurious f.m. on c.w.

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.

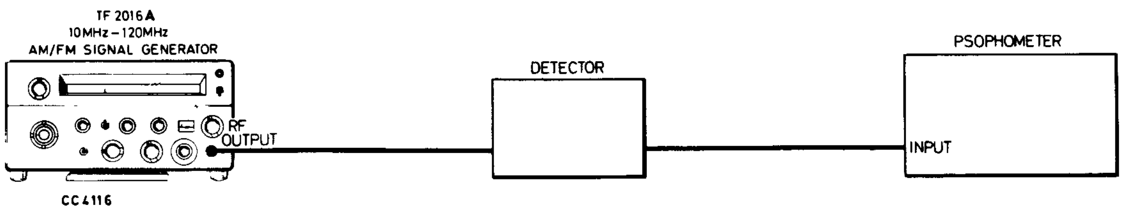

Fig. 5 Checking spurious a.m. on c.w.

(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
A5 TR8 e	4.95 V		FUNCTION : INT FM
A5 pin 41	3.2 V	TUNE to max.	DEVIATION kHz : 25 x 3
	310 mV	TUNE to min.	

Power supply

Circuit diagram : Chap. 5, 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. 3, 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. 5, 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. 5, 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 para. 29.

Modulation oscillator

Circuit diagram : Chap. 5 , 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. 5, 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. 5, 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. 5, 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. 5, 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. 5, 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 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.

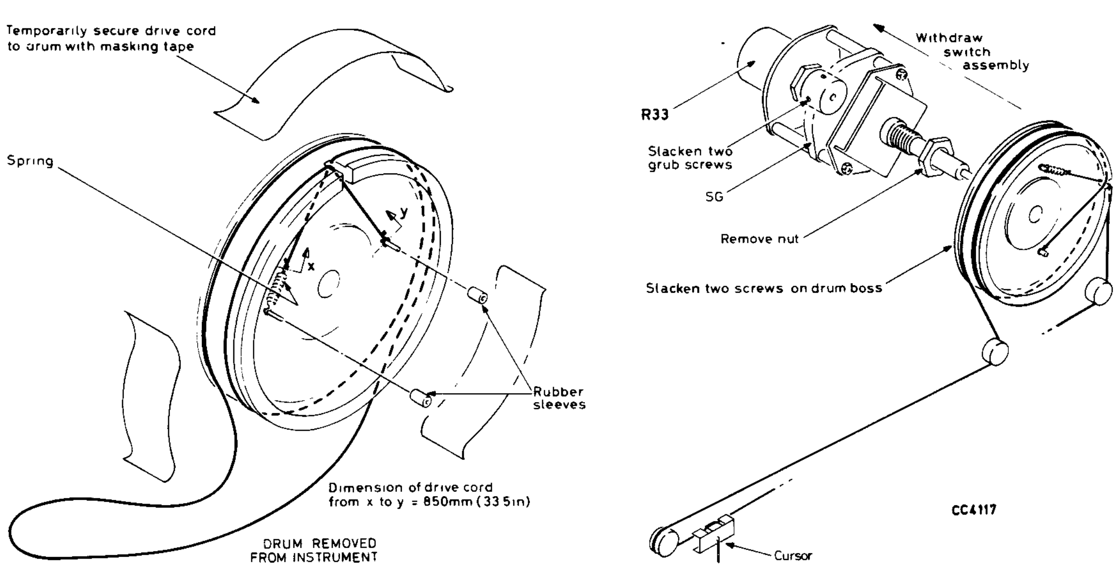

Fig. 6 Replacing drive cord.

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 ($\frac{1}{2}$ 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.

Chapter 5

REPAIR

CONTENTS

TABLES

ILLUSTRATIONS

INTRODUCTION

1. Since the functional checks given in Chap. 4 serve to localize the cause of incorrect performance of the instrument, this chapter is intended to assist in tracing the fault to the particular part of the suspect circuit. The information given should be read with reference to Chaps. 3 and

4 and the circuit diagrams in Chap. 7.

FAULT LOCATION

2. 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.

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

4. Unless stated otherwise the voltages were measured with the controls of TF 2016 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)

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

RF signal levels

Test equipment : item g.

6. The r.f. signal levels listed in Table 1 are indicative of those which can be expected using the specified meter on a typical TF 2016. Unless otherwise stated, measurements were made with the TF 2016 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.

TABLE 1 RF SIGNAL LEVELS

Test point (on A3)	Carrier frequency : 1 MHz	Carrier frequency : 120 MHz
Pin 1	72 mV	65 mV
TR1 e	10 mV	9.5 mV
c	10 mV	10 mV
IC1 pin 13	13 mV	8.4 mV
TR2 c	35 mV	12.5 mV
TR3 c	90 mV	76 mV

TABLE 1 RF SIGNAL LEVELS (continued)

	RF OUTPUT (with 50 Ω load)		RF OUTPUT (with 50 Ω load)	
	2 V	† 4 V	2 V	† 4 V
TR4 c	69 mV	100 mV	91 mV	125 mV
TR6 c	59 mV	125 mV	89 mV	210 mV
TR7 c	480 mV	960 mV	410 mV	900 mV
TR8 e	480 mV	950 mV	440 mV	950 mV
* TR9 c	2.15 V	4.3 V	1.85 V	3.8 V
e	440 mV	870 mV	250 mV	590 mV
* TR10 e	2.15 V	4.3 V	2.05 V	4.2 V
TP1	14 mV	-	5.6 mV	-
TP2	85 mV	-	45 mV	-
TP3	57 mV	-	56 mV	-
TP4	470 mV	-	290 mV	-

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

AF signal levels

Test equipment : item c.

7. The a.f. signal levels listed in Table 2 are indicative of those which can be expected on a typical TF 2016. Unless stated otherwise, measurements were made with TF 2016 set as follows :-

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

TABLE 2 AF SIGNAL LEVELS

<table>
<tr><th>Test point</th><th>Reading</th><th colspan="2">Control settings</th></tr>
<tr><td>A6 pin 8</td><td>1.2 V</td><td colspan="2"></td></tr>
<tr><td>A5 pin 2</td><td>1.0 V</td><td colspan="2">CARRIER & MOD METER centred</td></tr>
<tr><td>A5 pin 15</td><td>625 mV</td><td colspan="2">AM DEPTH : 80%</td></tr>
<tr><td>A5 pin 23</td><td>1 V</td><td></td><td rowspan="4">CARRIER RANGE : 7
FUNCTION : INT FM
DEVIATION kHz : 25 x 3</td></tr>
<tr><td>A5 TR8 e</td><td>4.95 V</td><td></td></tr>
<tr><td rowspan="2">A5 pin 41</td><td>3.2 V</td><td>TUNE to max.</td></tr>
<tr><td>310 mV</td><td>TUNE to min.</td></tr>
</table>

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

8. Typical power supply fault conditions are listed in Table 3.

TABLE 3 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. 3, para. 41). 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 100 μV r.m.s.	A0C61, A6C24 or C25 may be open circuit or low capacitance. D9 - D12 faulty. TR11 or TR12 may be faulty.
100 Hz ripple on 21 V supply is greater than 1 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)

9. Typical frequency calibration fault conditions are listed in Table 4.

TABLE 4 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.

RF output

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

10. Typical r.f. output fault conditions are listed in Table 5.

TABLE 5 RF OUTPUT FAULTS

Fault	Probable cause
Meter pointer not within white box.	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.
+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.

VSWR

11. Check that A3R84 is 50 Ω ±1% and recheck A7 as given in Chap. 4, para. 30.

Modulation oscillator

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

12. Typical modulation oscillator faults are listed in Table 6.

TABLE 6 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)

13. Typical amplitude modulation faults are listed in Table 7.

TABLE 7 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. Fault in amplifier output stage A3TR8 to TR11.

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

14. Typical frequency modulation faults are listed in Table 8.

TABLE 8 FREQUENCY MODULATION FAULTS

Fault	Probable cause
No frequency modulation.	Check a.f. path from SET MOD control to TR7. Incorrect operation of TR6 to TR10. Switch SG or switch SD faulty.
Incorrect deviation.	Faulty resistor A0R6 to R11 or A5R56 to R62.
FM distortion.	Incorrect operation of TR6 to TR10 or modulation oscillator.

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

15. Typical a.l.c. faults are listed in Table 9.

TABLE 9 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.

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

16. 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

17. 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.

REPLACING TUNING DRIVE CORD

18. The procedure for fitting a new drive cord is given below. A drive cord consists of 1 metre of nylon cord (MI Code 16410-604V). A new tension spring (MI Code 31119-017X) may also be required.

(1) Remove the case from the instrument and remove the attenuator unit (see Chap. 4, para. 8).

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

(3) Set the RANGE switch to the 14.3 - 20.5 MHz position.

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

(5) Referring to Fig. 1, slacken the grub screws and unscrew the nut to pull aside R38.

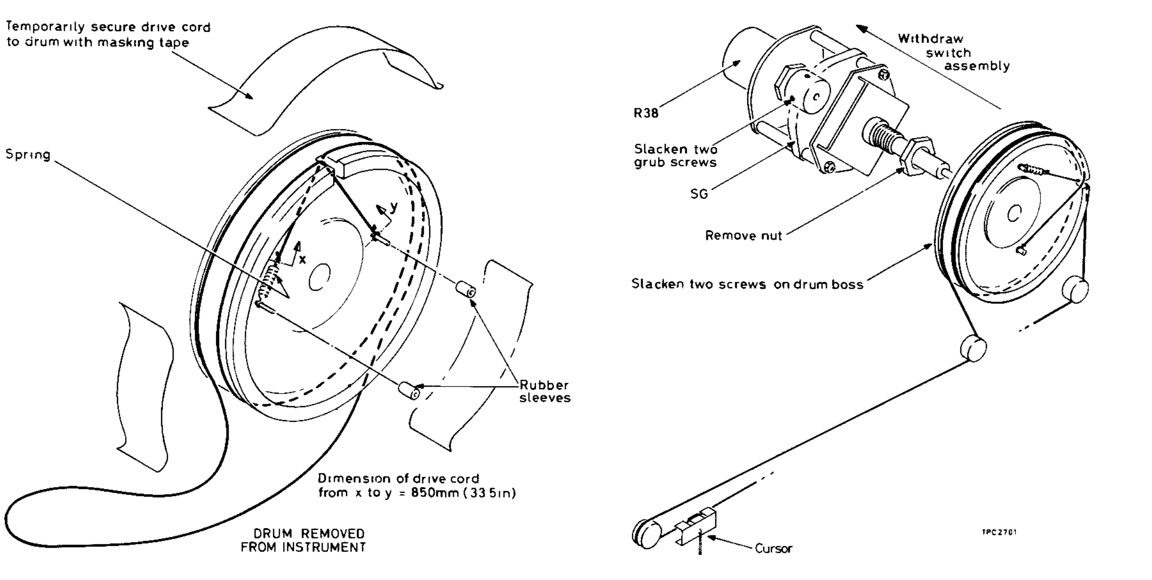

Fig. 1 Replacing cord drive

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. 1, 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 R38 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 ($\frac{1}{2}$ 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 and case.

ADDITIONAL INFORMATION

19. 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.

Chapter 5

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
TR1	c	20 V
	b	16.6 V
	e	16.0 V
Junction	D4/D5	4.5 V
TR2	c	20 V
	b	*10 V
	e	9.4 V
TR3	c	20 V
	b	12.7 V
	e	12.3 V
TR4	c	19.4 V
	b	11.2 V
	e	10.6 V

Test point		Reading
TR5	e	20 V
	b	19.4 V
	c	10.0 V
TR6	c	19.5 V
	b	*9.7 V
	e	9.0 V
TR7	c	12.0 V
	b	2.75 V
	e	2.2 V
TR8	c	19.2 V
	b	*12.0 V
	e	11.4 V
TR9	c	11.4 V
	b	2.2 V
	e	1.65 V

A6 DC Voltages

Test point		Reading
TR1	c	19.3 V
	b	*10 V
	e	9.3 V
TR2	e	20 V
	b	19.3 V
	c	9.5 V
TR4	c	20 V
	b	*12 V
	e	11.3 V
TR9	e	25 V
	b	24.4 V
	c	21 V
TR10	e	24.4 V
	b	23.7 V
	c	21 V
TR11	c	32 V
	b	21.3 V
	e	20.6 V

Test point		Reading
TR12	c	21.3 V
	b	8.8 V
	e	8.2 V
TR13	d	21 V
	g	6 V
	s	9 V
TR14	c	23.7 V
	b	6 V
	e	5.3 V
TR15	c	21 V
	b	6 V
	e	5.3 V
TR18	e	21.3 V
	b	20.6 V
	c	0 V
TR19	c	20.6
	b	0 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.

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

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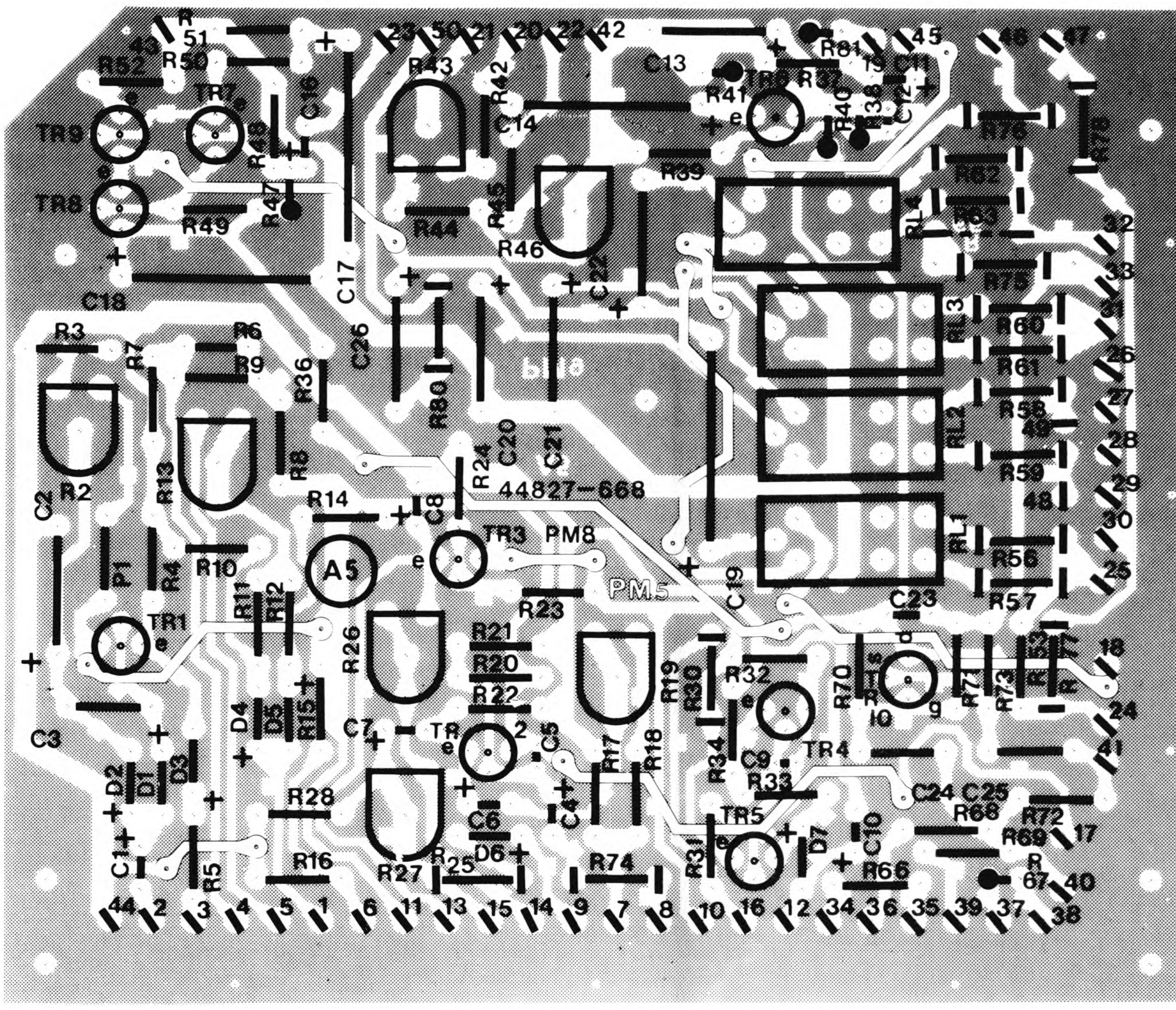

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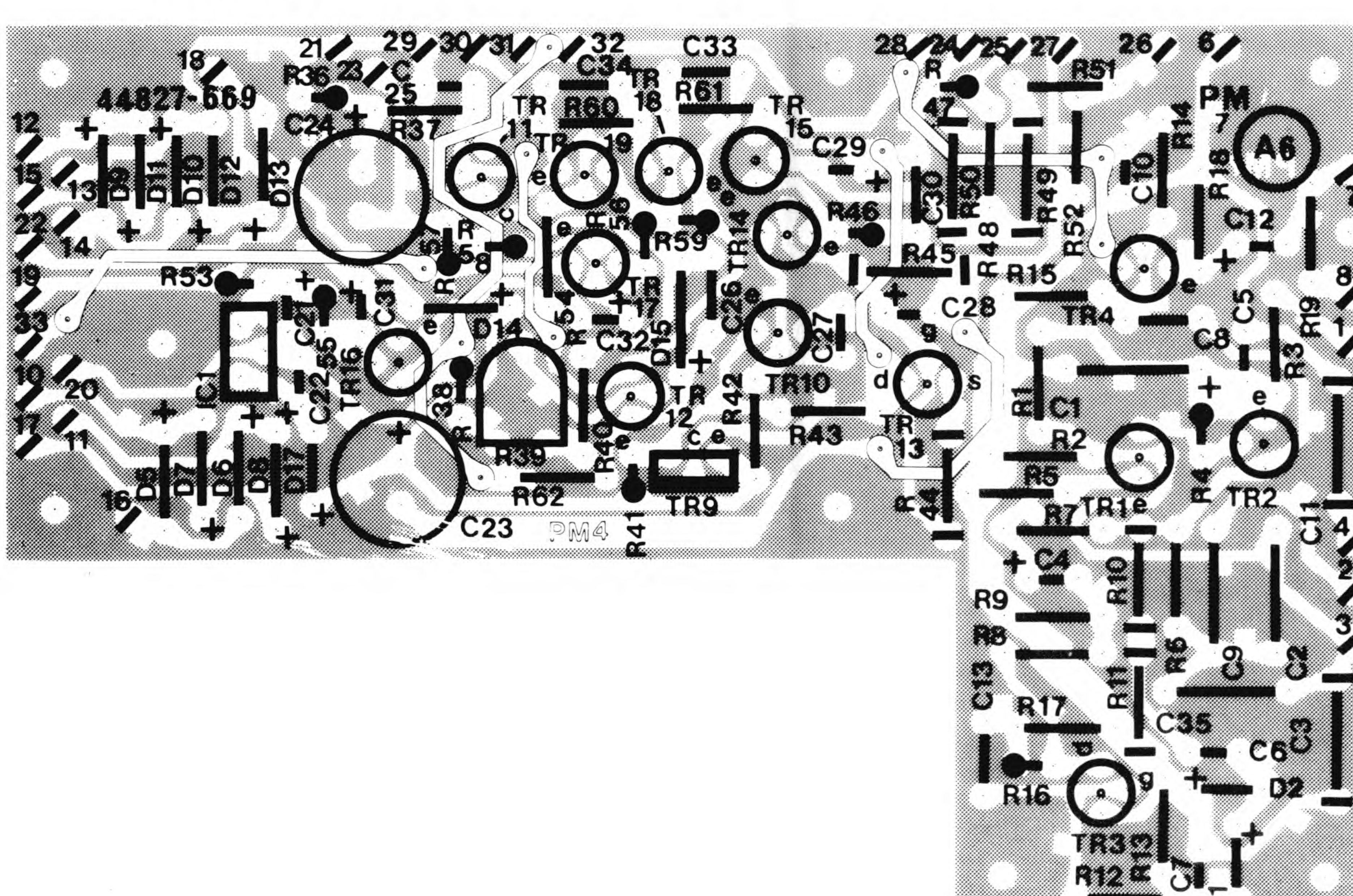
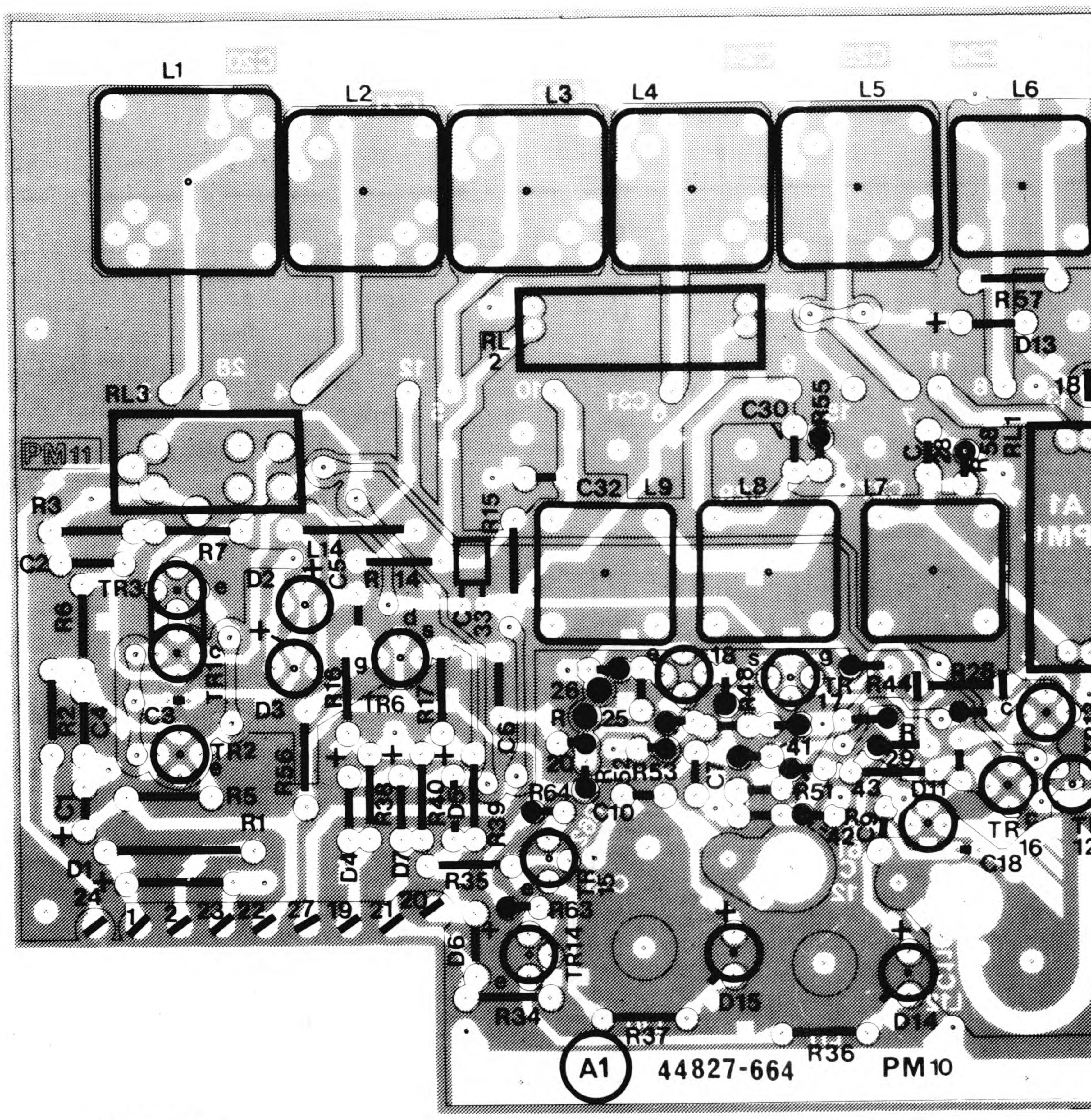


Component layout : A5 and A6

Fig. 1



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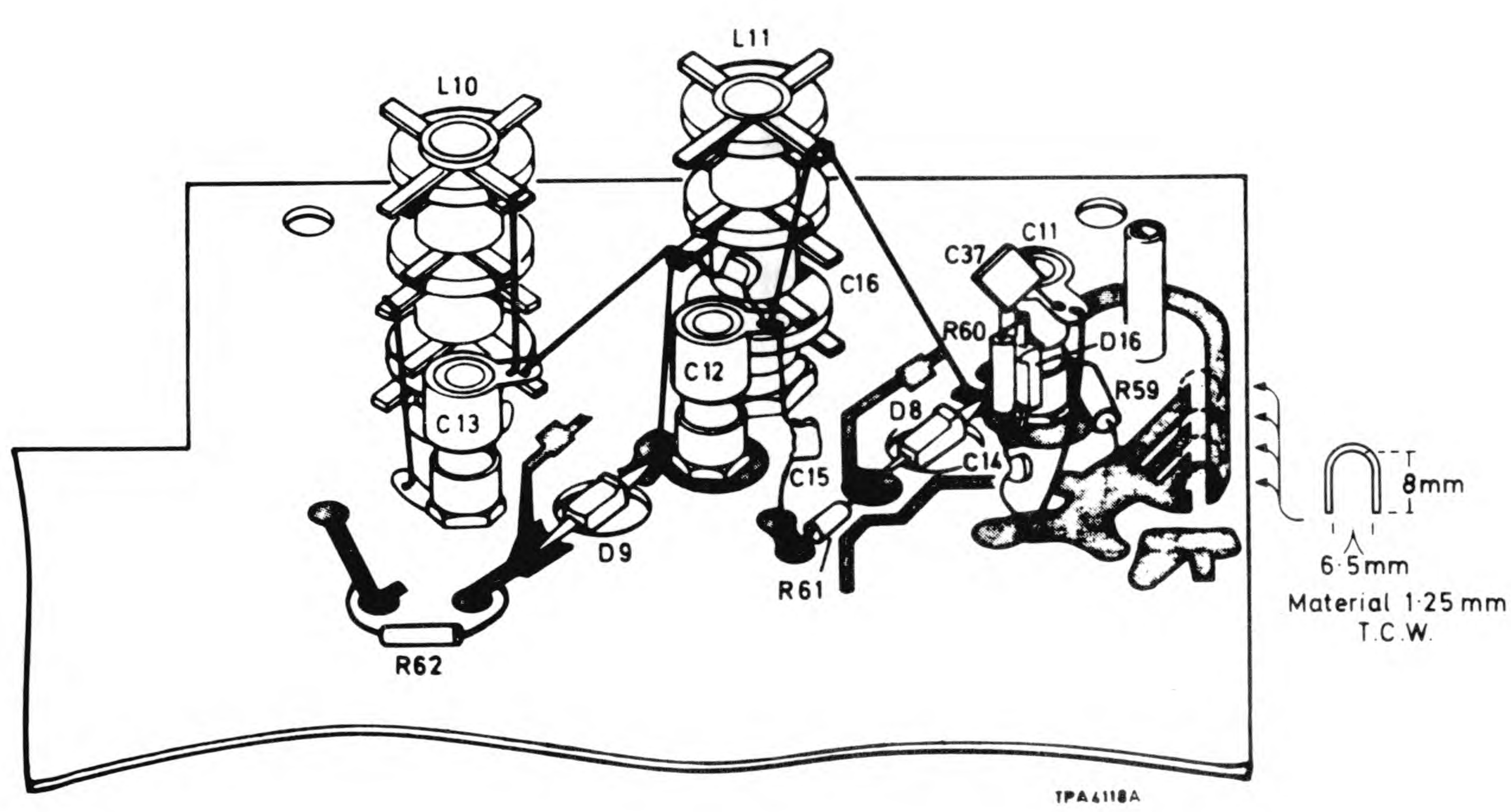


