Maintenance manual (Part 1)

RA. 1771/2 HF Communications Receivers

1 9 7 6
THE QUEEN'S AWARD
FOR EXPORT ACHIEVEMENT
TO RACAL COMMUNICATIONS LTD.

RACAL
THE ELECTRONICS GROUP

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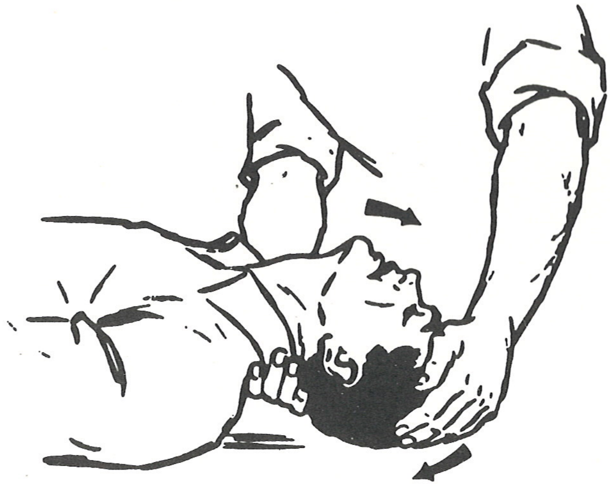
LETHAL WARNING

Voltages within this equipment are sufficiently high to endanger life.

Care should be taken when covers are removed.

Resuscitation instructions are given overleaf.

FIRST AID in case of Electric Shock



1. Lay victim on his back.
2. Clear victim's mouth and throat.
3. Tilt victim's head back as far as possible and raise his head.

4. Pinch victim's nostrils.
5. Take a deep breath.
6. Cover the victim's mouth with yours and blow, watching his chest rise. Note: Blow forcefully into adults, but gently into children.
7. Move your face away to allow victim to breathe out, watching his chest fall.
8. Repeat first five to ten breaths at a rapid rate; thereafter, take one breath every three to five seconds.
9. Keep victim's head back as far as possible all the time.

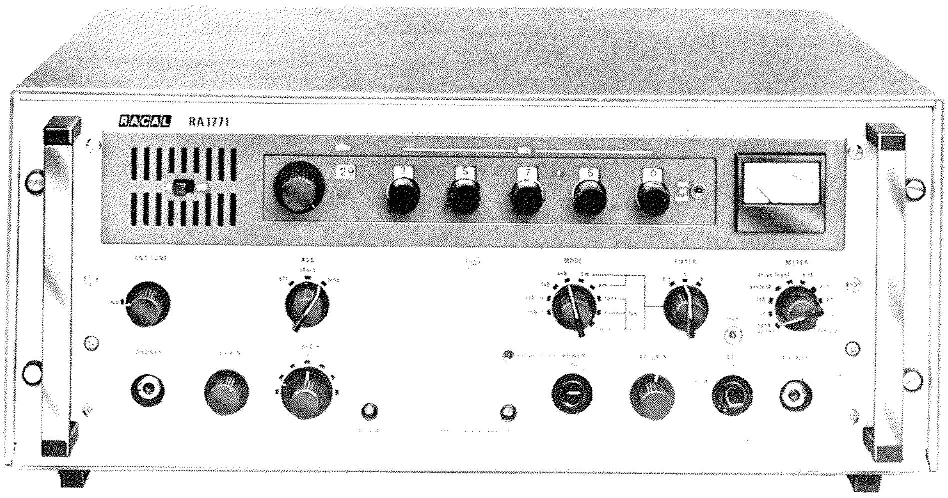
Have someone else send for a Doctor

Keep patient warm and loosen his clothing

DO NOT Give liquids until patient is conscious

HANDBOOK AMENDMENTS

Amendments to this handbook (if any), which are on coloured paper for ease of identification, will be found at the rear of the book. The action called for by the amendments should be carried out by hand as soon as possible.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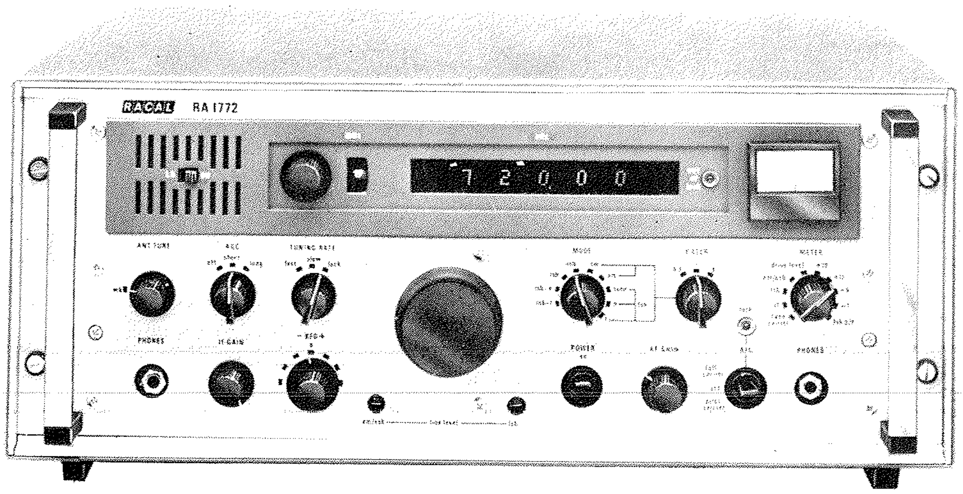
RA1771


RACAL
RA 1772
ANT TUNE
AGC
TUNING RATE
MODE
METER
PHONES
IF GAIN
POWER
AF GAIN
PHONES

RA.1771/72 MAINTENANCE MANUAL

PREFACE

This Manual contains detailed technical information for Maintenance purposes. It is assumed that the user also has a copy of the RA. 1771/72 Operators Manual, to which reference should be made for general information concerning installation, operation and brief technical details.

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TECHNICAL SPECIFICATION

The performance as stated in this specification is applicable to the wideband condition. If the optional RF tuning unit is fitted a nominal 20dB of protection is given at $\pm 12\frac{1}{2}\%$ off-tune.

Frequency Range: 15kHz - 30MHz.

Modes of Reception: A1, A2, A2H, A2J, A3, A3A, A3J, A3H with the following options:

(i) Choice of filter bandwidth.
(ii) Provision for ISB reception.
(iii) Provision for AFC.
(iv) Provision for FSK.

Tuning:

RA.1771
Fully synthesized in 10Hz steps. 30-way switch for MHz selection, five rotary decadic switches for kHz and Hz selection.

RA.1772
Switched selection of 1MHz steps and a continuously tunable synthesizer in 10Hz or 100Hz steps over each 1MHz band. Electronic readout of each 1MHz band to increments of 10Hz.

Overspill:

RA.1772
20kHz at either end of each 1MHz band.
Overrun indication is provided.

Tuning Accuracy: ±5Hz relative to the frequency of the wanted signal.

Frequency Stability:

(1) The following optional alternative frequency standards may be fitted:

(a) Temperature Compensated Crystal Oscillator (TCXO).

(i) Temperature: Better than $\pm 1.5:10^6$ from $-10^\circ C$ to $55^\circ C$.

(ii) Long Term: $\pm 2:10^7$ over a 30 day period.

(b) Frequency Standard Type 9400

(i) Temperature: $\pm 1:10^8/^\circ C$.

(ii) Long Term: $\pm 1.5:10^7$ over a 30 day period or $\pm 5:10^9$ per day.

(c) Frequency Standard Type 9420

(i) Temperature: $\pm 6:10^{10}/^{o}C$.

(ii) Long Term: $\pm 1.5:10^{8}$ over a 30 day period or $\pm 5:10^{10}$ per day.

(2) Provision is made for the use of an external frequency standard.

Antenna Input

(a) Wideband. 50 ohms to 75 ohms nominal. Coaxial BNC connector.

(b) RF tuning is available as an optional fitting within the receiver. This is provided by five automatically selected bandpass filters covering the frequency range 1MHz to 30MHz. Manual RF peak tuning is provided over each pre-selected band of frequencies. Each tuned range provides a nominal attenuation of 20dB at 12½% off-tune. A low pass filter is used below 1MHz.

(c) Receiver muting is provided to protect the receiver from local emissions on the tuned frequency. The operation of the muting circuits permits 'break-in' or 'listen through' operation when keying at a rate of up to 20 bauds.

(d) The receiver will withstand without damage RF input signals of 30V (emf) continuously. A fuse and spark gap is provided for protection against higher voltages.

(e) Re-radiation with the antenna input terminated in 50 ohms is less than 10 microvolts.

Sensitivity:

(a) CW and SSB (A1, A2H, A3A, A3H, A3J)
In a 3kHz bandwidth the signal-to-noise ratio is better than:

500kHz - 30MHz, 15dB with 1µV (emf) input.
50kHz - 500kHz, 15dB with 3µV (emf) input.
15kHz - 50kHz, 15dB with 10µV (emf) input.

(b) DSB (A2, A3)
In a 3kHz bandwidth the signal-to-noise ratio is better than:

500kHz - 30MHz, 15dB with 1.5µV (emf) input 70% modulated.
50kHz - 500kHz, 15dB with 5µV (emf) input 70% modulated.
15kHz - 50kHz, 15dB with 15µV (emf) input 70% modulated.

IF Selectivity:

(a) SSB (A3A, A3J)

Passband at -6dB: 250Hz to 3000Hz.
Passband at -60dB: -650 and +4100Hz.

(b) ISB (A3B)

Passband at -6dB: 250Hz to 3000Hz.
Passband at -60dB: -400 and +4100Hz.

ALTERNATIVELY - SSB and ISB

Passband at -6dB: 250 to 6000Hz.
Passband at -60dB: -300 and +8000Hz.

(c) CW/MCW/AM/FSK (A1, A2, A3, A2H, A3H, F1)

Standard Receivers: In addition to the mode-selected SSB or ISB filters, up to four optional IF filters may be fitted although certain combinations of facilities will permit only three filters to be fitted. IF filters of the following nominal passbands are available:

0.3kHz, 1kHz, 3kHz, 6kHz, 8kHz, 13kHz.

Cross Modulation:

With a wanted signal greater than 300 μV emf, in a 3kHz bandwidth, an unwanted signal, 30% modulated, removed not less than 20kHz, will be greater than 300mV emf, to produce an output 20dB below the output produced by the wanted signal.

Reciprocal Mixing:

With a wanted signal of less than 100μV emf, in a 3kHz bandwidth, an unwanted signal more than 20kHz removed will be greater than 70dB above the wanted signal level to give a noise level 20dB below the output produced by the wanted signal.

Blocking:

With a wanted signal of 1mV emf, an unwanted signal more than 20kHz removed must be greater than 500mV to reduce the output by 3dB.

Intermodulation Products:

(a) Out of Band

With two 30mV emf signals separated and removed from the wanted signal by not less than 20kHz the third order intermodulation products are not less than -85dB below either of the interfering signals and typically better than -90dB.

(b) In Band

Two in band signals of 30mV emf will produce third-order intermodulation products of not greater than -40dB.

Spurious Responses:

(a) External:

External signals, 20kHz removed from the wanted signal, must be at least 80dB above the level of the wanted signal to produce an equivalent output.

(b) Internal:

The specified sensitivity for CW and SSB is not reduced by more than 3dB as a result of any internally generated spurious signals.

AGC:

(a) Range:

An increase in input of 100dB above 2 microvolts emf will produce an output change of less than 6dB.

(b) Switched selection of AGC 'off' 'short' and 'long' time constants.

AFC: (A3A, A3B)

(a) AFC is available as an optional internal facility and is provided with a front panel switch for selecting AFC off, pilot carrier or full carrier.

(b) Capture range ± 50Hz.
Follow range ± 500Hz or beyond.
Stability: Over a temperature range of ±10°C relative to 25°C the incoming signal is held to within ± 2Hz of its tuned frequency setting.

IF OUTPUT: (AGC ON) 1.4MHz, nominally 100mV e.m.f. into 50 ohms.

BFO Range: ±3kHz variable by a slow motion control.

Audio Characteristics:

(a) Output Levels:

(i) Line outputs, 1mW nominal into 600 ohms balanced, adjustable by preset level control on front panel to +10 dBm.

(ii) Phone outputs balanced, 10mW nominal into 600 ohms.

(iii) 50mW into an internal loudspeaker which is capable of being switched in or out of operation.

(iv) Connection for external speaker 1 watt into 8 ohms.

(b) AF Response:

(i) Line outputs. Within 1dB from 100Hz to 6000Hz relative to the level of a standard 1000Hz tone.

(ii) The overall AF response will be dependent upon the IF bandwidth selected.

(c) AF Distortion:

(i) Line outputs: Not greater than 2% at specified output of 1mW nominal.

(ii) Loudspeaker outputs: Not greater than 5% at 50mW output to internal loudspeaker, and 1W output to external speaker.

(iii) Phone outputs: Not greater than 5% at specified output of 10mW nominal.

Cross Talk: (A3B)	With a wanted signal at a level of 1mV and the AF output adjusted to 1mW, the cross talk from an equal signal in the opposite sideband, at greater than 400Hz from the carrier, is not greater than -50dB relative to 1mW.
Frequency Shift Demodulation: (optional)	(a) Frequency shift range, 85Hz to 850Hz. (b) Maximum keying speed 200 bauds. (c) Telegraph distortion not greater than 5% up to 100 bauds. (d) Telegraph output. Polar (double current) DC output approximately 100mA with choice of 6-0-6V or 80-0-80V. Normally positive on 'Mark'. Provision is made, by a rear panel switch, for neutral (single current) operation. (e) Mark/space reversal is available to the operator and a 'tune' switch position is provided to permit tuning of the receiver without operating the teleprinter.
Metering:	A meter is provided on the front panel to indicate RF level, AF level to line, FSK tune, and suitable performance or supply test levels.
Front Panel Controls and Fittings:	RA.1772 MHz Frequency Control by rotary switch. kHz Frequency Selection by rotary VFO type control. Tuning Rate switch (Fast, Slow, Lock). RF Tuning Control (Optional). AGC Time Constants switch. AFC Full Carrier/Off/Pilot Carrier (Optional). AFC Lock Lamp (Optional). Mode Switch. Meter Facility Switch. Meter. Loudspeaker.

Loudspeaker switch.
Two Headphone sockets.
IF Gain Control.
AF Gain Control.
BFO Slow Motion Control.
Line Level Preset Adjusters.
Filter Switch.
Power On/Off Switch.

RA.1771
As for RA.1772 except that the kHz rotary control is replaced by five decadic switches for kHz and Hz settings.

Rear Panel Connections and Facilities:

RA.1771 and RA.1772
Antenna Input Socket.
Antenna Fuse.
Power Input Socket.
Mains Voltage Adjuster Panel.
Power Input Fuse.
Standby +12V Fuse.
Teleprinter Supply Fuse.
Teleprinter Supply Voltage Selector Switch.
Teleprinter Supply Polar/Neutral Switch.
Ground Terminal.
34MHz Input/Output Socket.
34MHz Internal/External Switch.
1MHz Frequency Standard Input/Output Socket.
Frequency Standard Internal/External Switch.
Local Oscillator Input/Output Socket.
Local Oscillator Internal/External Switch.
AGC Output (for diversity operation).)
Line Output(s) (2 outputs for ISB version only))
Loudspeaker Output.)
Mute Line.) Terminal Strip
FSK Input and Output)
Standby +12V Input.)
+12V Output)
1.4MHz IF Output Socket (2 outputs for ISB version).

Power Supply: 100V-125V or 200V-250V, ±10%, 45-65Hz

Power Consumption: Approx. 60VA (Basic receiver)
Approx. 90VA (Fully equipped)

Environmental Conditions: The equipment is designed to meet certain of the requirements of the British Defence Specification DEF.133, L2, for ambient temperature range of:

Operating Temperature	-10°C to $+55^{\circ}$C
Storage Temperature	-40°C to $+70^{\circ}$C
Relative Humidity	95% at 40°C

Dimensions:	Rack Mounted:	Height:	178mm (7 in)
		Width:	483mm (19 in)
		Depth:	410mm (16.14 in)
	In Bench Cabinet:	Height:	220mm (8.66 in)
		Width:	495mm (19.49 in)
		Depth:	445mm (17.52 in)
Weight:	Rack Mounted:	22kg (48.4lb) approximately	
	In Bench Cabinet:	28kg (61.6lb) approximately	

ACCESSORIES

AA.660/A	Headset, 600 ohms, with ventilated ear cushions, lead and plug.
BA.45520	Bench Mounting Cabinet.
DA.47020	Ruggerdised Bench Mounting Cabinet for marine applications.
DA.46531	Ruggerdised Bench Mounting Cabinet fitted with shock mounts for mobile/ transportable applications.

OPTIONAL EXTERNAL MODULES

MM532	Audio Switching Unit.
MS540	12V Battery Module.
MS530	Bandpass Filter, 2-30MHz, for use in antenna systems.
MS561	IF Conversion Module, 1.4MHz to 100kHz.

NATO NUMBERS

RA.1771	5820-99-626-3415
RA.1772	5820-99-624-5397

CHAPTER 1

PRINCIPLES OF OPERATION

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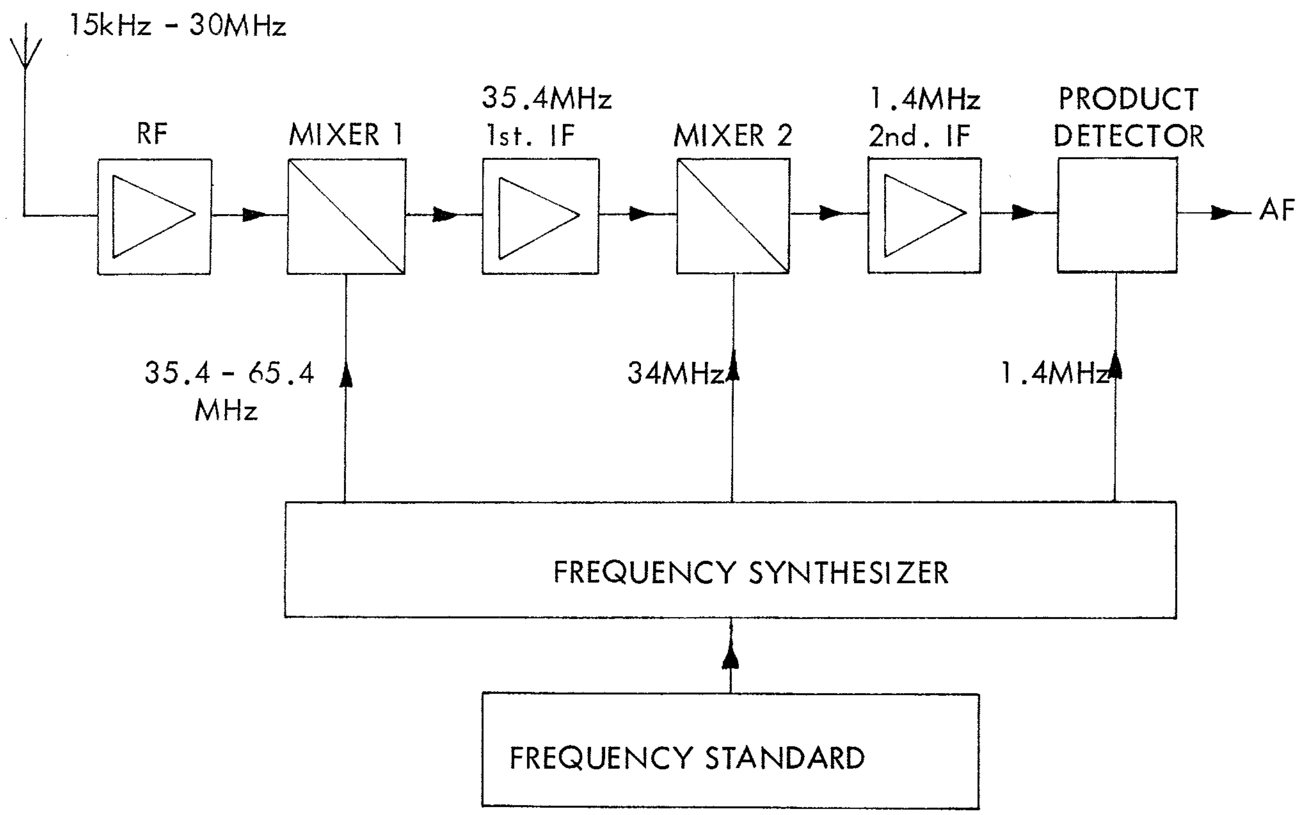
CHAPTER 1

PRINCIPLES OF OPERATION

INTRODUCTION

1. For explanation purposes, the receiver may be divided into two main sections, namely the frequency synthesizer and the RF/IF/AF section (see illustration below).



