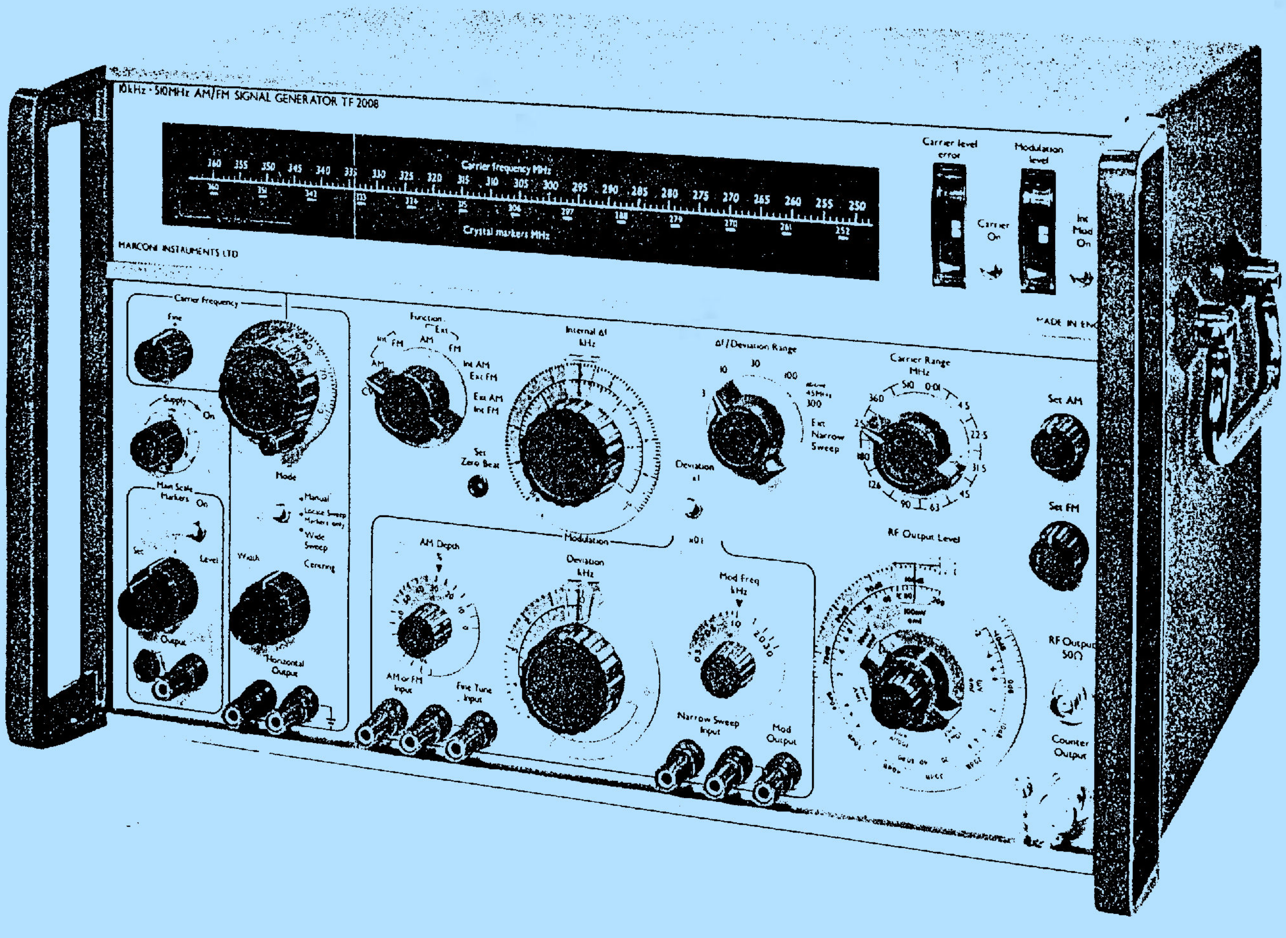
Marconi
Instruments



Instruction Manual
No. EB 2008
for

10 kHz-510 MHz AM/FM Signal Generator

TF 2008

Marconi
Instruments

AM/FM

SIGNAL GENERATOR

TF 2008

Instruction Manual
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10 kHz-510 MHz AM/FM Signal Generator

TF 2008

G.L. 3.5c
2/80/M

EB 2008
1j - 2/80

Contents

EQUIPMENT ... TF 2008

TITLE .... 10 kHz - 510 MHz AM/FM Signal Generator

CODE No...... 52008-015

SER Nos.
PREFIXED .... 114982 onwards

ACCOMPANYING
DOCUMENTS ... None

MANUAL CHANGE

As part of a policy of continuous development the following component changes have been carried out. Amend the manual as follows:-

Chap.6 REPLACEABLE PARTS

Page 75 Unit A3 Mixer, 31 - 45 MHz

Add C2† Cer 6.8pF ±0.5pF 200V MI code 26324-184

Page 76 Unit A5 Amplifier, 31 - 45 MHz

Change TR1 BSX20 MI code 28452-207
to read TR1 2N5179 MI code 28451-697.

Page 77 Unit A6 Crystal calibrator oscillator

Change TR4 BC108 MI code 28452-787
to read TR4 BC238 MI code 28452-781

Page 82 Unit A16 Amplifier, 22 - 31 MHz

Change C10 Plas 470pF 2% 125V MI code 26516-406
to read C10 Plas 220pF 2% 160V MI code 26516-327

Add C15 Plas 250pF 2% 160V MI code 26516-003

Page 83 Change TR1 BSX20 MI code 28452-207
to read TR1 2N5179 MI code 28451-697

Pages 83,87,88,89,90,91 Units A17,A21,A22,A23,A24,A25,A26,A27

Resistor R2 on all the above units has been changed from
Var Carb 4.7kΩ 20% 0.21W MI code 25541-226
to Var Carb 4.7kΩ 10% 0.5W MI code 25711-610

Page 93 Unit A31 Crystal calibrator amplifier and sweep driver

Change R3 Met ox 2.2kΩ 5% ½W MI code 24552-088
to read R3 Met ox 12kΩ 5% ½W MI code 24552-112

Page 96 Unit A36 Front panel assembly

Change R3,R5 MI code number from 25674-205 to 25674-210.

Change R6,R8 MI code number from 25674-209 to 25674-211.

Page 100 Unit A40 Buffer (VFO and VCO)

Change R9	Var Carb 4.7kΩ 20% 0.21W	MI code 25541-226
to read R9	Var Carb 4.7kΩ 10% 0.5W	MI code 25711-610

Page 101 Unit A42 Power supply regulator

Change R6†	Met ox 100kΩ 5% ½W	MI code 24552-135
to read R6†	Met ox 120kΩ 2% ½W	MI code 24573-123

Page 101/102 Unit A44 Coarse attenuator

Change the MI code number of R1 from 24636-360 to 24636-365,
R2 from 24636-358 to 24636-363,
R3 from 24636-625 to 24636-632,
R4,R6,R8,R10,R12,R14,R16,R18,R20,R22 from 24636-624 to 24636-634,
R5,R7,R9,R11,R13,R15,R17,R19,R21 from 24636-495 to 24636-491.

Change R23 from 24636-359 to 24636-364.

Unit Miscellaneous

Change the MI code number of the following switch knobs:-

Knob Sweep width control from 41141-304 to 41149-063.
Knob Sweep centring control from 41141-602 to 41141-503.
Knob Set markers control from 41141-304 to 41149-063.
Knob Marker level control from 41141-602 to 41141-503.

Chap. 7 CIRCUIT DIAGRAMS

Page 109, Fig. 7.2 - RF oscillators

R1, 47Ω shown coupled between C22 and C28 on the -16 V supply line is incorrectly positioned. This resistor should be coupled between C22 and pin 4 of board A39.

Page 113, Fig. 7.4 - Pre-processing, even ranges

Unit A3 may have an additional SIC capacitor C2 value 6.8p fitted. This should be shown dotted and connected from the junction D3 and D4 and the junction T16/pin 3.

Page 123, Fig. 7.9 - ALC

C14, connected between SKL and SKM on board A30 should now be deleted, this component is no longer fitted.

Page 125, Fig. 7.10 - Crystal markers

Unit A31, change the value of resistor R33 from 11k to 12k.

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND.

Chapter 6 REPLACEABLE PARTS

Chapter 7 CIRCUIT DIAGRAMS

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

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

Defects and abnormal stresses

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

Removal of covers

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

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

Mains plug

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

Fuses

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

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

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

CAUTION : STATIC SENSITIVE COMPONENTS

Components identified with the symbol ⚠ on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

(1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Mettalic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

RADIO FREQUENCY INTERFERENCE

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

Chapter 1

General information

1.1 INTRODUCTION

The TF 2008 is a wide range f.m./a.m. signal generator with the full 10 kHz to 510 MHz frequency range covered in eleven switch selected ranges and is particularly useful for checking wide and narrow deviation radio links and broadcasting systems. It uses solid state active circuit elements in order to utilize new mechanical and electrical arrangements. Particular attention has been paid to grouping controls together for ease of operation whilst the circuits are designed for complete independence of individual controls. Precise automatic level control circuits render the provision of a set carrier control unnecessary. A single master oscillator unit is used to cover the entire frequency band of the generator allowing particularly high stability. A unique feature is the use of a single dial, continuously variable output attenuator for levels from 0.2 μV up to 200 mV e.m.f.; an alternative version is available with the output expressed in terms of p.d. in 50 Ω, i.e. 0.1 μV up to 100 mV. In addition to being a high precision wide range signal generator, TF 2008 also operates as a versatile sweeper.

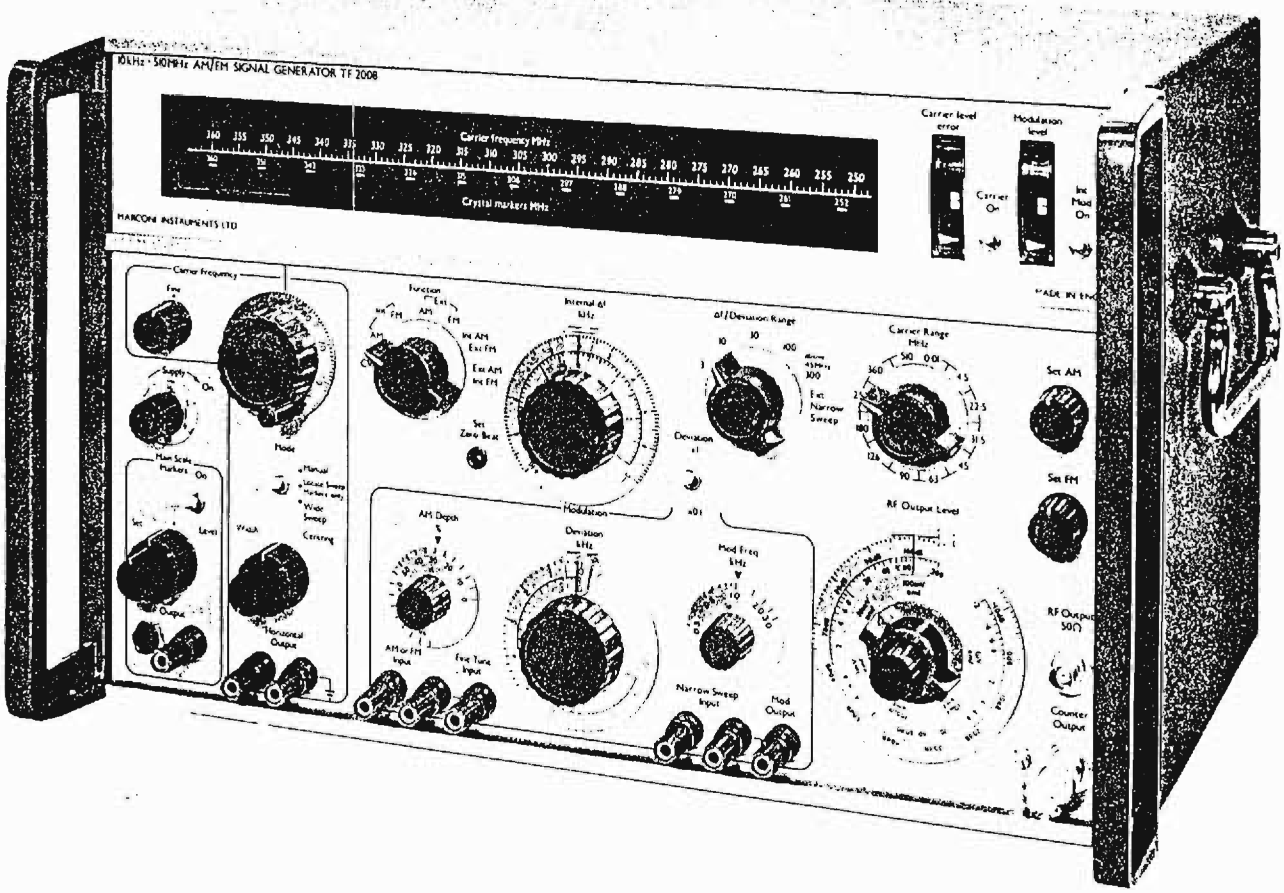


Fig. 1.1 TF 2008 10 kHz - 510 MHz A.M./F.M. Signal Generator

1.2 DATA SUMMARY

Characteristic	*Performance*	*Supplementary Information*

Frequency

Range:

10 kHz to 510 MHz in 11 bands:

1) 10 kHz to 4.5 MHz,
2) 22.5 MHz to 4.5 MHz,
3) 22.5 MHz to 31.5 MHz,
4) 45 MHz to 31.5 MHz,
5) 45 MHz to 63 MHz,
6) 90 MHz to 63 MHz,
7) 90 MHz to 126 MHz,
8) 180 MHz to 126 MHz,
9) 180 MHz to 252 MHz,
10) 360 MHz to 252 MHz,
11) 360 MHz to 510 MHz.

Mechanical tuning discrimination:

The frequency scales are linear and a 12-turn tuning control with 100 vernier divisions is provided.

Scale calibration:

Each band has a main scale calibrated as follows:

Frequency band	Scale divisions
1	50 kHz
2	100 kHz
3	100 kHz
4	100 kHz
5	200 kHz
6	200 kHz
7	500 kHz
8	500 kHz
9	1 MHz
10	1 MHz
11	1 MHz

Accuracy:

Better than ±0.5% on ranges 3 to 11.

The crystal calibrator can be used to increase the scale accuracy.

Stability:

At constant ambient temperature within the range 10 °C to 35 °C:
In the 15 minute period commencing 1 hour after switch-on, the frequency variation is typically 5 p.p.m. and will not exceed 15 p.p.m. on ranges 3-11.

Characteristic	Performance	Supplementary Information
	On range 1 the frequency variation is not greater than 350 Hz. On range 2 the frequency variation is not greater than 900 Hz. Following a 10 ^{o}C change in the ambient temperature within the range 10 ^{o}C to 35 ^{o}C occurring 3 hours after switch-on, the maximum frequency variation after $1\frac{1}{2}$ hours does not exceed 30 p.p.m. per 15 minutes on ranges 3-11. On ranges 1 and 2 the maximum frequency variation after $1\frac{1}{2}$ hours does not exceed 1.25 kHz per 15 minutes. After a supply voltage change of +10% or -10% on 230 V or 115 V the maximum frequency change is less than 1 p.p.m. +50 Hz.	
Microphony:	Less than 10 kHz deviation is caused by $\frac{1}{2}$ g acceleration in the range 10 Hz to 80 Hz.	Checked on a mechanical vibrator. The generator is checked to ensure freedom from audio feedback between the receiver speaker and the generator, under normal working conditions.
Load reaction:	With the coarse and fine attenuators set to give maximum output, the maximum frequency shift between the output open circuited and loaded with 50 Ω is 100 Hz up to 100 MHz and 200 Hz up to 510 MHz.	
Attenuator reaction:	With the output loaded with 50 Ω, the maximum frequency shift between the extremes of the attenuator settings is 100 Hz up to 100 MHz and 200 Hz up to 510 MHz.	
Internal Δf:	Each carrier frequency band is provided with 4 or 5 ranges of electrical fine tuning as follows: Bands 1-4: 3, 10, 30 and 100 kHz. Bands 5-11: 3, 10, 30, 100 and 300 kHz. The smallest division is 100 Hz.	
Accuracy:	±5% of f.s.d. ±0.5 kHz.	
External fine tuning:		An input voltage between -1.5 V and -15 V provides fine external frequency control.

Characteristic	Performance	Supplementary Information
Sweep Facility		
Internal		A front panel control enables sweep width to be varied up to the limits of each band; a second control allows positioning of the centre frequency for narrower sweeps.
Horizontal output:	8 V p-p minimum triangular wave (open circuit voltage).	
Markers:		The calibrator output provides up to 13 markers on each r. f. range which can be identified by the manual controlled oscillator.
Crystal Calibrator		0.01% in the ambient range $10^{\circ}C$ to $35^{\circ}C$
Fixed Sweep Rate:		Approx. 18 Hz.
External	A +ve or -ve voltage of 5 V d. c. or 10 V p-p from a d. c. coupled source of not more than 12 kΩ, can be used to sweep the generator as follows:	Drive frequency up to 30 Hz.

Carrier frequency	Max. Sweep Width
0.01 - 45 MHz	±150 kHz
45 - 90 MHz	±300 kHz
90 - 180 MHz	±600 kHz
180 - 360 MHz	±1200 kHz
360 - 510 MHz	±2400 kHz

The maximum frequency excursion should not extend beyond the limits of the range in use.

Characteristic	Performance	Supplementary Information
R.F. output		
R. F. output level	200 mV down to 0.2 μV e.m.f.	Alternative version calibrated 100 mV down to 0.1 μV p.d.
Attenuators		
Coarse:		11 steps of 10 dB.
Fine:		0 to 10 dB continuously variable.
A. L. C.		When terminated with 50 Ω the automatic level control maintains the level constant within the total level accuracy limits so that no manual adjustment is necessary.

Characteristic	*Performance*	*Supplementary Information*
Total level accuracy:	At 23 °C 100 kHz to 100 MHz: ±1 dB ±0.2 μV } above 2 μV e.m.f. 10 kHz to 510 MHz: ±2 dB ±0.2 μV } above 2 μV e.m.f.	An additional error of ±1 dB may occur at +10 °C and +35 °C.
Impedance:	Effectively 50 Ω	VSWR better than 1.3:1 with 20 dB or more set on the coarse attenuator. At maximum and 10 dB below maximum output better than 1.5:1.
Leakage:	Up to 510 MHz with a receiver sensitivity set at 1.0 μV p.d., a 1 inch 2 turn loop feeding the receiver cannot detect a signal of this level at a distance greater than 1 inch from the generator.	
Carrier distortion:	Harmonic distortion less than 5%. Non-harmonic frequencies less than 1% up to 180 MHz and less than 3% up to 510 MHz.	At maximum output.
Counter output :	Greater than 50 mV into 50 Ω, provided that r.f. output is loaded with 50 Ω.	Varies with the setting of the fine attenuator.

Modulation

Internal modulation oscillator

Range:	Continuously variable from 300 Hz. to 3 kHz.	
Dial accuracy:	10%.	
Output level:	Not less than 0.5 V e.m.f.	
Output impedance:		600 Ω nominal
Distortion:	Less than 0.15%.	

Characteristic	Performance	Supplementary Information
Amplitude modulation		Scale marked up to 95%.
Depth:	Continuously variable from 0 to 80%. 20 Hz to 15 kHz.	The carrier frequency should be at least 10 times the modulating frequency.
Monitor:		Peak reading.
Accuracy:	At 23 °C, ±6% Mod depth up to 40% modulation. ±15% of reading from 40% to 80% modulation.	An additional error of ±5% of reading may occur at +10 °C and +35 °C.
Envelope distortion:	Typically 3% up to 80% modulation, with external modulation the distortion may rise to 6% at higher modulating frequencies.	
Frequency modulation		
Deviation:	A calibrated scale and a scale multiplier provide 4 or 5 ranges of deviation as follows: Bands 1-4: 3, 10, 30 and 100 kHz. Bands 5-11: 3, 10, 30, 100 and 300 kHz.	On range 1 care must be taken that the instantaneous frequency never falls below 10 kHz.
Monitor:		A full-wave peak reading meter is used to set the full-scale deviation.
Accuracy:	±5% of f.s.d. at 1 kHz.	Int. Δf and f.m. facilities can be used simultaneously provided the total does not exceed the maximum shown for Int. Δf.
Distortion:	Using the internal oscillator for maximum deviation at modulating frequencies from 300 Hz to 3 kHz the total harmonic distortion does not exceed 1%.	
Modulation bandwidth:	30 Hz to 125 kHz. Suitable for f.m. stereo, channel separation better than 35 dB at 1 kHz and 15 kHz. Relative to 1 kHz, the accuracy (using the internal monitor) from 30 Hz to 53 kHz is better than ±0.3 dB and to 125 kHz is better than ±1 dB. Except on 3 and 10 kHz DEV Ranges when it is ±1.5 dB at signal frequencies above 126 MHz.	

Characteristic	Performance	Supplementary Information
External modulation		Terminals provide for external f.m., a.m., or fine tuning.
Range:	20 Hz to 15 kHz a.m., 30 Hz to 125 kHz f.m.	
Input level:		Approximately 0.5 V to set reference level.
Impedance:		600 Ω nominal.
Spurious signals		
A.M. on C.W.:	At least 60 dB down on 100% modulation in a 15 kHz bandwidth.	
F.M. on C.W.:	With telephone psophometric weighting, less than 10 Hz below 360 MHz, less than 20 Hz at higher carrier frequencies.	
A.M. on F.M.:	At full deviation typically less than 1% a.m. and not greater than 1.5% a.m. over internal modulating frequency range.	
F.M. on A.M.:	Less than 120 Hz up to 100 MHz, less than 600 Hz up to 360 MHz and less than 1.2 kHz up to 510 MHz at 30% depth at 1 kHz mod. frequency.	
Power requirements		
A.C. SUPPLY:		95 to 130 V (absolute limits) 190 to 264 V (absolute limits) 45 to 500 Hz.
Power consumption:		22 VA approx.
D.C. SUPPLY:		21 to 32 V (absolute limits) positive earth.
Current:		0.5 A approx.

Dimensions and weight	*Height*	*Width*	*Depth*	*Weight*
	285 mm ($11\frac{1}{4}$ in)	475 mm ($18\frac{1}{2}$ in)	315 mm ($12\frac{1}{2}$ in)	21 kg (46 lb)

1.3 ACCESSORIES

Accessories supplied

(1) Output lead, type TM 4969/3; BNC plug to BNC plug.

(2) Telephone jack plug. M.I. code 23421-612.

(3) Adapter, BNC to jack plug. M.I. code 43168-016.

(4) Mains lead. M.I. code 43129-071

Accessories available

(5) R.F. Fuse Unit, TM 9884.

(6) Matching Pad, type TM 5569; 50 Ω to 75 Ω,
BNC socket to Belling Lee plug.

(7) 20 dB Pad type TM 5573.

(8) Detector Probe, type TM 9650/1.

(9) Rack mounting kit. M.I. code 54127-021.

(10) Maintenance kit. M.I. code 54711-021

- (a) Extender lead, female to female.
- (b) Extender lead, female to female.
- (c) Extender lead, male to female.
- (d) Metric fasteners, 2 mm, 3 mm and 4 mm.
- (e) Strap - to support power chassis when hinged out.
- (f) Bracket - to support r.f. processing box when hinged out.
- (g) Hexagonal wrench 4 BA.
- (h) Trimming tool. M.I. code 22951-221.
- (i) Trimming tool. M.I. code 22951-225.

(11) Adapter, Conhex to BNC.

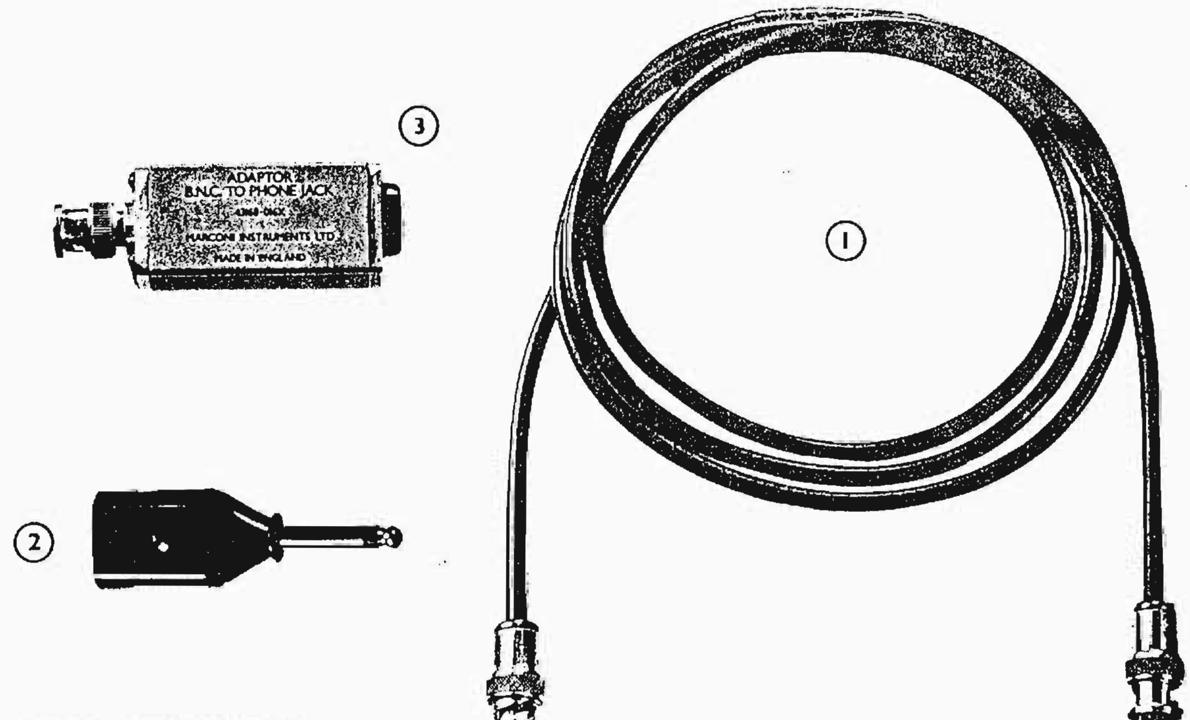


Fig. 1.2 Supplied accessories

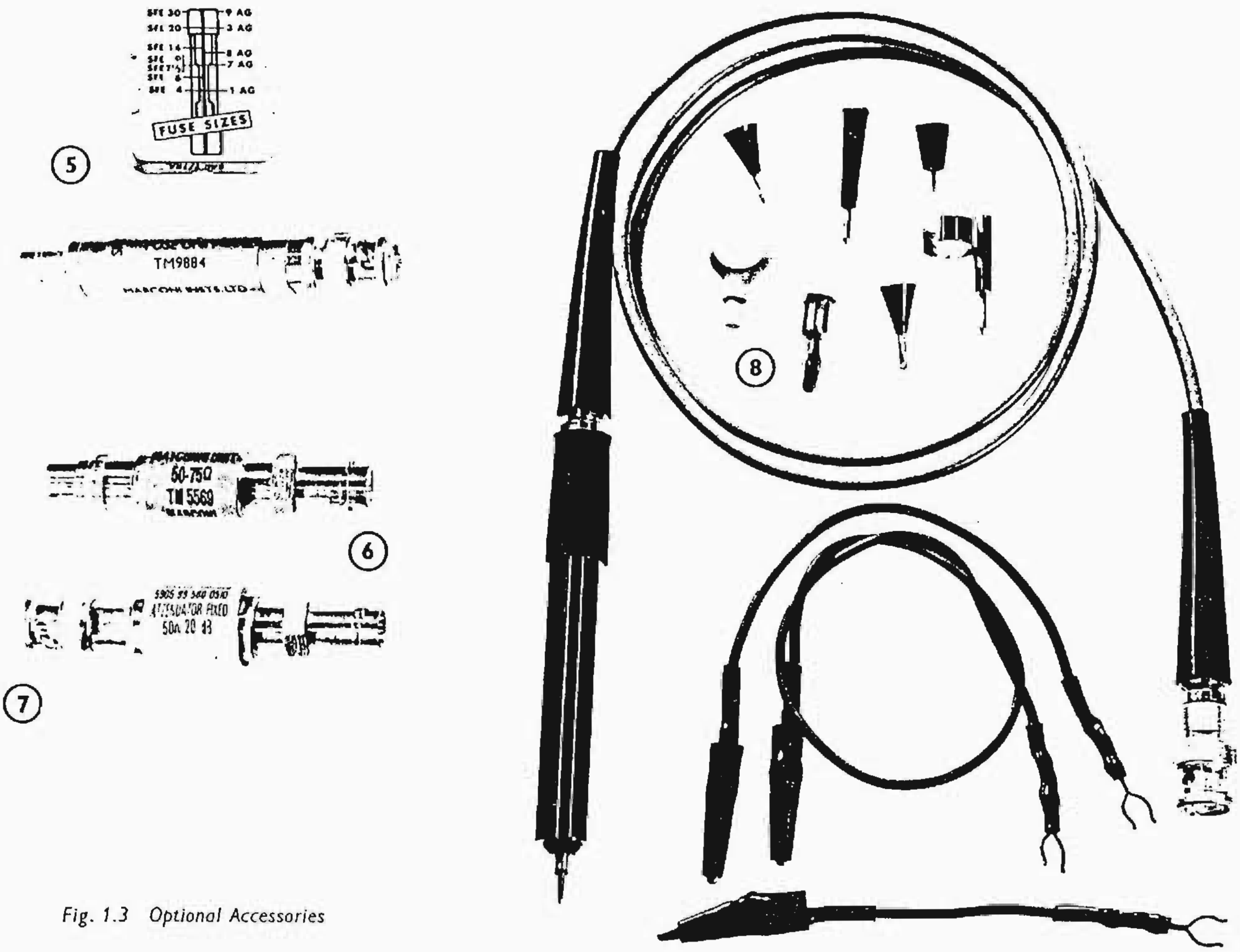


Fig. 1.3 Optional Accessories

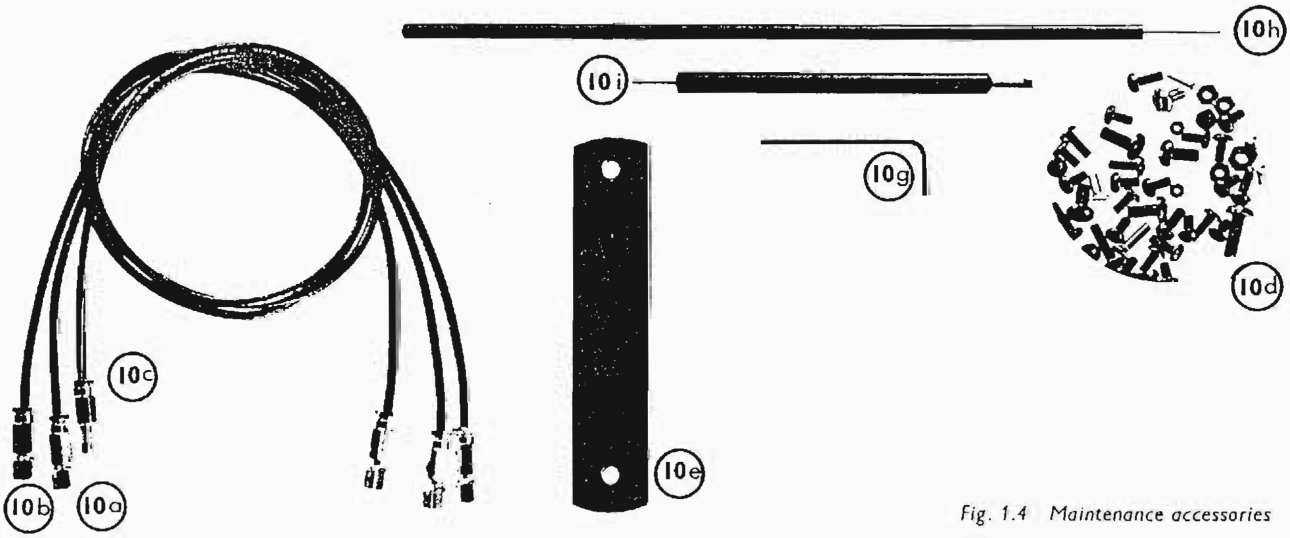


Fig. 1.4 Maintenance accessories

Chapter 2 Operation

2.1 PREPARATION FOR USE

Extensive use of silicon devices permits a wide range of ambient temperature, however, excessive temperatures may affect the instrument's performance. Therefore, completely remove the plastic cover, if one is supplied over the case, and avoid standing the instrument on or close to, other equipment that is hot.

A.C. power supply

Normally the instrument is supplied with the mains selector switch, located at the rear of the instrument, set for supply voltages within the range 190 to 264 V. For input voltages in the range 95 to 130 V the selector switch must be pressed to the left. Do this by removing the plate securing the switch button, pressing the switch to the correct position, reversing the plate and replacing it to hold the switch in the new position. The 160 mA mains fuses must be changed for 250 mA mains fuses for 110 V operation, see Sect. 5.1.

Attach a suitable 3 pin plug to the mains lead.

Note: the wires are colour coded as follows:

Earth (ground)	-	Green/Yellow
Neutral	-	Blue
Line (phase)	-	Brown

In addition the earth wire carries a yellow sleeve bearing a green earth symbol and the neutral wire has a sleeve marked N.

CAUTION The output of the generator should not be connected to an external circuit carrying d.c. unless a suitable series isolating capacitor is used.

The value of the capacitor should be large enough to present a low reactance compared to the external load at the operating frequency.

D.C. power supply

A d.c. supply of between 21 and 32 V, positive earthed, may be used. The current drain is approximately 0.5 A and the input terminals are located at the rear of the instrument.

Rack mounting

Before inserting TF 2008 into a rack that would be subjected to any violent movement or vibration, slides or runners must be fitted to the rack to give support to the rear of the instrument as the four retaining screws cannot be relied upon to bear its full weight. A rack mounting kit, M.I. code 54127-021 can be obtained from our Service Division.

2.2 CONTROLS—SUPPLY AND TUNING

Fig. 2. 1 Controls - supply and tuning

(1) SUPPLY switch. Turn clockwise to switch on.

(2) CARRIER switch. For temporary interruptions of carrier.

(3) CARRIER LEVEL ERROR meter. When the pointer is within the white block it indicates that the a.l.c. is operating correctly. It is also convenient as an indication that the instrument and carrier are switched on, except in the wide sweep mode, when there is no indication.

(4) CARRIER RANGE selector. Switches to any one of eleven frequency ranges as indicated by the upper and lower limits either side of the particular switch position.

(5) CARRIER FREQUENCY control. Adjusts main tuning frequency on main scale. The knob skirt carries a logging scale that enables the main tuning scale to be divided into 1200 divisions; it is calibrated by the figure in red on the CARRIER FREQUENCY scale.

(6) CARRIER FREQUENCY scale. The direction of reading the scale reverses between alternate ranges.

(7) FINE TUNING control.

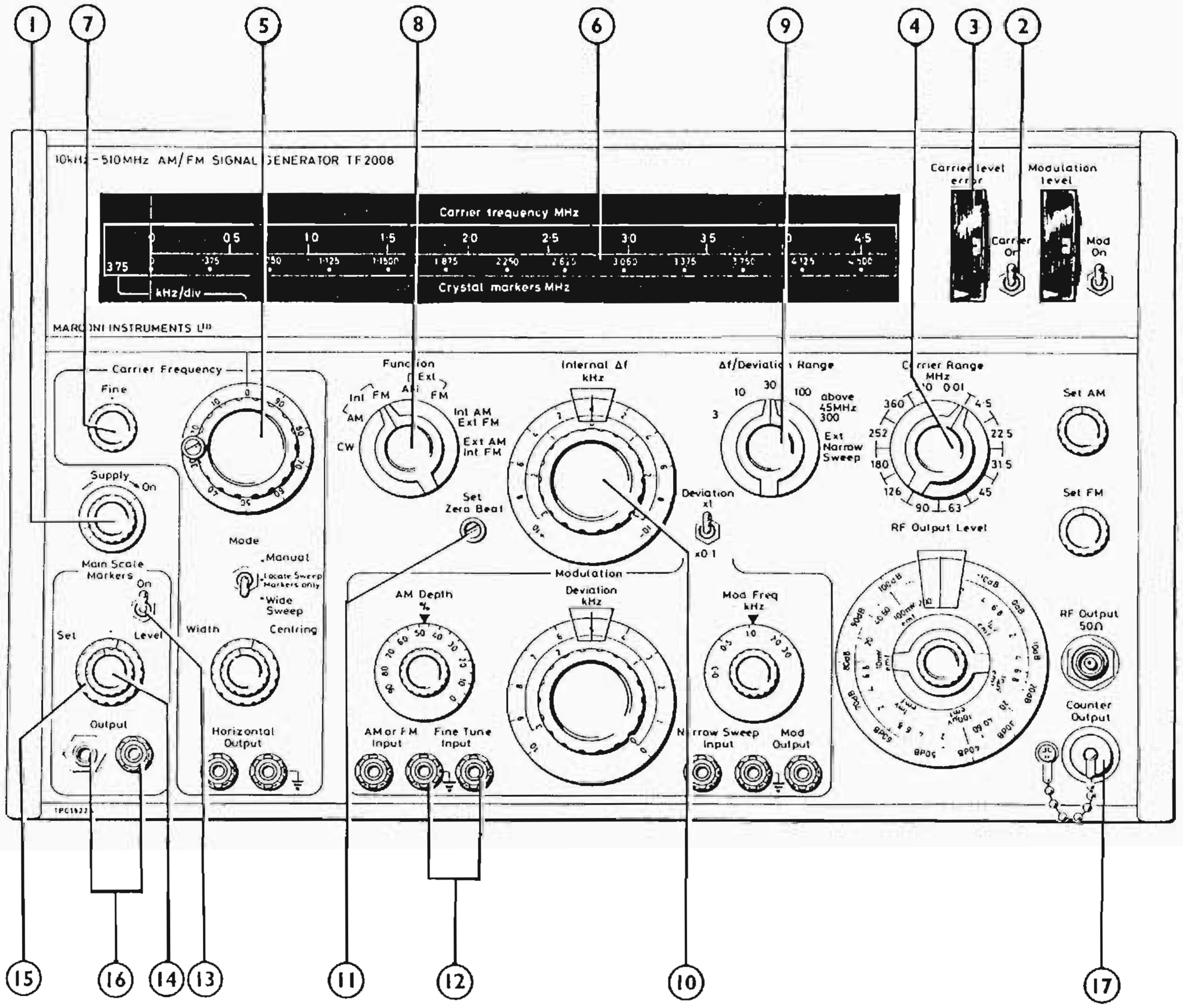


Fig. 2.1 Controls —supply and tuning

(8) FUNCTION SELECTOR. A seven position switch which selects the modulation function of the instrument.

(9) Δf/FM DEVIATION range selector.

(10) INT Δf. Calibrated tuning control with range as selected by (9).

(11) SET ZERO BEAT. Screwdriver adjustment. Used to restandardize the markers. Effectively sets the zero frequency point of the instrument.

(12) FINE TUNE INPUT. Input terminal for external control of fine tuning.

(13) MARKERS switch.

(14) SET MARKERS. Used to enhance CARRIER FREQUENCY scale accuracy by bringing any of the 13 marker points to zero beat.

(15) MARKER LEVEL control. Adjusts the level of the markers.

(16) MARKER OUTPUT. Jack for earphones and output terminal for displaying markers on an oscilloscope when using the sweep facility.

(17) COUNTER OUTPUT. This will drive a frequency counter which may be used to monitor the carrier frequency.

2.3 CONTROLS—MODULATION, SWEEP FACILITY AND OUTPUT

Fig. 2.2 Controls - modulation, sweep facility and output

(18) MODULATION LEVEL meter. Indicates that modulation drive is correctly set when the pointer is on the datum mark.

(19) SET AM. Adjusts the a.m. drive to the MODULATION LEVEL meter when the FUNCTION switch (8) is set to INT or EXT AM. For modulation depth see (23).

(20) SET FM. Adjusts the f.m. drive to the MODULATION LEVEL meter when the FUNCTION switch (8) is set to INT or EXT FM. For f.m. deviation see (9), (21) and (22).

(21) DEVIATION MULTIPLIER. Together with range selector (9) sets the f.m. deviation range.

(22) DEVIATION. Sets f.m. deviation when the range has been selected by (9) and (21).

(23) AM DEPTH. Amplitude modulation control with calibrated scale for adjustment between 0 and 80% when the SET AM control is set.

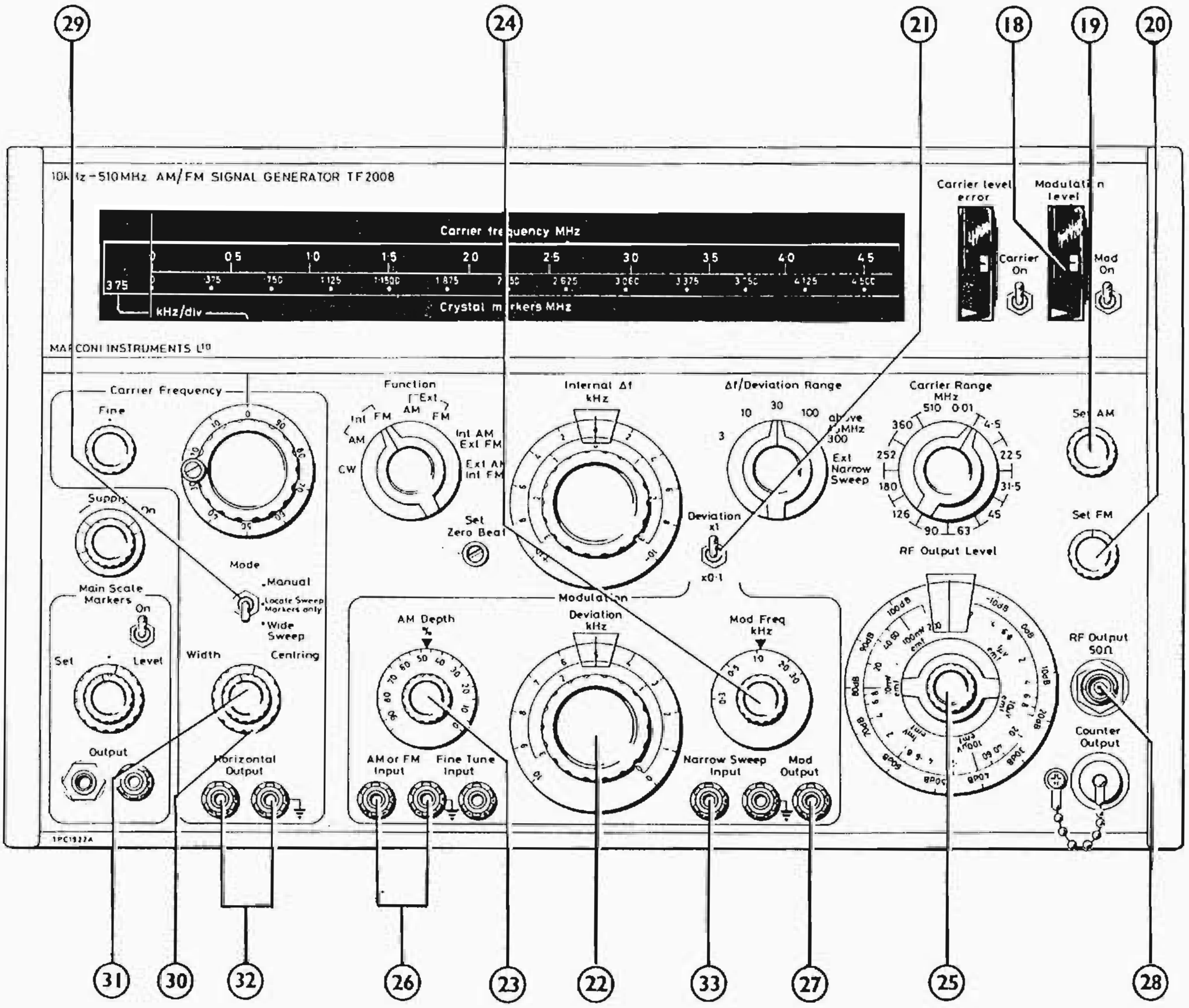


Fig. 2.2 Controls—modulation, sweep and output

(24) MODULATION FREQUENCY. Continuously variable control adjusting the internal modulating frequency for f.m. or a.m.

(25) OUTPUT LEVEL controls. Outer knob: a coarse attenuator of eleven 10 dB steps. Inner knob: a continuously variable 10 dB fine attenuator. The combined effect of both controls is read against the cursor on the output level scale.

(26) EXT INPUTS. Input sockets for external modulating signals.

(27) MODULATION OUTPUT. The modulating signal is available at this terminal and is particularly useful for synchronizing an oscilloscope.

(28) R.F. OUTPUT. 50 Ω BNC socket.

(29) MODE SELECTOR. A 3 position switch which may select either:

(1) manual tuning via (5),

(2) manual and swept tuning together; to aid identification of sweep markers.

(3) wide sweep.

(30) CENTRING. This control enables the sweep to be centred anywhere on the main tuning scale.

(31) WIDTH. Adjusts the width of the sweep.

(32) HORIZONTAL OUTPUT. Provides a signal for horizontal deflection of a display oscilloscope.

(33) NARROW SWEEP INPUT. Terminals for narrow sweep facility.

REAR PANEL

Battery terminals.
Voltage selector.
Mains input socket.

2.4 SETTING FREQUENCY

Turn the SUPPLY and CARRIER switches ON. Although the instrument operates within seconds of switching on, to obtain improved frequency stability allow a stabilizing period of fifteen minutes.

Select the MANUAL position with the MODE selector and using the CARRIER RANGE selector, select the range that includes the required carrier frequency. The ranges are as follows:

(1)	0.01 - 4.5 MHz	(7)	90 - 126 MHz
(2)	4.5 - 22.5 MHz	(8)	126 - 180 MHz
(3)	22.5 - 31.5 MHz	(9)	180 - 252 MHz
(4)	31.5 - 45 MHz	(10)	252 - 360 MHz
(5)	45 - 63 MHz	(11)	360 - 510 MHz
(6)	63 - 90 MHz		

Turn the INT Δf control to zero and adjust the CARRIER FREQUENCY control until the required frequency is indicated on the CARRIER FREQUENCY scale.

Use the FINE TUNING control to make small uncalibrated adjustments to the frequency, such as to bring the generator to the peak of a receiver's response.

Scale Standardization

The basic scale accuracy can be improved by standardizing at any of the 13 crystal marker points. To do this:

(1) Adjust the CARRIER FREQUENCY so that the scale cursor is at the marker point nearest to the frequency of interest and make sure that the logging scale around the knob is at zero.

(2) Plug headphones into the MARKERS OUTPUT jack, set MARKERS switch at ON, adjust MARKERS LEVEL control for convenient beat note loudness and turn the SET MARKERS control for zero beat.

(3) After standardization, switch markers OFF to prevent spurious modulation due to marker signal.

Marker Standardization

Occasionally restandardize the markers as follows:

(a) Tune to the zero frequency end of the 0.01 - 4.5 MHz band with the CARRIER FREQUENCY knob scale at zero.

(b) Turn the markers ON and set the INTERNAL ΔF control to full scale on the 100 kHz range.

(c) Adjust the SET MAIN SCALE MARKERS control to obtain zero beat at the MARKER OUTPUT socket. (The CARRIER LEVEL meter is unaffected).

(d) Set the ΔF control to zero and adjust the SET ZERO BEAT control with a screwdriver to obtain zero beat at the R.F. OUTPUT socket. (The CARRIER LEVEL meter falls sharply at the zero.)

2.5 FREQUENCY SHIFT

Internal ΔF

A known frequency shift above or below the frequency selected by the CARRIER FREQUENCY control can be produced directly by the INTERNAL ΔF control. Select the sensitivity of this control with the ΔF RANGE switch. Note that 300 kHz shift range is available only above 45 MHz.

Logging scale

For making larger calibrated frequency shifts than are available from the INTERNAL ΔF control, the logging scale may be used. This scale is calibrated such that as the CARRIER FREQUENCY control is rotated the zero coincides approximately with each of the 13 marker points on each band enabling each band to be divided into 1200 divisions. The size of each of these divisions is given by the red figure at the left hand side of the CARRIER FREQUENCY scale.

External fine tuning

This facility gives electrical access to the FINE tuning control and may be used for external frequency drift correction or fine frequency setting, by means of frequency or phase lock loops, whilst retaining all the modulation facilities.

Note : Δ F/deviation range should be selected before setting the generator frequency.

2.6 SETTING UP FOR C.W. OR MODULATED OUTPUT

2.6.1 Continuous wave

(1) Set the FUNCTION switch to C.W.

(2) Adjust the OUTPUT LEVEL controls as required.

2.6.2 Amplitude modulation

(a) Internal a.m.

To obtain amplitude modulation by the internal oscillator:

(1) Set the FUNCTION switch to INT A.M

(2) Set the MODULATION switch to ON.

(3) Adjust the SET A.M. control so that the pointer of the MODULATION LEVEL meter is on the datum mark.

(4) Adjust the MODULATION FREQUENCY control for the required modulating frequency.

(5) Select the depth of modulation by advancing the A.M. DEPTH control from zero to the required level.

(6) Suitably adjust the OUTPUT LEVEL attenuators.

When the FUNCTION switch is set to A. M. or F. M. the modulating signal is available between the MODULATION OUTPUT terminal and earth. This output is available with the MODULATION switch on or off and may be used, for example, to synchronize an oscilloscope at the modulating frequency.

(b) External a. m.

Set the FUNCTION switch to the EXT A. M. position. Apply an a. c. modulating signal between the EXT A. M. terminal and earth. Adjust the external source amplitude or the SET A. M. control, or both, till the pointer of the MODULATION LEVEL meter is on the datum mark. Adjust the A. M. DEPTH control for the required depth of modulation. Suitably adjust the OUTPUT LEVEL attenuators.

2.6.3 Frequency modulation

(a) To obtain frequency modulation by the internal oscillator:

(1) Set the FUNCTION switch to INT F. M.

(2) Set the MODULATION switch to ON.

(3) Adjust the MODULATION FREQUENCY control for the required modulating frequency.