Detail of L10, L11 & L12

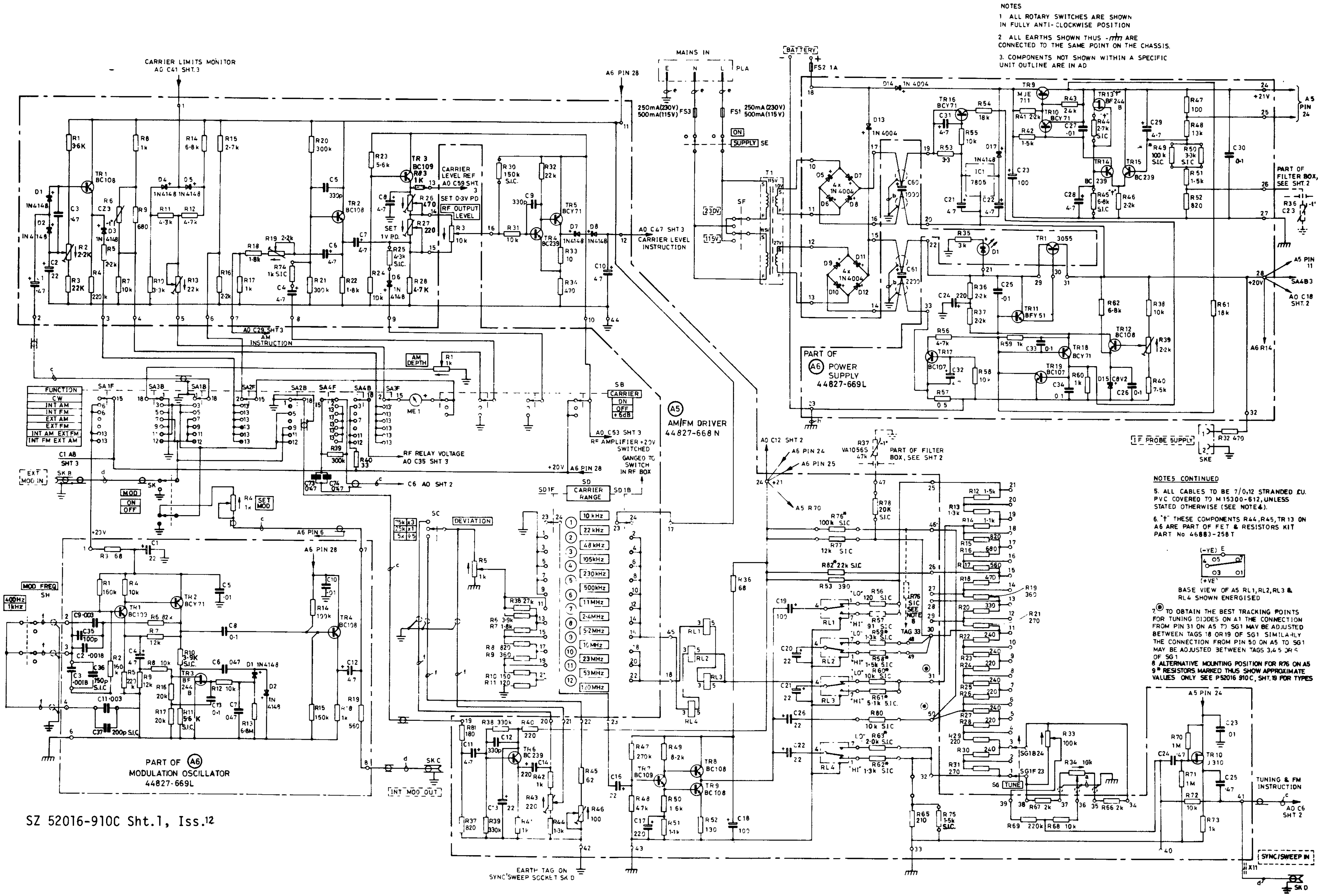
Component layout : A1

Fig. 3

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)



Power supply and modulation stages : A5 and A6

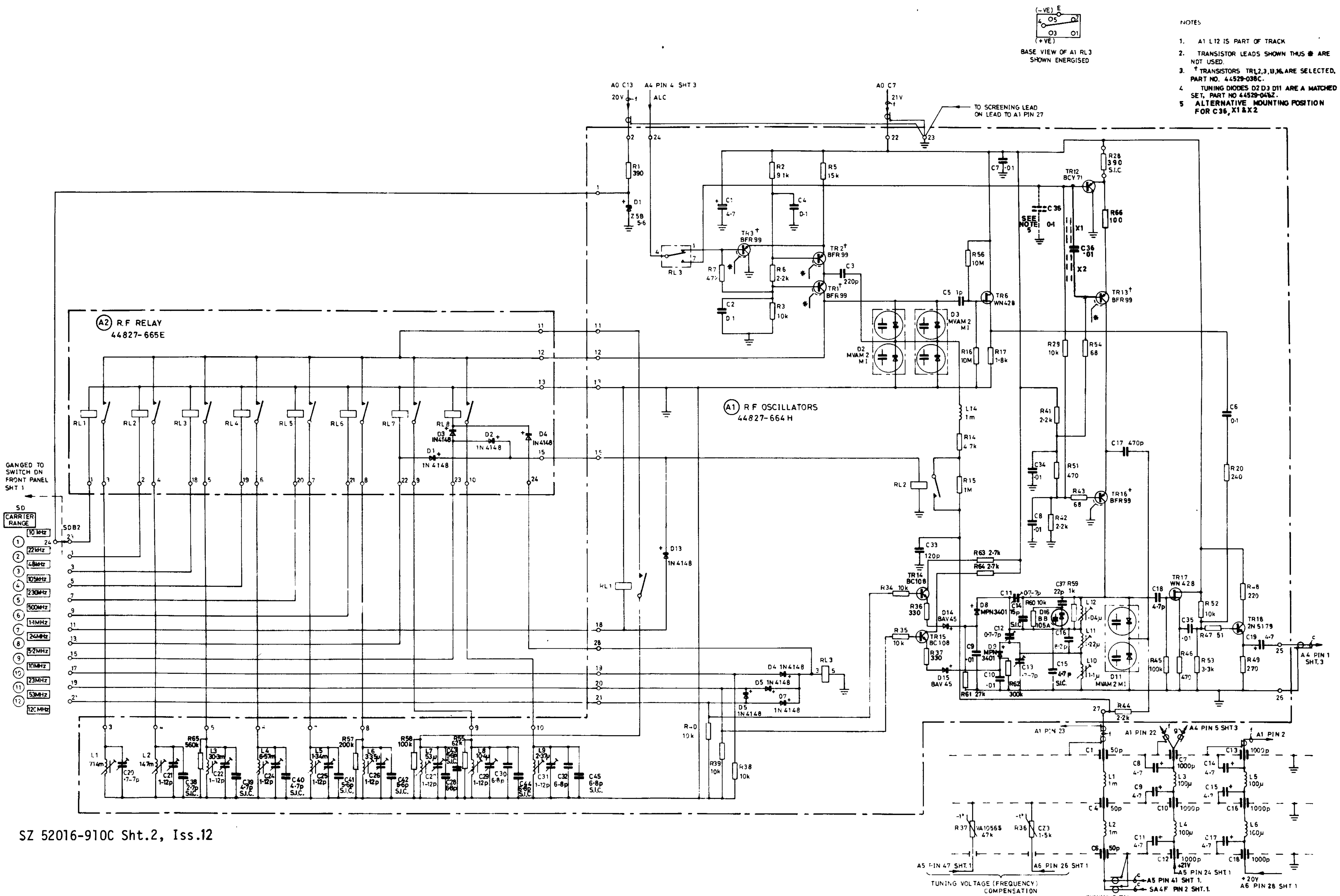


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Fig. 4 Oscillators : A1 and A2

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

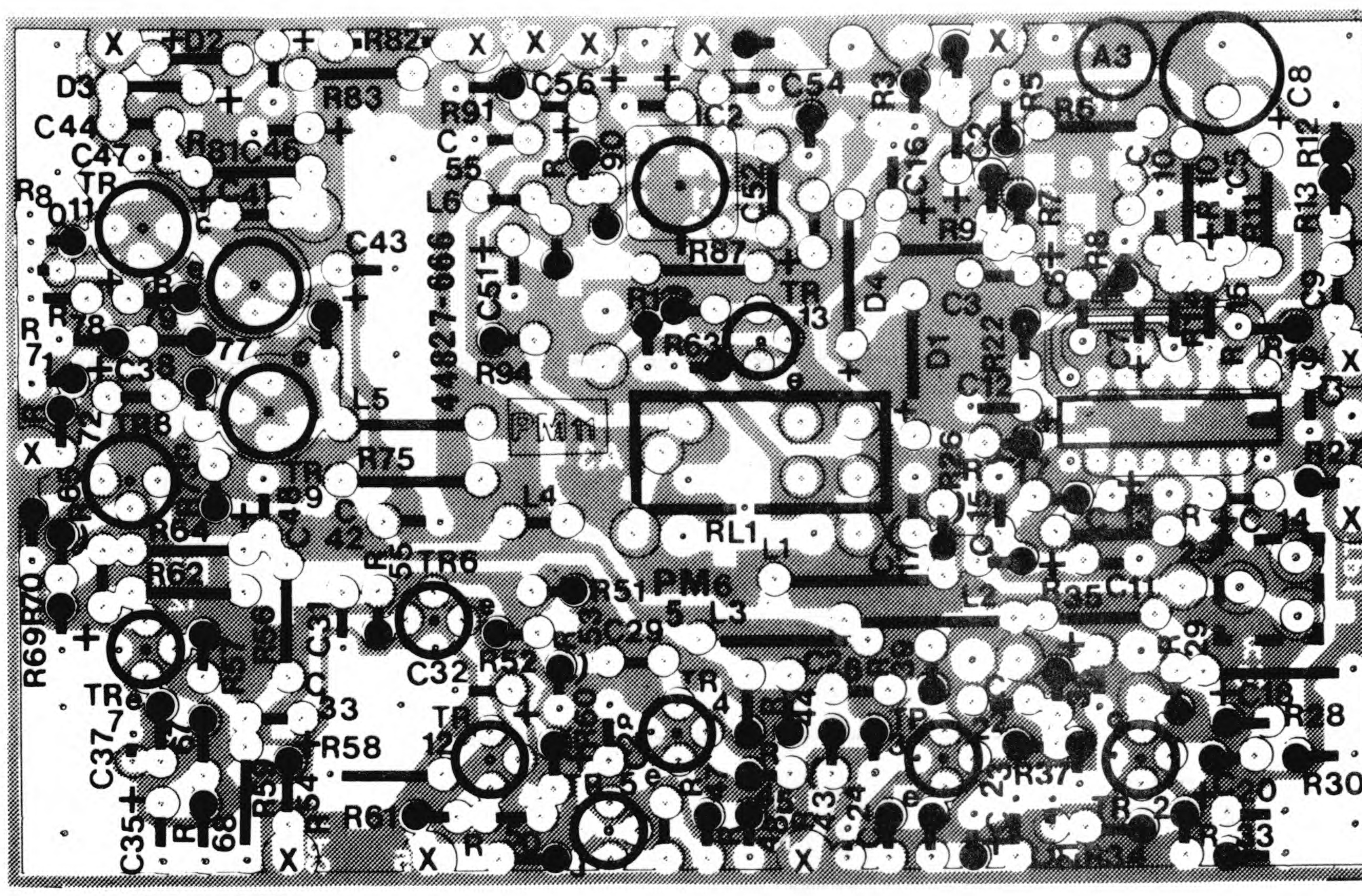
Test point		Reading
TR7	c	11 V
	b	5.7 V
	e	5.0 V
TR8	c	17.6 V
	b	12.1 V
	e	11.4 V
TR9	c	12.2 V
	b	3.5 V
	e	2.75 V
TR10	c	19.5 V
	b	12.1 V
	e	11.4 V
TR11	c	11.4 V
	b	2.75 V
	e	2.0 V
TR12	g	6.0 V
IC2	pin 1	3.7 V
	2	3.7 V
	3	3.7 V
	4	3.7 V
	5,6	0 V
	7	7.1 V
	8,9	11.6 V
	10	5.7 V

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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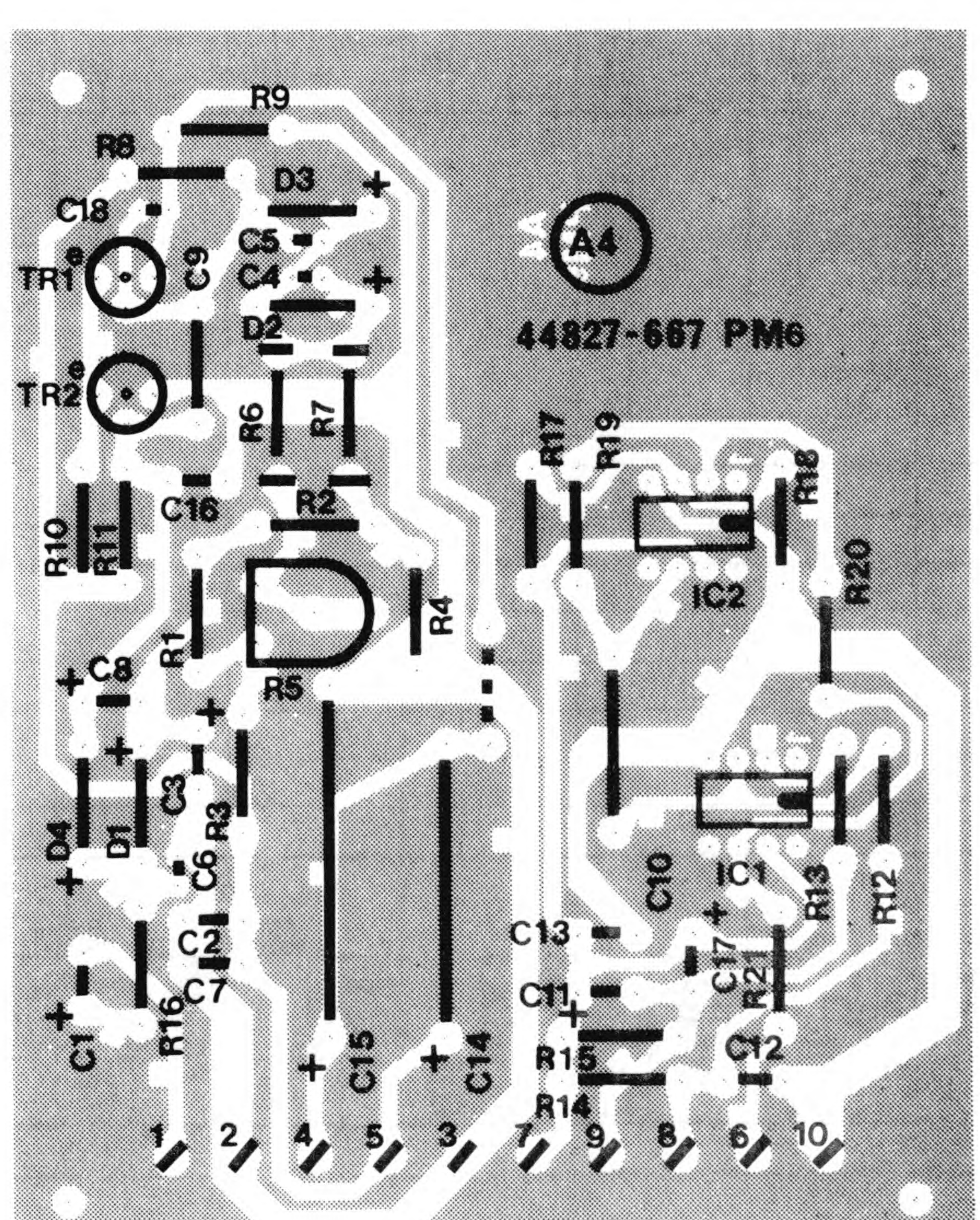

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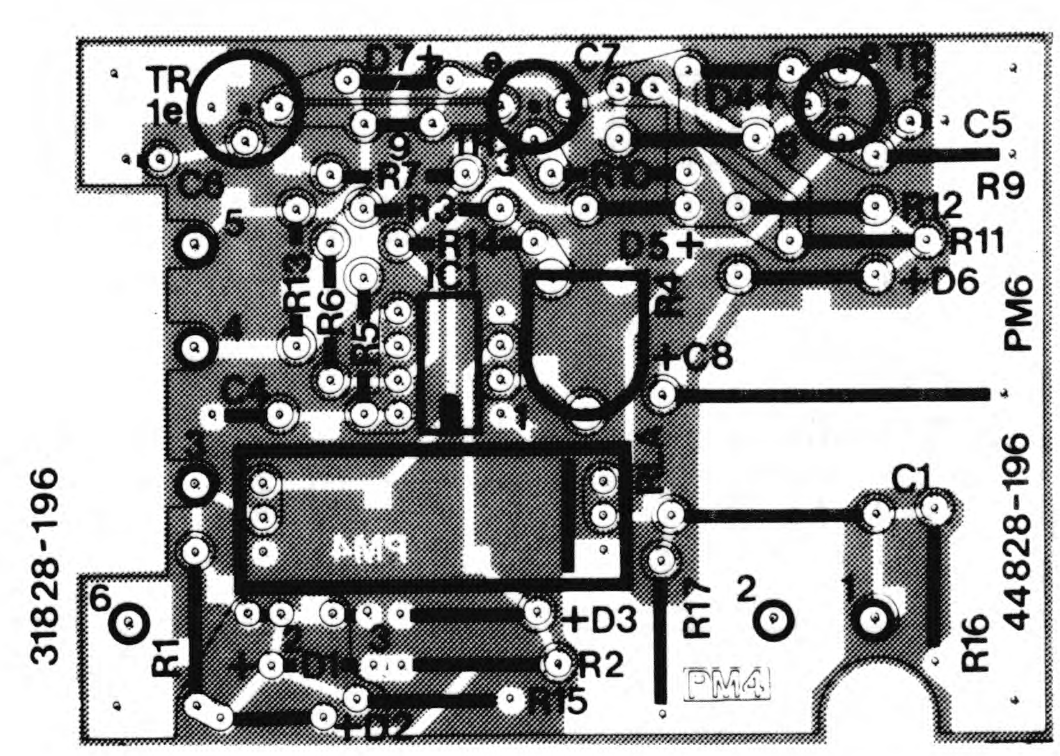
Component layout : A3 and A4

Fig. 5



Component layout : A8

Fig. 7

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

Fig. 7

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

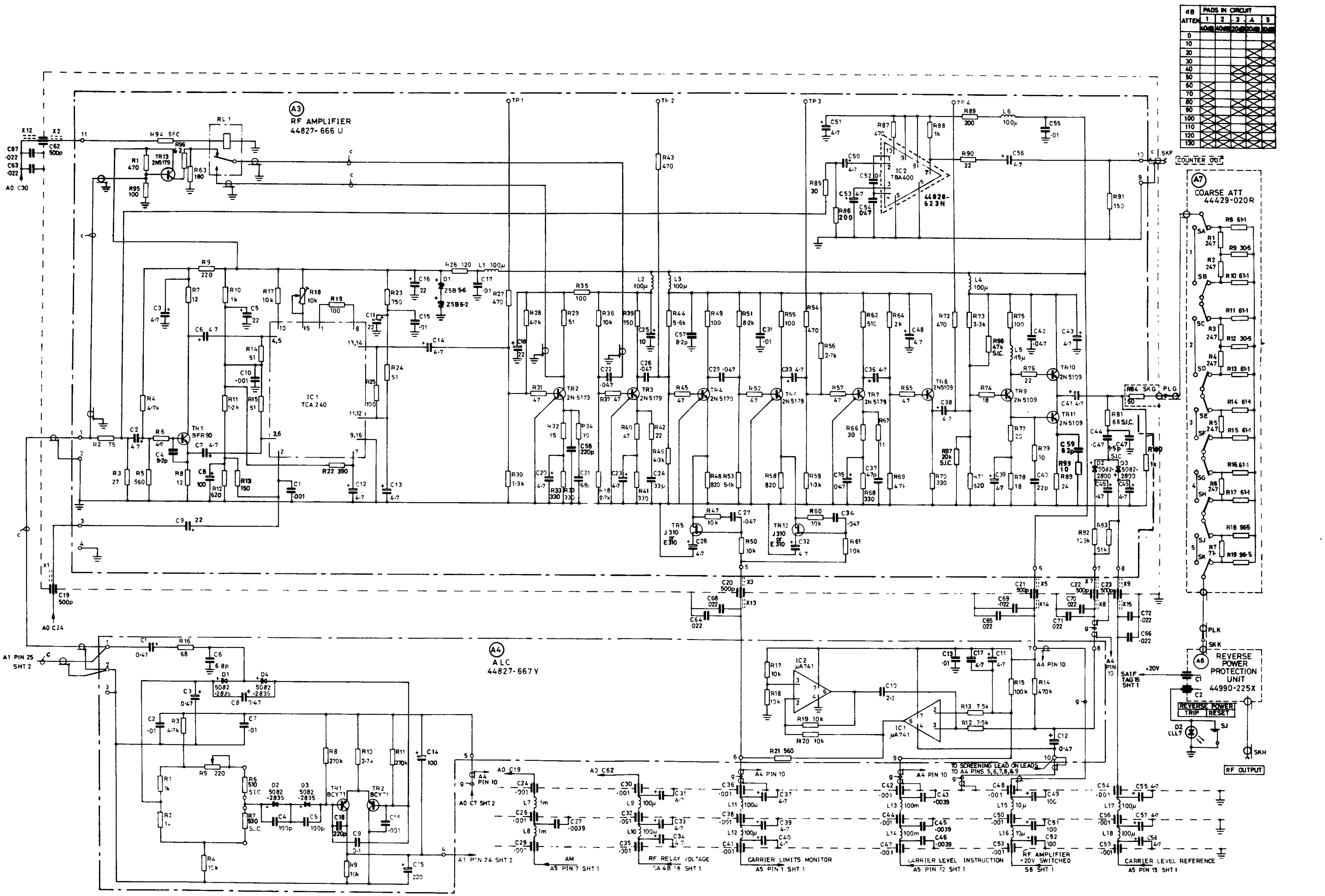


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Fig. 6

Output stages : A3, A4 and A7

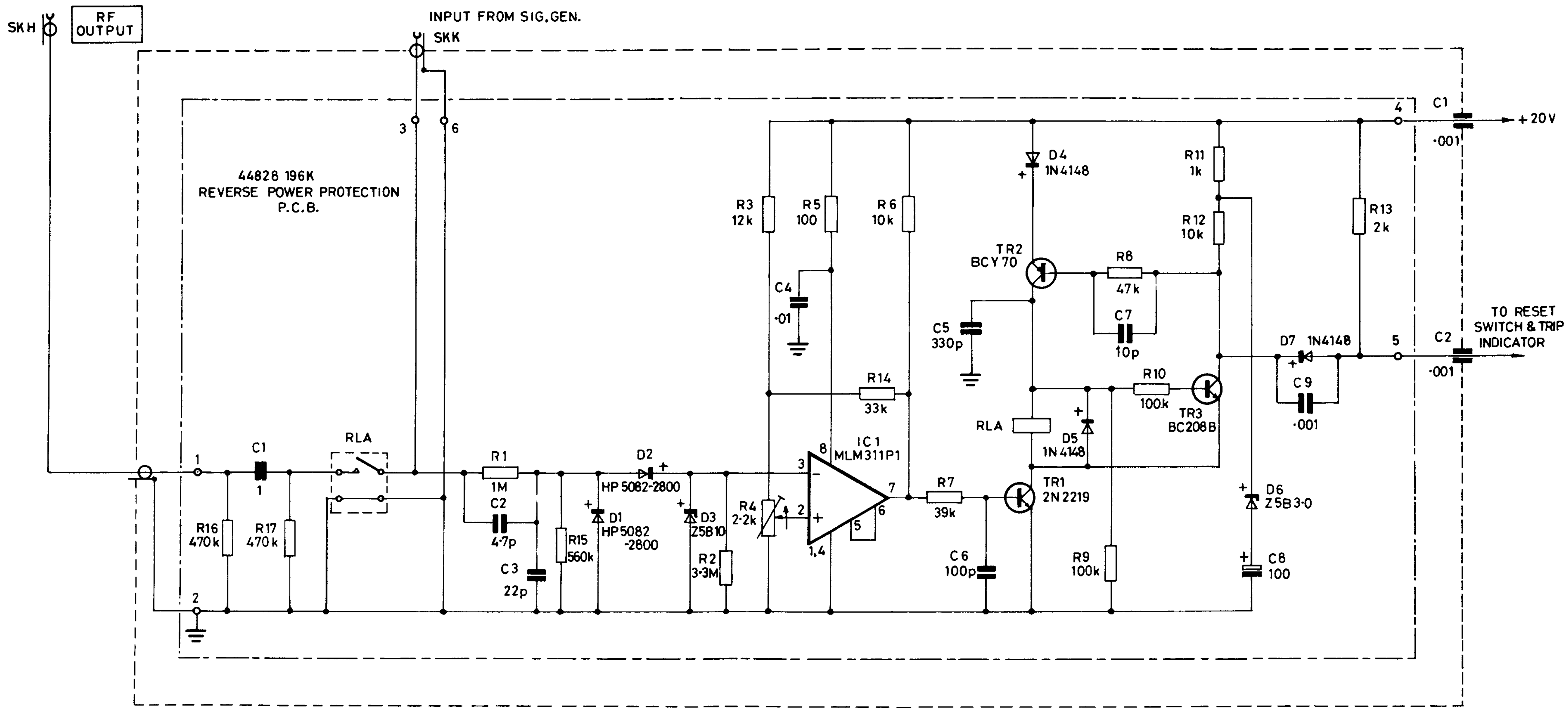

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Fig. 8 Reverse power protection unit : A8