FREQUENCY SYNTHESIS

2. The above simplified block diagram of the RA.1771/72 receiver shows the three mixer injection signals produced by the frequency synthesizer. The first IF, at 35.4MHz, is high, compared with the received signal frequency at the antenna, to provide good image rejection. To produce this first IF the frequency synthesizer must provide an output signal in the range 35.4 to 65.4MHz. The second IF, at 1.4MHz, is low to provide good selectivity, and requires a fixed frequency output signal from the synthesizer at 34MHz. Finally, a frequency of 1.4MHz is needed for the product detector for the reception

of SSB signals.

3. The indirect method of frequency synthesis is used where the required output frequencies (with the exception of the 1.4MHz output) are derived from voltage-controlled oscillators which are phase locked to a common frequency standard. A simplified functional diagram of the frequency synthesizer section of the receiver is given in Fig. 1.1.

FREQUENCY STANDARD

4. Any one of three types of 5MHz frequency standard may be fitted to the receiver, dependent upon the degree of frequency stability required. The output signal from the frequency standard is divided by five to produce a 1MHz reference frequency for the synthesizer. Alternatively, provision is made for the use of an external 1MHz frequency standard.

1.4MHz OUTPUT

5. The 1MHz reference frequency signal from the frequency standard is further divided by five to produce an output at 200kHz. A 1.4MHz crystal filter selects the seventh harmonic and this is amplified to produce a 1.4MHz output signal at the required level.

34MHz OUTPUT

6. The 34 MHz second mixer injection frequency is derived from a 34MHz voltage controlled oscillator (VCO) which is phase locked to the 1MHz reference frequency. A sample of the VCO output is first divided by 34 and is then phase compared with the 1MHz reference frequency; any difference in phase results in a correction voltage which is fed back to the VCO.

35.4 to 65.4MHz OUTPUT

7. This is the main output signal from the frequency synthesizer; it covers the frequency range 35.40000 to 65.39999MHz in 10Hz increments and is controlled by the 30-way MHz switch together with either the five decade frequency selection switches (RA.1771) or the shaft encoder (RA.1772). The digits of the required output frequency are derived from five cascaded phase-locked loops where the divided output from one loop becomes the phase detector input of the next loop.

LOW FREQUENCY LOOP

8. The low frequency loop consists of a 6 to 7 MHz VCO, a programmed divider, N1, and a phase comparator. The phase comparator compares the phase of the output signal from the programmed divider with that of a 1kHz reference frequency derived from the frequency standard. Should a phase difference exist, a correction voltage is derived which is fed back to the VCO to eliminate the error.

9. The programmed divider, N1, has a division ratio of from 7000 to 6001 and is controlled by the 10Hz, 100Hz and 1kHz digits of the selected receiver operating frequency; a receiver frequency setting of 000 sets the division ratio to 7000, a setting of 999 sets the division ratio to 6001, and the division ratio for intermediate frequency settings is given by the expression: N1 = 7000 minus selected 1kHz, 100Hz and 10Hz digits. The divider consists of a number of cascaded decade counters where the start of a count sequence may be programmed by the frequency determining switches (RA.1771) or shaft encoder (RA.1772) and where the counter is reset (strobed) when a count of 7000 is reached. When the VCO has been driven to the correct frequency, reset (strobe) pulses will occur at a repitition rate of exactly 1k pps, as will the output pulses applied to the phase comparator.

Tuning Example

10. Consider a receiver operating frequency of 12.34567MHz. The first mixer injection frequency required to produce our first intermediate frequency of 35.4MHz is, therefore, 12.34567MHz + 35.4MHz, which equals 47.74567MHz. Returning to our operating frequency of 12.34567MHz, only the last three digits, i.e. 567, need be considered for this part of the circuit. Thus the programmed divider, N1, is preset to start counting at 567 and counts up to 7000, a total of 6433 pulses (7000-567); this is equal to a VCO frequency of 6.433 MHz.

LOWER TRANSFER LOOP

11. The lower transfer loop, so called because the low frequency increments at its input, i.e. the 10Hz, 100Hz and 1kHz digits, are transferred to its output, consists of a programmed divider, N2, a 1.013187 to 1.019886MHz VCO, a mixer and a phase comparator. It generates, together with the upper loop, the 100kHz and 10kHz digits of the variable output frequency.

12. The programmed divider, N2, has a division ratio of from 453 to 354 and is controlled by the 100kHz and 10kHz digits of the selected receiver operating frequency. (This division ratio is modified to cover the range 455 to 352 for the RA.1772 when in the overspill condition, i.e. 20kHz beyond either end of the selected 1MHz band). A receiver frequency setting of 00 for the 100kHz and 10kHz digits results in a division ratio of 453, a setting of 99 results in a division ratio of 354 and the division ratio for intermediate frequency settings is given by the expression: N2 = 453 minus the selected 100kHz and 10kHz digits.

13. The output signal for the low frequency loop is first divided by N2 and is then applied as one input to the phase comparator. The output from the VCO is mixed with the 1MHz reference frequency, derived from the frequency standard, and the difference frequency signal from the mixer is applied as the second input to the phase comparator. Thus the output voltage from the phase comparator drives the VCO to a frequency which is exactly 1MHz above the output signal frequency from the programmed divider, N2.

Tuning Example

14. Returning to our receiver operating frequency of 12.34567MHz (see paragraph 10), the 100kHz and 10kHz digits required are 3 and 4 respectively. The division ratio of N2 is, therefore, 453-34 = 419. Our 6.433MHz output frequency from the low frequency loop is divided by 419 and the result is added to 1MHz.

$$\text{Lower Transfer Loop Output} = \frac{6.433 \times 10^6}{419} + 10^6 \text{Hz}$$

$$= 1.015353\text{MHz}$$

UPPER LOOP

15. The output signal from the lower transfer loop is first divided by 100 and is then applied as one input to a phase comparator; the other phase comparator input is from a programmed divider, N2, and a 3.6 to 4.6MHz VCO is driven to the required frequency by the phase comparator output. The programmed divider, N2, is set to the same division ratio as that of the lower transfer loop, as described in paragraph 12.

Tuning Example

16. Our 1.015353MHz output signal from the lower transfer loop (see paragraph 14) is first divided by 100 and is then multiplied by N2, i.e. 419.

$$\text{Upper Loop Output} = \frac{1.015353}{100} \times 419$$

$$= 0.010154 \times 419$$

$$= 4.25433 \text{ MHz}$$

UPPER TRANSFER LOOP

17. This loop, in conjunction with the HF loop, generates the MHz portion of the variable output frequency, and is controlled by the 30-way MHz switch. It consists of a programmed divider, N3, a phase comparator, a mixer and a VCO which covers the frequency range 884.950 to 948.116 kHz.

18. The programmed divider, N3, has a division ratio of from 40 to 69. In contrast to the previously described programmed dividers, N1 and N2, the division ratio of N3 is found by adding 40 to the setting of the receiver MHz switch. This is achieved by first converting the decimal 0 to 29 output from the MHz switch into a 'nines complement' code before application to the programmed divider which counts from the programmed starting point up to 99, and then to 39 when the reset occurs. Table 1 gives the conversion from decimal to nines complement code.

Decimal	BCD				Nines Complement				Decimal
	D	C	B	A	D9	C9	B9	A9	
0	0	0	0	0	1	0	0	1	9
1	0	0	0	1	1	0	0	0	8
2	0	0	1	0	0	1	1	1	7
3	0	0	1	1	0	1	1	0	6
4	0	1	0	0	0	1	0	1	5
5	0	1	0	1	0	1	0	0	4
6	0	1	1	0	0	0	1	1	3
7	0	1	1	1	0	0	1	0	2
8	1	0	0	0	0	0	0	1	1
9	1	0	0	1	0	0	0	0	0

Table 1: Decimal to Nines Complement Conversion

19. The 4.6 to 3.6MHz output from the upper loop is divided by N3 and is then applied as one input to a phase comparator. The output from the VCO is mixed with the 1MHz reference frequency, derived from the frequency standard, and the sum frequency output from the mixer is applied as the second input to the phase comparator. Thus the output voltage from the phase comparator drives the VCO to a frequency which is equal to 1MHz minus the output frequency from the programmed divider, N3.

Tuning Example

20. The division ratio for the programmed divider, N3, is obtained by adding 40 to the MHz digits of our receiver operating frequency. Thus for our frequency of 12.34567 MHz (see paragraph 10), N3 will be 40 plus 12 which equals 52. Our 4.25433MHz output from the upper loop (see paragraph 16) is divided by 52 and the result is then subtracted from 1MHz to give us the upper transfer loop output frequency.

$$\text{Upper Transfer Loop Output} = 1 - \frac{4.25433}{52} \text{ MHz}$$

$$= 1 - 0.081814$$

$$= 918.186 \text{ kHz}$$

HF LOOP

21. The output signal from the upper transfer loop is first divided by two and is then applied as one input to a phase comparator. The output from a 35.4 to 65.4MHz VCO is also divided by two and is then applied to the programmed divider, N3, which in turn provides the second input to the phase comparator. Thus the VCO is driven to the required frequency by the phase comparator output. The programmed divider, N3, is set to the same division ratio as that of the upper transfer loop.

Tuning Example

22. Our 918.186kHz output from the upper transfer loop is first divided by two and is then multiplied by 2N3, i.e. 2 x 52, to give us our final output frequency.

$$\text{First Mixer Injection Frequency} = \frac{0.918186}{2} \times 2 \times 52\text{MHz}$$

$$= 0.918186 \times 52\text{MHz}$$

$$= 47.74567\text{MHz}.$$

This figure is our receiver operating frequency plus the first intermediate frequency and agrees with out original frequency arrived at in paragraph 10.

ALGEBRAIC EQUATION FOR FREQUENCY SYNTHESIS

23. The variable output frequency of the synthesis section of the receiver may be worked out for any receiver operating frequency by using a simple algebraic equation. The following paragraphs show the derivation of this equation and should be read in conjunction with the Simplified Functional Diagram, Fig. 1.1.

24. The 1kHz reference frequency input to the phase comparator of the low frequency loop, designated f1, gives us the starting point of our equation and is expressed as: $f1 = 10^3$ Hz. The output from the low frequency loop (f2) is therefore:

$$f2 = 10^3 \, N1 \text{ Hz} \qquad (1)$$

25. The lower transfer loop divides its input by N2 and then adds the result to 1MHz. This is given by:

$$f3 = \frac{10^3 \, N1}{N2} + 10^6 \text{ Hz} \qquad (2)$$

26. The output from the lower transfer loop (f3) is first divided by 100 before being applied to the phase comparator of the upper loop.
Dividing equation (2) by 100 gives:

$$\frac{f3}{100} = \frac{10^3 \, N1}{100 \, N2} + \frac{10^6}{10^2} \text{ Hz} \qquad (3)$$

which resolves to:

$$\frac{10N1}{N2} + 10^4 \text{ Hz} \qquad (4)$$

27. The output from the upper loop (f4) is now found by multiplying equation (4) by the division ration N2:

$$f4 = 10N1 + 10^4 N2 \text{ Hz} \qquad (5)$$

28. The output from the upper loop (f4) is first divided by N3 before being applied to the phase comparator of the upper transfer loop.
Dividing f4 by N3 gives:

$$\frac{f4}{N3} \text{ Hz} \qquad (6)$$

29. The output from the upper transfer loop (f5) is now found by subtracting the output frequency of N3 from 1MHz.

$$f5 = 10^6 - \frac{f4}{N3} \text{ Hz} \qquad (7)$$

30. Frequency f5 is divided by 2 before being applied to the phase comparator of the HF loop.

$$\frac{f5}{2} = \frac{10^6}{2} - \frac{f4}{2N3} \text{ Hz} \qquad (8)$$

31. The final output frequency (f6) is now found by multiplying (f5 divided by 2) by 2N3

$$f6 = \frac{10^6 2N3}{2} - \frac{f42N3}{2N3} \text{ Hz} \qquad (9)$$

which resolves to:

$$f6 = 10^6 N3 - f4 \quad \text{Hz} \qquad (10)$$

32. For our 12.34567 MHz receiver operating frequency (paragraph 10) we established the division ratios of N1, N2 and N3, as below:

N1 = 6433 (paragraph 10)
N2 = 419 (paragraph 14)
N3 = 52 (paragraph 20)

33. Substituting the values for N1 and N2 in equation (5):

$$f4 = (10 \times 6433) + (419 \times 10^4) \text{ Hz}$$
$$= 4\ 254\ 330 \text{ Hz}$$

Substituting the values of N3 and f4 in equation (10):

$$f6 = (52 \times 10^6) - 4\ 254\ 330 \text{ Hz}$$
$$= 47.74567 \text{ MHz}.$$

RF/IF/AF Section

34. The following paragraphs should be read in conjunction with the respective simplified block diagram (Figs. 1.2 to 1.7) and also the overall block diagram of the receiver which is given in Fig. 1 at the back of the handbook (Part 2).

RF UNIT

Fig 1.2

35. The received signal at the antenna, in the frequency range 15kHz to 30MHz, is fed via a 500mA fuse and a re-radiation filter to a wideband protection stage. This consists of a voltage sensitive circuit and a relay (RLQ/1), which open-circuits the RF path for signals which exceed approximately 3V e.m.f. at the antenna socket. This relay is also used for receiver muting and operates when an earth is applied to the rear panel MUTE terminal. After operation of the relay the receiver is protected from input signals at the antenna socket of up to at least 30V e.m.f. with automatic recovery.

36. From relay contact RLQ1 the received signal is applied to a 30MHz low-pass filter and then takes one of a number of paths dependent on the type of RF board fitted, and also the selected position of the front panel MHz switch, as detailed below.

37. (1) Wideband RF Board

(a) MHz switch set to 0MHz position: An earth (0V) from the MHz switch is routed to relays RLA/1 and RLB/1. The relays energise, the received signal from RLQ1 and the low-pass filter is applied to a 1MHz low-pass filter, via RLA1, and thence via RLB1 and link Y to the wideband RF amplifier.

(b) MHz Switch set to any position other than 0MHz: An earth from the MHz switch is routed to relays RLN/1 and RLP/1 via link Z. The relays energise and a path is provided from the 30MHz low-pass filter to the wideband RF amplifier via RLN1, RLP1 and link Y.

(2) Tuned RF Board

(a) MHz Switch set to 0MHz position: An earth from the MHz switch is routed to relays RLA/1 and RLB/1. The relays energise, the received signal from RLQ1 and the low-pass filter is applied to a 1MHz low-pass filter, via RLA1, and thence, via RLB1 and contact RLR1 of the normally energised protection relay RLR/1, to the wideband RF amplifier.

(b) MHz Switch set to any position other than 0MHz and RF TUNE control set to WB (wideband)

Operation of the microswitch (controlled by RF TUNE control) routes an earth from the MHz switch to relays RLN/1 and RLP/1. The relays energise and a path is provided from the low-pass filter to the wideband RF amplifier via RLN1, RLP1 and contact RLR1 of the normally energised protection relay, RLR/1.

(c) MHz switch set to any position other than 0MHz, RF TUNE control not in WB position :

An earth from the MHz switch is applied to the appropriate pair of tuneable-circuit selection relays and a common +12V relay supply is provided by the normally closed contacts of the microswitch. The contacts of the selected relays close and the received signal from the low-pass filter is applied to the appropriate tuned circuit, tuned by the RF TUNE control, and thence to the RF amplifier via RLR1.

Protection Stage (Tuned Version)

38. A further protection stage is fitted to tuned versions of the RF board. This allows for 'working through' off-tune signals of up to approximately 10V e.m.f. at the antenna socket (the threshold of the wideband protection stage is altered accordingly). The circuit is similar to that of the wideband protection stage; relay RLR/1 becomes de-energised once the 3V e.m.f. threshold is exceeded and the signal path to the RF amplifier is broken.

RF Amplifier

39. A conventional high-linearity type of circuit is used. After amplification, the received signal is passed via a 30MHz low-pass filter to the first mixer.

FIRST MIXER

Fig. 1.3

40. The output signal from the RF unit is mixed with the 35.4 to 65.4 MHz local oscillator signal, from the frequency synthesizer, to produce the first IF at 35.4 MHz.

41. The local oscillator signal is applied to one of two filters, dependant on the setting of the front panel MHz switch; for settings of 0, 1, 2 or 3MHz, a filter with a passband of 35.415 to 39.4MHz is selected whereas for settings of 4 to 29 MHz a filter with a passband of 39.4 to 65.4 MHz is selected.

42. The output signal from the selected filter is applied to a drive amplifier and then to a high performance mixer. A detector and amplifier circuit provides an indication of DRIVE LEVEL at the front panel meter.

43. The output signal from the RF unit is mixed with the local oscillator signal and the difference frequency output is fed via a 35.4 MHz band-pass filter to the second mixer.

SECOND MIXER — Fig. 1.4

44. The 35.4 MHz first IF output from the first mixer is amplified and is then mixed with the 34MHz output from the frequency synthesizer. This produces the second IF, at 1.4MHz, which is fed to the IF amplifier stages via the front panel selected SSB, ISB or symmetrical filter (see Fig. 1).

45. The output signal level from the first stage of IF amplification is automatically controlled by the AGC1 input from the main IF/AF board (and, in ISB versions, AGC2 from the ISB IF/AF board) via a voltage controlled attenuator. The output from the second stage of IF amplification is applied to a balanced mixer via a 35.4MHz band-pass filter.

46. The 34MHz second mixer injection frequency, from the frequency synthesizer section, is applied to the mixer via a 34MHz band-pass filter. The difference frequency output from the mixer, at 1.4MHz, is amplified before being applied to the filter board.

MAIN IF/AF STAGES — Fig. 1.5

47. The 1.4MHz second IF output signal from the second mixer is applied to the IF/AF board via the selected 1.4MHz filter (see Fig. 1). The IF amplifier stage consists of an automatic gain controlled integrated circuit amplifier. This feeds two buffer amplifier stages; the output from one is applied to the product and AM detectors, whilst the output from the other is applied to the AGC detector and the 1.4MHz output amplifier.

Product and AM Detectors

48. Detector selection is controlled by the front panel MODE switch. The AM detector, which is of the envelope type, is selected in the AM position of the MODE switch, and a modified Foster-Seeley type of product detector is selected for all other modes.

AGC Detector

49. The AGC detector develops a d.c. voltage which is proportional to the amplitude of the 1.4MHz IF signal. This gain control voltage, after amplification, is applied to the 35.4MHz first IF amplifier (on the second mixer board), a rear panel terminal and also to the 1.4MHz second IF amplifier via the front panel AGC switch. This switch provides for the selection of either a long or a short AGC time constant. In the OFF position the AGC voltage is removed from the 1.4MHz second IF amplifier and the gain of this stage is then controlled by the front panel IF GAIN control.

Audio Pre-Amplifier

50. The output signal from either the product detector or the AM detector is applied to the audio pre-amplifier. This stage has a muting capability such that the output is inhibited when an earth is applied to the MUTE terminal on the rear panel. The amplified audio output is applied to the line amplifier via the AM/USB LINE LEVEL control and also to the loudspeaker amplifier (the input switching to the loudspeaker amplifier is only necessary in ISB versions of the receiver).

Loudspeaker Amplifier

51. The loudspeaker amplifier provides a 50 mW output for the internal loudspeaker, a 1 watt, 8 ohm output for an externally connected loudspeaker, and two 10 mW, 600 ohm headphone outputs.

ISB IF/AF BOARD

52. This board, which is fitted to ISB versions of the receiver only, is similar to the main IF/AF board except that the AM detector is not utilised and a loudspeaker amplifier is not fitted.

AUTOMATIC FREQUENCY CONTROL

53. The optional AFC facility is used to automatically lock the receiver frequency to that of the incoming carrier. This is achieved by transferring the frequency deviation of the received signal to a 1 MHz signal which is then applied to the synthesizer section of the receiver (34 MHz generator circuit) in place of the 1 MHz reference frequency derived from the frequency standard.