(4) Adjust the SET F. M. control till the pointer of the MODULATION LEVEL meter is on the datum mark.

(5) Set the F. M. DEVIATION range selector to the required deviation range.

(6) Set the DEVIATION MULTIPLIER as required.

(7) Adjust the DEVIATION control for the required deviation.

(8) Suitably adjust the OUTPUT LEVEL attenuators.

As with internal a. m. the modulating signal is available between the MODULATION OUTPUT terminal and earth.

(b) External f. m.

Set the FUNCTION switch to EXT F. M. Apply an a. c. modulating signal between the EXT F. M. terminal and earth. Adjust the external source amplitude or the SET F. M. control, or both, till the pointer of the MODULATION LEVEL meter is on the datum mark. Set the F. M. DEVIATION range selector for the required deviation range. Set the DEVIATION MULTIPLIER as required and adjust the DEVIATION control for the required deviation. Suitably adjust the OUTPUT LEVEL attenuators.

2.6.4 Mixed modulation

(a) Int a. m./ext f. m.

Set the FUNCTION switch to INT A. M. and set the MODULATION switch to ON. Adjust the SET A. M. control so that the pointer of the MODULATION LEVEL meter is on the datum mark.

Adjust the MODULATION FREQUENCY control for the required modulating frequency and select the depth of modulation required by means of the A. M. DEPTH control.

Switch the FUNCTION switch to INT A. M./ EXT F. M. and apply an a. c. modulating signal between the EXT F. M. terminal and earth. Adjust the external source amplitude or the SET F. M. control, or both, until the pointer of the MODULATION LEVEL meter is on the datum mark.

Set the F. M. DEVIATION range selector and the DEVIATION MULTIPLIER as required. Adjust the DEVIATION control to obtain the required deviation. Suitably adjust the OUTPUT LEVEL attenuators.

(b) Int f. m./ext a. m.

Switch the FUNCTION switch to INT F. M. and set the MODULATION switch to ON. Adjust the SET F. M. control so that the pointer of the MODULATION LEVEL meter is on the datum mark.

Set the MODULATION FREQUENCY control for the required modulating frequency and set the F. M. DEVIATION range selector for the required deviation range. Set the DEVIATION MULTIPLIER as required and adjust the DEVIATION control to give the required deviation.

Switch the FUNCTION switch to INT F. M./ EXT A. M. and apply an a. c. modulating signal between the EXT A. M. terminal and earth. Adjust the external source amplitude or the SET A. M. control, or both, till the pointer of the MODULATION LEVEL meter is on the datum mark. Adjust the A. M. DEPTH control for the required depth of modulation. Suitably adjust the OUTPUT LEVEL attenuators.

2.7 SWEPT OPERATION

Internal swept operation is possible to the limits of the carrier frequency range in use. Alternatively an external oscillator can be used to sweep the signal generator over a narrow band whose maximum width depends on the carrier frequency range, but lies between 300 kHz and 4800 kHz.

Internal sweep

(1) Connect the equipment as in Fig. 2. 3. Set the MODE switch to WIDE SWEEP and select the frequency range of interest with the CARRIER RANGE switch. NOTE. There will be no indication on the CARRIER LEVEL ERROR meter.

(2) Set the oscilloscope so that the horizontal amplifier is available without the time base running; if TF 2210 is in use, set trigger source switches to external, select x10 mag. and advance the intensity control. If a single trace oscilloscope has to be used, combine the output from the detector and the markers at a T-connector with the output to the oscilloscope vertical input.

Attenuate the markers signal by feeding it through a capacitor of about 10 pF.

(3) Adjust the WIDTH and CENTRING controls so that the swept band is appropriately positioned for the response of the unit under test. Note that the normal carrier frequency controls do not affect swept operation. If necessary the oscilloscope horizontal position (or shift) control can be adjusted for a convenient display.

(4) To display markers, set the MAIN SCALE MARKERS switch ON and adjust the MARKERS LEVEL control for convenient marker amplitude.

If the oscilloscope is set to the chop display mode a trace such as in Fig. 2. 4 will be obtained. The line carrying the markers can be moved up or down with respect to the response curve using the oscilloscope vertical position control.

By adjustment of the SWEEP WIDTH control and the oscilloscope horizontal position control the markers can be made to calibrate the oscilloscope graticule, as was done in Fig. 2. 4.

If the oscilloscope display mode is set to add the two input channels, a response curve with markers superimposed is obtained, see Fig. 2. 5.

(5) If the full sweep width is used thirteen or more markers will be displayed corresponding to the crystal marker points on the main tuning scale. Under any other conditions fewer markers will be seen, with consequent ambiguity. To resolve the ambiguity, set the MODE switch to LOCATE SWEEP MARKERS ONLY; the markers will disappear and be replaced by one marker whose frequency is that of the manual tuning system, i. e. a variable marker whose frequency can be read off the main tuning scale. This marker can be used to identify the centre or either end of the swept band or any oscilloscope graticule line. Use of this marker

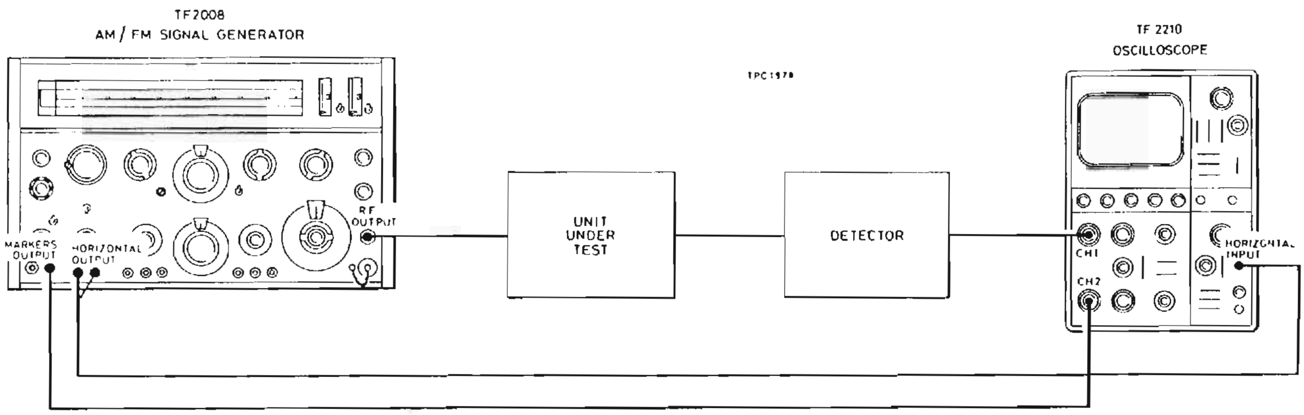


Fig. 2.3 Arrangement for wide sweep

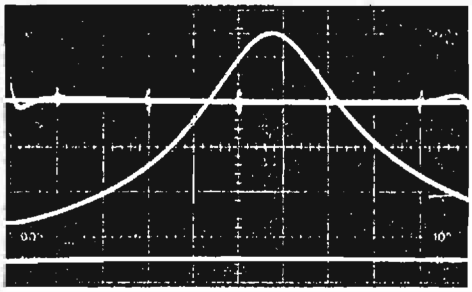


Fig. 2.4 Swept display with markers on separate trace

will distort the displayed response, and it must therefore be restricted to identifying the main markers. Ignore any disturbance of the CARRIER LEVEL ERROR meter indication in this mode.

Fig. 2.6 is a double exposure photograph; the upper trace is a response curve with superimposed markers, the lower trace shows the variable marker with the input to the other oscilloscope channel removed.

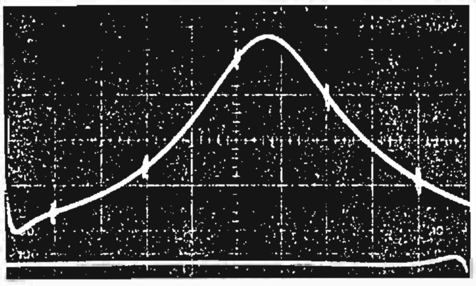


Fig. 2.5 Swept display with markers superimposed

The sweeping waveform is a 18 Hz triangular wave. R. F. output is blanked on the retrace so that a base line is produced on the display which can be used as a zero level datum. All the normal signal generator functions are available when sweeping; a.m. or f.m. or both can be applied so that demodulators can be tested under normal working conditions, or the attenuator can be used to adjust the level.

As with any swept system the maximum effective sweep speed that can be used is limited by the time constants of the circuit under test. If the sweep speed is too high the response displayed will be distorted. The sweep rate of the signal generator is fixed at 18 Hz to give a comfortable display, but the effective sweep speed is also governed by the width of the swept band. In general provided that the pass band of the circuit under test occupies at least one quarter of the width of the display, satisfactory results will be obtained. For narrow band circuits, i.e. those with a bandwidth less than about 1%, the sweep width cannot be reduced sufficiently and these should be examined by the external sweep method.

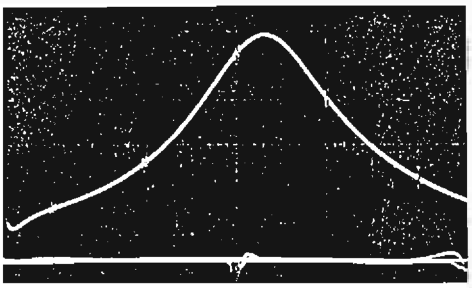


Fig. 2.6 Swept display with locate marker (double exposure)

Make sure that all r.f. connections are made using matching (50 Ω) cable and connectors and that cable lengths are as short as possible. If these precautions are not taken reflections or frequency dependent effects will distort the response, particularly at the higher frequencies.

External sweep

(1) Connect the equipment as in Fig. 2.7. Set the MODE switch to MANUAL, the DEVIATION RANGE switch to EXT NARROW SWEEP, select the frequency range of interest with the CARRIER RANGE switch and select the centre frequency with the CARRIER FREQUENCY control.

(2) Set the oscilloscope so that the horizontal amplifier is available without the time base running; if TF 2210 is in use, set the trigger source switches to external, select x10 mag. and advance the intensity control.

(3) Set the sweep width by adjusting the drive from the waveform generator. About 10 V p-p will give maximum sweep for the carrier range in use according to the following table:

Carrier frequency (MHz)	*Max. Sweep Width (kHz)*
0.01 - 45	±150
45 - 90	±300
90 - 180	±600
180 - 360	±1200
360 - 510	±2400

Select the frequency of the waveform generator (sweep rate) to suit the time constants of the circuit under test. The signal generator will accept sweep rates up to 30 Hz.

(4) Markers are not available in the narrow sweep mode and so some other way of identifying parts of the displayed response is required. The most convenient way of doing this is to calibrate the narrow sweep input against a counter using a variable d.c. source. Alternatively, if a waveform generator such as M.I. TF 2120 (which has the facility to hold the sweep at any point) is being used, direct identification of selected points is possible with a counter.

2.8 SETTING OUTPUT

Turn the CARRIER switch ON and observe that the pointer of the CARRIER LEVEL ERROR meter comes within the white box. A.L.C. action will maintain the output level constant irrespective of changes of frequency or modulation conditions. Turn the coarse and fine attenuator dials until the desired output is indicated.

The specified v.s.w.r. at maximum output applies only by virtue of the a.l.c. action. Therefore to preserve good v.s.w.r. if the carrier is switched off with the generator connected to other equipment (as might occur in two-signal-generator tests), insert at least 10 dB with the coarse attenuator.

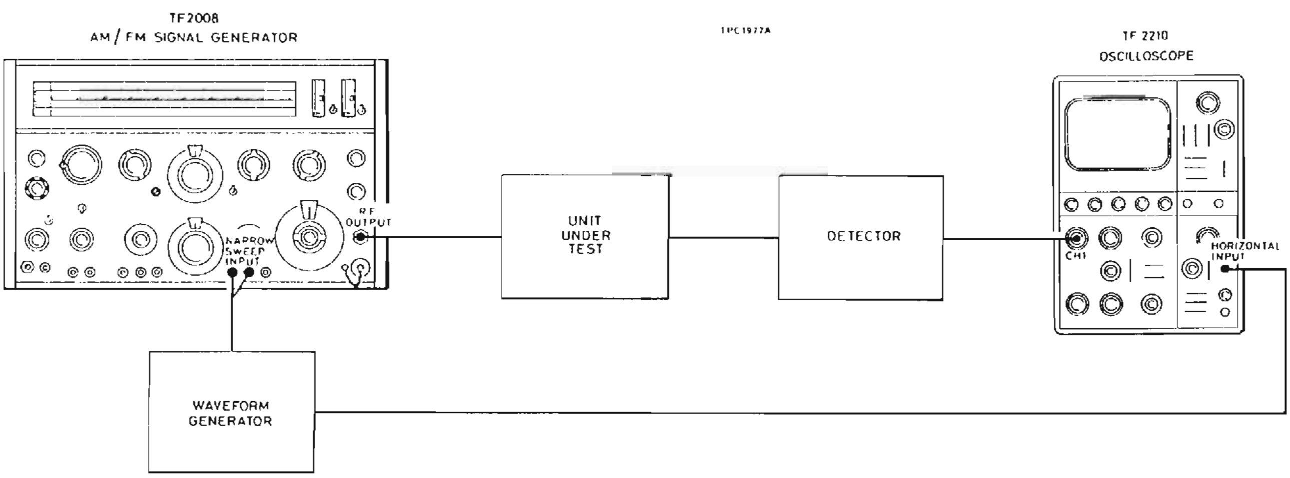


Fig. 2.7 Arrangement for narrow sweep

Counter output

For applications such as operating a counter type frequency meter, an alternative output is provided. This output is modulated and its level is 100 mV or more into 50 Ω, depending on the position of the fine attenuator and the carrier frequency, provided the r.f. output is loaded with 50 Ω.

It is good practice to switch modulation off when checking carrier frequency. Make sure that the level of output does not overload the counter, since this could give erratic counting.

2.9 MISMATCHED LOADS

The performance specifications for the instrument assume operation into 50 Ω loads but it is sometimes desired to work into other, mismatched, loads. This is, in general, possible although certain degradation or uncertainty of performance may be introduced. For example with open circuit load the a.l.c. action can become unstable and a.m. distorted, or at the higher frequencies of the generator the reflections caused by mismatching can produce misleading standing waves. Most of these effects can be minimised by introducing 10 dB or more into the coarse attenuator.

The r.f. output circuit of the signal generator should be regarded as a zero impedance voltage source in series with a resistance of 50 Ω. This is shown in Fig. 2.8 where:

E is the indicated source e.m.f.,

R_O is the source resistance,

Z_L is the external load impedance,

V_L the voltage developed across the load is given by

$$V_L = E\frac{Z_L}{R_O + Z_L}$$

or, for purely resistive loads

$$V_L = E\frac{R_L}{R_O + R_L}$$

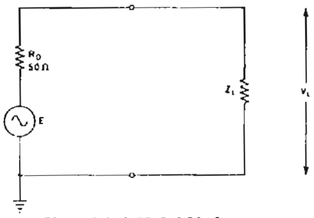


Fig. 2.8 Equivalent output circuit

Table 2.1 shows the conversion factors for obtaining the load voltage from the indicated e.m.f. at different load impedances.

Table 2.1

To find load voltage

Load ohms	*Multiply e.m.f. by*	*or subtract dB*
10	0.167	15.5
20	0.286	10.9
30	0.375	8.5
40	0.445	7.0
50	0.50	6.0
60	0.55	5.2
70	0.58	4.7
75	0.60	4.4
80	0.62	4.2
90	0.64	3.8
100	0.67	3.5

When using a correctly matched, i.e. 50 Ω, output lead its output end can be regarded as an extension to the output socket on the generator, and wide variations of load impedance do not seriously affect the calculated load voltage obtained from table 2.1. Standing waves produced by the mismatched load can, for most purposes at lower frequencies, be ignored.

For greatest accuracy - if the additional attenuation can be tolerated - use a 20 dB attenuator pad as type TM 5573 between seriously mismatched loads and the output lead. This ensures that the lead is correctly terminated and also attenuates any extraneous noise induced in the leads.

Matching to high impedance loads

To present a load that is greater than 50 Ω with a signal derived from a matched source, a resistor R_S is added in series with the generator output. The value of R_S is given by the difference between the load and the generator impedances, that is

$$R_s = R_L - R_o$$

The voltage across the load, V_L, is given by

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

(see Fig. 2.9)

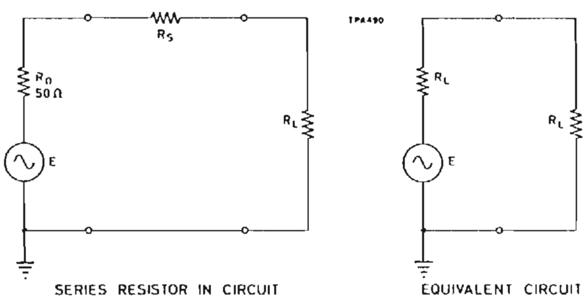


Fig. 2.9 Matching to high impedance loads

Matching to low impedance loads

To present a load that is less than 50 Ω with a signal derived from a matched source, a resistor R_p is added in parallel with the generator output. The value of R_p is given by

$$R_p = \frac{R_o R_L}{R_o - R_L}$$

The effective source e.m.f. is now different and is given by

$$E_1 = E \frac{R_p}{R_o + R_p}$$

and the voltage across the load, V_L, is given by

$$V_L = \frac{E_1}{2}$$

(see Fig. 2.10)

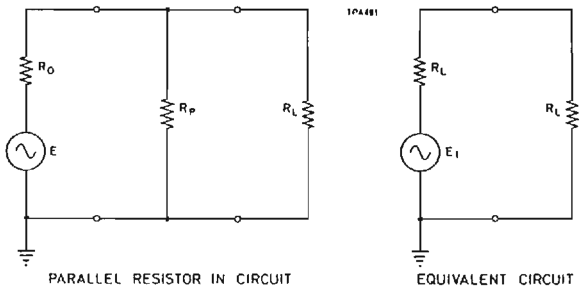


Fig. 2.10 Matching to low impedance loads

Matching to balanced loads

Equipment whose input circuit is in the form of a balanced winding can be fed from the generator by using two series resistors as shown in Fig. 2.11. This method makes use of the auto-transformer effect of the centre tapped winding and is not suitable for resistive balanced loads. (see Fig. 2.11)

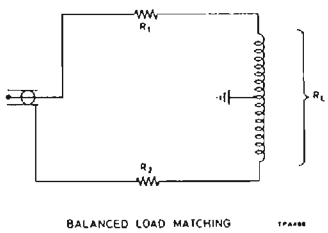


Fig. 2.11 Matching to balanced loads

The values of R_1 (for use in centre conductor) and R_2 (for the earth lead) are given by

$$R_1 = \frac{R_L}{2} - 50$$

$$R_2 = \frac{R_L}{2}$$

Decibel conversion table

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

Decibel conversion table *(continued)*

Ratio Down VOLTAGE	POWER	DECIBELS	*Ratio Up* VOLTAGE	POWER
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	6·310 x 10^{-3}	**22**	12·59	158·5
·06310	3·981 x 10^{-3}	**24**	15·85	251·2
·05012	2·512 x 10^{-3}	**26**	19·95	398·1
·03981	1·585 x 10^{-3}	**28**	25·12	631·0
·03162	1·000 x 10^{-3}	**30**	31·62	1,000
·02512	6·310 x 10^{-4}	**32**	39·81	1·585 x 10^{3}
·01995	3·981 x 10^{-4}	**34**	50·12	2·512 x 10^{3}
·01585	2·512 x 10^{-4}	**36**	63·10	3·981 x 10^{3}
·01259	1·585 x 10^{-4}	**38**	79·43	6·310 x 10^{3}
·01000	1·000 x 10^{-4}	**40**	100·00	1·000 x 10^{4}
7·943 x 10^{-3}	6.310 x 10^{-5}	**42**	125·9	1·585 x 10^{4}
6·310 x 10^{-3}	3·981 x 10^{-5}	**44**	158·5	2·512 x 10^{4}
5·012 x 10^{-3}	2·512 x 10^{-5}	**46**	199·5	3·981 x 10^{4}
3·981 x 10^{-3}	1·585 x 10^{-5}	**48**	251·2	6·310 x 10^{4}
3·162 x 10^{-3}	1·000 x 10^{-5}	**50**	316·2	1·000 x 10^{4}
2·512 x 10^{-3}	6·310 x 10^{-6}	**52**	398·1	1·585 x 10^{5}
1·995 x 10^{-3}	3·981 x 10^{-6}	**54**	501·2	2·512 x 10^{5}
1·585 x 10^{-3}	2·512 x 10^{-6}	**56**	631·0	3·981 x 10^{5}
1·259 x 10^{-3}	1·585 x 10^{-6}	**58**	794·3	6·310 x 10^{5}
1·000 x 10^{-3}	1·000 x 10^{-6}	**60**	1,000	1·000 x 10^{6}
5·623 x 10^{-4}	3·162 x 10^{-7}	**65**	1·778 x 10^{3}	3·162 x 10^{6}
3·162 x 10^{-4}	1·000 x 10^{-7}	**70**	3·162 x 10^{3}	1·000 x 10^{7}
1·778 x 10^{-4}	3·162 x 10^{-8}	**75**	5·623 x 10^{3}	3·162 x 10^{7}
1·000 x 10^{-4}	1·000 x 10^{-8}	**80**	1·000 x 10^{4}	1·000 x 10^{8}
5·623 x 10^{-5}	3·162 x 10^{-9}	**85**	1·778 x 10^{4}	3·162 x 10^{8}
3·162 x 10^{-5}	1·000 x 10^{-9}	**90**	3·162 x 10^{4}	1·000 x 10^{9}
1·000 x 10^{-5}	1·000 x 10^{-10}	**100**	1·000 x 10^{5}	1·000 x 10^{10}
3·162 x 10^{-6}	1·000 x 10^{-11}	**110**	3·162 x 10^{5}	1·000 x 10^{11}
1·000 x 10^{-6}	1·000 x 10^{-12}	**120**	1·000 x 10^{6}	1·000 x 10^{12}
3·162 x 10^{-7}	1·000 x 10^{-13}	**130**	3·162 x 10^{6}	1·000 x 10^{13}
1·000 x 10^{-7}	1·000 x 10^{-14}	**140**	1·000 x 10^{7}	1·000 x 10^{14}

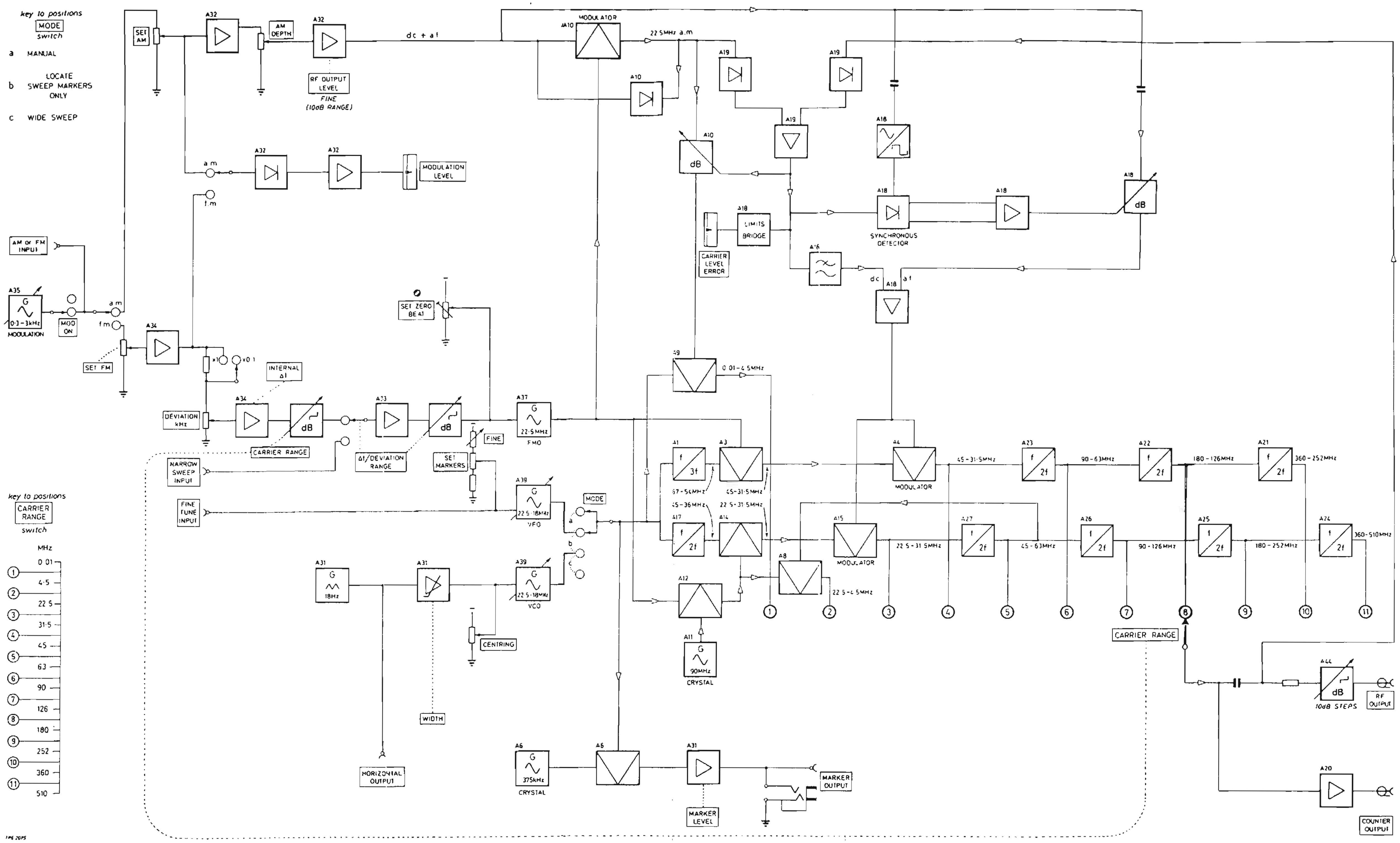


Fig. 3.1 Simplified block diagram

Chapter 3 Technical description

Each of the printed boards and other sub-assemblies in this instrument has been allocated an identification number in the sequence A1 to A44, which wherever practicable is marked upon it. The complete circuit reference for a component carries its unit number as a prefix, e.g. A6R15.

For convenience in this chapter and on the circuit diagrams, the circuit reference is abbreviated by dropping the prefix, except where there is risk of ambiguity.

3.1 CIRCUIT SUMMARY

The overall system of the generator is as shown in fig. 3.1. The primary signal path originates in the oscillator unit, which is a cast box mounted in the coolest part of the front half of the instrument. The box contains three oscillators as detailed below:

(1) A variable frequency oscillator (VFO), variable from below 18 MHz to above 22.5 MHz and controlled by the main tuning control.

(2) A voltage controlled oscillator (VCO), variable from below 18 MHz to above 22.5 MHz and controlled by the sweep drive waveform.

(3) A 22.5 MHz oscillator used to provide the ΔF and f.m. facilities in the generator and referred to as the FMO or frequency modulated oscillator.

The VFO and VCO outputs are fed to a dual input buffer and from there via a band-pass filter to the r.f. processing unit. The FMO output is also fed through a tuned buffer to the r.f. processing unit. This unit produces the eleven carrier ranges through the action of a chain of multipliers and mixers from the original signals. Ranges 1, 2, 3 and 4 are derived via their own subtractive mixers. Ranges 5, 7, 9 and 11 are obtained from a string of doublers following range 3, and similarly ranges 6, 8 and 10 are obtained from range 4. The provision of a boustrophedon tuning scale requires the reversal of the sense of tuning between alternate ranges, and this is achieved by introducing an additional stage of mixing into the sequence for the odd numbered ranges. A 90 MHz crystal oscillator is used in the mixer to preserve stability. A 375 kHz crystal oscillator is used to provide a calibration function for the VFO and VCO oscillators in the generator.

An automatic level control system is provided, which also combines the functions of amplitude modulator and fine output level control. Envelope feedback is provided on all ranges except no. 1. The carrier signal path is completed by a ladder attenuator, with 10 dB steps. A separate output path, via an amplifier stage, is provided to the counter output socket.

The modulating signal arising either from the modulation oscillator, which covers the speechband, or from external signals applied to the a.m. or f.m. input socket follows one of two paths. The a.m. path leads to the a.l.c. system and the f.m. path to the frequency modulated oscillator (FMO). At the start of each path the applied signal level is established by the set a.m. or set f.m. controls to the datum measured by the modulation monitoring circuit. Changes of modulation depth or deviation are then achieved by calibrated controls. Since the FMO works at a fixed frequency no tracking system is needed but attenuation, ganged to the carrier range switch, is provided in the f.m. path to maintain constant deviation despite the later frequency multiplication.

Swept operation is obtained by the sweep driver, a fixed frequency triangular wave generator, acting via a predistorting amplifier upon the VCO.

3.2 R.F. OSCILLATORS

Circuit diagram Fig. 7.2

Variable frequency oscillator

The manually tuned VFO, which forms part of A39, consists of a Hartley circuit employing a high Q tuned circuit and a field effect transistor to give good temperature stability and low noise. The high Q tuned circuit consists of the primary winding of transformer T2 coupled with the precision tuning capacitor A41C26, which is varied by the carrier frequency control. The capacitor is a large, stable component to ensure a low level of microphony and to maintain this low level many of the other components in the VFO are coated with a semi-rigid compound.

To provide the electrical fine tuning facility the varactor diode D3 is coupled to the tuned circuit via C10 and C11 to effect small changes in frequency. It is influenced by internally derived voltages from the fine tune and set markers controls and by external voltages applied to the fine tune input. The transistor TR2 is used for the remote switching of the oscillator. The oscillator output is fed via the secondary winding of transformer T2 to the dual input buffer.

VCO

The VCO, which is the other part of A39, consists of a Hartley circuit employing a varactor diode D2, driven by the specially predistorted sweep drive waveform to provide the swept frequency. The remote switching of this oscillator is achieved by applying a voltage to diode D1. The output from the oscillator is fed via transformer T1 to the dual input buffer. The oscillator is screened from the VFO by being placed in its own screening can.

Dual input buffer

The buffer, unit A40, which serves the VFO and VCO has two inputs which comprise identical common emitter stages, TR1 and TR2, which provide a current feed to the signal levelling arrangement of a back to back limiter pair of diodes, D1 and D2. The signal then passes through the tuned output stage TR3 and band-pass filter to the r.f. processing unit. The output level is set by R9 to be +8 dBm (at 50 Ω).

Frequency modulated oscillator and buffer

To eliminate tracking errors a separate oscillator is used for frequency modulation. This oscillator, forming unit A37, also provides the ΔF facility and is housed in a separate compartment of the oscillator unit from the other two oscillators to ensure good screening. The FMO consists of a Colpitts circuit employing a field effect transistor TR1 to give low carrier noise. The fixed frequency of 22.5 MHz is set by capacitors C3, C4 and C8 in parallel with the primary winding of transformer T1.

The ΔF facility is provided by applying a voltage to varactor diode D1 which acts with C7, C12 and L4 to give up to ±150 kHz frequency deviation. Since the volts/frequency transfer function for a varactor diode is non-linear, distortion correction is required, and is provided by the combination of C7, C12 and L4. The transistor TR2 is used for the remote switching of the oscillator. The output of the FMO is taken via the secondary winding of transformer T1 to the first buffer stage, transistor TR3, and then to the second buffer stage.

Second buffer

Because the FMO also feeds the a.m. system in the generator, very good buffering is required to prevent spurious f.m. on a.m. and a second buffer, forming unit A38, is fitted. To ensure good isolation a field effect transistor TR1 is used. The output of this stage then passes to the tuned output stage consisting of transistor TR2 and tuned circuits using L3, L4, C7, C8 and C10. The level of the output signal is set by R1 to be +7 dBm (at 50 Ω) as required by the r.f. processing unit.

3.3 MODULATION OSCILLATOR

Circuit diagram Fig. 7.11

This oscillator, unit A35, is housed on the modulation chassis and consists of a simple Wien bridge oscillator designed to cover the speech band of 0.3 to 3.0 kHz. The series elements of the bridge are R14 in series with the parallel combination of C4, C6 and C8. The shunt elements are R5 in parallel with C7 and C9.

The capacitors C6 and C7 are provided by a solid dielectric ganged capacitor of which the trimmers C8 and C9 also form part. Thermistor R12 provides the level stabilizing feedback.
A field effect transistor TR1 is used to provide the high input impedance necessary for compatability with the Wien bridge components. Resistor R16 in series with the output components of the oscillator pads the impedance to 600 Ω. The output level is 0 dBm.

3.4 SWEEP DRIVE UNIT

Circuit diagram Fig. 7.10

The sweep driver unit, which forms part of A31, supplies two waveforms; one is the linear triangular waveform appearing at the horizontal output terminals, the other is the specially predistorted triangular waveform which drives the voltage controlled oscillator.

The transistors TR8 and TR9 are arranged as a simple monostable multivibrator to feed a square wave signal to the transistor TR10, which is arranged as a Miller Integrator. The output from the collector of TR10 is a linear triangular waveform, which is fed via R34 to the horizontal output terminals.

The square wave signal from the monostable multivibrator is also fed to transistor TR12 where the predistortion bend in the output waveform is achieved by the exponential charging of a capacitor, the rate of which is controlled by R40 and R41. The width of the sweep is determined by the amplitude of the waveform and this is adjusted by the width control A36R6. The centring of the sweep is adjusted by varying the static d.c. level present in the output waveform and this is achieved by the potential divider chain of which the centring control A36R8 forms part. The output waveform is then fed to the voltage controlled oscillator.

When the datum level of 4 V p-p has been established, it is fed to the a.m. depth control A36R13. A d.c. level of 2.5 V is introduced by potentiometer R8 and this composite signal is fed to the feedback pair of transistors TR3 and TR4. This pair is adjusted by R12 for an overall gain of 2 so that at the top of the calibrated fine output level control there is a composite signal of 5 V d.c. +8 V p-p for 80% modulation.

The combination of A36R17 and A36R18 is operated by the fine output level control. The signal then passes through emitter follower TR5 and via R17 to a filter which feeds the carrier level and a.m. instruction signal to the r.f. processing unit.

3.5 A.M. DRIVER AND MODULATION MONITOR

Circuit diagram Fig. 7.1

These functions are performed on unit A32.

The input to the a.m. driver is approximately 0 dBm (at 600 Ω) applied to the junction of C1 and R1 from either the internal modulation oscillator or an external source depending on the setting of the function switch. The set a.m. control R12 has an adjustment range of about 6 dB and supplies the signal to the feedback pair of transistors TR1 and TR2. These act as an impedance isolator and have an approximate overall gain of 3. The datum signal level of 4 V p-p is established at the collector of TR2 by adjusting A36R12 (set a.m.) and observing the modulation level meter. When the function switch is in the int a.m., ext a.m. or ext a.m./int f.m. position one of the switch wafers connects the output from the collector of TR2 to the modulation monitor.

The datum signal of 4 V p-p is coupled to the modulation monitor by C5. The signal is rectified by diodes D4 and D5, and the rectified voltage charges C7. From the voltage appearing across C7 is subtracted the voltage which 'backs off' transistor TR7. The resultant voltage drives the transistor TR7, which is an emitter follower, to bring the meter pointer to the meter scale datum position. The diode D6 is present to prevent reverse deflection of the meter and to offset the temperature effects at the resistor junctions in the stage on the 'backing off' voltage. The sensitivity of the meter is $\pm 1\frac{1}{2}$ dB for extreme deflections.

3.6 F.M./ΔF DRIVER AND OUTPUT STAGE

Circuit diagram Fig. 7.1

These functions are performed on unit A34.

The signal levels and circuit arrangements up to the collector of transistor TR2 are identical to those of the a.m. driver and similarly the datum signal level of 4 V p-p is established at the collector of TR2. The deviation control A36R14 feeds a calibrated fraction of the datum voltage into the impedance converter comprising transistors TR3 and TR4. The deviation multiplier comprises the combination of switch A36SG, R7 and R8, and reduces the output fed to TR3 and TR4 to one tenth when in the x0.1 position.

The impedance converter TR3 and TR4 has an overall gain of 3 providing a maximum of 12 V p-p to the coupling capacitors C4, C5 and C6. The internal ΔF control A36R38 feeds a matched amount of d.c. voltage, up to 12 V, to the a.c. voltage. The coupling capacitor C5 provides a longer time constant for external modulating voltages which may be as low as 30 Hz.

The composite voltage is passed through a unity gain impedance isolator made up of transistors TR5 and TR6. To keep the deviation constant when the carrier range is changed, the output from the collector of TR6 is fed to the potentiometer chain of A36R33 to A36R37 which reduces the drive voltage by a factor corresponding to the multiplying factor of the carrier range in use.

The composite voltage is then passed through a temperature compensated impedance isolator comprising transistors TR1, TR2 and TR3. This arrangement provides a 2.66 kΩ source impedance for the composite voltage when fed to the f.m. drive filter. The composite voltage is fed to the filter via a matched attenuator comprising resistors A36R21 to A36R26. The combination selected depends upon the setting of the deviation range switch.

3.7 R.F. PROCESSING

All the carrier ranges are derived by mixing and multiplication from the frequency modulated oscillator (FMO) at 22.5 MHz and either the manually tuned oscillator (VFO) or the swept oscillator (VCO), both of which cover the range 18 MHz to 22.5 MHz.

The odd and even carrier ranges are generated in two distinct paths: the VFO or VCO input to the processing unit is trebled in A1 to provide the even ranges and doubled in A17 to provide the odd ranges. From A1 the even range input passes, via an amplifier and filter - A2, to the mixer A3, where it meets the FMO signal. Amplitude modulation and level control is performed for the even ranges in A4 and, after amplification in A5, the signal forms carrier range 4. Ranges 6, 8 and 10 are obtained by successively doubling in A23, A22 and A21. The odd ranges are generated by mixing the output from A17 (2 x VFO) with a 67.5 MHz signal in A14. This 67.5 MHz signal is obtained from a 90 MHz crystal oscillator A11, mixed with the FMO signal in A12 and amplified in A13.

Amplitude modulation and level control for the odd ranges is performed in A15 and, after amplification in A16, the signal forms carrier range 3. Ranges 5, 7, 9 and 11 are obtained by successively doubling in A27, A26, A25 and A24.

The first two ranges are generated in different ways. For range 1 the FMO signal is amplitude modulated in A10 and passed via a level control circuit in A10 to be mixed directly with the VFO signal in A9. For range 2 the range 5 signal (45 - 63 MHz) is mixed with the 67.5 MHz signal in A8 and is amplified in A7.

These processing operations for the eleven frequency ranges may be summarized as follows:

Range 1	FMO-VFO	0.01 to 4.5 MHz
Range 2	FMO+4VFO-90	4.5 to 22.5 MHz
Range 3	90-FMO-2VFO	22.5 to 31.5 MHz
Range 4	3VFO-FMO	31.5 to 45 MHz
Range 5	(90-FMO-2VFO)x2	45 to 63 MHz
Range 6	(3VFO-FMO)x2	63 to 90 MHz
Range 7	(90-FMO-2VFO)x2x2	90 to 126 MHz
Range 8	(3VFO-FMO)x2x2	126 to 180 MHz
Range 9	(90-FMO-2VFO)x2x2x2	180 to 252 MHz
Range 10	(3VFO-FMO)x2x2x2	252 to 360 MHz
Range 11	(90-FMO-2VFO)x2x2x2x2	360 to 510 MHz

The outputs from the ranges are routed via wafer 3 of the carrier range switch SJ to A20. The switch in addition to carrying the output signal, carries a d.c. level which operates the diode switches in the multiplier units. Fig. 3.2 shows a typical arrangement: normally D2 is held on by the -11 V fed from the following multiplier and D1 is earthed by the carrier range switch; when the output is to be taken from A22, connection is made to A20, the higher bias voltage switches D1 on (and D2 off), thereby changing the r.f. path from A22 - A21 into A22 - A20.

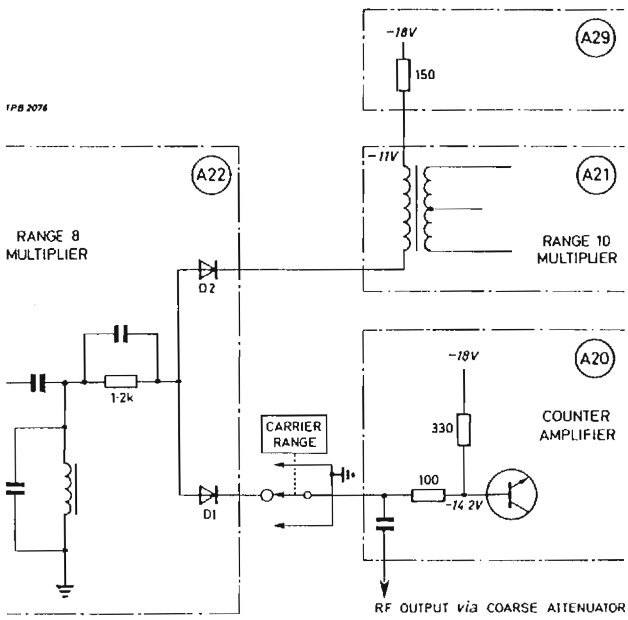


Fig. 3.2 Multiplier range switching

Another wafer, SJ4, switches the d.c. supplies to the r.f. processing units via A29. The diode interconnections on A29 provide the appropriate combination of units switched on for the range selected.

Many of the units are similar in function and design and are therefore described together in the following sections.

Filters

To minimize generation of unwanted signals many of the processing units incorporate filters. These are similar in design, being of the m-derived band-pass type plus half sections of constant-k filters for impedance matching and harmonic reduction purposes. Where the series legs of the filters are series tuned, the leg is adjusted for passing the frequency at which it is tuned, and where the series legs are parallel tuned they are tuned for maximum rejection outside the pass band. The reverse is true for the parallel leg tuning.

Unit A28 contains the input filters which are conventional in design. There are four filters, i.e. for H.T., crystal calibration, modulation and metering.

3.8 FREQUENCY DOUBLERS—UNITS A17 21, 22, 23, 24, 25, 26 and 27

Circuit diagrams Fig. 7.7 and Fig. 7.8

These units are all similar in design. The input signal to each unit is applied across the transformer, T1, which is wound coaxially with a centre tapped secondary. Signals which are opposite in phase are applied to the bases of transistors TR1 and TR2. As the collectors are connected to a common point the fundamental frequency of the input is cancelled in the output but the second harmonic of that frequency is additive. The second harmonic passes through the output filter to the output of the unit.

The resistors R1, R2, R3 and R4 determine the bias to the two transistors; R4 being adjusted to give good fundamental frequency rejection. The capacitor A17C14, and corresponding capacitor on other units, is an insulated wire soldered to the collectors of the transistors and adjusted near to the base track of either transistor in order to cancel any third harmonic signals.

3.9 TREBLER—UNIT A1

Circuit diagram Fig. 7.4

TR1 is an amplifier biased to give high third harmonic content. The output filter passes this harmonic so that the input frequency appears trebled in the output.

3.10 MIXER UNITS A3, A8, A9, A12 and A14

Circuit diagrams Fig. 7.3 — 7.5

These five units all employ conventional double balanced mixers. Line transformers are used throughout in order to achieve the required bandwidth; these amount to sections of transmission line, terminated in their characteristic impedance, and generally wound on ferrite toroids.

The two units A8 and A9 employ additional circuitry. A8 employs a conventional amplifier, with provision for gain adjustment by R5, which amplifies the 67.5 MHz input signal before it is applied, via the fixed filter, to the switching terminals of the mixer.

Unit A9 employs two amplifiers. Transistor TR1 with its associated circuitry is an r.f. buffer amplifier which amplifies the 22.5 MHz FMO signal. After amplification this signal is fed to one input of the mixer via T2B. The VFO/VCO signal at 18 to 22.5 MHz is fed to the other input via T1A. The mixer gives an output at 0 to 4.5 MHz which is passed through the low-pass filter and fed via transistor TR2 to the complementary output pair TR3 and TR4. This amplifier has a feedback loop via R7 and C11. The two diodes D5 and D6 provide thermal stability and the two resistors, R4 and R12, protect the complementary pair against excessive current. The output is switched by switch SJ to give the range 1 output.

3.11 AMPLIFIER UNITS—A2, A5, A7, A13 and A16

Circuit diagrams Fig. 7.3 — 7.6

These amplifiers are similar and conventional. Each unit has either an input or output filter or both tuned to the required pass band. The unit A13 is a two stage amplifier, and employs a parallel tuned circuit (L4, C8 and C9) to match the output from transistor TR1 to the base of transistor TR2, and a similar tuned circuit (L5, C12 and C13) gives an output via the series tuned circuit (L6 and C15).

3.12 MODULATED AMPLIFIERS—UNITS A4 and A15

Circuit diagram Fig. 7.6

The two modulated amplifiers are similar. Unit A4 is situated in the even range chain and A15 in the odd range chain. They are closely associated with units A10, A18 and A19 in order to provide amplitude modulation and control of level. Instruction signals from the a.l.c. amplifier, A18, are fed to these units consisting of an a.f. signal to give the required modulation depth and a d.c. voltage to provide a.l.c. along with the 10 dB attenuation facility.

The r.f. input signal is passed through the input filter to the first gate of the FET, TR1. The resistor R3 sets the bias on this gate whilst the second gate is biased by the instruction signal from unit A18. This instruction signal from unit A18 is fed via pin 6 to the second gate of the FET where the a.f. component amplitude modulates the r.f. input signal. The Zener diode, D1, stabilizes the d.c. supply to the source of TR1 and D2 is a protection device against gate breakdown.

3.13 90 MHz CRYSTAL OSCILLATOR—UNIT A11

Circuit diagram Fig. 7.3

The inductor, L3, in parallel with capacitors C4 and C5 form a 90 MHz tuned circuit in the collector of transistor TR1. The output via the buffer stage TR2 as well as the feedback is taken from the junction of capacitors C4 and C5. The feedback is fed via the 90 MHz crystal and its associated components to the emitter of the transistor. Capacitor C6 is adjusted to give the correct frequency and resistor R5 clamps the crystal frequency and aids in reducing harmonics. The base of the transistor is r.f. grounded via the capacitor C3 and resistor R3.

3.14 CRYSTAL CALIBRATOR—UNIT A6

Circuit diagram Fig. 7.10

The crystal oscillator produces the indicated check points in the manual mode and the markers in the wide sweep mode. The transistor TR1 is a crystal controlled oscillator which is switched on by taking the emitter resistor R3 to H.T. via a resistor A31R10 on the front panel assembly. The crystal oscillator does not function in the locate sweep markers mode; in this situation the VCO and VFO operate together so that the VFO acts as variable marker for the swept oscillator.

The frequency of the crystal oscillator may be set to precisely 375 kHz by adjustment of capacitor C2. The output is applied to the Schmitt trigger circuit, TR2 and TR3 giving a square wave which is differentiated by capacitor C9 and resistor R13. Transistor TR5 with associated circuitry forms a monostable blocking oscillator which is triggered into operation when transistor TR4 is turned on by a positive pulse at its base. The second winding on transformer T1 couples the pulse into the diode mixer, D2 to D5. The VFO/VCO signal enters the mixer via resistor R17 and the primary winding of transformer T2. Resistor R16 biases the mixer diodes on slightly in order to give greater output. The output of the mixer is taken via the capacitor C12 and the filter unit A28 to the crystal calibrator amplifier.

The crystal calibrator amplifier, which forms part of A31, is a conventional high gain audio amplifier with the exception of components C6 and C7. These capacitors allow the amplifier to shape the bandwidth for the marker pips. The amplifier performs the dual function of providing both the audio beat note and the marker pips for display in the sweep mode.

3.15 COUNTER AMPLIFIER—UNIT A20

Circuit diagram Fig. 7.9

The range output signal enters the unit on pin 5 and is fed via the resistor R1 to the amplifier transistor TR1. The complex network comprising capacitors C5, C6, C7 and C9, inductors X2 and X3 and resistor R5 bypasses the emitter of TR1 and provides a degree of frequency response control. The collector signal of transistor TR1 is coupled by capacitor C8 to the base of the second amplifier transistor TR2. The emitter of this second transistor is bypassed by capacitors C13 and C14 which ensure amplifier stability.

The d.c. supply via C1 and L1 is further filtered by the network C3 and C4 with L2 and X1. Inductor L4 with capacitors C10 and C11 decouple the supply at low carrier frequencies.

3.16 R.F. COARSE ATTENUATOR—UNIT A44

Circuit diagram Fig. 7.11

The processed frequency for each range is taken via the coarse attenuator to the r.f. output socket. The attenuator is of conventional ladder construction and gives a maximum of 110 dB loss in 10 dB steps and has a source impedance of 50 Ω. At zero attenuation a microswitch is made to open causing the ladder network to be disconnected from the signal path.

3.17 A.L.C. SYSTEM

The instrument's a.l.c. system is provided for by the units A4, A10, A15, A18 and A19. The system performs three functions. It maintains the output level accuracy, provides 10 dB fine carrier level adjustment and provides a.m. with envelope feedback.

A combined d.c. + a.f. signal, representing carrier level and modulation instruction and derived from the setting of front panel controls is used to amplitude modulate the FMO signal in the reference modulator. The resulting signal is detected in Unit A19 and compared with the detected output of the range in use. The difference or error signal thus produced is processed in unit A18 and used to drive the modulators A4 and A15, which are in the signal paths.

The error signal follows two paths; first to a synchronous detector and thence via a d.c. amplifier to the voltage variable attenuator where it controls the amount of modulating instruction signal fed to the summing amplifier; the other path is via a low-pass filter which passes the d.c. component to the other input of the summing amplifier. The error voltage is metered to give a 'GO-NO GO' indication of satisfactory control loop operation.

As can be seen from the block diagram there are two main feedback loops. The first loop controls the amplitude modulation of the FMO signal at the reference modulator, using a high level detector, and gives the reference signal which, as an instruction to the second loop, controls the amplitude of the processed carrier frequency.

Range 1 employs the 22.5 MHz a.m. signal directly in conjunction with a small range of a.l.c. correction via the thermistor attenuator in A10, using the error signal produced by the comparator in A19. This directly controls the output level for range 1.