Chapter 7

CIRCUIT DIAGRAMS

CONTENTS

ILLUSTRATIONS

CIRCUIT NOTES

Component values

1 Resistors : No suffix = ohms, k = kilohms, M = megohms.
Capacitors : No suffix = 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
TR1	c	20 V
	b	16.6 V
	e	16.0 V
Function	D4/D5	4.5 V
TR2	c	20 V
	b	10 V
	e	9.4 V
TR3	c	20 V
	b	12.7 V
	e	12.3 V
TR4	c	19.4 V
	b	11.2 V
	e	10.6 V

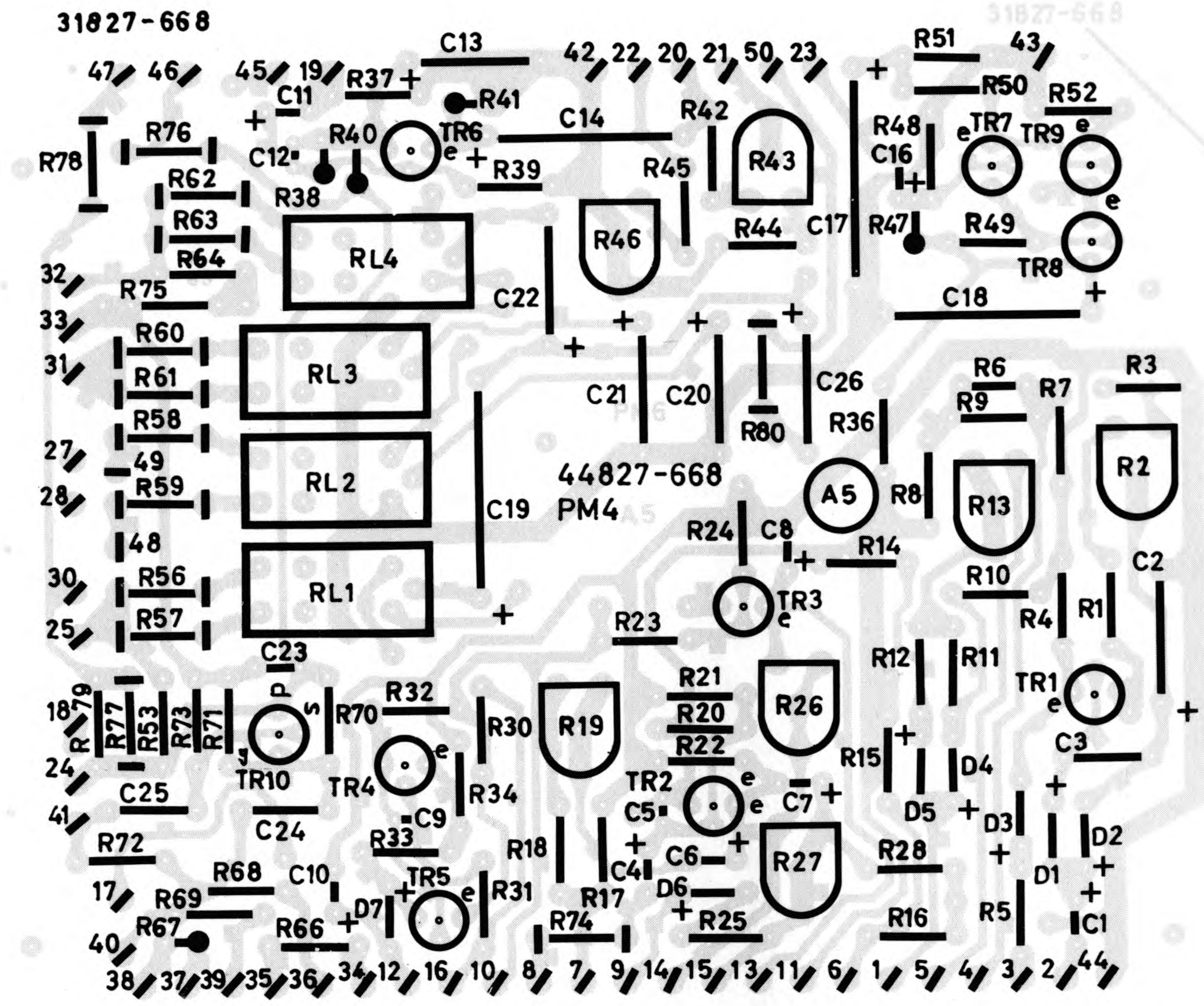
Test point		Reading
TR5	e	20 V
	b	19.4 V
	c	10.0 V
TR6	c	19.5 V
	b	9.7 V
	e	9.0 V
TR7	c	12.5 V
	b	3.0 V
	e	2.3 V
TR8	c	20 V
	b	12.5 V
	e	11.8 V
TR9	c	11.8 V
	b	2.3 V
	e	1.7 V

A6 DC Voltages

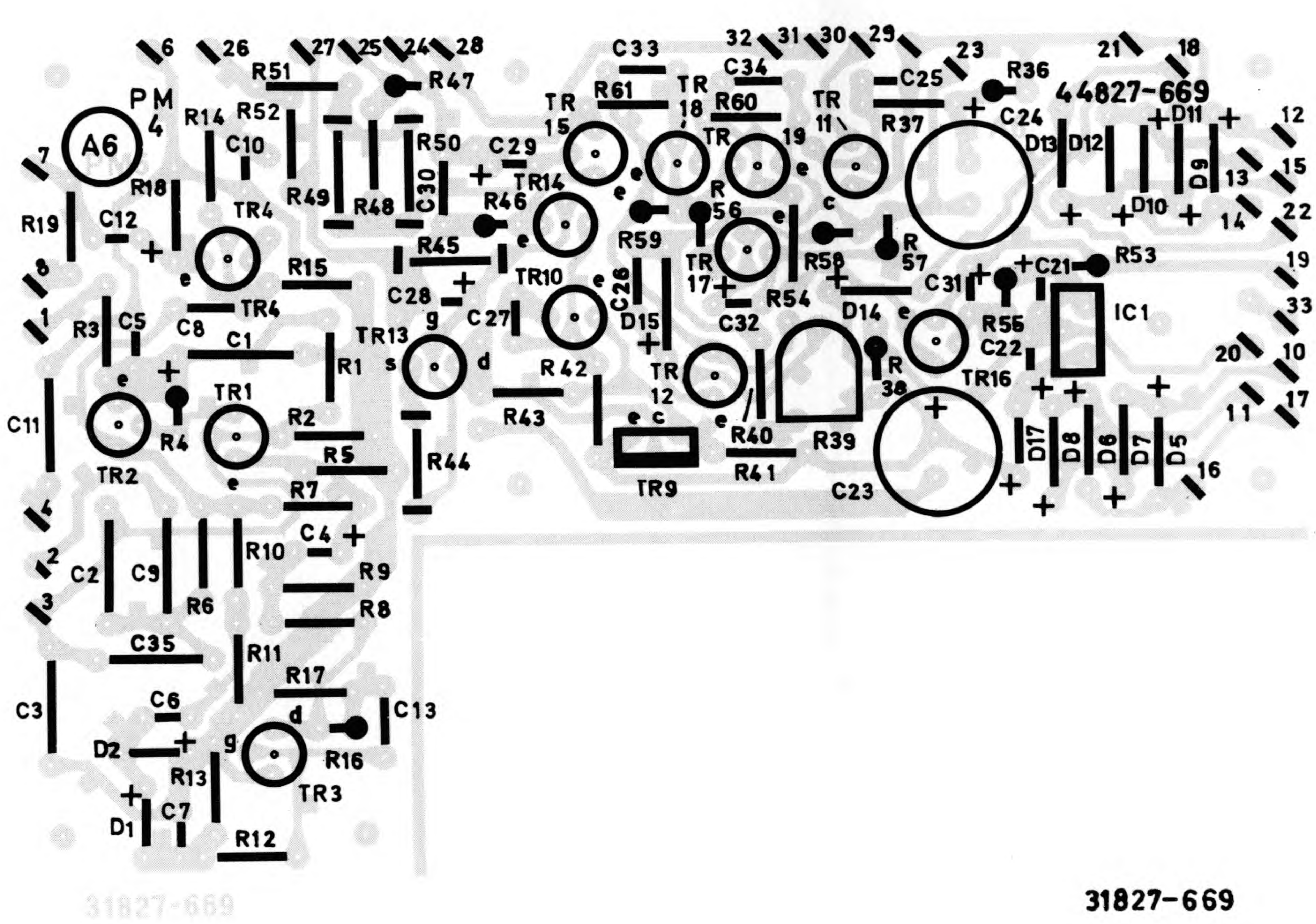
Test point		Reading
TR1	c	19.3 V
	b	10 V
	e	9.3 V
TR2	e	20 V
	b	19.3 V
	c	9.5 V
TR4	c	20 V
	b	12 V
	e	11.3 V
TR9	e	25 V
	b	24.4 V
	c	21 V
TR10	e	24.4 V
	b	23.7 V
	c	21 V
TR11	c	32 V
	b	21.3 V
	e	20.6 V

Test point		Reading
TR12	c	21.3 V
	b	8.8 V
	e	8.2 V
TR13	d	21 V
	g	6 V
	s	9 V
TR14	c	23.7 V
	b	6 V
	e	5.3 V
TR15	c	21 V
	b	6 V
	e	5.3 V
TR18	e	21.3 V
	b	20.6 V
	c	0 V
TR19	c	20.6
	b	0 V
	e	0 V
A6 pin	22	32 V
	19	33 V
Function	D14/D17	25 V

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



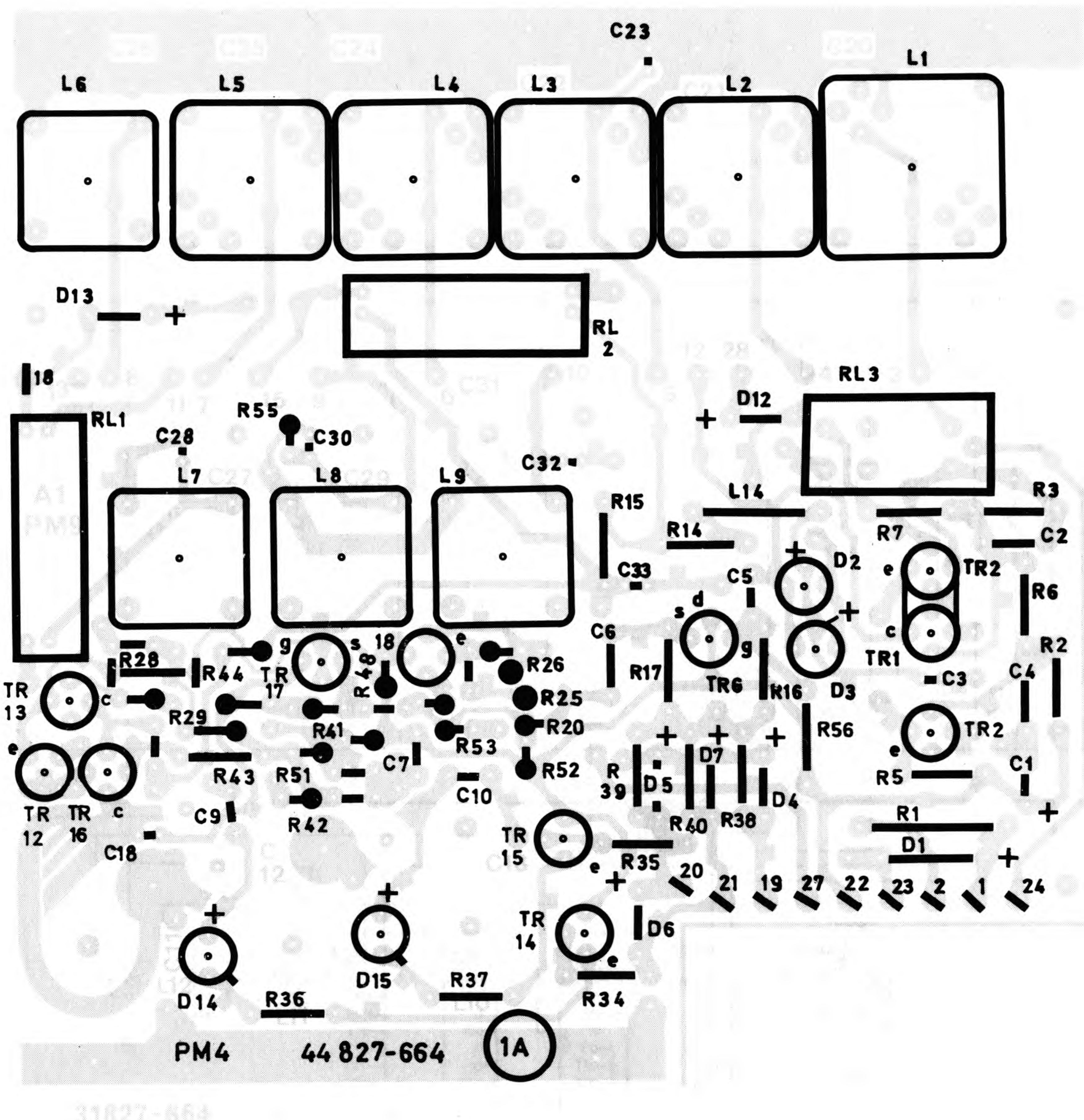
(A) A5 viewed from wiring side



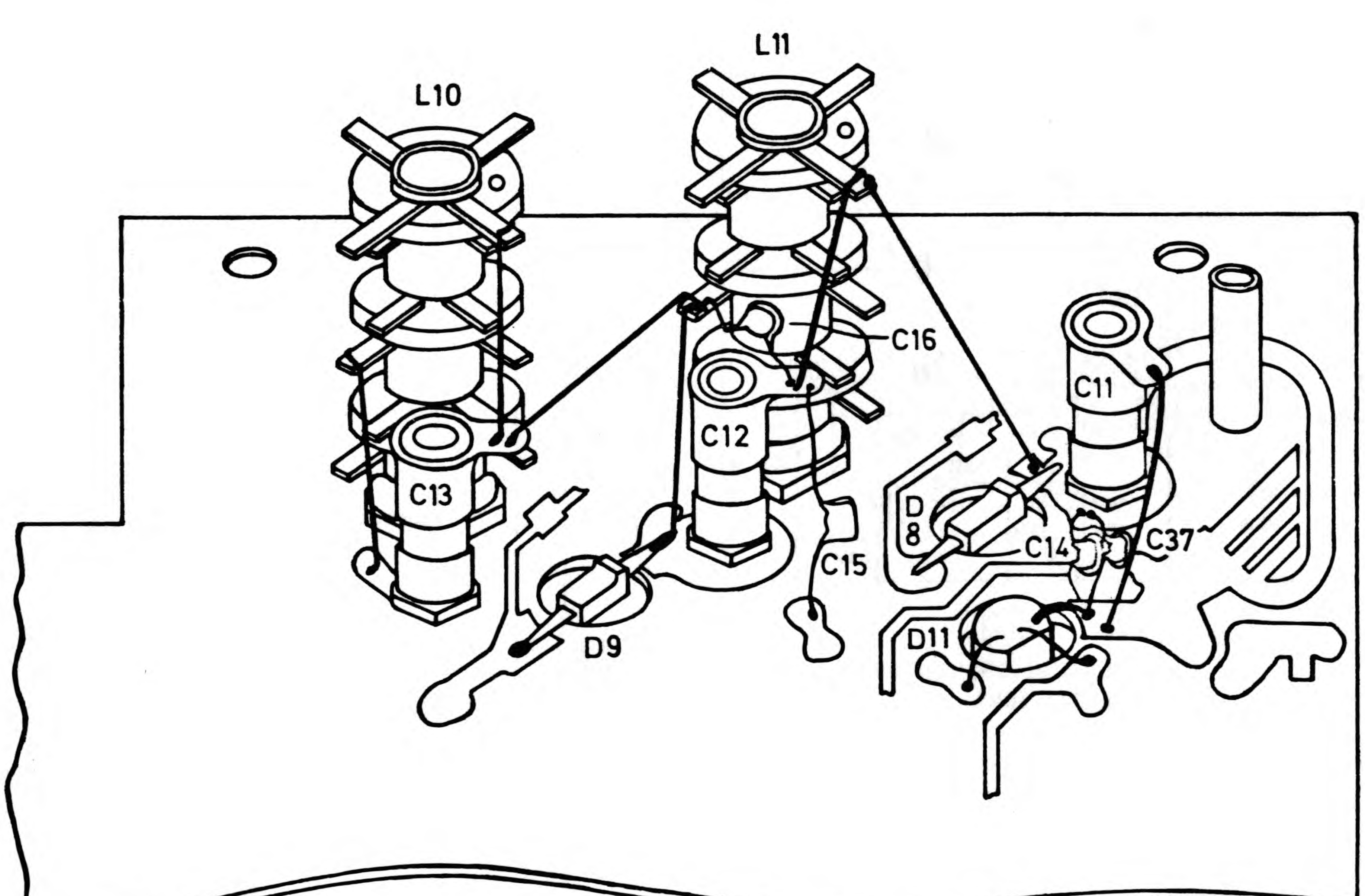
(B) A6 viewed from wiring side

Component layout: A5 and A6

Fig. 1



(A) Viewed from wiring side



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(B) Detail of L10, L11

Component layout : A1

Fig. 3

A1 DC Voltages

Test point		Reading
Range 9 : 5.2 MHz		
TR1	c	0 V
	b	10.1 V
	e	10.5 V
TR2	c	10.5 V
	b	12.2 V
	e	12.7 V
TR3	c	0 V
	b	12.1 V
	e	12.7 V
TR6	d	21 V
	g	10.5 V
	s	13.3 V
Tuning voltage pin 27		1 V
Range 12 : 53 MHz		
TR12	c	0 V
	b	13.0 V
	e	13.7 V
TR13	e	13.7 V
	b	13.0 V
	c	11.7 V

Test point		Reading
TR16	c	0 V
	b	11 V
	e	11.7 V
TR14	c	21 V
	b	5.2 V
	e	4.5 V
TR15	c	21 V
	b	4.4 V
	e	3.7 V
TR17	d	21 V
	g	0 V
	s	2.3 V
TR18	c	20.5 V
	b	18.4 V
	e	17.7 V
Tuning voltage		1 V

DC voltages : A1

(See Chap.5 for conditions)

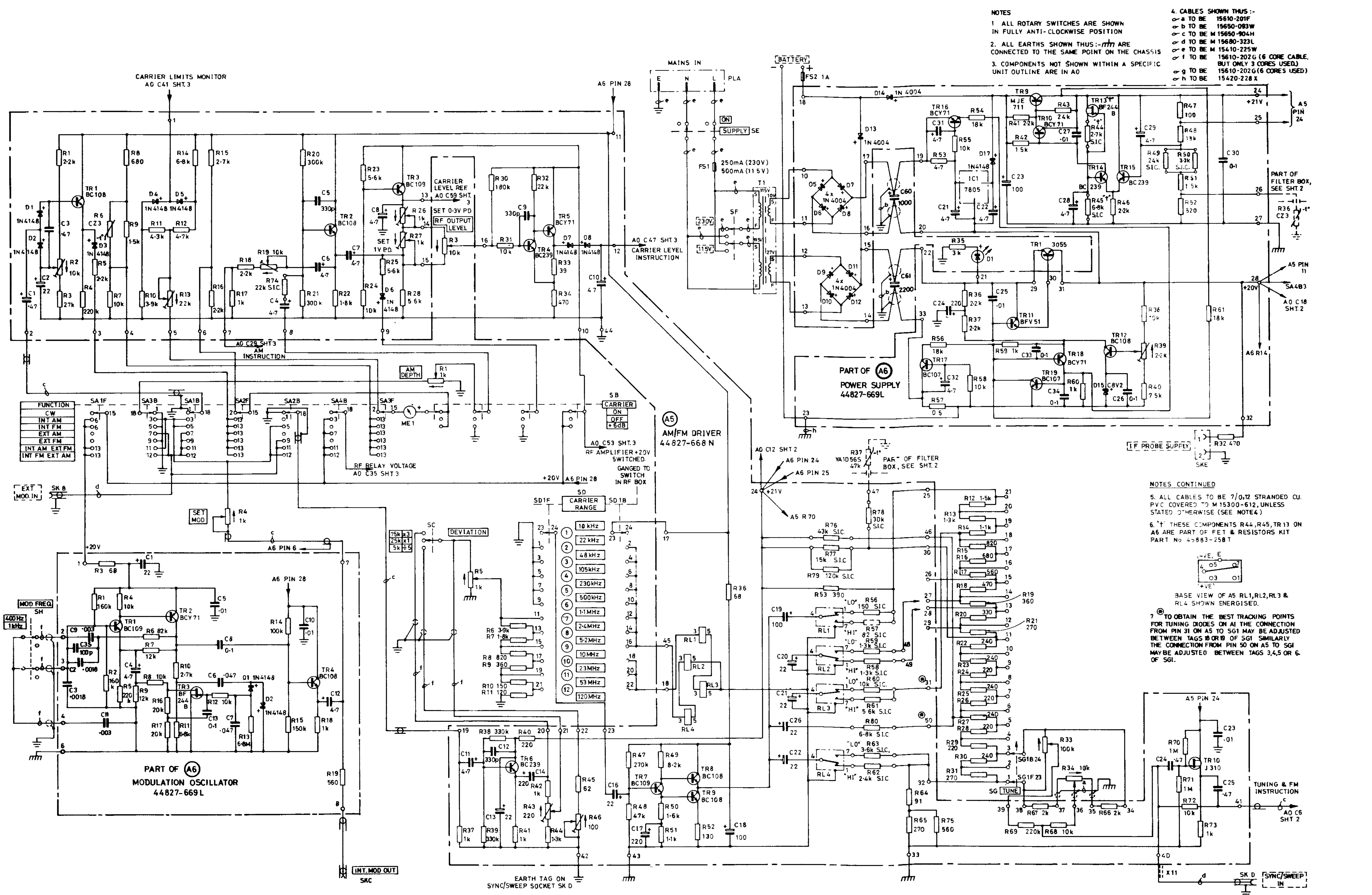

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Fig. 2 Power supply and modulation stages : A5 and A6

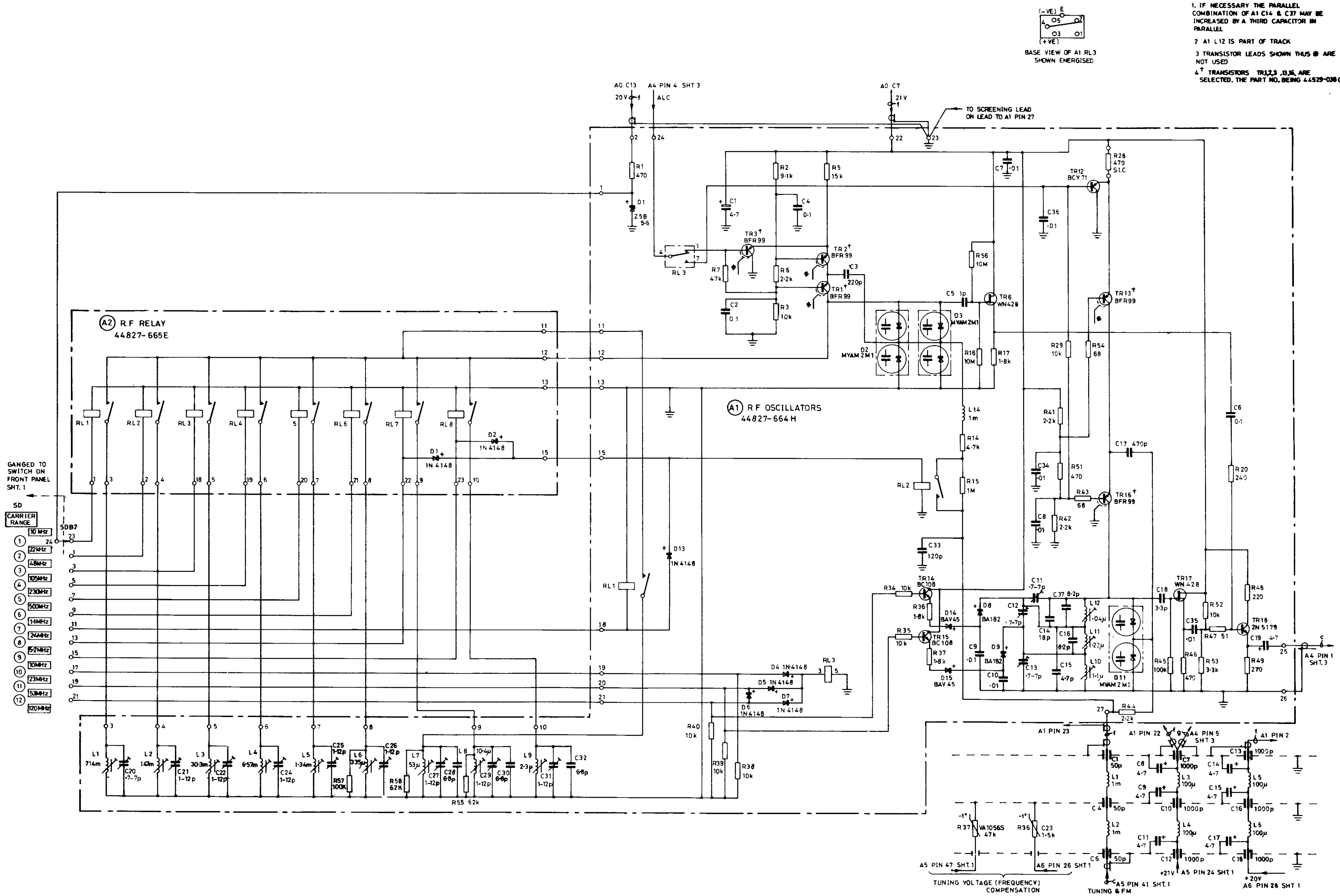

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Fig. 4 Oscillators: A1 and A2 Fig. 4