PM664 Board Fig. 1.6

54. The 1.4 MHz second IF output from the carrier filter (on the filter board) is applied via an attenuator to an amplifier stage. The attenuator is controlled by the front panel AFC switch and is switched on for FULL CARRIER, off for PILOT CARRIER. The amplified 1.4 MHz carrier is fed to a crystal band-pass filter (passband 100 Hz) and is then mixed with a 1 MHz signal derived from the frequency standard. The resultant 400 kHz difference frequency output is amplified, and applied to a buffer stage with two outputs. One output is fed via a square wave shaper to the digital mixer and the second output is fed to the AGC circuits.

55. The 1 MHz reference frequency derived from the frequency standard, is divided by five resulting in two 200 kHz outputs with a phase difference of 72° which are applied to the digital mixer.

56. The 400 kHz square wave and the 200 kHz inputs to the digital mixer provide two outputs from the mixer. One output is a square wave at the error frequency and the other output is d.c. up/down information. These are fed to a 12-bit synchronous binary counter which increments the up/down data at the error rate. The ten most significant outputs from the counter are connected to a 10-bit digital to analogue convertor. The analogue output is used, after buffering and level shifting, as the varactor control voltage of the 7 MHz VCO.

57. The second output from the 400 kHz buffer is detected, amplified and applied to the 1.4 MHz and 400 kHz gain controlled amplifiers and also to a pair of output distribution amplifiers. The AGC1 and AGC2 outputs are used to supplement the AGC outputs from the main (and ISB, where fitted) IF/AF boards.

58. When the AFC is switched off, the phase comparator compares the 1 MHz reference frequency derived from the frequency standard with 1 MHz derived from the 7 MHz VCO. This ensures that the 1 MHz from the AFC board is the same as the 1 MHz reference frequency from the frequency standard when the AFC is switched on.

59. The signal to noise detector is provided with an input from the AGC detector. Should the carrier level fall below a pre-determined threshold, the a.f.c. action is inhibited immediately. This holds the frequency of the 7 MHz VCO until the carrier is restored.

60. The 7 MHz output signal is applied to a divide-by-seven stage, and the final output signal, at 1 MHz plus or minus the frequency deviation, is applied to the 34 MHz generator board in place of the reference 1 MHz derived from the frequency standard.

PM369 Board (Earlier Versions) Fig. 1.6a

61. The 1.4 MHz second IF output from the carrier filter (on the filter board) is applied via an attenuator to an amplifier stage. The attenuator is controlled by the front panel AFC switch and is switched on for FULL CARRIER, off for PILOT CARRIER. The amplified 1.4 MHz carrier is fed to a crystal band-pass filter (passband 200 Hz) and is then mixed with a 1 MHz signal derived from the frequency standard. The resultant 400 kHz difference frequency output is amplified and buffered and is then applied as one input to a phase comparator.

62. The output signal from a 1.6 MHz VCO is divided by four and the resulting 400 kHz signal is applied as the second input to the phase comparator.

63. The phase comparator compares the frequency and phase of the 400 kHz input derived from the received signal with the 400 kHz input derived from the 1.6 MHz VCO. Any error between these two input signals is used to develop a d.c. voltage which is applied, via the loop amplifier, to the 1.6 MHz VCO to eliminate the error. Thus any frequency deviation in the received signal will cause a deviation in the frequency of the 1.6 MHz VCO.

64. A second output from the phase comparator is used to develop an AGC voltage which is proportional to the amplitude of the received carrier. This AGC voltage, after amplification, is applied to the 1.4 MHz amplifier stage and also to a pair of output amplifiers. The AGC1 and AGC2 outputs are used to supplement the AGC outputs from the main (and ISB, where fitted) IF/AF boards.

65. A second 400 kHz output from the divide-by-four stage is again divided, this time by 16, to provide a 25 kHz input to a digital phase comparator. The second input signal to the digital phase comparator, also at a frequency of 25 kHz, is derived from the reference 1 MHz input and a divide-by-40 stage. The digital output from the phase comparator is applied to a voltage control circuit where it is converted to a d.c. voltage, the level of which is proportional to the difference in frequency and phase of the two input signals to the phase comparator. This voltage is applied to a 7 MHz VCO via a hold switch, a narrow band loop filter and a loop amplifier.

66. The hold switch is controlled by a signal-to-noise ratio detector. Should the signal-to-noise ratio fall below a pre-determined threshold or should the carrier input to the AFC board fail, the hold switch effectively open circuits the output from the voltage control circuit, and holds the voltage level applied to the loop filter. This holds the frequency of the 7 MHz VCO until an improvement in the signal-to-noise ratio occurs or until the carrier re-appears.

67. The 7 MHz output signal is applied to a divide-by-seven stage, and the final output signal, at 1 MHz plus or minus the frequency deviation, is applied to the 34 MHz generator board in place of the reference 1 MHz derived from the frequency standard. The purpose of this 1 MHz comparison is to pre-lock the 7 MHz VCO to a nominal frequency before AFC lock is attempted.

FREQUENCY SHIFT KEYING

Fig. 1.7

68. The optional FSK board converts a frequency shift keyed signal into bipolar d.c. information suitable for operating a teleprinter or similar device. Provision is included for dual diversity operation (using a pair of receivers), with keying speeds up to 200 bauds and a frequency shift range of 85 Hz to 850 Hz.

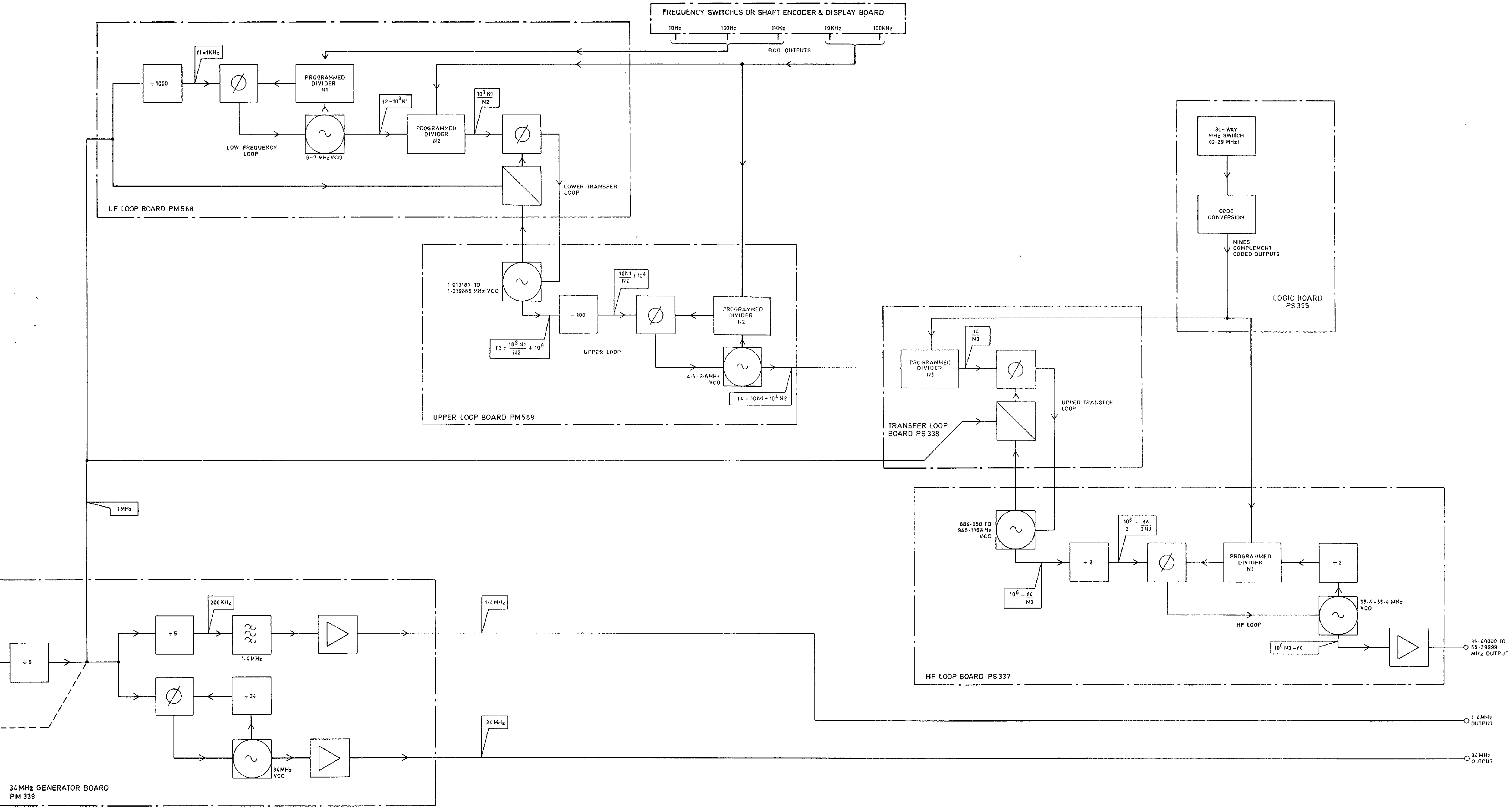
69. The 1.4 MHz IF output from the selected IF filter is applied to a mixer via a 1.4 MHz band pass filter. The second input to the mixer is a 1398 kHz signal generated by a crystal oscillator. The difference output from the mixer at 2 kHz, is clipped by a limiting amplifier and fed to a frequency discriminator consisting of two active band-pass filters and two full-wave rectifier circuits.

70. One of the active filters has a pass-band centred on 2600 Hz; the second filter pass-band is centred on 1400 Hz. The output from each filter is an amplitude modulated signal, the envelope shape of which is stepped. Both signals are full wave rectified, and then summed in a differential amplifier.

71. The output from the differential amplifier is compared with a reference voltage. The compared output is a switching FSK signal which is taken to a rear panel terminal for connection to a second receiver for diversity operation; it is also applied via a Schmitt trigger to a diversity signal comparator and switch.

72. An AGC comparator, which consists of a high-gain differential amplifier, compares the diversity AGC input (from the second receiver) with a voltage derived from the AGC output from the main IF/AF board. The output from the differential amplifier, limited by a zener diode to either +5V (approximately) or 0V, is applied to the diversity signal comparator and switch.

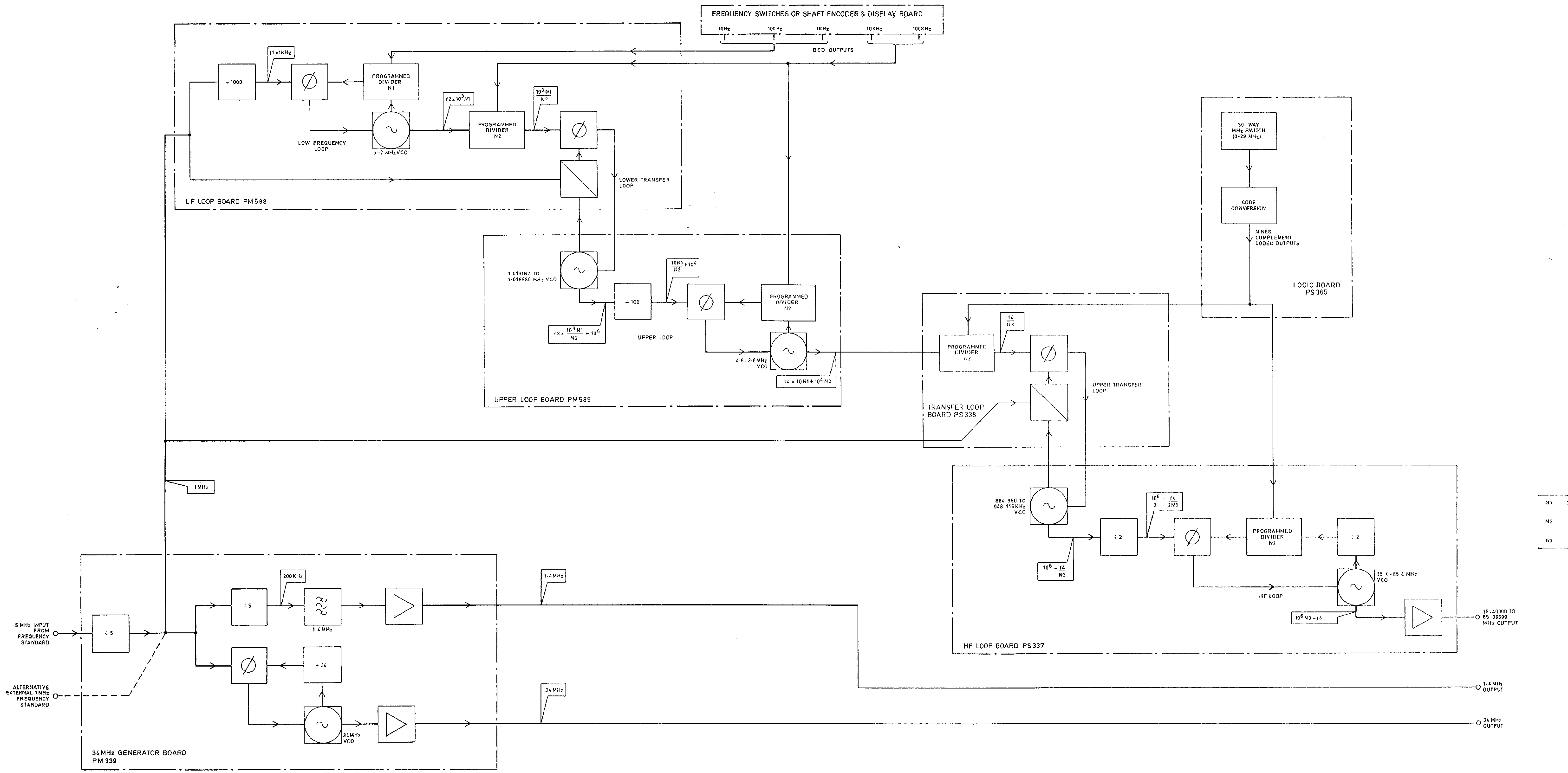
73. The diversity signal comparator and switch employs digital techniques to compare the FSK signal from the Schmitt trigger with the diversity FSK input (via a Schmitt trigger), and, in conjunction with the information obtained from the AGC comparator, opens a path for the selected FSK signal. Switching only occurs when the mark or space output signal from one receiver is coincident with that from the second receiver. This is to avoid the introduction of switching distortion. The output signal from the diversity signal comparator and switch is routed by the MODE switch-controlled on/off and normal/reverse switching circuits to the relay drive amplifier.



N1	7000 MINUS 1KHz 100Hz & 10Hz DIGITS
N2	453 MINUS 100KHz & 10KHz DIGITS
N3	40 PLUS MHz DIGITS

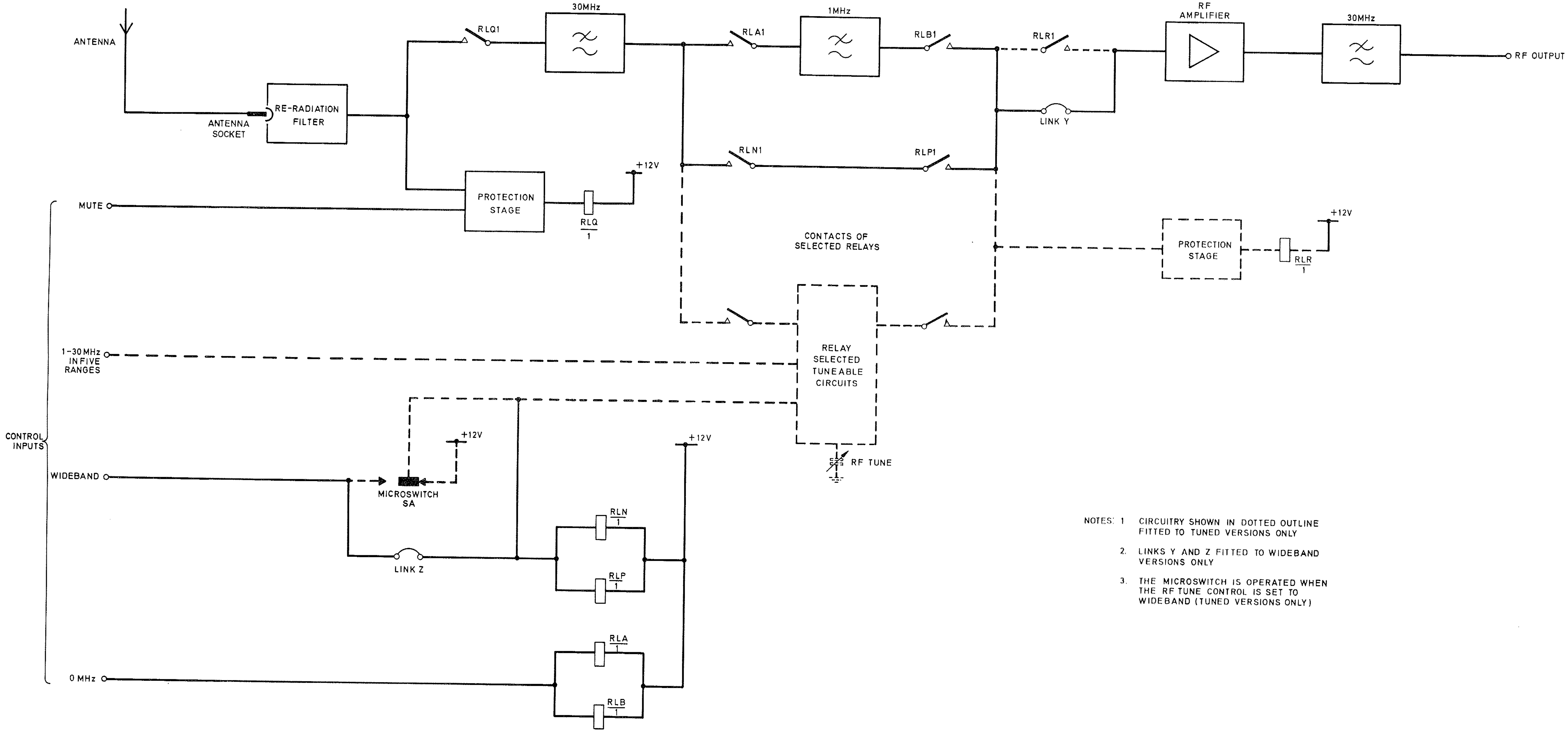
Simplified Functional Diagram: Frequency Synthesis

Fig.1.1



WOH 3078

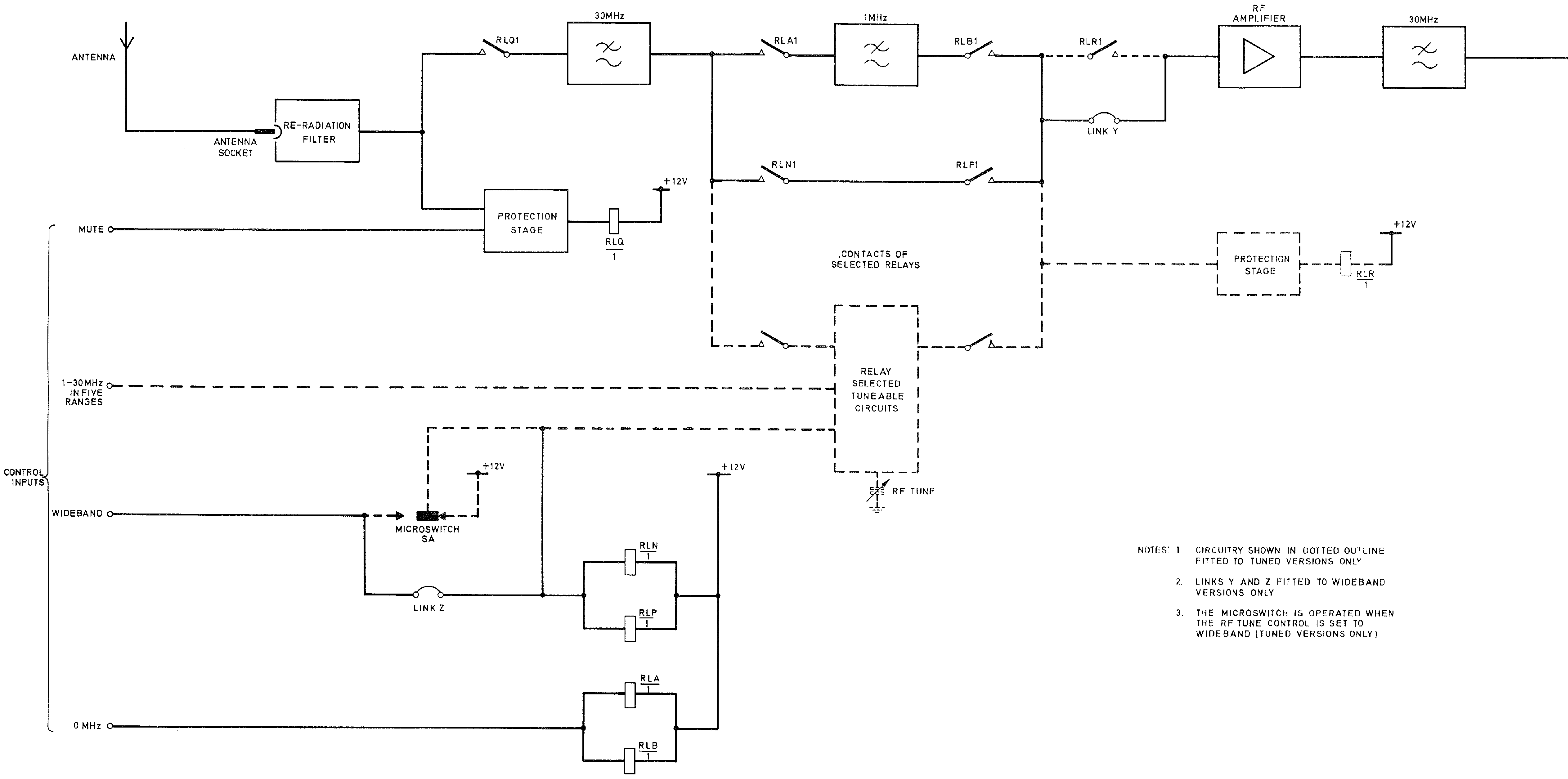
Simplified Functional Diagram: Frequency Synthesis