3.18 REFERENCE MODULATOR—UNIT A10

Circuit diagram Fig. 7.5

The modulating signal and variable d.c. from the 10 dB fine attenuator enters the unit at pin 7 from the drive unit, A32, and is fed to the transistors TR1 and TR2. As soon as the signal on the base of the drive transistor A32TR5 rises negatively the transistor TR2 will conduct giving an instantaneous response. The resistor R8 adjusts the bias of the transistor pair TR1 and TR2, so that the standing current of the pair is matched to that of the drive signal circuitry.

The 22.5 MHz FMO signal is fed to the r.f. amplifier and modulator transistor TR3 via the series tuned circuit, L2 and C2. The gain of the amplifier transistor is controlled by the d.c. and a.f. from the emitter of TR1. One output goes via pin 13 to unit A19 and another via pin 16 to the mixer unit A9 and range 1 amplifier.

The resistor R10 with diode D2 provides envelope feedback to the base of transistor TR2 in order to provide the output with a high degree of linearity.

For range 1 only, the error signal produced in unit A19 is fed via transistor TR4 to the thermistor R17 in order to control the r.f. output at pin 16.

3.19 DETECTOR AND COMPARATOR—UNIT A19

Circuit diagram Fig. 7.9

This unit contains two matched low level detectors housed in a heat sharing block. The diode D1 detects the 22.5 MHz modulated reference signal and D4 detects the output of the range in use. Early instruments used full wave detectors with diode D2 instead of R20 and D3 instead of R21; for service purposes they can be altered to the latest circuit. The resistor R1 is also housed in the heat sharing block in order to give the 50 Ω source resistance with near unity v.s.w.r.

The d.c. and audio signal outputs of the two detectors are compared in the differential amplifier, IC1. The difference or error signal thus produced is fed via pin 7 to the a.l.c. amplifier and via pin 9 to the range 1 thermistor control, A10R17.

Range 1 requires a.l.c. only as the modulation accuracy is derived by mixing from the reference modulator. When range 1 is in use the diodes D5 to D10 are switched on by a negative voltage at pin 5, thus bringing capacitors C7, C8 and C11 into the circuit. This gives the detector and i.c. circuits a slow correction response. However, modulation envelope feedback as well as a.l.c. is provided for ranges 2 to 11 via the a.l.c. amplifier and two modulator units, A4 and A15. In these cases the diodes are switched off and the circuits have a quick response allowing the error signal to follow the outline of the modulation envelope.

Resistor R7 is adjusted to zero the balance of the two detectors and differential amplifier. Capacitor C12 with resistor R18 and capacitor C13 with resistor R19 provide phase correction in the feedback loops of the amplifier. The emitter follower TR1 provides the negative and positive d.c. supply requirements of the i.c. differential amplifier.

3.20 A.L.C. AMPLIFIER—UNIT A18

Circuit diagram Fig. 7.9

This unit along with units A4, A10, A15 and A19 completes the instrument's a.l.c. system and provides for:

(a) Automatic level control including the 10 dB fine attenuator facility,

(b) Envelope feedback in order to reduce modulation distortion and

(c) Servo control of a.m. depth.

The operation of the circuitry in relation to the above functions is briefly as follows:

(a) Amplified a.c. and d.c. error voltages from unit A19 are fed via pin 1 to the low-pass filter C9, R14 and R19. The d.c. is amplified by TR7, 8 and 9 and used to drive the modulators A4 and A15. The correct carrier level is maintained and a variable range of 10 dB attenuation is provided depending on the setting of the fine attenuator control.

(b) A small amount of envelope feedback is tapped off at the junction of R14 and R19. This signal is amplified by TR7, 8 and 9 and allows distortion reduction of the modulation envelope and improved levelling during the operation in the sweep mode.

(c) Audio instruction signals are fed to unit A18 on pin 3. These signals are fed two ways. One is via R25 to the voltage variable attenuator which is basically comprised of TR6 and R25. The bias on TR6 is controlled by the output of the phase sensitive detector which will be described later. The bias determines the passive resistance of the source/drain path in TR6 and hence the attenuator is voltage variable.

The second route of the audio instruction voltage is via the sine to square wave converter, IC1, to the synchronous detector, TR1 and TR2. The synchronous detector serves to recognize the phase of the error signal, which is fed in via C6, and the d.c. output produced is used, after amplification by TR3, 4 and 5, to vary the bias on TR6. In this way the source/drain resistance of TR6 is varied in the correct direction and the correct value of audio instruction reaches the output summing amplifier, TR7, 8 and 9.

Low pass r.c. filter

C9, R14 and R19 form a low-pass filter which serves to remove part of the modulation frequencies from the comparator error signal. The d.c. obtained is fed via the output summing amplifier to the modulators, A4 and A15, in order to maintain the correct carrier level.

The resistor R19, in series with R14, allows a selected amount of the modulating frequency to be fed to the amplifier TR7, 8 and 9. This signal is amplified with the d.c. and serves to improve distortion performance of a.m.

R12, R33 and C16 prevent spurious oscillation of the control loop. The diodes D6 and D7 bypass R14 whilst C9 is uncharged and cease conducting as soon as the d.c. across C9 has reached nearly full charge. In this way the error voltages reach C9 instantly at switch on.

Voltage variable attenuator

The voltage variable attenuator is provided by R25 and TR6. These components form an 'L' pad where the shunt arm is formed by the drain/ source resistance of the FET, TR6. The attenuator is voltage variable because the bias on the gate of the FET determines its effective passive resistance.

The resistor R24 provides a fixed amount of attenuation and the diode D5 with R26 introduce an amount of predistortion which tends to cancel the distortion introduced by the modulators A4 and A15.

Output summing amplifier

Both inputs to this summing amplifier originate at the modulating signal instruction source. One input arrives via the reference modulator and comparator units and the other via the voltage variable attenuator.

The transistors TR7 and TR8 are a conventional long tailed pair. The emitter of TR9 is coupled directly to the collector load of TR7 and the collector current of TR9 is fed back via R31.

The feedback resistor R31 provides the amplifier with the required low d.c. gain and C14 serves to prevent any possible h.f. instability. The capacitor C15 reduces the h.f. noise bandwidth. The resistor R13 cancels any of the modulation signal which may break through TR6 when its effective resistance reaches its lowest limits.

This is done by feeding a small selected amount of the original modulating signal in opposite polarity to the amplifier input.

Squarer

This sine to square wave converter uses a very high gain integrated operational amplifier, IC1. Only a small sine wave input will cause the output to swing from one extreme to the other, thus producing a square wave.

The d.c. gain is reduced to unity by R5 which is decoupled by C3. C4 and R4 not only determine the phase delay of the circuit but with C5 provide gain stability. C2 overcomes any phase shift which would be caused by the limiting resistor, R3.

Synchronous detector

The two complementary transistors, TR1 and TR2, function as switches, being turned on and off by alternate halves of the square wave which is applied to their bases via the limiting resistor, R6. The a.c. component of the error signal from A19 is fed from pin 1 and via C6, R7 and R8 to the collectors of TR1 and TR2.

When the transistor TR1 is switched on the signal on its emitter is shorted to earth via C7. At the same time the signal on the collector of the non-conducting transistor flows through R11 to the d.c. amplifier transistor, TR5. The reverse procedure takes place when the polarity of the switching signal changes and the signal on the collector of TR1 is fed via R10 to the d.c. amplifier transistor, TR3. The change in polarity of the square wave switching signal is in synchronism with the modulating information of the error signal.

The diodes D1 and D2 form a peak-to-peak limiter for the signal on both sides of the detector. The capacitor C8 in conjunction with R10 and R11 forms a low-pass filter in order to remove any detector audio ripple.

D.C. amplifier

This amplifier, composed of TR4 and the long tailed pair TR3 and 5, is insensitive to in-phase audio input signals. As already described the signals from the synchronous detector are fed to the transistors TR3 or TR5. TR3 produces a non-inverted output and TR5 an inverted output. The resultant output is fed to TR6, the voltage variable attenuator, and in this way the bias to TR6 is altered causing its resistance to vary in the correct direction.

Limits bridge

The limits bridge controls the indication of the carrier level error meter. This meter reads mid-scale when the instrument is operating correctly when the voltage of the error signal on pin 1 will be between 9 and 15 V. It reads high or low when these limits are exceeded, when the a. l. c. system would be on the verge of losing control.

The resistors R15, 16, 17 and 18 are chosen so that when the error voltages are within the limits to enable satisfactory a. l. c. loop operation the voltage on pin 10 holds the meter at central deflection. If for instance the voltage should exceed the higher limit, D3 will conduct causing a higher potential at pin 10 to deflect the meter.

Summary of operation

Consider the case when the peak of modulation is insufficient. The carrier sample which is compared against the reference in A19 will produce an output from A19 more positive (i. e. towards earth) than it should be (i. e. if the modulation was perfect). This error signal arrives at TR2 while it is 'off'. The signal is allowed to pass to the inverting input (TR5) of the d. c. amplifier. As this signal is more positive than it should be the collector potential of TR5 is caused to change to a voltage which is correspondingly more negative. A higher drain/source resistance in TR6 is produced permitting more modulating signal to flow through the voltage variable attenuator. This results in a higher peak in the modulators which overcomes the defect in the carrier sample.

Similarly, the modulation trough is separately sampled by the other half of the synchronous detector and any variation from the reference signal is corrected.

3.21 POWER SUPPLY AND VOLTAGE STABILIZER

Circuit diagram Fig. 7.12

Power supply circuits, carried on units A42, A43 and A31, provide along conventional lines, the stabilized supplies called for in the generation of high stability signals. The circuits on units A43 and A42 produce a -18 V stabilized supply, from either a. c. or d. c. inputs, but because of the high frequency stability and low noise requirement of this instrument the -18 V supply is further stabilized to -16 V to drive the r. f. oscillators and the critical f. m. and Δf control circuits.

The a. c. input is fed to 43T1 whose primary winding can be arranged in series or parallel for supply voltages in the ranges 190 - 264 V r. m. s. (45 to 500 Hz) or 95 to 130 V r. m. s. (45 - 500 Hz) respectively. The a. c. input is rectified and smoothed, by diodes D2 to D5 on board A42 and C1, C2 and R1 on the power unit chassis A43, before being fed to the stabilizer. The resistor A42R11, which as part of a sampling potential divider chain, feeds a sample output to TR2. TR2 then compares the sample with the reference voltage provided by the Zener diode D6 and error signals are fed via the emitter follower, TR1, to the base of the series regulator transistor A43TR1.

A four wire system is used; two carry the current and two provide the voltage sampling. This arrangement allows the stabilizer to respond to voltage changes due to impedance of the supply line. R8 and R9 are fitted to retain operation of the stabilizer if the load is totally disconnected but for normal operation they are effectively short-circuited.

The second, or sub-stabilizer on board A31 is again a conventional series stabilizer with an overload protection device. The transistors TR3a and TR3b are an amplifier pair which form a comparator between the reference voltage provided by Zener diode D1 and the sample output provided by R6. TR1 is the series regulator transistor, controlled by the amplifier pair TR3a and TR3b. TR2 is an overload protection device. The resistor R4 provides a selected degree of forward control to the amplifier pair enabling best regulation and minimum output ripple to be obtained.

Chapter 4

Maintenance

4.1 INTRODUCTION

This chapter contains information for keeping the equipment in good working order and for checking its overall performance.

Before attempting any maintenance on the signal generator, you are advised to read the preceding Technical Description chapter.

CAUTION

This instrument uses semiconductor devices which, although having inherent long term reliability and mechanical ruggedness, are susceptible to damage by overloading, reversed polarity and excessive heat or radiation. Avoid hazards such as reversal of batteries, prolonged soldering, strong r.f. fields or other forms of radiation, use of insulation testers or accidentally applied short circuits. Even the leakage current from an unearthed soldering iron could cause trouble. Before shorting or breaking any circuit, refer to the circuit diagrams to establish the effect on bias arrangements of the transistors.

4.2 SCREW FASTENERS

Screw threads used on this instrument are mostly ISO metric. They are the following sizes M1, M2, M3 and M6 and may be identified by their blue tint.

CAUTION

Do not replace ISO metric screws with BA, BSF, BSW or Unified screw sizes.

4.3 MAINTENANCE ACCESSORIES

The extender leads provided are to allow work to be carried out on the instrument whilst the processing box, unit A30, is hinged out.

The strap, item 10e, in Fig. 1.4 is provided to give the necessary support to the power supply chassis when hinged out. To fit the strap:

(1) Remove the bracket between the power supply and the oscillator box.

(2) Remove two of the screws holding the power supply chassis to the main chassis (the two nearest the r.f. processing unit).

(3) Hinge the power supply chassis backwards on the other two screws and fit the strap between it and the main chassis, using the now vacant fixing holes on one side.

The bracket is used to hold the processing box in an open position. The two fixing holes on one flange locate with the two fixing holes of the perforating top plate nearest the left hinge. The processing box is then hinged out through 180° and the third hole in the bracket locates against the hole provided in the processing box casting.

4.4 DISMANTLING AND COMPONENT ACCESS

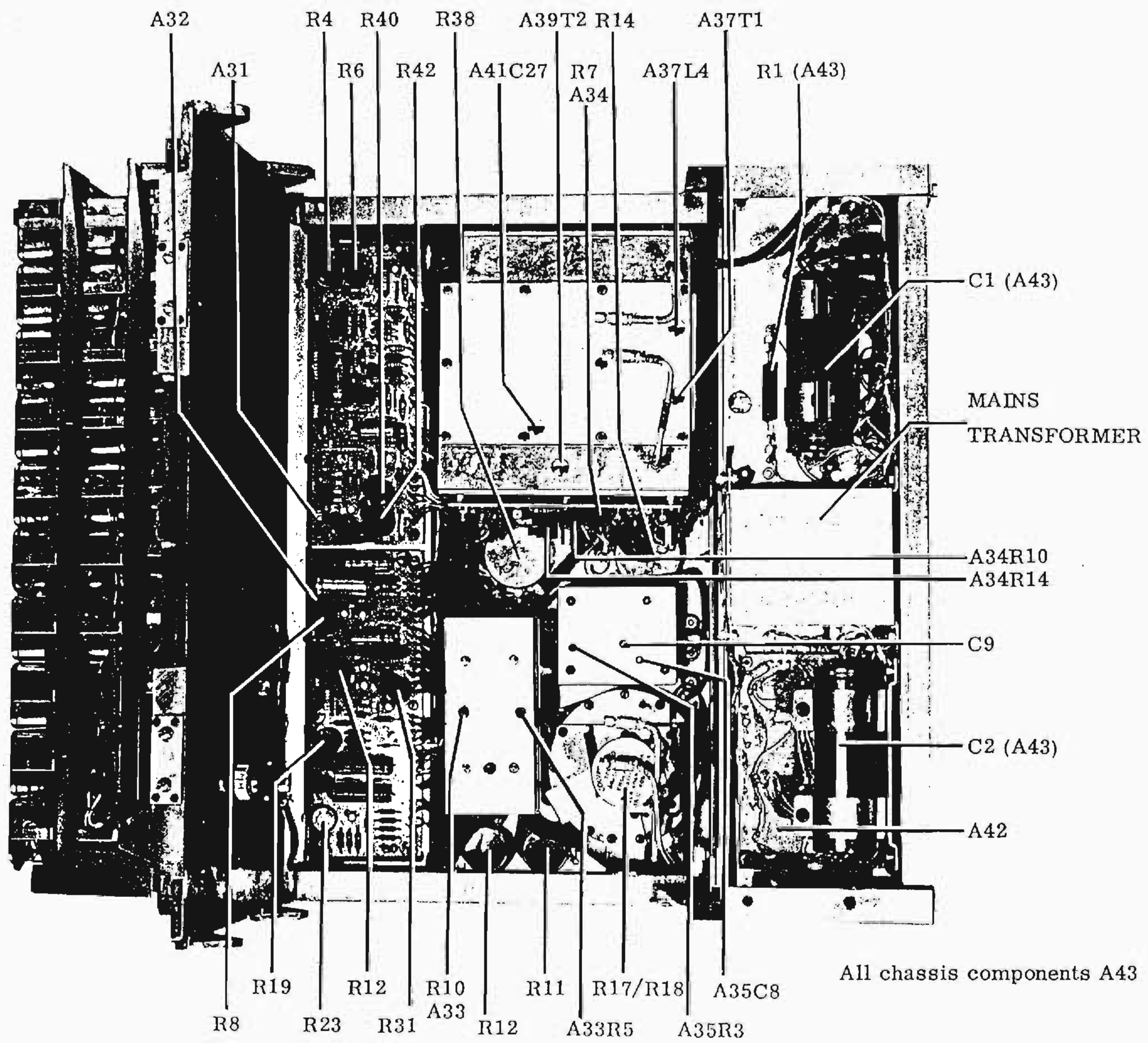
Removal of case

Stand the instrument on its face. Remove the four coin slotted screws in the rear panel and the two 4 BA screws at the sides near the front. The case and rear panel can now be lifted away from the instrument.

Removal of r.f. processing unit

Unscrew and hinge out the power supply chassis as described in Sect. 4.3. Disconnect the four r.f. couplings and extract the four M4 screws (two each side) that secure the r.f. processing unit to the main frame. Slacken the two grub screws on the range coupler which secure it to the metal spindle of the frequency range switch.

Fig. 4.1 Rear view, with case removed and with power supply and r.f. processing units hinged away.



All chassis components A43

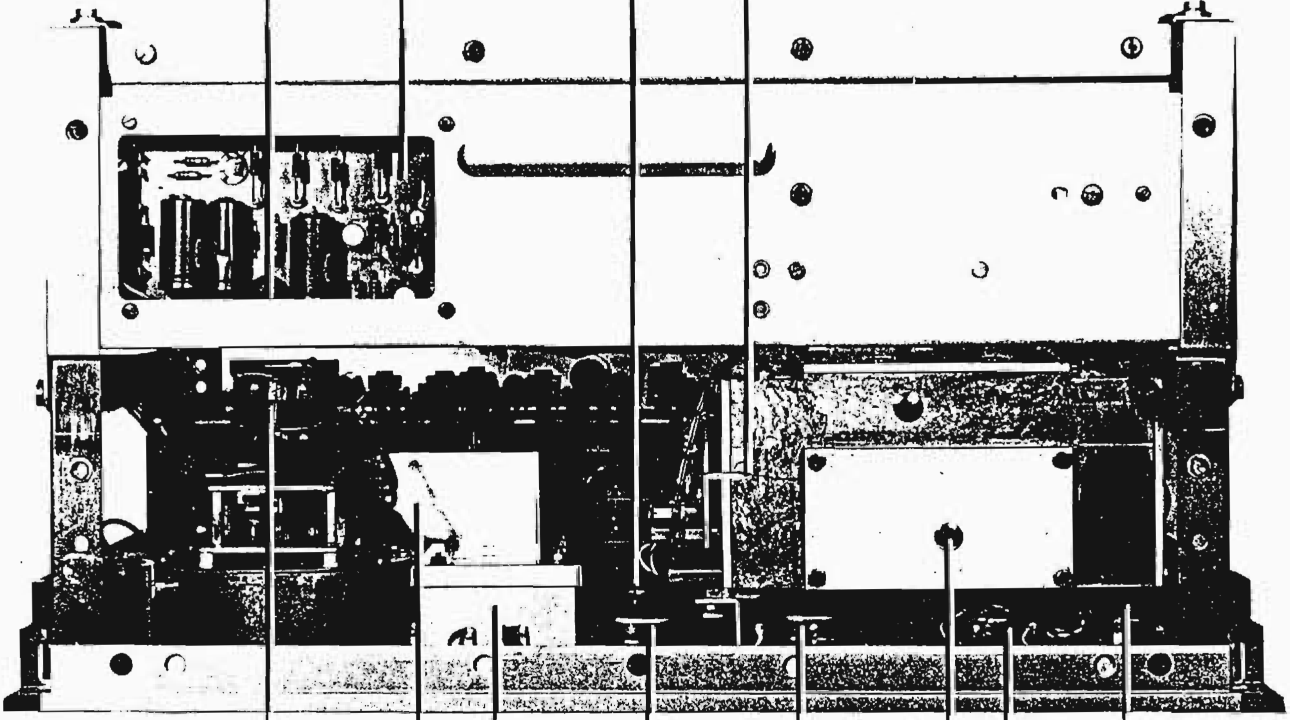


Fig. 4.2 Underside view, with case removed.

The r. f. processing unit may now be hinged out to allow access to its printed circuit boards. If the unit is required to be completely removed, unsolder the four wires on the filter inputs and remove the four hinge screws (two on each hinge).

The r. f. processing unit consists of 27 printed circuit boards A1 to A27, each, save two, in its own r. f. screening box, one r. f. filter in an r. f. screening box and a diode switching circuit. The complete unit is mounted in three tiers, all of which are hinged, the top tier containing units A1 to A10, the centre tier units A11 to A20 and the lower tier units A21 to A27, filter A28 and the diode switch. Earth springs soldered to the printed circuit boards on each of the screened units ensure a good earth between the board and r. f. screening box.

If access is required to either the centre or bottom tier, the two screws must be removed from the left-hand side of the unit, thereby allowing the top two tiers to be hinged up. Do not attempt to hinge the centre tier by more than 90° and the top tier by more than 180°.

When refitting the r. f. processing unit, set the range switch on the front panel to RANGE 1 and the plastic spindle on the r. f. processing box so that 1 on the spindle flange lines up with the mark on the casting box. Retighten the grub screws on the coupler. Switch slowly through each range ensuring the range change switch makes contact on every range.

Power Supply

To hinge open the power supply chassis it is necessary to remove the bracket between the power supply and the oscillator box, also the two screws (one each side) nearest the processing box which secure it to the main chassis. Hinge the chassis backwards fitting the strap (item 10e of the accessory kit) between two locating holes left by removal of one of the screws from the main and power supply chassis.

Should the complete power supply be required to be removed, unscrew the four screws securing it to the main chassis, but do not attempt to move it more than six inches away from the main chassis without first disconnecting all the leads comprising the cableform attached to it.

To remove the mains transformer proceed as follows:

(1) Unsolder the seven leads connected to the mains transformer.

(2) Unscrew the four M6 screws securing the mains transformer to the back panel and the two screws holding it to the power supply sub-assembly.

(3) Slide the transformer forward and remove it.

To remove the printed circuit board, unscrew the four screws securing it to the back panel and carefully extract it from behind capacitor A43C2. Avoid moving the board more than approximately 6 inches away from its original position without first disconnecting all the leads comprising the cableform attached to it.

Attenuator

To remove the attenuator unit from the main frame:

(1) Hinge out the power supply.

(2) Remove the attenuator cursor by sliding it upwards. Slacken the grub screws securing the coarse and fine attenuator knobs and pull both knobs off.

(3) Unscrew the nut securing the r.f. output socket.

(4) Disconnect the r.f. input lead to the attenuator and the three wires to the fine attenuator.

(5) Remove the two screws holding the complete assembly to the chassis.

(6) Lift out the assembly.

To obtain access to the attenuator components, extract the screws from the top of the assembly.

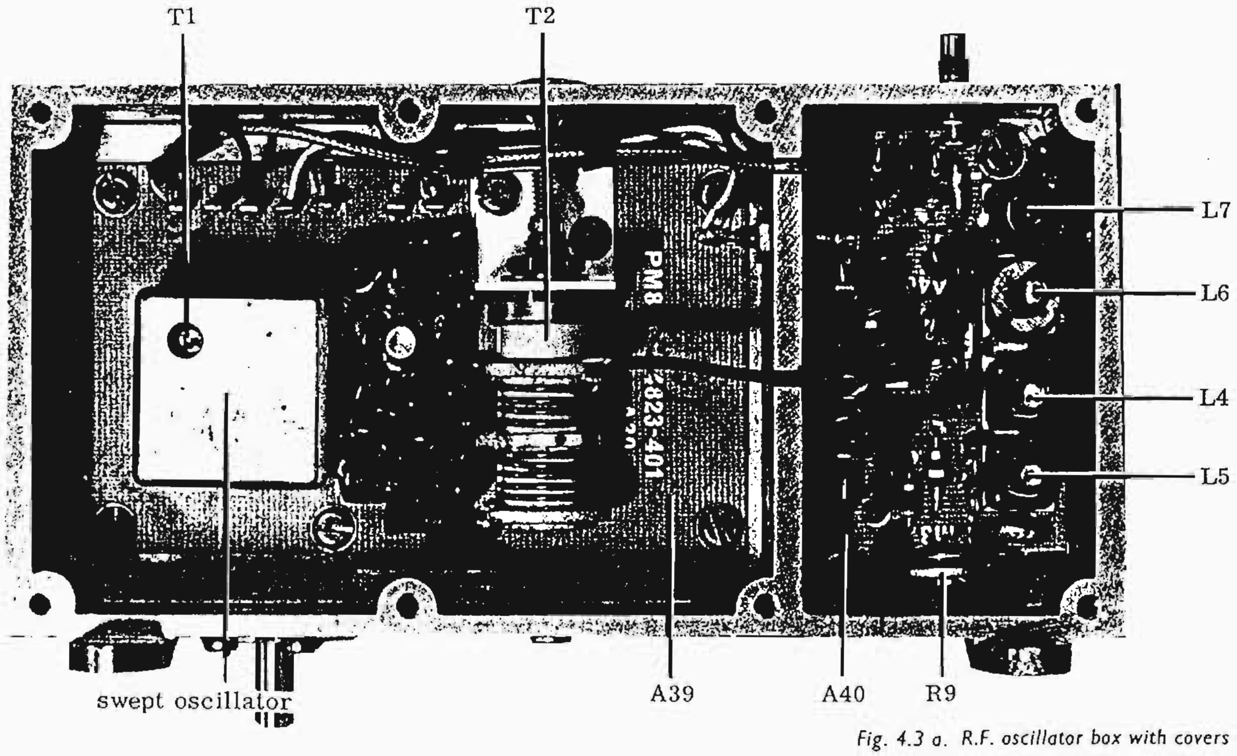


Fig. 4.3 a. R.F. oscillator box with covers removed

Modulation oscillator

Hinge out the power supply and the r.f. processing unit. The top cover of the r.f. screening box which contains the modulation oscillator may be removed by extracting the four nuts, which leaves the modulation oscillator printed board exposed.

Carrier range switch

Hinge out the power supply and the r.f. processing unit. Access to the CARRIER RANGE switch is obtained by removing four 6 BA nuts and removing the top cover of the r.f. screening box; this leaves the switch fully exposed.

R.F. oscillator box

To remove the oscillator box from the main chassis:

(1) Remove the CARRIER FREQUENCY knob and dial assembly, and the gear retaining washer.

(2) Hinge out the power supply and the r.f. processing unit.

(3) Remove A34 - extract three M3 screws at the rear edge of the board and three extended head screws at the front edge of the board; these latter require the use of a 4 BA spanner but the thread is M3. Pull the board clear on its cableform.

(4) Unsolder the connections to the r.f. oscillator unit. Extract the three M4 screws that hold the unit to the front brackets. Lift the oscillator unit out.

Access to the boards is obtained by removal of the appropriate cover panel from the main assembly.

Replacement

When refitting the oscillator unit disengage the cursor drive gear wheel by moving the screw adjacent to the oscillator spindle entry along the slot, and hold it in this position. Offer up the oscillator unit, allow the gear wheel to engage and replace the three M4 screws to hold the unit in place. Check the gear engagement by turning the tuning spindle and noting the position of the cursor Do not allow the cursor to travel beyond the scale window. On the highest frequency range, with the tuning spindle turned to its high frequency end stop the cursor should be on or slightly beyond the 510 MHz mark. If the engagement is wrong, disengage the gear again and reset. Refit the washer and knob and remake the connections.

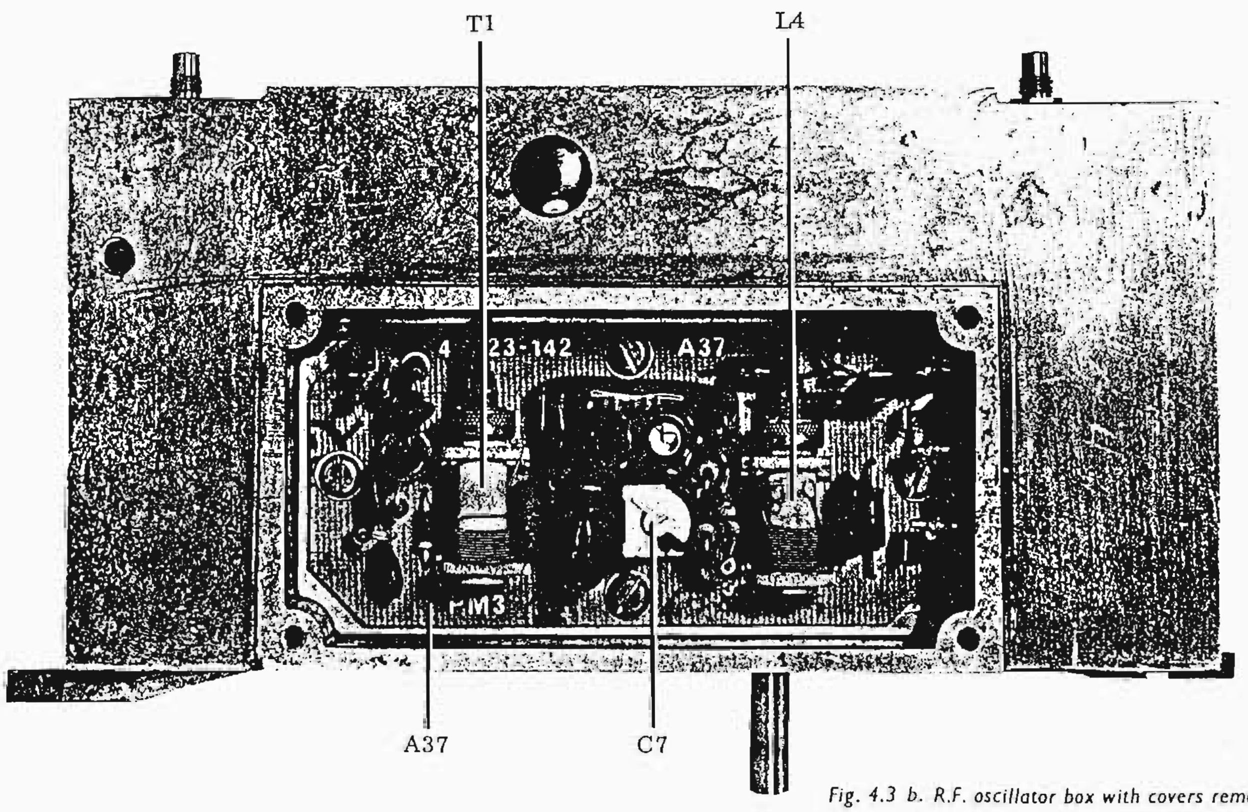


Fig. 4.3 b. R.F. oscillator box with covers removed

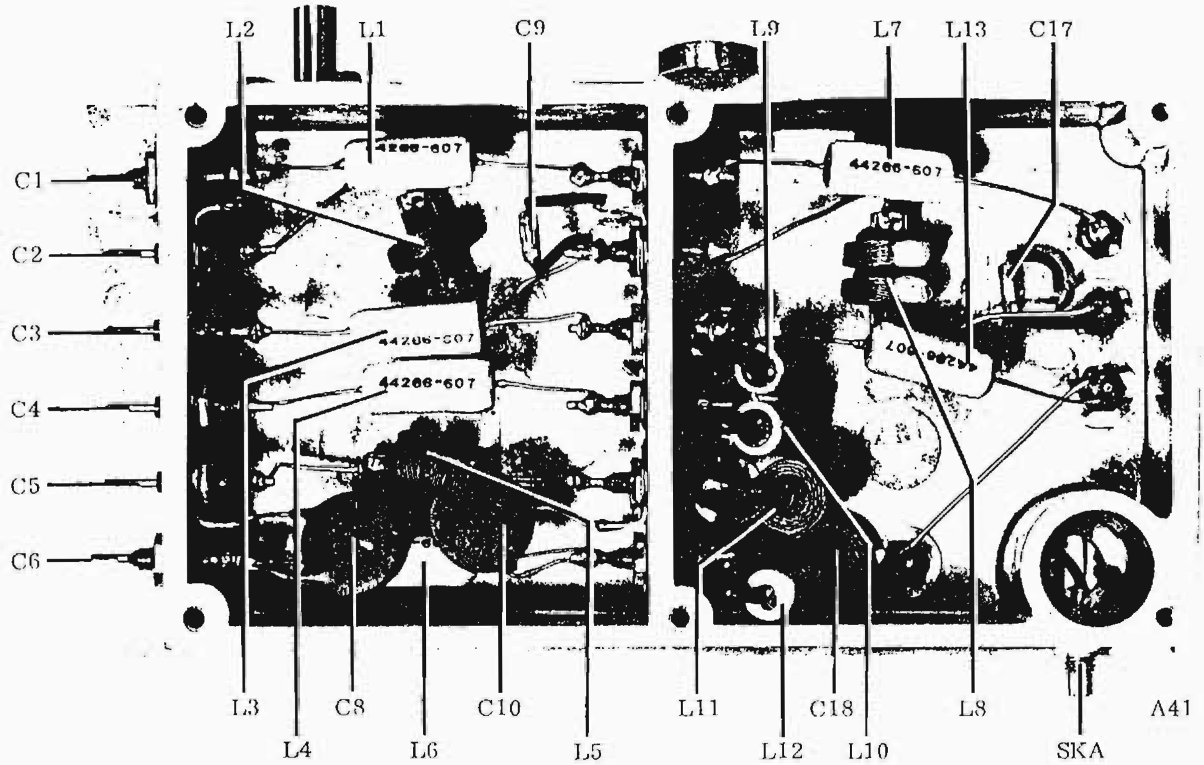


Fig. 4.3 c. R.F. oscillator box with covers removed

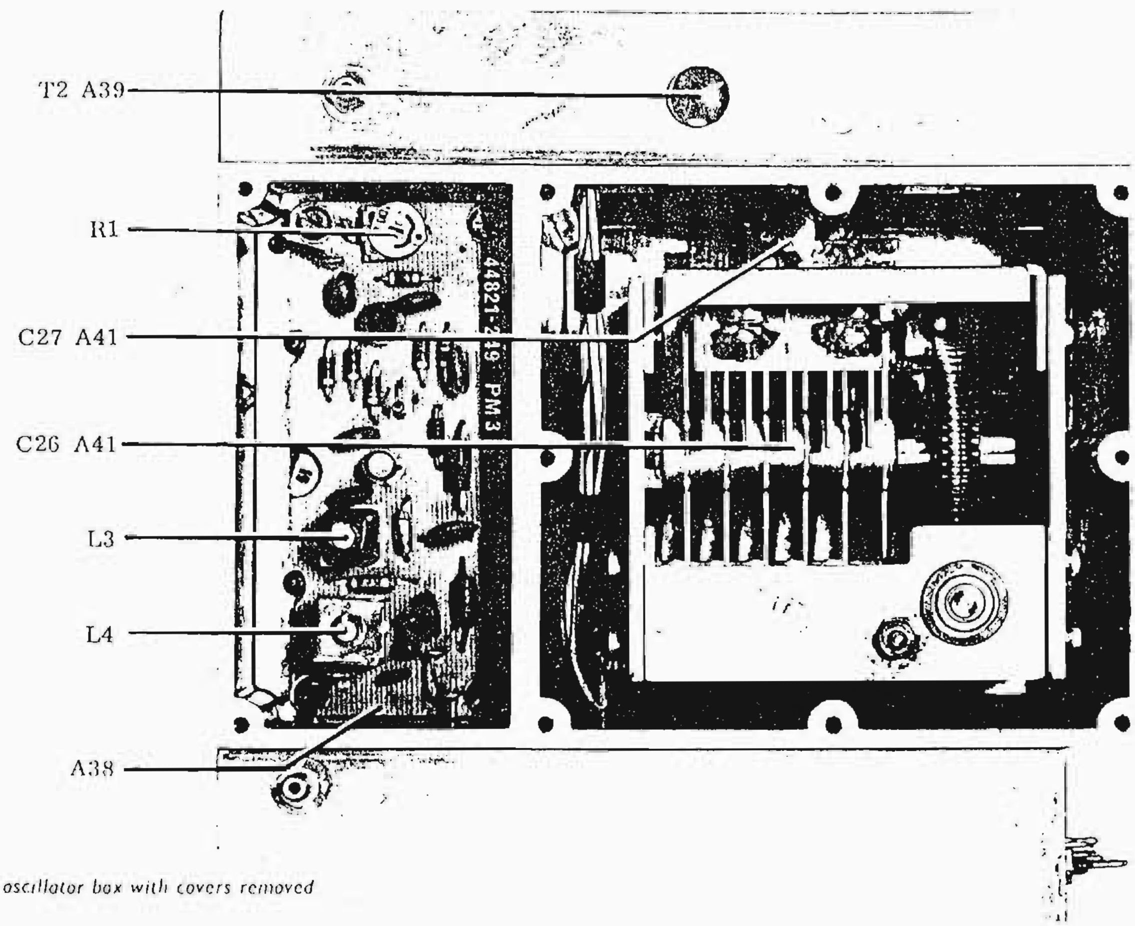


Fig. 4.3 d. R.F. oscillator box with covers removed

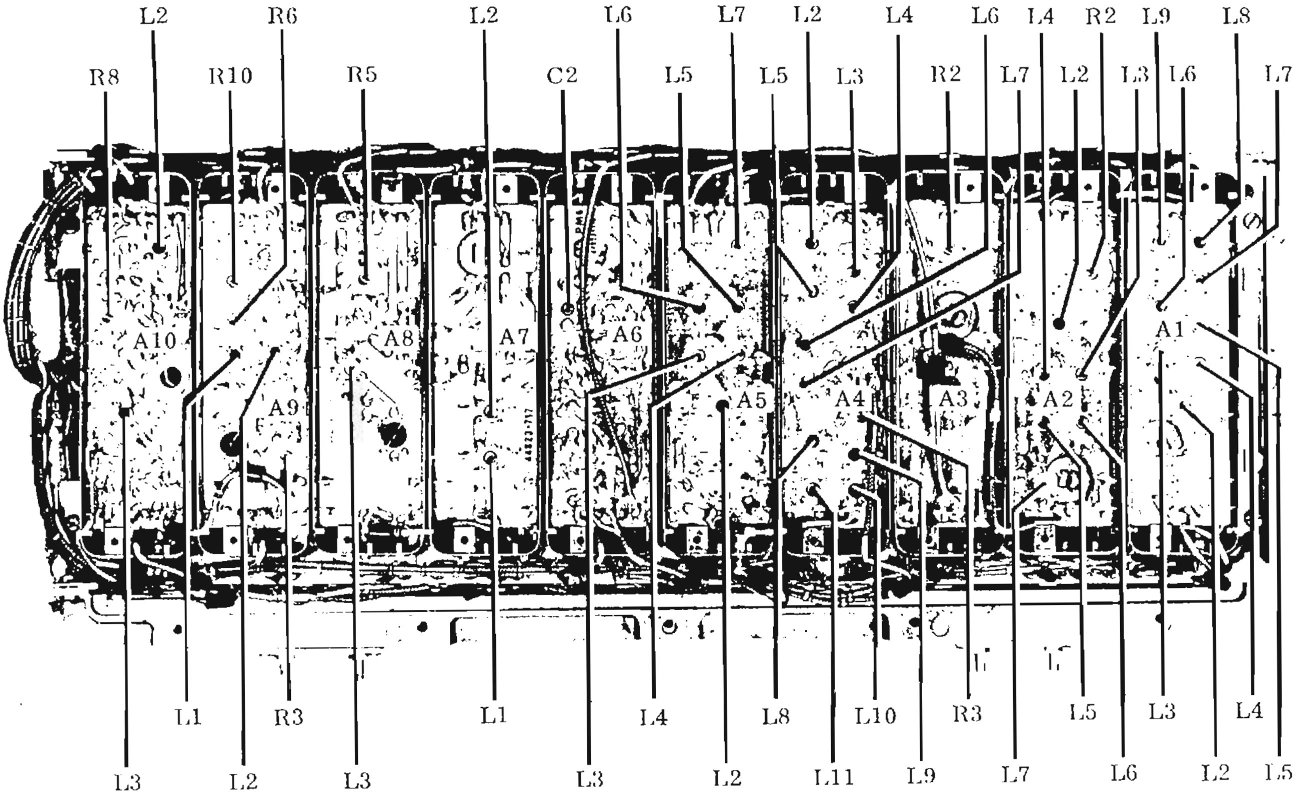


Fig. 4.4 R.F. processing box A1–A10.

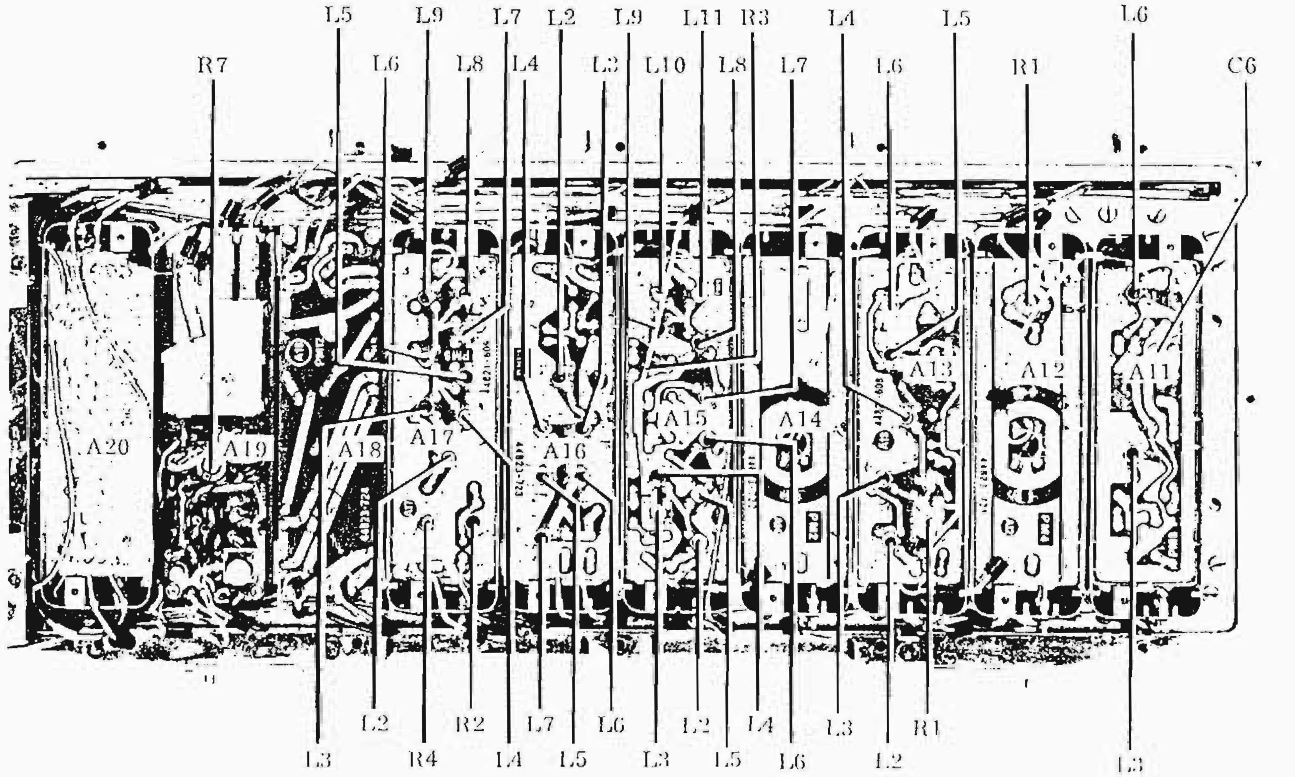


Fig. 4.5 R.F. processing box A11–A20

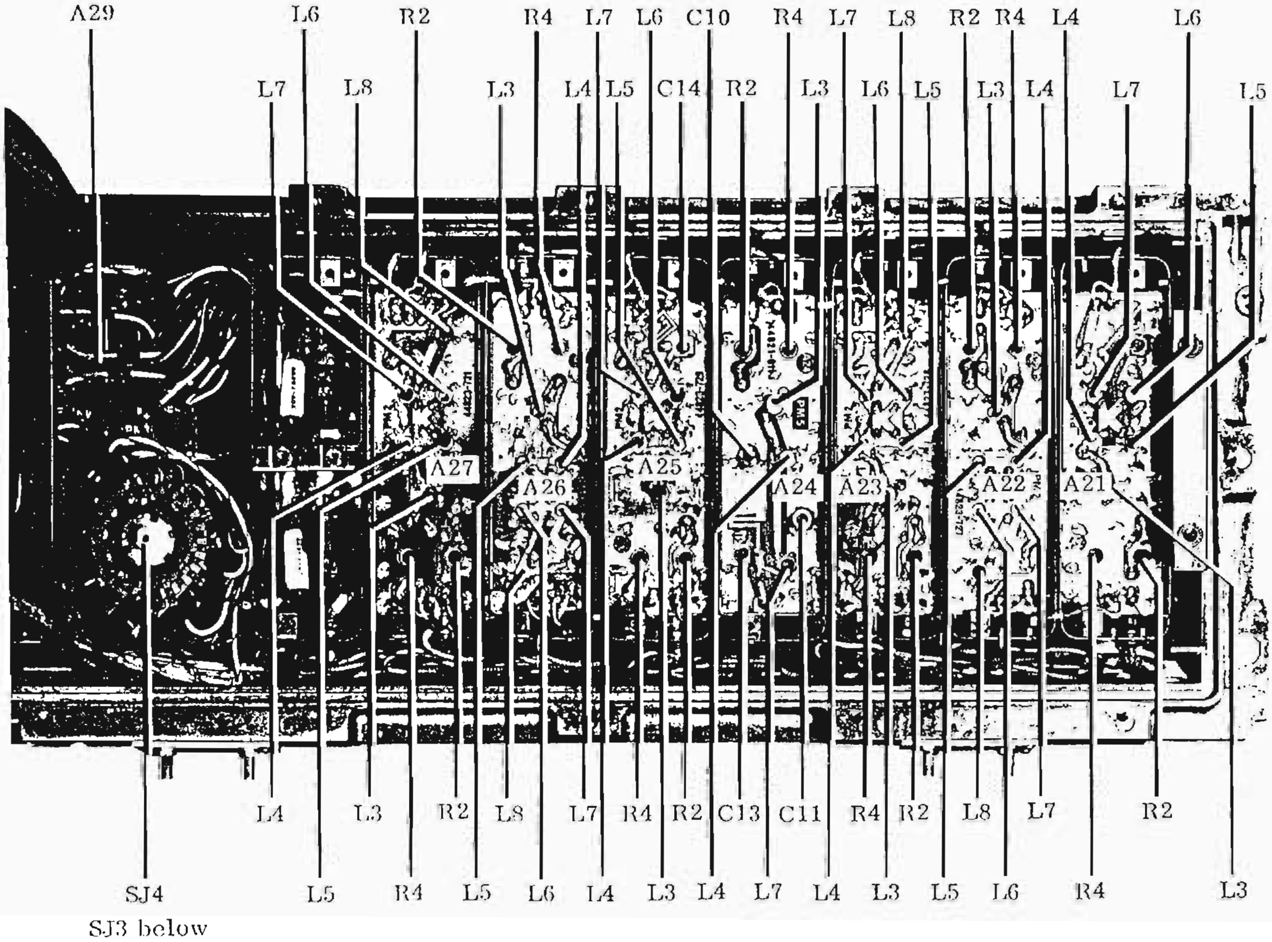


Fig. 4.6 R.F. processing box A21 A27

4.5 CIRCUIT VOLTAGES

The voltages given on the circuit diagrams are those which may be expected on a typical TF 2008 at a mains input of 240 V, using a 20 kΩ/V meter. All are negative with respect to earth.

The controls were set as follows:

Frequency	27 MHz
Fine tuning	Fully counter-clockwise
Mode	Manual
Sweep width	Mid-travel
Centring	Mid-travel
Main scale markers	Off, A31 on
Set markers	Mid-travel
Markers level	Mid-travel
Functio	Int. a.m., A31 c.w., A34 Int. f.m.
Modulation depth	80%
Internal ΔF	0
Deviation	0
Modulation frequency	1 kHz
ΔF/deviation range	30
Deviation multiplier	x1
Step attenuator	Fully counter-clockwise
Fine attenuator	Fully clockwise
Carrier	ON
Modulation	ON, A31 off

4.6 CLEANING ROTARY SWITCHES

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.

4.7 PERFORMANCE TESTS

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 repair is needed.

4.7.1 Test equipment required

A list of the test equipment required for these tests is given in table 4.1.

Table 4.1

Test equipment

Item	*Description*	*Recommended model*
a	120 MHz Counter	TF 2410
b	600 MHz Converter	TM 8334
c	'N' type 50 Ω load	
d	Headphones	
e	30 MHz Oscilloscope and Dual Trace Plug-in	TF 2201 & TM 6971
f	D. C. power supply	(up to -18 volts)
g	Sensitive Valve Voltmeter	TF 2600
h	'T' connector	
i	R. F. Millivoltmeter	TF 2603
j	R. F. Attenuator	TF 2163
k	Receiver and 'S' Meter, 150 MHz	Eddystone 770R
l	20 cm Air Spaced Line 20 cm Adjustable Line	GR 874-L20 GR 874-LK20L
m	D. C. Microvoltmeter	Dymar 70 & 721 plug-in
n	Distortion Factor Meter	TF 2331
o	A. M./F. M. Modulation Meter	TF 2300
p	A. F. Oscillator	TF 1101
q	Stereo Modulator	Radiometer SMG 40
r	Psophometer	Hatfield Inst. SPO 7525
s	R. F. Detector	H. P. 420A
u	Short circuit connector - see Fig. 4.7	

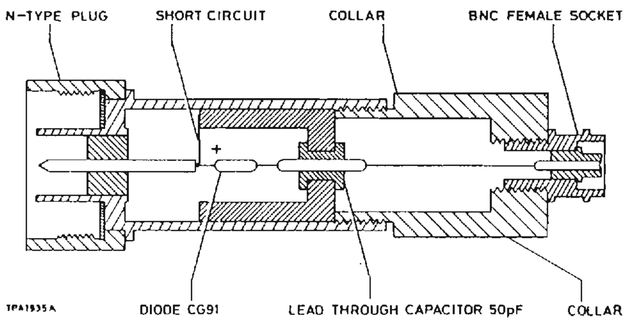


Fig. 4.7 Short circuit load

4.7.2 Frequency calibration

Test equipment : items a, b.