A3 DC Voltages

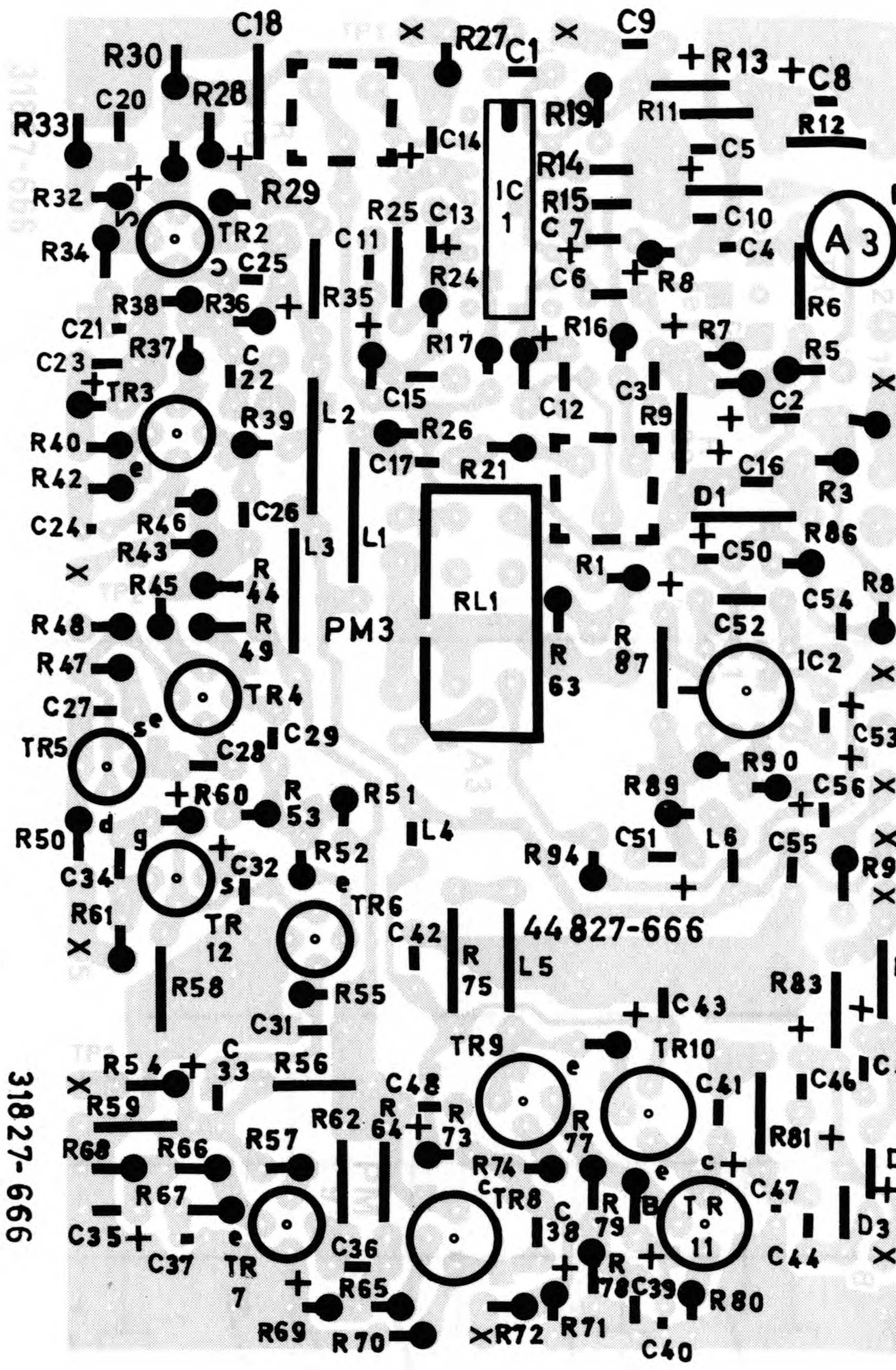
Test point	Reading	Test point	Reading
TR1 c	9.1 V	TR7 c	11 V
b	0.93 V	b	5.7 V
e	0.2 V	e	5.0 V
Function R9/R7	9.3 V	TR8 c	17.6 V
Function R9/R10	12.7 V	b	12.1 V
Function R10/R11	5.7 V	e	11.4 V
IC1 pin 3	5.7 V		
IC1 pin 4	5.7 V	TR9 c	13 V
IC1 pin 2	1.9 V	b	3.2 V
IC1 pin 7	1.9 V	e	2.6 V
IC1 pin 11	9.8 V		
IC1 pins 13	10.0 V	TR10 c	19.7 V
IC1 pins 1, 8	1.2 V	b	13.7 V
Function R23/R24	10.1 V	c	12.5 V
		TR11 c	12.5 V
TR2 c	17.5 V	b	2.6 V
b	3.9 V	e	1.9 V
e	3.2 V		
		TR12 g	6.0 V
TR3 c	18 V		
b	3.9 V	IC2 pin 1	3.7 V
e	3.3 V	2	3.7 V
TR4 c	16.8 V	3	3.7 V
b	7.5 V	4	3.7 V
e	6.8 V	5,6	0 V
		7	7.1 V
TR5 g	6.0 V	8,9	11.6 V
s	6.8 V	10	5.7 V
A3 pin 5	6.0 V		
TR6 c	16.9 V		
b	6.6 V		
e	6.0 V		

A4 DC Voltages

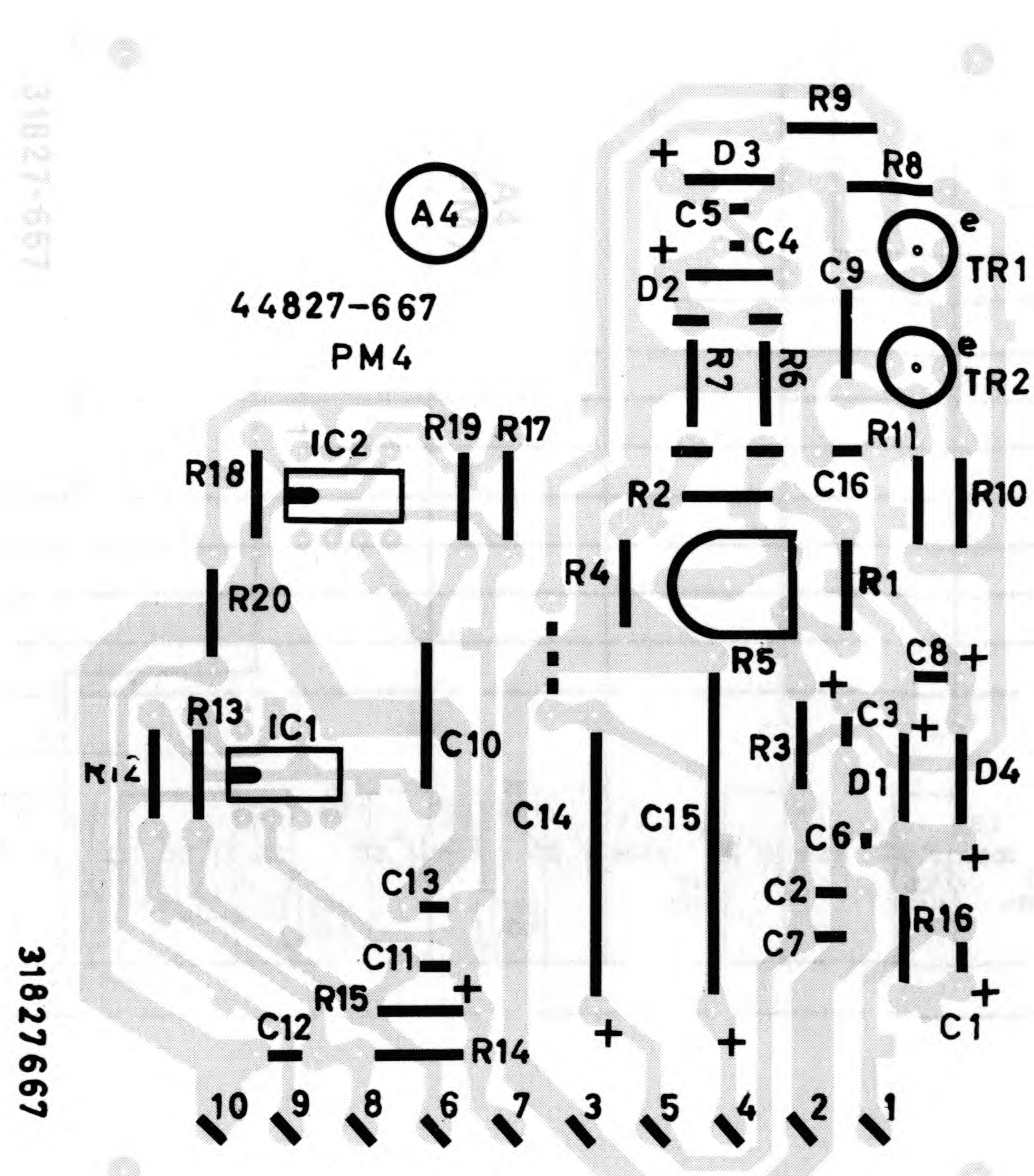
Test point	Reading	Test point	Reading
Range 12 : 53 MHz		RF output 4 V e.m.f. (CARRIER '+6dB')	
TR1 c	13.5 V	IC1 pin 2	10.2 V
b	14.7 V	3	10.4 V
e	15.4 V	6	7.0 V
TR2 c	0 V	IC2 pin 2	10 V
b	14.7 V	3	10 V
e	15.4 V	6	13.3 V
RF output : 2 V e.m.f.(CARRIER ON)		Range 6 : 1 MHz	
IC1 pin 2	11.5 V		
3	11.8 V	TR1 c	11.8 V
6	5.5 V		
IC2 pin 2	10 V		
3	10 V		
6	14.5 V		

Fig. 5

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



(A) A3 viewed from wiring side



(B) A4 viewed from wiring side

Component layout: A3 and A4

Fig. 5

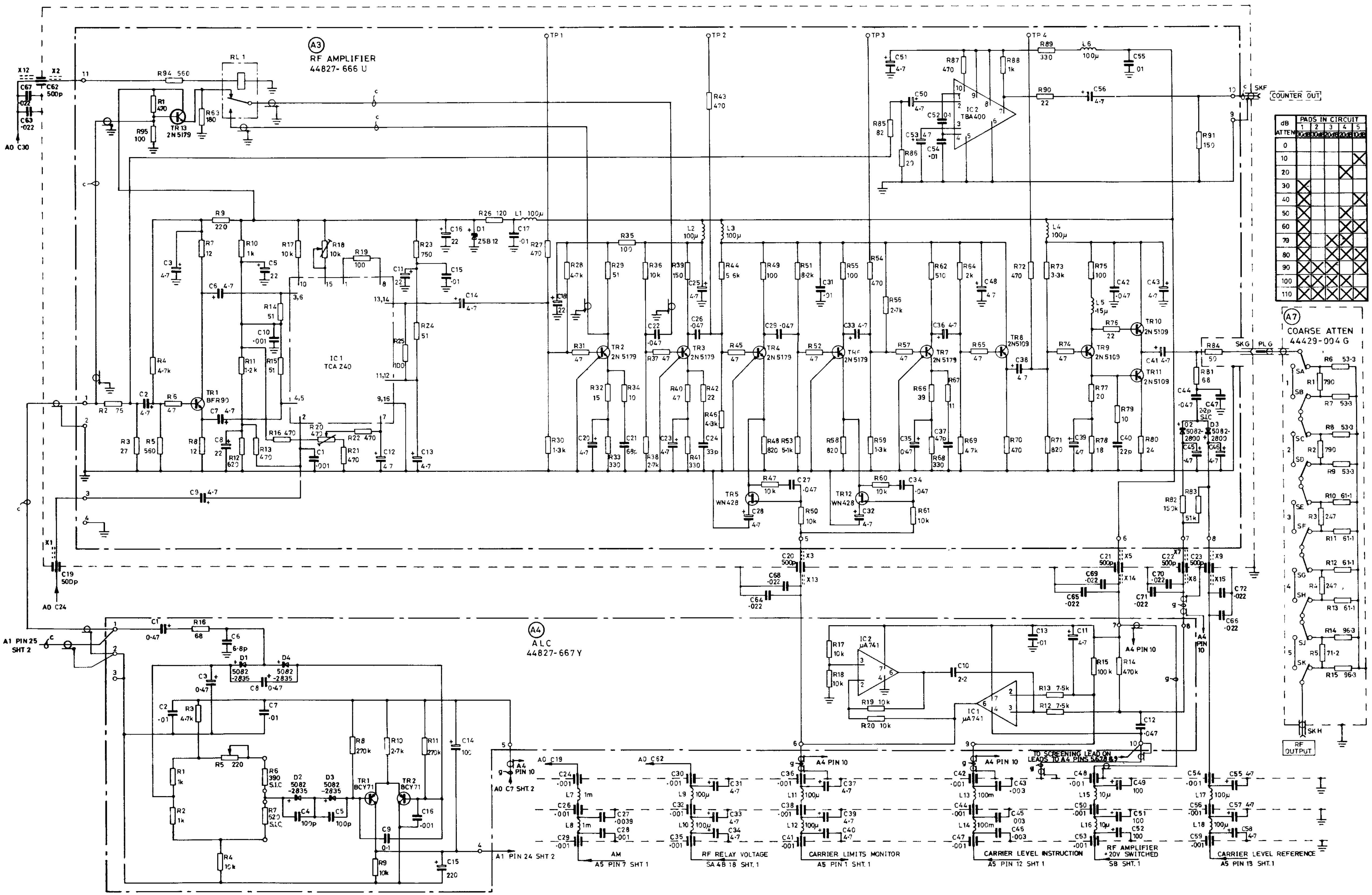


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Fig.6 — Output stages: A3, A4 and A7 — Fig.6

PART 2

DIGITAL SYNCHRONIZER TF 2173

PART 2

DIGITAL SYNCHRONIZER TF 2173

CONTENTS

Chapter

Chapter 1

GENERAL INFORMATION

CONTENTS

Fig. 1 Digital Synchronizer TF 2173 fitted to Signal Generator TF 2016

INTRODUCTION

1. Digital Synchronizer TF 2173 is designed for use with Signal Generator TF 2016. The two instruments are used jointly to produce a 10 kHz to 120 MHz signal generator system with high discrimination tuning and very good frequency stability.

2. The function of the synchronizer is to lock the signal generator to a high stability reference frequency. Digital frequency locking takes place over the whole of the signal generator bandwidth in increments of 10 Hz.

3. The selection and locking of the required frequency is extremely simple. Rotary frequency selection switches are set to give a lock frequency at a resolution of 10 Hz. The TF 2016 is then tuned to obtain a lock-on condition, indicated by the OUT OF LOCK lamp being extinguished.

4. Warm-up drift is eliminated and after a period of ten minutes an accuracy of 1 part in 10^6 (when measured over a period greater than 10 s) can be expected. All the generator facilities are fully maintained including the a.m. and f.m. facilities.

5. Switching facilities on the synchronizer allow the TF 2016 to be unlocked and used as an independent signal source. Provision is also made for obtaining an output from the internal 1 MHz standard or for accepting an input from an external 1 MHz standard.

PERFORMANCE DATA

6. Carrier

Range :	10 kHz to 119.99999 MHz (specifically for use with Signal Generator TF 2016).
Selection :	Seven decade switch controls in 10 Hz steps.
▶ Incremental frequency control :	After synchronization, the decade controls may be used to digitally increment the generato carrier frequency over a range of typically 2% without retuning the generator.

▶ 7. Internal frequency standard

Ageing rate :	Not greater than ±1 in 10^7 per month after 3 months continuous use.
Temperature coefficient :	Not greater than ±1 in 10^7 frequency change over the range 0 to +40°C.
Warm-up time :	Typically 10 minutes for the frequency to be within 2 in 10^7 of final value.
Output level :	Not less than 2 V p-p square wave at 1 MHz.

8. RF input level — Compatible with TF 2016 counter output. ◀

▶ 9.	External standard input :	Switched socket providing internally generated 1 MHz standard signal or accepting a 1 MHz input signal from an external standard. Maximum input 5 V p-p, minimum input 2.5 V p-p.
10.	RF leakage :	When used with TF 2016 and internal frequency standard, the r.f. leakage specification of the generator is not degraded.
11.	Power requirements :	AC supply. Any voltage within the limits 95 V to 132 V and 190 V to 264 V; 45 Hz to 65 Hz (usable to 500 Hz).
	Power consumption :	30 VA.

▶ 12. Dimensions and weight :

Height	Depth	Width	Weight
140 mm (5.5 in)	311 mm (12.25 in)	286 mm (11.25 in)	5.7 kg (12.5 lb)

ACCESSORIES

13. Supplied accessories

AC supply cable, 43129-071D.
Flexible screened coaxial cable, 50 Ω, BNC to BNC, 43129-063F.
Semi-rigid coaxial cable, 50 Ω, TNC to TNC, 43129-064G.
Protective front panel cover, 41690-102S.

14. Optional accessories

Carrying case, 41690-044B.
Shelf rack mounting (single), 54127-231 } Fitting instructions for
Shelf rack mounting (double), 54127-341 } these are included in the kit.

Chapter 2

OPERATION

CONTENTS

PREPARATION FOR USE

Note ...

1. Retain the container, packing materials and the packing instruction note (if included) in case it is necessary to reship the instrument. Re-packing instructions are given in Chap. 4.

2. Before use, the instrument should be checked for any obvious physical damage which may have occurred during transit. The synchronizer may then be prepared for use as follows:-

Mains input

3. The instrument operates on 95 V to 130 V or 190 V to 264 V a.c. input ranges These ranges are selected by removing the plate on the rear panel, setting the switch in its correct position and refitting the plate.

Fuse FS1

4. Check that the fuse is of the correct rating. Normally the instrument is supplied with a fuse rated at 250 mA (for voltage range 190 V to 264 V a.c.). For voltages in the range 95 V to 130 V change the fuse for one rated at 500 mA. In both cases the fuse fitted should be of the slow blow (time lag) type.

Supply cable

5. The a.c. mains cable is supplied with a connector which mates with the mains input connector on the rear panel. When fitting a suitable supply plug to the cable, ensure that the wires are connected to the plug as follows:-

Live - Brown
Neutral - Blue
Earth - Green/yellow

Fitting to Signal Generator TF 2016

6. If the synchronizer is to be used in conjunction with the TF 2016 in a semi-permanent role the two instruments may be fitted together as follows:-

(1) Position the TF 2016 on top of the synchronizer. Clamp the two instruments together using the clips attached to each side of the synchronizer case which locate into the latching plates fitted to the bottom of TF 2016.

(2) Using the *flexible* coaxial cable supplied, connect SYNC OUT on the synchronizer to SYNC/SWEEP IN on the TF 2016.

(3) Connect RF INPUT on the synchronizer to COUNTER OUT on the TF 2016 using the *semi-rigid* coaxial cable provided.

CONTROLS AND CONNECTORS

7. Front panel

(1) AC SUPPLY switch. Press up to switch ON. Lamp indicates rectified supply present.

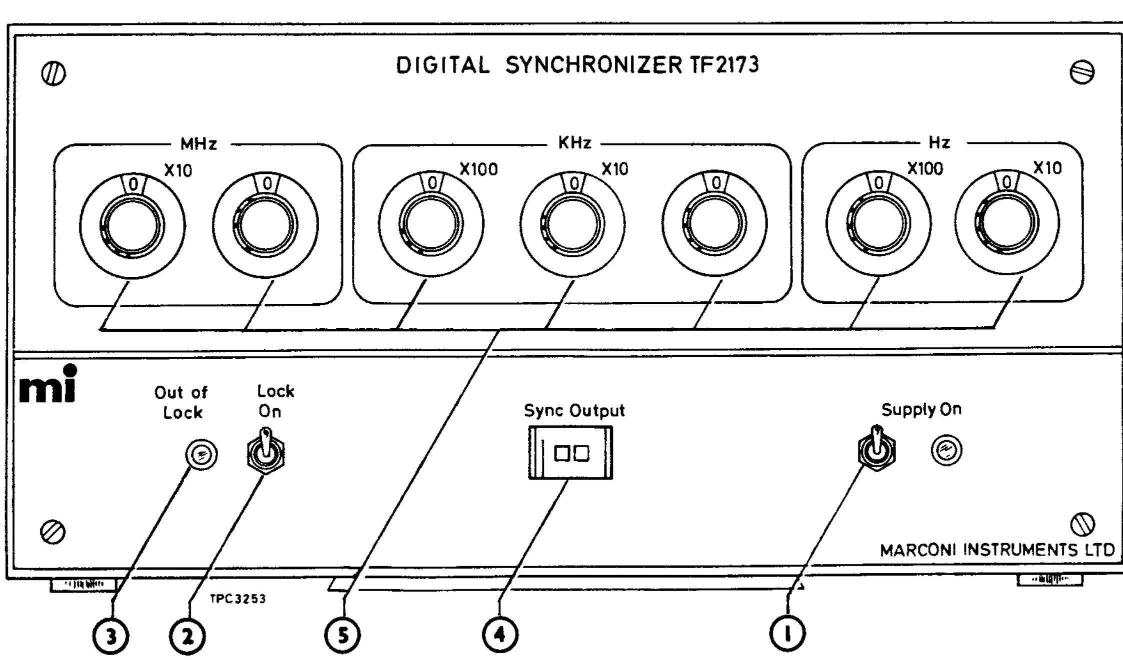


Fig. 1 Front panel

(2) LOCK ON switch. Press up to lock generator to synchronizer. In the down position the generator may be used independently of the synchronizer.

(3) OUT OF LOCK lamp. Goes out when the generator has achieved lock.

(4) SYNC OUTPUT meter. Indicates the control signal level of the synchronizer, i.e. the position of the generator frequency within the lock range.

(5) Frequency switches. Rotary decade switches set to select required frequency.

8. Rear panel

(1) AC input connector. Accepts the mains input cable 43129-071D.

(2) Voltage selector switch. Selects either 95 V to 130 V or 190 V to 264 V a.c. ranges.

▶ (3) Fuses. AC input fuses rated at 250 mA (slow blow) for 190 V to 264 V or 500 mA (slow blow) for 95 V to 130 V.

(4) RF INPUT connector (TNC 50 Ω). Accepts the COUNTER OUTPUT signal for the TF 2016.

(5) SYNC OUT connector (BNC 50 Ω). Carries the synchronizer control signal to the SYNC/SWEEP IN on the TF 2016.

(6) 1 MHz STANDARD connector (BNC 50 Ω). Connector for 1 MHz standard input or output dependent upon the setting of the 1 MHz STANDARD switch.

(7) 1 MHz STANDARD switch. Provides a 1 MHz STANDARD output when switched to INT OUTPUT. In the EXT INPUT position an external standard may be applied to replace the internal crystal standard.

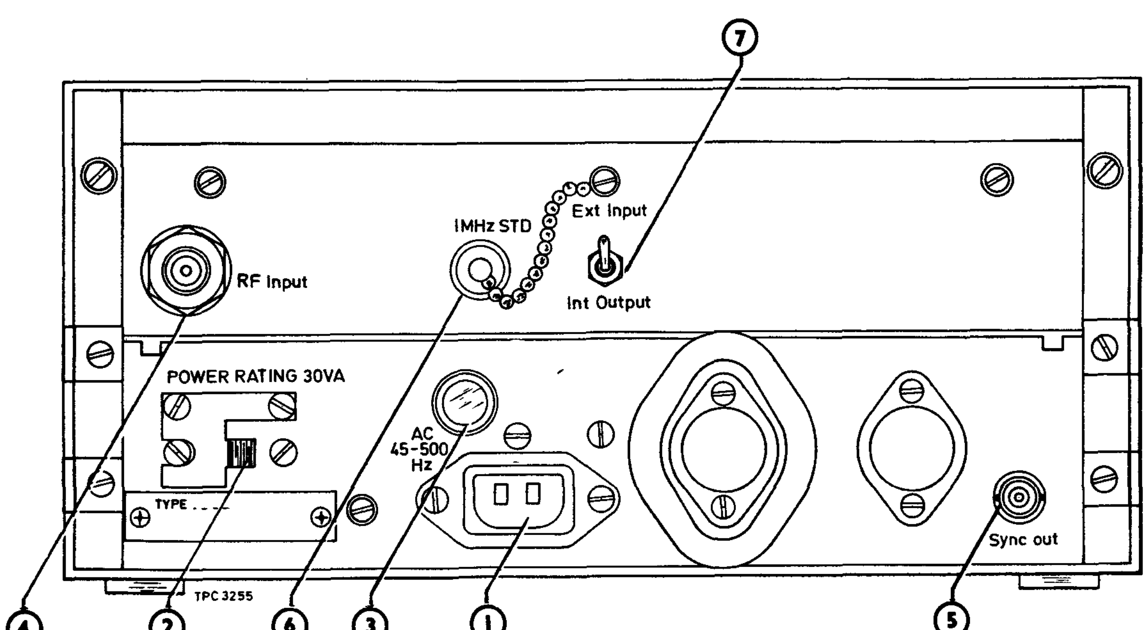


Fig. 2 Rear panel

OPERATING PROCEDURE

9. The setting up procedure is as follows:

(1) With both synchronizer and generator connected to the a.c. supply and switched on, check that both pilot lamps are lit.

(2) On the synchronizer, set the frequency switches as required and switch to LOCK ON.

(3) On the generator, set the function selector at CW and the CARRIER switch at ON. Select the appropriate carrier range and check that the pointer of the MOD & CARRIER LEVEL meter is within the white box on the meter scale.

(4) Using the TUNE control, and FINE TUNE control if necessary, carefully adjust the generator frequency to extinguish the OUT OF LOCK lamp on the synchronizer. Check that the pointer of the SYNC OUTPUT meter is stationary. It is advisable, particularly if the incremental frequency facility is to be used, to adjust the generator FINE controls to bring the pointer of the synchronizer SYNC OUTPUT meter to the centre of the white box.

Range of incremental frequency control

10. Once locked the carrier frequency may be controlled by rotating the digital control knobs on the front of the synchronizer. The extent of the frequency shift available before losing lock is limited by the loop gain and the control range of the synchronizer interface amplifier. In practise the maximum shift available varies between instruments and over each carrier frequency range. The typical maximum frequency swing obtained with several different units is shown by the shaded envelopes in Fig. 3. This diagram assumes that when the signal generator is initially locked the FINE TUNE control on the generator is adjusted to centre the pointer on the synchronizer meter. Although frequencies are shown for only three carrier ranges of the TF 2016 Generator similar results are to be expected on other ranges.