WOH 3076

Simplified Block Diagram: RF Unit

Fig. 1·2



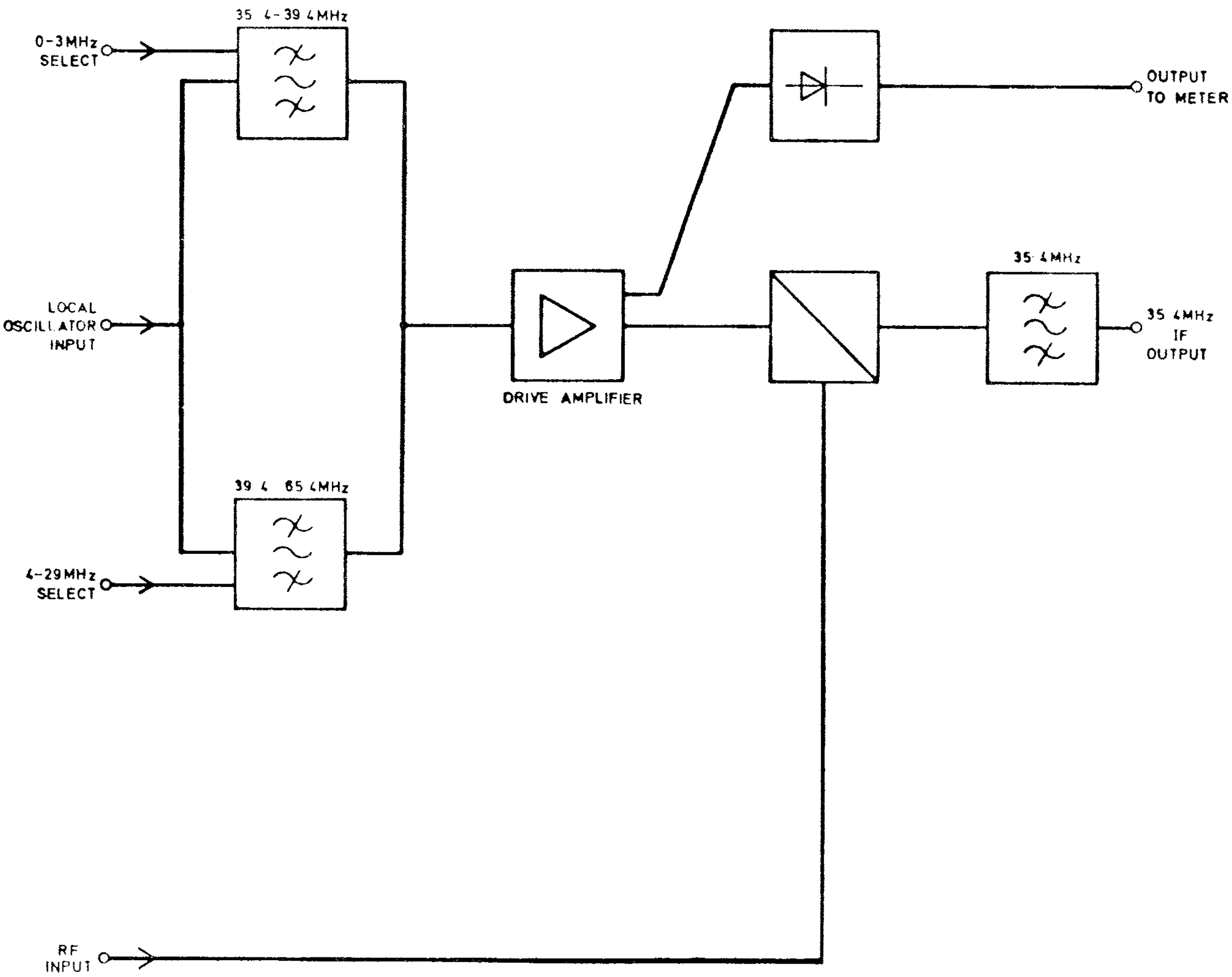
NOTES: 1 CIRCUITRY SHOWN IN DOTTED OUTLINE FITTED TO TUNED VERSIONS ONLY

2. LINKS Y AND Z FITTED TO WIDEBAND VERSIONS ONLY

3. THE MICROSWITCH IS OPERATED WHEN THE RF TUNE CONTROL IS SET TO WIDEBAND (TUNED VERSIONS ONLY)

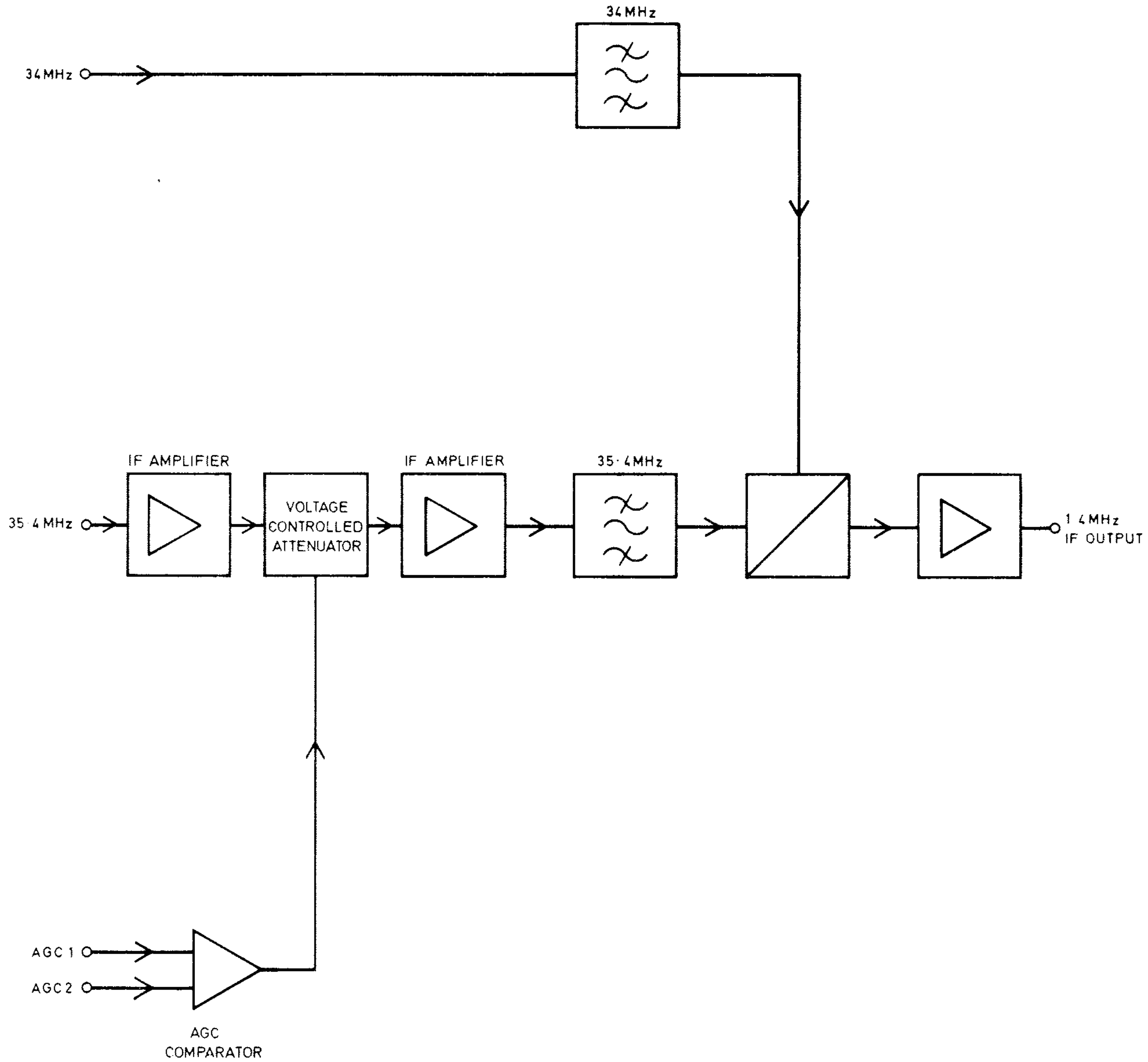
WOH 3076

Simplified Block Diagram: RF Unit



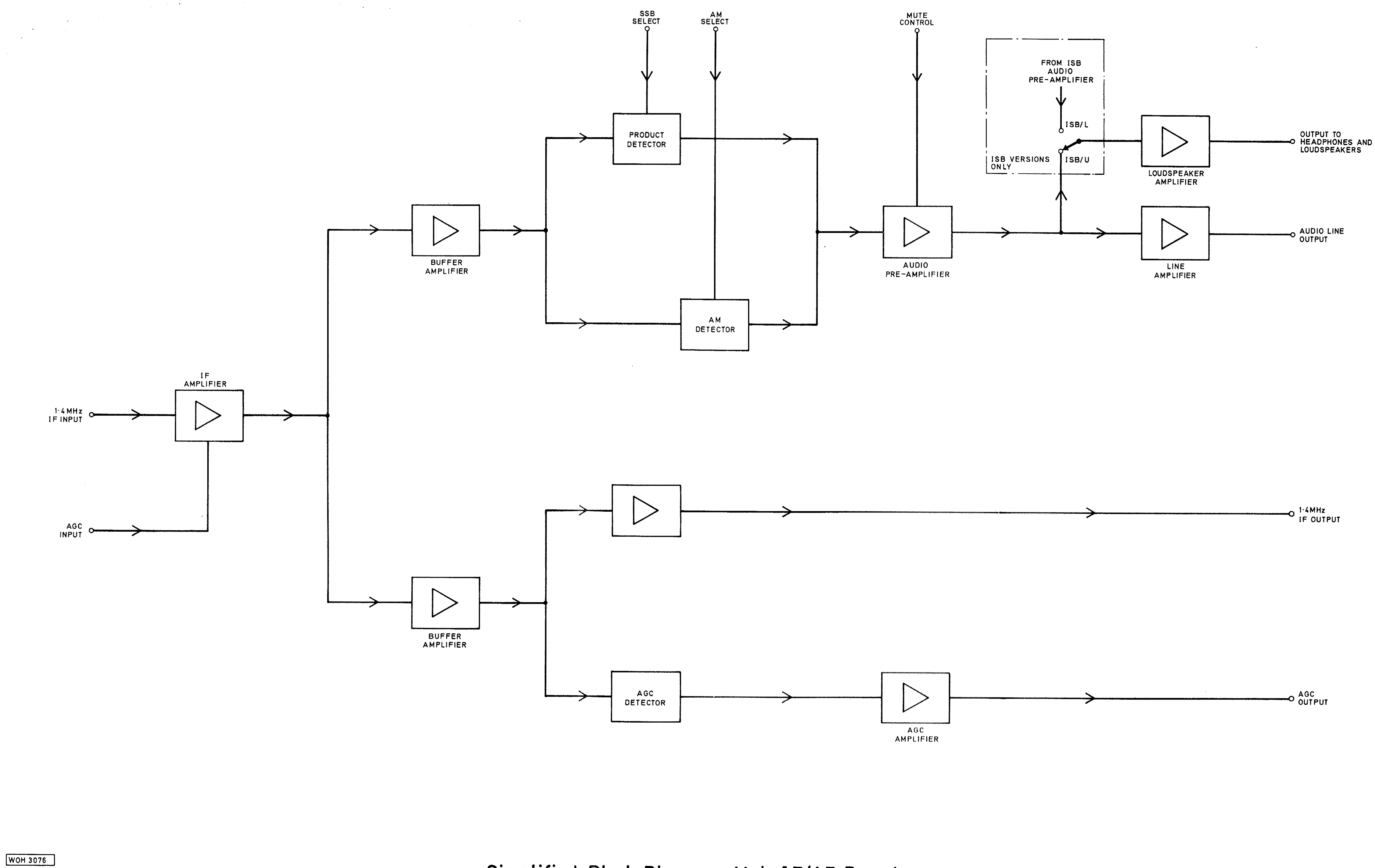
WOH 3076

Simplified Block Diagram: First Mixer PM 335 Fig. 1·3



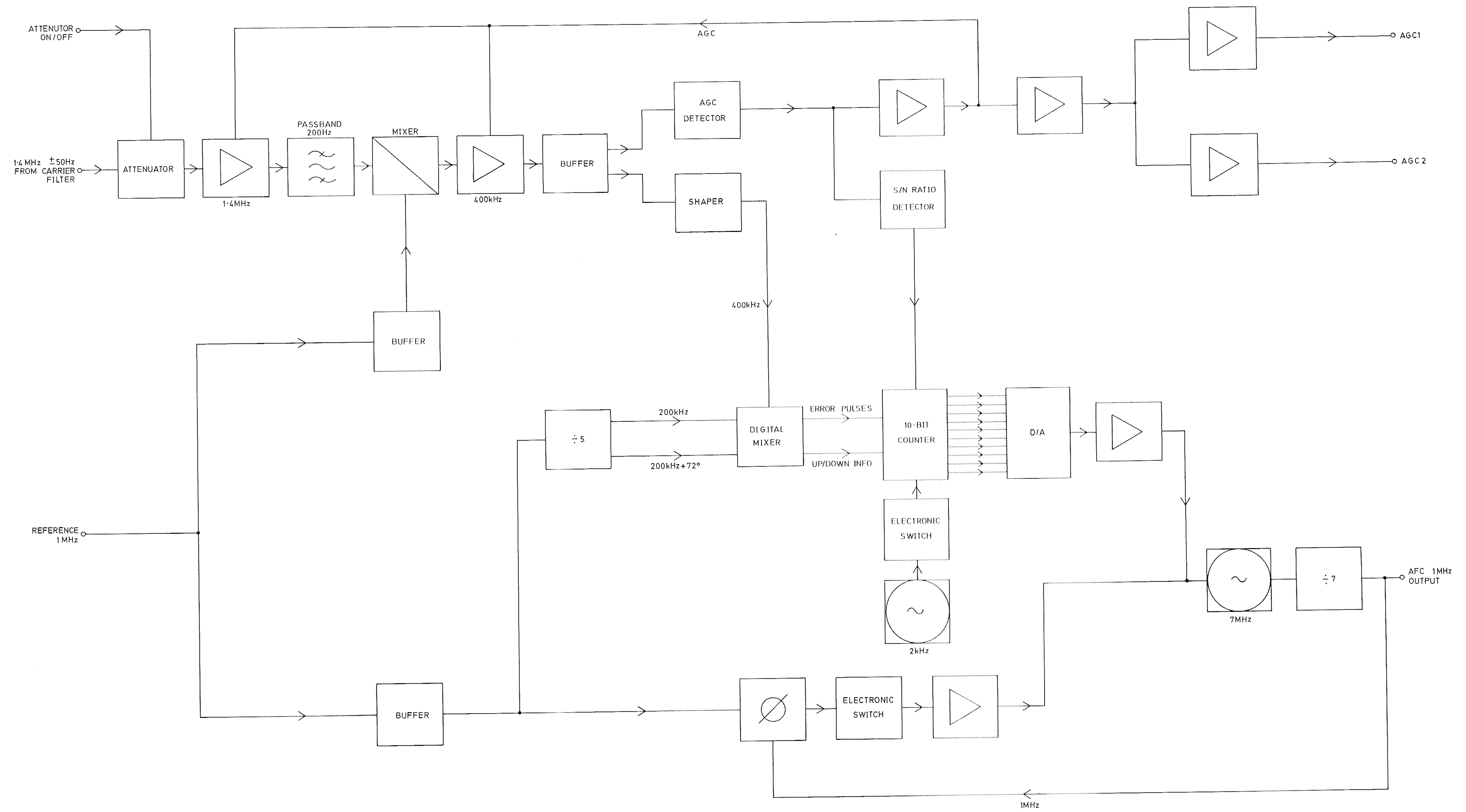
WOH 3076

Simplified Block Diagram: Second Mixer Fig. 1·4



Simplified Block Diagram: Main IF/AF Board

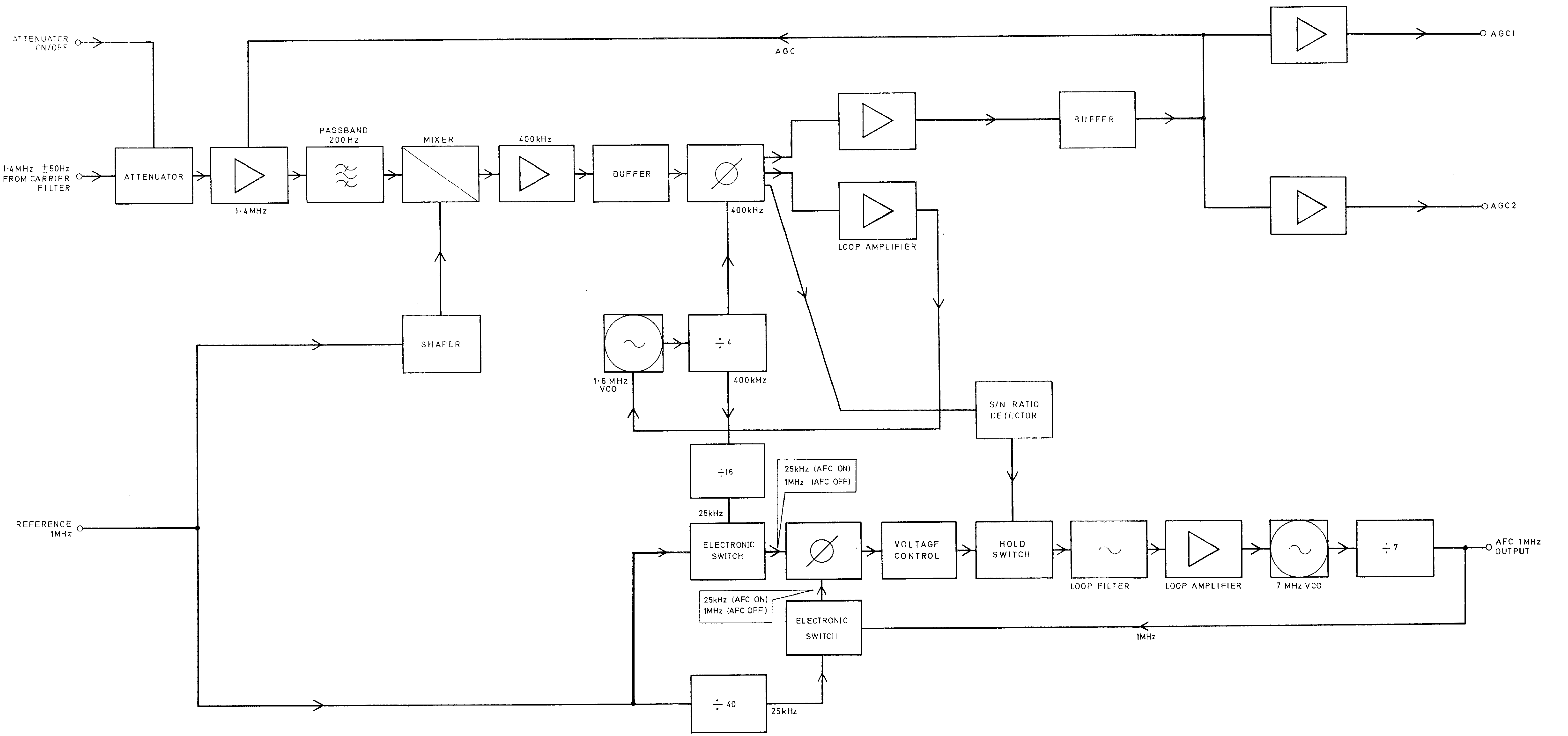
Fig. 1·5



Simplified Block Diagram :
AFC Board PM664

Fig. 1·6

WOH3076



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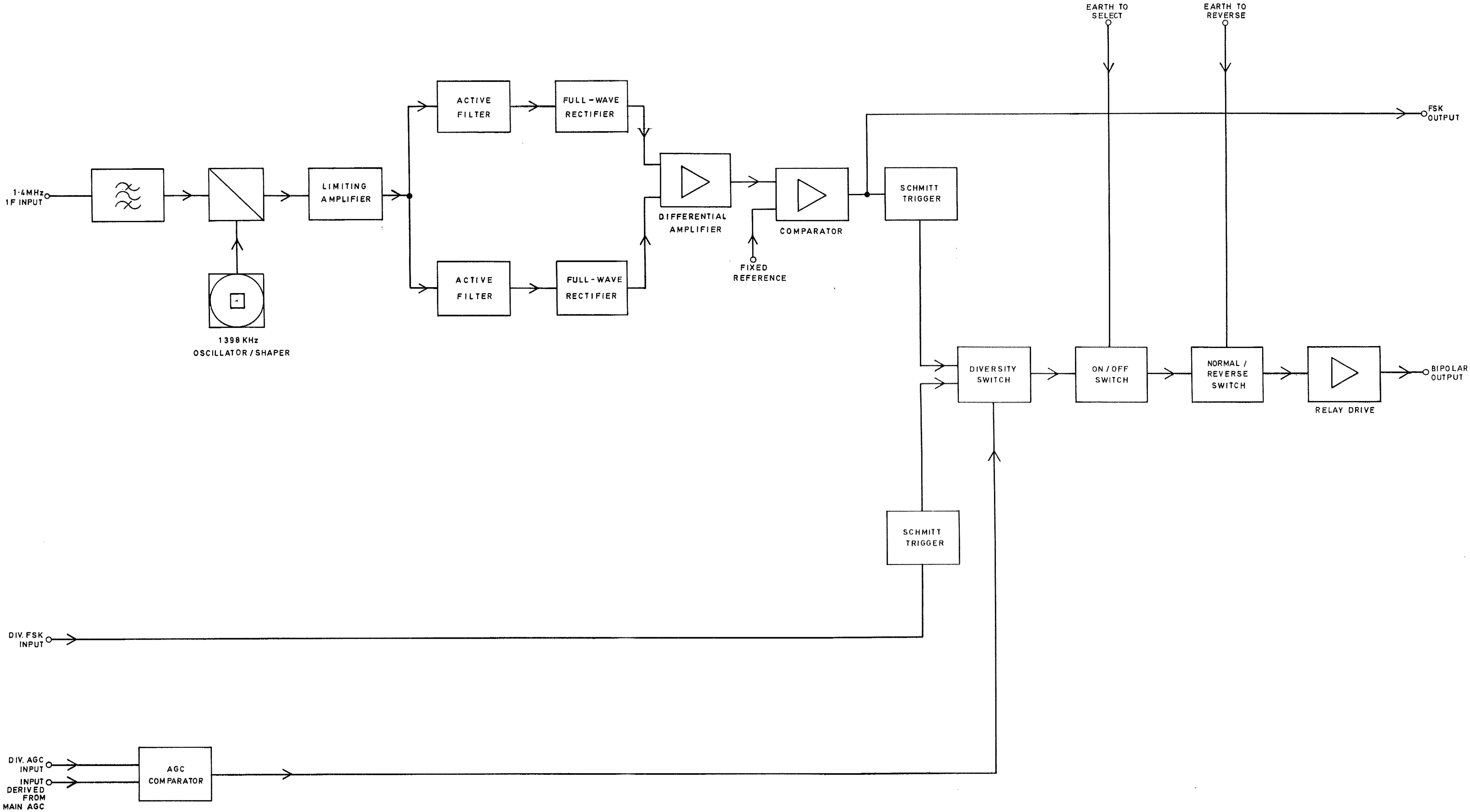
Simplified Block Diagram : AFC Board PM 369

Fig. 1·6a



WOH 3076/2

Simplified Block Diagram: FSK Board

Fig. 1·7

CHAPTER 2

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CHAPTER 2

CIRCUIT DESCRIPTION

SYNTHESIZER SECTION

LOW FREQUENCY LOOP BOARD PM588

Fig. 6

1. This board contains the low frequency loop and also the programmed divider, mixer phase comparator and lock detector circuits of the lower transfer loop; the lower transfer loop VCO is contained on the upper loop board (PM589). A block diagram of the board is given in Fig. 2.1.

6-7 MHz Voltage Controlled Oscillator

2. The 6 to 7MHz VCO for the low frequency loop consists of transistor TR1, a tuned circuit, L1, C1, C2, and a varactor diode D1; feedback is provided by the inverting gate, G1 (ML1). The square wave output signal is applied to the programmed divider, N1, and also to the programmed divider of the lower transfer loop, N2, via G8 (ML1).

Programmed Divider N1

3. The programmed divider consists of four presettable decade counters, ML3, ML5, ML6, ML10, NAND gates G2, G3, and a dual J-K flip-flop, ML11.

4. The decade counters have strobed parallel-entry capability such that the starting point of a count sequence may be preset. A '1' or a '0' at a data input (Da, Db, Dc, Dd) is transferred to the associated output (Ao, Bo, Co, Do,) when the strobe (S) input is at '0'. The counting operation is performed on the negative-going edge of the input clock pulse.

5. The division ratio of the programmed divider, which is controlled by the 1kHz, 100Hz, 10Hz digits of the selected operating frequency, is given by the expression N1 = 7000 minus the selected digits, i.e. the division ratio is 7000 for a setting of 000 and is 6001 for a setting of 999. The operation of the divider is described below.

6. Binary coded decimal (BCD) frequency setting information is applied to the data inputs of ML3 (10Hz data), ML5 (100Hz data) and ML6 (1kHz data). The Da, Dc, and Dd data inputs of ML10 are connected to the 0V line whilst the Db data input is floating and is equivalent to logic '1'. ML10, therefore, is set to start counting at binary 2.

7. To start a counting sequence, assume that a logic '0' strobe pulse is applied to the strobe (S) input of each decade counter. As described in paragraph 4, this causes the

logic level applied to each input line (Da, Db, Dc, Dd) to be transferred to the corresponding output line (Ao, Bo, Co, Do). The negative-going edge of the clock pulse (from the VCO) is applied to the clock 1 input of ML3 and each pulse is now counted until an output from the counter of 8996 is reached, i.e. untill the Do output from ML10 is at '1', the Ao and Do outputs from ML6 and ML5 are at '1', and the Bo and Co outputs from ML3 are at '1'. Since ML10 is set to start counting at 2, and since the remaining counters may be set to start counting at any number from 0 to 9, the maximum number of clock pulses that may be counted is equal to 8996 minus 2000 which equals 6996.

8. Once a count of 8996 is reached, the input lines to the NAND gate, G2 are all at logic '1' and the '0' output, inverted by G3, is applied to the K input of a dual negative-edge triggered J-K flip-flop, ML11. The operation of this flip-flop, which generates the strobe pulse for the decade counters, is given in the Timing Diagram, Figure 2.2. From this diagram it can be seen that two clock pulses elapse before the start of the strobe pulse and a further two clock pulses elapse to coincide with the end of the strobe pulse. Thus four clock pulses are counted by ML11, making a total count of 7000, i.e. 6996 + 4.

Reference Frequency Divider

9. The 1MHz input signal at board pins 45 and 46 is coupled by transformer T1 to a shaper stage, TR2; the square wave output signal from the collector of TR2 is applied to a divider consisting of three cascaded decade dividers, ML2, ML4, ML7 and the output signal, at 1000pps,is applied to one of the clock inputs of the LF loop phase comparator, ML8.

LF Loop Phase Comparator

10. The phase comparator consists of a dual D-type flip-flop, ML8, a two-input NAND gate, G4 and a voltage control circuit, TR3, TR4, TR5. It compares the output signal frequency from the programmed divider, N1, with the output signal frequency from the reference divider; any error between these two frequencies is used to develop a d.c. voltage which is applied to the 6 - 7 MHz VCO to eliminate the error. The action of the circuit is as follows.

11. The output signal from the programmed divider, N1, from ML10 pin 12, consists of positive-going pulses which are applied to the clock input of ML8b (Pin 3). The output signal from the reference divider also consists of positive-going pulses, and these are applied to the clock input of ML8a (Pin 11). The D inputs of ML8, at pins 2 and 12, are both taken to the +5V rail (logic '1') via R50. Thus when the positive edge from ML10 pin 12 clocks ML8b, the Q output at pin 5 changes to '1' and the $\overline{Q}$ output changes to '0'. Similarly, when the positive edge from the reference divider clocks ML8a, the Q output at pin 9 changes to '1' and the $\overline{Q}$ output changes to '0'. When both Q outputs are at '1' the output from the NAND gate, G4 (ML1), changes to '0' clearing both flip-flops of ML8 via R53 and thus resets the Q outputs to '0' and the $\overline{Q}$ outputs to '1'.

12. Consider the case where the 6 - 7MHz VCO frequency is high. This will mean that the positive edge from the programmed divider will occur before the positive edge from the reference divider. The resulting setting and resetting of the flip-flops causes increased conduction of TR4, due to the Q output waveform from ML8b (see Timing Diagram, Fig. 2.3) as compared with the conduction of TR5; this causes the voltage at the collector of TR4 to become less positive, thereby reducing the voltage applied to varactor diode, DI, and reducing the VCO frequency.

13. If the VCO frequency is low, the programmed divider output pulse will occur after the reference pulse, the Q output waveform from ML8a will cause increased conduction of TR5 and the voltage at the collector of TR4 will become more positive. The increased voltage applied to the varactor diode causes the VCO frequency to increase, thus correcting the error.

14. When the two signals are equal in frequency and phase the two flip-flops of ML8 are clocked at the same time, the two Q output waveforms are equal and the varactor line voltage remains constant.

LF Loop Lock Detector

15. The LF loop lock detector consists of a bistable latch, G5, G6 and an output buffer, G7. The $\bar{Q}$ outputs from the phase comparator, ML8, are connected directly to G5, and also to G6 via integrating components, R50, C19 and R51, C20. Under phase-locked conditions the in-phase negative-going $\bar{Q}$ output pulses from ML8, pins 6 and 8 ($\bar{Q}$ 1 and $\bar{Q}$ 2 of Fig. 2.3) are prevented from reaching G6 due to the time constants presented by the integrating components. Pins 1 and 2 of G6 therefore float up to logic '1' and the resulting logic '0' output, at G6 pin 12, forces the output of G5 to logic '1'. The inputs to the output buffer, G7, are connected in parallel with those of G6 and the logic '0' in-lock indication output is taken to board pin 1.

16. When an out-of-lock condition exists, the clock input waveforms applied to ML8 are no longer in phase and the resultant longer-duration negative-going output pulses from ML8 pin 6 or ML8 pin 8 (dependant on whether a phase lead or a phase lag exists) are sufficient in width to overcome the time constant presented by the respective integrating components. The effect of this is to produce an alternating '0' - '1' output signal from the buffer, G7, as shown in the timing diagram, Fig. 2.4.

Programmed Divider N2