Check marker standardization (see p. 18). Connect the R. F. OUTPUT of the TF 2008 to the input of the counter/converter. Ensuring that the SET MARKERS, FINE TUNE and ΔF controls are at mid-travel check that the calibration accuracy on bands 3 - 11 is within ±0.5% and that the frequency cover can be obtained on all ranges. The ΔF/DEVIATION RANGE selector must not be set to EXT NARROW SWEEP.

4.7.3 Attenuator reaction

Test equipment : items a, b, c.

Connect the 50 Ω load to the R. F. OUTPUT socket of the TF 2008 and the counter/converter to the COUNTER OUTPUT. Set the TF 2008 controls as follows :

FUNCTION SELECTOR	C. W.
MODE SELECTOR	MANUAL
INT ΔF	0
DEVIATION RANGE	3 kHz
COARSE ATTENUATOR	Maximum output
FINE ATTENUATOR	Maximum output
MARKERS	OFF

Adjust the FREQUENCY control to obtain a frequency of about 100 MHz as displayed on the counter and note the reading. Turn FINE attenuator to -10 dB and again note the counter reading. Ensure that the difference in the two readings does not exceed 100 Hz.

Repeat the test at a frequency of 510 MHz ensuring the frequency change does not exceed 200 Hz.

4.7.4 Load reaction

Test equipment : items a, b, c.

Connect the 50 Ω load to the R. F. OUTPUT of the TF 2008 and the counter/converter to the COUNTER OUTPUT. Set the TF 2008 controls as follows :

FUNCTION SELECTOR	C. W.
MODE SELECTOR	MANUAL
INT ΔF	0
DEVIATION RANGE	3 kHz
COARSE ATTENUATOR	Maximum output
FINE ATTENUATOR	Maximum output
MARKERS	OFF

Adjust the FREQUENCY control to obtain a frequency of 100 MHz on the counter. Disconnect the 50 Ω load and note the new reading on the counter. Ensure that the difference in the two readings on the counter does not exceed 100 Hz.

Repeat the test at a frequency of 510 MHz ensuring the frequency change does not exceed 200 Hz.

4.7.5 ΔF accuracy

Test equipment : items a, b.

Connect the R. F. OUTPUT of the TF 2008 to the input of the counter/converter. Set the TF 2008 controls as follows :

INT ΔF	0
ΔF RANGE SELECTOR	3 kHz
ΔF MULTIPLIER	x1
FUNCTION SELECTOR	C. W.
MODE SELECTOR	MANUAL
FREQUENCY	100 MHz

Note the reading displayed on the counter/converter with the ΔF dial set to 0, and set the dial to +3 kHz. Note the new reading obtained on the counter and ensure that the difference in the two frequencies is 3 kHz ±650 Hz. Repeat the above procedure in the negative excursion.

Repeat the procedure for each ΔF range ensuring that the ΔF accuracy is within the limits shown in table 4. 2.

Table 4.2

ΔF Accuracy limits at carrier frequency of 100 MHz

ΔF dial reading	Actual ΔF reading (limits)
±3 kHz	2350 - 3650 Hz
±10 kHz	9.0 - 11.0 kHz
±30 kHz	28.0 - 32.0 kHz
±100 kHz	94.5 - 105.5 kHz
±300 kHz	284.5 - 315.5 kHz

4.7.6 Crystal calibrator markers

Test equipment : items c, d, e.

Set the controls of the TF 2008 as follows :

FUNCTION SELECTOR	C.W.
RANGE SELECTOR	10 kHz - 4.5 MHz
MODE SELECTOR	MANUAL
MARKERS	ON

Connect the headphones to the MARKERS OUTPUT jack and adjust the MARKER LEVEL control to obtain a suitable level. Set the main tuning scale on a calibrator mark and adjust the SET MARKERS control to obtain zero beat. Set the MODE SELECTOR to SWEEP, centralize the frequency with the CENTRING control and connect the oscilloscope to the MARKERS OUTPUT terminal. Connect the HORIZONTAL OUTPUT of the TF 2008 to the oscilloscope horizontal input and, adjusting the WIDTH control, ensure thirteen markers are obtainable on the oscilloscope display. The LEVEL control may need to be altered to adjust the amplitude of the beats.

4.7.7 External narrow sweep

Test equipment : items a, b, f.

Connect the counter/converter to the R. F. OUTPUT of the TF 2008 and the d.c. power supply to the EXT ΔF terminals. Set the TF 2008 controls as follows :

ΔF/DEVIATION RANGE SWITCH	EXT NARROW SWEEP
FUNCTION SELECTOR	C.W.
MODE SELECTOR	MANUAL
FREQUENCY	4.5 MHz

With the d.c. power supply at zero volts, note the frequency reading on the counter. Then increase the d.c. level until the frequency shifts by 150 kHz as monitored on the counter. Record the d.c. input voltage required to achieve this difference frequency. Repeat the test in a negative direction and again record the result.

Repeat this test at the frequencies stated in table 4.3 ensuring that not more than 5 V is required to obtain the required incremental frequency.

Table 4.3

Carrier frequency (MHz)	ΔF frequency (kHz)
4.5	±150
22.5	±150
31.5	±150
45	±150
63	±300
90	±300
126	±600
180	±600
252	±1200
360	±1200
510	±2400

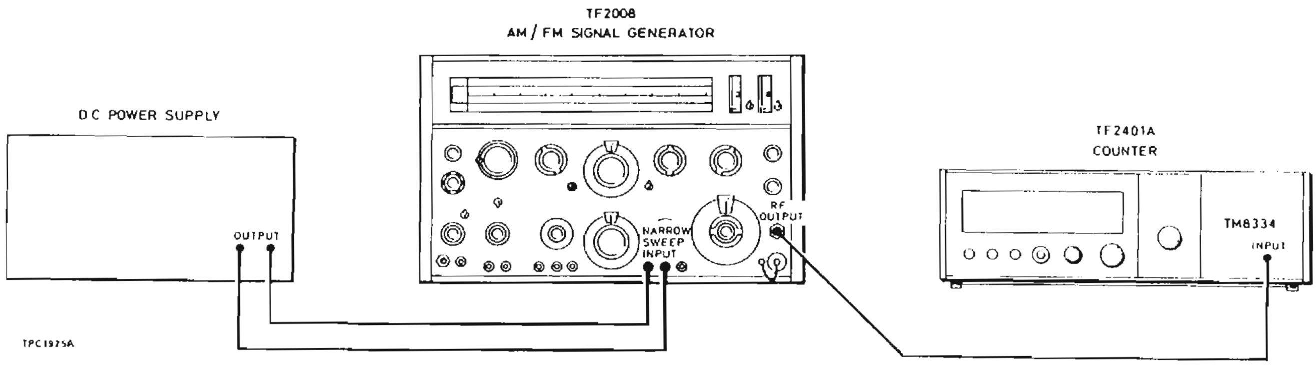


Fig. 4.8 Test gear arrangement to check external ΔF

4.7.8 R.F. output levels

Test equipment : items c, g, h, i.

(a) Frequency characteristic

Connect the R. F. OUTPUT of the TF 2008 to the input of the sensitive valve voltmeter loaded with 50 Ω. Set the TF 2008 controls as follows :

FUNCTION SELECTOR	C.W.
MODE SELECTOR	MANUAL
OUTPUT LEVEL control	200 mV e.m.f.
FREQUENCY RANGE	0.01 - 4.5 MHz
FREQUENCY SCALE	0
INT ΔF	+10 kHz

Ensure that the valve voltmeter reads 100 mV ±2 dB. Repeat this test at frequencies of 100 kHz and 1 MHz ensuring the valve voltmeter reads 100 mV ±1 dB.

Disconnect the sensitive valve voltmeter and connect up the test equipment as shown in Fig. 4.9 :

Set the TF 2008 controls as follows :

FUNCTION SELECTOR	C.W.
MODE SELECTOR	MANUAL
INT ΔF	0
OUTPUT LEVEL control	200 mV e.m.f.
FREQUENCY	150 MHz

At a frequency of 150 MHz adjust the OUTPUT LEVEL control to obtain a reading of 100 mV on the r. f. millivoltmeter. Disconnect the r. f. millivoltmeter and T connector and set the r. f. attenuator to 100 dB. Connect the R. F. OUTPUT of the TF 2008 to the r. f. input of the attenuator and adjust the sensitivity of the receiver to obtain a reading of f. s. d. on the 'S' meter. The receiver is now set up to a sensitivity of 2 μV.

Set the OUTPUT LEVEL control to the points shown in table 4.4 and ensure that attenuator setting required to return the 'S' meter to f. s. d. is within the limits shown in the table.

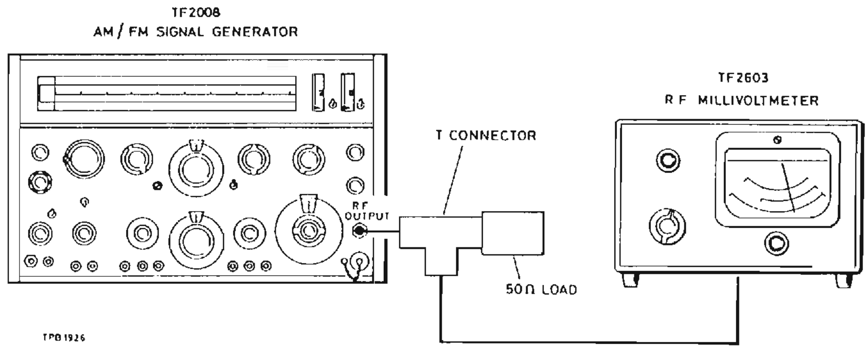


Fig. 4.9 Test gear arrangement to check r.f. output level

Repeat the above test at frequencies of 4.5 MHz, 22.5 MHz, 31.5 MHz, 45, 63 and 90 MHz, ensuring that the r. f. millivoltmeter reads 100 mV ±1 dB.

(b) Low level accuracy

Test equipment : items c, h, i, j, k.

Connect the test equipment as in Fig. 4.10

Table 4.4

Output level setting (dB)	*Limits of attentuator setting (dB)*
100	92 - 96
90	82 - 86
80	72 - 76
70	62 - 66
60	52 - 56
50	42 - 46
40	32 - 36
30	22 - 26
20	12 - 16
10	2 - 6

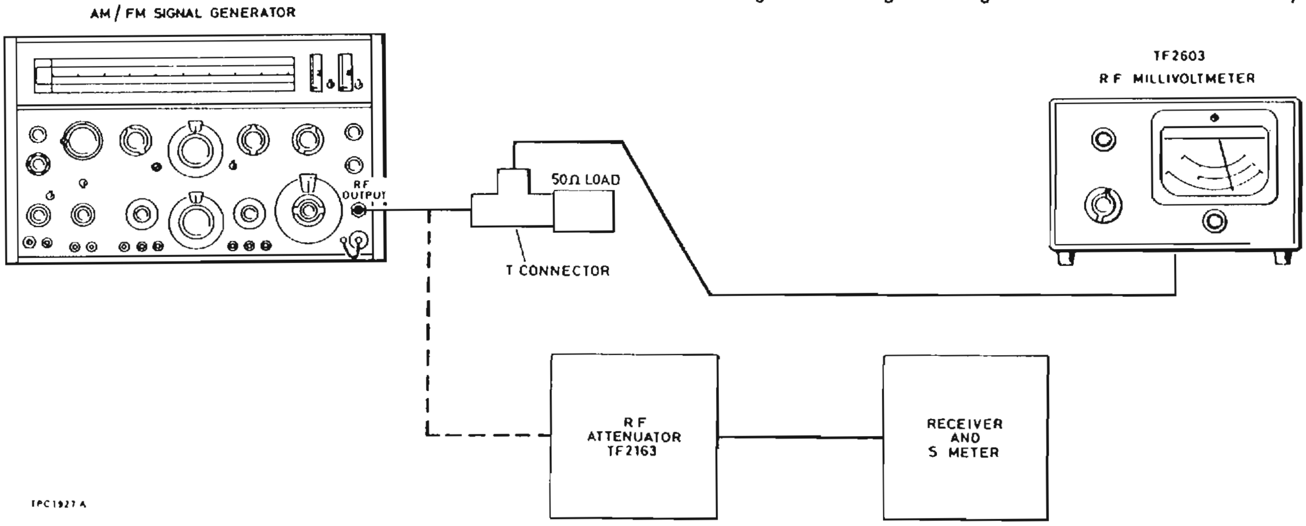


Fig. 4.10 Test gear arrangement to check low level accuracy

4.7.9 V.S.W.R.

Test equipment : items l, m, u.

Set the TF 2008 controls as follows :

FUNCTION SELECTOR	C.W.
MODE SELECTOR	MANUAL
FINE ATTENUATOR	Maximum output
COARSE ATTENUATOR	10 dB below maximum output

Connect up the test equipment as shown in Fig. 4.11. Set up the TF 2008 to give maximum c.w. output at a frequency of 500 MHz. Set the adjustable line to $\frac{1}{2}$ (half wavelength) of the signal by applying the formula :

$$= \frac{300}{f} \quad \text{where } \lambda = \text{wavelength in metres} \quad \text{and } f = \text{frequency in MHz}$$

Adjust the line length for a maximum indication on the microvoltmeter and note its reading. Adjust the line length for minimum indication on the microvoltmeter, at $\frac{1}{4}$ wavelength away from the maximum response. Again note the voltmeter reading.

By definition, v.s.w.r. is the ratio of the maximum to minimum line voltage. The r.f. voltage developed across the virtual short circuit is detected by the diode and the corresponding d.c. maximum and minimum (e max. and e min.) are measured on the microvoltmeter. As the diode is being used on the lowest part of this characteristic a square law voltage applies, the v.s.w.r. being equal to $\sqrt{\frac{e\ max.}{e\ min.}}$

Repeat this test at 350, 400 and 450 MHz, ensuring the v.s.w.r. is within 1.5:1.

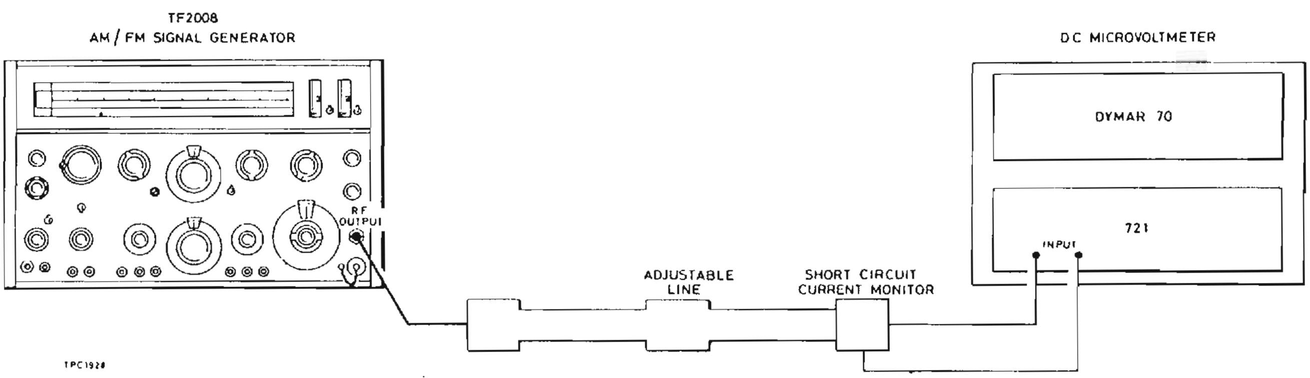


Fig. 4.11 Test gear arrangement to check v.s.w.r.

4.7.10 Counter output level

Test equipment : items c, h, i.

Set up the test equipment as shown in the Fig. 4.12. With the fine attenuator set to -10 dB check that from 50 kHz to 510 MHz at least 50 mV output is obtainable from the COUNTER OUTPUT socket as monitored on the r.f. millivoltmeter. The r.f. output socket should also be terminated with a 50 Ω load.

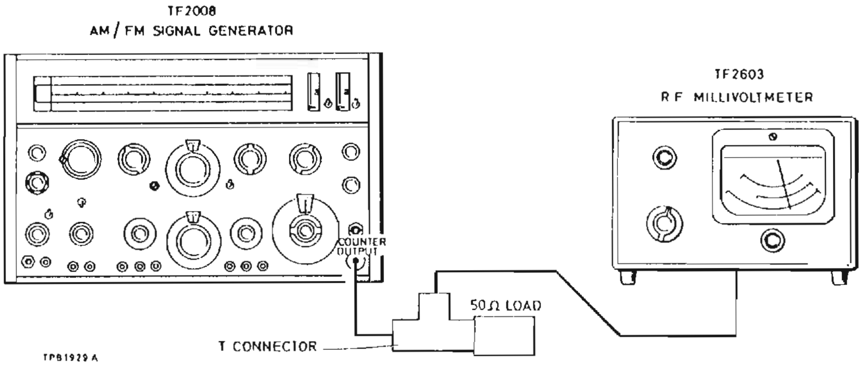


Fig. 4.12 Test gear arrangement to check counter output level

4.7.11 Modulation oscillator dial accuracy

Test equipment : item a.

Connect the input of the counter between the MODULATION OUTPUT and EARTH terminals of the TF 2008. At modulation frequencies of 300 Hz, 500 Hz, 1 kHz and 3 kHz, ensure that the modulation oscillator dial accuracy is within ±10%.

4.7.12 Modulation oscillator distortion

Test equipment : item n.

Connect the input of the distortion factor meter to the MODULATION OUTPUT and EARTH terminals of the TF 2008. At modulation frequencies of 300 Hz, 500 Hz, 1 kHz and 3 kHz, ensure that the total harmonic distortion does not exceed 0.15%.

4.7.13 A.M. accuracy

Test equipment : items g, o, p.

Set up the test equipment as shown in Fig. 4.13. Set the TF 2008 controls as follows :

FUNCTION SELECTOR	Ext A.M.
MODE SELECTOR	MANUAL
INT ΔF	0
OUTPUT LEVEL	200 mV e.m.f.
FREQUENCY	300 MHz
A.M. DEPTH	80%
MODULATION FREQUENCY	1.0 kHz

Measure the depth of modulation on the modulation meter ensuring that up to 40% the modulation depth is within ±6% and from 40% to 80% is within ±15% of reading. Repeat at modulating frequencies of 20 Hz and 15 kHz.

Repeat the test at carrier frequencies of 5 MHz, 10 MHz and 100 MHz.

4.7.14 Envelope distortion

Test equipment : items n, o.

Connect the R. F. OUTPUT of the TF 2008 to the r.f. input of the modulation meter and the l.f. output of the modulation meter to the input of the distortion factor meter. Set up the TF 2008 to give an internal a.m. output of 80% depth at a carrier frequency of 4 MHz and an output level of 200 mV e.m.f. Tune the modulation meter to the

TF 2008 and measure the distortion present on the distortion factor meter, ensuring that it is less than 5%. Repeat this test at carrier frequencies of 10 MHz, 30 MHz, 45 MHz, 100 MHz and 350 MHz.

4.7.15 External a.m. sensitivity

Test equipment : items g, o, p.

Connect the test equipment as shown in the Fig. 4.13. Set the TF 2008 controls as follows :

FUNCTION SELECTOR	EXTERNAL A.M.
MODE SELECTOR	MANUAL
FREQUENCY	100 MHz
SET A.M.	Fully clockwise

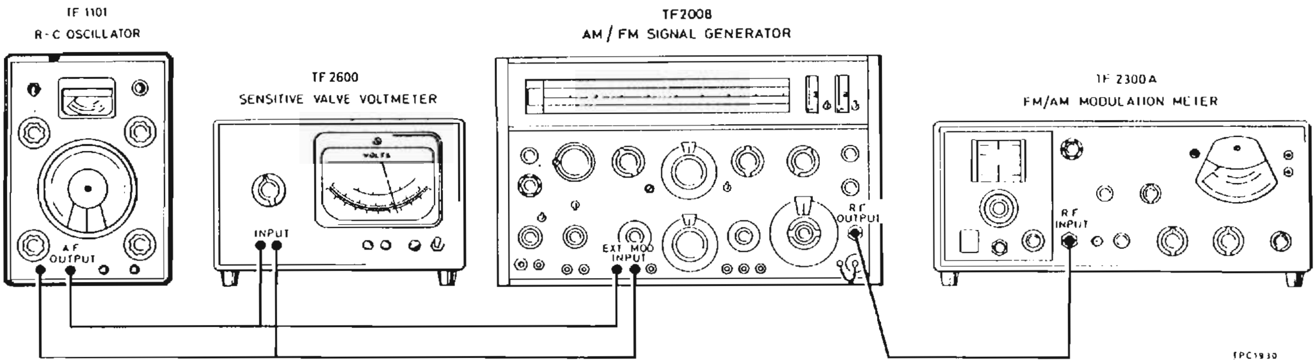


Fig. 4.13 Test gear arrangement to check a.m.

Ensure that at any modulating frequency from 20 Hz to 15 kHz the input required to give an indication at the datum of the MODULATION LEVEL meter is approximately 0.5 V.

4.7.16 Deviation accuracy

Test equipment : item o.

Connect the R. F. OUTPUT of the TF 2008 to the r. f. input of the modulation meter. Set the TF2008 controls as follows :

MODE SELECTOR	MANUAL
FUNCTION SELECTOR	INTERNAL F. M.
MODULATION FREQUENCY	1 kHz
DEVIATION	3 kHz
DEVIATION RANGE	3
DEVIATION MULTIPLIER	x1
INT ΔF	0
FREQUENCY	100 MHz

Tune the modulation meter to the TF 2008 and measure the deviation on the modulation meter ensuring that it is 3 kHz ±5%. Repeat this test for deviation frequencies of 10 kHz, 30 kHz, 100 kHz and 300 kHz, ensuring that the deviation accuracy is within ±5%.

Repeat the test at carrier frequencies of 1 MHz, 10 MHz, 300 MHz and 500 MHz omitting the test at 300 kHz deviation frequency for carrier frequencies of 1 MHz and 10 MHz.

4.7.17 F.M. distortion

Test equipment : items n, o.

Connect up the test equipment as shown in Fig. 4.14. Set up the TF 2008 controls as follows:

MODE SELECTOR	MANUAL
FUNCTION SELECTOR	INTERNAL F. M.
MODULATION FREQUENCY	300 Hz
DEVIATION	300 kHz
DEVIATION RANGE	300
DEVIATION MULTIPLIER	x1
INT ΔF	0
FREQUENCY	108 MHz

Tune the modulation meter to the TF 2008 and measure the f. m. distortion on the distortion factor meter ensuring that it does not exceed 1%. Repeat this test at MODULATION FREQUENCIES of 1 kHz and 3 kHz.

EXTERNAL MODULATION	L and R
INPUT	L

Set the audio oscillator to 1 kHz and adjust its output to give a % system deviation of 45%.

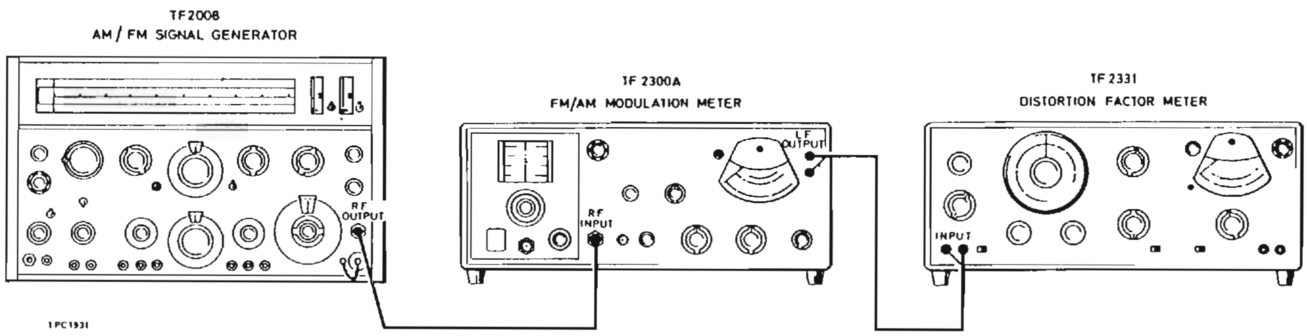


Fig. 4.14 Test gear arrangment to check f.m. distortion

4.7.18 Modulation bandwidth

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

With the output of the stereo modulator connected directly to the oscilloscope, set the stereo modulator controls as follows :

Set the oscilloscope controls as follows :

INPUT	Channel A, d. c. coupled (input B OFF)
VOLTS RANGE	0. 5 V/cm

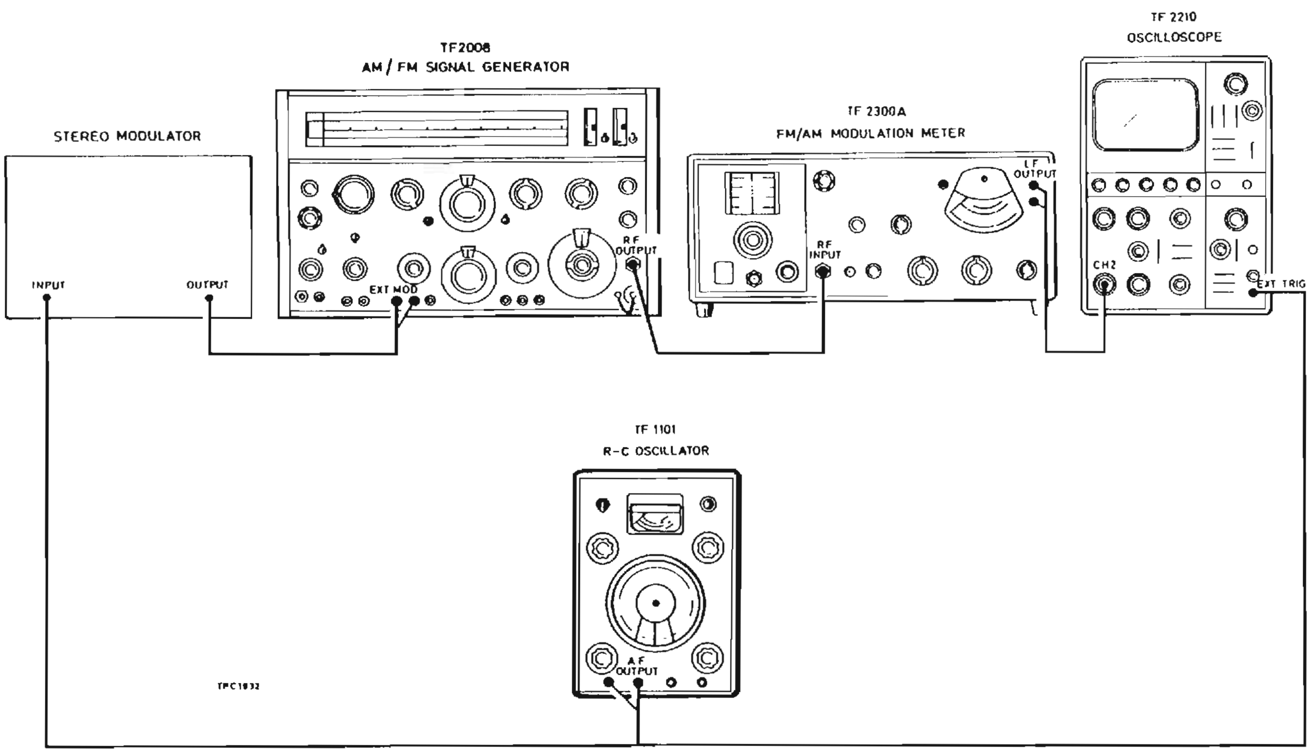


Fig. 4.15 Test gear arrangement to check modulation bandwidth

GAIN CONTROL	x1
VARIABLE GAIN CONTROL	MAX
TIME BASE SETTING	200 μs/cm

Adjust the stereo modulator output control for approximately 5 cm peak-to-peak display.

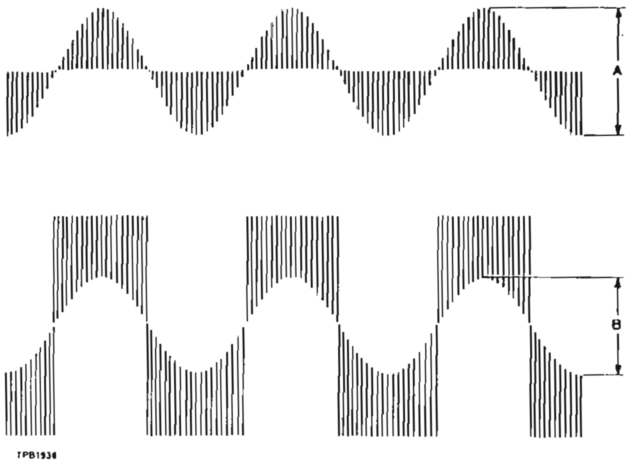


Fig. 4.16 Stereo waveforms

Reconnect the test equipment as shown in Fig. 4.15 and set the TF 2008 controls as follows:

FUNCTION SELECTOR	EXTERNAL F. M.
MODE SELECTOR	MANUAL
FREQUENCY	100 MHz

Adjust the output from the stereo modulator to give 67.5 kHz deviation on the TF 2008 as monitored on the modulation meter. Set the MAXIMUM MODULATION FREQUENCY switch on the modulation meter to 150 kHz and the DE-EMPHASIS switch off. Adjust the oscilloscope sensitivity control to give a display as shown in fig. 4.16 and measure the amplitude of A.

Increase the sensitivity of the oscilloscope to obtain a display as shown in fig. 4.16 and measure the amplitude of B.

The channel separation is given by the formula :

$$20 \log_{10} \frac{A}{B} \text{ dB}$$

Ensure that the channel separation is at least 35 dB.

Repeat this test with the audio oscillator set at 15 kHz, ensuring that the channel separation is at least 35 dB.

4.7.19 External f.m.

Test equipment : items g, o, p.

Connect up the test equipment as shown in Fig. 4.17 Set the TF 2008 controls as follows:

FUNCTION SELECTOR	EXTERNAL F. M.
MODE SELECTOR	MANUAL
FREQUENCY	100 MHz
SET F. M.	Fully clockwise

Set the audio oscillator to 30 Hz and set its output level to obtain indication at the datum mark

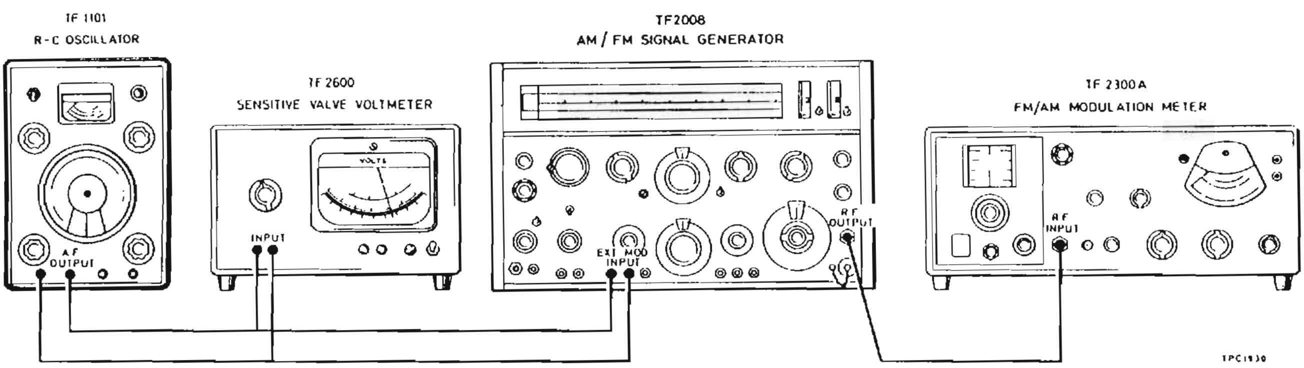


Fig. 4.17 Test gear arrangement to check f.m.

on the MODULATION LEVEL meter. Ensure that the reading on the valve voltmeter is approximately 0.5 V. Repeat the test at modulating frequencies of 1 kHz, 30 kHz, 53 kHz and 125 kHz.

In each test measure the deviation with the modulation meter. Ensure that the readings up to 53 kHz are within ±0.3 dB or at 125 kHz are within ±1 dB of the reading at 1 kHz.

4.7.20 F.M. on a.m.

Test equipment : items n, o.

Connect up the test equipment as shown in Fig. 4.18 and set up the TF 2008 controls as follows:

FUNCTION SELECTOR	INT. F.M.
MODULATION FREQUENCY	1 kHz
DEVIATION	5 kHz
DEVIATION RANGE	10 kHz
FREQUENCY	100 MHz

Adjust the DEVIATION control to give a deviation reading of 5 kHz on the modulation meter. Set the distortion factor meter FUNCTION switch to SET REFERENCE LEVEL and by adjustment of the SET LEVEL control and the METER RANGE switch obtain a suitable reference at 0 dB on the meter.

Switch the TF 2008 to INTERNAL A.M. and adjust the A.M. DEPTH control to give 30% A.M.

Note, by using a more sensitive range as necessary, the difference in level shown on the distortion factor meter and ensure that it is greater than 32 dB (less than 120 Hz).

Repeat the above check at 310 MHz and ensure that the change in level is greater than 18 dB (less than 600 Hz).

Repeat at 500 MHz and ensure that the change in level is greater than 12 dB (less than 1.2 kHz).

4.7.21 F.M. on c.w.

Test equipment : items o, r.

Connect the R.F. OUTPUT of the TF 2008 to the r.f. input of the modulation meter and the l.f. output of the modulation meter to the input of the psophometer. Set the TF 2008 controls as follows :

FUNCTION SELECTOR	INT F.M.
MODE SELECTOR	MANUAL
FREQUENCY	100 MHz
DEVIATION	5 kHz
DEVIATION RANGE	10 kHz

Set the psophometer controls as follows :

INPUT CONDITIONS	TERMINATED
WEIGHTING	TELEPHONE
ATTENUATION	0 dB (1 V)

Tune and crystal lock the modulation meter to the TF 2008. Adjust the front panel calibration control for an indication of 0 dB on the psophometer Switch the TF 2008 to c.w. and note the dB change on the psophometer attenuator required to return the psophometer reading to 0 dB.

Ensure that the f.m. noise is greater than 54 dB down (less than 10 Hz). Repeat the above

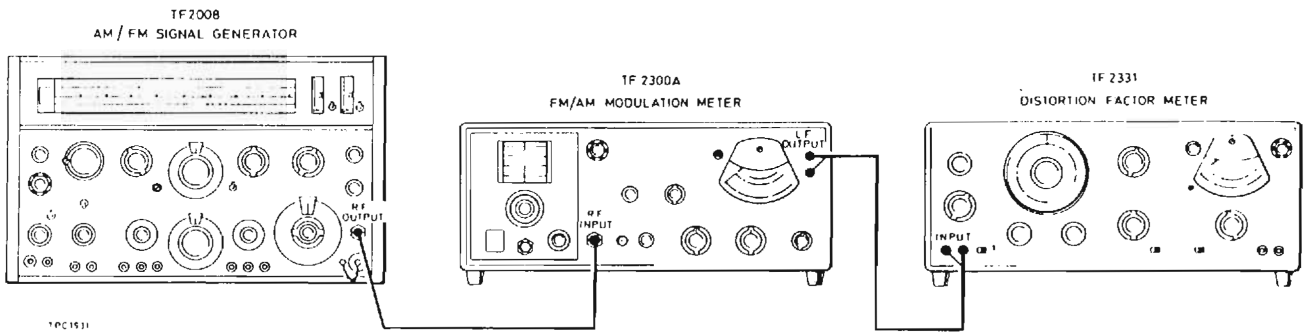


Fig. 4.18 Test gear arrangement to check f.m. on a.m.

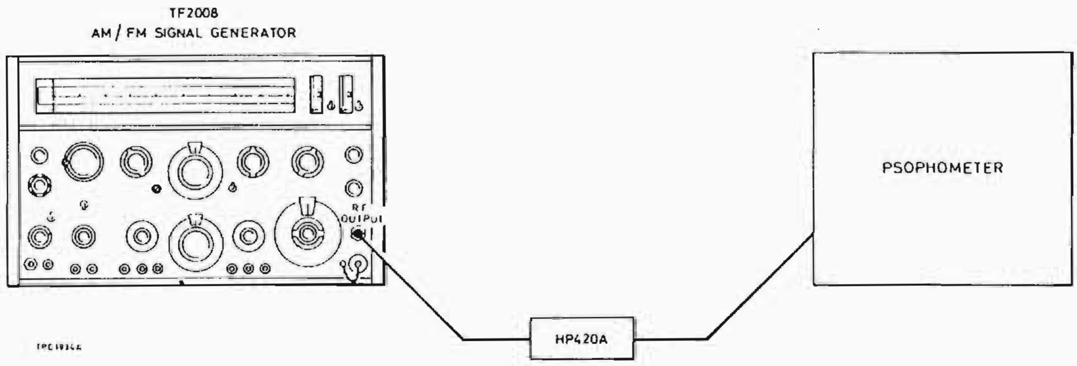


Fig. 4.19 Test gear arrangement to check a.m. on c.w. and a.m. on f.m.

check at a carrier frequency of 450 MHz and ensure that the f.m. noise is greater than 48 dB down (less than 20 Hz).

4.7.22 A.M. on C.W.

Test equipment : items r, s.

Connect up the test equipment as shown in Fig. 4.19 using the psophometer set to its flat 20 kHz bandwidth. Set the TF 2008 controls as follows :

FUNCTION SELECTOR	INT A.M.
MODE SELECTOR	MANUAL
MODULATION FREQUENCY	1 kHz
A.M. DEPTH	50%
FREQUENCY	100 MHz

Adjust the psophometer control to give an indication of 0 dB on its meter.

Switch the TF 2008 FUNCTION switch to c.w. and increase the sensitivity of the psophometer until the same reading as before is obtained. Ensure that the second reading is at least 54 dB down on the first.

4.7.23 A.M. on F.M.

Test equipment : items r, s.

Connect up the test equipment as in Fig. 4.19 with the psophometer set to its flat 20 kHz bandwidth and set the TF 2008 controls as follows :

FUNCTION SELECTOR	INT A.M.
MODE SELECTOR	MANUAL
MODULATION FREQUENCY	1 kHz
A.M. DEPTH	50%
FREQUENCY	100 MHz

Adjust the psophometer controls to give an indication of 0 dB on its meter.

FUNCTION SELECTOR	INT F.M.
DEVIATION RANGE	300
DEVIATION	300 kHz
F.M. MULTIPLIER	x1

Note the new reading obtained on the psophometer and ensure that the spurious a.m. on f.m. does not exceed 1.5% by applying the formula :

$$\text{a.m. on f.m.} = \frac{50 \times \text{new meter reading}}{\text{original meter reading}} \%$$

or that the second reading is at least 30 dB down on the first.

Chapter 5 Repair

5.1 INTRODUCTION

This chapter contains information for the localization and repair of faults. Performance limits quoted are for guidance only and should not be taken as guaranteed performance specifications unless they are also quoted in the Data Summary section.

CAUTION

See Maintenance, Sect. 4.1, for precautions in handling semiconductors and for advice on screw fasteners.

Fuses

Three fuses are fitted to the instrument, These fuses, FS1, FS2 and FS3, protect the power supply circuits and are accessible at the rear of the instrument. All are standard 20 mm x 5 mm time-lag components. Suitable replacements are given below.

Fuse	*Rating*	*Type*
FS1 FS3	160 mA (190-264 V inputs)	Beswick TDC123/160 mA
	250 mA (95-130 V inputs)	Beswick TDC123/250 mA
FS2	1 A	Beswick TDC 123/1 A

In the case of any difficulty, please write to or phone the Marconi Instruments Service Division (see address on back cover) or nearest representative, quoting the type and serial number on the data plate at the rear of the 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.

5.2 FAULT FINDING

Some hints on fault finding procedures are given in the following section. They are not meant to be exhaustive but will probably point the way to an area of further investigation. They should be supplemented by study of the block and circuit diagrams together with the technical description in chapter 3.

5.2.1

Symptom : Mains switch is on, plug is in to mains supply, CARRIER switch is on, MODE switch is at MANUAL but no reading on the CARRIER LEVEL ERROR meter.

(a) Switch FUNCTION switch to INT A. M. or F. M. and ensure MODULATION switch is to ON position, does the MODULATION LEVEL meter read?

(b) If so the -18 V rail is alright and fault lies elsewhere, probably the r. f. circuitry.

(c) If the MODULATION LEVEL meter does not read, check the mains fuses, FS1, FS3.

(d) If the fuse has blown, check that the power supply voltage selector is correctly set and check the correct rating for the fuse is installed.

(e) If the fuse is alright remove the case and check the -18 V rail, say A43, pin 12.

(f) Switch off and connect an ohmmeter between A43, pin 12 and earth. If a short is indicated isolate the short.

(g) If there is not a short on the -18 V rail remove the ohmmeter, switch on again. Check the a. c. to the transformer.

(h) Check the a. c. to the power supply printed circuit board between pins 3 and 5 of A42.

(j) Check the regulator circuit.

5.2.2

Symptom: CARRIER LEVEL ERROR meter reads at the low end of scale.

(a) Switch to 0.01 - 4.5 MHz carrier range; if fault still present, check the r.f. output. If nó output, check both the FMO and VFO outputs. If no output from FMO and VFO, check the -16 V line through the filter to the oscillator.

(b) If output on all ranges is alright check the monitoring circuit.

(c) Check the A19 detectors balance.

5.2.3

Symptom: CARRIER LEVEL ERROR meter reads at the high end of scale.

(a) If the fault is present on all carrier ranges check the r.f. output.

(b) If output is correct check the monitoring circuit.

(c) If the output is faulty check the balance between the detectors on A19.

(d) If the output is faulty on all ranges except range 1 check unit A18.

(e) If the output is faulty on even ranges only check units A4 and A5, (i.e. range 4, 6 and etc.).

(f) If the output is faulty on odd ranges only check units A15 and A16, (i.e. range 3, 5 and etc.).

5.2.4

Symptom: CARRIER LEVEL ERROR meter reads correctly but there is no r.f. output.

(a) No output on all ranges, check the output of the FMO and the VFO. Check the input and output of A10. Check the input and output of A9. Check the coarse attenuator and the connections to it.

(b) Faulty output on all ranges except range 1, check units A18 and A19.

(c) Faulty output on even ranges only, check units A4 and A5.

(d) Faulty output on odd ranges only, check units A15 and A16.

(e) Faulty output on range 2 only, check units A7 and A8.

5.2.5

Symptom: Output correct on c.w. but CARRIER LEVEL ERROR meter reading lies outside the white box when on a.m. and varies with the modulation depth.

Note. There may be some variation in the meter indication at extremes of temperature although there is not a fault on the instrument.

(a) Check the error signal, A19 pin 7, with modulation on, over the entire r.f. range. If the error signal flattens to a straight line on either peak, this indicates that the available output is insufficient. Therefore check the appropriate unit associated with the range.

(b) With a low modulating frequency, say 300 Hz, check the error signal over the r.f. range for any oscillations on the peaks of the error signal. If on several ranges check unit A18. If on one range only, check the unit associated with the range, i.e. reduce the output by adjusting the level control of that unit.

5.2.6

Symptom: CARRIER LEVEL ERROR meter reads full-scale when a.m. is switched on but can be corrected by reducing the modulation depth and then returning to a full 80% modulation.

(a) This would probably be due to the a.l.c. error signal 'locking on' to the wrong slope of the modulation signal. Check units A18 and A19.

5.2.7

Symptom: Excessive a.m. on f.m.

(a) Fault present on all ranges; check bandwidth of FMO buffer A38.

(b) Fault present on odd ranges only; check bandwidth of unit A13.

(c) Fault present on range 1 only; check bandwidth of unit A10.

5.2.8

Symptom: Amplitude modulation low.

(a) On all ranges, check unit A10.

(b) On all ranges except range 1, check units A18 and A19.

5.2.9

Symptom: Excessive spurious signals.

Spurious signals are likely to arise from faults in or misadjustment of the multipliers, mixers and filters in the r.f. processing unit. Since the correct adjustment of the unit is critical to the proper working of the instrument, do not attempt any work on the r.f. processing unit unless you are confident that you understand the purpose of the adjustment and have suitable test apparatus. See also section 5.3.5.

Connect an r.f. spectrum analyser to the R.F. OUTPUT socket.

When viewing the output signal on a spectrum analyser with appropriate sweep width you will see the wanted output signal and the spurious signals. As the frequency of the signal generator is shifted the wanted signal will move across the face of the spectrum analyser tube. The spurious signals will be of two categories; one, those which move across the screen at the same rate as the wanted signal and two, those which move at a different rate and cross over the wanted signal. The possible causes of these spurious signals are varied and are discussed separately.

1. Spurious signals moving across the screen at the same speed as the wanted signal for both the odd and even chain of ranges.

These are the unwanted harmonics and input fundamentals of the multiplier which add up on every range and are therefore more numerous and pronounced on the last range. They increase in amplitude by roughly 6 dB for every times two multiplication.

If the right compromise between the input fundamentals (seen at the high end of the band) and third harmonics (seen at the low end of the band) cannot be realized, this means a heavy unbalance in the multipliers due either to unmatched pairs of transistors or to wrong adjustment of the capacitors of any of the ranges in the chain, or to incorrect alignment of the filters. These capacitors are the single wire on the collector connection of the transistor pairs making capacitance to either of the transistor base tracks.

2. Spurious signals crossing over the wanted signal on the odd ranges chain when the Δf control is operated, regardless of the output frequency.

This kind of spurious signal is produced in unit A12 mixer and can be clearly seen at the output of unit A13, the 67.5 MHz amplifier. It is due either to an insufficient level of the 90 MHz signal from unit A11 (minimum output required is 0.7 V, i.e. 10 dBm) or to a too high level from the FMO to the mixer of unit A12 (setting of A12R1). As they increase in number and size at every multiplication they can be seen more clearly on range 11.

3. Spurious signals crossing over the wanted signal on the odd ranges, only at some points of the band and independent of the setting of the Δf control.

These come from the unit A14 mixer, and provided the level of the 67.5 MHz signal coming from unit A13 is sufficient (about 0.7 V, 10 dBm) it should be possible to reduce these to more than 30 dB down on the wanted signal on the last range (further down on the lower ranges), by appropriate setting of the gain control, A17R2. As above these signals increase in amplitude and number for every multiplication. If A17R2 is readjusted check that the error signal on A18 pin 1 does not limit with the instrument set for 80% a.m.

4. Steady 45 MHz signal on range 4 which multiplies up in amplitude and number for each multiplication on the even ranges.

On range 6 the 45 MHz spurious signal is doubled to 90 MHz and increased in amplitude by 6 dB. A further sideband is produced at 70 MHz due to mixing of the 80 and 90 MHz signal and similarly on ranges 8 and 10 further multiplication occurs.

The 45 MHz signal is produced either by unbalance of the mixer, unit A3, or the second sideband produced in the mixer is insufficiently attenuated by the filter at the input of unit A4, giving intermodulation with the wanted sideband in the FET amplifier. The level of this signal is dependent on the setting of A3R2; if the setting is altered check that the error signal on A18 pin 1 does not limit with the instrument set for 80% a.m. As this signal (as is the case for all spurious signals) increases in level by 6 dB with every multiplication, in order to obtain a level of various signals greater than 30 dB below the wanted signal on range 10 it is necessary for the spurious signal to be down greater than 50 dB on range 4.

5. Spurious signals crossing over the wanted signal at some point on the bands of the even chain.

These spurious signals come from mixer, unit A3, and provided that the level of the 53 to 68 MHz signal coming from unit A2 is sufficient (about 0.7 V, 10 dBm) it should be possible to reduce them to more than 30 dB down on the wanted signal on the last range of the chain by appropriate setting of A3R2. If this control is readjusted, check that it is still possible to obtain the required output level (225 mV, 0 dBm) on range 4.

Fault location in r.f. processing box

If there is no r.f. output on some or all ranges, check that the VFO, VCO and the FMO oscillators are alright. If they are correct, connect the r.f. voltmeter to pins 2 and 3 of A20 and check for an r.f. output on every range. By the application of the chart faults may be localized to one or a few sub-assemblies and each sub-assembly may then be tested individually.

No output on range	*Check unit*
1	A9, A10
2	A7, A8
3	A16
4	A5
5	A27
6	A23
7	A26
8	A22
9	A25
10	A21
11	A24
2, 3, 5, 7, 9, 11	A11, A12, A13
3, 5, 7, 9, 11	A14, A15, A16
4, 6, 8, 10	A1, A2, A3, A4, A5
5, 7, 9, 11	A27
6, 8, 10	A23
7, 9, 11	A26
8, 10	A22
9, 11	A25
All ranges	A20, A10, A18, A19

5.2.10

Symptom: f.m. low but Δf correct

(a) Check that deviation multiplier is set to x1.

(b) If monitor meter reads low with control fully advanced, check that the output of the modulation oscillator, unit A35 is correct.

(c) Check deviation controls.

(d) Check unit A34.

5.2.11

Symptom: f.m. and incremental frequency low.

(a) Check f.m. and Δf drive to unit A37.

(b) Check unit A37.

5.2.12

Symptom: f.m. drops excessively at higher modulating frequency relative to 1 kHz modulating frequency.

(a) On all ranges check processing box input filter. Check modulating frequency characteristic directly out from FMO. If wrong, check the bandwidth of FMO buffer unit A38. On odd ranges only, check bandwidth of the 67.5 MHz amplifier, unit A13.

5.2.13

Symptom: Standardizing of the FMO cannot be completed through insufficient range of the SET ZERO BEAT control.

(a) Reset the FMO frequency by adjustment of A37T1. Note the f.m. and Δf sensitivity control A37C7 and the distortion control A37L4 may also need adjusting when A37T1 is changed by any appreciable amount.

5.2.14

Symptom: The main scale marker signal (crystal calibrator) does not function.

(a) Check the crystal calibrator oscillator, unit A6, and the mixer in unit A6.

(b) Check the calibrator amplifier on unit A31.

5.2.15

Symptom: WIDE SWEEP facility - the marker points do not function.