11. The FINE TUNE adjustment procedure above is not required for normal operation of the synchronizer at a fixed frequency; the meter position is of no significance once the OUT OF LOCK light is extinguished. However, to obtain a roughly symmetrical swing above and below the carrier frequency, the meter may be initially set to the centre using the generator FINE TUNE control. This adjustment alters the internal d.c. control voltage but <u>not</u> the carrier frequency:- the output frequency is <u>always</u> the same as the digital control knob settings. ◄

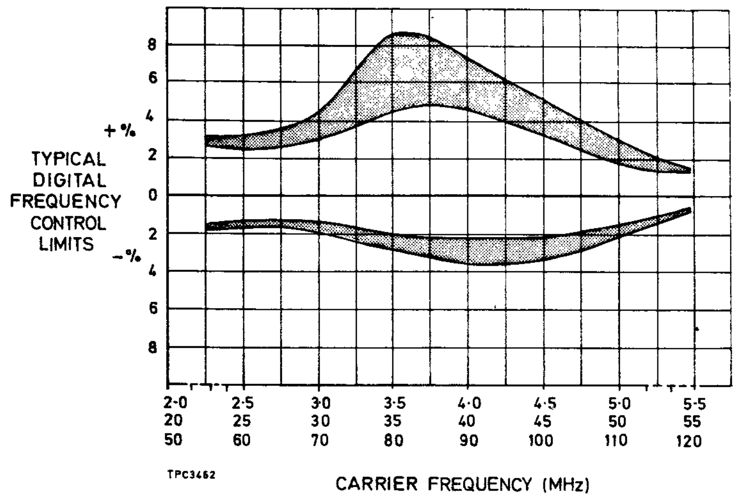


Fig. 3 Typical percentage detuning

FUNCTIONAL TESTS

12. The following tests describe the methods by which the instrument may be functionally tested. They are only intended as self-checking procedures to prove the general serviceability of the instrument.

13. With the mains input selector set to the correct setting for the local supply and a fuse fitted of the correct rating, switch on and observe that the supply lamp glows.

14. Connect the synchronizer to the TF 2016. Set the generator controls to give any frequency output in any mode. Select the frequency on the synchronizer and switch to LOCK ON. Adjust the generator tuning controls to extinguish the OUT OF LOCK lamp. The signal generator is now locked to the synchronizer and the SYNC OUTPUT meter should give a steady indication.

15. Use the tuning controls on the generator to centre the SYNC OUTPUT meter. Check that incremental frequency changes may be made up to 0.5% of the selected frequency by moving the synchronizer decade switches only. These changes should give a valid output despite changes in the SYNC OUTPUT meter provided that the OUT OF LOCK lamp remains unlit.

16. Setting the LOCK switch off (down position) will enable the TF 2016 to be used independently. The OUT OF LOCK lamp should now be lit.

17. Connect a frequency counter to the 1 MHz STANDARD connector and switch the 1 MHz STANDARD switch to INT OUTPUT. Check that the counter reads 1 MHz ±1 Hz. If an external standard is available connect it to the 1 MHz STANDARD input connector, switch to EXT INPUT and ensure that frequency lock may be achieved as normal.

18. Before putting the synchronizer into use ensure that the 1 MHz STANDARD switch is returned to INT OUTPUT. This will ensure that the internal standard is being used and a false lock condition avoided.

Chapter 3

TECHNICAL DESCRIPTION

CONTENTS

INTRODUCTION

1. The following description should be read in conjunction with the block diagram, Fig. 1, and the circuit diagrams in Chap. 7. The circuit is summarized in paras. 2 to 12 and the individual boards described in paras. 13 to 46.

CIRCUIT SUMMARY

2. RF input from Signal Generator TF 2016 is divided by a ratio set by the synchronizer dials and then compared with a standard frequency in a phase detector. The output from the phase detector is returned to the signal generator tuning control line and corrects any frequency drift.

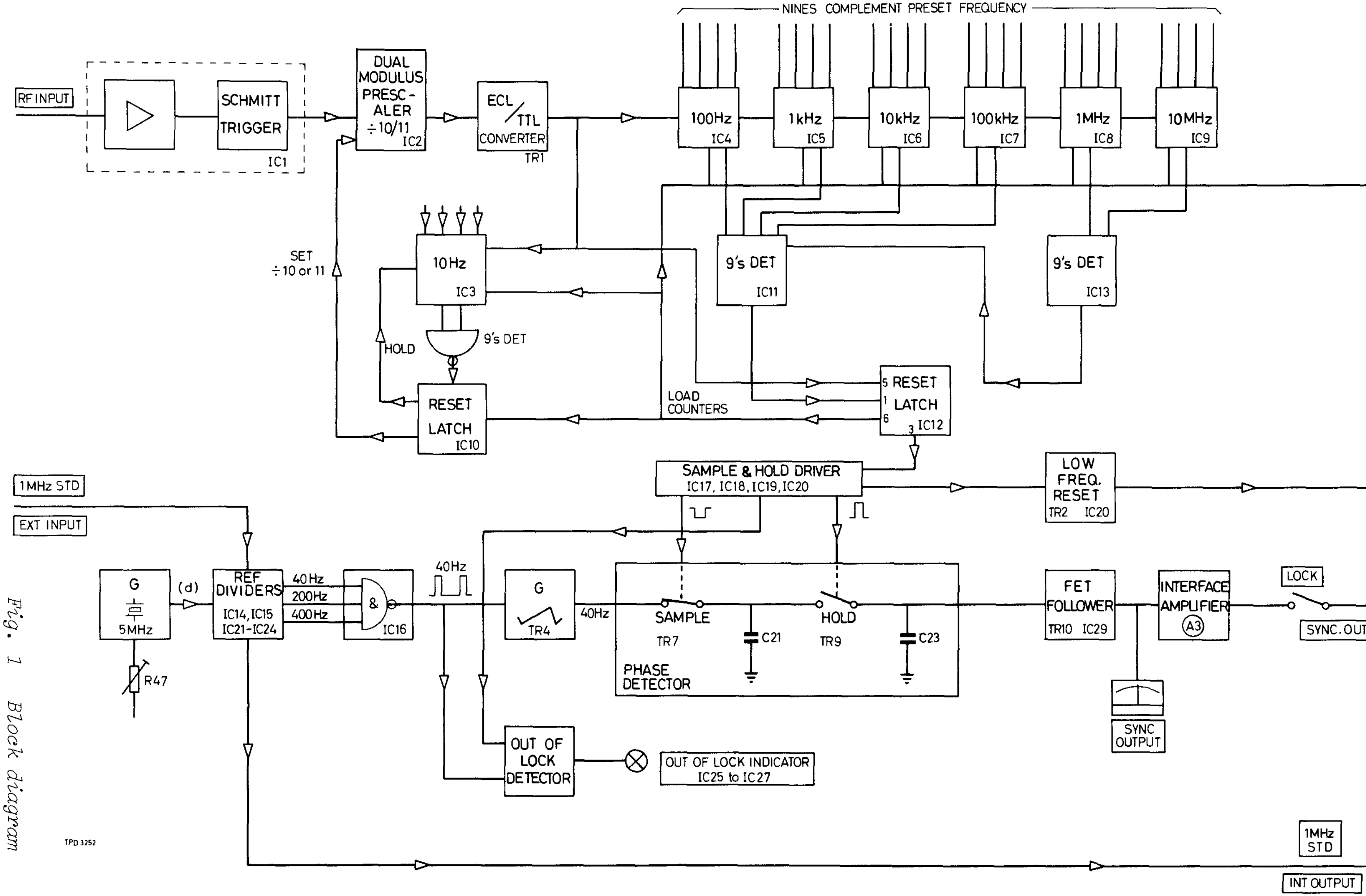


Fig. 1 Block diagram

3. Input amplifier. After amplification, IC1 improves the rise time of the signal. This enables the variable modulus prescaler IC2, which is an edge triggered device, to work down to 10 kHz.

4. Variable modulus prescaler and e.c.l./t.t.l. converter. This circuit carries out the 10 Hz increments division and conversion to t.t.l. logic. It is controlled by programmable counter IC3. The count cycle is 11 until the 10 Hz count is complete; it is then programmed to divide by 10 for the remainder of the count.

5. Programmable counters (v.r.d.). Each counter operates over one decade, counting in 9's complement form, i.e. with input 3 the counter sets to 6, with input 4 the counter sets to 5, and so forth. When all counts are complete, the 9's detector operates reset latch IC12 and the count is restarted.

6. Sample and hold driver. This circuit consists of four bistables, three of which are used to produce gating pulses for the sample and hold phase detector. The two pulses are in antiphase and of differing width and timed so that one lies within the period of the other. The pulse width of the sampling pulse is roughly one and a half times wider than the holding pulse. The remaining bistable provides a reset circuit in the event of a change in frequency selection part way through a counting cycle.

7. Reference oscillator. A 5 MHz crystal controlled oscillator provides the reference frequency for the sample and hold circuits. Its frequency may be adjusted by a fine control R47, or a coarse mechanical trimmer, when referred to an external standard of higher accuracy. By switching to EXT INPUT an external input of 1 MHz may be used as a standard. With this switch in the INT OUTPUT position a 1 MHz output derived from the reference oscillator is available at the 1 MHz STANDARD socket.

8. Reference divider and pulse gating circuit. The divider consists of six IC's arranged to divide the reference frequency by 125×10^3. Outputs of 40 Hz, 200 Hz and 400 Hz are gated together to provide 1 ms pulses at 40 Hz to drive the sample and hold ramp generator and the OUT OF LOCK circuit.

9. Ramp generator. The 1 ms pulses from IC16 cause a capacitor to be discharged and recharged through a constant current source. The recharging of the capacitor provides a 25 ms ramp. This ramp is fed to the sample and hold circuits.

10. Sample and hold phase detector. The sample and hold gates are operated by the outputs of the driver. Driver pulses open the sample gate and close the hold gate. While the sample gate is closed C21 continuously samples the incoming ramp. A pulse from the driver opens the sample gate and the voltage on C21 is frozen. After a slight delay the hold gate closes and this frozen sample charges C23. If the ramp and drive pulses remain in phase the d.c. voltage fed to the interface amplifier remains constant. A change in signal generator frequency results in a change in ramp sample point and a resulting change in voltage as shown in Fig. 2.

11. Interface amplifier (A3). This amplifier provides a current drive for the varactor diodes in the signal generator from the voltage across C23. The amplifier also corrects for gain changes in the feedback loop caused by the non-linear response of the signal generator varactor.

12. Power supplies. Voltages of +24, +12, +5 and -12 V are provided. All these outputs are regulated.

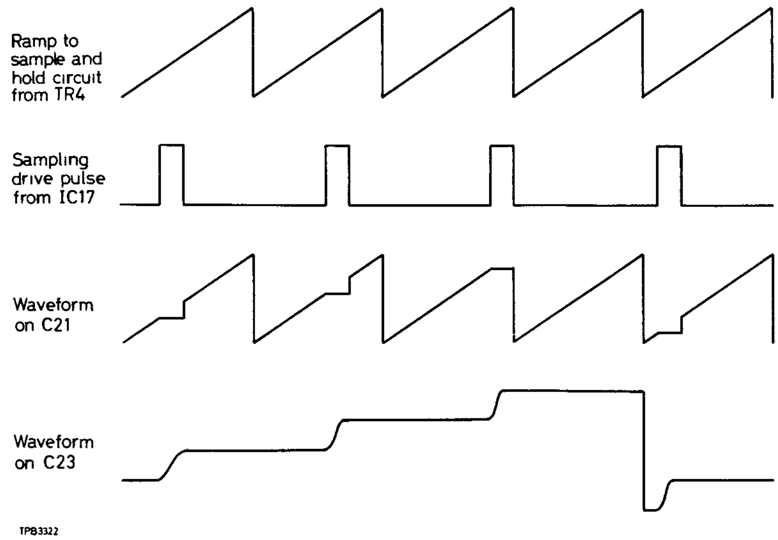


Fig. 2 Phase detector sampling and ramp waveforms

SYNCHRONIZER BOARD A2

Circuit diagram : Chap. 7, Fig. 2

Input amplifier and shaper (IC1)

13. The input from Signal Generator TF 2016 is amplified by the first two sections of IC1. Both stages have a gain of approximately 16 and are arranged in cascade. The third stage of IC1 is wired as a Schmitt trigger. This trigger shortens the rise time of the signal and in doing so lowers the working frequency of the dual modulus prescaler. R9 provides adjustment of the Schmitt trigger to ensure reliable operation at the extremes of the input frequency range.

14. TR11, diodes D11 to D17, capacitors C41 and C42 form a high frequency filter. When switches SF and SG are at zero, that is selecting a frequency below 1 MHz, diodes D11 to D15 will all be high. TR11 conducts and current drawn will enable D17 to conduct. C41 and C42 are then connected to the input circuit of IC1 and will filter any unwanted high frequency jitter. When a selection other than zero on either switches SF or SG is made, at least one of the diodes D11 to D15 conduct. TR11 and D17 cut off, isolating C41 and C42 from the input of IC1.

Dual modulus prescaler (IC2) and variable ratio dividers (IC3 to IC9)

15. To provide the variable ratio dividers with a frequency within their range (maximum 50 MHz) the input is prescaled or divided down and also, because this prescaler is an e.c.l. device its output is converted to t.t.l. levels.

16. Ideally the counters should be operated at the highest speed possible to enable rapid locking of the selected TF 2016 frequency. The counter speed, however, is limited by its reset time and with the presettable counters used a reset pulse width of 30 ns is required. This, coupled with the finite delay incurred during reset, would produce errors at high clock rates. IC2 can be instructed to divide by 10 or 11 at any time up to half way through its count cycle, so allowing a time of approximately five times that of the input clock period to be used.

17. IC3 to IC9 are nines complement ratio dividers controlled by b.c.d. logic derived from the frequency selector switches SA to SG. IC3 to IC8 count up to nine whilst IC9 counts to eleven. When all counters are full their outputs at pins 5, 6 and 12 are fed to the nines detector IC11 and 13. IC2 divides by 11 only until the 10 Hz count of IC3 is complete.

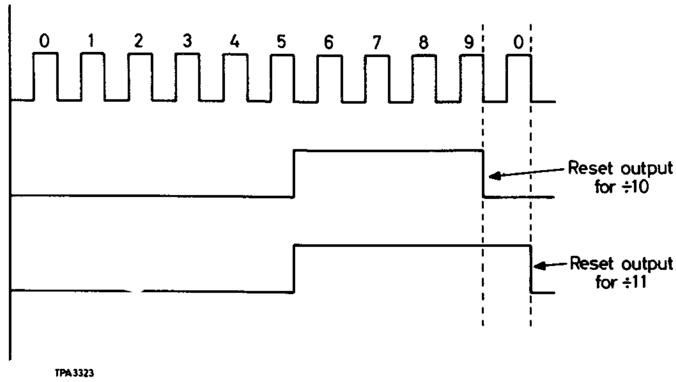


Fig. 3 Reset pulse operation

18. At this time IC3 outputs at pins 5, 6 and 12 operate reset latch IC10. IC10 pin 11 resets IC2 to divide by 10 and instructs IC3 to stop counting. IC4 to IC9 continue the count until the nines detector is activated. IC11 pin 8 operates reset latch IC12 which in turn performs three functions:-

(1) IC12 pin 3 provides pulses for the sample and hold circuit.

(2) IC12 pin 6 instructs IC2 to return to divide by 11, and

(3) Sets a '1' at IC3 pin 1 to reload all counters to their input information.

<u>Principle of v.r.d. operation</u>

19. The function of the VRD is to produce a pulse output with a p.r.f. of 10 Hz when the frequency selector controls are set to the value of the input frequency from the signal generator.

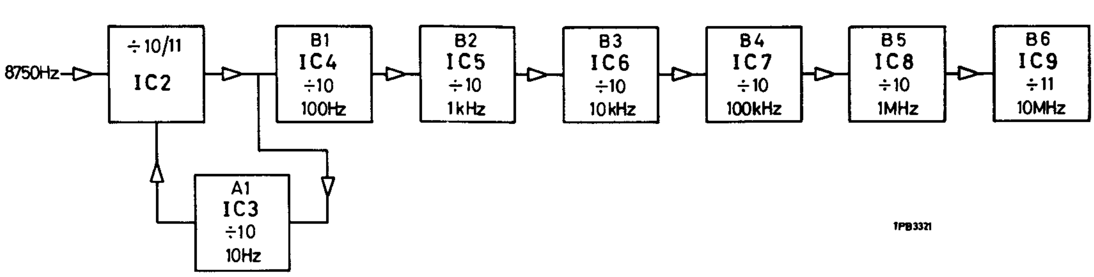


Fig. 4 VRD operation

20. The general expression for the division ratio, N, of such a v.r.d. is

$$N = 11(A1) + 10\ (B1 + 10B2 + 10^2B3 + 10^3B4 + 10^4B5 + 10^5B6 - A1)$$

where A1,B2,B3 etc. represent the initial settings of the 10 Hz, 100 Hz, 1 kHz etc. decades of the frequency selector.

21. If, for example, the frequency selector is set to 8750 Hz,

then A1 = 5
B1 = 7
B2 = 8
B3, B4, B5, B6 = 0

$$\therefore N = 11 \times 5 + 10\,(7 + 10 \times 8 - 5) = 55 + 820 = 875$$

22. The v.r.d. therefore converts an input frequency of 8750 Hz to one of 10 Hz, i.e. pulses at 100 ms intervals. Any subsequent shift of input frequency causes the interval between output pulses to change, which initiates the appropriate change in control voltage.

23. In practice the v.r.d. stages operate in the 9's complement mode, i.e. by counting up from the 9's complement of the setting of the frequency selector. In the above example of 8750 Hz, the 9's complements are as follows:-

10 Hz counter	9 - 5 = 4
100 Hz counter	9 - 7 = 2
1 kHz counter	9 - 8 = 1
All other counters	9 - 0 = 9

The action of counting by the two lowest counters is shown below.

24.

		IC3 :10 Hz	*IC4 :100 Hz*
(1)	Initial b.c.d. 9's complement setting	4	2
(2)	After 11 input pulses to prescaler	4 advances to 5	2 advances to 3
(3)	" 22 " " " "	5 " " 6	3 " " 4
(4)	" 33 " " " "	6 " " 7	4 " " 5
(5)	" 44 " " " "	7 " " 8	5 " " 6
(6)	" 55 " " " "	8 " " 9 (full)	6 " " 7

At this point the 10 Hz counter is full and initiates a reset pulse through IC10 to reset prescaler to divide now by 10.

(7)	After 65 input pulses to prescaler	9 (full)	7 advances to 8
(8)	" 75 " " " "	9 (full)	8 " " 9 (full)

25. After each subsequent 100 pulses IC5, the 1 kHz counter (initially set at 1) advances by 1 and therefore reaches 9 after a total of 875 input pulses. The 9's detectors IC11 and 13 are then activated, which reset latch IC12, and the cycle restarts.

<u>Sample and hold driver</u> (IC17 to IC20)

26. These IC's are monostable devices with Schmitt trigger inputs. Their output pulse duration is determined by choice of timing components across pins 10 and 11. The sample and hold pulses from IC17 and IC19 are in anti-

phase and of approximately 1.5:1 pulse width ratio i.e. if IC17 pin 6 is 0.7 ms then IC19 pin 1 will be 0.45 ms (see Chap. 5, Fig. 3j). IC18 and IC19 provide pulses to the out-of-lock indicator circuit IC25 to IC27.

27. IC20 provides a kick reset facility in the event of the generator output and the v.r.d. program being incompatible. This may occur upon selecting a low frequency output on the generator and synchronizer after a high frequency count; if the 'load counters' instruction (IC12 pin 6) has yet to be received, e.g. count of 100 MHz changed to 10 kHz, the v.r.d's will continue counting to 100 MHz until the full count is complete. Driven by a low frequency input this count would take an unacceptable time. IC20 senses missing or less frequent pulses and resets the counters to the lower frequency count.

Reference oscillator

28. This is a 5 MHz crystal controlled oscillator with temperature control. The frequency of the oscillator may be adjusted by two controls, one mechanical and one electrical. A mechanical trimmer on the body of the oscillator controls the coarse adjustment whilst fine adjustment is effected by R47. It should be noted, however, that incorrect adjustment of these controls will impair the accuracy of the signal generator while using the internal standard. The output is a square wave of approximately 5 V in amplitude.

Reference divider (IC14, 15 and IC21 to 24)

29. Division of the standard input is by 125×10^3. These dividers are wired to divide either by 2, 5 or 10, and the output may be of equal or unequal mark/space ratio, dependent upon the interconnection of the pins. Dividers IC14, 21, 23, 24, 22 and 15 divide by 10, 5, 5, 10, 5 and 10 respectively. The output from IC16 pin 8 consists of 1 ms pulses at 40 Hz. To achieve this, outputs of 400 Hz, 200 Hz and 40 Hz, of various mark/space ratios, are taken from IC15 and IC22 and gated in IC16.

Pulse gating circuit (IC16)

30. IC16 NANDS together the outputs of the reference divider and provides drive pulses to the ramp generator. The 1 ms pulses are derived as shown in Fig. 5 when divider outputs A, D and C are coincident.

Ramp generator (TR3 to TR5)

31. The 40 Hz pulses from IC16 drive the ramp generator switch TR3. TR3 switches on for the duration of each pulse. While TR3 is switched off C16 charges up via constant current source TR4. When TR3 switches on C16 is discharged and the ramp resets. The ramp therefore lasts for the period between 1 ms pulses, i.e. 25 ms. Emitter follower TR5 couples the ramp to the sampling gate TR7.

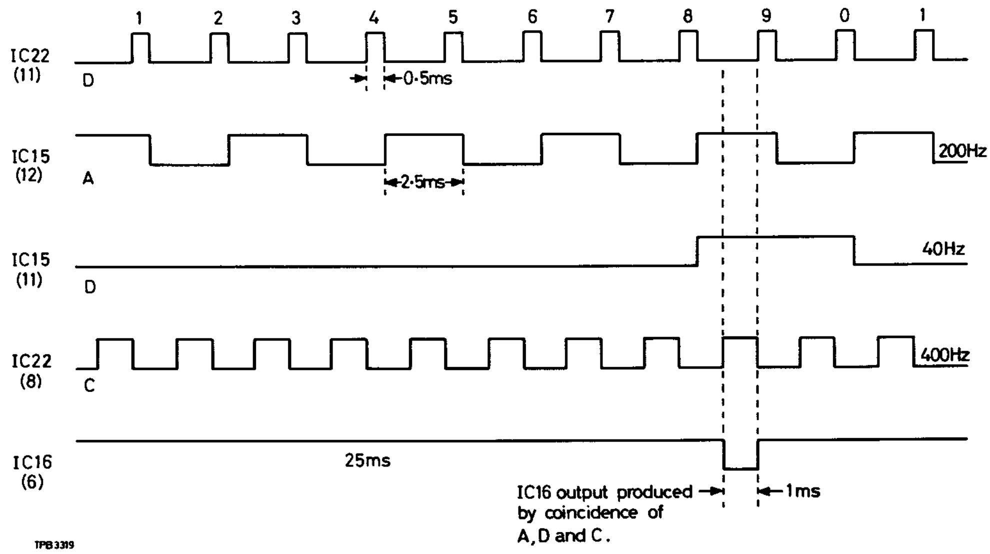


Fig. 5 Operation of IC16 pulse gating circuit

<u>Sample and hold phase detector</u> (TR7 to TR9)

32. Output pulses from IC17 drive TR6 which in turn switches TR7 on and off. TR8 and TR9 are similarly switched by pulses from IC19. With no pulse output from IC17, TR7 is switched on and the voltage across C21 follows the ramp voltage. On receipt of a pulse, TR7 switches off and TR9, driven by an inverse output, switches on. The instantaneous voltage of the ramp is thus held on C21. The switching on of TR9 lies within TR7 off time; therefore the output is isolated from the ramp. When TR9 switches on, the sampled voltage on C21 is transferred to C23. TR9 now switches off holding the sampled voltage on C23.

<u>Synchronizer board output</u> (TR10 and IC29)

33. TR10(1) is a f.e.t. follower providing the interface amplifier A3 with the control voltage from the sample and hold circuitry. To ensure that only changes in control voltage are passed to A3 TR10(1) is operated under stable conditions. TR10(2) provides a constant current source offsetting changes in supply whilst IC29 holds the drain source voltage below 9 V (approx.) to keep gate leakage current to a minimum.

<u>Out-of-lock indicator circuit</u> (IC25, 26, 27)

34. The out-of-lock indicator circuit detects all conditions in the digital circuitry that would result in failure to synchronize or synchronization at a false locking point.

35. It functions as shown in Fig. 6 by taking the 40 Hz ramp pulses from IC16, dividing them by four and then checking for coincidence with a v.r.d. output. If this condition is met a pulse is fed to the monostable IC28, triggers it and the l.e.d. indicator is then unlit. This continuous process results in the monostable being continually retriggered and the lamp remaining extinguished.

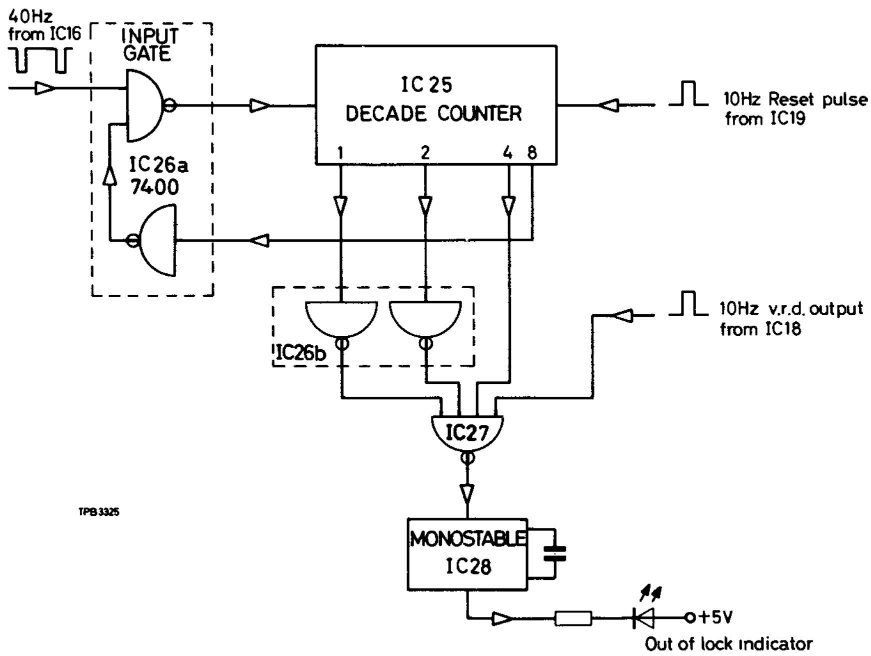


Fig. 6 Out-of-lock indicator circuit

36. The decade counter IC25 is initially set to zero by the last v.r.d. pulse and starts to count the ramp pulses from IC16. A decoding circuit is arranged to produce an output when IC25 has counted four pulses and at the same time looks for coincidence of this output with a v.r.d. output obtained from IC18.