17. This programmed divider, which forms part of the lower transfer loop, consists of three presettable decade counters, ML14, ML15, ML19, NAND gates, G10, G11, and a dual J-K flip-flop, ML20.

18. The decade counters have strobed parallel - entry capability such that the starting point of a count sequence may be preset. A '1' or a '0' at a data input (Da, Db, Dc, Dd) is transferred to the associated output (Ao, Bo, Co, Do) when the strobe (S) input is at '0'. The counting operation is performed on the negative-going edge of the input

clock pulse.

19. The division ratio of the divider is controlled by the 10kHz and 100kHz digits of the selected operating frequency and also by overspill data from the display board (RA. 1772 only) which is applied to ML19. The division ratio, without overspill, is given by the expression N2 = 453 minus selected digits; i.e. the division ratio is 453 for a setting of 00 and is 354 for a setting of 99. With overspill the division ratio is modified to cover the range 455 to 352. The operation of the divider is described below.

20. BCD frequency setting information is applied to the data inputs of ML14 (10kHz data) and ML15 (100kHz data). For the RA.1771, or the RA.1772 when not in the overspill condition, the data inputs to ML19 are all at 0V (logic '0') and under this condition ML19 starts counting at zero.

21. To start a counting sequence, assume that a logic '0' strobe pulse is applied to the strobe (S) input of each decade counter. As described in paragraph 18, this causes the logic level applied to each data input line (Da, Db, Dc, Dd) to be transferred to the corresponding output line (Ao, Bo, Co, Do). The negative-going edge of the clock pulse (the output from the LF loop via G8) is applied to the clock 1 input of ML14 and each pulse is counted until a count of 449 is reached, i.e. until the Co output from ML19 is at '1', the Co output from ML15 is at '1' and the Ao and Do outputs from ML14 are at '1'. Thus when a count of 449 is reached the four input lines to the NAND gate, G10, are at logic '1' and the resulting '0' output, inverted by G11, is applied to the K input of a dual, negative-edge triggered, J-K flip-flop, ML20. The operation of this flip-flop, which generates the strobe pulse for the decade counters, is given in the timing diagram, Fig. 2.5. From this diagram it can be seen that two clock pulses elapse before the start of the strobe pulse and a further two clock pulses elapse to coincide with the end of the strobe pulse. Thus four clock pulses are counted by ML20, making a total count of 453, i.e. 449 + 4, before the start of the next sequence.

Mixer Stage

22. ML13 is an integrated circuit mixer where the 1MHz square wave from TR2 is applied to the carrier input, pin 8, and the 1.013 - 1.020MHz output from the lower transfer loop oscillator is applied to the signal input, pin 1. The output signal from the mixer, at pin 6, is applied to a low-pass filter, C27, C28, L3, which selects the difference frequency. The filter is followed by a buffer stage, TR19, and an output shaper, G9, which is fed from a voltage regulator consisting of TR20 and a 5.6V zener diode, D3; the square-wave output from G9 is applied to the lower transfer loop phase comparator.

Lower Transfer Loop Phase Comparator

23. The phase comparator consists of a dual D-type flip-flop, ML16, NAND gate, G15, and a voltage control circuit, TR21, TR22, TR23. It compares the output signal frequency from the mixer with the output signal frequency from the programmed divider N2; any error between these two frequencies is used to develop a d.c. voltage which is applied to the lower transfer loop oscillator to eliminate the error. The action of the circuit is described below.

24. The output signal from the programmed divider, at ML20 pin 3, consists of negative-going pulses which are applied to the clock input of ML16b (pin 11). The output signal from the mixer via ML17 pin 6 is applied to the clock input of ML16a (pin 3). The D inputs of ML16, at pins 2 and 12, are both taken to the +5V (logic '1') via R66. Thus when the positive edge from ML20 pin 3 clocks ML16b, the Q output at pin 9 changes to '1' and the $\overline{Q}$ output at pin 8 changes to '0'. Similarly, when the positive edge from ML17 pin 6 clocks ML16a, the Q output at pin 5 changes to '1' and the $\overline{Q}$ output at pin 6 changes to '0'. When both Q outputs are at '1' the output from the NAND gate, G15, changes to '0' clearing both flip-flops of ML16 via R74 and thus resets the Q outputs to '0' and the $\overline{Q}$ outputs to '1'.

25. Consider the case where the output frequency from the mixer is high (due to an increase in the frequency of the lower transfer loop oscillator). This will mean that the positive edge from the programmed divider will occur after the positive edge from the mixer. The resulting setting and resetting of the flip-flops causes increased conduction of TR23, due to the Q output waveform from ML16a (see timing diagram, Fig. 2.3), as compared with the conduction of TR21; this causes the voltage at the collector of TR23 to become less positive, thereby reducing the voltage applied to the varactor diode of the lower transfer loop oscillator. This causes a reduction in the oscillator frequency and a corresponding decrease in the output frequency from the mixer.

26. If the mixer output frequency is low (due to a decrease in the frequency of the lower transfer loop oscillator), the positive edge from the programmed divider will occur before the edge from the mixer, the Q output waveform from ML16b will cause increased conduction of TR21 and the voltage at the collector of TR23 will become more positive. The increased voltage applied to the varactor diode of the lower transfer loop oscillator causes an increase in the oscillator frequency and a corresponding increase in the output frequency from the mixer.

27. When the two signals are equal in frequency and phase the two flip-flops of ML16 are clocked at the same time, the two Q output waveforms are equal and the varactor line voltage remains constant.

Lower Transfer Loop Lock Detector

28. This consists of a bistable latch, G12, G13, and an output buffer, G14. It is fed from the $\overline{Q}$ outputs of the phase comparator flip-flop, ML16, and produces a steady logic '0' in-lock signal or an alternating '0' - '1' out-of-lock signal at board pin 42. The action of the circuit, which is identical to that of the LF loop lock detector (paragraph 15) is depicted in the timing diagram, Fig. 2.4.

UPPER LOOP BOARD PM589   Fig. 8

29. This board contains the upper loop, the lower transfer loop VCO and also a lock indicator circuit; a block diagram of the board is given in Figure 2.6.

Lower Transfer Loop VCO

30. This voltage controlled oscillator/shaper stage TR5, TR6, produces a square-wave output signal in the frequency range 1.013 to 1.020 MHz. The tuned circuit comprises L4, capacitor C10, C11, C13, and a varactor diode, D4; positive feedback is applied to the tuned circuit via R14. TR4 and 5.6V Zener diode D3 provide supply voltage stabilization.

31. The oscillator output signal to the mixer stage of the lower transfer loop (PM588) is taken from the emitter of TR5 and is fed to board pin 8 via C12; the varactor line input, from PM588, is applied to D4 via board pin 7 and inductor L5.

32. The lower transfer loop VCO output signal is taken from the collector of TR6 and may be monitored at TP1; it is applied to the lower loop phase comparator via a fixed divider stage ML4, ML6.

Upper Loop VCO/Shaper

33. This VCO/Shaper stage comprises emitter followers, TR19, TR2, inverting NAND gate, G1, and a tuned circuit, L1, C2, C3, and varactor diode, D2. Supply voltage stabilization is provided by TR1 and 5.6V Zener diode, D1. The oscillator output signal, in the frequency range 4.6 to 3.6MHz, is applied to the following:-

(1) The upper transfer loop board (PS338) via a NAND gate, G2, a filter R4, L2, C5, a tuned circuit, T1, C1, and board pins 1 and 2.

(2) The programmed divider, N2, of the upper loop via a NAND gate G3.

(3) ML8a (Pin 11), which forms part of the strobe pulse generator for the programmed divider, N2.

Programmed Divider N2.

34. The upper loop programmed divider, which has the same division ratio, N2, as that of the lower transfer loop, consists of three presettable decade counters, ML2, ML3, ML5, NAND gate, G4, and a D-type flip-flop, ML8a.

35. The decade counters have strobed parallel - entry capability such that the starting point of a count sequence may be preset. A '1' or a '0' at a data input (Da, Db, Dc, Dd) is transferred to the associated output (Ao, Bo, Co, Do) when the strobe (S) input is at '0'. The counting operation is performed on the negative-going edge of the input clock pulse.