(a) Check as for 5.2.14.

(b) Check the MODE switch is in the WIDE SWEEP position.

5.2.16

Symptom: With MODE switch in the LOCATE SWEEP MARKERS ONLY position no locate marker appears.

(a) Check the sweep width control is set to full width or the variable frequency oscillator is set to the middle of the sweep width setting.

(b) Check that both the variable frequency oscillator and the voltage controlled oscillator are functioning.

(c) Check the calibrator amplifier part of unit A31.

5.2.17

Symptom: WIDE SWEEP not functioning, MODE switch in WIDE SWEEP position.

(a) Check output from horizontal output terminals. If no output check sweep driver on unit A31.

(b) Output from horizontal output terminal then check signal on A31, pin 27.

(c) If signal on A31, pin 27, then check the VCO unit A39.

5.3 ADJUSTMENT AND CALIBRATION

5.3.1 Test equipment required

The following equipment will be required to perform these tests:

(a) Variable mains transformer.
(b) Differential D.C. Voltmeter, TF 2606.
(c) Multimeter.
(d) Wave Analyser, TF 2330.
(e) Frequency Counter, TF 2410.
(f) Sensitive Valve Voltmeter, TF 2600.
(g) Distortion Factor Meter, TF 2331.
(h) Oscilloscope, TF 2210.
(j) R.F. Millivoltmeter, TF 2603.
(k) Modulation Meter, TF 2300.
(m) Power Meter - Sanders type 6598.
(n) Spectrum analyser.

5.3.2 Power supply and sub-stabilizer

Test equipment: items a, b, c, d.

Connect the VARIABLE MAINS TRANSFORMER input across the supply and connect the TF 2008 to its output. Connect the differential d.c. voltmeter between pins 1 and 16 on unit A34. Set the TF 2008 mains input selector to 230 V and set the VARIABLE MAINS TRANSFORMER to give 230 V output. Adjust the resistor A42R11 to give a reading of -18 V on the differential d.c. voltmeter. Vary the mains input between 190 and 264 V ensuring that the reading on the differential d.c. voltmeter does not vary by more than ±50 mV.

Reset the mains input selector to 115 V and ensure that between 90 V and 130 V the reading on the differential d.c. voltmeter is -18 V ±50 mV.

If the differential d.c. voltmeter reading has an excessive variation over the mains input range, reselect A42R6. If this action is taken, it will be necessary to reset A42R11.

Disconnect the differential d.c. voltmeter and connect the wave analyser in its place. Measure the level of ripple voltage at mains frequency ensuring that it does not exceed 10 μV at 230 V mains input. Repeat the test at the 2nd and 3rd harmonics of the mains frequency ensuring that the ripple voltage levels do not exceed 20 μV and 10 μV respectively.

Connect a multimeter set to its 25 V d.c. range across A31 pins 1 and 4. Connect the differential d.c. voltmeter across A31, pins 1 and 2. Adjust A42R11 to obtain a reading of 18 V on the multimeter. Adjust A31R6 to obtain a reading of 16 V on the differential d.c. voltmeter. Adjust A42R11 to obtain readings of between 17.5 and 18.5 V on the multimeter and adjust A31R4 for a minimum variation of output. The output variation should not exceed 25 mV for an input variation between 17.5 and 18.5 V. Readjust A42R11 to obtain a reading of 18 V on the multimeter.

5.3.3 Modulation oscillator

Test equipment : items c, e, f, g.

Set the TF 2008 controls as follows:

FUNCTION SELECTOR	INTERNAL A.M.
MODULATION FREQUENCY	300 Hz

Connect the multimeter set to its 10 V d.c. range between the emitter of A35TR3 and earth. Adjust A35R3 to give a reading of 7.75 V.

Connect the counter to the MODULATION OUTPUT socket and ensure that the frequency range of the modulation oscillator is at least 300 Hz to 3 kHz. Connect the sensitive valve voltmeter to the MODULATION OUTPUT socket and ensure that the output level is at least 0.5 V over the entire frequency range. Ensure that the modulation oscillator dial accuracy is correct within ±10%. The modulation oscillator frequency may be adjusted by A35C8 and A35C9 which should be set relative to each other for least bounce in output when frequency is changed.

Connect a distortion factor meter to the MODULATION OUTPUT socket and ensure that by adjustment of A35R3, the distortion does not exceed 0.15% over the entire range.

5.3.4 R.F. oscillators

Test equipment : items e, f, g, h, j, k.

F.M.O.

Disconnect PLA from SKA and connect the modulation meter and counter via a 'T' connector to SKA. Connect the distortion factor meter to

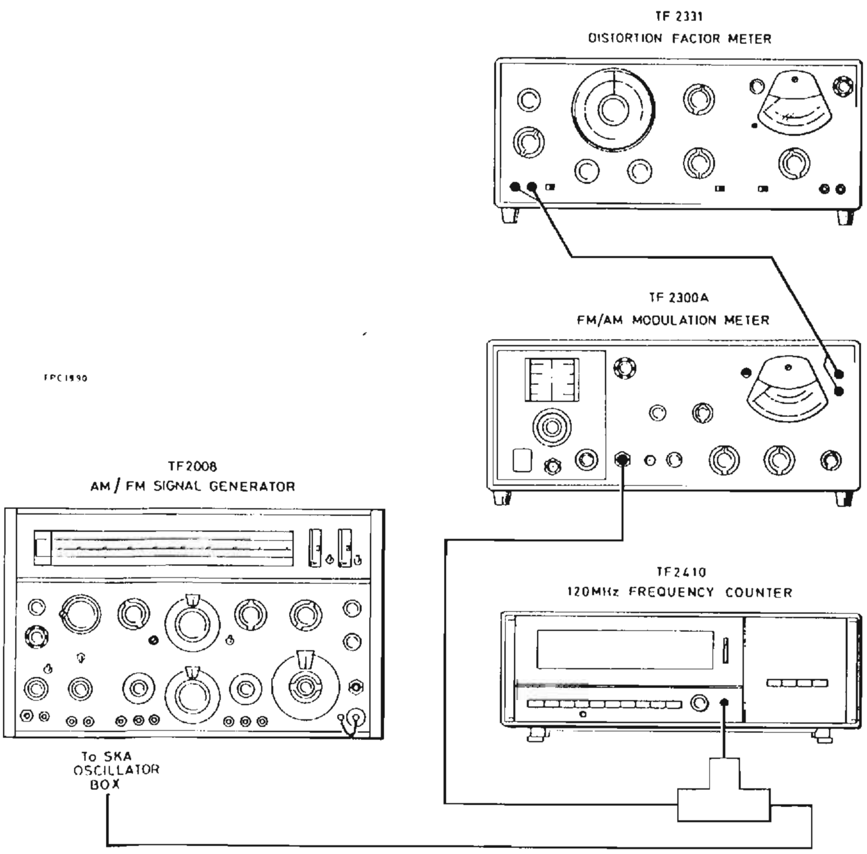


Fig. 5.1 Test gear arrangement to check FMO

the l.f. output terminals of the modulation meter. Set the TF 2008 FUNCTION switch to C.W. Set capacitor A37C7 to mid-travel and adjust A37T1 to obtain a frequency reading of 22.5 MHz ±5 kHz on the counter.

Connect the sensitive valve voltmeter between A41C2 and earth. Switch the TF 2008 FUNCTION SELECTOR to INTERNAL F.M. and adjust the DEVIATION control until a reading of 4.25 V is obtained on the valve voltmeter. Adjust A37C7 to give a deviation reading of 158 kHz on the modulation meter, and adjust A37L4 to a minimum level of distortion. The distortion should not exceed 0.4%. As T1, C7 and L4 are interacting, repeat the adjustment to ensure that all the requirements are satisfied.

Connect the r.f. millivoltmeter to SKA in place of the counter and adjust A38R1 to give 500 mV output, equivalent to -7 dBm.

V.F.O.

Disconnect PLC from SKC and connect a counter to SKC. Set the main tuning capacitor, C26, for zero frequency on the lowest range of the CARRIER FREQUENCY scale. Ensure that the SET MARKER and FINE FREQUENCY controls are at mid-travel. Adjust A41C27 to obtain a frequency reading of 22.5 MHz ±5 kHz on the counter. Reset the TF 2008 MAIN TUNING dial to 4.5 MHz on the first range. Adjust A39T2 to obtain a frequency reading on the counter of 18.5 MHz ±5 kHz. Repeat the procedure until satisfactory results are obtained.

5.3.5 R.F. processing box

Test equipment : items c, h, k, m.

For the following adjustments it is necessary to open the leaves of the processing box as described in Sect. 4.4. Before adjusting the processing box be sure that the modulation monitor is correctly set up - see Sect. 5.3.8.

Disconnect the two coaxial lines from pins 6 and 8 on unit A18, hence disconnecting the a.l.c. and modulation circuits. Connect the test jig to the two disconnected coaxial lines as shown in Fig. 5.2.

Note: the earth screen can be left disconnected.

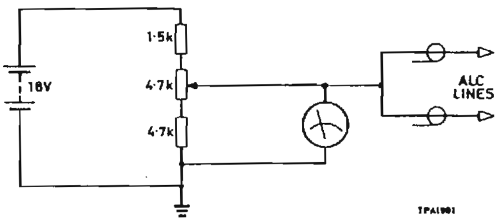


Fig. 5.2 Test jig for setting up a.l.c.

Switch the TF 2008 on and switch the R.F. RANGE switch to range 3. Adjust the a.l.c. voltage on the jig potentiometer to give an indication of -8.5 V on the multimeter.

Disconnect the plug from socket SKE and connect the power meter in its place. Adjust the FREQUENCY control over the whole range and note the point of least output. At this point, adjust A17R2 to give a reading of 0 dBm on the power meter.

Note: Do not adjust for greater output as this increases the relative levels of spurious signals.

Repeat this procedure for ranges 4 to 11, setting the levels by the adjustment of the following resistors.

Range 4	-	A3R2
Range 5	-	A27R2
Range 6	-	A23R2
Range 7	-	A26R2
Range 8	-	A22R2
Range 9	-	A25R2
Range 10	-	A21R2
Range 11	-	A24R2

Reduction of non-harmonic spurious signals

On range 11 adjust the a.l.c. volts to give a reading of -7 dBm at the point of minimum output.

Remove the power meter connection and connect the spectrum analyser to the output socket, SKE.

Set the frequency to the low end of range 11 and adjust A27R4, A26R4, A25R4 and A24R4 to give the lowest level of spurious signal on the high side of the fundamental frequency as displayed on the spectrum analyser. These must be at least 30 dB down on the fundamental.

Change the frequency to the high end of range 11. Ensure that the spurious signals below the fundamental frequency are at least 30 dB down, if not readjust A27R4, A26R4, A25R4 and A24R4 for the best compromise between the two ends.

Switch to range 10 and repeat the above procedure adjusting A23R4, A22R4 and A21R4 for the reduction of spurious signals.

Remove the spectrum analyser and replace it with the power meter and on ranges 3 - 11 check that the output is -7 dBm at the lowest point. On each of these ranges, increase the a.l.c. voltage by adjusting the potentiometer on the test jig to obtain a reading of -14.5 V on the multimeter. Check that the output drops by at least 33 dB, and tuning through the range check that there are no spurious signals. This would be indicated by a sharp increase in output.

With the a.l.c. set to give -7 dBm at the output, remove the power meter and connect the spectrum analyser.

Recheck all ranges, ensuring that spurious signals due to mixing are at least 40 dB down up to 180 MHz and 30 dB down up to 510 MHz. These spurious signals can usually be identified as, in most instances, they move in towards and out from the fundamental frequency as the frequency is tuned over the range.

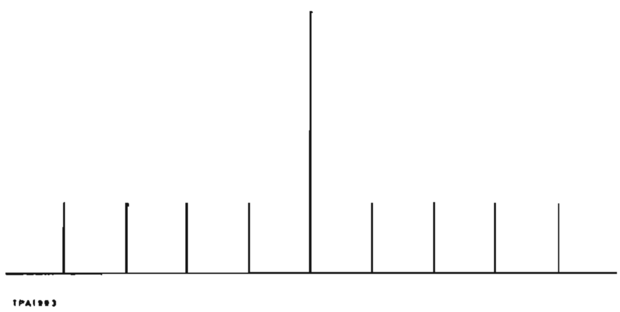


Fig. 5.3 Relationship of wanted to spurious signals

Switch to range 2. Tune throughout the range, and adjust A8R5 for minimum spurious signals.

Replace the spectrum analyser with the power meter and check that the output is at least -7 dBm over the range. Increase the a.l.c. voltage to -14.5 V and ensure the output falls by at least 33 dB.

Setting up filter circuits

Because of the nature and complexity of the setting up procedure for the filter circuits in the processing box, you are advised to return the instrument to the Service Division (see address on back cover) if some filter circuit malfunction is suspected.

R.F. level, fine attenuator and a.m. adjustment

For the following adjustments, it is necessary to hinge out the processing box as described in Sect. 4.4 of this handbook.

Connect the FMO and the VFO outputs and the attenuator input (PLE) to SKB, SKD and SKE of the processing box respectively via extension leads (see Fig. 5.4).

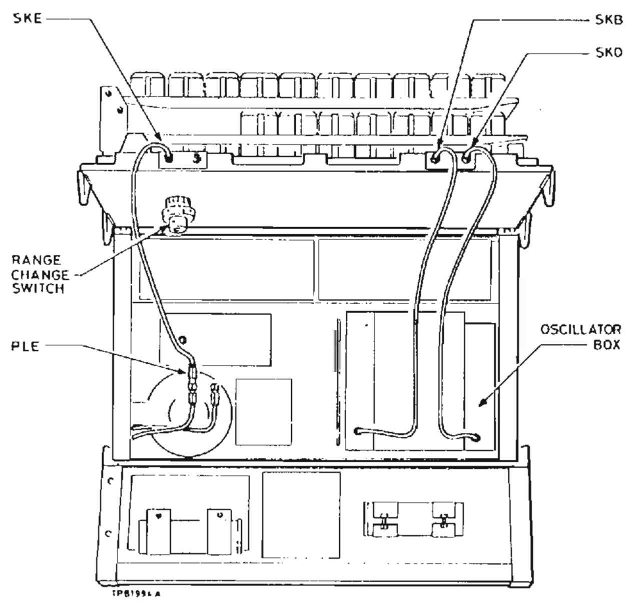


Fig. 5.4 Processing box opened for calibration

Disconnect the coaxial plug A30PLK from the socket A19SKK and set the fine attenuator to maximum output. Connect the power meter to the plug A30PLK hence measuring output of A10, the reference modulator. Adjust A32R12 for -1 dBm as shown on the power meter. Connect the modulation monitor in place of the power meter and set the TF 2008 controls to indicate 80% INT A. M. at a frequency of 1 kHz. Adjust A32R8 to give correct 80% modulation, indicated by the modulation monitor, while readjusting A32R12 to maintain the correct output level as indicated on the modulation monitor level indicator.

Disconnect the modulation monitor and connect the power meter. Check that the output level is -1 dBm and change the fine attenuator to its -10 dB position. Adjust A32R31 to give a precise 10 dB decrease in the output level.

Connect the modulation monitor in place of the power meter and adjust A10R8 for correct modulation depth while adjusting A32R31 to maintain correct output.

Repeat the above adjustments until all conditions are met.

Reconnect the coaxial plug A30PLK to the socket A19SKK.

Connect the r. f. millivoltmeter (terminated with 50 Ω) and the modulation monitor in turn to the R. F. OUTPUT socket and on range 1, with the R. F. OUTPUT LEVEL control at maximum output, readjust A32R12, A32R8, A32R31 and A10R8 as above for a carrier level, with no modulation, of -7 dBm and an accurate 80% modulation as necessary.

With the fine attenuator set at -10 dBm, switch to range 3 and adjust A19R7 for an accurate 80% modulation. Switch between ranges 2, 3 and 4 noting the variation in modulation depth and then adjust A19R7 for the best compromise.

Connect the oscilloscope via a d. c. coupled probe to A18, pin 1 and monitor the error signal. Switch to INT A. M. at a frequency of about 300 Hz and a modulation depth of 80%. Check over the r. f. range, for both maximum output and -10 dB on the fine attenuator, with the output loaded with 50 Ω ensuring that there is no spurious oscillation on the error signal and it is free from limiting.

If any spurious oscillation is present, reduce the value of A18R19 enough to remove it but no further than necessary, thus retaining the highest possible loop gain. With the fine attenuator at maximum, tune through the range and check that the voltage on test point TP11 remains at 1 V or above. If the voltage drops below 1 V insert a 1 MΩ resistor for A18R13 and repeat the above check.

If the error signal is limiting, also shown by the pointer of M1 being outside the white box, the r. f. from the particular range must be readjusted as follows:

Connect the oscilloscope via a d. c. coupled probe to A18, pin 1, and also connect the signal generator output to the spectrum analyser.

Set the attenuator to maximum output.

Tune throughout each band in turn and check that the error signal is not limiting. If limiting occurs, adjust the preset as listed below until the limiting just stops.

Range	*Preset*
3	A12R1
4	A3R2
5	A27R2
6	A23R2
7	A26R2
8	A22R2
9	A25R2
10	A21R2
11	A24R2

Again tune throughout the r. f. range, at both maximum output and -10 dB on the fine attenuator, with the output loaded with 50 Ω checking for any spurious oscillations on the error signal. If any occur, readjust A18R19 enough to remove the spurious oscillations but no further.

The above procedure must be repeated until satisfactory results are obtained.

After making any adjustment for limiting, switch off the a. m., maintain maximum carrier output and check that spurious signals at both ends of the band are at least 40 dB below the carrier up to 180 MHz and 30 dB below the carrier up to 510 MHz.

If necessary, spurious signals can be reduced by adjustment of R4 and C15 on the appropriate boards.

5.3.6 VCO and sweep facility

Adjustments to the sweep facility must be carried out by firstly adjusting the sweep driver and then adjusting the sweep width and linearity.

Connect the oscilloscope d.c. coupled to the horizontal output terminals and switch the mode switch to the sweep position. Ensure that a triangular waveform of 10 V ±1 V p-p amplitude is obtained. If the required output cannot be obtained suspect TR8, TR9 or TR10.

Disconnect the oscilloscope and connect the frequency counter in its place. Ensure that the output frequency is 18 Hz ±2 Hz.

For the following adjustments it is necessary to hinge out the processing box as described in Sect. 4.4 of this handbook.

Reconnect the FMO and the VFO outputs and the attenuator input (PLE) to SKB, SKD and SKE of the processing box respectively via extension leads (see Fig. 5.4).

Connect the HORIZONTAL OUTPUT terminals to the d.c. coupled X input of the oscilloscope and connect the MARKER OUTPUT to the Y input of the oscilloscope. Set the SWEEP CENTRING control to mid-travel and set the SWEEP WIDTH control fully clockwise. Set the R.F. RANGE switch to any range.

Switch the MODE switch to LOCATE SWEEP MARKERS ONLY and set the main tuning control fully clockwise. Adjust A31R40 so that the marker is displayed at extreme right-hand end of trace. Switch the MODE switch to SWEEP and adjust A31R42 until the 7th marker from the right-hand end is in the middle of the trace. At the same time ensure the right-hand marker stays in the same place by adjusting A31R40 as necessary. Switch the MODE switch back to LOCATE SWEEP MARKERS ONLY and tune the main frequency control fully counter-clockwise. If necessary adjust the core slug of A39T1 so that the single marker is just at the left-hand end of the trace. Repeat adjustments of A31R40, A31R42 and A39T1 until correct results are obtained.

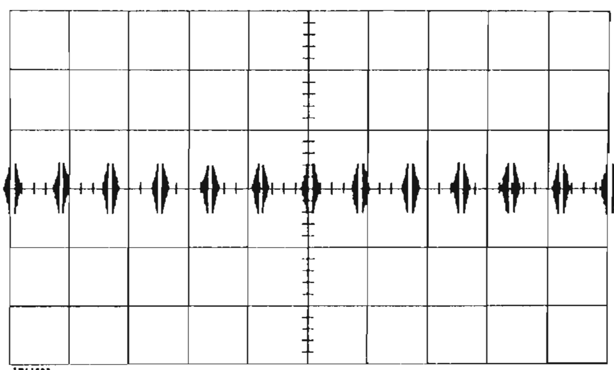


Fig. 5.5 Correct disposition of markers

With the MODE switch set to SWEEP and MARKERS ON, there should be 13 markers displayed on the face of the oscilloscope tube with possibly some frequency in hand at each end.

5.3.7 Carrier level meter

With the carrier levels and the a.m. set up as described in Sect. 5.3.5, switch the CARRIER switch ON and adjust A32R19 until the meter reads the centre of the white box.

Switch the CARRIER switch OFF and ensure that the meter reading falls to zero.

5.3.8 Modulation monitor

Test equipment : item f.

Switch FUNCTION SELECTOR to INT F.M., the MODULATION switch to ON and CARRIER switch to ON.

Monitor the voltage between A32, pin 26, and A32, pin 27, with the valve voltmeter.

With the MODULATION FREQUENCY set to 1 kHz, adjust the SET F.M. control until 1.5 V is shown on the valve voltmeter and set A32R23 to indicate the centre mark on the MODULATION LEVEL meter.

5.3.9 ΔF/F.M. driver

Test equipment : items c, f.

Set the TF 2008 controls as follows:

FUNCTION SELECTOR	INT F.M.
MODULATION	ON
MODULATION FREQUENCY	1 kHz
INTERNAL ΔF	zero

Connect the valve voltmeter between A34, pin 6 and pin 2 earth. Adjust A36R11 to give 0.5 V on valve voltmeter.

Connect the valve voltmeter across A34, pin 8 and pin 2 and a reading of approximately 1.5 V should be noted. Re-connect the valve voltmeter across A34, pins 9 and 2. Switch the DEVIATION MULTIPLIER to x0.1 and adjust A34R7 until the valve voltmeter reads 1/10th of the previous value measured at pin 8. Return the DEVIATION MULTIPLIER to x1.

Connect the valve voltmeter between A34, pins 11 and 2. Adjust A36R14 to give a reading of 1.5 V. Connect the valve voltmeter across A34, pins 13 and 2 and a multimeter set to its 10 V d.c. range across the collector of TR4 and earth. Adjust A34R14 to obtain a reading on the valve voltmeter of 4.5 V and A34R10 to give a reading of 9 V on the multimeter.

The adjustment of A34R14 and R10 should be repeated until satisfactory results are obtained as they tend to interact with one another.

5.3.10 ΔF/F.M. output stage

Test equipment : item b.

Connect the differential d.c. voltmeter between A41C2 and earth. Set the TF 2008 controls as follows:

FUNCTION SELECTOR	C.W.
CARRIER RANGE	45 - 63 MHz

Set A33R5 to mid-travel and the SET ZERO BEAT potentiometer to mid-travel. Adjust A33R10 to give a difference of 12 V on the differential d.c. voltmeter when the Δf dial is varied between -10 and +10. Ensure that the voltage changes when the control is moved from -10 to 0 and from +10 to 0 are within 2% of each other.

5.4 REPLACEMENT OF FREQUENCY SCALE DRIVE WIRES

It is easiest to rewire the scale assembly when it is removed from the front panel.

5.4.1 Preliminary dismantling

(1) Remove the case - see Sect. 4.4.

(2) Remove all the knobs - slide the cursors upwards and slacken the two setscrews (use a 1/16 in across flats hexagon wrench) in each knob.

(3) Remove the securing nuts from the toggle switches, the R.F. OUTPUT socket and the MARKERS OUTPUT jack socket.

(4) Remove the handles - extract the four chrome headed screws in each.

(5) Remove the r.f. processing unit and the power unit chassis - see Sect. 4.4. Both may be left attached by their cable forms.

(6) Remove the side frames - from each extract the two countersunk screws through the lip of the front panel, the two M3 screws into A31/A32 chassis, the two M3 screws into the top chassis crossmember and from the left-hand frame extract the two M4 screws into the r.f. oscillator box.

(7) Remove the top and bottom panel edge moulding - from each extract three countersunk screws.

(8) Lift away the dummy front panel.

(9) Extract the four M3 countersunk screws above the tuning scale that engage with tapped holes in the scale drive unit. The remaining screws, which engage with nuts, will be removed later.

(10) Stand the instrument on its face, supporting the panel on blocks so that the weight is not taken by the control spindles.

(11) Remove the attenuator - extract two M4 screws that hold it to the front panel and lift it away still attached to its cable form.

(12) Remove A34 - extract three M3 screws at the rear edge of the board and three extended head screws at the front edge of the board; these latter require the use of a 4 BA spanner but the thread is M3. Pull the board clear on its cable form.

(13) Unsolder the connections to the r.f. oscillator unit. Extract the three M4 screws that hold the unit to the front brackets. Lift the oscillator unit out.

(14) Remove the cover from the CARRIER RANGE and ΔF/DEVIATION RANGE switch assembly - remove four 6 BA nuts. Remove the three M3 nuts that secure the front plate of this switch assembly to the tuning scale assembly. Slacken the set screws that secure bobbin 2 to the switch shaft. Lift the assembly clear, still attached to the wiring.

(15) Remove A31 and A32 - extract the four M3 screws that attach A31/A32 chassis to the top chassis crossmember; lift A31/A32 clear, still attached to the cable form.

(16) Remove the frequency scale assembly - release by removing the nuts from the remaining six M3 screws that hold the drive wire assembly to the front panel; lift the assembly out.

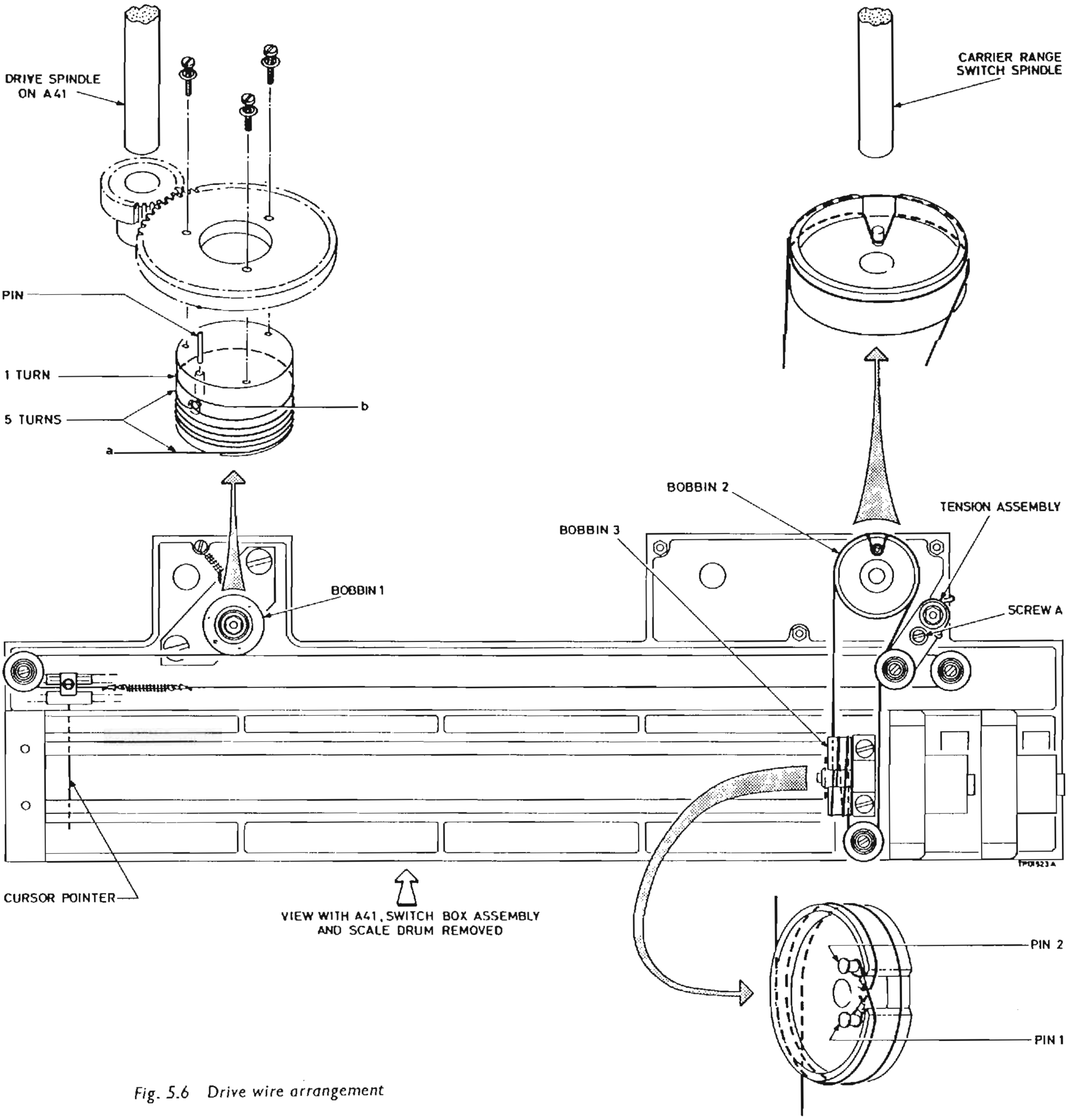


Fig. 5.6 Drive wire arrangement

5.4.2 Replacement of drive wires

(1) Remove the two M4 screws that hold the left-hand scale drum bearing to the casting.

(2) By inserting a screwdriver tip between bobbin 3 and the brass disc at the end of the drum spindle, press the disc away from the bobbin so that the locating pegs are clear and the drum can be lifted away.

Drum drive wire

(1) Take a length of wire at least 630 mm (24.8 in) and prepare it as in Fig. 5.7 with 3.5 mm (1/8 in) diameter loops, and secure the loops by crimping the eyelets.

(2) Slacken screw A, move the tensioning arm away, retighten the screw and remove the old drive wire.

(3) With the bobbins in the position shown in Fig. 5.6 attach one end of the wire to pin 1, take $1\frac{1}{2}$ turns round the bobbin 3, lead it round the top pulley, past the tension pulley and then $1\frac{1}{2}$ turns around bobbin 2 ensuring that a loop is taken around the screw as shown in Fig. 5.6. Finally take $\frac{1}{2}$ turn around bobbin 3 and attach the end to pin 2.

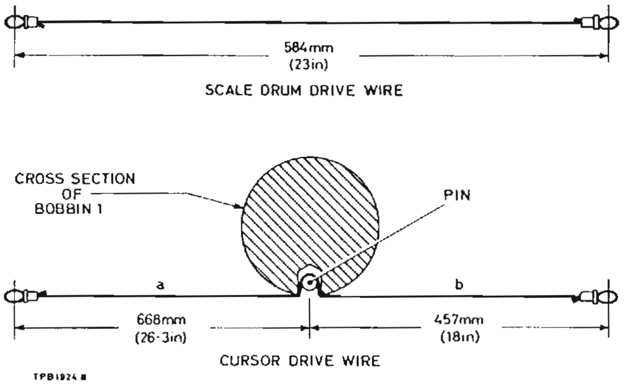


Fig. 5.7 Dimensions of drive wires

(4) Slacken screw A and allow the tension arm to bear upon the wire so that there is neither excessive slack in the wire nor excessive resistance to rotation of the drum. Retighten screw A.

Cursor drive wire

(1) Release the old drive wire from the cursor.

(2) Remove bobbin 1 complete with the gear wheel spindle and mounting plate; remove the M3 screw attaching the spring to the casting and the two large screws that attach the mounting plate to the casting. Note, these two screws are locked with varnish and may at first be stiff to remove; when reassembling, varnish such as Hadfields 4270-001 Blue should be applied.

(3) Remove the gear wheel from bobbin 1, extract the pin and remove the remains of the old wire.

(4) Take a length of wire at least 1160 mm (45.7 in), attach it to the pin in bobbin 1, prepare the ends with 2 mm (3/32 in) diameter loops so that the dimensions are as in Fig. 5.7. Secure the loops by crimping the eyelets. Refit the gear wheel.

(5) Wind five turns using end a, and one turn with end b and temporarily secure the turns with adhesive tape.

(6) Refit bobbin 1. Pass wire around the pulleys and pull to remove slack before joining the ends with the spring.

(7) Refit cursor approximately 15 mm ($\frac{1}{2}$ in) from end a of the wire. Refit scale drum by pressing the locating pegs into engagement, refit left-hand scale drum bearing.

5.4.3 Reassembly

(1) Refit drive wire assembly to front panel. It will be sufficient to insert the six M3 screws that are secured with nuts.

(2) Refit the CARRIER RANGE and ΔF/ DEVIATION RANGE switch assembly to the tuning scale assembly. With the 0 - 4.5 MHz frequency scale visible in the window and the range switch fully counter-clockwise as viewed from the front of the instrument (fully clockwise as viewed from the rear), lock one of the set screws in bobbin 2. Turn the switch until the other set screw is accessible and lock it too.

(3) Refit A31 and A32.

(4) Refit the oscillator unit - turn the tuning capacitor drive shaft fully clockwise and set the scale pointer to be about 1 mm from its extreme right-hand limit of travel before engaging the gear wheels. Refit the three M4 screws to hold the unit to the front brackets and resolder the connections. Refit A34 to the side of the oscillator unit.

(5) Insert the remaining four M3 screws that secure the tuning scale assembly to the front panel. Refit the dummy front panel, securing it in position with the top and bottom panel edge moulding.

(6) Refit the side frames, r. f. processing unit and power chassis (leave these latter in the hinged out position).

(7) Check the operation of the range change switch mechanism and the scale.

(8) Refit the attenuator and assemble the knobs, dial and cursor on the shaft. Set both attenuators to maximum output, then slip the dial so that the last graduation on the dial coincides with the cursor line.

(9) Refit the front panel toggle switches and sockets and the knobs. Refit the handles.

(10) Switch the instrument ON. Set the CARRIER RANGE switch to the 0.01 - 4.5 MHz band, making sure that the switch section on the r. f. processing box is in the corresponding position. Set the Δf, fine tune and marker controls to mid-travel and allow 15 minutes for the instrument to stabilize. Connect a counter frequency meter to the COUNTER OUTPUT socket and tune to a frequency of 3 MHz. Switch to range 11 and ensure the instrument will tune to the 510 MHz position.

(11) Refit the power chassis and r. f. processing unit in their normal positions, making sure that all r. f. connections are securely made.

(12) Refit the case.

Chapter 6

Replaceable parts

Introduction

Each of the printed boards and other sub-assemblies in this instrument has been allocated a unit identification number in the sequence A1 to A44 , which wherever practicable is marked upon it. The complete circuit reference for a component carries its unit number as a prefix, e.g. A6R15.

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

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

C	:	capacitor
Carb	:	carbon
Cer	:	ceramic
Elec	:	electrolytic
FS	:	fuse
JK	:	jack
L	:	inductor
M	:	meter
Met	:	metal
Min	:	minimum
MR	:	semiconductor diode
Ox	:	oxide
PL	:	plug
Plas	:	plastic
R	:	resistor
RV	:	variable resistor
S	:	switch
SKT	:	socket
T	:	transformer
TE	:	total excursion
TH	:	thermistor
Var	:	variable
VT	:	transistor
WW	:	wirewound
X	:	crystal
Ø	:	lead through
†	:	value selected during test; nominal value shown
⚠	:	static sensitive component : see page 4 Notes and cautions.
W	:	resistor rating at 70 °C
W*	:	resistor rating at 55 °C

Ordering

When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required.

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

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

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

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

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

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

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

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

UNIT A1 V.F.O. Tripler

When ordering prefix with A1

Circuit reference	Description	M.I. code
	Complete board	44821-605
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Cer 0.001μF +80-20% 500V	26383-242
C3	Cer 0.001μF +80-20% 500V	26383-242
C4	Cer 0.001μF +80-20% 500V	26383-242
C5	Plas 22pF ±2pF 125V	26516-088
C6	Cer 2.2pF ±0.5pF 63V	26343-457
C7	Cer 7.5pF ±0.5pF 200V	26324-185
C8	Plas 22pF ±2pF 125V	26516-088
C9	Plas 33pF ±2pF 125V	26516-127
C10	Cer 8.2pF ±0.5pF 200V	26324-186
C11	Cer 8.2pF ±0.5pF 200V	26324-186
C12	Plas 12pF ±1pF 125V	26516-014
C13	Plas 15pF ±1.5pF 125V	26516-018
L1	100μH coil	23642-325
L2	Filter coil	44278-135
L3	Filter coil	44278-119
L4	Filter coil	44278-108
L5	Filter coil	44278-109
L6	Filter coil	44278-110
L7	Filter coil	44278-111
L8	Filter coil	44278-112
L9	Filter coil	44278-113
L10	Bead coil	44223-827
R1	Met film 120Ω 2% ¼W	24773-251
R2	Met film 3.3kΩ 2% ¼W	24773-285
R3	Met film 47kΩ 2% ¼W	24773-313
R4	Met ox 390Ω 2% ½W	24573-063
R5	Met film 680Ω 2% ¼W	24773-269
TR1	BSX 20	28452-197

UNIT A2 Amplifier and filter, 54-67 MHz

When ordering prefix with A2

Circuit reference	Description	M.I. code
	Complete board	44821-606
C1	Cer 0.001μF +80-20% 500V	26383-242
C2	Cer 0.001μF +80-20% 500V	26383-242
C3	Cer 0.001μF +80-20% 500V	26383-242
C4	Cer 6.8pF ±0.5pF 63V	26343-463
C5	Cer 2.2pF ±0.5pF 63V	26343-457
C6a	Cer 4.7pF ±0.5pF 63V	26343-461
C6b	Cer 4.7pF ±0.5pF 63V	26343-461
C7	Plas 27pF ±2pF 125V	26516-108
C8	Plas 15pF ±1.5pF 125V	26516-018
C9	Cer 6.8pF ±0.5pF 200V	26324-184
C10	Plas 160pF 2% 125V	26516-294
C11	Cer Ø 0.001μF +80-20% 300V	26373-733
L1	100μH coil	23642-325
L2	Filter coil	44278-136
L3	Filter coil	44278-120
L4	Filter coil	44278-189
L5	Filter coil	44278-137
L6	Filter coil	44278-138
L7	Filter coil	44278-139
L8	Bead coil	44223-827

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R1	Met film 68Ω 2% ¼W	24773-245
R2	Var Carb 4.7kΩ 10% ½W	25711-542
R3	Met film 18kΩ 2% ¼W	24773-303
R4	Met film 220Ω 2% ¼W	24773-256
R5	Met film 820Ω 2% ¼W	24773-271
TR1	BFY 90	28452-157

UNIT A3 Mixer, 31–45 MHz

When ordering prefix with A3

Circuit reference	Description	M.I. code
	Complete board	44823-714
C1	Cer 470pF +40-20% 500V	26383-139
D1, D2, D3, D4	HP 5082-2800	44529-036
R2	Var Carb 100Ω 20% 0.21W	25541-308
T1a, T1b	Line transformer	43541-011
T2a, T2b	Line transformer	43541-011

UNIT A4 Modulated amplifier, 31–45 MHz

When ordering prefix with A4

Circuit reference	Description	M.I. code
	Complete board	44811-603
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Plas 43pF ±2pF 125V	26516-157
C3	Plas 68pF ±2pF 125V	26516-201
C4	Plas 43pF ±2pF 125V	26516-157
C5	Plas 15pF ±1.5pF 125V	26516-018
C6	Cer 6.8pF ±0.5pF 200V	26324-184
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Cer 470pF +40-20% 500V	26383-139
C9	Cer 0.001μF +80-20% 500V	26383-242
C10	Cer 0.001μF +80-20% 500V	26383-242
C11	Cer 1.5pF ±0.5pF 63V	26343-501
C12a	Cer 5.6pF ±0.5pF 63V	26343-462
C12b	Cer 5.6pF ±0.5pF 63V	26343-462
C13	Plas 33pF ±2pF 125V	26516-127
C14	Plas 15pF ±1.5pF 125V	26516-018
C15	Plas 15pF ±1.5pF 125V	26516-018
D1	Zener Z5B 13	28372-213
D2	1N 914	28336-676
L1	100μH	23642-325
L2	Filter coil	44278-125
L3	Filter coil	44278-126
L4	Filter coil	44278-127
L5	Filter coil	44278-128
L6	Filter coil	44278-129
L7	Filter coil	44278-130
L8	Filter coil	44278-131
L9	Filter coil	44278-132
L10	Filter coil	44278-134
L11	Filter coil	44278-133
L12	Bead coil	44223-827

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R1	Met film 820Ω 2% $\frac{1}{4}$W	24773-271
R2	Met ox 27kΩ 5% $\frac{1}{2}$W	24552-120
R3	Var Carb 4.7kΩ 10% $\frac{1}{2}$W	25711-542
R4	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5	Met film 68Ω 2% $\frac{1}{4}$W	24773-245
R6	Met ox 330Ω 5% $\frac{1}{2}$W	24552-063
R7	Met ox 100Ω 5% $\frac{1}{2}$W	24552-050
R8	Met film 1.8kΩ 2% $\frac{1}{4}$W	24773-279
R9	Met film 47kΩ 2% $\frac{1}{4}$W	24773-313
TR1 ⚠	40673	28459-010
X1	Ferrox cube bead	23635-833

UNIT A5 Amplifier, 31-45 MHz

When ordering prefix with A5

Circuit reference	Description	M.I. code
	Complete board	44823-715
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Cer 0.001μF +80-20% 500V	26383-242
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Cer 5.6pF ±0.5pF 200V	26324-182
C9	Plas 18pF ±2pF 125V	26516-028
C10	Plas 130pF 2% 125V	26516-273
C11	Plas 68pF ±2pF 125V	26516-201
C12	Plas 27pF ±2pF 125V	26516-108
C13	Plas 160pF 2% 125V	26516-294
C14	Cer 0.001μF +80-20% 500V	26383-242
D1	Pin diode	28383-997
D2	Pin diode	28383-997
L1	100μH	23642-325
L2	Filter coil	44278-166
L3	Filter coil	44278-161
L4	Filter coil	44278-162
L5	Filter coil	44278-163
L6	Filter coil	44278-164
L7	Filter coil	44278-165
L8	Bead coil	44223-827
L9	6.8μH 10%	44247-204
R1	Met ox 270Ω 5% $\frac{1}{2}$W	24552-061
R2	Met ox 2.7kΩ 5% $\frac{1}{2}$W	24552-092
R3	Met ox 47kΩ 5% $\frac{1}{2}$W	24552-126
R7	Met ox 33Ω 5% $\frac{1}{2}$W	24552-033
R8	Met ox 1.8kΩ 5% $\frac{1}{2}$W	24552-086
R9	Met film 1.2kΩ 2% $\frac{1}{4}$W	24773-275
TR1	BSX 20	28452-207

UNIT A6 Crystal calibrator oscillator

When ordering prefix with A6

Circuit reference	Description	M.I. code
	Complete board	44823-716
C1	Plas 0.001μF 2% 125V	26516-481
C2	Var Cer 10-60 pF	26847-267
C3	Plas 33pF 2% 125V	26516-127
C4	Cer 0.1μF +50-20% 30V	26383-031
C5	Cer 0.1μF +50-20% 30V	26383-031
C6	Plas 470pF 2% 125V	26516-406
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Plas 47pF ±2pF 125V	26516-165
C9	Plas 150pF 2% 125V	26516-287
C10	Cer 0.1μF +50-20% 30V	26383-031
C11	Plas 33pF ±2pF 125V	26516-127
C12	Elec 1μF +100-20% 50V	26414-106
C13	Elec 4.7μF ±20% 35V	26486-219
C15	Cer Ø 0.001μF +80-20% 300V	26373-733

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
D1	1N 914	28336-676
D2	1N 914	28336-676
D3	1N 914	28336-676
D4	1N 914	28336-676
D5	1N 914	28336-676
L1	100μH	23642-325
L2	Bead coil	44223-827
R1	Met ox 4.7kΩ 2% ½W	24573-089
R2 †	Met ox 22kΩ 2% ½W	24573-105
R3	Met ox 330Ω 2% ½W	24573-061
R4	Met ox 3.9kΩ 2% ½W	24573-087
R5	Met ox 1.2kΩ 2% ½W	24573-075
R6	Met ox 2.7kΩ 2% ½W	24573-083
R7	Met ox 12kΩ 2% ½W	24573-099
R8	Met ox 1kΩ 2% ½W	24573-073
R9	Met ox 2.2kΩ 2% ½W	24573-081
R10	Met ox 12kΩ 2% ½W	24573-099
R11	Met ox 2.7kΩ 2% ½W	24573-083
R12	Met ox 3.9kΩ 2% ½W	24573-087
R13	Met ox 680Ω 2% ½W	24573-069
R14	Met ox 220Ω 2% ½W	24573-057
R15	Met ox 27kΩ 2% ½W	24573-107
R16	Met ox 330kΩ 2% ½W	24573-133
R17	Met ox 470Ω 2% ½W	24573-065
R18	Met film 27Ω 2% ¼W	24773-235
TR1	BC 108	28452-787
TR2	BC 108	28452-787
TR3	BC 108	28452-787
TR4	BC 108	28452-787
TR5	BC 108	28452-787
T1	Transformer	43542-507
T2	Transformer	43556-503
XL1	375 kHz crystal	28311-685

UNIT A7 Range 2 filter and amplifier

When ordering prefix with A7

Circuit reference	Description	M.I. code
	Complete board	44823-717
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Plas 33pF ±2pF 125V	26516-127
C3	Plas 68pF ±2pF 125V	26516-201
C4	Plas 33pF ±2pF 125V	26516-127
C5	Cer 0.01μF +80-20% 100V	26383-055
C6	Cer 0.01μF +80-20% 100V	26383-055
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Cer 0.01μF +80-20% 100V	26383-055
C9	Cer Ø 0.001μF +80-20% 300V	26373-733
L1	Filter coil	44278-190
L2	Filter coil	44278-191
L4	470μH	23642-565
L5	100μH	23642-325
L6	Bead coil	44223-827
L7	Bead coil	44223-827
R1	Met film 56Ω 2% ¼W	24773-243
R2	Met film 8.2kΩ 2% ¼W	24773-295
R3	Met film 8.2kΩ 2% ¼W	24773-295
R4	Met film 560Ω 2% ¼W	24773-267
R5 †	Met film 100Ω 2% ¼W	24773-249
TR1	ZTX 320	28452-101
T1	Transformer	43561-510

For symbols and abbreviations see introduction to this chapter

UNIT A8 Mixer and 67 MHz amplifier

When ordering prefix with A8

Circuit reference	Description	M.I. code
	Complete board	44823-718
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Cer Ø 0.001μF +80-20% 300V	26373-733
C3	Cer 0.01μF +80-20% 100V	26383-055
C4	Cer 0.001μF +80-20% 500V	26383-242
C5	Cer 0.001μF +80-20% 500V	26383-242
C6	Cer 0.001μF +80-20% 500V	26383-242
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Plas 33pF ±2pF 125V	26516-127
C9	Plas 150pF 2% 125V	26516-287
C10	Cer 68pF ±20pF 500V	26343-163
D1, D2, D3, D4	HP 5082-2800	44529-036
L1	470μH	23642-565
L2	100μH	23642-325
L3	Filter coil	44278-194
L4	Bead coil	44223-826
L5	Bead coil	44223-827
R1	Met film 56Ω 2% ¼W	24773-243
R2	Met film 68Ω 2% ¼W	24773-245
R3	Met film 120Ω 2% ¼W	24773-251
R5	Var Carb 4.7kΩ 10% 0.21W	25711-542
R6	Met film 12kΩ 2% ¼W	24773-299
R7	Met film 470Ω 2% ¼W	24773-265
R8	Met film 56Ω 2% ¼W	24773-243
T1A, T1B	Line transformer	43541-011
T2A, T2B	Line transformer	43541-011
TR1	ZTX 320	28452-101

UNIT A9 Mixer and range 1 amplifier

When ordering prefix with A9

Circuit reference	Description	M.I. code
	Complete board	44823-719
C1	Cer 0.001μF +80-20% 500V	26383-242
C2	Elec 4.7μF 20% 35V	26486-219
C3	Cer 0.01μF +80-20% 100V	26383-055
C4	Plas 300pF 2% 125V	26516-358
C5	Plas 680pF 2% 125V	26516-444
C6	Plas 300pF 2% 125V	26516-358
C7	Elec 0.47μF 20% 35V	26486-207
C8	Elec 4.7μF 20% 35V	26486-219
C9	Cer 0.1μF +50-25% 30V	26383-031
C10	Plas 27pF ±2pF 125V	26516-108
C11	Cer 0.047μF +50-25% 30V	26383-018
C12	Elec 4.7μF 20% 35V	26486-219
C13	Cer Ø 0.001μF +80-20% 300V	26373-733
D1, D2, D3, D4	HP 5082-2800	44529-036
D5	Pin diode	28383-997
D6	Pin diode	28383-997
D7	1N914	28336-676

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
L1	Filter coil	44278-195
L2	Filter coil	44278-196
L3	100µH	23642-325
R1	Met film 15kΩ 2% $\frac{1}{4}$W	24773-301
R2	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R3	Var Carb 470Ω 10% $\frac{1}{2}$W	25711-541
R4	Met film 10Ω 2% $\frac{1}{4}$W	24773-225
R5	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R6	Var Carb 47kΩ 10% $\frac{1}{2}$W	25711-549
R7	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R8	Met ox 680kΩ 2% $\frac{1}{2}$W	24573-141
R9	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R10	Var Carb 470Ω 10% $\frac{1}{2}$W	25711-541
R11	Met film 1.2kΩ 2% $\frac{1}{4}$W	24773-275
R12	Met film 10Ω 2% $\frac{1}{4}$W	24773-225
R13	Met film 47Ω 2% $\frac{1}{4}$W	24773-240
T1a, T1b	Line transformer	43542-503
T2a, T2b	Line transformer	43542-503
TR1	ZTX 320	28452-101
TR2	BCY 71	28435-235
TR3	BCY 71	28435-235
TR4	BC 108	28452-787