37. Coincidence of these two signals is an indication of correct locking and the resultant pulse is used to trigger the monostable IC28 which causes the OUT OF LOCK lamp to be extinguished. Immediately following the pulse from IC18 a pulse is produced by IC19 and this will reset IC25 to zero so that the cycle can be repeated.

38. The circuit as described will be satisfactory for the following out-of-lock conditions:-

(i) Loss of 40 Hz pulses due to circuit failure or not applying an external standard when in external mode of operation.

(ii) Loss of v.r.d. pulses due to circuit failure or signal generator carrier being off, or the more usual condition of the signal generator being inadvertently set to the wrong frequency.

39. One special condition that could cause incorrect operation of the lamp is if the signal generator should be set at a certain frequency on the low side of that set on the synchronizer; whereupon the v.r.d. pulses appear not every four ramp pulses but every fourteen or twenty four and a trigger pulse will be produced. This condition is prevented by the input gate and its connection to pin 8 output of IC25.

40. This stops the ramp pulses reaching IC25 input if the v.r.d. pulse has not occurred by the time that eight ramp pulses have been counted. Correct operation of the circuit can be seen by the indicated pulses being present as illustrated in Chap. 5, Fig. 3n.

INTERFACE AMPLIFIER (BOARD A3)

Circuit diagram : Chap. 7, Fig. 1

41. The amplifier provides a current drive for the TF 2016 tuning circuits from the error voltage output of the synchronizer board A2. TR3 to TR6 form a long-tailed pair in which TR5 acts as a current inverter adding the current of TR6 to that of TR3. Temperature compensation is provided by diodes D3 and D4.

42. During setting up, the amplifier is balanced by R13 and R17. Their values are selected to give zero output current into a load split between supply rails and with the input connected to earth.

43. An l.e.d., D2, and light sensitive resistor, PCC1, are included to vary the gain of the interface amplifier so as to compensate for the non-linearity of the varactors in the TF 2016. The sensitivity of the varactors is low at the high end (maximum tuning voltage) and high at the low end (minimum tuning voltage) of each frequency range.

44. When the tuning voltage is high D2 remains unlit and PCC1 remains at high resistance. The pad formed by PCC1 and R6 has low attenuation and the amplifier gain is high for the low sensitivity region of the varactor. At the other end of the range when the tuning voltage is low, D2 is fully illuminated and PCC1 has a low resistance. This results in attenuation of the control signal to compensate for the high varactor sensitivity.

POWER SUPPLY (BOARD A4)

Circuit diagram : Chap. 7, Fig. 1

45. This power supply has regulated outputs of +24 V, +12 V, +5 V and -12 V. The circuits for +24 V, +12 V and +5 V are all of similar design. Single chip regulators are used for each of the supply rails.

46. The -12 V rail is regulated by IC1 and TR1. TR1 is in series with the output and is controlled by comparator IC1. IC1 compares a sampled voltage (junction of R5 and R6) of nominally 0 V with earth potential. This is detected by the comparator which, via the series regulating element TR1, returns the output voltage to -12 V.

47. Relay RL1 ensures that when the TF 2173 is switched off no interaction will affect the accuracy of the TF 2016 when operating independently.

Chapter 4

MAINTENANCE

CONTENTS

INTRODUCTION

1. This chapter contains information for keeping the equipment in good working order and for checking its overall performance. Before attempting any maintenance on the equipment you are advised to read Chap. 3, Technical Description.

Screw fasteners

2. The majority of screw threads used in this instrument are metric of various sizes but in some positions BA sizes are used. All chromium plated screws and all blue tinted screws are metric. Ensure that removed screws are refitted in their original positions.

Sensitive components

3. There are no static sensitive components fitted to this instrument but normal care should be exercised when handling IC's or transistors, particularly in the use of excessive heat. Before attempting continuity or insulation checks or before shorting or open circuiting a circuit, refer to the circuit diagram to establish the effect on the biasing of affected components.

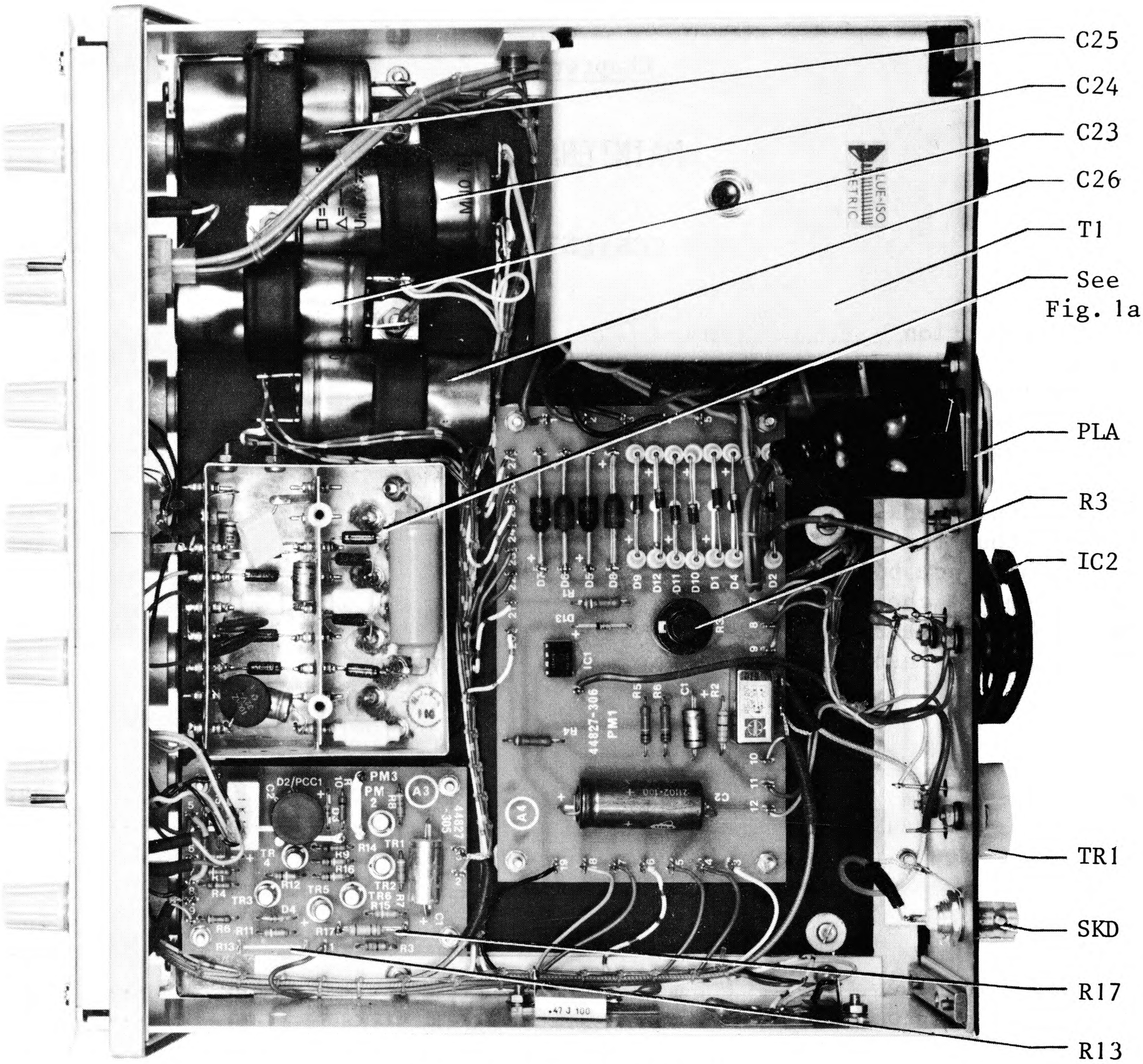


Fig. 1 Underside view

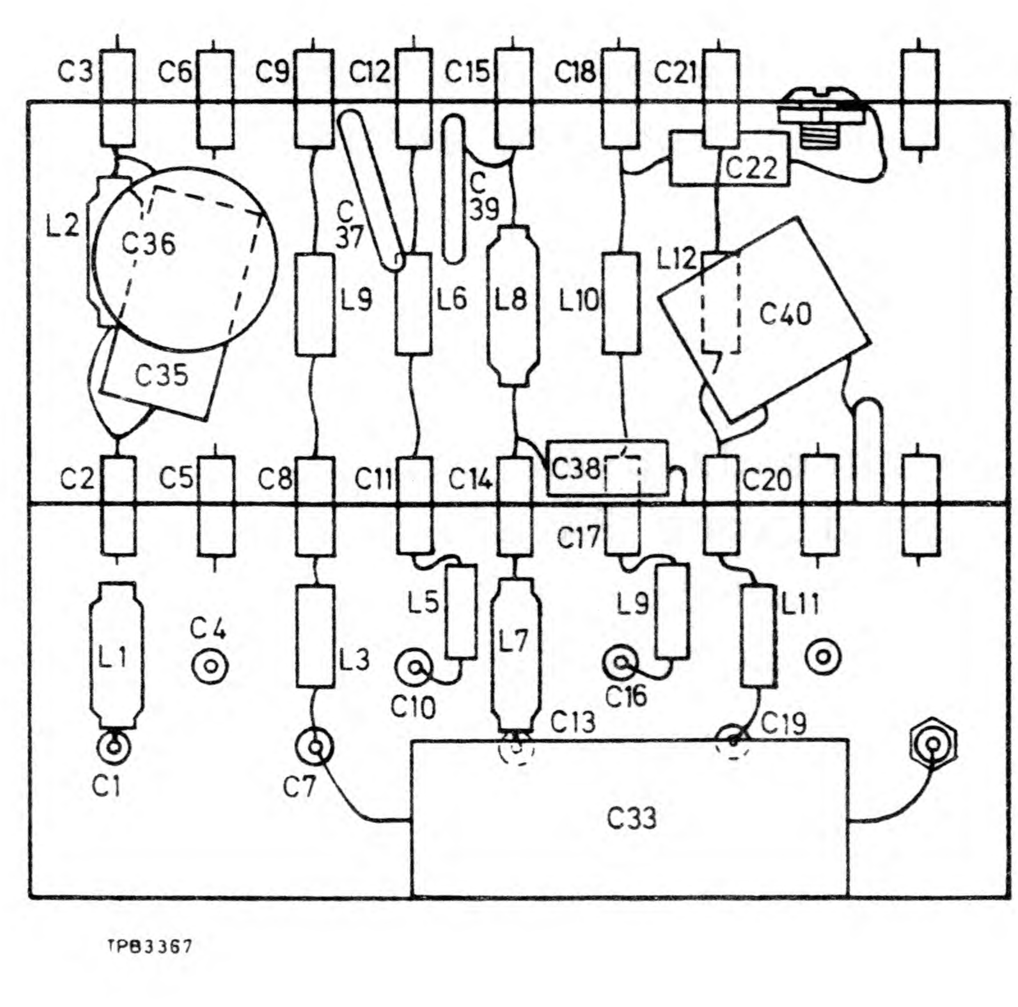


Fig. 1a Filter box components

ACCESS AND LAYOUT

4. The instrument is housed in a case which has top and bottom covers. These covers are removed by unscrewing six retaining screws (three each side). The case contains three sub-assemblies A2, A3 and A4. A3 and A4 are located on the underside of the instrument, A2 is located on the top after removing the r.f. box lid. A2 may be swung out to access its underside by removing the three retaining screws, loosening its pivot screws and lifting the rear of the board, taking care not to strain the cable harness.

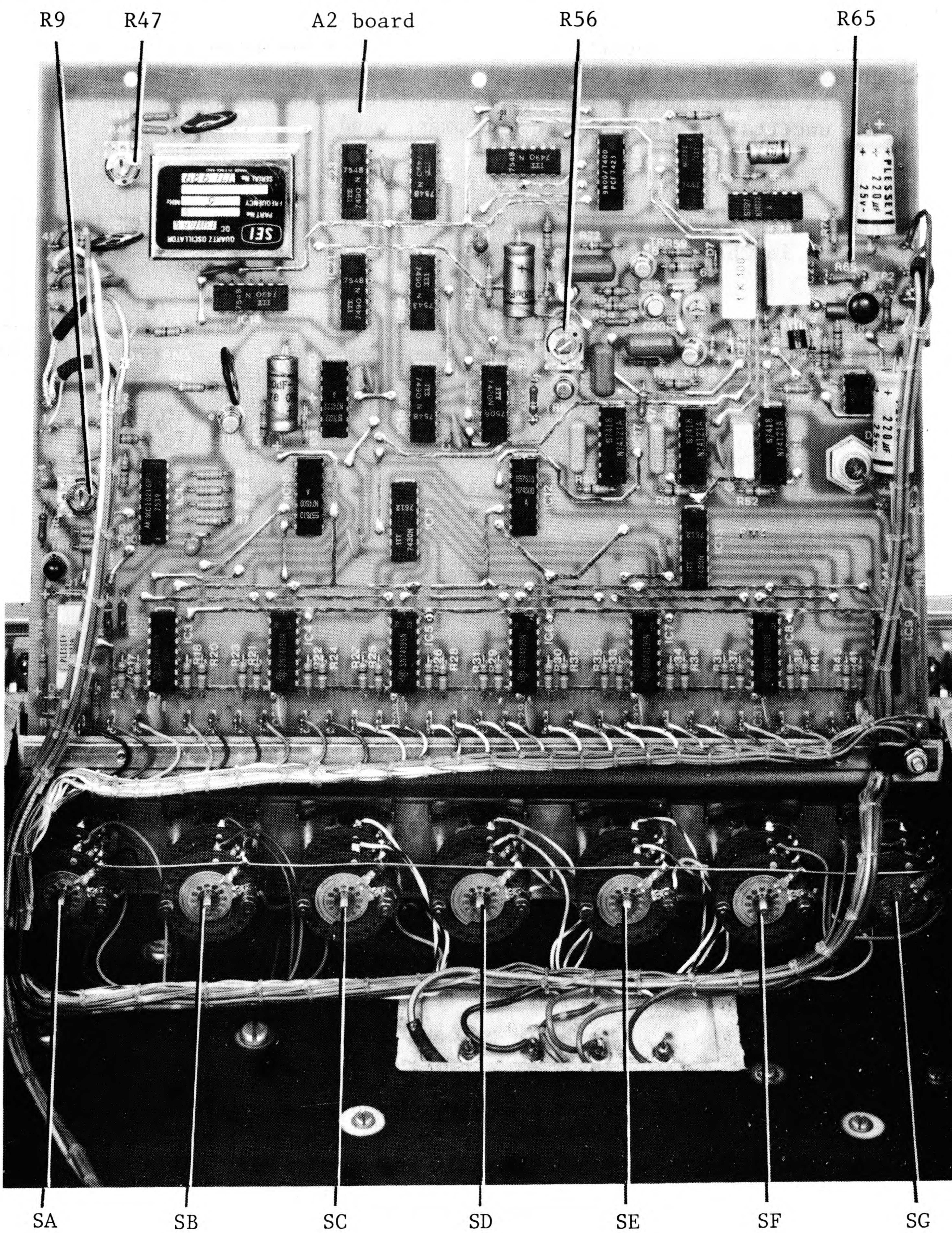


Fig. 2 Top view - A2 hinged back

PERFORMANCE CHECKS

Introduction

5. Many of the methods described in this section are simplified and of restricted range compared with those which would be required to demonstrate 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.

6. Performance limits quoted are for guidance only and should not be taken as guaranteed performance specifications unless they are also quoted in the performance data contained in Chap. 1. When making tests to verify that the equipment meets the guaranteed performance limits, allowance must always be made for the uncertainty of the test equipment used.

Note ...

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

TABLE 1 TEST EQUIPMENT

Item	*Description*	*Minimum use specifications*	*Recommended model*
a	Multimeter	Input resistance >20 kΩ/V Accuracy ±1.5% of f.s.d.	GEC Selectest
b	Differential d.c. voltmeter	Input resistance 1 MΩ nominal. Accuracy ±0.02% of reading ±100 μV. Voltage range 1 mV to 1100 V.	
c	Oscilloscope (dual trace)	Time base 10 ns/cm to 100 ms/cm ±5% with rise time >2 ns. Amplitude 0 to 25 V ±5%.	
d	x10 Oscilloscope probe		
e	Frequency counter	Frequency range greater than 120 MHz with resolution of 100, 10, 1 or 0.1 Hz. Accuracy ±1 count ± stability of frequency standard. Sensitivity 10 mV r.m.s. (sinewave).	MI TF 2432
f	Variable voltage transformer	Variable between 95 V to 264 V at 2 A.	Variac
g	2 x 47 kΩ resistors	¼ W ±2% tolerance.	
h	Signal generator	Freq. range 10 kHz to 120 MHz with facilities for SYNC/ SWEEP IN, accepting a frequency sweep voltage from Digital Synchronizer TF 2173.	MI TF 2016

Power supply A4

Test equipment : items a, f.

7. To check the outputs from the power supply and the function of the stabilizers proceed as follows :-

(1) Disconnect the TF 2173 from the supply and remove the connections to pins 14, 15, 17 and 18.

(2) Connect the TF 2173 to the supply, switch on and check that 5.25 V d.c. appears across pin 18 (positive) and pin 8 (negative). If necessary adjust R3 to correct this voltage.

(3) Leave the negative lead of the multimeter connected to pin 8 and check that +24 V ±1 V and +12 V ±0.5 V appear on pins 14 and 17 respectively.

(4) Reconnect the multimeter positive lead to pin 8 and check that -12 V ±0.5 V appears on pin 15.

(5) Switch off the supply and reconnect the wires to pins 14, 15, 17 and 18. Switch on again and check that the voltages present are the same as those noted in paras. (3) and (4).

(6) With the supply to the instrument connected via the Variac, check that the outputs remain within ±100 mV for an input variation of 190 to 264 V (or 95 to 130 V).

Frequency standard

Test equipment : item e.

8. The frequency standard has been carefully set during manufacture and should not need frequent adjustment. If it becomes necessary to reset the standard proceed as follows:-

(1) Connect the frequency counter to the 1 MHz STANDARD output connector. Allow at least ten minutes for the oven to warm up.

(2) Adjust R47 to read 1 MHz ±0.5 Hz.

Input amplifier

Test equipment : item h.

9. Connect the TF 2016 to the synchronizer and set both to 10 kHz. Adjust R9 on A2 so that the meter needle of the synchronizer is steady and locked. Set both instruments to 119.9 MHz and adjust R9 again for a steady lock. Check the lock again at 10 kHz, adjusting R9 for the best compromise at both ends of the range. Extreme care must be taken to achieve a steady lock throughout the whole range of the instrument.

Ramp generator

Test equipment : item c.

10. To obtain a symmetrical ramp about 0 V (±7 to 8 V) connect the oscilloscope to the collector of TR3 and adjust R56 to give the waveform shown in Chap. 5, Fig. 3f. If necessary, R55 may be selected to extend the range of R56.

Output f.e.t. current

Test equipment : item a.

11. To set the current of the output f.e.t., TR10, disconnect the coaxial cable from pins 36 and 37. Connect the multimeter across R64 and select R65 to give a voltage drop of 50 to 60 mV across R64. Reconnect pins 36 and 37.

Interface board A3

Test equipment : items a, g.

12. Balance the output current of TR3 and TR6 as follows:-

(1) Disconnect the input to the amplifier by removing the coaxial lead to pin 9. Short out the input by connecting pin 9 to pin 8.

(2) Connect the two resistors (47 kΩ) across the +24 V, -12 V supplies (pins 1 and 5).

(3) Set the LOCK ON switch to ON and connect the multimeter, set to 1 mA f.s.d., between pin 2 and the centre point of the two resistors.

(4) Switch on the TF 2173 and, turning the meter range down to 50 μA f.s.d., measure the current drawn (reverse the meter connections if necessary). If the reading is zero the amplifier output is balanced.

(5) Should the current reading be greater or less than zero place a 220 kΩ resistor (±2% tol.) in either the R13 or R17 position. If the current increases place the resistor in the alternate position and select a resistance value which will reduce the current reading to zero.

(6) Remove the 47 kΩ resistors and the short from pins 9 and 8. Reconnect the coaxial cable to pin 9.

Overall checks

Test equipment : items c, d, h.

13. Carry out an overall check by measuring the waveforms shown in Chap. 5, Fig. 3. If the results are unsatisfactory refer to the fault location tables in Chap. 5.

CLEANING ROTARY SWITCHES

14. If it becomes 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 1% solution of petroleum jelly in white spirit. Avoid lubricants containing soap or solid materials.

REPACKING INSTRUCTIONS

15. 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 plywood 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 plywood 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 is also advisable.

Chapter 5

REPAIR

CONTENTS

INTRODUCTION

1. This chapter is intended to assist in fault finding and repairing the instrument, and should be used in conjunction with the technical description, Chap. 3, and circuit diagrams, Chap. 7.

2. Integrated circuits and semiconductor devices are used throughout this instrument and although these have inherent long term reliability and mechanical ruggedness, they are susceptible to damage by overloading, reverse polarity and excessive heat or radiation. Avoid hazards such as prolonged soldering, strong r.f. fields or other forms of radiation and the use of insulation testers.

3. In case of difficulties which cannot be resolved with the aid of this book, please contact our service division at the address given on the rear cover, or your nearest Marconi Instruments representative. Always quote the

type and serial number found on the data plate at the rear of the instrument.

FAULT LOCATION

4. Some aid to fault finding is provided by the chart, table and sub-circuit checks included in this chapter. It is emphasized that a good working knowledge of the instrument must be achieved before attempting any sub-circuit or component replacement.

DC voltages

Test equipment : item a.

5. Voltages given on the circuit diagrams and in the following tables approximate those which can be expected using a 20 kΩ/V multimeter on a typical TF 2173 connected to a supply of 240 V a.c., 50 Hz.

TABLE 1 DC VOLTAGES

Test point		*Voltage*	*Remarks*
A2 Synchronizer board			
TR3	base	-7.8 V	
	emitter	-8.0 V	
	collector	0.75 V	
TR4	gate	0.65 V	
	drain	12 V	
	source	2.25 V	
TR5	base	0.75 V	
	emitter	0.65 V	
	collector	-12 V	
TR6	base	-11.5 V	
	emitter	-12 V	
	collector	10.6 V	
TR7	gate	0.27 V	
	drain	0.95 V	
	source	0.65 V	
TR8	base	-11.25 V	
	emitter	-12 V	
	collector	-12 V	
TR9	gate	-11.5 V	
	drain	-	Varies according to a.c. conditions
	source	0.95 V	
TR10	gate 1	-	Varies according to a.c. conditions
	drain 1	9.5 V	
	source 1	0.7 V	
	gate 2	-	Varies according to a.c. conditions
	drain 2	0.7 V	
	source 2	-10.6 V	

TABLE 1 DC VOLTAGES continued

Test point	*Voltage*	*Remarks*
A3 Interface board		
TR1 base	0.55 V	
emitter	1.25 V	
collector	1.25 V	LOCK ON switch to off.
TR2 base	0 V	
emitter	0.55 V	
collector	0 V	
TR3 base	-	Varies with synchronizer 'range of lock setting'
emitter	-	
collector	19.5 V	
TR4 base	-9.3 V	
emitter	-10 V	
collector	-5 V	
TR5 base	19.5 V	
emitter	≈21 V	A very high input impedance measuring instrument should be used in lieu of (a) to prevent instability and voltage fluctuations.
collector	0.7 V	
TR6 base	0 V	
emitter	-0.5 V	
collector	0.7 V	

TABLE 2 POWER SUPPLY FAULTS

Fault	*Possible causes*
No SUPPLY ON indication	A0FS1, A0D1, A4R4 or +12 V supply
No +12 V supply (pin 17)	A0IC1 or A0T1
No -12 V supply (pin 15)	A0TR1, A4IC1, A4R1, A4R5/6 or A0T1
No +5 V supply (pin 18)	A4IC2 or A0T1
No 24 V supply (pin 14)	A4IC3 or A0T1
Incorrect supply levels	A0D1 to A0D12, A0C23 to A0C32
Incorrect +5 V supply	A4R2 or A4R3
Incorrect -12 V supply	A4IC1 offset components or +5 V supply

6. Further fault finding may be assisted by reference to Fig. 2.

A3 Interface amplifier check

7. Check the amplifier for output current balance as described in Chap. 4, para. 12. Check d.c. conditions as presented in Table 1.

A2 Synchronised output check

8. Carry out the output current balance check described in Chap. 4, para. 11. Change the signal generator frequency and check that the voltage change across

C23 is proportional to the change across R64. Check the components surrounding TR10 and IC29.

Frequency reference divider check

9. Confirm the period of the divider outputs on IC16 pins 6 and 8, the output from pin 6 being the inverse of that on pin 8, Fig. 3e. If these are incorrect the individual IC's may be checked for their respective divisions as shown in Table 3.

TABLE 3 FREQUENCY REFERENCE DIVIDER PERIODS

IC	*Pin No.*	*Period*	*Frequency*	*Remarks*
14	11	1 μs	1 MHz	} via switch AOSL
14	14	1 μs	1 MHz	
14	12	2 μs	500 kHz	
15	11	25 ms	40 Hz	
15	1/12	5 ms	200 Hz	
21	11	10 μs	100 kHz	
22	8	2.5 ms	400 Hz	
22	11	2.5 ms	400 Hz	
23	11	50 μs	20 kHz	
24	11	0.5 ms	2 kHz	
24	1/12	100 μs	10 kHz	

Out-of-lock circuit check

10. Check the 10 Hz phase detector drive pulses on IC25 pins 2 and 3, and also on IC27 pin 4. Check that the weighted outputs 1, 2, 4, 8 are present on pins 1, 9, 8, 11, and that three outputs also appear on IC27 pins 1, 2 and 5. Check the 10 Hz v.r.d. pulse is present on IC27 pin 4. With all IC27 inputs coincident a 10 Hz output will be obtained at pin 6. This in turn triggers the monostable IC28 keeping the OUT-OF-LOCK lamp extinguished.

Variable ratio dividers, dual modulus prescaler and e.c.l./t.t.l. converter check

11. Check the frequency selection on switches SA to SF, which are identical in operation; a short circuit to earth will indicate a '0' in the nines complement code. Switch SG differs only in that it has eleven switch positions and is used in the 10 MHz step selection.