36. The division ratio of the divider is controlled by the 10kHz and 100kHz digits of the selected operating frequency and also by the overspill data from the display board (RA.1772 only), which is applied to ML5. The division ratio, without overspill, is given by the expression N2 = 453 minus selected digits, i.e. the division ratio is 453 for a setting of 00 and is 354 from a setting of 99. With overspill the division ratio is modified

to cover the range 455 to 352. The operation of the divider is described below.

37. BCD frequency setting information is applied to the data inputs of ML2 (10kHz) and ML3 (100kHz). For the RA.1771, or the RA1772 when not in the overspill condition, the data inputs to ML5 are all at 0V (logic '0') and under this condition ML5 starts counting at zero.

38. To start a counting sequence, assume that a logic '0' strobe pulse is applied to the strobe (S) input of each decade counter. As described in paragraph 35, this causes the logic level applied to each data input line (Da, Db, Dc, Dd) to be transferred to the corresponding output line (Ao, Bo, Co, Do). The negative-going edge of the clock pulse (the 4.6 - 3.6MHz VCO output via G3) is applied to the clock 1 input of ML2 and each clock pulse is counted until a count of 451 is reached, i.e. until the Co output from ML5 is at '1', the Ao and Co outputs from ML3 are at '1', and the Ao output from ML2 is at '1'. Thus when a count of 451 is reached, the four input lines to NAND gate G4 are at logic '1', and the output from G4, which is applied to the D input of flip-flop ML8a (pin 12), changes to '0'. The next clock pulse to arrive at ML8 pin 11 transfers the logic '0' at ML8 pin 12 to the Q output at pin 9, and this is applied as the strobe pulse to the three decade counters. The four input lines to the NAND gate, G4, are now no longer at logic '1' and the D input of ML8a changes to '1'. The next clock pulse to arrive at ML8 pin 11 transfers the logic '1' at ML8 pin 12 to the Q output at pin 9, the '0' strobe pulse is removed, and the counter is ready to start the next count sequence. Thus two clock pulses are used to generate the strobe pulse, making a total count of 453, i.e. 451 + 2.

Range Blanking

39. The range blanking input, at board pin 11 (RA1772 only), is used to momentarily inhibit the two inputs to the upper loop phase comparator when, during receiver tuning, a 9-to-0 or a 0-to-9 transition of the 10kHz digit occurs. This allows the LF and lower transfer loop outputs to run up or down to the new frequency whilst the 3.6 to 4.6MHz VCO is prevented from changing frequency.

40. The range blanking input line, which is normally at approximately +5V (logic '1'), is connected to the D (pin 12) and clear (pin 13) inputs of a D-type flip-flop, ML9a. This provides the required logic '1' to the D inputs of the phase comparator, ML8b, ML9b. The logic '0' 25 millisecond range blanking pulse, from the display board, clears ML9a and forces the Q output, at ML9 pin 9, to '0'. This is applied to the D inputs of the phase comparator and also to the clear input of the strobe pulse generator flip-flop, ML8a. Thus a 25 millisecond strobe pulse, from ML8 pin 9, is applied to the programmed divider, N2, and the output is inhibited.

Fixed Divider

41. The fixed divider consists of two decade counters, ML4, ML6, connected in cascade. The lower transfer VCO output signal is applied to the A input of ML4 and the divide-by-100 output is taken from ML6 pin 11; this is applied as the clock input to the phase comparator (ML9b pin 3) and may be monitored at TP3.

Phase Comparator

42. The phase comparator consists of two D-type flip-flops, ML8b, ML9b, NAND gate, G5, and a voltage control circuit, TR16, TR17, TR18. It compares the output signal frequency from the programmed divider with the output signal frequency from the fixed divider; any error between these two frequencies is used to develop a d.c. voltage which is applied to the 3.6 to 4.6MHz VCO to eliminate the error. The action of the circuit is as follows.

43. The output from the programmed divider, at ML8 pin 8, consists of positive-going pulses which are applied to the clock input of ML8b (pin 3). The output from the fixed divider, at ML6 pin 11, also consists of positive going pulses and these are applied to the clock input of ML9b (pin 3). The D inputs of both ML8b and ML9b are at logic '1' (see paragraph 40). Thus when the positive edge from ML8a pin 8 clocks ML8b, the Q output at pin 5 changes to '1' and the $\overline{Q}$ output at pin 6 changes to '0'. Similarly, when the positive edge from ML6 pin 11 clocks ML9b, the Q output at pin 5 changes to '1' and the $\overline{Q}$ output at pin 6 changes to '0'. When both Q outputs are at '1', the output from the NAND gate, G5, changes to '0', clearing both ML8b and ML9b; thus the Q outputs are reset to '0' and the $\overline{Q}$ outputs are reset to '1'.

44. Consider the case where the frequency from the programmed divider is high. This will mean that the positive edge from ML8a pin 8 will occur before the positive edge from ML6 pin 11. The resultant setting and resetting of the flip-flop causes increased conduction of TR18, due to the Q output waveform from ML8b (see Q1 on Timing Diagram Fig. 2.3), as compared with the conduction of TR16; this causes the voltage at the collector of TR18 to become less positive, thereby causing a reduction in the voltage applied to the varactor diode, D2, of the 3.6 to 4.6 MHz VCO, and a corresponding reduction in the VCO frequency.

45. If the output frequency from the programmed divider is low, the positive edge from ML8a pin 8 will occur after the positive edge from ML6 pin 11, the Q output waveform from ML9b pin 5 will cause increased conduction of TR16 and the voltage at the collector of TR18 will become more positive. The resultant increase in the voltage applied to the varactor diode, D2, causes a corresponding increase in the VCO frequency, thus correcting the error.

46. When the two signals are equal in frequency and phase the two comparator flip-flops are clocked at the same time, the two Q output waveforms are equal and the varactor line voltage remains constant.

Lock Detector

47. This consists of a bistable latch, G6, G7, and an output buffer, G8. It is fed from the $\overline{Q}$ outputs of the phase comparator flip-flops, ML8b, ML9b, and produces a steady '0' in-lock signal, or an alternating '0' - '1' out-of-lock signal, at ML11 pin 8. The action of the circuit, which is identical to that of the LF loop lock detector (paragraph 15), is depicted in the Timing Diagram, Fig. 2.4.

Lock Indicator

48. The lock indicator consists of five NAND gates, G9 to G13 inclusive. The lock detector outputs from the LF and lower transfer loops are applied to G10 and G9 via board pins 13 and 14 respectively, whilst the upper loop lock detector output, at ML11 pin 8, is applied to G11. The output from G13 ('1' for in-lock, '0' for out-of-lock) is applied to a diode OR gate and the out-of-lock indicator lamp driver on the display board (RA.1772) or the out-of-lock board (RA.1771).

TRANSFER LOOP BOARD PS338

Fig. 10

49. The transfer loop board contains the upper transfer loop (with the exception of the upper transfer loop oscillator which is located on the HF loop board PS337), programmed divider N3 and lock indicator circuits. This board, together with HF loop board, generates the 35.4 to 65.4MHz local oscillator injection frequency for the first mixer. A block diagram of the two boards is given in Fig. 2.7.

50. The 4.6 to 3.6MHz output signal from upper loop, at board pin 17, is coupled by C3 to a shaper stage, TR4, TR5. The squarewave output is inverted by ML4a and is then applied to a programmed divider consisting of two presettable decade counters, ML1, ML2, and inverter, ML4b, a six-input NAND gate, ML5 and a D-type flip-flop, ML6.

Programmed Divider N3

51. The two decade counters, ML1, ML2, have strobed parallel-entry capability so that the starting point of a count sequence may be preset. A '1' or a '0' at a data input (Da, Db, Dc, Dd) is transferred to the associated output (Ao, Bo, Co, Do) when the strobe (S) input is at '0'. The counting operation is performed on the negative-going edge of the input clock pulse.

52. The division ratio of the programmed divider, which is controlled by the front panel MHz switch, is given by the expression N3 = 40+ selected MHz digits, ie, when 00MHz is selected, the division ratio is 40, and when 29MHz is selected, the division ratio is 69. The operation of the divider is described below.

53 Information from the front panel 30-way MHz switch is applied to the logic board where it is converted into a BCD nines complement code (see Table 1). The nines complement coded outputs from the logic board are applied to the data inputs of the two decade counters, 'units' to ML1 and 'tens' to ML2, and preset the starting point of a count sequence.

54. To start the counting sequence, assume that a logic '0' strobe pulse is applied to the strobe (S) inputs of both ML1 and ML2 (at pin 1). As described in paragraph 51, this causes the logic level applied to each input line (Da, Db, Dc, Dd) to be transferred to the corresponding output line (Ao, Bo, Co, Do). The negative going edge of the clock pulse (from the shaper stage, TR4, TR5 and the inverter ML4a) is now applied to the clock 1 input of ML1 at pin 8. Each clock pulse is now counted until a count of 37 is reached, i.e. until

the Ao, Bo and Co outputs from ML1 and the Ao and Bo outputs from ML2 are all at logic '1'. (The C output from ML2 is applied to an inverter, ML4b, to inhibit binary 7).

55. When a count of 37 is reached, the input lines to the NAND gate, ML5, are all at logic '1' and the '0' output, at ML5 pin 8, is applied to the D input of flip-flop ML6. The next clock pulse, which is applied to pin 3 of ML6, transfers the '0' at ML6 pin 2 to the Q output, at ML6 pin 5, and this is applied as the next strobe pulse to the two decade counters, ML1 and ML2, ready for the next count. The output from ML5 changes to logic '1' and the next clock pulse applied to ML6 causes the Q output to change to logic 1; this output is applied to the phase comparator, ML8.

56. Table 2 shows the operation of the divider for various settings of the MHz switch.

Mixer

57. ML3 is an integrated circuit mixer; the 1MHz reference frequency signal, shaped by TR1, TR2, is applied to pin 8 and the 885-948kHz transfer loop oscillator output signal, from the HF loop board, buffered by TR3, is applied to pin 4 via a low-pass filter, L9, L10, C29 to C32. The difference frequency output from the mixer, 115kHz to 52kHz, is coupled to a low-pass filter, L11, L12, C36, C38, C39, and is then applied to a shaper stage, TR6. The squarewave output from TR6 is applied to the phase comparator, ML8 via a buffer, ML7a.

Phase Comparator

58. The phase comparator consists of a dual D-type flip-flop, ML8, a two-input NAND gate, ML7b and a voltage control circuit, TR7, TR8, TR9, TR10. It compares the output signal frequency from the programmed divider with the output signal frequency from the mixer; any error between these two frequencies is used to develop a d.c. voltage, which is applied to the transfer loop oscillator (on the HF loop board) to eliminate the error. The action of the circuit is as follows.

59. The output from the programmed divider, at ML6 pin 5, consists of negative-going pulses; these are applied to the clock input of ML8b. The output from the mixer (via the low-pass filter, shaper and buffer), at ML7a pin 8, is applied to the clock input of ML8a. The D inputs to both ML8a and ML8b are taken to the +5V rail (logic '1'). Thus when the positive edge from ML6 pin 5 clocks ML8b, the Q2 output at pin 5 changes to '1' and the $\bar{Q}2$ output changes to '0'. Similarly, when the positive edge from ML7a pin 8 clocks ML8a, the Q1 output changes to '1' and the $\bar{Q}1$ output changes to '0'. When both Q outputs are at '1', the output from the NAND gate, ML7b, changes to '0', clearing both ML8 flip-flops via R38 and thus resetting the Q outputs to '0' and the $\bar{Q}$ outputs to '1'.

60. Consider the case where the frequency of the mixer output signal is high. This will mean that the positive edge from ML7a will occur before the edge from ML6. The resultant setting and resetting of the flip-flops causes increased conduction of TR7, due to the $\bar{Q}1$ output from ML8a (see timing diagram, Fig. 2.3), as compared with the conduction of TR10; this causes the voltage of the collector of TR9 to become more positive,

Decimal	BCD				Nines Complement				Decimal
	D	C	B	A	D9	C9	B9	A9	
0	0	0	0	0	1	0	0	1	9
1	0	0	0	1	1	0	0	0	8
2	0	0	1	0	0	1	1	1	7
3	0	0	1	1	0	1	1	0	6
4	0	1	0	0	0	1	0	1	5
5	0	1	0	1	0	1	0	0	4
6	0	1	1	0	0	0	1	1	3
7	0	1	1	1	0	0	1	0	2
8	1	0	0	0	0	0	0	1	1
9	1	0	0	1	0	0	0	0	0

Table 1: Code Conversion

'MHz' setting	Nines Comple-ment	Clock Pulses				
		Count up to 100	Fixed Count	Strobe Pulse Begin	Strobe Pulse End	Total Division ratio
00	99	1	37	1	1	40
07	92	8	37	1	1	47
14	85	15	37	1	1	54
21	78	22	37	1	1	61
29	70	30	37	1	1	69

Table 2: Programmed Divider Operation (PS338)

thereby increasing the varactor line voltage applied to the transfer loop oscillator on the HF loop board. This increases the oscillator frequency, but since this frequency is subtracted from the reference 1MHz in the mixer, ML3, the output frequency from the mixer is reduced.

61. If the mixer output signal frequency is low, the pulse from ML7a will occur after the pulse from ML6, the $\overline{Q}$ 2 output waveform from ML8b will cause increased conduction of TR10 and the voltage at the collector of TR9 will become less positive. Thus the reduced varactor line voltage applied to the transfer loop oscillator causes a reduction in oscillator frequency and a corresponding increase in the mixer output signal frequency.

62. When the two frequencies are in phase, the two flip-flops of ML8 are clocked at the same time, the $\overline{Q}$ 1 output waveform is equal to the $\overline{Q}$ 2 output waveform and the varactor line voltage remains constant.

Lock Indicator and Fast Lock Circuit

63. This circuit comprises two monostables, ML9, ML10, a dual D-type flip-flop, ML11, and NAND gates ML4c, ML4d. Its purpose is to augment the conduction of TR7 or TR10 in the out-of-lock condition and so obtain a faster return to the locked condition; it also provides a lock indication output signal. The action of the circuit is as follows.

64. The Q output from the phase comparator flip-flop, ML8a, is applied to the B input (Schmitt trigger) of the monostable, ML9, and also to the D and clear inputs of a D-type flip-flop, ML11a. Similarly, the Q output from ML8b is applied to the B input of the monostable, ML10, and also to the D and clear inputs of a second D-type flip-flop, ML11b. The two monostables, triggered when positive going signals are applied to the respective B inputs, each produce a negative going output pulse ($\overline{Q}$), of approximately 1.5μs duration.

65. From the timing diagram, Fig. 2.8, it will be seen that for the in-lock condition, the $\overline{Q}$ outputs from the two flip-flops, ML11a, ML11b, are both at logic '1'; these two signals do not, however, affect the conduction of the voltage control transistors, TR7, TR10, due to the presence of the two diodes, D2, D3. The logic '0' output from ML4c is inverted by ML4d to produce a logic '1' in-lock signal at board pin 6.

66. If the output frequency from the mixer is low, as depicted by the out-of-lock waveform of Fig. 2.8, the negative excursion of the $\overline{Q}$ output from ML11b will be applied to TR10, via diode D3. The conduction of TR10 will, therefore, be rapidly increased to bring about a fast return to the in-lock condition. The $\overline{Q}$ output waveform from ML11b is also applied to ML4c to produce an alternating '0' - '1' out-of-lock signal at board pin 6.

67. Should the out-of-lock condition be due to a high mixer output frequency the $\overline{Q}$ output from ML11a will cause a rapid return to the in-lock condition by increasing the conduction of TR7; the $\overline{Q}$ output from ML11a is also applied to ML4c to produce an alternating '0' - '1' out-of-lock signal at board pin 6, as before.

HF LOOP BOARD PS337

Fig. 12

68. This board provides the 35.4 - 65.4MHz local oscillator frequency for the first mixer; it also contains the 885-948kHz upper transfer loop oscillator. The block diagram of the HF loop board, together with the upper transfer loop board, is given in Fig. 2.7.

Upper Transfer Loop Oscillator

69. Transistors TR17 and TR20, together with associated components, form a variable frequency LC oscillator, tunable by the voltage applied to the varactor diode D19. The varactor line voltage at pin 18, from the transfer loop board, is applied to D19 via a filter, C66, C67, R62, C69 and L19.

70. The oscillator output signal, at the collector of TR20, is applied to the clock input of a divide-by-two stage, ML12; the output from ML12, at pin 5, is applied as one signal input to the phase comparator, ML7.

71. A second output from the oscillator is coupled by C76 to a buffer amplifier, TR21, the output from which is applied to the mixer on the transfer loop board, via C81 and pin 13.

HF Loop Oscillators

72. Three separate, switched oscillators are provided to cover the frequency range 35.40000 to 65.39999 MHz. Oscillator selection is controlled by the 30-way MHz switch on the front panel of the receiver; an earth (0V) is connected to the appropriate switching transistor, TR1, TR2 or TR3 (via pins 28, 27 or 26 respectively) and the supply voltage to the selected oscillator is switched on. The oscillator selected is in accordance with the table below.

OSCILLATOR	FREQUENCY RANGE (MHz)	MHz SWITCH SETTING
1	35.40000 to 43.9999	0 to 7
2	43.40000 to 53.9999	8 to 17
3	53.40000 to 65.39999	18 to 29

73. The three oscillators are similar in construction and operation. Frequency is controlled by the voltage applied to a pair of varactor diodes; this voltage, derived by the phase comparator, is applied via a common line and an inductor (L21, L22, L23) to each oscillator. The gain of the selected oscillator stage is automatically controlled by peak-detecting diodes D13, D14, and the current source transistor, TR13; the automatic

gain control (AGC) level is preset by R38.

74. The output from the selected oscillator transistor and associated buffer (TR7, TR8 or TR9) is amplified by TR10 and applied to:-

(a) The AGC stage, TR13, via C26.

(b) A programmed divider, via C24.

(c) A pair of output buffer amplifier stages, TR14, TR15, via C36.

75. Details of the three oscillator stages are tabulated below.

OSCILLATOR NUMBER	VOLTAGE SWITCH	OSCILLATOR CIRCUIT	OUTPUT BUFFER
1	TR3	TR6, D8, D9, L6	TR9
2	TR2	TR5, D6, D7, L5	TR8
3	TR1	TR4, D4, D5, L4	TR7

LO Output Buffer Stages

76. The output buffer amplifier stages, TR14, TR15, are conventional and are of similar design; stage gain is preset by potentiometers R44 (for TR14) and R50 (for TR15). The amplified outputs are fed to a diode switch, D16, D17, D18, which is controlled by the rear panel LO INT/EXT switch. When this switch is set to EXT, an earth (0V) is connected to board pin 25; this causes diodes D16 and D17 to become reversed biassed, and diode D18 to become forward biassed. The outputs from the two buffer stages are inhibited and an external LO signal (from a second receiver), connected to the rear panel LO IN/OUT socket, is routed to board pin 24 and thence via C57, D18, C58 and pin 22 to the first mixer board.

77. When the LO INT/EXT switch is set to INT, the earth is removed from board pin 25; diodes D16, D17 are now forward biassed and diode D18 is reverse biassed. The output signal from TR14 is routed to the first mixer board via C44, D16, C58 and board pin 22; the output signal from TR15 is routed to the rear panel LO IN/OUT socket via C54, D17, C57 and board pin 24.

Programmed Divider N3

78. The programmed divider, which is set to the same division ratio, N3, as that of the upper transfer loop board programmed divider, consists of a shaper stage, TR11, TR12, a divide-by-two stage, ML2a, two presettable decade counters, ML3, ML5, with associated gates, and three J-K flip-flops, ML2b, ML9a, ML9b.

79. The two decade counters, ML3, ML5, have strobed parallel-entry capability such that the starting point of a count sequence may be preset. A '1' or '0' at a data input (Da, Db, Dc, Dd) is transferred to the associated output (Ao, Bo, Co, Do) when the strobe (S) input is at '0'. The counting operation is performed on the negative-going edge of the input clock pulse.

80. The division ratio of the programmed divider, which is controlled by the front panel MHz switch, is given by the expression N3 = 40+ selected MHz digits, ie. when 00MHz is selected, the division ratio is 40, and when 29MHz is selected, the division radio is 69. The operation of the divider is described below.

81. Frequency setting information from the front panel 30-way MHz switch is applied to the logic board where it is converted into a nines complement code (see Table 1). The nines complement coded outputs from the logic board are applied to the data inputs of the two decade counters, 'units' to ML3 and 'tens' to ML5, and preset the starting point of a count sequence.