UNIT A10 Reference modulator

When ordering prefix with A10

Circuit reference	Description	M.I. code
	Complete board	44823-720
C1	Cer Ø 0.001µF +80-20% 300V	26373-733
C2	Cer 4.7pF ±0.5pF 200V	26324-180
C3	Cer 68pF 20% 500V	26343-163
C4	Cer 0.001µF +80-20% 500V	26383-242
C5	Cer 100pF 20% 500V	26343-167
C6	Cer 0.001µF +80-20% 500V	26383-242
C8	Cer 10pF 20% 500V	26343-120
C9	Mica 150pF 2% 350V	26272-381
C10	Mica 662pF 2% 350V	26272-379
C11	Mica 150pF 2% 350V	26272-381
C12	Cer 0.001µF +80-20% 500V	26383-242
C13	Plas 47pF ±2pF 125V	26516-165
C14	Cer 0.001µF +80-20% 500V	26383-242
C15	Cer 0.01µF +80-20% 100V	26383-055
C16	Cer Ø 0.001µF +80-20% 300V	26373-733
D1	Z5B 4.7	28371-373
D2	1N 914	28336-676
D3	1N 914	28336-676
L1	100µH	23642-325
L2	Filter coil	44278-167
L3	Filter coil	44278-168
L4	10µH	23642-313
L5	100µH	23642-325
L6	100µH	23642-325
L7	Bead coil	44223-826
L9	100µH	23642-325
R1	Met ox 1kΩ 5% $\frac{1}{2}$W	24552-080
R2	Met ox 91kΩ 5% $\frac{1}{2}$W	24552-134
R3	Met ox 2.4kΩ 5% $\frac{1}{2}$W	24552-089
R4	Met ox 1kΩ 5% $\frac{1}{2}$W	24552-080
R5	Met ox 1kΩ 5% $\frac{1}{2}$W	24552-080
R6	Met ox 39kΩ 5% $\frac{1}{2}$W	24552-124

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R7	Carb 2.2MΩ 5% ¼W	24312-974
R8	Var Carb 50kΩ 20% 0.21W	25541-344
R9	Met ox 4.3kΩ 5% ½W	24552-097
R10	Met ox 91kΩ 5% ½W	24552-134
R11	Met ox 180Ω 5% ½W	24552-056
R12	Met ox 22Ω 5% ½W	24552-028
R14	Met ox 10kΩ 5% ½W	24552-110
R15	Met ox 1.2kΩ 5% ½W	24552-082
R16	Met ox 47Ω 5% ½W	24552-037
R17	Thermistor 10kΩ 20%	25683-263
TR1	ZTX 320	28452-101
TR2	MPS 3640	28431-766
TR3	BSX 20	28452-197
TR4	BC 108	28452-787

UNIT A11 Crystal oscillator, 90 MHz

When ordering prefix with A11

Circuit reference	Description	M.I. code
	Complete board	44821-607
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Cer 0.001μF +80-20% 500V	26383-242
C3	Cer 0.001μF +80-20% 500V	26383-242
C4	Plas 27pF ±2pF 125V	26516-108
C5	Plas 100pF ±2pF 125V	26516-241
C6	Var Cer 3pF-12pF	26847-241
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Plas 27pF ±2pF 125V	26516-108
C9	Cer 130pF 20% 500V	26383-131
C10	Cer 0.001μF +80-20% 500V	26383-242
L1	Bead coil	44223-827
L2	10μH	23642-313
L3	Filter coil	44278-150
L4 †	0.22μH	23642-545
L5	0.47μH	23642-547
L6	Filter coil	44278-150
R1	Met film 470Ω 2% ¼W	24773-265
R2	Met film 3kΩ 2% ¼W	24773-284
R3	Met film 100Ω 2% ¼W	24773-249
R4	Met film 470Ω 2% ¼W	24773-265
R5	Met film 15Ω 2% ¼W	24773-229
R6	Met film 470Ω 2% ¼W	24773-265
R7	Met film 3kΩ 2% ¼W	24773-284
R8	Met film 51Ω 2% ¼W	24773-242
R9	Met film 68Ω 2% ¼W	24773-245
R10	Met film 47Ω 2% ¼W	24773-241
TR1	BSX 20	28452-197
TR2	BSX 20	28452-197
XL1	90 MHz crystal	28311-919

UNIT A12 Mixer 67 MHz

When ordering prefix with A12

Circuit reference	Description	M.I. code
	Complete board	44823-721
C1	Cer 100pF 20% 500V	26343-167
C2 †	Cer 3.3pF ±0.5pF 200V	26324-176
D1, D2, D3, D4	HP 5082-2800	44529-036
R1	Var Carb 100Ω 10% ½W	25711-545

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
T1a, T1b	Line transformer	43541-011
T2a, T2b	Line transformer	43541-011

UNIT A13 Amplifier 67 MHz

When ordering prefix with A13

Circuit reference	Description	M.I. code
	Complete board	44821-608
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Plas 110pF 2% 500V	26516-254
C3	Cer 5.6pF ±0.5pF 63V	26343-462
C4	Cer 470pF +40-20% 500V	26383-139
C5	Cer 5.6pF ±0.5pF 63V	26343-462
C6	Plas 43pF ±2pF 125V	26516-157
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Plas 110pF 2% 125V	26516-254
C9	Plas 130pF 2% 125V	26516-273
C10	Cer 0.001μF +80-20% 500V	26383-242
C11	Cer 0.001μF +80-20% 500V	26383-242
C12	Plas 110pF 2% 125V	26516-254
C13	Plas 110pF 2% 125V	26516-254
C14	Cer 0.001μF +80-20% 500V	26383-242
C15	Cer 5.6pF ±0.5pF 200V	26324-182
C16	Cer 10pF 20% 500V	26343-120
L1	100μH	23642-325
L2	Filter coil	44278-114
L3	Filter coil	44278-115
L4	Filter coil	44278-116
L5	Filter coil	44278-117
L6	Filter coil	44278-118
L7	Bead coil	44223-827
R1	Var Carb 4.7kΩ 10% ½W	25711-542
R2	Met film 33kΩ 2% ¼W	24773-309
R3	Met film 390Ω 2% ¼W	24773-263
R4	Met film 22Ω 2% ¼W	24773-233
R5	Met film 100Ω 2% ¼W	24773-249
R6	Met film 4.7kΩ 2% ¼W	24773-289
R7	Met film 6.8kΩ 2% ¼W	24773-293
R8	Met film 470Ω 2% ¼W	24773-265
R9	Met film 47Ω 2% ¼W	24773-241
R10	Met film 56Ω 2% ¼W	24773-243
TR1	BFY 90	28452-157
TR2	ZTX 320	28452-101

UNIT A14 Mixer 22-31 MHz

When ordering prefix with A14

Circuit reference	Description	M.I. code
	Complete board	44823-722
C1 †	Cer 6.8pF ±0.5pF 200V	26324-184
D1, D2, D3, D4	HP 5082-2800	44529-036
T1a, T1b	Line transformer	43541-011
T2a, T2b	Line transformer	43541-011

For symbols and abbreviations see introduction to this chapter

UNIT A15 Modulated amplifier 22-31 MHz

When ordering prefix with A15

Circuit reference	Description	M.I. code
	Complete board	44811-271
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Plas 110pF 2% 125V	26516-254
C3	Plas 100pF ±2pF 125V	26516-241
C4	Plas 68pF ±2pF 125V	26516-201
C5	Plas 27pF ±2pF 125V	26516-108
C6	Cer 7.5pF +0.5pF 200V	26324-185
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Cer 470pF +40-20% 500V	26383-139
C9	Cer 0.001μF +80-20% 500V	26383-242
C10	Cer 0.001μF +80-20% 500V	26383-242
C11a	Cer 5.6pF ±0.5pF 63V	26343-462
C11b	Cer 5.6pF ±0.5pF 63V	26343-462
C12	Cer 9.1pF ±0.5pF 200V	26324-187
C13	Plas 56pF ±2pF 125V	26516-181
C14	Plas 33pF ±2pF 125V	26516-127
C15	Plas 27pF ±2pF 125V	26516-108
D1	Z5B 13	28372-213
D2	1N 914	28336-676
L1	100μH	23642-325
L2	Filter coil	44278-151
L3	Filter coil	44278-152
L4	Filter coil	44278-153
L5	Filter coil	44278-181
L6	Filter coil	44278-154
L7	Filter coil	44278-155
L8	Filter coil	44278-156
L9	Filter coil	44278-157
L10	Filter coil	44278-182
L11	Filter coil	44278-183
L12	Bead coil	44223-827
R1	Met film 820Ω 2% ¼W	24773-271
R2	Met ox 27kΩ 5% ½W	24552-120
R3	Var Carb 4.7kΩ 10% ½W	25711-542
R4	Met film 10kΩ 2% ¼W	24773-297
R5	Met film 68Ω 2% ¼W	24773-245
R6	Met ox 330Ω 2% ½W	24552-063
R7	Met ox 100Ω 2% ½W	24552-050
R8	Met film 2.2kΩ 2% ¼W	24773-281
R9	Met film 47kΩ 2% ¼W	24773-313
TR1 ⚠	40673	28459-010
X1	Ferrox cube bead	23635-833

UNIT A16 Amplifier 22-31 MHz

When ordering prefix with A16

Circuit reference	Description	M.I. code
	Complete board	44823-723
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Cer 0.001μF +80-20% 500V	26383-242
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Cer 4.7pF ±0.5pF 200V	26324-180
C9	Plas 20pF ±2pF 125V	26516-075
C10	Plas 470pF 2% 125V	26516-406
C11	Plas 160pF 2% 125V	26516-294
C12	Plas 27pF ±2pF 125V	26516-108
C13	Plas 300pF 2% 125V	26516-358
C14	Cer 0.001μF +80-20% 500V	26383-242

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
D1	Pin diode	28383-997
D2	Pin diode	28383-997
L1	100μH	23642-325
L2	Filter coil	44278-140
L3	Filter coil	44278-141
L4	Filter coil	44278-142
L5	Filter coil	44278-143
L6	Filter coil	44278-144
L7	Filter coil	44278-145
L8	Bead coil	44223-827
R1	Met ox 150Ω 5% ½W	24552-054
R2	Met ox 2.7kΩ 5% ½W	24552-092
R3	Met ox 47kΩ 5% ½W	24552-126
R7	Met ox 33Ω 5% ½W	24552-033
R8	Met ox 1.8kΩ 5% ½W	24552-086
R9	Met film 1.2kΩ 2% ¼W	24773-275
TR1	BSX 20	28452-207

UNIT A17 Doubler 36–45 MHz

When ordering prefix with A17

Circuit reference	Description	M.I. code
	Complete board	44821-609
C1	Cer Ø 0.001μF +80–20% 300V	26373-733
C2	Cer 0.001μF +100–20% 40V	26387-252
C3	Cer 0.001μF +100–20% 40V	26387-252
C4	Cer 0.01μF +80–20% 100V	26383-055
C5a	Cer 6.8pF ±0.5pF 63V	26343-463
C5b	Cer 8.2pF ±0.5pF 63V	26343-464
C6	Cer 2.2pF ±0.5pF 63V	26343-457
C7	Plas 10pF ±1pF 125V	26516-009
C8	Plas 82pF ±2pF 125V	26516-222
C9	Plas 56pF ±2pF 125V	26516-181
C10	Plas 12pF ±1pF 125V	26516-014
C11	Plas 47pF ±2pF 125V	26516-165
C12	Plas 33pF ±2pF 125V	26516-127
C13	Plas 22pF ±2pF 125V	26516-088
C14	Special	
C15	Cer 0.001μF −20%+100% 40V	26387-252
L1	100μH	26342-325
L2	Filter coil	44278-146
L3	Filter coil	44278-122
L4	Filter coil	44278-147
L5	Filter coil	44278-121
L6	Filter coil	44278-148
L7	Filter coil	44278-123
L8	Filter coil	44278-149
L9	Filter coil	44278-198
L10	Bead coil	44223-827
R1	Met film 12kΩ 2% ¼W	24773-299
R2	Var Carb 4.7kΩ 20% 0.21W	25541-226
R3	Met film 100Ω 2% ¼W	24773-249
R4	Var Carb 100Ω 20% 0.21W	25541-208
R5	Met film 1.5kΩ 2% ¼W	24773-277
R6	Met film 68Ω 2% ¼W	24773-245
R7	Met film 120Ω 2% ¼W	24773-251
R8	Met film 68Ω 2% ¼W	24773-245
T1	Transformer	43542-504
TR1	ZTX 320	28452-101
TR2	ZTX 320	28452-101

For symbols and abbreviations see introduction to this chapter

UNIT A18 A.L.C. Amplifier

When ordering prefix with A18

Circuit reference	Description	M.I. code
	Complete board	44823-724
C1	Elec 4.7µF 20% 35V	26486-219
C2	Cer 0.001µF +40-20% 500V	26383-144
C3	Elec 0.47µF 20% 35V	26486-207
C4	Cer 68pF 20% 500V	26343-163
C5	Cer 3.3pF ±0.5pF 500V	26343-111
C6	Elec 0.47µF 20% 35V	26486-207
C7	Elec 4.7µF 20% 35V	26486-219
C8	Elec 4.7µF 20% 35V	26486-219
C9	Elec 0.47µF 20% 35V	26486-207
C10	Elec 4.7µF 20% 35V	26486-219
C11	Cer 33pF 20% 500V	26343-146
C12	Elec 4.7µF 20% 35V	26486-219
C13	Elec 4.7µF 20% 35V	26486-219
C14	Cer 10pF 20% 500V	26343-120
C15	Cer 4700pF 10% 63V	26383-591
C16	Cer 0.001µF +80-20% 500V	26383-242
C17	Cer 0.1µF +50-25% 30V	26383-031
C18	Tant 0.47µF 20% 35V	26486-207
C19	Mica 2034pF 1% 200V	26268-368
D1	1N 914	28336-676
D2	1N 914	28336-676
D3	1N 914	28336-676
D4	1N 914	28336-676
D5	1N 914	28336-676
D6	Z5B 3.3	28371-208
D7	Z5B 3.3	28371-208
IC1	µA 709C	28461-301
R1	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321

Circuit reference	Description	M.I. code
R2	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R3	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R4	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5	Carb 1MΩ 5% 1/8W	24311-945
R6	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R7	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R8	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R9	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R10	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R11	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R12	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R13 †	Carb 1MΩ 5% 1/8W	24311-945
R14	Met film 33kΩ 2% $\frac{1}{4}$W	24773-309
R15	Met film 43kΩ 2% $\frac{1}{4}$W	24773-312
R16	Met film 33kΩ 2% $\frac{1}{4}$W	24773-309
R17	Met film 33kΩ 2% $\frac{1}{4}$W	24773-309
R18	Met film 91kΩ 2% $\frac{1}{4}$W	24773-320
R19 †	Met film 330Ω 2% $\frac{1}{4}$W	24773-261
R20	Met film 22kΩ 2% $\frac{1}{4}$W	24773-305
R21	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R22	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R23	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R24	Met film 33kΩ 2% $\frac{1}{4}$W	24773-309
R25	Met film 47kΩ 2% $\frac{1}{4}$W	24773-313
R26	Met film 33kΩ 2% $\frac{1}{4}$W	24773-309
R27	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R28	Met film 47kΩ 2% $\frac{1}{4}$W	24773-313
R29	Met film 68kΩ 2% $\frac{1}{4}$W	24773-317
R30	Met film 120kΩ 2% $\frac{1}{4}$W	24773-323
R31	Met film 220kΩ 2% $\frac{1}{4}$W	24773-329
R32	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R33	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R34	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R35	Carb 10MΩ 10% 1/6W	24322-991

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
TR1	BCY 71	28435-235
TR2	BSX 20	28452-197
TR3	BC 109	28452-777
TR4	BC 109	28452-777
TR5	BC 109	28452-777
TR6	2N 3819	28459-003
TR7	BCY 71	28435-235
TR8	BCY 71	28435-235
TR9	BSX 20	28452-197
TR10	BC 108	28452-787

UNIT A19 Detectors and comparator

When ordering prefix with A19

Circuit reference	Description	M.I. code
	Complete board	44823-725
C1	Cer 0.1μF 20% 100V	44435-203
C2	Cer 0.1μF 20% 100V	44435-203
C3	Cer Ø 56pF 20% 500V	26373-855
C4	Cer Ø 0.0047μF +80-20% 500V	26373-665
C5	Cer Ø 0.0047μF +80-20% 500V	26373-665
C6	Cer Ø 56pF 20% 500V	26373-855
C7	Cer 0.1μF +50-25% 30V	26383-031
C8	Cer 0.1μF +50-25% 30V	26383-031
C9	Cer 10pF 20% 500V	26343-120
C10	Cer 33pF 20% 500V	26343-146
C11	Cer 0.1μF +50-25% 30V	26383-031
C12	Cer 220pF 20% 500V	26383-134
C13	Cer 3.3pF ±0.5pF 500V	26343-111
C15	Elec. 0.47μF 20% 35V	26486-207
D1 – D4	HP 5082-2800	44529-043
D5	1N 914	28336-676
D6	1N 914	28336-676
D7	1N 914	28336-676
D8	1N 914	28336-676
D9	1N 914	28336-676
D10	1N 914	28336-676
IC1	SL 701 B	28461-305
L1	33μH	23642-558
R1	Met film 50Ω 1% 1/8W	24616-321
R2	Met film 10kΩ 2% ¼W	24773-297
R3	Met film 10kΩ 2% ¼W	24773-297
R6	Met film 100kΩ 2% ¼W	24773-321
R7	Var Carb 100Ω 20% 0.21W	25541-308
R8	Met film 100kΩ 2% ¼W	24773-321
R9	Met film 47kΩ 2% ¼W	24773-313
R10	Met film 47kΩ 2% ¼W	24773-313
R11	Met film 10kΩ 2% ¼W	24773-297
R12	Met film 6.8kΩ 2% ¼W	24773-293
R13	Met film 12kΩ 2% ¼W	24773-299
R14 †	Carb 470kΩ 10% ¼W	24312-952
R15 †	Carb 470kΩ 10% ¼W	24312-952
R16	Met film 27kΩ 2% ¼W	24773-307
R17	Met film 2.2kΩ 2% ¼W	24773-281
R18	Met film 1kΩ 2% ¼W	24773-273
R19	Met film 47kΩ 2% ¼W	24773-313
R20	Met film 1kΩ 2% ¼W	24773-273
R21	Met film 1kΩ 2% ¼W	24773-273
R22 †	Met film 100Ω 2% ¼W	24773-249
TR1	BCY 71	28435-235

For symbols and abbreviations see introduction to this chapter

UNIT A20 Counter amplifier

When ordering prefix with A20

Circuit reference	Description	M.I. code
	Complete board	44823-726
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Elec 4.7μF 20% 35V	26486-219
C3	Cer 0.01μF +80-20% 100V	26383-055
C4	Elec 4.7μF 20% 35V	26486-219
C5	Cer 1.8pF ±0.5pF 500V	26343-108
C6	Cer 8.2pF ±0.5pF 500V	26343-118
C7	Cer 220pF 20% 500V	26383-134
C8	Cer 0.01μF +80-20% 100V	26383-055
C9	Elec 4.7μF 20% 35V	26486-219
C10	Cer 0.01μF +80-20% 100V	26383-055
C11	Elec 250μF +100-20% 25V	26417-167
C12	Cer 0.1μF +50-25% 30V	26383-031
C13	Cer 1pF ±0.5pF 500V	26343-101
C14	Cer 15pF 10% 500V	26343-127
C15	Cer 5.6pF 20% 500V	26343-115
L1	Bead coil	44223-827
L2	100μH	23642-325
L4	100μH	23642-325
R1	Met film 100Ω 2% ¼W	24773-249
R2	Met ox 330Ω 2% ½W	24573-061
R3	Met ox 180Ω 2% ½W	24573-055
R4	Met ox 390Ω 2% ½W	24573-063
R5	Met film 10Ω 2% ¼W	24773-225
R6	Met ox 2.7kΩ 2% ½W	24573-083
R7	Met ox 10kΩ 2% ½W	24573-097
R8	Met ox 150Ω 2% ½W	24573-053
R9	Met ox 390Ω 2% ½W	24573-063
R10	Met film 10kΩ 2% ¼W	24773-297
TR1	BFY 90	28452-157
TR2	BFY 90	28452-157
X1	Ferrite bead	23635-833
X2	Ferrite bead	23635-833
X3	Ferrite bead	23635-833

UNIT A21 Doubler, 252-360 MHz

When ordering prefix with A21

Circuit reference	Description	M.I. code
	Complete board	44821-610
C1	Cer Ø 0.001μF+80-20% 300V	26373-733
C2	Cer Ø 0.001μF+80-20% 300V	26373-733
C3	Cer 47pF 20% 500V	26343-160
C4	Cer 33pF 20% 500V	26343-471
C5	Special	-
C6	Cer 22pF 20% 500V	26343-134
C7	Cer 47pF 20% 500V	26343-160
C8	Cer 47pF 20% 500V	26343-160
C9	Cer 47pF 20% 500V	26343-160
C10	Cer 2.2pF ±0.5pF 63V	26343-457
C11	Cer 1.8pF ±0.5pF 63V	26343-456
C12	Cer 1.5pF ±0.5pF 63V	26343-501
C13	Cer 4.7pF ±0.5pF 200V	26324-180
C14a	Cer 5.6pF ±0.5pF 63V	26343-462
C14b	Cer 5.6pF ±0.5pF 63V	26343-462
C15a	Cer 6.8pF ±0.5pF 63V	26343-463
C15b	Cer 6.8pF ±0.5pF 63V	26343-463
C16	Var Cer 4-20pF	26847-243
C17	Cer 47pF 20% 500V	26343-160

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
L1	Bead coil	44223-827
L2	100μH	23642-325
L3	Filter coil	44223-159
L4	Filter coil	44223-205
L5	Filter coil	44223-206
L6	Filter coil	44223-207
L7	Filter coil	44223-208
L8	Part of copper track	-
L9	Bead coil	44223-827
R1	Met film 15kΩ 2% $\frac{1}{4}$W	24773-301
R2	Var Carb 4.7kΩ 20% 0.21W	25541-226
R3	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R4	Var Carb 100Ω 20% 0.21W	25541-208
R5	Met film 680Ω 2% $\frac{1}{4}$W	24773-269
R6	Met film 1.2kΩ 2% $\frac{1}{4}$W	24773-275
R7	Met film 68Ω 2% $\frac{1}{4}$W	24773-245
T1	Transformer	43542-504
TR1 } TR2 }	BFY 90 matched pair	44522-046

UNIT A22 Doubler, 126–180 MHz

When ordering prefix with A22

Circuit reference	Description	M.I. code
	Complete board	44823-727
C1	Cer Ø 0.001μF+80-20% 300V	26373-733
C2	Cer Ø 0.001μF+80-20% 300V	26373-733
C3	Cer 220pF 20% 500V	26383-134
C4	Cer 68pF 20% 500V	26343-163
C5	Cer 220pF 20% 500V	26383-134
C6	Cer 220pF 20% 500V	26343-481
C8	Cer 220pF 20% 500V	26383-134
C9	Cer 2.2pF ±0.5pF 63V	26343-457
C10	Cer 5.6pF ±0.5pF 200V	26324-182
C11	Cer 7.5pF ±0.5pF 200V	26324-185
C12a	Cer 6.8pF ±0.5pF 63V	26343-463
C12b	Cer 8.2pF ±0.5pF 63V	26343-464
C13	Cer 7.5pF ±0.5pF 200V	26324-185
C14	Plas 33pF ±2% 125V	26516-127
C15	Cer 220pF 20% 500V	26383-134
C16	Special	
D1	Pin diode	28383-997
D2	Pin diode	28383-997
L1	Bead coil	44223-827
L2	100μH	23642-325
L3	Filter coil	44278-186
L4	Filter coil	44278-188
L5	Filter coil	44278-184
L6	Filter coil	44278-187
L7	Filter coil	44278-185
L8	Filter coil	44278-197
L9	Bead coil	44223-827
R1	Met film 15kΩ 2% $\frac{1}{4}$W	24773-301
R2	Var Carb 4.7kΩ 20% 0.21W	25541-226
R3	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R4	Var Carb 100Ω 20% 0.21W	25541-208
R5	Carb 2.2kΩ 10% $\frac{1}{4}$W	24341-288
R6	Met film 1.2kΩ 2% $\frac{1}{4}$W	24773-275
R7	Met film 100Ω 2% $\frac{1}{4}$W	24773-249

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
T1	Transformer	43542-504
TR1 / TR2	BFY 90 matched pair	44522-046

UNIT A23 Doubler, 63–90 MHz

When ordering prefix with A23

Circuit reference	Description	M.I. code
	Complete board	44823-728
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Cer Ø 0.001μF +80-20% 300V	26373-733
C3	Cer 220pF ±20% 500V	26383-134
C4	Cer 470pF ±10% 63V	26343-599
C5	Cer 470pF ±10% 63V	26343-599
C6	Cer 470pF ±10% 63V	26343-599
C7	Cer 470pF +40-20% 500V	26383-139
C8a	Cer 6.8pF ±0.5pF 63V	26343-463
C8b	Cer 6.8pF ±0.5pF 63V	26343-463
C9	Cer 9.1pF ±0.5pF 200V	26324-187
C10	Plas 15pF ±1.5pF 125V	26516-018
C11	Cer 8.2pF ±0.5pF 200V	26324-186
C12	Plas 15pF ±1.5pF 125V	26516-018
C13	Plas 56pF ±2pF 125V	26516-181
C14	Cer 470pF +40-20% 500V	26383-139
C15	Special	
D1	Pin diode	28383-997
D2	Pin diode	28383-997
L1	Bead coil	44223-827
L2	100μH	23642-325
L3	Filter coil	44278-175
L4	Filter coil	44278-176
L5	Filter coil	44278-177
L6	Filter coil	44278-178
L7	Filter coil	44278-179
L8	Filter coil	44278-180
L9	Bead coil	44223-827
R1	Met film 15kΩ 2% ¼W	24773-301
R2	Var Carb 4.7kΩ 20% 0.21W	25541-226
R3	Met film 100Ω 2% ¼W	24773-249
R4	Var Carb 100Ω 20% 0.21W	25541-208
R5	Met film 1.5kΩ 2% ¼W	24773-277
R6	Met film 1.2kΩ 2% ¼W	24773-275
R7	Met film 68Ω 2% ¼W	24773-245
T1a / T1b	Transformer	43542-506
TR1 / TR2	BFY 90 matched pair	44522-046

UNIT A24 Doubler, 360–504 MHz

When ordering prefix with A24

Circuit reference	Description	M.I. code
	Complete board	44821-611
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Cer Ø 0.001μF +80-20% 300V	26373-733
C3	Cer 100pF 20% 500V	26343-167
C4	Cer 10pF 5% 50V	26343-465
C5	Cer 22pF 20% 500V	26343-134
C6	Cer 47pF 20% 500V	26343-160
C7	Cer 47pF 20% 500V	26343-160
C8	Cer 47pF 20% 500V	26343-160
C9a	Cer 6.8pF ±0.5pF 63V	26343-463
C9b	Cer 5.6pF ±0.5pF 63V	26343-462

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C10	Var Cer 0.5-5pF	26845-141
C11	Var Cer 0.5-5pF	26845-141
C12	Cer 2.2pF ±0.5pF 63V	26343-457
C13	Var Cer 10-40pF	26847-264
C14	Cer 68pF 20% 500V	26343-163
C16	Special	
L1	Bead coil	44223-827
L2	10μH	23642-313
L3	Filter coil	44278-213
L4	Filter coil	44278-192
L5	Filter coil	35688-106
L6	Filter coil	35688-107
L7	Filter coil	44278-193
L8	Part of copper track	-
L9	Bead coil	44223-827
R1	Met film 15kΩ 2% $\frac{1}{4}$W	24773-301
R2	Var Carb 4.7kΩ 20% 0.21W	25541-226
R3	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R4	Var Carb 100Ω 20% 0.21W	25541-208
R5	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R6	Met film 1.2kΩ 2% $\frac{1}{4}$W	24773-275
R7	Met film 68Ω 2% $\frac{1}{4}$W	24773-245
T1	Transformer	43542-504
TR1 } TR2 }	BFY 90 matched pair	44522-046
X1	Ferrite bead	23635-833

UNIT A25 Doubler, 180-252 MHz

When ordering prefix with A25

Circuit reference	Description	M.I. code
	Complete board	44823-729
C1	Cer Ø 0.001μF+80-20% 300V	26373-733
C2	Cer Ø 0.001μF+80-20% 300V	26373-733
C3	Cer 220pF 20% 500V	26383-134
C4	Cer 22pF 20% 500V	26343-469
C5	Cer 130pF 20% 500V	26383-131
C6	Cer 100pF 20% 500V	26343-167
C7	Cer 47pF 20% 500V	26343-160
C8	Cer 1.5pF ±0.5pF 63V	26343-501
C9	Cer 1.8pF ±0.5pF 63V	26343-456
C10	Cer 1.5pF ±0.5pF 63V	26343-501
C11	Cer 4.7pF ±0.5pF 500V	26324-180
C12	Cer 2.2pF ±0.5pF 63V	26343-457
C13	Cer 4.7pF ±0.5pF 500V	26324-180
C14	Var Cer 10-40pF	26847-264
C15	Cer 47pF 20% 500V	26343-160
C16	Special	
C17	Cer 100pF 20% 500V	26343-167
D1	Pin diode	28383-997
D2	Pin diode	28383-997
L1	Bead coil	44223-827
L2	100μH	23642-325
L3	Filter coil	44278-160
L4	Filter coil	44278-209
L5	Filter coil	44278-210
L6	Filter coil	44278-211

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
L7	Filter coil	44278-212
L8	Part of copper track	-
L9	Bead coil	44223-827
R1	Met film 15kΩ 2% $\frac{1}{4}$W	24773-301
R2	Var Carb 4.7kΩ 20% 0.21W	25541-226
R3	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R4	Var Carb 100Ω 20% 0.21W	25541-208
R5	Met film 1.2kΩ 2% $\frac{1}{4}$W	24773-275
R6	Met film 1.2kΩ 2% $\frac{1}{4}$W	24773-275
R7	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
TR1 } TR2 }	BFY 90 matched pair	44522-046
T1	Transformer	43542-504

UNIT A26 Doubler, 90–126 MHz

When ordering prefix with A26

Circuit reference	Description	M.I. code
	Complete board	44823-730
C1	Cer Ø 0.001μF +80-20% 300V	26373-733
C2	Cer Ø 0.001μF +80-20% 300V	26373-733
C3	Cer 0.001μF +80-20% 500V	26383-242
C4	Cer 330pF 20% 500V	26383-136
C5	Cer 0.001μF +100-20% 40V	26387-252
C6	Cer 330pF 2% 50V	26343-483
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Cer 2.2pF ±0.5pF 63V	26343-457
C9	Cer 4.7pF ±0.5pF 200V	26324-180

Circuit reference	Description	M.I. code
C10	Cer 7.5pF ±0.5pF 200V	26324-185
C11	Cer 5.6pF ±0.5pF 200V	26324-182
C12	Plas 10pF ±1pF 125V	26516-009
C13	Plas 47pF ±2pF 125V	26516-165
C14	Cer 330pF 20% 500V	26383-136
C15	Special	
D1	Pin diode	28383-997
D2	Pin diode	28383-997
L1	Bead coil	44223-827
L2	100μH	23642-325
L3	Filter coil	44278-199
L4	Filter coil	44278-200
L5	Filter coil	44278-201
L6	Filter coil	44278-202
L7	Filter coil	44278-203
L8	Filter coil	44278-204
L9	Bead coil	44223-827
R1	Met film 15kΩ 2% $\frac{1}{4}$W	24773-301
R2	Var Carb 4.7kΩ 20% 0.21W	25541-226
R3	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R4	Var Carb 100Ω 20% 0.21W	25541-208
R5	Met film 1.2kΩ 2 % $\frac{1}{4}$W	24773-275
R6	Met film 1.2kΩ 2% $\frac{1}{4}$W	24773-275
R7	Met film 82Ω 2% $\frac{1}{4}$W	24773-247
T1	Transformer	43542-504
TR1 } TR2 }	BFY 90 matched pair	44522-046

For symbols and abbreviations see introduction to this chapter

UNIT A27 Doubler, 45-63 MHz

When ordering prefix with A27

Circuit reference	Description	M.I. code
	Complete board	44823-731
C1	Cer Ø 0.001µF +80-20% 300V	26373-733
C2	Cer Ø 0.001µF +80-20% 300V	26373-733
C3	Cer 0.001µF +40-20% 500V	26383-144
C4	Cer 0.001µF +100-20% 40V	26387-252
C5	Cer 0.001µF +100-20% 40V	26387-252
C6	Cer 0.001µF +100-20% 40V	26387-252
C7	Cer 0.01µF +80-20% 100V	26383-055
C8a	Cer 6.8pF ±0.5pF 63V	26343-463
C8b	Cer 6.8pF ±0.5pF 63V	26343-463
C9	Plas 12pF ±1pF 125V	26516-014
C10	Plas 22pF ±2pF 125V	26516-088
C11	Plas 10pF ±1pF 125V	26516-009
C12	Plas 20pF ±2pF 125V	26516-075
C13	Plas 120pF 2% 125V	26516-262
C14	Cer 0.001µF +80-20% 500V	26383-242
C15	Special	-
D1	Pin diode	28383-997
D2	Pin diode	28383-997
D3	Pin diode	28383-997
L1	Bead coil	44223-827
L2	100µH	23642-325
L3	Filter coil	44278-174
L4	Filter coil	44278-169
L5	Filter coil	44278-170
L6	Filter coil	44278-171
L7	Filter coil	44278-172
L8	Filter coil	44278-173
L9	Bead coil	44223-827
R1	Met film 15kΩ 2% ¼W	24773-301
R2	Var Carb 4.7kΩ 20% 0.21W	25541-226
R3	Met film 100Ω 2% ¼W	24773-249
R4	Var Carb 100Ω 20% 0.21W	25541-208
R5	Met film 1.8kΩ 2% ¼W	24773-279
R6	Met film 1.2kΩ 2% ¼W	24773-275
R7	Met film 68Ω 2% ¼W	24773-245
T1	Transformer	43542-504
TR1	ZTX 320	28452-101
TR2	ZTX 320	28452-101

UNIT A28 Filters

When ordering prefix with A28

Circuit reference	Description	M.I. code
C1	Cer Ø 0.001µF +80-20% 300V	26373-733
C2	Cer Ø 0.001µF +80-20% 300V	26373-733
C3	Cer Ø 0.001µF +80-20% 300V	26373-733
C4	Cer 0.001µF 2% 125V	26516-481
C5	Cer 0.001µF 2% 125V	26516-481
C6	Cer Ø 0.001µF +80-20% 300V	26373-733
C7	Cer Ø 0.001µF +80-20% 300V	26373-733
C8	Cer Ø 0.001µF +80-20% 300V	26373-733
C9	Cer 0.1µF +25-20% 30V	26383-031
C10	Cer 0.1µF +25-20% 30V	26383-031
C11	Cer 0.1µF +25-20% 30V	26383-031
C16	Cer Ø 0.001µF +80-20% 300V	26373-733
C17	Cer Ø 0.001µF +80-20% 300V	26373-733
C18	Cer Ø 0.001µF +80-20% 300V	26373-733
C19	Cer 0.1µF +25-20% 30V	26383-031
C20	Cer 0.1µF +25-20% 30V	26383-031
C21	Cer 0.1µF +25-20% 30V	26383-031
C22	Cer Ø 0.001µF +80-20% 300V	26373-733

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C23	Cer Ø 0.001µF +80-20% 300V	26373-733
C24	Cer Ø 0.001µF +80-20% 300V	26373-733
C25	Cer 0.047µF +50-25% 30V	26383-018
C26	Cer 0.047µF +50-25% 30V	26383-018
C27	Cer 0.047µF +50-25% 30V	26383-018
L1	2.2mH	23642-391
L2	2.2mH	23642-391
L3	18µH	44247-012
L4	18µH	44247-012
L7	65µH	44262-405
L8	65µH	44262-405
L9	1mH	23642-388
L10	1mH	23642-388

UNIT A29 Switching Diodes

When ordering prefix with A29

Circuit reference	Description	M.I. code
D1	1N 4004	28357-028
D2	1N 4004	28357-028
D3	1N 4004	28357-028
D4	1N 4004	28357-028
D5	1N 4004	28357-028
D6	1N 4004	28357-028
D7	1N 4004	28357-028
D8	1N 4004	28357-028
D9	1N 4004	28357-028
D10	1N 4004	28357-028
D11	1N 4004	28357-028
D12	1N 4004	28357-028
R1	WW 150Ω 5% 1½W	25123-054

UNIT A30 R.F. processing box assembly

When ordering prefix with A30

Circuit reference	Description	M.I. code
C1	Elec 470µF +100-20% 25V	26415-822
SKB	Bulkhead cable jack	23444-363
SKD	Bulkhead cable jack	23444-363
SKE	Bulkhead cable jack	23444-363
SKG	Bulkhead cable jack	23444-363
SJ3B	Part of CARRIER RANGE switch	44332-502
SJ4B	Part of CARRIER RANGE switch	44332-501
SJ4F	Part of CARRIER RANGE switch	44332-501

UNIT A31 Crystal calibrator Amplifier and Sweep Driver

When ordering prefix with A31

Circuit reference	Description	M.I. code
	Complete board	44823-139
C1	Cer 0.1µF +50-25% 30V	26383-031
C2	Elec 1µF +100-20% 50V	26414-106
C3	Cer 0.01µF +80-20% 100V	26383-055
C4	Elec 47µF +100-20% 40V	26415-810
C5	Elec 47µF +100-20% 40V	26415-810
C6	Cer 0.01µF +80-20% 100V	26383-055
C7	Cer 0.1µF +50-25% 30V	26383-031
C8	Elec 47µF +100-20% 25V	26415-810
C9	Elec 220µF +100-20% 25V	26415-818
C10	Paper 0.1µF 5% 160V	26511-349
C11	Elec 1µF +100-20% 50V	26414-106
C12	Elec 1µF +100-20% 50V	26414-106

For symbols and abbreviations see introduction to this chapter

Circuit reference	*Description*	*M.I. code*
C13	Plas 0.1μF 10% 250V	26582-208
C14	Elec 4.7μF +100-20% 100V	26423-211
C15	Elec 1μF +100-20% 50V	26414-106
D1	1N 825	28371-494
D2	1N 914	28336-676
D3	1N 914	28336-676
R1	Met ox 5.6Ω 5% $\frac{1}{2}$W	24552-014
R2	Met ox 1.3kΩ 5% $\frac{1}{2}$W	24552-083
R3	Met ox 2.2kΩ 5% $\frac{1}{2}$W	24552-088
R4	Var WW 100Ω 10% 1W	25811-013
R5	Met ox 5.6kΩ 5% $\frac{1}{2}$W	24552-103
R6	Var WW 1kΩ 10% 1W	25811-019
R7	Met ox 3.9kΩ 5% $\frac{1}{2}$W	24552-096
R8	Met ox 1kΩ 5% $\frac{1}{2}$W	24552-080
R9	Met ox 8.2kΩ 5% $\frac{1}{2}$W	24552-108
R10	Met ox 390Ω 5% $\frac{1}{2}$W	24552-065
R11	Met ox 56kΩ 5% $\frac{1}{2}$W	24552-129
R12	Met ox 4.7kΩ 5% $\frac{1}{2}$W	24552-100
R13	Met ox 1.2kΩ 5% $\frac{1}{2}$W	24552-082
R14	Met ox 6.8kΩ 5% $\frac{1}{2}$W	24552-106
R15	Met ox 1.2kΩ 5% $\frac{1}{2}$W	24552-082
R16	Met ox 180kΩ 5% $\frac{1}{2}$W	24552-141
R17	Met ox 1MΩ 5% $\frac{1}{2}$W	24552-166
R18	Met ox 9.1kΩ 5% $\frac{1}{2}$W	24552-109
R19	Met ox 270Ω 5% $\frac{1}{2}$W	24552-061
R20	Met ox 3.9kΩ 5% $\frac{1}{2}$W	24552-096
R21	Met ox 15kΩ 5% $\frac{1}{2}$W	24552-114
R22	Met ox 1MΩ 5% $\frac{1}{2}$W	24552-166
R23	Met ox 270Ω 5% $\frac{1}{2}$W	24552-061
R24	Met ox 680Ω 5% $\frac{1}{2}$W	24552-076
R25	Met ox 22kΩ 5% $\frac{1}{2}$W	24552-118
R26	Met ox 11kΩ 5% $\frac{1}{2}$W	24552-111
R27	Met ox 1kΩ 5% $\frac{1}{2}$W	24552-080
R28	Met ox 82Ω 5% $\frac{1}{2}$W	24552-046
R29	Met ox 12kΩ 5% $\frac{1}{2}$W	24552-112
R30	Met ox 2.2kΩ 5% $\frac{1}{2}$W	24552-088
R31	Met ox 1MΩ 5% $\frac{1}{2}$W	24552-166
R32	Met ox 22kΩ 5% $\frac{1}{2}$W	24552-118
R33	Met ox 11kΩ 5% $\frac{1}{2}$W	24552-111
R34	Met ox 100kΩ 5% $\frac{1}{2}$W	24552-135
R35	Met ox 100kΩ 5% $\frac{1}{2}$W	24552-135
R36	Met ox 18kΩ 5% $\frac{1}{2}$W	24552-116
R37	Met ox 18kΩ 5% $\frac{1}{2}$W	24552-116
R39	Met ox 100kΩ 5% $\frac{1}{2}$W	24552-135
R40	Var Carb 22kΩ 20% $\frac{1}{4}$W	25611-080
R41	Met ox 1kΩ 5% $\frac{1}{2}$W	24552-080
R42	Var Carb 2.2MΩ 20% $\frac{1}{4}$W	25611-092
R43	Met ox 10kΩ 5% $\frac{1}{2}$W	24552-110
TR1	BC 108	28452-787
TR2	BC 108	28452-787
TR3a, TR3b	Dual transistor 2N5843	28434-826
TR4	BCY 71	28435-235
TR5	BCY 71	28435-235
TR6	BC 108	28452-787
TR7	BC 108	28452-787
TR8	BC 108	28452-787
TR9	BC 108	28452-787
TR10	BCY 71	28435-235
TR11	BCY 71	28435-235
TR12	BCY 71	28435-235

For symbols and abbreviations see introduction to this chapter

UNIT A32 A.M. driver and monitors

When ordering prefix with A32

Circuit reference	Description	M.I. code
C1	Elec 100μF +100-20% 25V	26415-813
C2	Elec 220μF +100-20% 25V	26415-818
C3	Elec 100μF +100-20% 25V	26415-813
C4	Plas 0.47μF 10% 100V	26582-330
C5	Plas 0.47μF 10% 400V	26512-268
C6	Elec 10μF +100-20% 63V	26423-215
C7	Plas 0.47μF 10% 400V	26512-268
D1	1N 914	28336-676
D3	1N 914	28336-676
D4	1N 914	28336-676
D5	1N 914	28336-676
D6	1N 914	28336-676
R1	Met ox 620Ω 5% ½W	24552-074
R2	Met ox 18kΩ 5% ½W	24552-116
R3	Met ox 4.7kΩ 5% ½W	24552-100
R4	Met ox 3.3kΩ 5% ½W	24552-094
R5	Met ox 680Ω 5% ½W	24552-076
R6	Met ox 330Ω 5% ½W	24552-063
R7	Met film 820kΩ 1% ¼W	24637-853
R8	Var Carb 100kΩ 20% ¼W	25611-084
R9 †	Met film 100kΩ 1% ¼W	24637-701
R10	Met ox 3.3kΩ 5% ½W	24552-094
R11	Met ox 1.5kΩ 5% ½W	24552-084
R12	Var WW 470Ω 10% 1W	25811-017
R13 †	Met ox 820Ω 5% ½W	24552-078
R14	Met ox 470Ω 5% ½W	24552-069
R15	Met ox 1kΩ 5% ½W	24552-080
R16	Met ox 68Ω 5% ½W	24552-043
R17	Met ox 1kΩ 5% ½W	24552-080
R18	Met ox 2.2kΩ 5% ½W	24552-088
R19	Var Carb 2.2kΩ 20% ¼W	25611-018
R20	Met ox 5.1kΩ 5% ½W	24552-101
R21	Met ox 15kΩ 5% ½W	24573-101
R22	Met ox 22kΩ 5% ½W	24552-118
R23	Var Carb 10kΩ 20% ¼W	25611-025
R24	Met ox 4.7kΩ 5% ½W	24552-100
R25	Met ox 220kΩ 5% ½W	24552-143
R26	Met ox 3.3kΩ 5% ½W	24552-094
R27	Thermistor 1.5kΩ 5% ½W	25683-644
R28	Met ox 10kΩ 5% ½W	24552-110
R29	Met ox 1kΩ 5% ½W	24552-080
R30	Met ox 680Ω 5% ½W	24552-076
R31	Var WW 4.7kΩ 10% 1W	25811-023
TR1	BCY 71	28435-235
TR2	BC 108	28452-787
TR3	BCY 71	28435-235
TR4	BC 108	28452-787
TR5	BC 108	28452-787
TR7	BC 109	28452-777

UNIT A33 F.M./ΔF output

When ordering prefix with A33

Circuit reference	Description	M.I. code
C1	Cer 100pF 2% 750V	26324-897
R1	Met ox 10kΩ 5% ½W	24552-110
R2	Met ox 10kΩ 5% ½W	24552-110
R3	Met ox 100kΩ 5% ½W	24552-135
R4	Met ox 100kΩ 5% ½W	24552-135
R5	Var Carb 4.7kΩ 20% 0.21W	25541-226
R6	Met film 16kΩ 1% ¼W	24637-516
R7	Met film 30kΩ 1% ¼W	24637-557
R8	Met ox 430Ω 5% ½W	24552-067

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R9	Met film 420Ω 1% $\frac{1}{4}$W	24636-718
R10	Var Carb 50kΩ 20% 0.21W	25541-244
R11	Met ox 10kΩ 5% $\frac{1}{2}$W	24552-110
R12	Met film 1.54kΩ 1% $\frac{1}{4}$W	24637-115
R13	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
TR1	BC 108	28452-787
TR2	BC 108	28452-787
TR3	BCY 71	28435-235

UNIT A34 F.M./ΔF driver

When ordering prefix with A34

Circuit reference	Description	M.I. code
	Complete board	44823-141
C1	Elec 100μF +100-20% 25V	26417-158
C2	Elec 100μF +100-20% 25V	26417-158
C3	Elec 1μF +100-20% 50V	26414-106
C4	Elec 10μF +50-20% 35V	26414-121
C5	Elec 47μF +100-20% 63V	26415-801
C6	Elec 0.47μF 20% 35V	26486-207
D1	1N 914	28336-676
R1	Met ox 620Ω 5% $\frac{1}{2}$W	24552-074
R2	Met ox 18kΩ 5% $\frac{1}{2}$W	24552-116
R3	Met ox 4.7kΩ 5% $\frac{1}{2}$W	24552-100
R4	Met ox 3.3kΩ 5% $\frac{1}{2}$W	24552-094
R5	Met ox 680Ω 5% $\frac{1}{2}$W	24552-076
R6	Met ox 330Ω 5% $\frac{1}{2}$W	24552-063
R7	Var Carb 10kΩ 20% $\frac{1}{4}$W	25611-078
R8	Met film 38kΩ 1% $\frac{1}{4}$W	24637-560
R9	Carb 680kΩ 2% $\frac{1}{2}$W	24573-141
R10	Var Carb 100kΩ 20% $\frac{1}{4}$W	25611-084
R11	Met ox 150kΩ 5% $\frac{1}{2}$W	24552-139
R12	Met ox 33kΩ 5% $\frac{1}{2}$W	24552-122
R13	Met ox 160Ω 5% $\frac{1}{2}$W	24552-055
R14	Var WW 100Ω 10% 1W	25811-013
R15	Met ox 47Ω 5% $\frac{1}{2}$W	24552-037
R16	Met ox 100kΩ 5% $\frac{1}{2}$W	24552-135
R17	Carb 1MΩ 2% $\frac{1}{2}$W	24573-145
R18	Met ox 3.9kΩ 5% $\frac{1}{2}$W	24552-096
R19	Met ox 18kΩ 5% $\frac{1}{2}$W	24552-116
R20	Met ox 300Ω 5% $\frac{1}{2}$W	24552-062
R21	Met ox 10kΩ 5% $\frac{1}{2}$W	24552-110
R22	Met ox 10kΩ 5% $\frac{1}{2}$W	24552-110
TR1	BCY 71	28435-235
TR2	BC 108	28452-787
TR3	BCY 71	28435-235
TR4	BC 109	28452-777
TR5	BCY 71	28435-235
TR6	BC 109	28452-777

UNIT A35 Modulation oscillator

When ordering prefix with A35

Circuit reference	Description	M.I. code
	Complete board	44821-248
C1	Elec 47μF +100-25% 25V	26423-231
C2	Elec 47μF +100-25% 25V	26423-231
C3	Paper 0.003μF 10% 350V	26174-133
C4	Cer 10pF ±0.25pF 750V	26324-709
C5	Elec 47μF +100-25% 25V	26423-231
C6	Var Plas 280pF } one assembly	26878-501
C7	Var Plas 280pF } one assembly	
C8	Var Plas 9pF } one assembly	
C9	Var Plas 9pF } one assembly	
R1	Met ox 47Ω 5% $\frac{1}{2}$W	24552-037
R2	Met ox 10kΩ 5% $\frac{1}{2}$W	24552-110

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R3	Var Carb 100kΩ 20% 0.21W	25541-346
R4	Met ox 47kΩ 5% $\frac{1}{2}$W	24552-126
R5	Carb 2MΩ 1% $\frac{1}{2}$W	24157-200
R6	Met ox 22kΩ 5% $\frac{1}{2}$W	24552-118
R7	Met ox 220Ω 5% $\frac{1}{2}$W	24552-058
R8	Met ox 5.6kΩ 5% $\frac{1}{2}$W	24552-103
R9	Met ox 10kΩ 5% $\frac{1}{2}$W	24552-110
R10	Met ox 220Ω 5% $\frac{1}{2}$W	24552-058
R11	Met ox 33Ω 5% $\frac{1}{2}$W	24552-033
R12	Thermistor 20kΩ 20% $\frac{1}{2}$W	25683-388
R13	Met ox 680Ω 5% $\frac{1}{2}$W	24552-076
R14	Carb 2MΩ 1% $\frac{1}{2}$W	24157-200
R15	Met ox 100kΩ 5% $\frac{1}{2}$W	24552-135
R16	Met ox 560Ω 5% $\frac{1}{2}$W	24552-072
TR1	2N 3819	28459-003
TR2	BCY 71	28435-235
TR3	BC 108	28452-787

UNIT A36 Front panel assembly

When ordering prefix with A36

Circuit reference	Description	M.I. code
C1	Cer 10pF ±0.25pF 750V	26324-709
C2	Cer 100pF 2% 750V	26324-897
C3	Elec 470μF +100-20% 25V	26415-822
C4	Elec 100μF 20% 20V	26486-609
JKA	Jack socket	23421-677
M1	200μA	44558-414
M2	200μA	44558-414
PLA, PLB	50Ω, part of lead PLA to PLB	43126-043
PLC, PLD	50Ω, part of lead PLC to PLD	43126-042
PLE, PLF	50Ω, part of lead PLE to PLF	43126-044
PLG	50Ω, lead PLG to counter output	43126-045
R1	Var Carb 1kΩ 20% 2W	25645-331
R3	Var Carb 47kΩ 10% 2W (includes R5)	25674-205
R4	Met ox 8.2kΩ 2% $\frac{1}{2}$W	24573-095
R5	Var Carb 4.7kΩ 10% 2W	part of R3
R6	Var Carb 1MΩ 10% 2W	25674-209
R8	Var Carb 10kΩ 10% 2W	
R9	Met ox 1.3kΩ 5% $\frac{1}{2}$W	24552-083
R10	Met ox 560Ω 5% $\frac{1}{2}$W	24552-072
R11	Var Carb 4.7kΩ 20% 2W	25645-368
R12	Var Carb 4.7kΩ 20% 2W	25645-368
R13	Var WW 5kΩ 10% 3W	25822-626
R14	Var WW 5kΩ 10% 3W	25822-626
R15	Var Carb 10kΩ 20% 2W	25645-381
R16	Met ox 47kΩ 7% $\frac{1}{2}$W	24552-126
R17	Var WW 1kΩ 2%	44371-248
R18	Var WW 400Ω 2%	
R19	Met film 4.88kΩ 1% $\frac{1}{4}$W	24637-213
R20	Met film 6.28kΩ 1% $\frac{1}{4}$W	24637-310
R21	Met film 1.144kΩ 1% $\frac{1}{4}$W	24637-113
R22	Met film 209Ω 1% $\frac{1}{4}$W	24636-623
R23	Met film 42.1kΩ 1% $\frac{1}{4}$W	24637-577
R24	Met film 42.1kΩ 1% $\frac{1}{4}$W	24637-577
R25	Met film 26.6kΩ 1% $\frac{1}{4}$W	24637-559
R26	Met film 8.41kΩ 1% $\frac{1}{4}$W	24637-407

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R27	Met film 2.66kΩ 1% $\frac{1}{4}$W	24637-210
R28	Met film 6.51kΩ 1% $\frac{1}{4}$W	24637-311
R29	Met film 5.06kΩ 1% $\frac{1}{4}$W	24637-312
R30	Met ox 160kΩ 2% $\frac{1}{2}$W	24573-126
R31	Met ox 240kΩ 2% $\frac{1}{2}$W	24573-130
R32	Met ox 160kΩ 2% $\frac{1}{2}$W	24573-126
R33	Met film 1.65kΩ 1% $\frac{1}{4}$W	24637-114
R34	Met film 4.5kΩ 1% $\frac{1}{4}$W	24637-211
R35	Met film 9kΩ 1% $\frac{1}{4}$W	24637-403
R36	Met film 18kΩ 1% $\frac{1}{4}$W	24637-515
R37	Met film 36kΩ 1% $\frac{1}{4}$W	24637-561
R38	Var WW pot with dial assembly	44371-249
R39	Met ox 10kΩ 5% $\frac{1}{2}$W	24552-110
R40	WW 100Ω 5% 3W	25125-350
R41	Met ox 12kΩ 2% $\frac{1}{2}$W	24573-099
R42	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
SA	Supply switch	44321-406
SB	Main scale marker switch	23462-258
SC	Mode switch	23462-264
SD	Int. Mod. switch	23462-258
SE1F, SE2F, SE1B, SE2B	Function switch	44325-115
SF	Carrier switch	23462-258
SG	Deviation switch	23462-258
SH1F, SH1B, SH2B, SH2F	Δ F/deviation range switch	44324-720
SJ1F, SJ2F, SJ1B	Carrier range switch	44326-225

Circuit reference	Description	M.I. code
SKH	Part of 43126-045	23443-502
TP1	Terminal post	23235-176
TP2	Terminal post	23235-176
TP3	Terminal post	23235-176
TP4	Terminal post	23235-176
TP5	Terminal post	23235-176
TP6	Terminal post	23235-176
TP7	Terminal post	23235-176
TP8	Terminal post	23235-176
TP9	Terminal post	23235-176

UNIT A37 F.M.O.