TABLE 4 VRD TRUTH TABLES

Switch No.	*A2 pin no. for b.c.d. code* 1	2	4	*code* 8
SA	7	8	9	10
SB	11	12	13	14
SC	15	16	17	18
SD	19	20	21	22
SE	23	24	25	26
SF	27	28	29	30
SG	31	32	33	34

TABLE 4 VRD TRUTH TABLES continued

Setting of SA to SF	*Logic state* 1	2	4	8
9	0	0	0	0
8	1	0	0	0
7	0	1	0	0
6	1	1	0	0
5	0	0	1	0
4	1	0	1	0
3	0	1	1	0
2	1	1	1	0
1	0	0	0	1
0	1	0	0	1

Setting of SG	*Logic state* 1	2	4	8
11	0	0	0	0
10	1	0	0	0
9	0	1	0	0
8	1	1	0	0
7	0	0	1	0
6	1	0	1	0
5	0	1	1	0
4	1	1	1	0
3	0	0	0	1
2	1	0	0	1
1	0	1	0	1
0	1	1	0	1

12. In order that the waveforms in Fig. 1 can be seen on the test oscilloscope ensure that the TF 2016 is at 20 MHz and the TF 2173 is set to 0000300. Failure to obtain any of these waveforms will indicate the area of breakdown.

Note...

The initial 20 MHz input is prescaled to 2 MHz by the action of IC1.

Sample and hold drivers

13. The input to the sample and hold drivers from the reset latch IC12 pin 3 and 4 as shown in Chap. 5, Fig. 3(c) should be checked, and then the following:

(i) IC17 pin 1 : 10 Hz negative-going pulse, duration 0.7 ms (h)
(ii) IC17 pin 6 : 10 Hz positive-going pulse, duration 0.7 ms (h)
(iii) IC18 pin 1 : 10 Hz negative-going pulse, duration 70 μs (i)
(iv) IC18 pin 6 : 10 Hz positive-going pulse, duration 70 μs (i)
(v) IC19 pin 6 : 10 Hz positive-going pulse, duration 0.45 ms (j)
(vi) IC19 pin 1 : 10 Hz negative-going pulse, duration 0.45 ms (j)
(vii) The reset pulse on IC20 pin 6 will only appear should a low frequency selection be made from a previous higher setting, as explained in Chap. 3, para. 27.

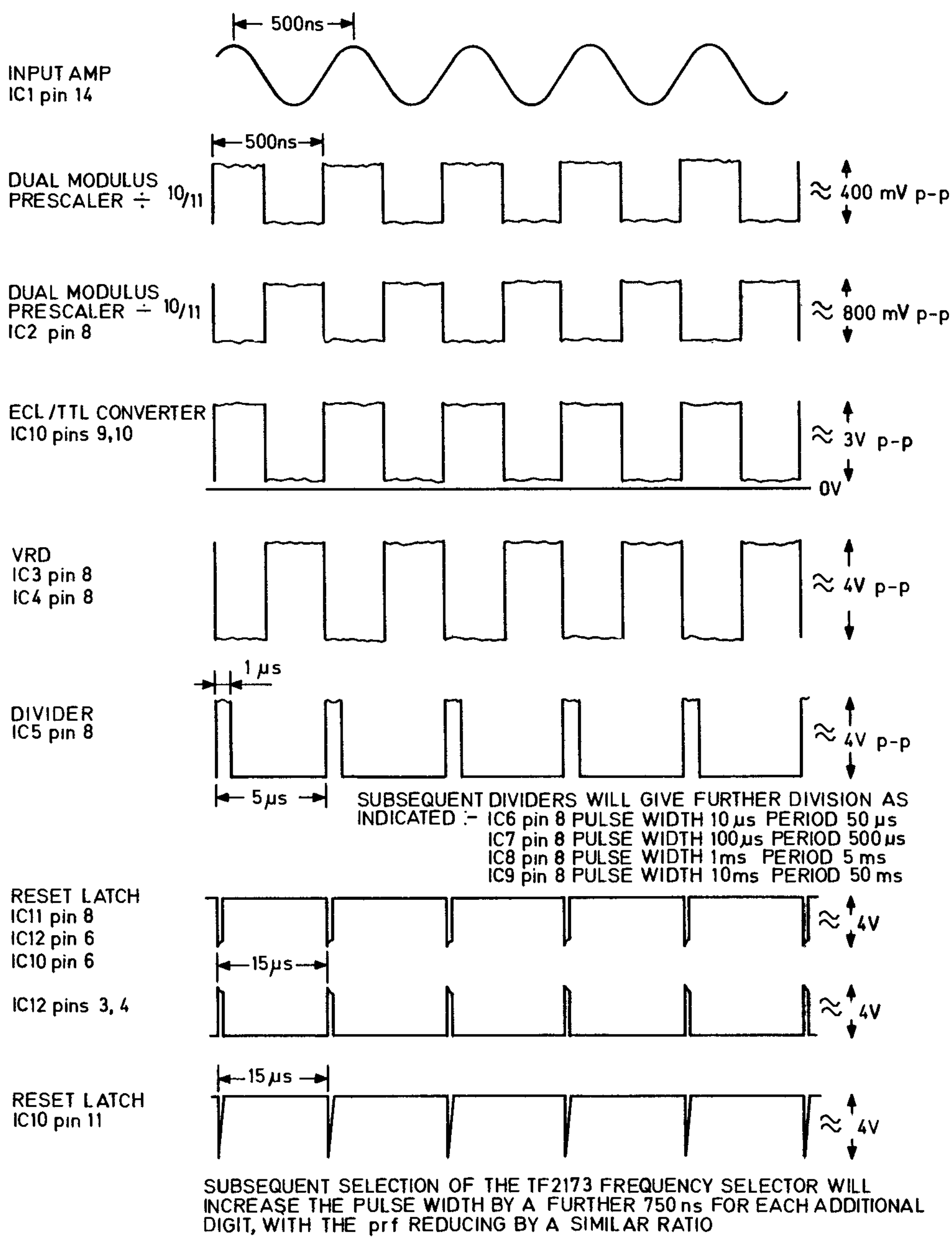


Fig. 1 VRD waveforms

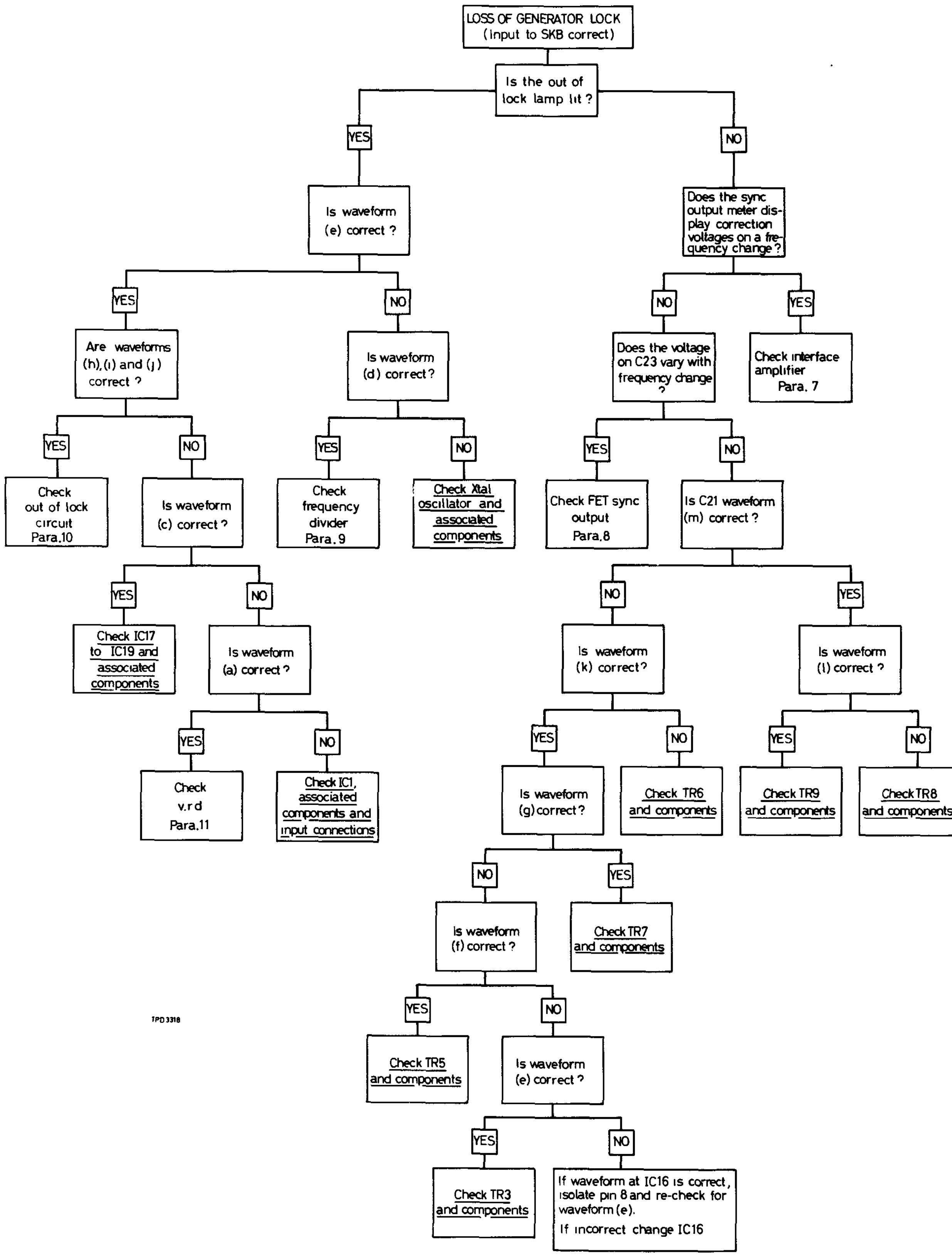


Fig. 2 Fault finding chart

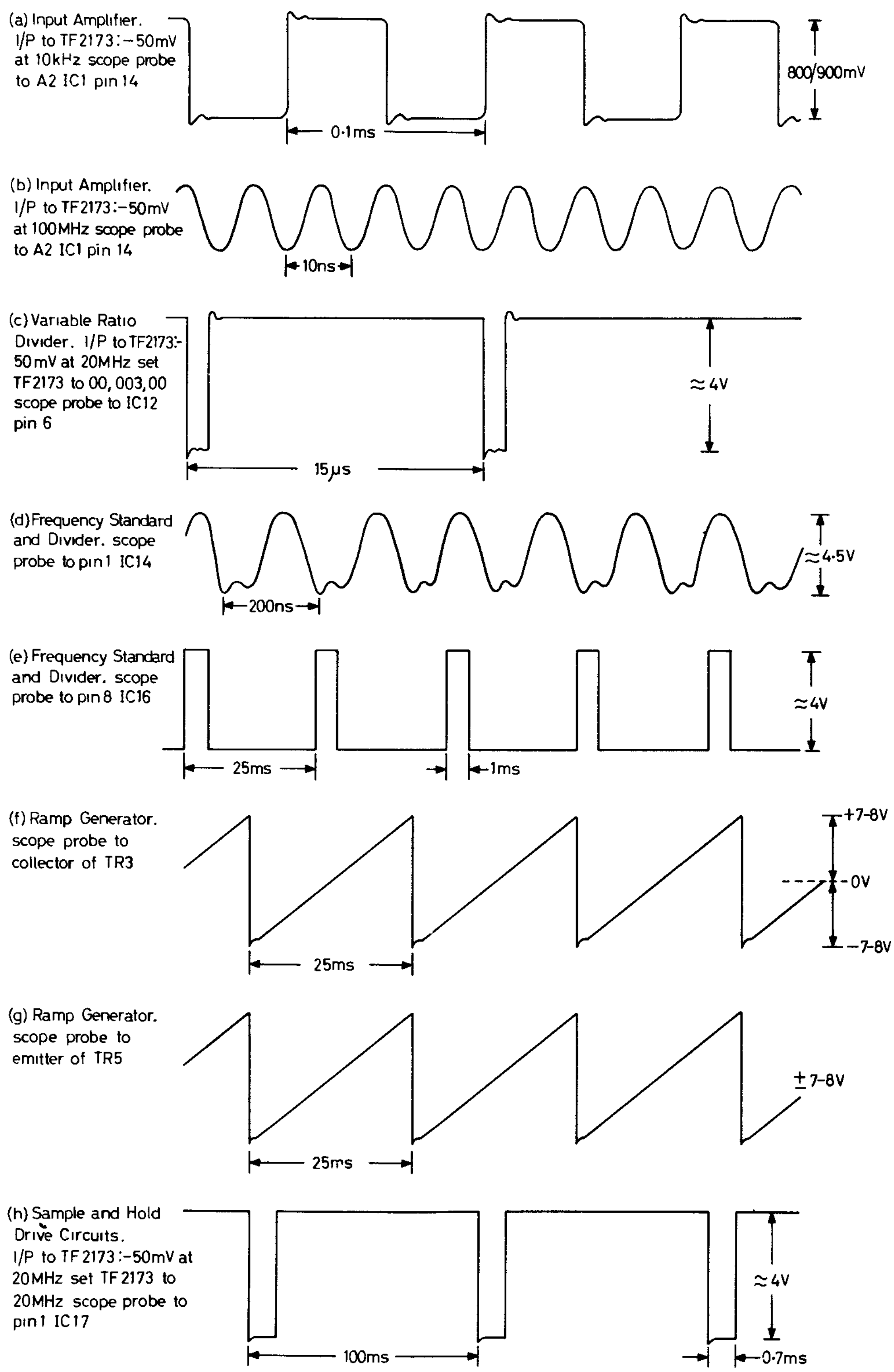


Fig. 3 Typical waveforms

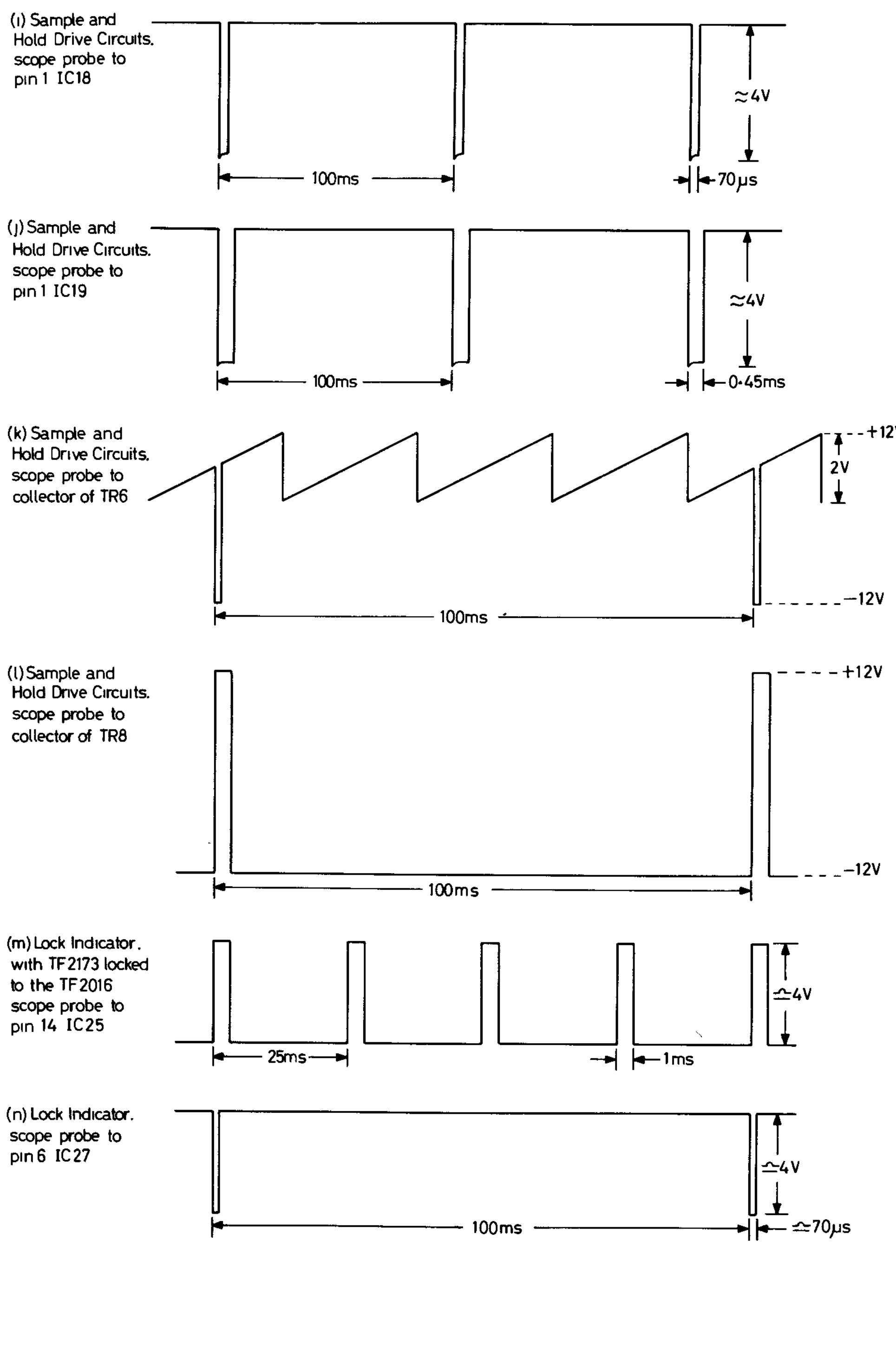

(i) Sample and Hold Drive Circuits. scope probe to pin 1 IC18
≈4V
100ms
70µs
(j) Sample and Hold Drive Circuits. scope probe to pin 1 IC19
≈4V
100ms
0·45ms
(k) Sample and Hold Drive Circuits. scope probe to collector of TR6
+12V
2V
−12V
100ms
(l) Sample and Hold Drive Circuits. scope probe to collector of TR8
+12V
−12V
100ms
(m) Lock Indicator. with TF2173 locked to the TF2016 scope probe to pin 14 IC25
≏4V
25ms
1ms
(n) Lock Indicator. scope probe to pin 6 IC27
≏4V
100ms
≏70µs
TPD3328

Fig. 3 (contd.)

Chapter 7

CIRCUIT DIAGRAMS

CONTENTS

CIRCUIT NOTES

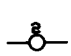
Component values

1. Resistors : no suffix = ohms, k = kilohms, M = megohms.
Capacitors : no suffix = microfarads, p = picofarads.
Inductors : no suffix = henrys, m = millihenrys, μ = microhenrys.
† SIC : value selected during test, nominal value shown.

Symbols

2. Symbols are based on the provisions of BS 3939.

SUPPLY etc. external front or rear panel marking

 tag on printed board

(A2) unit identification number

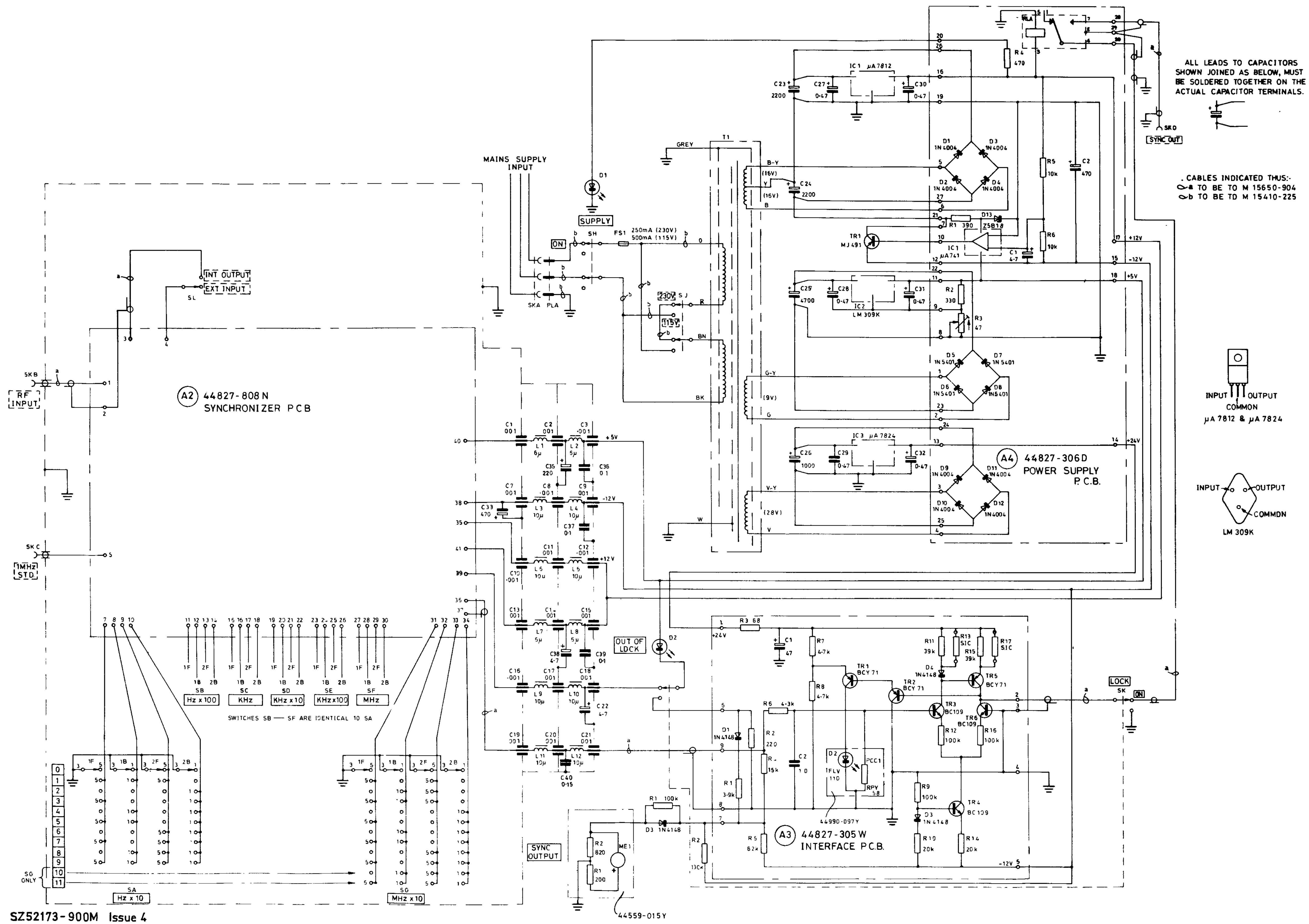
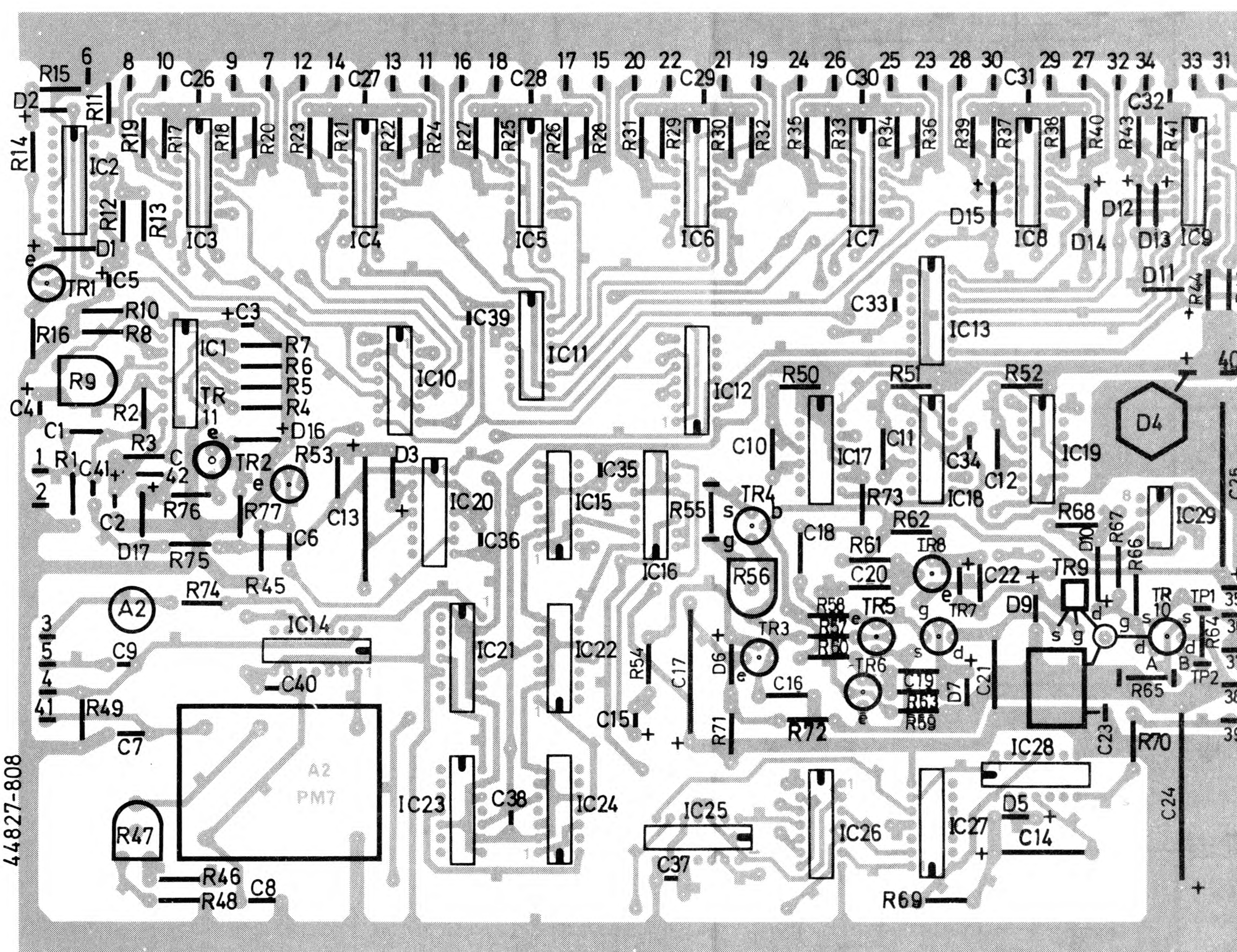
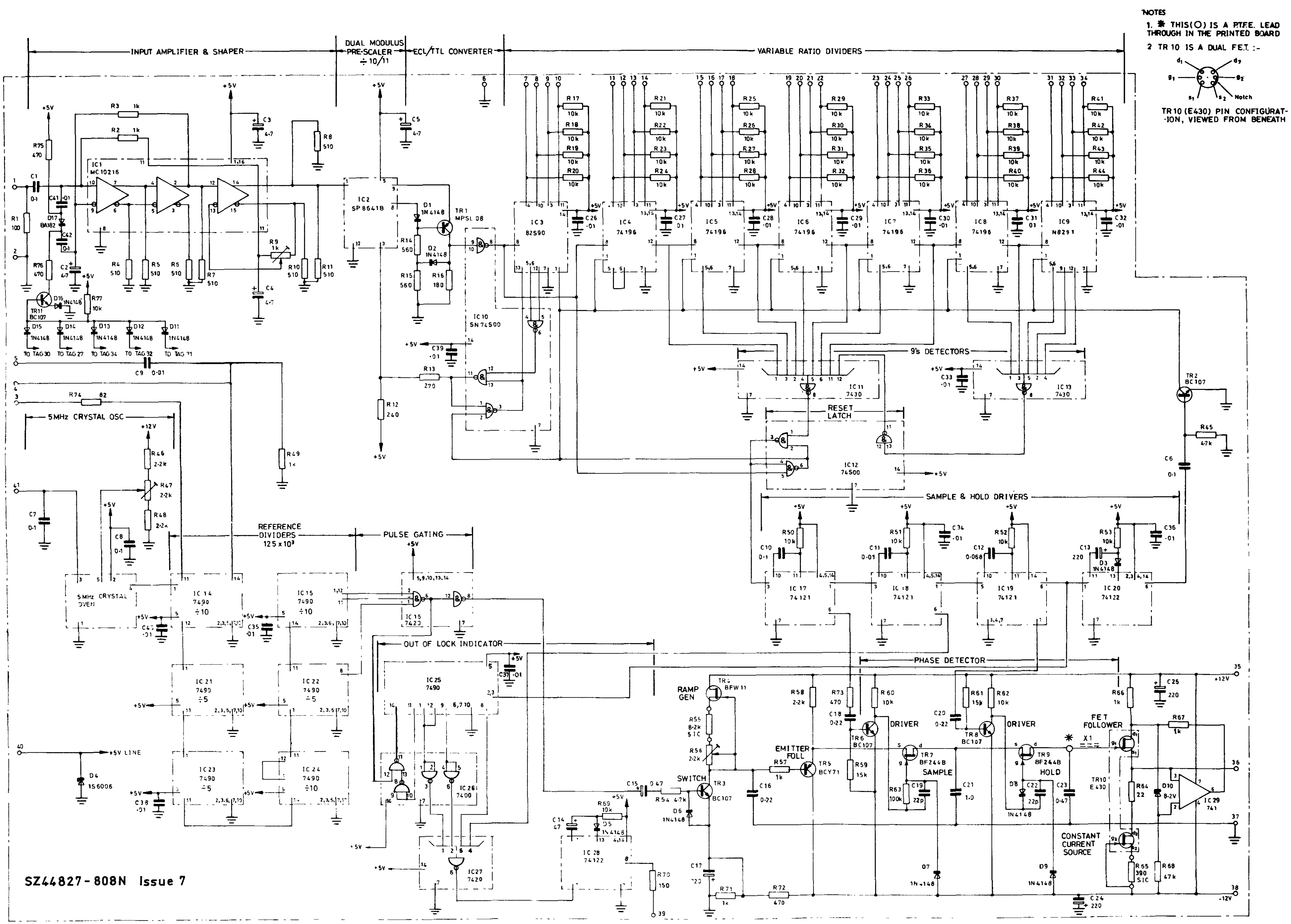


Fig. 1 Main chassis: A0, with A3 and A4 Fig. 1



Viewed from wiring side

Fig. 2　　Component layout : A2　　Fig.2



Synchronizer board: A2

SIGNAL GENERATOR

AM/FM 10 kHz-120 MHz

(MARCONI INSTRUMENTS TF 2016 & 2016A)

AND

DIGITAL SYNCHRONIZER

(MARCONI INSTRUMENTS TF 2173)

GENERAL ORDERS AND MODIFICATIONS

July 81 (Amdt. 2)

CONTENTS

Notes...