82. To start the counting sequence, assume that a logic '0' strobe pulse is applied to the strobe (S) inputs of both ML3 and ML5 (at pin 1). As described in paragraph 79, this causes the logic level applied to each input line (Da, Db, Dc, Dd) to be transferred to the corresponding output line (Ao, Bo, Co, Do,). The negative going edge of the clock pulse (from the shaper stage, TR11, TR12 and the divide-by-two ML2a) is now applied to the clock 1 input of ML3 at pin 8. Each clock pulse is now counted until a count of 35 is reached, i.e. until the Ao and Co outputs from ML3 and the Ao and Bo outputs from ML5 are all at logic '1'. (The C output from ML5 is applied to an inverter, ML6d, to inhibit binary 7).

83. When a count of 35 is reached, the input lines to the AND gate, ML4b, are all at logic '1' and the '1' output, at ML4 pin 6, is applied to the J input of flip-flop ML2B. Both Q outputs from ML2b are fed to the dual J-K flip-flop, ML9 (Q to J, $\bar{Q}$ to K), and the Q output of ML9b is fed back to the K input of ML2b. The effect of this circuit is to produce a logic '0' strobe pulse (ML2B$\bar{Q}$) sufficient in width for the two decade counters, ML3 and ML5. As can be seen from the timing diagram, Fig. 2.9, the strobe pulse is extended to the negative-going edge of the 39th clock pulse, at which point the counting sequence is repeated.

84. Table 3 shows the operation of the programmed divider for various settings of the MHz switch.

'MHz' Setting	Nines Complement	Clock Pulses			
		Count Up to 100	Fixed Count	Strobe Pulse Generation	Total Division Ratio
00	99	1	35	4	40
07	92	8	35	4	47
14	85	15	35	4	54
21	78	22	35	4	61
29	70	30	35	4	69

Table 3: Programmed Divider Operation (PS337)

Phase Comparator

85. The phase comparator comprises a dual D-type flip-flop, ML7, a two-input NAND gate, ML6 (pins 4, 5 and 6), and a voltage control circuit TR16, TR18, TR19. It compares the output signal frequency from the transfer loop oscillator (after division by two in ML12) with the output signal frequency from the programmed divider; any error between these two frequencies is used to develop a d.c. voltage which is applied to the selected HF loop oscillator to eliminate the error. The action of the circuit, which is similar to that of the transfer loop board (PS338), is as follows.

86. The programmed divider output, which is taken from ML2b pin 9, consists of positive-going pulses; these are applied to the clock input of ML7a. The output from the divide-by-two stage, ML12, at pin 5, is applied to the clock input of ML7b. The D inputs of both ML7a and ML7b are taken to the +5V rail (logic '1'). Thus when the positive edge from ML2b clocks ML7a, the Q output at pin 5 changes to '1' and the $\overline{Q}$ output changes to '0'. Similarly, when the positive edge from ML12 pin 5 clocks ML7b, the Q output changes to '1' and the $\overline{Q}$ output changes to '0'. When both Q outputs are at '1', the output from the NAND gate, ML6, changes to '0', clearing both ML7 flip-flops via R61 and thus resetting the Q outputs to '0' and the $\overline{Q}$ outputs to '1'.

87. Consider the case where the frequency of the selected HF loop oscillator output signal (which is applied to the programmed divider) is high. This will mean that the positive edge from ML2b will occur before the edge from ML12. The resultant setting and resetting of the flip-flops causes increased conduction of TR19, due to the $\overline{Q}$ output from ML7a (see timing diagram, Fig. 2.3), as compared with the conduction of TR16; this causes a reduction in the varactor line voltage, taken from the collector of TR18, and thus a reduction in the frequency of the selected HF loop oscillator output signal.

88. If the frequency of the selected HF loop oscillator output signal is low, the edge from ML2b will occur after the edge from ML12; the $\overline{Q}$ output from ML7b will cause increased conduction of TR16, the voltage at the collector of TR18 will become more positive and this will cause an increase in the frequency of the selected HF loop oscillator output signal.

89. When the two frequencies are equal, the two flip-flops of ML7 are clocked at the same time, the $\overline{Q}$ output waveform from ML7a is equal to that from ML7b and the varactor line voltage remains constant.

Lock Indicator and Fast Lock Circuit

(Applicable to later versions only - Issue 7 onwards)

90. This circuit comprises a monostable ML11, a D-type flip-flop ML12a, and two NAND gates ML6b, ML6c. Its purpose is to augment the conduction of TR16 or TR19 in the out-of-lock condition and so obtain a faster return to the locked condition; it also provides a lock indication output signal. The following description should be read in conjunction with the timing diagram Fig. 2.10.

91. The Q output waveforms from the phase comparator, ML7a and ML7b, are applied to NAND gates ML6b, ML6c, via integrating components R36, C92 and R60, C94 respectively, whilst the phase comparator $\overline{Q}$ output waveforms are applied to the A inputs of a monostable, ML11.

Under phase-locked conditions, the in-phase positive-going Q output pulses from ML7a and ML7b are prevented from reaching NAND gates ML6c, ML6b respectively due to the time constants presented by the integrating components; pins 9 and 12 of ML6, and also the D input of ML12a, are therefore at logic '0'. The resulting logic '1' outputs from ML6 pin 8 and 11 do not, however, affect the conduction of the voltage control transistors, TR16, TR18, TR19, due to the presence of the two diodes, D20 and D22.

92. ML11 is a negative edge-triggered monostable which produces a negative-going output pulse ($\overline{Q}$) of approximately 1.5 microsecond duration (timing components R69, C75) when either or both of the A inputs are at logic '0' with the B input at logic '1'. (The B input is not connected externally and therefore floats up to logic '1'). Under phase-locked conditions, the in-phase negative-going phase comparator output pulses applied to ML11 produce a negative-going pulse train at ML11 pin 1 which clocks ML12a (positive-edge triggered) to produce a steady logic '1' in-lock signal at board pin 12 (Fig. 2.10).

93. If the output frequency from the programmed divider is low (as depicted by the centre set of waveforms of Fig. 2.10), the longer-duration positive-going output pulses at ML7b pin 9 are sufficient in width to overcome the time constant presented by integrating components R36 and C92. The effect of this, together with the $\overline{Q}$ output waveform from ML11, is to produce a negative-going output pulse from ML6b; this is applied to TR16, via D20, and rapidly increases the conduction of TR16 to bring about a fast return to the locked condition (in practice, a rapid succession of negative-going pulses appear at ML6b pin 11 as the programmed divider output frequency increases). At the same time, the combination of the D and CK waveforms applied to ML12a produce an alternating '0'-'1' out-of-lock signal at board pin 12.

94. Should the out-of-lock condition be due to a high programmed divider output frequency (lower set of waveforms of Fig. 2.10) the resulting longer-duration positive-going output pulses at ML7a pin 5 are sufficient in width to overcome the time constant presented by R60 and C94 and the negative-going output pulse at ML6c pin 8 will cause a rapid return to the locked condition by increasing the conduction of TR19; the output pulse from ML6c is also applied to the clear input of ML12a, and the combination of this and the $\overline{Q}$ output waveform from ML11 produces an alternating '0'-'1' out-of-lock signal at board pin 12, as before.

Earlier Versions (Issue 5)

94a. Earlier versions of the HF loop board contained a slightly different lock indicator and fast lock circuit; this is described below and should be read in conjunction with Figs. 12a (in Part 2) and 2.10a.

94b. This circuit comprises two monostables, ML8, ML11, a dual D-type flip-flop, ML10, and NAND gates ML6a, ML6b. Its purpose is to augment the conduction of TR16 or TR19 in the out-of-lock condition and so obtain a faster return to the locked condition; it also provides a lock indication output signal.

94c. The Q output from the phase comparator flip-flop, ML7a, is applied to the B input (Schmitt trigger) of the monostable, ML11, and also to the D and clear inputs of a D-type flip-flop, ML10b. Similarly, the Q output from ML7b is applied to the B input of the monostable, ML8, and also to the D and clear inputs of a second D-type flip-flop, ML10a. The two monostables, triggered when positive-going signals are applied to the respective B inputs, each produce a negative-going output pulse $\overline{Q}$, of approximately 1.5 μs duration.

94d. From the timing diagram, Fig. 2.10a, it will be seen that for the in-lock condition, the $\overline{Q}$ outputs from the two flip-flops, ML10a, ML10b, are both at logic '1'; these two signals do not, however, affect the conduction of the voltage control transistors, TR16, TR19, due to the presence of the two diodes, D20, D22. The logic '0' output from ML6a is inverted by ML6b to produce a logic '1' in-lock signal at board pin 12.

94e. If the output frequency from the programmed divider is low, as depicted by the out-of-lock waveform of Fig. 2.10a, the negative excursion of the $\overline{Q}$ output from ML10a will be applied to TR16, via diode D20. The conduction of TR16 will, therefore, be rapidly increased to bring about a fast return to the in-lock condition. The $\overline{Q}$ output waveform from ML10a is also applied to ML6 to produce an alternating '0' - '1' out-of-lock signal at board pin 12.

94f. Should the out-of-lock condition be due to a high programmed divider output frequency, the $\overline{Q}$ output from ML10b will cause a rapid return to the in-lock condition by increasing the conduction of TR19; the $\overline{Q}$ output from ML10b is also applied to ML6 to produce an alternating '0' - '1' out-of-lock signal at board pin 12, as before.

34MHz GENERATOR BOARD PM339

Figs 14 and 15

95. This board provides the 34MHz second mixer injection frequency; it also contains the 1.4MHz carrier re-insertion generator and the 1.4MHz BFO. A block diagram of the board is given in Figure 2.11.

34MHz Oscillator

96. The 34MHz oscillator stage, TR6, TR7, is controlled by the switching/voltage regulator transistor, TR1. With no earth applied to diode D1, TR1 conducts and provides a regulated +5V supply to the oscillator transistors. A sample of the oscillator output signal is fed to the buffer amplifier stage, TR3, TR5, and then, via the forward biassed switching diodes, D5 and D6, to a balanced output amplifier, TR11, TR12 and the rear panel 34MHz IN/OUT socket via board pin 22.

97. When the rear panel 34MHz INT/EXT switch is set to EXT (for slave operation), an earth is routed to D1, to switch off TR1 and thereby remove the +5V supply to the oscillator transistors, and also to the diode switch via L7. Diodes D5 and D6 are reverse biassed, diode D7 is forward biassed, and the 34MHz external input (from the master receiver) is routed via board pin 22, C34, D7 and C33 to the output amplifier, TR11, TR12.

Divide-by-34 Stage

98. A second output from the 34MHz oscillator is buffered by NAND gate G1 of ML2 before being applied to a divide-by-34 stage; this consists of a divide-by-two (ML4 CK1-A output) and a divide-by-17 stage (ML3, ML4 CK2-C output, G2 and G3). The 17MHz output from ML4 pin 5 is applied to the clock inputs of both halves of ML3 whilst the J1 input (ML3 pin 14) is held at logic '1' (+5V). The division factor of 17 is obtained by dividing the first 9 input clock pulses by three and the next 8 clock pulses by four. Thus for the first 9 clock pulses, 3 output pulses are produced ($9 \div 3 = 3$) and for the next 8 clock pulses, 2 output pulses are produced ($8 \div 4 = 2$), making a total of 5 output pulses for 17 input pulses. These 5 pulses are then divided by ML4 to produce a 3:2 mark-to-space ratio 1MHz squarewave output at ML4 pin 2. The operation of the divider is illustrated in Fig. 2.12.

1MHz Divider

99. The output from the 5MHz frequency standard, at board pin 27, is applied to a buffer amplifier, TR2, and then to a shaper stage, TR4. The squarewave output from TR4 is applied to a divide-by-five stage, ML1, which is controlled by the rear panel 1MHz INT/EXT switch. When this switch is set to INT an earth is applied to board pin 16; this is routed to the reset (R9) inputs of ML1 (via L5) and enables the divider. The resultant 1MHz output from ML1 is amplified by TR9 and the filtered (C39, L9, C44) sinusoidal output is taken to the rear panel 1MHz IN/OUT socket, via board pin 4, and also to a shaper stage, TR13.

100. When the rear panel 1MHz INT/EXT switch is set to EXT, the earth is removed from the reset (R9) inputs of ML1 and the counter is inhibited. An external 1MHz signal (from a Master receiver), applied to the rear panel 1MHz IN/OUT socket, is routed to the shaper stage, TR13, (via board pin 4) in place of the internally generated 1MHz signal.

101. The 1MHz squarewave output from TR13 is applied to ML7; this consists of four NAND gates which are used as buffers. The output from G8, at ML7 pin 6, is taken to the

synthesizer, via board pin 6; the output from G9, at ML7 pin 11, is taken to the transfer loop, via board pin 8, and the output from G10, at ML7 pin 8, is taken to the phase comparator, via ML5. G11 of ML7, which has a controlling input from TR14, is used as part of the 1.4MHz carrier re-insertion generation circuit and is described in paragraph 110.

Phase Comparator

102. The output signal from the 34MHz oscillator is divided to provide a frequency of 1MHz when the oscillator frequency is correct. This frequency is compared with a reference 1MHz frequency and any error between the two frequencies is used to develop a d.c. voltage which adjusts the oscillator frequency to eliminate the error. This voltage is generated in the phase comparator, and is applied to 34MHz oscillator varactor diode, D4 via L3.

103. The 1MHz reference frequency signal is derived either from the 5MHz frequency standard and 1MHz divider (ML7 pin 8) or within the AFC board, connected to board pin 18. When the AFC mode is selected an earth (logic '0') is applied to board pin 19. This is inverted by G6 of ML5 to open G7, and is also applied to G5 to open G4. The 1MHz signal at board pin 18 is now applied to the clock 1 input of ML6 (part of the phase comparator) via gates G7 and G4 of ML5. When the AFC switch is set to OFF (or should the AFC facility not be fitted) gates G5 and G4 are opened for the 1MHz reference frequency from ML7 pin 8.

104. The phase comparator consists of a dual D-type flip-flop, ML6, a two-input gate, G12 of ML2, and an output voltage control circuit, TR17, TR18, TR19. The action of the circuit is as follows.

105. The output from the divide-by-34 stage, at ML4 pin 2, is applied to the clock 1 input of ML6, whilst the reference frequency output, from ML5 pin 8, is applied to the clock 2 input of ML6. The D inputs to ML6, at pins 2 and 12, are both taken to the +5V rail (logic '1'). Thus when the positive edge from ML4 pin 2 clocks ML6, the Q1 output at pin 5 changes to '1' and the $\overline{Q}1$ output changes to '0'. Similarly, when the positive edge from ML5 pin 8 clocks ML6, the Q2 output changes to '1' and the $\overline{Q}2$ output changes to '0'. When both Q1 and Q2 are at '1', the output from the NAND gate, G12 of ML2, changes to '0', clearing both ML6 flip-flops via R74 and thus resetting the Q outputs to '0' and the $\overline{Q}$ outputs to '1'.

106. Consider the case where the 34MHz oscillator frequency is high. This will mean that the positive going edge from the divide-by-34 stage will occur before the edge from the 1MHz reference frequency. The resultant setting and resetting of the flip-flops causes increased conduction of TR18, due to the $\overline{Q}1$ output waveform (see Figure 2.3) as compared with the conduction of TR19; this causes the voltage at the collector of TR18 to become less positive, thereby reducing the voltage applied to the varactor diode, D4, and reducing the oscillator frequency.

107. if the oscillator frequency is low, the divide-by-34 pulse will occur after the reference pulse, the $\bar{Q}$ 2 output waveform will cause increased conduction of TR19 and the voltage at the collector of TR18 will become more positive. The increased voltage applied to the varactor diode causes the oscillator frequency to increase, thus correcting the error.

108. When the two frequencies are in phase the two flip-flops of ML6 are clocked at the same time, the $\bar{Q}$ 1 output waveform is equal to the $\bar{Q}$ 2 output waveform and the varactor line voltage remains constant.

1.4MHz Generation

109. The 1.4MHz output signals at board pins 10 and 11 may be derived from the fixed frequency carrier re-insertion generator, a beat frequency oscillator (BFO) or a fixed offset 1.4MHz oscillator.

110. 1.4MHz Carrier Re-insertion Generator When a 1.4MHz carrier re-insertion output is required, an earth is connected to board pin 15; this is routed to the reset (Ro) inputs of a divide-by-five stage, ML8, via L11, and the divider is enabled. The earth is also routed to the base of TR14; the transistor switches off and a logic '1' is applied to the NAND gate, G11 of ML7, at pin 1. The gate opens and the 1MHz square-wave signal from TR13 is applied to the BD input of ML8. The resultant 200kHz output from ML8, at pin 8, is applied to a 1.4MHz crystal filter which selects the seventh harmonic of the input. The filter is followed by a two-stage amplifier, TR15, TR16, which feeds the two output amplifier stages, TR20, TR21.

111. BFO. The BFO is selected by applying an earth to board pin 14; this completes the circuit for transistor TR8 which, with associated components, forms a 1.4MHz ± 3kHz oscillator. The front panel BFO control (a potentiometer), which is connected to board pins 23, 24 and 25, controls the voltage applied to the varactor diode, D3, and hence the oscillator frequency. The BFO output signal is coupled by C30 to the two output amplifier stages, TR20, TR21, and the amplified outputs appear at board pins 10 and 11.

112. Fixed Offset 1.4MHz Oscillator. This is an optional facility and consists of a crystal controlled Colpitts oscillator, TR10. It is switched on by applying an earth to board pin 13 and the amount of frequency offset is determined by the frequency of the crystal, XL1, and the adjustment of C35. The oscillator output signal is coupled by C47 to the two output amplifier stages, TR20, TR21.

RF/IF/AF SECTION

RF UNIT

Fig. 17

113. The received signal at the antenna is applied to the RF board via a 500mA protection fuse and a re-radiation filter. Capacitor C13 couples the received signal to the wideband protection stage.

Wideband Protection Stage

114. This comprises transistors TR1, TR2, TR3, relay RLQ/1 and associated components. Under normal reception conditions TR2 is turned off, TR3 is turned on and relay RLQ/1 is energised. Relay contact RLQ/1 is closed and the received signal is applied to a 30MHz low-pass filter, L7, L9, C14, C15, C16, C19 and C20.

115. Should the amplitude of the received signal at the antenna socket exceed a predetermined threshold (set by trimmer C31), the detected output from TR1, which is applied to the base of TR2, rises sufficiently positive to cause TR2 to conduct. Conduction of TR2 cuases TR3 to switch off, relay RLQ/1 is de-energised and contact RLQ/1 removes the received signal from the 30MHz low-pass filter.

116. For the wideband versions of the RF board, the threshold is set by C31 such that RLQ/1 becomes de-energised for signals which exceed approximately 3V e.m.f. at the antenna socket. For tuned versions, where the wideband protection stage is operated in conjunction with a further protection stage, the threshold is set to approximately 30V e.m.f. at the antenna socket.

Mute Control

117. An earth, from the rear panel MUTE terminal, is routed to the base of TR3 via board pin 3 and diode D8. TR3 is turned off, relay RLQ/1 becomes de-energised, and the RF path to the 30MHz low-pass filter is broken.

118. The output signal from the 30MHz low-pass filter, which may be monitored at TP1, may take one of a number of paths dependent on the type of RF board fitted and also the selected position of the front panel MHz switch, as detailed below.

119. (1) Wideband RF Board

(a) MHz switch set to 0MHz position: An earth (0V) from the MHz switch is applied to board pin 4 to energise relays RLA/1 and RLB/1. Closure of contact RLA1 connects the output signal from the 30MHz filter to a 1MHz low-pass filter, L10, C29, C30, C39, and RLB1 connects the output from the 1MHz low-pass filter to the wideband RF amplifier via link Y.

(b) MHz switch set to any position other than 0MHz : An earth from the MHz switch at board pin 13 is routed via link Z to relays RLN/1 and RLP/1. The relays energise and a path is provided from the 30MHz low-pass filter to the wideband RF amplifier via RLN1, RLP1 and link Y.

(2) Tuned RF Board

(a) MHz switch set to 0MHz position : An earth from the MHz switch is routed to board pin 4. Relays RLA/1 and RLB/1 are energised, the received signal from the 30MHz low-pass filter is applied to the 1MHz low-pass filter via RLA1, and thence to the wideband RF amplifier via RLB1 and contact RLR1 of the normally energised protection relay, RLR/1.