When ordering prefix with A37

Circuit reference	Description	M.I. code
	Complete board	44823-142
C1	Cer 0.01μF +80-20% 100V	26383-055
C2	Mica 10pF ±1pF 350V	26272-010
C3	Mica 56pF 2% 350V	26272-055
C4	Mica 56pF 2% 350V	26272-055
C5	Cer 0.01μF 20% 100V	26386-405
C6	Mica 150pF 2% 350V	26272-381
C7	Var Cer 2.0-9.3pF	26817-235
C8	Cer 6.8pF 10% 750V	26324-706
C9	Cer 0.01μF +80-20% 100V	26383-055
C10	Cer 0.001μF +80-20% 500V	26383-242
C11	Cer 0.001μF +80-20% 500V	26383-242
C12	Cer 4.7pF ±0.25pF 750V	26324-017
D1	V47	28381-135
L1	330μH	23642-564
L2	100μH	23642-561

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
L3	330μH	23642-564
L4	Filter coil	44243-014
R1	Met ox 100kΩ 5% $\frac{1}{2}$W	24573-121
R2	Met ox 100kΩ 5% $\frac{1}{2}$W	24573-121
R3	Met ox 100kΩ 5% $\frac{1}{2}$W	24573-121
R4	Met ox 22kΩ 5% $\frac{1}{2}$W	24552-118
R5	Met ox 7.5kΩ 5% $\frac{1}{2}$W	24552-107
R6	Met ox 51Ω 5% $\frac{1}{2}$W	24552-038
R7	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R8	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299
R9	Met film 470Ω 2% $\frac{1}{4}$W	24773-265
R10	Met film 10Ω 2% $\frac{1}{4}$W	24773-225
R11	Met film 560Ω 2% $\frac{1}{4}$W	24773-267
T1	Transformer	43571-007
TR1	TIS 34	28459-008
TR2	BCY 71	28435-235
TR3	ZTX 320	28452-101

UNIT A38 Second buffer (F.M.O)

When ordering prefix with A38

Circuit reference	Description	M.I. code
	Complete board	44821-249
C1	Cer 0.01μF +80-20% 100V	26383-055
C2	Cer 0.01μF +80-20% 100V	26383-055
C3	Cer 0.01μF +80-20% 100V	26383-055
C4	Cer 0.001μF +80-20% 500V	26383-242
C5	Cer 0.001μF +80-20% 500V	26383-242
C6	Cer 0.001μF +80-20% 500V	26383-242
C7	Plas 150pF 2% 125V	26516-287
C8	Plas 330pF 2% 125V	26516-369
C9	Cer 0.001μF +80-20% 500V	26383-242
C10	Cer 8.2pF ±0.25pF 750V	26324-708
C11	Cer 47pF 20% 500V	26343-160
L1	330μH	23642-564
L2	330μH	23642-564
L3	Filter coil	44278-105
L4	Filter coil	44278-106
R1	Var Carb 100Ω 20% 0.21W	25541-308
R2	Met film 3.3 kΩ 2% $\frac{1}{4}$W	24773-285
R3	Met film 47kΩ 2% $\frac{1}{4}$W	24773-313
R4	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R5	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R6	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R7	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R8	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299
R9	Met film 220Ω 2% $\frac{1}{4}$W	24773-257
TR1	2N 3819	28459-003
TR2	BSX 20	28452-197

UNIT A39 V.C.O. and V.F.O.

When ordering prefix with A39

Circuit reference	Description	M.I. code
	Complete board	44823-401
C1	Cer 0.01μF +80-20% 100V.	26383-055
C2	Cer 0.01μF +80-20% 100V	26383-055
C3	Cer 0.01μF +80-20% 100V	26383-055
C4	Cer 0.01μF 20% 100V	26386-405
C5	Cer 0.001μF +80-20% 500V	26383-242
C6	Cer 0.001μF +80-20% 500V	26383-242
C7	Plas 220pF 2% 500V	26516-332

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C8	Cer 10pF ±0.25pF 750V	26324-709
C9	Cer 0.01μF +80-20% 100V	26383-055
C10	Cer 0.01μF +80-20% 100V	26383-055
C11	Cer 15pF ±0.25pF 750V	26324-712
C12 †	Cer 6.8pF 10% 750V	26324-512
C13	Cer 0.01μF +80-20% 100V	26383-055
C14	Cer 1500pF 10% 500V	26343-607
C15	Mica 1000pF 2% 350V	26272-150
C16	Cer 1.5pF ±0.5pF 500V	26343-106
D1	Pin diode	28383-997
D2	V 100	28381-284
D3	BA 110	28381-092
L1	100μH	23642-561
L2	330μH	23642-564
R1	Met ox 100kΩ 2% ½W	24573-121
R2	Met ox 100kΩ 2% ½W	24573-121
R3	Met ox 100kΩ 2% ½W	24573-121
R4	Met film 10kΩ 2% ¼W	24773-297
R5	Met ox 22kΩ 5% ½W	24552-118
R6	Met film 470Ω 2% ¼W	24773-265
R7	Met film 1.5kΩ 2% ¼W	24773-277
R8	Met film 7.5kΩ 2% ¼W	24773-294
R9 †	Met film 8.2kΩ 2% ¼W	24773-295
R10	Met ox 100kΩ 2% ½W	24573-121
R11	Met ox 6.8kΩ 2% ¼W	24511-606
T1	Transformer	44278-107
T2	Transformer	43573-001
TR1	TIS 34	28459-008
TR2	BCY 71	28435-235
TR3	BFY 90	28452-157

UNIT A40 Buffer (V.F.O. and V.C.O.)

When ordering prefix with A40

Circuit reference	Description	M.I. code
	Complete board	44823-143
C1	Cer 0.01μF +80-20% 100V	26383-055
C2	Cer 0.01μF +80-20% 100V	26383-055
C3	Cer 0.01μF +80-20% 100V	26383-055
C4	Cer 0.001μF +80-20% 500V	26383-242
C5	Cer 0.001μF +80-20% 500V	26383-242
C6	Cer 0.001μF +80-20% 500V	26383-242
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Cer 0.001μF +80-20% 500V	26383-242
C9	Cer 0.001μF +80-20% 500V	26383-242
C10	Plas 47pF ±2pF 125V	26516-165
C11	Plas 220pF 2% 125V	26516-327
C12	Plas 110pF 2% 125V	26516-254
C13	Plas 47pF ±2pF 125V	26516-165
D1	OA202	28337-534
D2	OA202	28337-534
L1	330μH	23642-564
L2	330μH	23642-564
L3	100μH	23642-561
L4	Filter coil	44278-101
L5	Filter coil	44278-102
L6	Filter coil	44278-103
L7	Filter coil	44278-104
R1	Met ox 62Ω 5% ½W	24552-041
R2	Met ox 62Ω 5% ½W	24552-041
R3	Met film 4.7kΩ 2% ¼W	24773-289
R4	Met film 12kΩ 2% ¼W	24773-299

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R5	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R6	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299
R7	Met film 390Ω 2% $\frac{1}{4}$W	24773-263
R8	Met film 330Ω 2% $\frac{1}{4}$W	24773-261
R9	Var Carb 4.7kΩ 20% 0.21W	25541-226
R10	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299
R11	Met film 220Ω 2% $\frac{1}{4}$W	24773-257
R12	Met film 39Ω 2% $\frac{1}{4}$W	24773-239
R13	Met film 470Ω 2% $\frac{1}{4}$W	24773-265
TR1	ZTX 320	28452-101
TR2	BFY90	28452-157
TR3	BFY90	28452-157

Circuit reference	Description	M.I. code
C18	Cer 0.1µF +50-25% 30V	26383-031
C19	Cer Ø 0.0047µF +80-20% 500V	26373-665
C20	Cer Ø 0.0047µF +80-20% 500V	26373-665
C21	Cer 56pF 20% 500V	26373-855
C22	Cer Ø 0.0047µF +80-20% 500V	26373-665
C23	Cer Ø 0.0047µF +80-20% 500V	26373-665
C24	Cer Ø 200pF 20% 500V	26333-568
C25	Cer Ø 0.0047µF +80-20% 500V	26373-665
C26	Var 14.0-39.3pF	44436-045
C27	Var Cer 2.5-13.4pF	26817-238
C28	Cer Ø 0.0047µF +80-20% 500V	26373-665
C29	Cer Ø 0.0047µF +80-20% 500V	26373-665

UNIT A41 R.F. oscillator assembly

When ordering prefix with A41

Circuit reference	Description	M.I. code
C1	Cer Ø 0.0047µF +80-20% 500V	26373-665
C2	Cer Ø 12pF 20% 500V	26333-151
C3	Cer Ø 0.0047µF +80-20% 500V	26373-665
C4	Cer Ø 0.0047µF +80-20% 500V	26373-665
C5	Cer Ø 200pF 20% 500V	26333-568
C6	Cer Ø 0.0047µF +80-20% 500V	26373-665
C8	Cer 0.1µF +50-25% 30V	26383-031
C9	Plas 33pF ±2pF 125V	26516-127
C10	Cer 0.1µF +50-25% 30V	26383-031
C11	Cer Ø 0.0047µF +80-20% 500V	26373-665
C12	Cer 56pF 20% 500V	26373-855
C13	Cer Ø 0.0047µF +80-20% 500V	26373-665
C14	Cer Ø 0.0047µF +80-20% 500V	26373-665
C15	Cer Ø 200pF 20% 500V	26333-568
C16	Cer Ø 0.0047µF +80-20% 500V	26373-665
C17	Plas 150pF ±2pF 125V	26516-287

Circuit reference	Description	M.I. code
L1	180µA	44266-607
L2	0.68µH	23642-386
L3	180µH	44266-607
L4	180µH	44266-607
L5	1mH	23642-388
L6	180µH	44266-607
L7	180µH	44266-607
L8	2.2mH	23642-391
L9	180µH	44266-607
L10	180µH	44266-607
L11	1mH	23642-388
L12	180µH	44266-607
L13	180µH	44266-607
R1	Met film 47Ω 2% $\frac{1}{4}$W	24773-241
R2	Met film 47Ω 2% $\frac{1}{4}$W	24773-241
SKA	Bulkhead cable jack	23444-382
SKC	Bulkhead cable jack	23444-382

For symbols and abbreviations see introduction to this chapter

UNIT A42 Power supply regulator

When ordering prefix with A42

Circuit reference	Description	M.I. code
	Complete board	44823-013
C1	Elec 100μF +100-20% 50V	26417-160
C2	Paper 0.001μF 10% 500V	26174-125
C3	Elec 1μF +100-20% 50V	26414-106
C4	Elec 50μF +100-20% 50V	26417-189
C5	Elec 100μF +100-20% 50V	26417-160
D1	1N 4004	28357-028
D2	1N 4004	28357-028
D3	1N 4004	28357-028
D4	1N 4004	28357-028
D5	1N 4004	28357-028
D6	Z5B 8.2	28371-673
R1	Met ox 100Ω 5% ½W	24552-050
R2	Met ox 15kΩ 5% ½W	24552-114
R3	WW 1.5Ω 5% 1½W	25123-002
R4	Met ox 1kΩ 5% ½W	24552-080
R5	Met ox 3.9kΩ 5% ½W	24552-096
R6 †	Met ox 100kΩ 5% ½W	24552-135
R7	Met ox 1.8kΩ 5% ½W	24552-086
R8	Met film 100Ω 2% ¼W	24773-249
R9	Met film 100Ω 2% ¼W	24773-249
R10	Met ox 2.4kΩ 5% ½W	24552-089
R11	Var Carb 470Ω 20% ¼W	25611-070
R12	Met ox 2.2kΩ 5% ½W	24552-088
TR1	2N2905	28434-879
TR2	2N2905	28434-879

UNIT A43 Power supply

When ordering prefix with A43

Circuit reference	Description	M.I. code
C1	Elec 2500μF +50-20% 50V	26427-134
C2	Elec 2500μF +50-20% 50V	26427-134
C3	Plas 0.1μF 10% 100V	26582-211
FS1	160mA for 230V	23411-054
	250mA for 110V	23411-055
FS2	1A	23411-058
FS3	160mA for 230V	23411-054
	250mA for 110V	23411-055
PLH	Mains plug	23423-151
R1	WW 6.5Ω 5% 4½W	25126-515
SM	Supply voltage switch	23467-155
T1	Transformer	43453-016
TP10	Terminal post	23235-176
TP11	Terminal post	23235-176
TR1	MJ 491	28435-876

UNIT A44 Coarse attenuator

When ordering prefix with A44

Circuit reference	Description	M.I. code
	Complete assembly	44426-013
R1	Met film 70.5Ω 1% ½W	24636-360
R2	Met film 63.3Ω 1% ¼W	24636-358
R3	Met film 228Ω 1% ¼W	24636-625

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R4	Met film 142.3Ω 1% ¼W	24636-624
R5	Met film 96.3Ω 1% ¼W	24636-495
R6	Met film 142.3Ω 1% ¼W	24636-624
R7	Met film 96.3Ω 1% ¼W	24636-495
R8	Met film 142.3Ω 1% ¼W	24636-624
R9	Met film 96.3Ω 1% ¼W	24636-495
R10	Met film 142.3Ω 1% ¼W	24636-624
R11	Met film 96.3Ω 1% ¼W	24636-495
R12	Met film 142.3Ω 1% ¼W	24636-624
R13	Met film 96.3Ω 1% ¼W	24636-495
R14	Met film 142.3Ω 1% ¼W	24636-624
R15	Met film 96.3Ω 1% ¼W	24636-495
R16	Met film 142.3Ω 1% ¼W	24636-624
R17	Met film 96.3Ω 1% ¼W	24636-495
R18	Met film 142.3Ω 1% ¼W	24636-624
R19	Met film 96.3Ω 1% ¼W	24636-495
R20	Met film 142.3Ω 1% ¼W	24636-624
R21	Met film 96.3Ω 1% ¼W	24636-495
R22	Met film 142.3Ω 1% ¼W	24636-624
R23	Met film 65.8Ω 1% ¼W	24636-359
SL	Microswitch	23483-131
SKF	Bulkhead cable jack	23444-382
SKJ	BNC 50Ω bulkhead socket	23443-507

Miscellaneous

Cursor	Internal ΔF	31185-727
Cursor	Deviation	31185-727
Cursor	Attenuator	31188-709
Cap and chain for Counter Output		23443-591

Circuit reference	Description	M.I. code
Knob	Supply	41142-209
	Indicator ring for above	37438-902
Knob	Fine frequency control	41141-206
Knob	Frequency control	41146-015
Boss and dial assembly for above		41174-023
Knob	Sweep width control	41141-304
Knob	Sweep centring control	41141-602
Knob	Set markers control	41141-304
Knob	Marker level control	41141-602
Knob	Function switch	41145-206
Knob	Internal ΔF control	41141-307
Dial for above - part of A36R38		
Knob	ΔF deviation range control	41145-206
Knob	Carrier range control	41145-206
Knob	Set a.m. control	41141-206
Knob	Set f.m. control	41141-206
Knob and dial assy. - mod. frequency		41143-103
Knob	Deviation control	41141-307
Boss and dial assembly for above		41174-024
Knob	Fine level control	41141-601
Knob and dial assy. - level control		
Instrument serial number prefix up to 114907, to read e.m.f.		41174-517
Later instruments, scaled in e.m.f.		41174-030
Later instruments, scaled in p.d.		41174-029
*Knob and dial assy. for a.m. depth		41142-310
	Reading high	41142-242
	Reading low	41142-241

* The knob and dial assembly is selected for greatest accuracy. The assemblies required for reading high or low are so marked on the reverse side of the dial, whilst the other assembly (41142-310) is unmarked. Instruments with serial number prefix up to 114907 were fitted with dials marked up to 80%, later dials marked up to 95% may be fitted as replacements if A32R9 has the value 100kΩ and A32R13 has the value 820Ω.

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code	Circuit reference	Description	M.I. code
Button	Set zero beat	37481-102		Coin screws	33563-112
	Panel handle	35852-119		Casing screws	33534-115
	Side handle	41148-022			
Case	Back	41635-019		Foot	37574-109
	Cover assembly	41651-132		Fuse holder	23416-271
	Front panel cover	41684-003		Fuse holder	23416-271

For symbols and abbreviations see introduction to this chapter

Index to Units

Unit number	M.I. code	Description	Parts list page	Circuit diagram Fig.
A1	44821-605	VFO tripler	74	7.4
A2	44821-606	Amplifier and filter, 54 - 67.5 MHz	74	7.4
A3	44823-714	Mixer, 31.5 - 45 MHz	75	7.4
A4	44811-603	Modulated amplifier 31.5 - 45 MHz	75	7.6
A5	44823-715	Amplifier, 31.5 - 45 MHz	76	7.6
A6	44823-716	Crystal calibrator oscillator	76	7.9
A7	44823-717	Amplifier, 4.5 - 22.5 MHz	77	7.5
A8	44823-718	Mixer and 67.5 MHz amplifier	78	7.5
A9	44823-719	Mixer and 0.01 - 4.5 MHz amplifier	78	7.5
A10	44823-720	Reference modulator	79	7.5
A11	44821-607	Crystal oscillator, 90 MHz	80	7.3
A12	44823-721	Mixer, 67.5 MHz	80	7.3
A13	44821-608	Amplifier, 67.5 MHz	81	7.3
A14	44823-722	Mixer, 22.5 - 31.5 MHz	81	7.3
A15	44811-271	Modulated amplifier, 22.5 - 31.5 MHz	82	7.6
A16	44823-723	Amplifier, 22.5 - 31.5 MHz	82	7.6
A17	44821-609	Doubler, 36 - 45 MHz	83	7.3
A18	44823-724	A.L.C. amplifier	84	7.9
A19	44823-725	Detectors and comparator	85	7.9
A20	44823-726	Counter amplifier	86	7.9
A21	44821-610	Doubler, 252 - 360 MHz	86	7.8
A22	44823-727	Doubler, 126 - 180 MHz	87	7.7
A23	44823-728	Doubler, 63 - 90 MHz	88	7.7
A24	44821-611	Doubler, 360 - 504 MHz	88	7.8
A25	44823-729	Doubler, 180 - 252 MHz	89	7.8
A26	44823-730	Doubler, 90 - 126 MHz	90	7.7
A27	44823-731	Doubler, 45 - 63 MHz	91	7.7
A28	-	Processing box filters	91	7.1, 7.9, 7.10
A29	-	Processing box switching diodes	92	7.3 - 7.10
A30	-	Processing box miscellaneous	92	7.3 - 7.10

Unit number	M.I. code	Description	Parts list page	Circuit diagram Fig.
A31	44823-139	Crystal markers amplifier and sweep driver	92	7.10, 7.12
A32	44823-140	A. M. driver and monitors	94	7.1, 7.9
A33	44821-247	F. M./ Δ F output	94	7.1
A34	44823-141	F. M./ Δ F driver	95	7.1
A35	44821-248	Modulation oscillator	95	7.11
A36	-	Front panel components	96	7.1, 7.2, 7.10, 7.11
A37	44823-142	FMO	97	7.2
A38	44821-249	Second buffer (FMO)	98	7.2
A39	44823-401	VCO and VFO	98	7.2
A40	44823-143	Buffer (VFO and VCO)	99	7.2
A41	-	R. F. oscillators miscellaneous	100	7.2
A42	44823-013	Power supply regulator	101	7.12
A43	-	Power supply	101	7.12
A44	44426-013	Coarse attenuator	101	7.11

Chapter 7 Circuit diagrams

CIRCUIT NOTES

1. COMPONENT VALUES

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

2. VOLTAGES

Shown in italics adjacent to the point to which the measurement refers. See Sect. 4.5 for conditions.

3. SYMBOLS

Symbols are based on the provisions of B.S. 3939.

—+→ arrow indicates clockwise rotation of knob.

RANGE etc., external front or rear panel marking.

—o— tag on printed board.

preset control.

(A28) unit identification number.

These symbols are used to identify branches of the power supply circuitry but have no particular physical reality on the printed boards.

point marked with this symbol is connected to and receives power from point marked with this symbol.

⚠ static-sensitive component. See page 4 Notes and cautions.

4. CIRCUIT REFERENCES

These are, in general, given in abbreviated form. See also introduction to Chap. 6.

5. SWITCHES

Rotary switches are drawn schematically.
Letters or figures indicate control knob settings.
1F = 1st section (front panel), front.
1B = 1st section, back
2F = 2nd section, front.
etc.

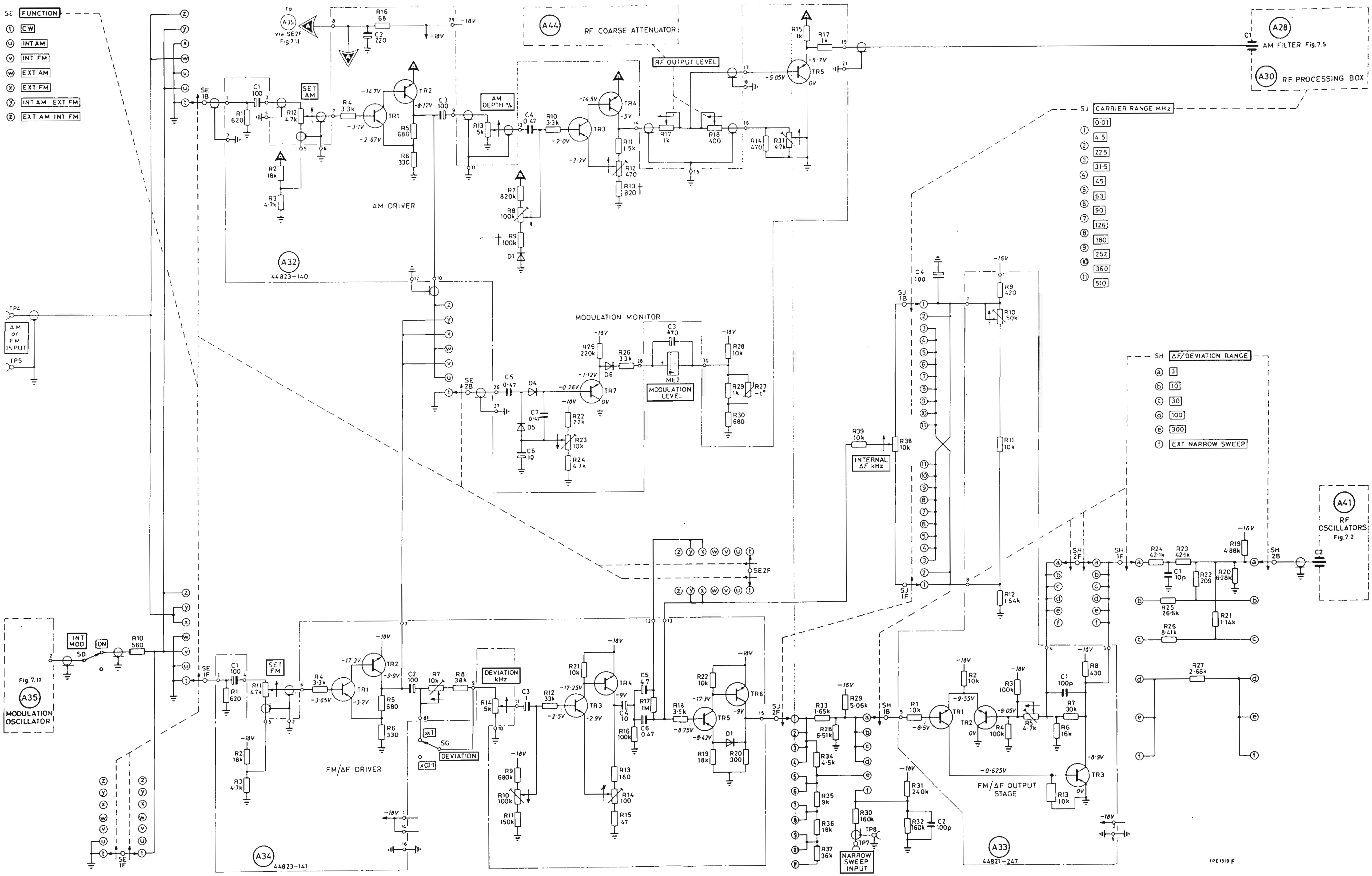


Fig. 7.1 Circuit diagram—modulation path

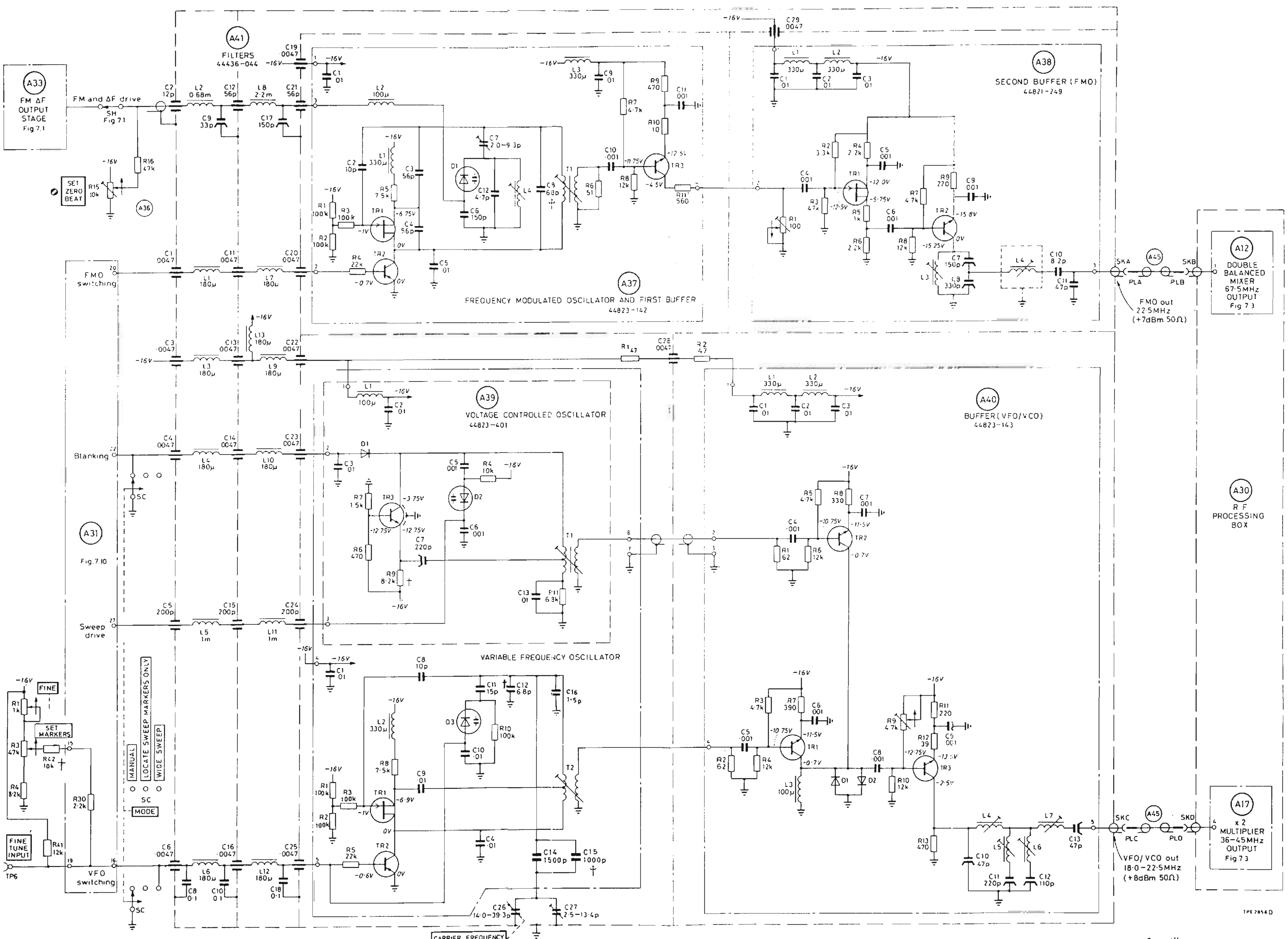


Fig. 7.2 Circuit diagram—r.f. oscillators

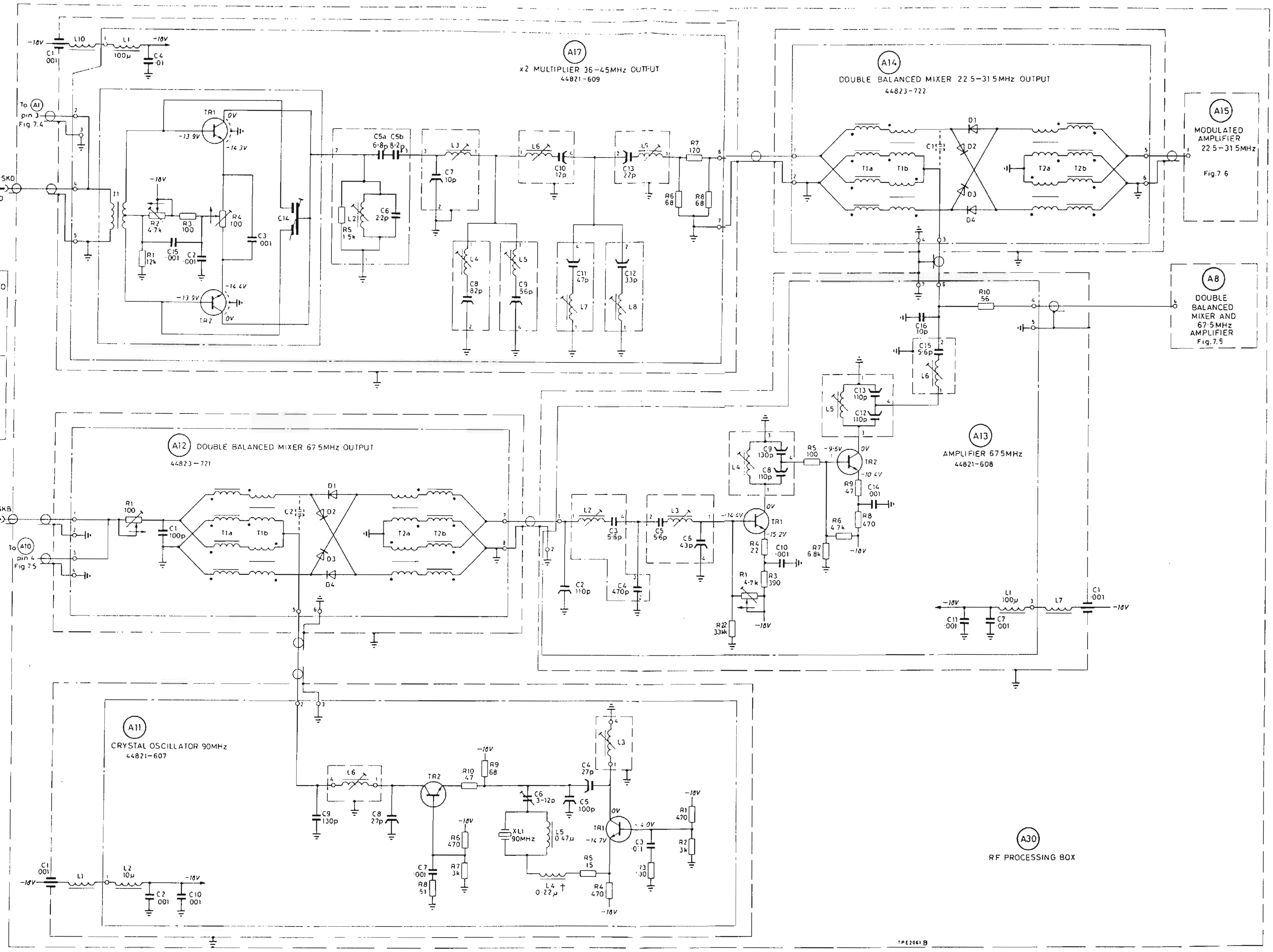


Fig. 7.3 Circuit diagram—pre-processing, odd ranges.

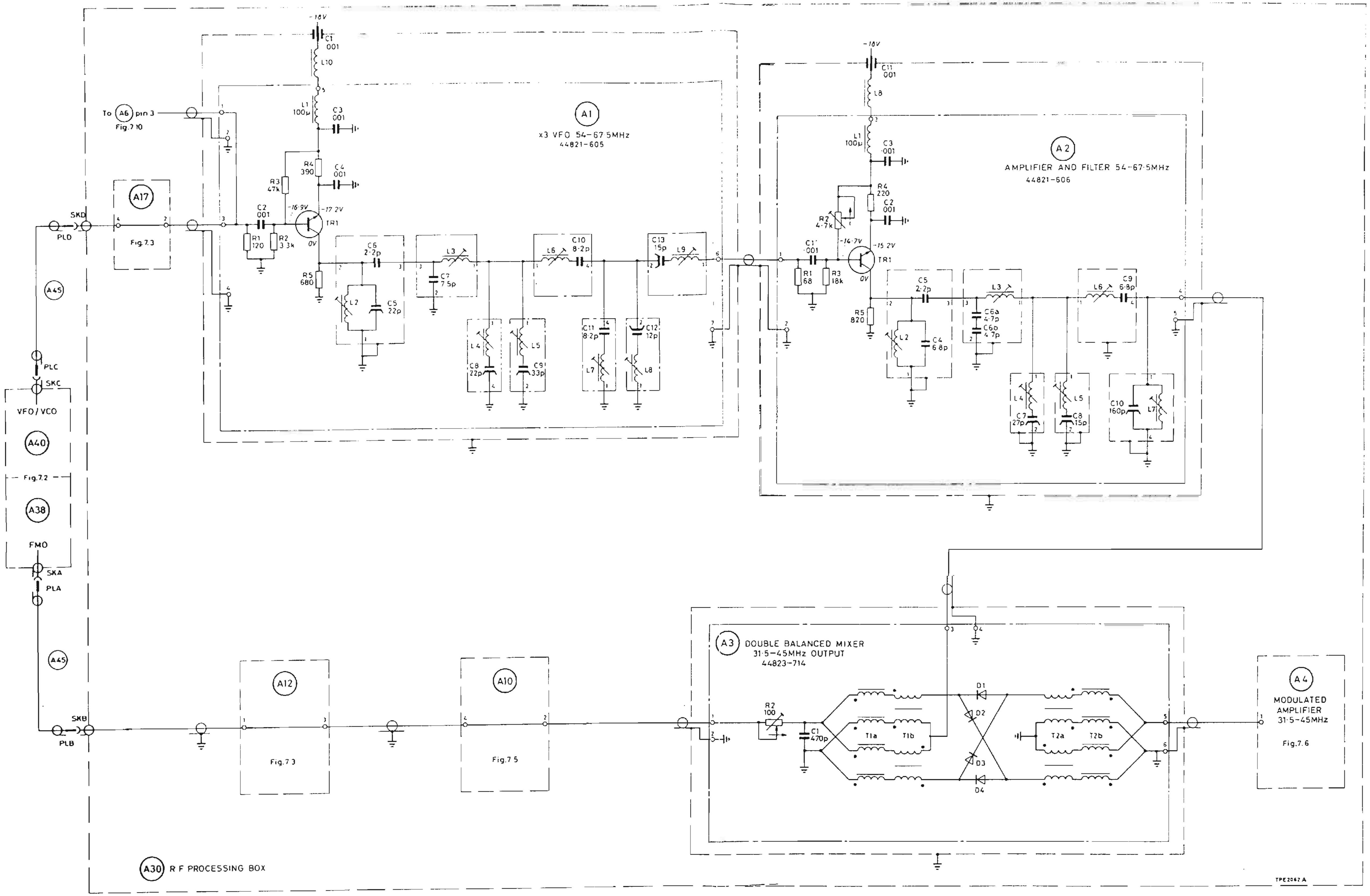


Fig. 7.4 Circuit diagram—pre-processing, even ranges.