(1) Sections not divided into sub-sections each contain a section modification list followed by the modification leaflets appropriate to that section.

(2) A section divided into sub-sections contains a sub-section modification list for each sub-section, which is followed by the modification leaflets appropriate to the sub-section.

(3) Plain marker cards to separate the sections should be obtained by local demand.

PREFACE

1. The divisions of this publication are:

1.1 General orders. These leaflets are identified by the letters 'GO'.

1.2 Equipment modification list. This list shows all MOD-approved modifications affecting the subject of this Topic 2, including those for which leaflets will not be issued. The list will be reissued periodically.

1.3 Section/sub-section modification lists. Each list shows all MOD-approved modifications affecting the subject of a section/sub-section, including those for which leaflets will not be issued. The lists will be reissued periodically.

1.4 Modification leaflets. Letters preceding the leaflet numbers correspond with the section or sub-section letters. Leaflets should be filed in alpha-numerical order within each section or sub-section.

Note...

As leaflets are received, suitable entries should be made in the applicable columns of the equipment and section/sub-section modification lists.

2. When a complete leaflet or individual leaf is reissued in amended form the alterations are indicated by triangles thus ▶ ----- ◀ to show where text has been changed.

SIGNAL GENERATOR

AM/FM 10 kHz-120 MHz

(MARCONI INSTRUMENTS TF 2016 & 2016A)

AND

DIGITAL SYNCHRONIZER

(MARCONI INSTRUMENTS TF 2173)

SCALE OF SERVICING SPARES

PART 1

LIST OF SERVICING SPARES

AM/FM SIGNAL GENERATOR TF2016A

6625-99-654-0885

NOTES TO USERS

1. This Test Equipment has been spares ranged in accordance with the current servicing policy.

2. Any aspect of the list considered unsatisfactory should be reported in accordance with AP 100B-01 order 0504, to MOD(AFD),ADSM 25(RAF) via Command Headquarters.

Man Code NATO Stock No	Item Name and Description	Makers Part No /DRG No	No Off	Circuit Ref Remarks
210H/5935-12-153-2721	CONNECTOR,RECEPTACLE ELECTRICAL moulded phenolic housing,2 pin non-reversible w/o switch,panel mtd, black	MARCONI 23435-252Y	2	SKE If probe supply
510H/5935-14-342-9843	CONNECTOR,RECEPTACLE ELECTRICAL	MARCONI 23444-741Z Radial Microwave Comp R143323	2	SKF "Counter out"
10H/5920-99-110-3952	FUSE,LINK CARTRIDGE cartridge; glass; 1A, 250V; 5.20mm dia, 20.00mm lg	K E BESWICK TYPE TDA13/1A	1	FS2
10H/5920-99-112-6181	FUSEHOLDER singleway, 250V ac, 5A	MARCONI 23416-191C	2	FS 1 and FS 2
10W/5905-99-117-2463	RESISTOR,FIXED WIRE WOUND vitreous enamelled; 470 ohms, ±5% 5w	MARCONI 25123-067B Welwyn Electrical Ltd. Type W21	1	If Probe Supply R32

Man Code NATO Stock No	Item Name and Description	Makers Part No /DRG No	No Off	Circuit Ref Remarks
10F/5930-99-625- 7131	SWITCH,TOGGLE DPDT, ON/OFF maintained 5A max, 115Vac; 5A max, 28V dc c/w rubber insulation boot	MARCONI 23462-258L	2	MOD. ON/OFF SWITCH "SK" Main Supply ON/OFF Switch "SE"
10H/5935-99-635- 6352	SOCKET,ELECTRICAL fixed, brass, single through hole mtg; 1 pole, coaxial 50 ohm; male shell, bayonet locking	MARCONI 23443-443K	3	Coaxial Socket BNC 50 ohm SKB, SKC and SKD
10AP/5935-99-635- 9276	COVER,ELECTRICAL PLUG-SOCKET metallic; 0.580 in (14.80mm) lg, 0.630 in (16.00mm) dia; pressure mtg	GREENPAR ENG GE30801/GP	1	Cover for Socket SKF "Counter out"
10AK/5355-99-638- 0413	KNOB plastics, setscrew type; 1/4 in bore, 1 in lg 11/16in w; 23/32in thk; w/skirt	MARCONI B41145-407B	3	Front Panel Controls "Carrier Range", Function RF Output Coarse
10H/5935-99-645- 7868	PLUG ELECTRICAL fixed; steel or brass; flange mtd; 3 pole; 6A 250Vac; male shell	MARCONI 23423-158T	1	Mains Input "PLA"
10HA/5995-99-529- 0257	CABLE ASSEMBLY POWER,ELECTRICAL 3 conductors, 2500 00mm lg.	MARCONI C43129-071D	1	Mains Input
10AK/5355-99-649- 8507	KNOB plastics; setscrews round with flutes; round, integrally moulded, 11/16in. o/d, 9/16in w o/a, black	MARCONI H1141-708K ISSUE 1	1	Front Panel Control "Fine Tune"

List of Servicing Spares

AM/FM SIGNAL GENERATOR TF 2016

10S-6625-99-645-9230

NOTES TO USERS

1. This Test Equipment has been spares ranged in accordance with the current servicing policy.

2. Any aspect of the list considered unsatisfactory should be reported in accordance with AP 100B-01 order 0504, to MOD(AFD), ADSM 25(RAF) via Command Headquarters.

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
210H/5935-12-153-2721	CONNECTOR,RECEPTACLE ELECTRICAL moulded phenolic housing, 2 pin non-reversible w/o switch, panel mtd, black	MARCONI 23435-252Y	2	SKE IF probe supply
510H/5935-14-342-9843	CONNECTOR,RECEPTACLE ELECTRICAL	MARCONI 23444-741Z Radial Microwave Comp R143323	2	SKF "Counter out"
10H/5920-99-110-3952	FUSE,LINK CARTRIDGE cartridge; glass; 1A, 250V; 5.20mm dia, 20.00mm lg	K.E. BESWICK TYPE TDA13/1A	1	FS2
10H/5920-99-112-6181	FUSEHOLDER single-way, 250V ac, 5A	MARCONI 23416-191C	2	FS1 and FS2
10W/5905-99-117-2463	RESISTOR, FIXED WIRE WOUND vitreous enamelled; 470 ohms, ±5% 5W	MARCONI 25123-067B Welwyn Electrical Ltd Type W21	1	IF Probe Supply R32
10F/5930-99-625-7131	SWITCH, TOGGLE DPDT, on/on momentary 5A max, 115V ac; 5A max, 28V dc	MARCONI 23462-258L	1	Mains Supply On/Off Switch "SE"

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
10H/5935-99-635-6352	SOCKET, ELECTRICAL fixed brass, single through hole mtg; 1 pole, coaxial 50 ohm; male shell, bayonet locking	MARCONI 23443-443K	3	Coaxial Socket BNC 50 ohm SKB, SKC and SKD
10AP/5935-99-635-9276	COVER, ELECTRICAL PLUG-SOCKET metallic; 0.580 in (14.80mm) lg, 0.630 in (16.00mm) dia; pressure mtg	GREENPAR ENG GE30801/GP	1	Cover for Socket SKF "Counter out"
10AK/5355-99-638-0413	KNOB plastics, setscrew type; 1/4 in bore, 1 in lg 11/16 in w; 23/32 in thk; w/skirt	MARCONI B41145-407B	3	Front Panel Controls "Carrier Range", Function RF Output Coarse
10H/5935-99-645-7868	PLUG ELECTRICAL fixed; steel or brass; flange mtd; 3 pole; 6A 250V ac; male shell	MARCONI 23423-158T		Mains Input "PLA"
10HA/5995-99-529-0257	CABLE ASSEMBLY POWER, ELECTRICAL 3 conductors, 2500.00mm lg.	MARCONI C43129-071D	1	Mains Input
10AK/5355-99-649-8507	KNOB plastics; setscrews round with flutes; round, integrally moulded, 11/16 in. o/d, 9/16 in w o/a, black	MARCONI H41141-708K ISSUE 1	1	Front Panel Control "Fine Tune"
10AK/5355-99-649-8508	KNOB plastics; setscrew round; w/flutes; round; integrally moulded; 11.81mm o/d, 10.72mm o/a w; black	MARCONI 41149-002M	2	Front Panel Control "AM Depth" "Deviation"
10AK/5355-99-649-8509	KNOB plastics; setscrew; round with quad fin lever; round, integrally moulded; 19.05mm o/a thk, 31.75mm o/a w, black	MARCONI B41149-014U	1	Front Panel Control "Tune"

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
10AK/5355-99-649-8510	KNOB plastics; setscrew round, w/flutes; round, integrally moulded, 19.00mm o/d, 10.72mm o/a w, maroon	MARCONI B41149-016N	1	Front Panel Control "Extra Fine Tune"
10AR/5340-99-650-8486	HANDLE END CAP steel, nickel plated chrome 1.300 in lg 0.940 in w	MARCONI 22315-573L	2	P/O Side Carrying Handle
10AK/5340-99-650-8487	HANDLE SECTION steel, plastics covered, 8 in lg 0.880 in w.	MARCONI 22315-575F	1	P/O Side Carrying Handle
10AK/5340-99-650-8488	HANDLE LINER steel, cadmium plated, 1.250 in. lg, 0.850 in w	MARCONI 22315-572N		P/O Side Carrying Handle
10AK/6625-99-651-0646	HANDLE ATTACHMENT polyacetol hostafoam 125.0mm lg, 19.3mm w, o/a dim.	MARCONI D37588-110B	1	P/O Front Carrying Handle
10AK/5340-99-652-1103	HANDLE, BAIL cres, polyacetol hostafoam grip, 117.60mm inside lg of bail, 58.00mm clearance, 3.98mm dia of material 87.60mm o/a lg, moulded grip	MARCONI C37587-925L ISSUE 5	1	P/O Front Carrying Handle
10AK/5355-99-652-1104	KNOB plastics; round, w/o skirt, 0.490 in dia, 0.620 in h, setscrew; maroon	B41149-015Y ISSUE 1	1	Front Panel Control "Set Mod"
10AK/5355-99-652-1105	KNOB plastics; round; w/skirt; setscrew; 0.687 in dia knob, 1.500 in dia skirt 0.562 o/a h black	B41149-026W ISSUE 3	1	Front Panel Control "RF Output Fine"

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
10AK/5355-99-652-1106	KNOB plastics; round; w/skirt; 0.487 in. dia knob, 1.00 in. dia skirt, 0.658 in. o/a h; black	B41149-027D ISSUE 1	1	Front Panel Control "Mod Freq"
10AG/5310-99-652-1107	WASHER, FLAT al. alloy, 22.20mm o/d, 4.50mm i/d, 0.91mm thk cromate conversion coating	MARCONI B33900-438J ISSUE 1	1	P/O Rubber Foot Fitting
10G/6625-99-652-1804	FOOT RUBBER natural rubber, 60 deg shore hardness, 7/8 in dia.	TOWNSEND RUBBER PRODUCTS TRP 25	4	
10AR/5340-99-652-1805	CLIP rislon nylon; grey 19.50mm w, 24.50mm h 18.00mm thk; 5.00mm dia hole central to base, material bent 3.80mm rad to give 8.30mm hook.	MARCONI C37553-506Y		Top Cover Rear
10AR/5999-99-652-1806	PLATE, MOUNTING ELECTRICAL EQUIPMENT 1.58mm thk mild steel; 127.00mm lg 15.36mm w; 2 slots from ends of c/l 23.02mm lg, 4.20mm w; 2 holes 30.12mm from ends of c/l 4.60mm dia.	MARCONI 34167-605B	2	P/O Front Carrying Handle
10AR/5310-99-654-6594	NUT, SPECIAL steel, ressagon, 15.27mm A/F; 4.50mm thk o/a, tapped M4 right through; cad-mium plated and passivated	MARCONI 33900-120K	2	P/O Side Carrying Handle
10F/5930-99-652-1808	SWITCH, TOGGLE 4 pole, dt, 2A 250V ac, on-off-on	MARCONI 23462-267W	1	Front Panel Control "Carrier"
10H/5920-99-956-1252	FUSE LINK CARTRIDGE cartridge; glass; 250mA, 250V; 20.00mm lg	K.E. BESWICK TDA 123/250 MA	1	Mains Fuse "FS1"

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
10AR/5340-99-652-6573	STRIP, HANDLE ASSEMBLY mild steel; pcp. finish; 9.843 in lg 0.472in w, 0.104 in thk; 4 x 4.60mm dia holes csk 8.40mm x 90deg	MARCONI C34900-193E Issue 1	1	P/O Front Carrying Handle
10AD/6625-99-652-6574	ATTENUATOR, FIXED Elcom type AT-50-20dB, sleeve marked 44429-018B	MARCONI B44429-018B Issue 1		Supplied Accessory BNC to BNC 50 ohm

Man Code NATO Stock No	Item Name and Description	Makers Part No /DRG No	No Off	Circuit Ref Remarks
10AK/5355-99-649-8508	KNOB plastics; setscrew round; w/flutes; round; integrally moulded; 11.81mm o/d, 10.72mm o/a w; black	MARCONI 41149-002M	2	Front Panel Control "AM Depth" "Deviation"
10AK/5355-99-649-8509	KNOB plastics; setscrew; round with quad fin lever; round, integrally moulded; 19.05mm o/a thk, 31.75mm o/a w, black	MARCONI B41149-014U	1	Front Panel Control "Tune"
10AK/5355-99-649-8510	KNOB plastics; setscrew round, w/flutes; round, integrally moulded, 19.00mm o/d, 10.72mm o/a w, maroon	MARCONI B41149-016N	1	Front Panel Control "Extra Fine Tune"
10AR/5340-99-650-8486	HANDLE END CAP steel, nickel plated chrome 1.300in lg 0.940in w	MARCONI 22315-573L	2	P/O Side Carrying Handle
10AK/5340-99-650-8487	HANDLE SECTION steel, plastics covered, 8in lg 0.880in w	MARCONI 22315-575F	1	P/O Side Carrying Handle
10AK/5340-99-650-8488	HANDLE LINER steel, cadmium plated, 1.250in. lg, 0.850in w	MARCONI 22315-572N	1	P/O Side Carrying Handle
10AK/6625-99-651-0646	HANDLE ATTACHMENT polyacetol hostafoam, 125.0mm lg, 19.3mm w, o/a dim.	MARCONI D37588-110B	1	P/O Front Carrying Handle

Man Code NATO Stock No	Item Name and Description	Makers Part No /DRG No	No Off	Circuit Ref Remarks
10AK/5340-99-652-1103	HANDLE, BAIL cres, polyacetol hostafoam grip, 117.60mm inside lg of bail, 58.00mm clearance, 3.98mm dia of material 87.60mm o/a lg, moulded grip.	MARCONI C37587-925L ISSUE 5	1	P/O Front Carrying Handle
10AK/5355-99-652-1104	KNOB plastics; round, w/o skirt, 0.490 in dia, 0.620in h, setscrew; maroon	B41149-015Y ISSUE 1	1	Front Panel Control "Set Mod"
10AK/5355-99-652-1105	KNOB plastics; round; w/skirt; setscrew; 0.687in dia knob, 1.500in dia skirt 0.562 o/a h black	B41149-026W ISSUE 3	1	Front Panel Control "RF Output Fine"
10AK/5355-99-652-1106	KNOB plastics; round; w/skirt; 0.487in. dia knob, 1.00in. dia skirt, 0.658in. o/a h; black	B41149-027D ISSUE 1	1	Front Panel Control "Mod Freq"
10AC/5310-99-652-1107	WASHER,FLAT al. alloy, 22.20mm o/d, 4.50mm i/d, 0.91mm thk chromate conversion coating	MARCONI B33900-438J ISSUE 1	1	P/O Rubber Foot Fitting
10G/6625-99-652-1804	FOOT RUBBER natural rubber, 60 deg shore hardness, 7/8in dia.	TOWNSEND RUBBER PRODUCTS TRP 25	4	
10AR/5340-99-652-1805	CLIP rislon nylon; grey 19.50mm w, 24.50mm h, 18.00mm thk; 5.00mm dia hole central to base, material bent 3.80mm rad to give 8.30mm hook	MARCONI C37553-506Y	2	Top Cover Rear

Man Code NATO Stock No	Item Name and Description	Makers Part No /DRG No	No Off	Circuit Ref Remarks
10AR/5999-99-652-1806	PLATE,MOUNTING ELECTRICAL EQUIPMENT 1.58mm thk mild steel; 127.00mm lg 15.36mm w; 2 slots from ends of c/l 23.02mm lg, 4.20mm w; 2 holes 30.12mm from ends of c/l 4.60mm dia.	MARCONI 34167-605B	2	P/O Front Carrying Handle
10AR/5310-99-654-6594	NUT, SPECIAL steel, hexagon, 15.27mm A/F;4.50mm thk o/a, tapped M4 right through; cadmium plated and passivated.	MARCONI 33900-120K	2	P/O Side Carrying Handle
10F/5930-99-652-1808	SWITCH, TOGGLE 4 pole, dt, 2A 250V ac, on-off-on	MARCONI 23462-267W	1	Front Panel Control "Carrier"
10H/5920-99-956-1252	FUSE LINK CARTRIDGE cartridge; glass; 250mA, 250V; 20.00mm lg	K E BESWICK TDA 123/250 MA	1	Mains Fuse "FS 1"
10AR/5340-99-652-6573	STRIP, HANDLE ASSEMBLY mild steel; pcp. finish; 9.843in lg 0.472in w, 0.104in thk; 4 by 4.60mm dia holes csk 8.40mm x 90 deg	MARCONI C34900-193E Issue 1	1	P/O Front Carrying Handle

List of Servicing Spares

DIGITAL SYNCHRONIZER TF 2173

10S-6625-99-645-9552

NOTES TO USERS

1. This Test Equipment has been spares ranged in accordance with the current servicing policy.

2. Any aspect of the list considered unsatisfactory should be reported in accordance with AP 100B-01 order 0504, to MOD(AFD), ADSM 25(RAF) via Command Headquarters.

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
510H/5935-14-342-9843	CONNECTOR, RECEPTACLE, ELECTRICAL	MARCONI 23444-741Z Radial Microwave Comp R143323	1	Socket SKB TNC 50 ohms
10H/5920-99-112-6181	FUSEHOLDER singleway, 250Vac, 5A	MARCONI 23416-191C	1	FS 1
10AK/5355-99-112-9474	KNOB plastics, through hole type, rd, fluted, 21/32 in.1g 37/64 in. dia, 15/32 in. thk, w/o skirt	RADIATRON 70-14-1/4 GREY	7	Decade Switch Controls
10AR/5340-99-112-9477	PLUG, PROTECTIVE, DUST AND MOISTURE SEAL plastics, friction type, 8.50mm id, 11.00mm o/a dim.	RADIATRON 1450-14 GREY	7	Decade Switch Controls
10AP/5935-99-625-2739	COVER, ELECTRICAL PLUG-SOCKET metallic, 45/64 in. lg, 9/16 in. dia, friction mtg.	MARCONI	1	BNC SKT SKC/SKD Cap and Chain
10F/5930-99-625-7131	SWITCH, TOGGLE dpdt, on/on momentary, 5A max, 115Vac, 5A max, 28Vdc	MARCONI 23462-258L	2	Switch SK and SA "Lock on" "Mains"

PART 2

DIGITAL SYNCHRONIZER TF 2173

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
10D/5355-99-634-0276	DIAL SCALE plastics, 26.00mm dia, 70.00mm thk, marked 0-11 anti-clockwise	MARCONI 22318-335T Radiatron Twickenham 1452-14-1	7	Decade Switch Controls
10AR/5355-99-634-0367	STATOR plastics, 26.00mm dia, 1.40mm thk	RADIATRON 1453-14-1	7	Decade Switch Controls
10H/5935-99-635-6352	SOCKET, ELECTRICAL fixed, brass, single through hole mtg; 1 pole, coaxial 50 ohm; male shell, bayonet locking	MARCONI 23443-443K	2	SKT, SKC and SKD BNC 50 ohms
10AP/5920-99-645-5723	COVER, FUSE non-metallic, 30.47mm lg, 17.13mm w, 13.22mm thk	MARCONI 37575-121B	1	FS1
10HA/5995-99-649-6681	CABLE ASSEMBLY, RADIO FREQUENCY 250.00mm lg.	MARCONI B43129-063F	1	Flexible Screened coaxial cable 50 ohms BNC-BNC
10HA/5995-99-649-6682	CABLE ASSEMBLY, RADIO FREQUENCY A.D. Auriema UT-141-A, 215.00mm developed lg.	MARCONI C43129-064G	1	Semi-Rigid Co-axial Cable 50 ohm TNC-TNC
10HA/5995-99-529-0257	CABLE ASSEMBLY, POWER, ELECTRICAL 3 conductors, 2500.00mm lg.	MARCONI C43129-071D	1	AC Supply
10AR/5340-99-650-8486	HANDLE END CAP steel, nickel plated chrome, 1.300 in. lg, 0.940 in. w	MARCONI 22315-573L	2	Side Case Handle
10AK/5340-99-650-8487	HANDLE SECTION steel, plastics covered, 8 in. lg, 0.880 in. w.	MARCONI 22315-575F	1	Pt of Side Carrying Handle
10AK/5340-99-650-8488	HANDLE LINER steel, cadmium plated, 1.250 in. lg, 0.850 in. w.	MARCONI 22315-572N	2	Part of Side Carrying Handle

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
10AK/6625-99-651-0646	HANDLE ATTACHMENT polyacetol hostafoam, 125.0mm lg, 19.3mm w. o/a dim.	MARCONI D37588-110B	1	Front Carrying Handle
10AK/5340-99-652-1103	HANDLE, BAIL cres, polyacetol hostafoam grip, 117.60mm inside lg of bail, 58.00mm clearance, 3.98mm dia of material, 87.60mm o/a lg, moulded grip.	MARCONI C37587-925L ISSUE 5	1	Front Carrying Handle
10AG/5310-99-652-1107	WASHER, FLAT al. alloy, 22.20mm o/d, 4.50mm i/d, 0.91mm thk, cromate conversion coating	MARCONI B33900-438J ISSUE 1	1	Front Carrying Handle
10G/6625-99-652-1804	FOOT RUBBER natural rubber, 60 deg shore hardness, 7/8in. dia.	TOWNSEND RUBBER PRODUCTS TRP 25	4	
10AR/5340-99-652-1805	CLIP rislon nylon; grey 19.50mm w, 24.50mm h., 18.00mm thk; 5.00mm dia hole central to base, material bent 3.80mm rad. to give 8.30mm hook.	MARCONI C37553-506Y	2	Part of Cover Rear
10AR/5310-99-654-6594	NUT, SPECIAL steel, ressagon, 15.27mm A/F; 4.50mm thk o/a, tapped M4 right through; cadmium plated and passivated.	MARCONI 33900-120K	2	Part of Side Carrying Handle
10H/5920-99-956-1252	FUSE LINK, CARTRIDGE cartridge; glass; 250mA, 250V; 20.00mm lg.	K.E. BESWICK TDA 123/250 MA	2	Main Fuse FS1

Man Code NATO Stock No.	Item Name and Description	Makers Part No. /DRG No.	No. Off	Circuit Ref Remarks
10H/5935-99-645-7868	PLUG ELECTRICAL fixed; steel or brass; flange mtd; 3 pole; 6A 250V ac; male shell	MARCONI 23423-158T	1	Mains Input PLA