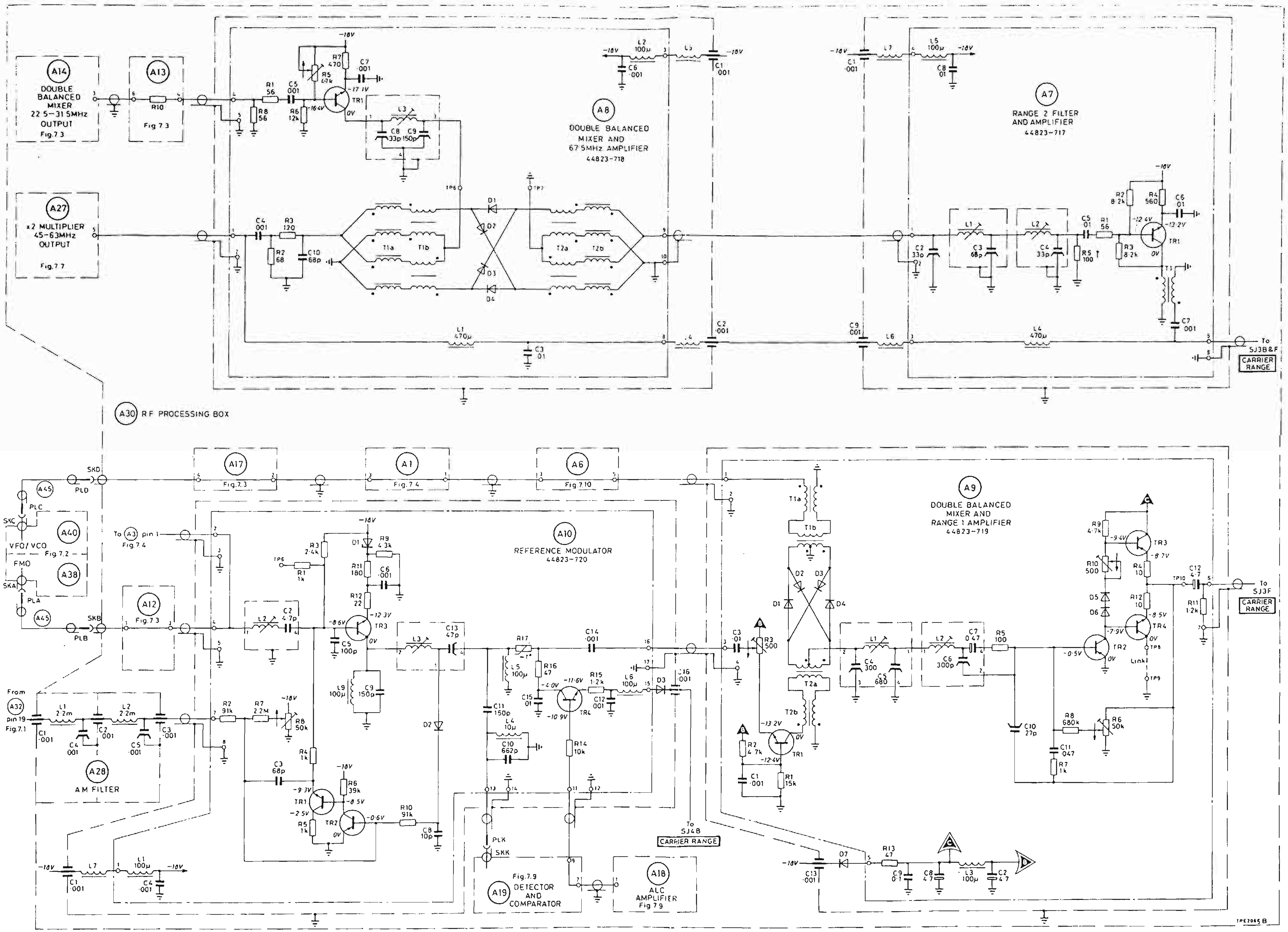


Fig. 7.5 Circuit diagram—r.f. processing 0·01–22·5 MHz

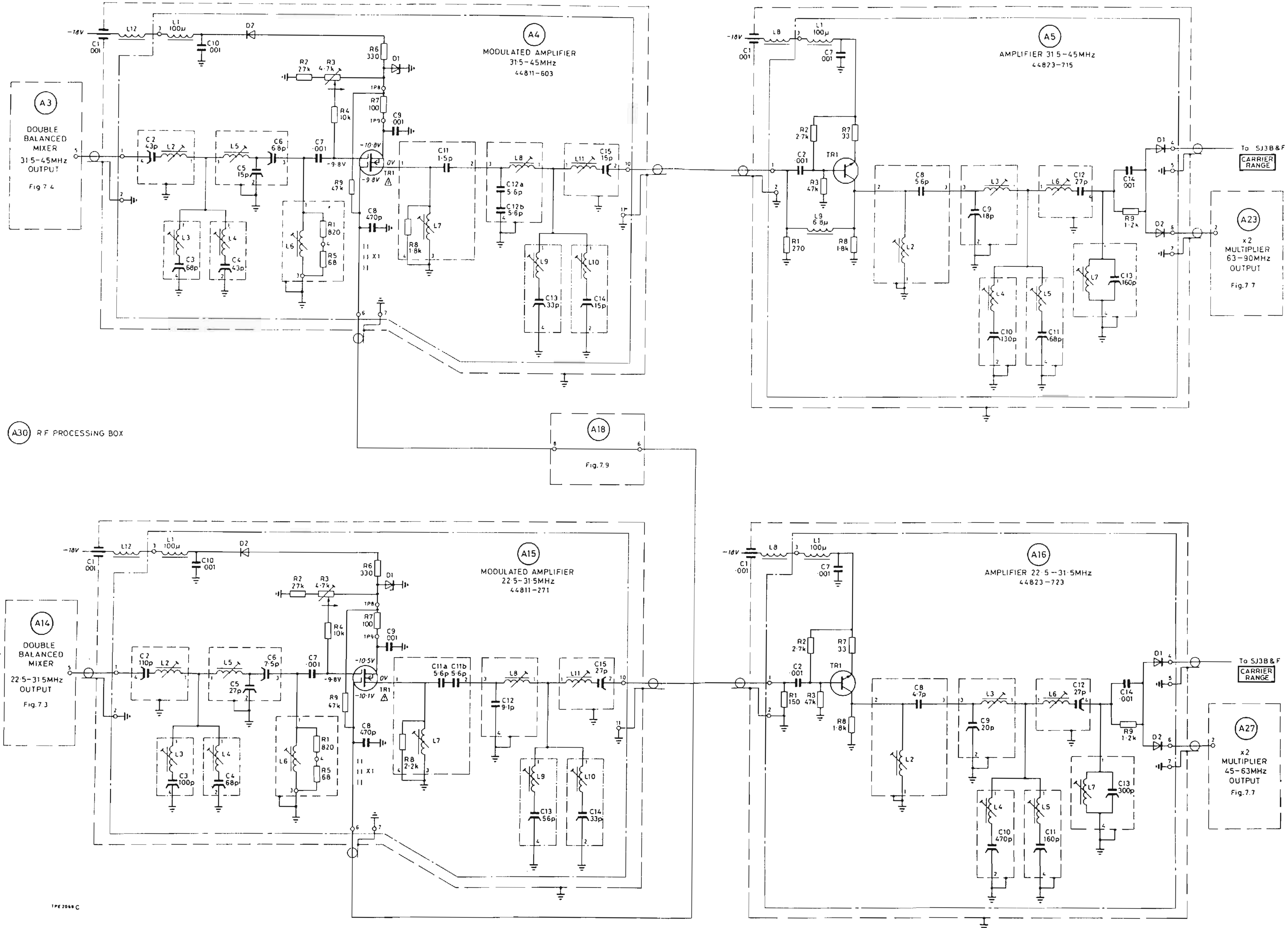


Fig. 7.6 Circuit diagram—r.f. processing 22·5–45 MHz

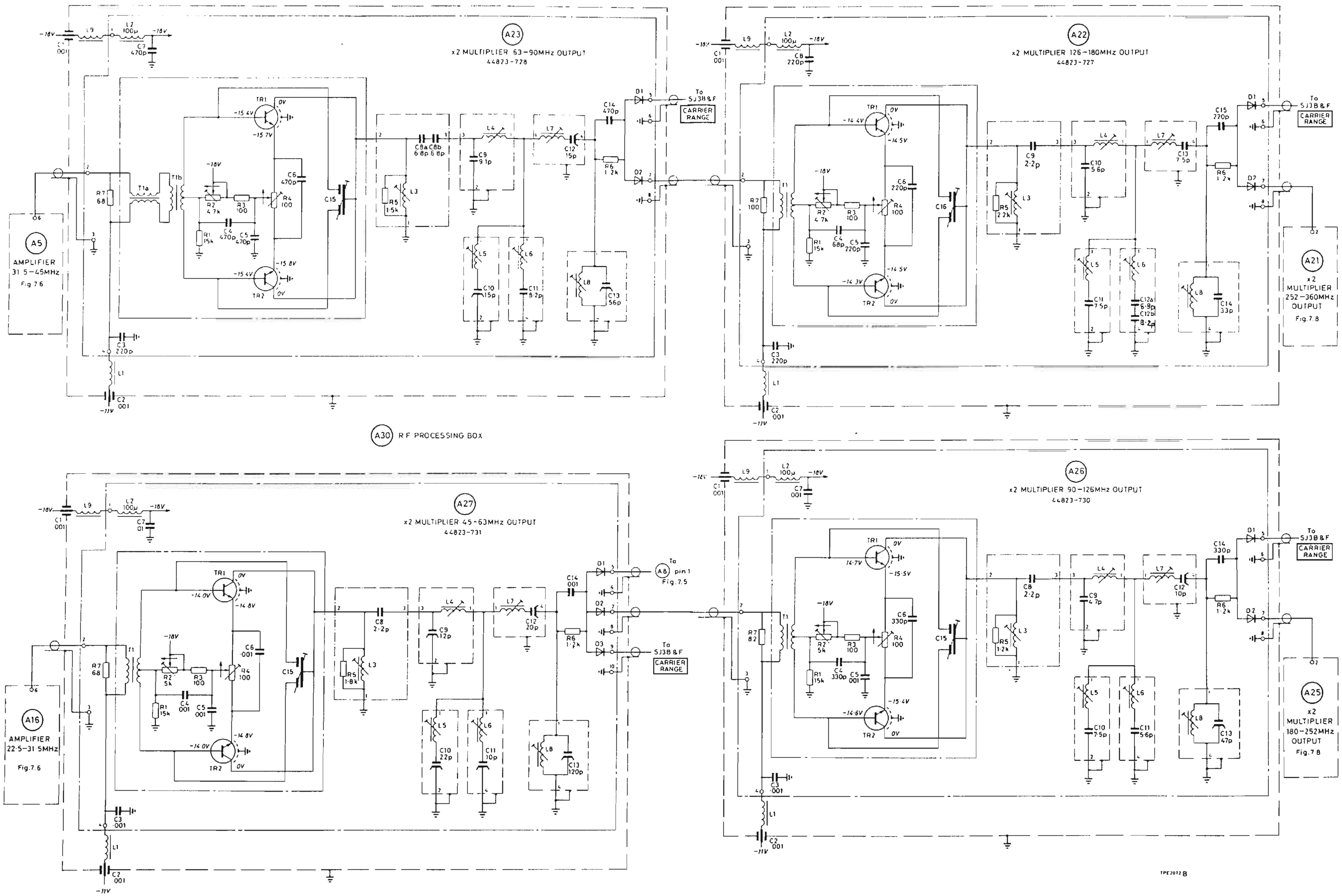


Fig. 7.7 Circuit diagram—r.f. processing 45–180 MHz

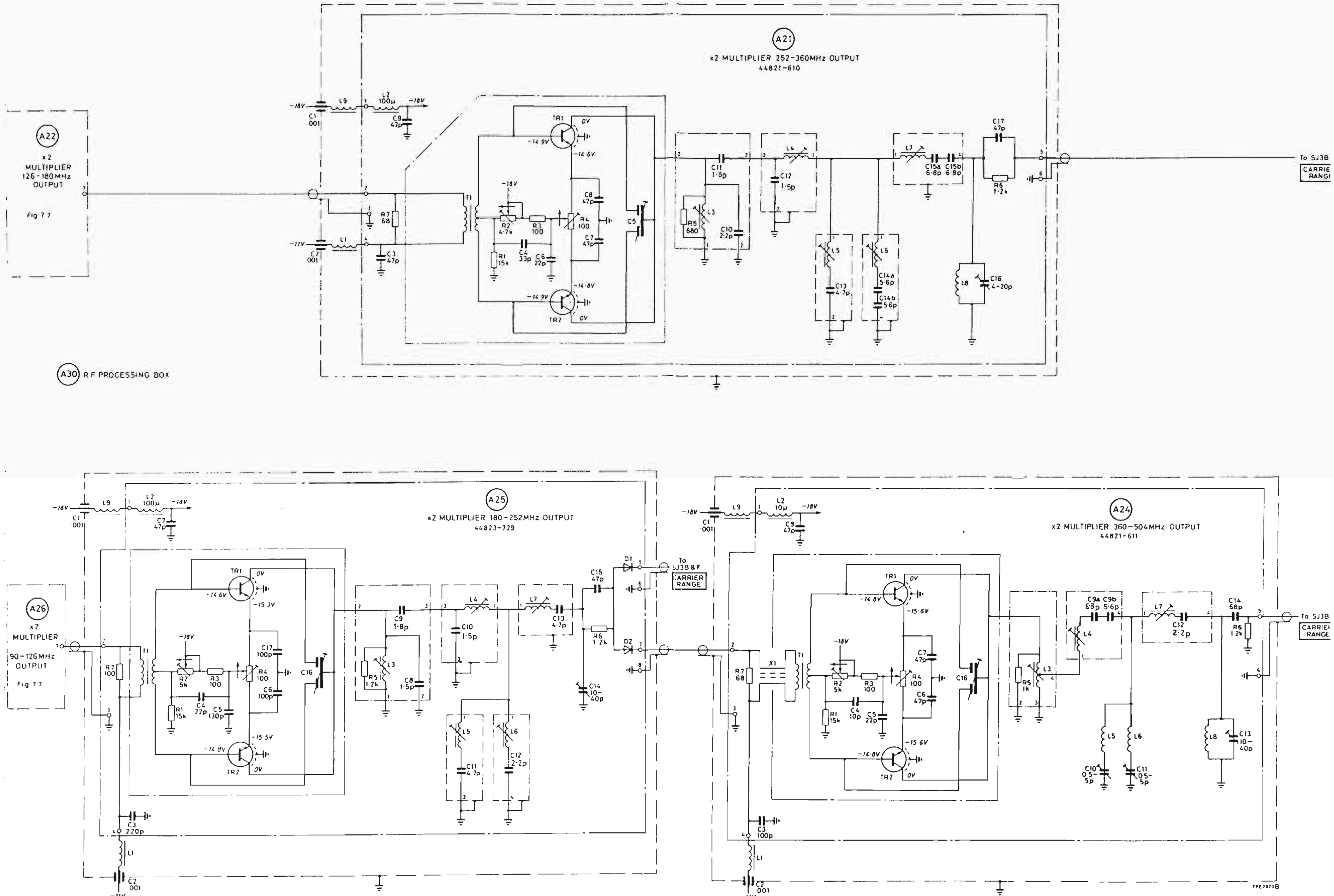


Fig. 7.8 Circuit diagram—r.f. processing 180–504 MHz

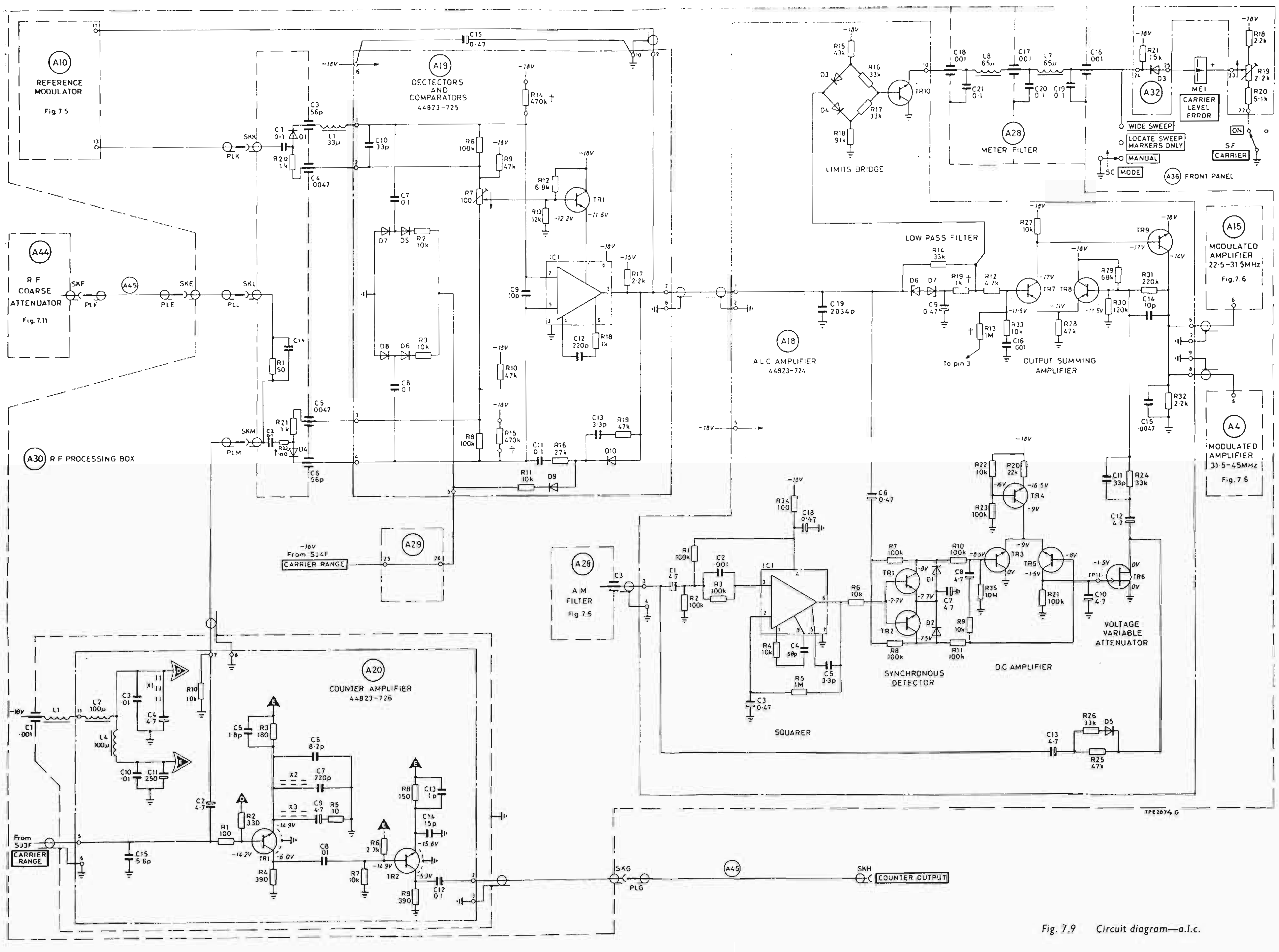


Fig. 7.9 Circuit diagram—a.l.c.

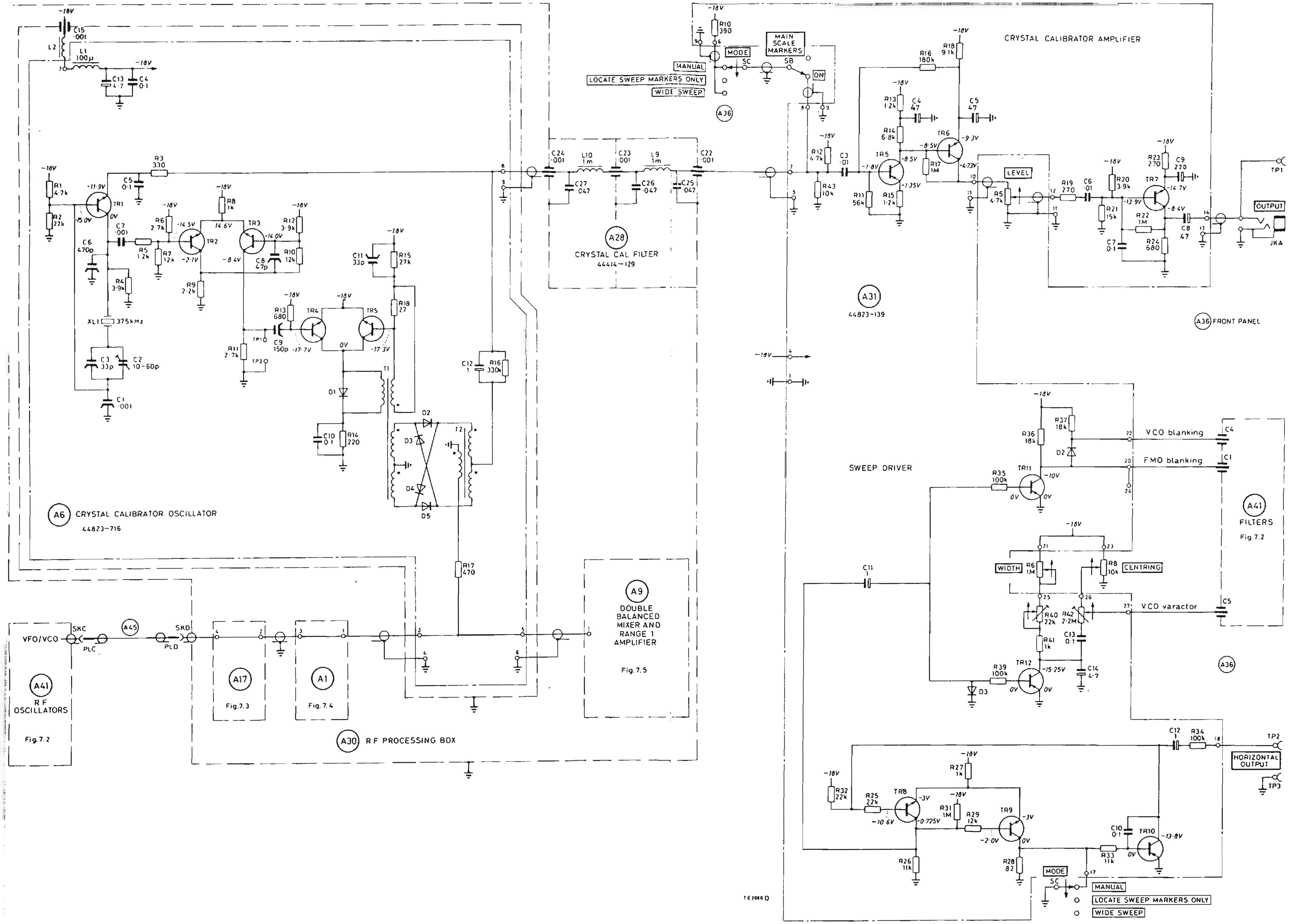
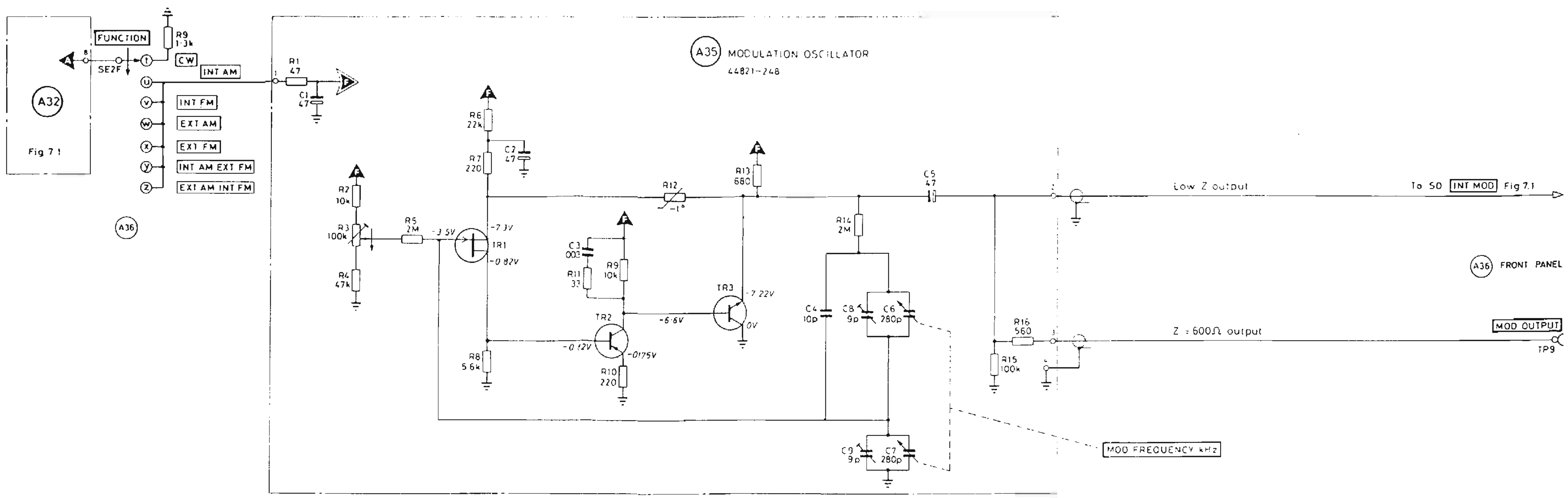


Fig. 7.10 Circuit diagram—crystal markers



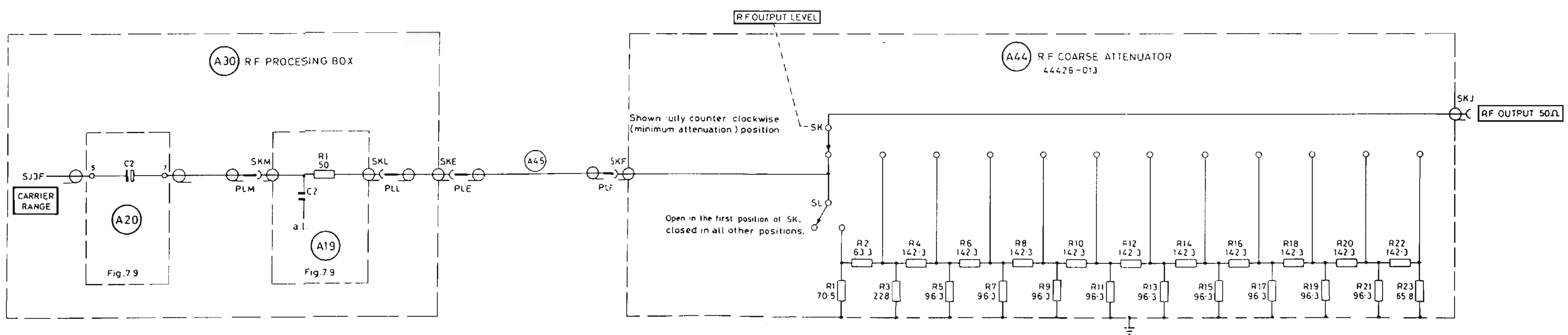


Fig. 7.11 Circuit diagram—modulation oscillator and coarse attenuator

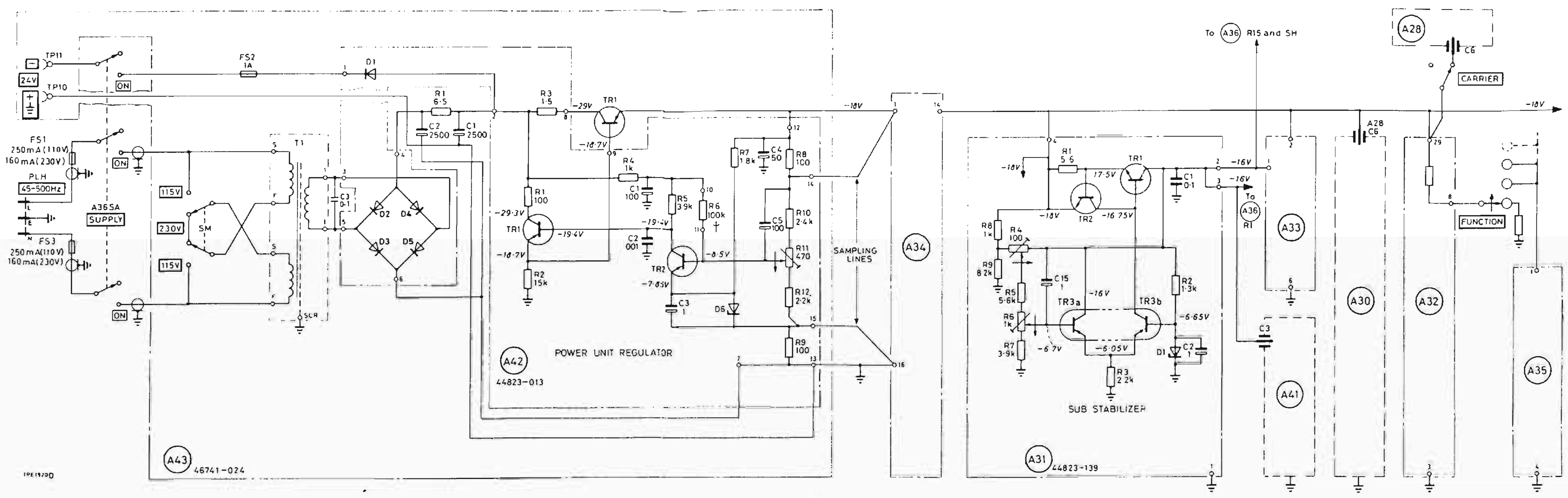


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Fig. 7.12 Circuit diagram—power supplies

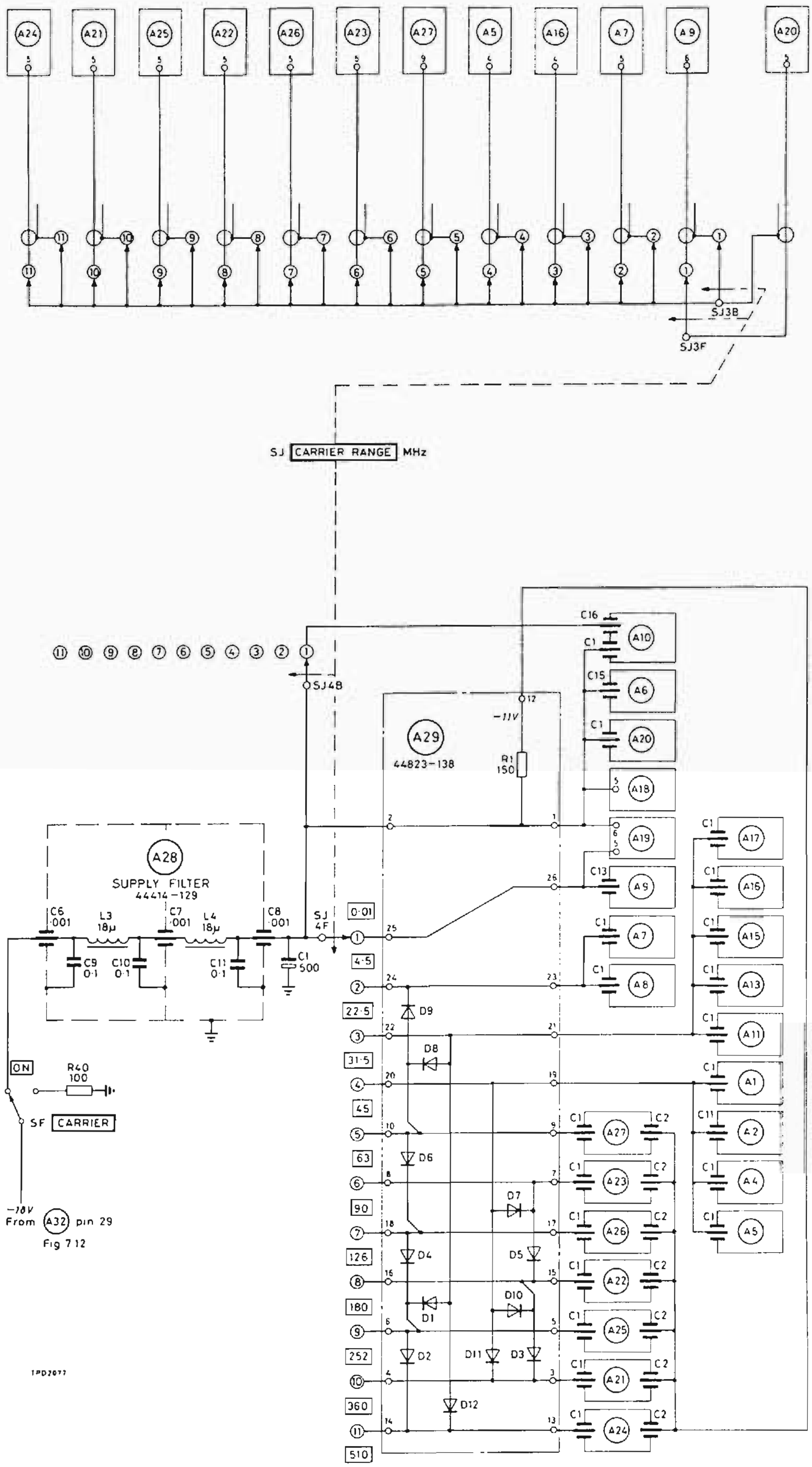

Fig. 7.6a Circuit diagram—r.f. processing range switching

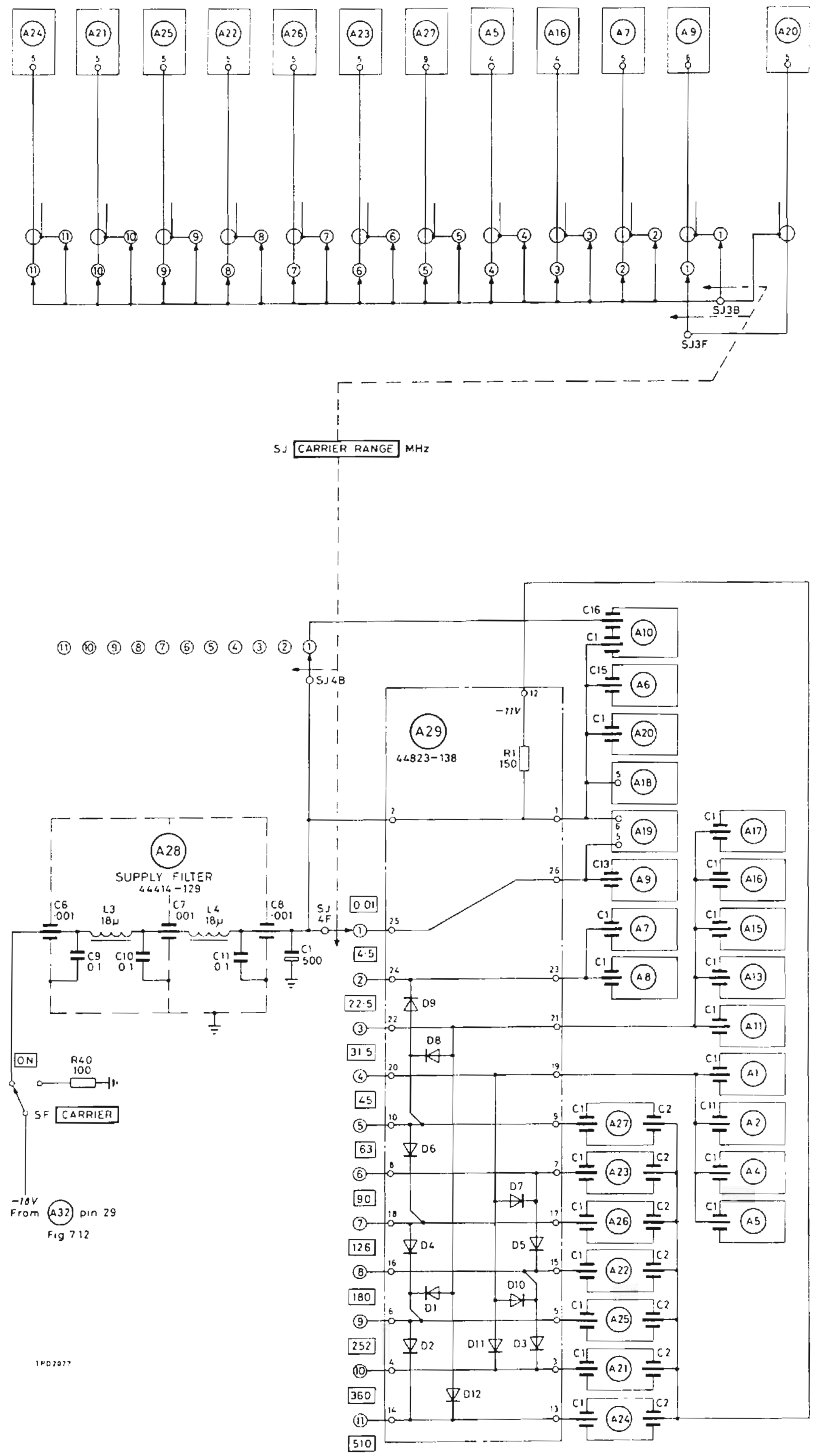

Fig. 7.9a Circuit diagram—r.f. processing range switching

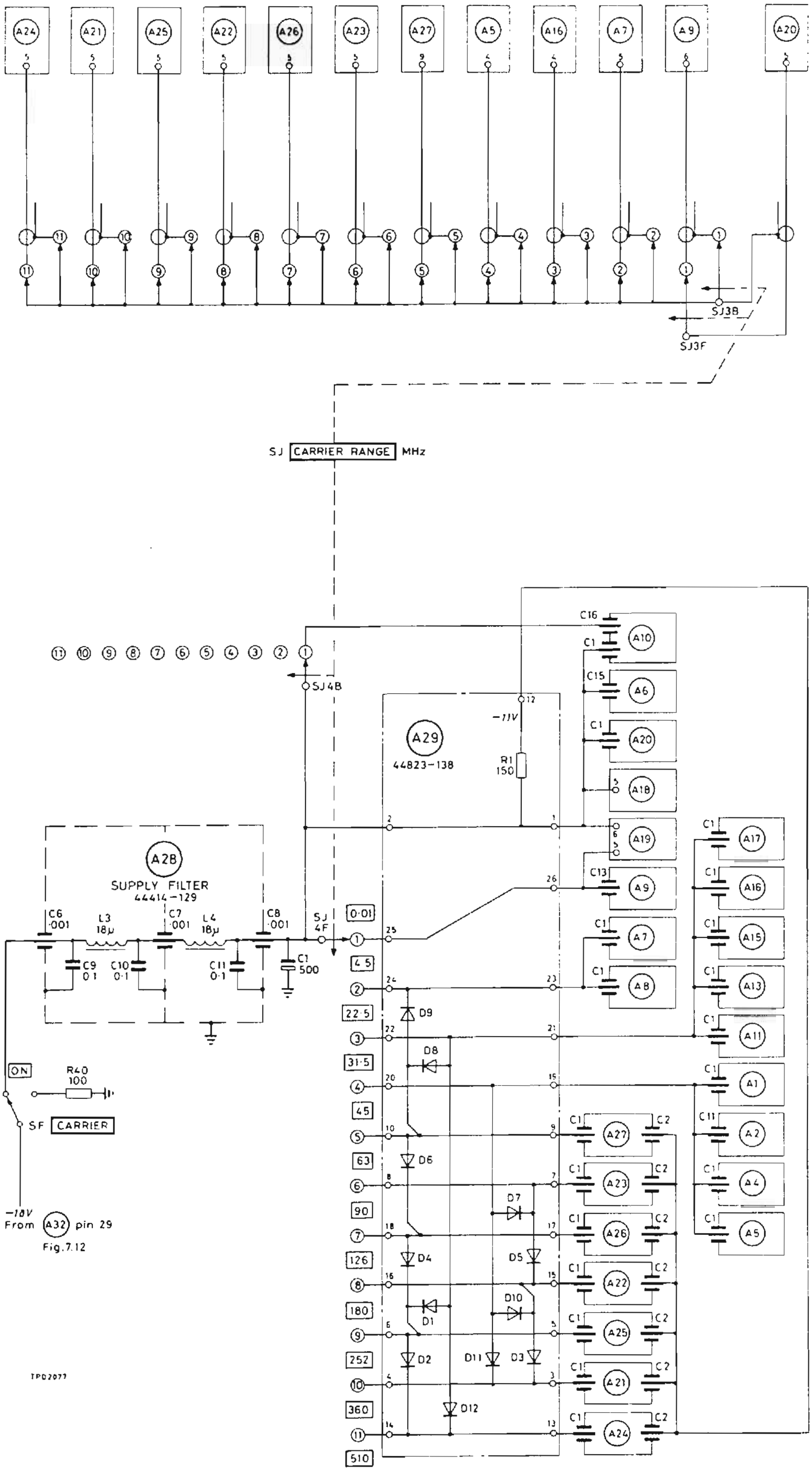

Fig. 7.3 a Circuit diagram—r.f. processing range switching

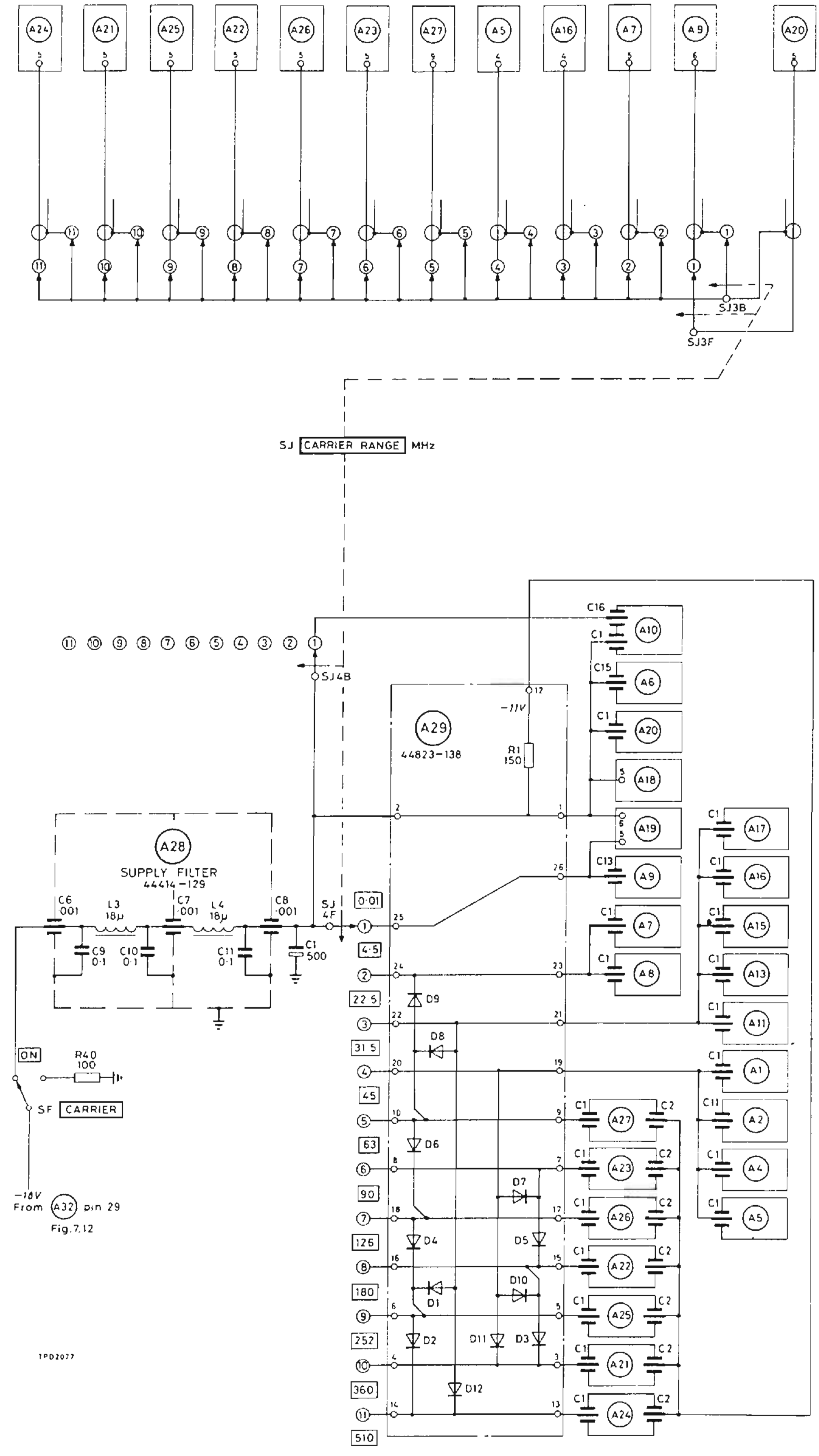

Fig. 7.7a Circuit diagram—r.f. processing range switching

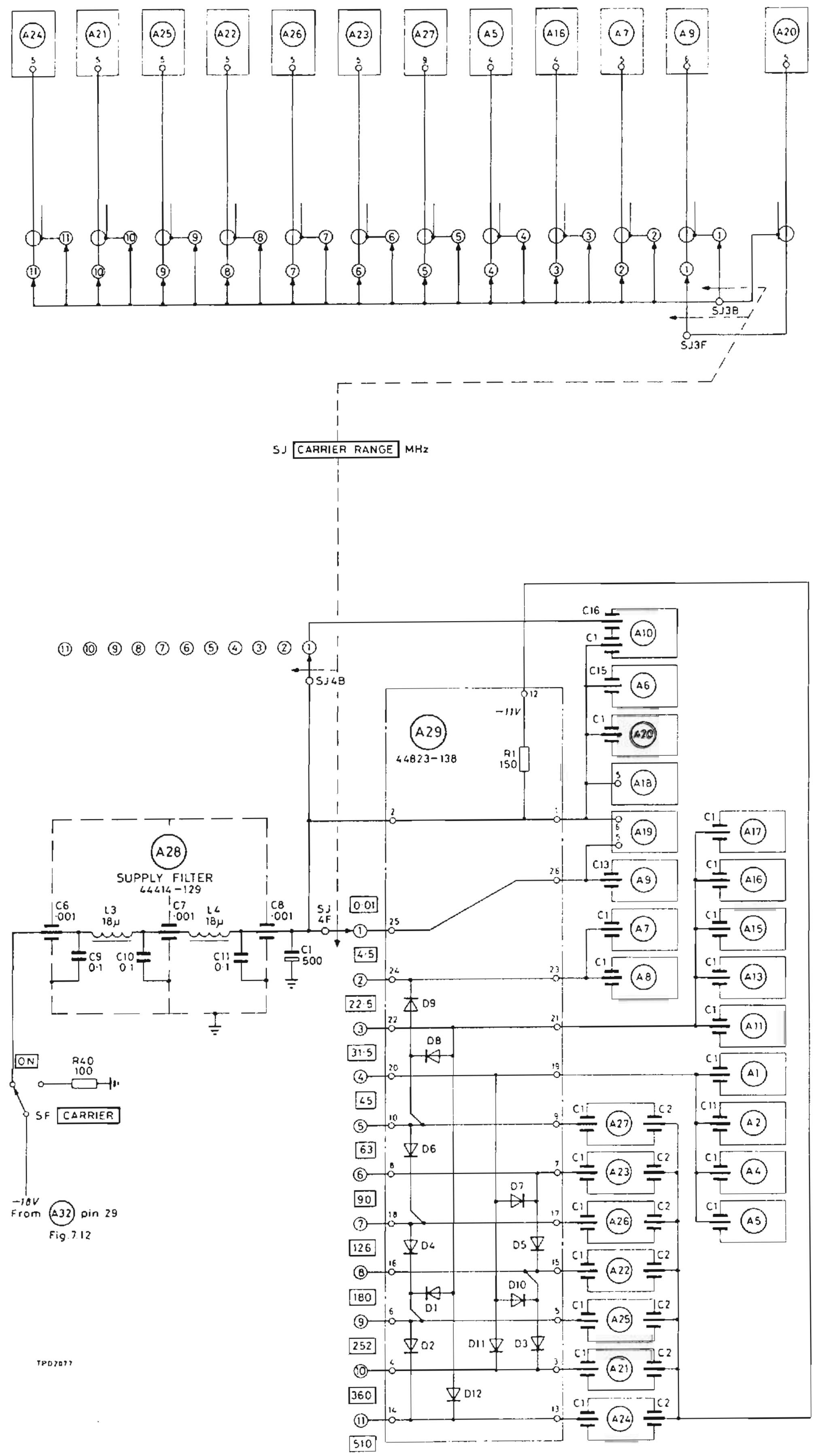

Fig. 7.8a Circuit diagram—r.f. processing range switching

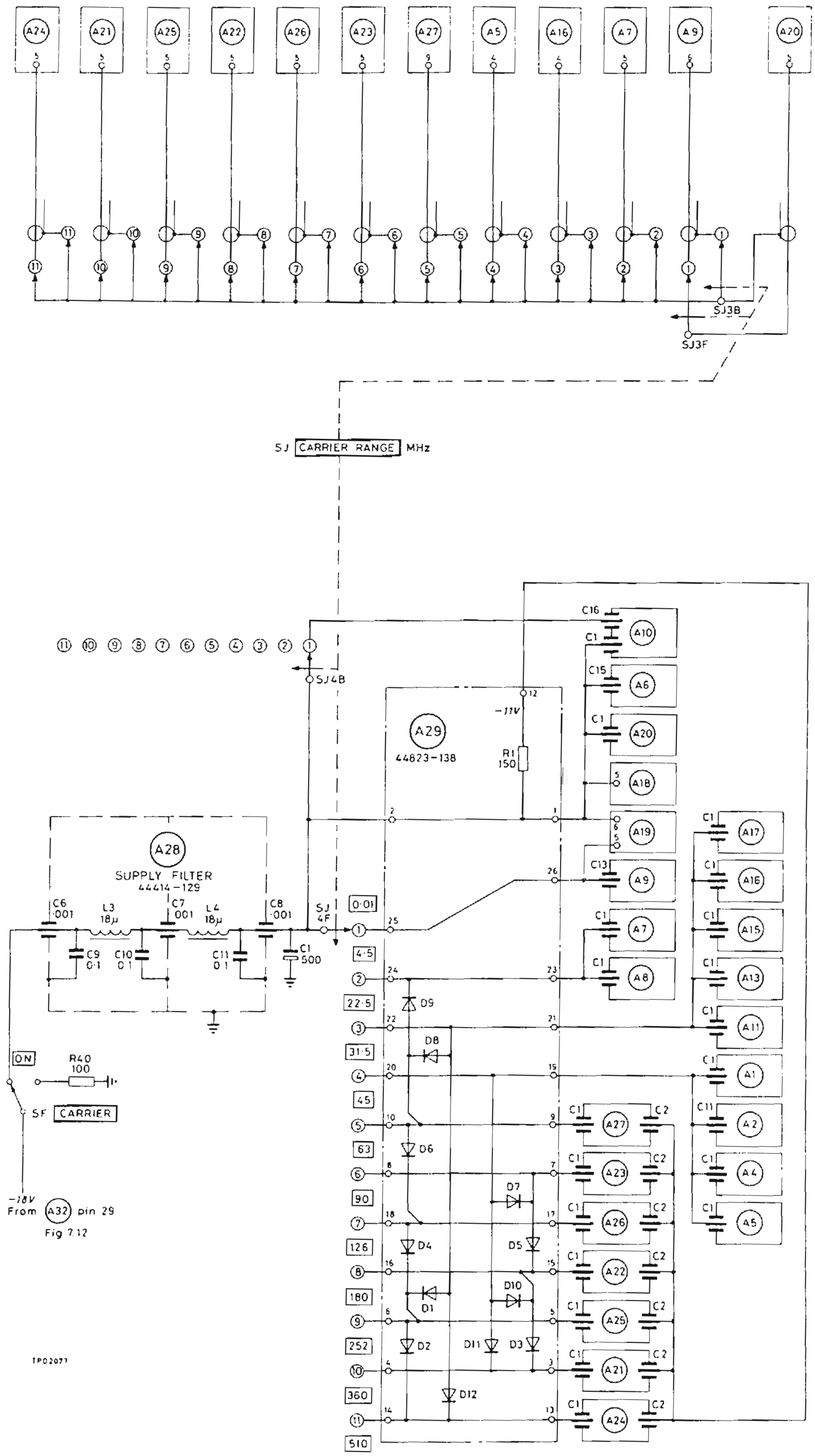

Fig. 7.4a Circuit diagram—r.f. processing range switching

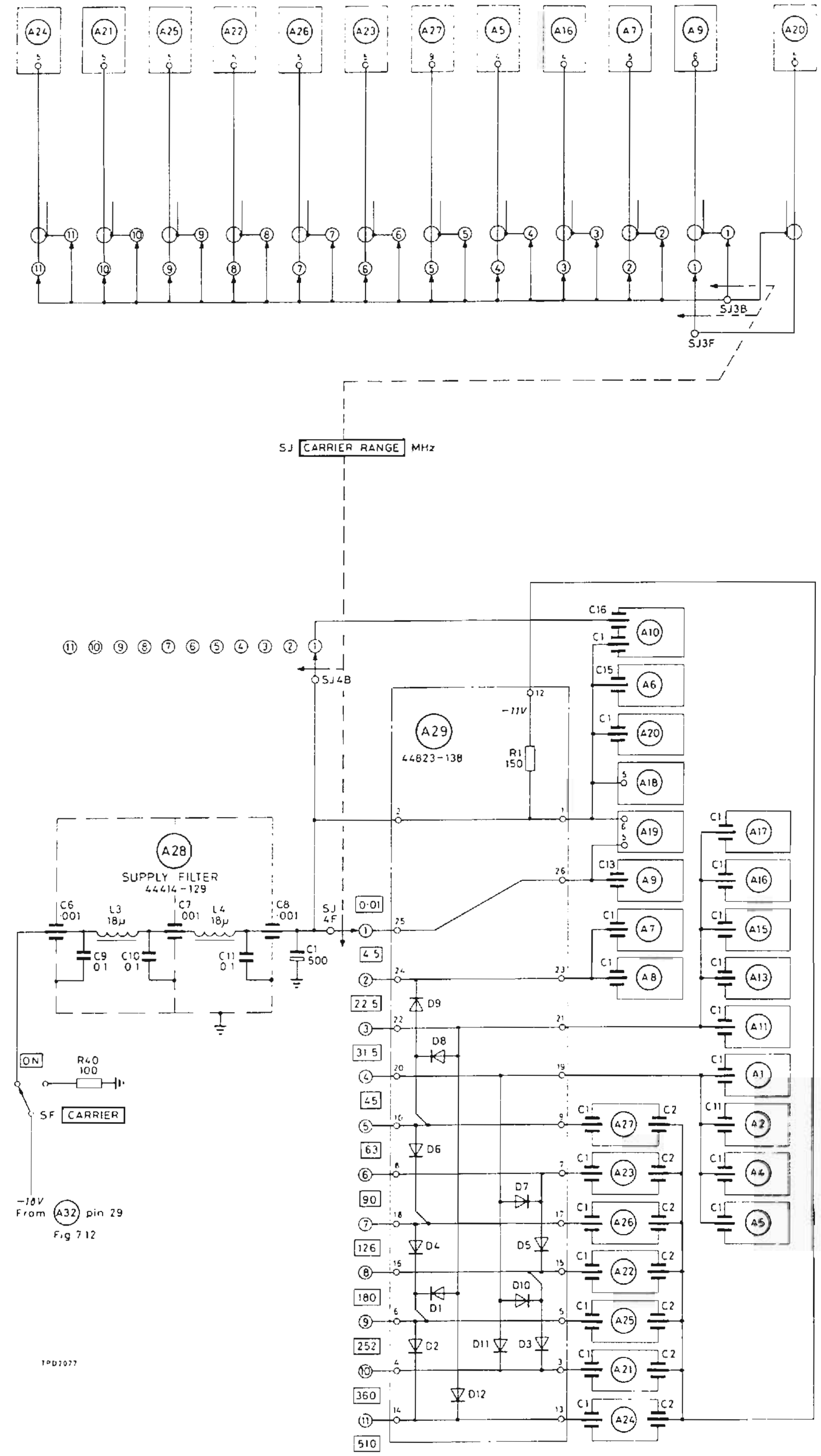

Fig. 7.5a Circuit diagram—r.f. processing range switching

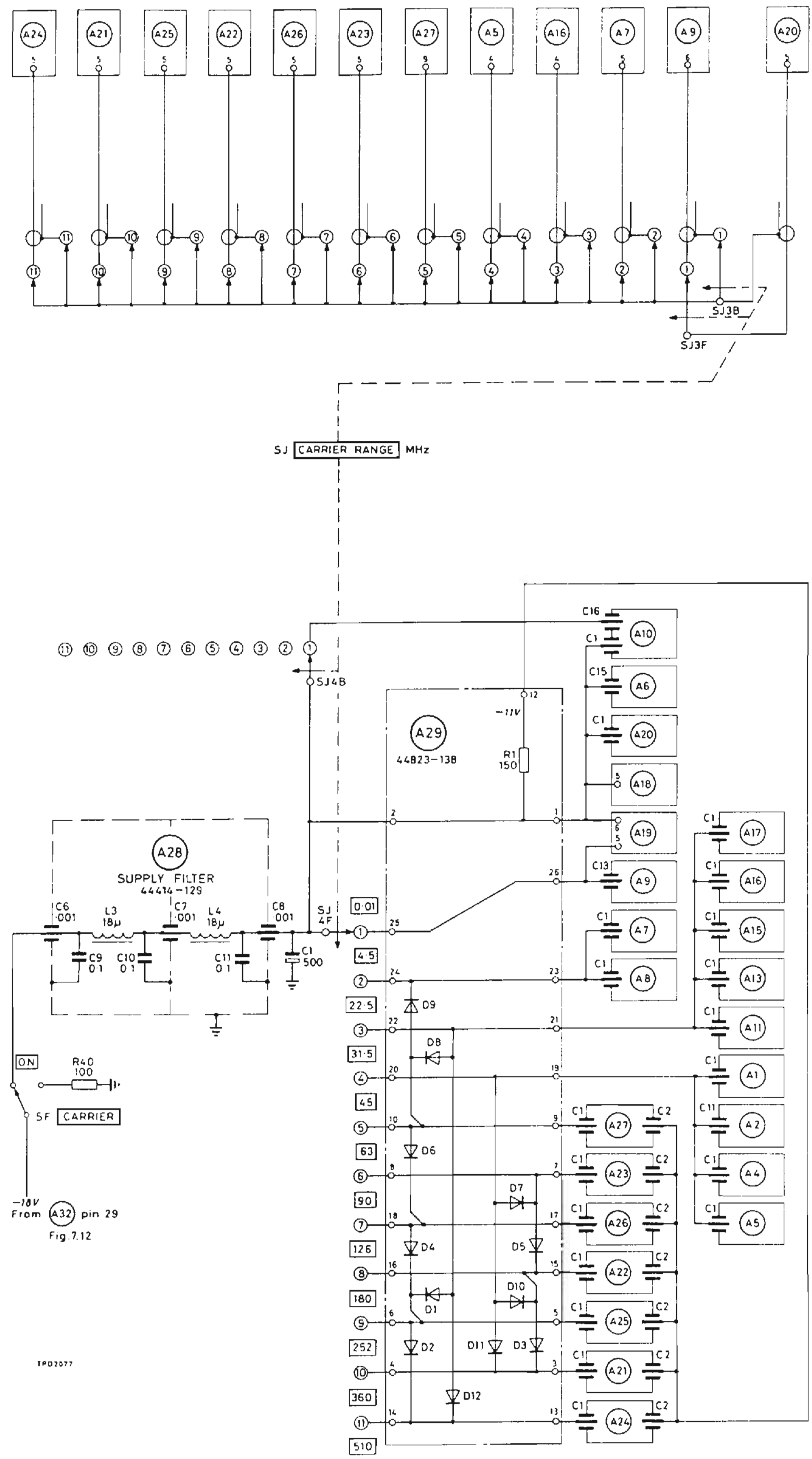

Fig. 7.10a Circuit diagram—r.f. processing range switching