(b) MHz switch set to any position other than 0MHz and RF TUNE control set to WB (wideband): Microswitch SA, operated when the RF TUNE control is set to WB, routes an earth from the MHz switch at pin 13 to relays RLN/1 and RLP/1. The relays energise and the received signal from the 30MHz low-pass filter is routed to the wideband RF amplifier via RLN1, RLP1 and contact RLR1 of the normally energised protection relay, RLR/1.

(c) MHz switch set to any position other than 0MHz, RF TUNE control not in WB position: An earth from the MHz switch is routed to the appropriate board pin (5 to 9) and the respective pair of relays are energised from a common +12V supply via the normally closed contacts of the microswitch, SA. The contacts of the selected relays close and the received signal from the 30MHz low-pass filter is applied to the appropriate tuned circuit, tuned by the RF TUNE control, and thence to the wideband RF amplifier via RLR1.

120. Contact wetting for the reed-type control relays is provided from the +12V rail via resistors R9 and R11.

Protection Stage (Tuned Versions)

121. A further protection stage is fitted to tuned versions of the RF board. The circuit, which is similar to that of the wideband protection stage, comprises transistors TR4, TR7, TR8, relay RLR/1 and associated components. Under normal reception conditions TR7 is turned off, TR8 is turned on and relay RLR/1 is energised. Relay contact RLR1 is closed and the received signal is applied via C42 to the wideband RF amplifier.

122. Should the amplitude of the RF signal applied to the protection stage exceed a pre-determined threshold (set by C33) the detected output from TR4, which is applied to the base of TR7, rises sufficiently positive to cause TR7 to conduct. This causes TR8 to switch off, relay RLR/1 is de-energised and contact RLR/1 opens to remove the input to the wideband RF amplifier.

Wideband RF Amplifier

123. The wideband RF amplifier, TR5, TR6 is of conventional design. The amplified output is coupled by C51 to a five-section 30MHz low-pass filter and is then applied to the first mixer via board pin 12.

FIRST MIXER PM335 — Fig. 20

124. The 35.4 to 65.4MHz local oscillator signal, from the frequency synthesizer, is applied to one of two band-pass filters, dependent on the setting of the front panel MHz switch. For settings of 0, 1, 2 or 3 MHz, an earth from the MHz switch is applied to board pin 11; this is routed to diode D1 via L2 and also to D3 via L11. Diode D1 becomes forward biassed and opens a path for the local oscillator signal at board pin 10 to a crystal notch filter (passband 35.415 to 39.4MHz with a notch frequency of 35.400MHz) via C2, D1 and C6. Diode D3 is also forward biassed and allows the output from the crystal filter to be applied to the drive amplifier via C20, D3 and C24. Diodes D2 and D4 are both reverse biassed, via the potential dividers R3, R4, R6 and R9, R11, R12 respectively, and thus isolate the LC band-pass filter.

125. For MHz switch settings between 4 and 29MHz inclusive, the earth is applied to board pin 8. This causes diodes D2 and D4 to become forward biassed and diodes D1 and D3 to become reverse biassed. Thus a path is opened for the local oscillator signal via the LC band-pass filter (pass-band 39.4 to 65.4MHz) whilst the crystal filter becomes isolated.

Drive Amplifier

126. The mixer drive amplifier comprises transistors TR1, TR2 and TR5. The local oscillator signal from the selected filter, which may be monitored at TP5, is coupled by C28 to a common-emitter amplifier TR1. This is followed by an emitter-coupled differential amplifier, TR2, TR5 and the balanced output is coupled by transformer T4 to the mixer circuit via transformer T6.

127. A second output from transformer T4 is rectified by diode D5 to provide a d.c. output via TR8 and board pin 5. This is fed to the meter switching board and provides a meter indication of the DRIVE LEVEL to the first mixer.

Mixer

128. The mixer is of the balanced bridge type and uses four N-channel insulated gate field effect transistors, TR3, TR4, TR6 and TR7. The local oscillator signal from T6 is capacity coupled to the gate of each transistor (via pin 30 to TR4 and TR6; via pin 26 to TR3 and TR7) whereas the RF input from the RF unit is coupled by transformer T7 to the source of each transistor (via pin 16 to TR3 and TR6; via pin 27 to TR4 and TR7). The mixer output is taken via transformer T5 from the drains of the four transistors and is applied to a 35.4MHz band-pass filter, FL1. Finally, the output from FL1, at the first intermediate frequency of 35.4MHz, is applied to the second mixer board via transformer T3 and board pin 3.

SECOND MIXER PM336 — Fig. 22

129. The 35.4MHz first IF output from the first mixer is applied to an amplifier stage, TR1, via board pin 13 and C1. The amplified output is applied via C8 to a further

amplifier stage, TR5, and is also applied via C7 to a voltage controlled attenuator. This utilises two PIN diodes, D1, D2, and is controlled by the AGC 1 input at board pin 9 from the main IF/AF board. (In ISB versions AGC2 from the ISB IF/AF board is applied to board pin 8).

PIN Diode Attenuator

130. The impedance presented to the 35.4MHz IF signal by the PIN diodes is a function of the forward direct current passing through the diodes. When no forward current is allowed to flow the impedance is extremely high and this impedance is progressively reduced as the forward current is allowed to rise.

131. The AGC voltage output from the emitter follower TR7 (or, in ISB versions, the differential AGC output from TR7, TR8) is applied to the base of TR6. This stage controls the current flow through TR2 and TR3, and hence the current flow through the two PIN diodes, D1 and D2. Thus an increase in the AGC voltage causes an increased current to flow through the PIN diodes and the output from the tuned circuit of TR1 is reduced.

Mixer

132. A cross-coupled balanced mixer circuit, TR9, TR10, produces the 1.4MHz second intermediate frequency, this being the difference frequency between the 35.4MHz first IF and the second mixer injection signal from the 34MHz generator board. The 35.4MHz output signal from TR5 is applied via a band-pass filter to the base of TR9 and the 34MHz signal at board pin 7 is applied via a band-pass filter to the base of TR10. The output from the mixer is applied to a 1.4MHz IF amplifier stage, TR11, which has a stage gain of approximately 10dB, and the final output is applied to the IF filter board via pin 3.

IF FILTER BOARD PS 367 Fig. 24

133. This board contains all the crystal filters which are used in the control of received signal selectivity. Up to six crystal filters may be fitted of which two may be SSB filters, where required (FL1 for USB, FL5 for LSB). Filter selection is effected by applying an earth to the appropriate selection line and the filtered output is taken via diode switches to a common output line. For ISB receivers however, the output from FL5 (ISB/LSB) is routed separately, via LK1 and board pin 4, to the ISB IF/AF board. In receivers equipped with AFC, the FL6 position is used for a carrier filter; link LK2 bypasses the input switching and the output is routed to the AFC board via LK3 and board pin 6.

NOTE: Due to inversion in the receiver, a USB filter at FL1 has LSB characteristics and an LSB filter at FL5 has USB characteristics.

134. Since the selection circuit for each filter is the same, only one example is given, that of filter FL1.

135. An earth from either the MODE switch (USB filter) or the FILTER switch (Symmetrical filter), as appropriate, is applied to board pin 15. This is routed via L1 and L8 to diode D1, and also via L14 to diode D7. Diode D1 becomes forward biased and opens a path for the IF signal at board pin 14 to FL1 via capacitor C2, D1, C3 and R8. Diode D7 is also forward biased and the output from FL1 is routed to board pin 2 via C27, D7 and C35. The remaining diodes, D2 to D6 and D8 to D12, are all reverse biased and isolate the IF signal from the remaining filters, FL2 to FL6.

MAIN IF/AF BOARD PM674 — Fig. 26

136. The 1.4 MHz IF signal from the filter board is applied to an integrated circuit gain controlled amplifier ML1. This is followed by another gain controlled amplifier ML2 to provide high gain and AGC range. The input signal is applied via R1 and C1 to pin 1 of ML1 and the output from ML1, at pin 5, is applied via R11 and C4 to the input of ML2, at pin 1. The output, which is taken from pin 5, is applied via C8, TR1, a band-pass filter and C13 to an IF output amplifier, TR2, TR3 and TR4. The output from TR3 is taken to the rear panel MAIN IF OUT socket via C24, R35 and board pin 2.

AGC Detector and Amplifier Stages

137. A second output from amplifier TR2 is coupled by C19 to the AGC detector, TR7, TR8, and is also fed via C31 to the hang detector, TR10, switching amplifier stages ML4A, ML4B and TR11 (see para. 140). The positive output voltage from the AGC detector is taken from the emitter of TR7 and is applied to the switched time constant capacitors, C16, C17 and C22, via R33. The front panel AGC switch, when set to SHORT, routes an earth to board pin 25 and this connects R30 across the series/parallel connected time constant capacitors (effective total capacitance approximately 25 μF). When the AGC switch is set to LONG the earth is transferred to board pin 26; R30 is disconnected and capacitors C17 and C20 are short circuited to produce a time constant capacitance of 66 μF (parallel combination of C16 and C22).

138. ML3A is connected as a linear amplifier. The output at pin 12 is applied via diode D2 and board pin 29 to various points within the receiver and also via the LONG and SHORT positions of the AGC switch to board pin 30. Amplifier ML3B and variable resistor R9 and resistors R6 and R7 provide a means of shifting and amplifying the d.c. level of the AGC voltage before it is applied to the IF amplifier stages ML1 and ML2. When the AGC switch is set to OFF a positive voltage is applied to board pin 30 via the manual IF GAIN control.

Hang Detector

139. This circuit holds the level of the AGC output voltage from ML3A, following an interruption in the received transmission, for a period of approximately 2.5 seconds. The circuit is only operative when the AGC switch is in the LONG position.

140. The IF output from TR2 is coupled to the base of detector TR10 via C19 and C31. The output from TR10 is applied to the inverting input of ML4A and the preset variable resistor R55 sets the voltage level applied to the non-inverting input such that the output at ML4A pin 12 is negative when a received signal is present. This negative voltage (clamped to approximately -0.7V by D8) is applied to the inverting input of ML4B. The potential divider, R61, R62, sets the voltage applied to the non-inverting input of ML4B to approximately +6V and the resulting positive output, at ML4B pin 10, is applied to the base of TR11 via R65. Since this voltage is more positive than that applied to the emitter of TR11 (which is held at approximately +7V) the transistor is switched off and the resulting negative voltage at the collector of TR11 holds off TR5 via D9. Board pin 24 is taken to earth by the AGC switch when set to LONG (as is pin 26).

141. When a break in the received transmission occurs the corresponding reduction in the emitter current of TR10 causes the voltage level applied to pin 1 of ML4A to fall below the preset voltage level applied to pin 2 (of ML4A). The output from ML4A switches from negative to positive and capacitor C38 charges, via R58 and R59. Once the level of the exponentially rising voltage at ML4B pin 7 exceeds the level of the fixed potential applied to ML4B pin 6 (approximately +6V), the output of ML4B, at pin 10, switches from positive to negative. TR11 conducts, the negative voltage applied to D9 is removed and TR5 conducts. The time constant capacitors C16 and C22 discharge via R34 and TR5 and the AGC voltage output from ML3A falls exponentially to zero.

142. When the received transmission recommences, the emitter voltage of TR10 rises, the output of ML4A switches from positive to negative and C38 rapidly discharges via R58, D7 and the low impedance output circuit of ML4A. The output of ML4B switches from negative to positive, both TR11 and TR5 are cut off and the AGC voltage from TR7 charges the time constant capacitors, C16 and C22, via R33.

143. The operation of the hang detector circuit, as described above, and also where the duration of the break in the received signal is shorter than the hang time period, is shown in the timing diagram, Fig. 2.13.

AM and SSB Detectors

144. The IF output from TR1 and the band-pass filter is coupled to a buffer stage TR6, via C13 and C15. The output from TR6, at TP4, is capacity coupled to both the AM detector, via C27, and the SSB detector, via C29.

145. The low distortion AM detector, TR9, is followed by a low-pass filter, L5, R49, C32. A similar filter follows the SSB detector which consists of a modified Foster-Seeley circuit, T1, D3 to D6, R53 and C34.

146. A diode switching arrangement, controlled by the MODE switch, is used to select the output from either the AM detector or the SSB detector. In the AM position of the MODE switch an earth is applied to board pin 7. This is routed to D11 via R64, the diode becomes forward biased, and a path is opened for the output from the AM detector to the audio pre-amplifier via C37, D11 and C40. Diode D10 remains reverse biased and isolates the output from the SSB detector.

147. For all remaining positions of the MODE switch the earth is transferred to board pin 6. Diode D10 becomes forward biased and opens a path for the output from the SSB detector whilst D11 becomes reverse biased and isolates the output from the AM detector.

Audio Pre-Amplifier

148. The output from the selected detector is applied to a high gain, impedance matching amplifier, TR12, TR13. The output, which is applied to the MODE switch and the preset USB line level control, via C51 and board pin 8, is muted by transistor TR14 when an earth is applied to board pin 10.

Audio Line Amplifier

149. The audio line amplifier is an integrated circuit linear amplifier ML5. The output signal, from the preset USB line level control, is applied via board pin 11 and C44 to ML5 pin 8. The output from ML5 pin 12 is taken via C63, R89 and line output transformer T2 to board pins 15 and 16.

Loudspeaker Amplifier

150. In SSB versions of the receiver the output of the audio pre-amplifier, at board pin 8, is routed to the loudspeaker amplifier via the front panel AF GAIN control and board pin 23. For ISB versions only, the input to the loudspeaker amplifier is switched (MODE switch) to receive either the pre-amplifier output from the main IF board (USB) or that from the ISB IF board (LSB).

151. The loudspeaker amplifier is an integrated circuit linear amplifier ML6, which has complete protection against output short circuits. The input from board pin 23 is applied via C43 to ML6 pin 8. The output from ML6 pin 12 is taken via C65 to board pin 18. The amplifier output, at board pin 18, is taken direct to the rear panel loudspeaker terminal and via dropper resistors to the two headphone jacks and the internal loudspeaker.

ISB IF/AF BOARD PM674/3 Fig. 26

152. This board is similar to the main IF/AF board except that it does not contain the loudspeaker amplifier components. The component layout for the board is given in Fig. 28.

152a. The 1.4MHz IF signal from the filter board is applied to an integrated circuit gain controlled amplifier, ML1. This device contains two amplifier sections which, in this application, are connected in cascade to provide high gain and AGC range. The input signal is applied via C1 to pin 1 and the output from the first section, at pin 12, is applied via R3 and C7 to the input of the second section, at pin 10. The output, which is taken from pin 7, is applied via a band-pass filter and C12 to an IF output amplifier, TR2, TR4 and TR6. The output from TR6 is taken to the rear panel MAIN IF OUT socket via C23, R100 and board pin 2.

AGC Detector and Amplifier Stages

152b. A second output from amplifier TR2 is coupled by C19 to the AGC detector, TR7, TR9, and is also fed via C30 to the hang detector, TR11, switching amplifier stages ML3, ML4 and TR13 (see para. 152d). The positive output voltage from the AGC detector is taken from the emitter of TR7 and is applied to the switched time constant capacitors, C13, C14, C16 and C20, via R20. The front panel AGC switch, when set to SHORT, routes an earth to board pin 25 and this connects R13 across the series/parallel connected time constant capacitors (effective total capacitance approximately 25μF). When the AGC switch is set to LONG the earth is transferred to board pin 26; R13 is disconnected and capacitors C14 and C16 are short circuited to produce a time constant capacitance of 66μF (parallel combination of C13 and C20).

152c. ML2 is connected as a linear amplifier. The output at pin 6 is applied via diode D2 and board pin 29 to various points within the receiver and also via the LONG and SHORT positions of the AGC switch to board pin 30. Transistor TR1 and variable resistor R4 provide a means of shifting the d.c. level of the AGC voltage before it is applied to the IF amplifier stage, ML1. When the AGC switch is set to OFF a positive voltage is applied to board pin 30 via the manual IF GAIN control.

Hang Detector

152d. This circuit holds the level of the AGC output voltage from ML2, following an interruption in the received transmission, for a period of approximately 2.5 seconds. The circuit is only operative when the AGC switch is in the LONG position.

152e. The IF output from TR2 is coupled to the base of detector TR11 via C19 and C30. The output from TR11 is applied to the inverting input of ML3 and the preset variable resistor R42 sets the voltage level applied to the non-inverting input such that the output at

ML3 pin 6 is negative (clamped to approximately -0.7V by D7) when a received signal is present. This negative voltage is applied to the inverting input of ML4. The potential divider, R48, R49, sets the voltage applied to the non-inverting input of ML4 to approximately +7V and the resulting positive output, at ML4 pin 6, is applied to the base of TR13 via R53. Since this voltage is more positive than that applied to the emitter of TR13 (which is held at approximately +7V) the transistor is switched off and the resulting negative voltage at the collector of TR13 holds off TR3 via D9. Board pin 24 is taken to earth by the AGC switch when set to LONG (as is pin 26).

152f. When a break in the received transmission occurs the corresponding reduction in the emitter current of TR11 causes the voltage level applied to pin 2 of ML3 to fall below the preset voltage level applied to pin 3 (of ML3). The output from ML3 switches from negative to positive and capacitor C38 charges, via R45 and R46. Once the level of the exponentially rising voltage at ML4 pin 2 exceeds the level of the fixed potential applied to ML4 pin 3 (approximately +7V), the output of ML4, at pin 6, switches from positive to negative. TR13 conducts, the negative voltage applied to D9 is removed and TR3 conducts. The time constant capacitors C13 and C20 discharge via R17 and TR3 and the AGC voltage output from ML2 falls exponentially to zero.

152g. When the received transmission recommences, the emitter voltage of TR11 rises, the output of ML3 switches from positive to negative and C38 rapidly discharges via R46, D8 and the low impedance output circuit of ML3. The output of ML4 switches from negative to positive, both TR13 and TR3 are cut off and the AGC voltage from TR7 charges the time constant capacitors, C13 and C20, via R20.

152h. The operation of the hang detector circuit, as described above, and also where the duration of the break in the received signal is shorter than the hang time period, is shown in the timing diagram, Fig. 2.13a.

AM and SSB Detectors

152j. The IF output from ML1 and the band-pass filter is coupled to a buffer stage TR8, via C12 and C15. The output from TR8, at TP4, is capacity coupled to both the AM detector, via C26, and the SSB detector, via C29.

152k. The low distortion AM detector, TR10, is followed by a low-pass filter, L5, R37, C31. A similar filter follows the SSB detector which consists of a modified Foster-Seeley circuit, T1, D3 to D6, R43 and C33.

152l. A diode switching arrangement, controlled by the MODE switch, is used to select the output from either the AM detector or the SSB detector. In the AM position of the MODE switch an earth is applied to board pin 7. This is routed to D11 via R52, the diode becomes forward biassed, and a path is opened for the output from the AM detector to the audio pre-amplifier via C37, D11 and C40. Diode D10 remains reverse biassed and isolates the output from the SSB detector.

152m. For all remaining positions of the MODE switch the earth is transferred to board pin 6. Diode D10 becomes forward biassed and opens a path for the output from the SSB detector whilst D11 becomes reverse biassed and isolates the output from the AM detector.

Audio Pre-Amplifier

152n. The output from the selected detector is applied to a high gain, impedance matching amplifier, TR14, TR15. The output, which is applied to the MODE switch and the preset USB line level control, via C41 and board pin 8, is muted by transistor TR16 when an earth is applied to board pin 10.

Audio Line Amplifier

152p. The audio line amplifier consists of an integrated circuit linear amplifier, ML5, which drives the complementary output transistors, TR22 and TR23. The output signal, from the preset USB line level control, is applied to ML5 via board pin 11, C45 and a low-pass filter, R74 and C49. The audio line output is taken to the rear panel terminals via transformer T2 and board pins 15 and 16.

Loudspeaker Amplifier

152q. In SSB versions of the receiver the output of the audio pre-amplifier, at board pin 8, is routed to the loudspeaker amplifier via the front panel AF GAIN control and board pin 23. For ISB versions only, the input to the loudspeaker amplifier is switched (MODE switch) to receive either the pre-amplifier output from the main IF board (USB) or that from the ISB IF board (LSB).

152r. The direct-coupled amplifier comprises transistors TR17 to TR21, TR24 and TR25. The input from board pin 23 is applied to the input stage, TR17, via C42 and a low-pass filter, R69 and C47 with feedback components C46 and R72. This is followed by a further amplifier stage, TR18, with negative feedback provided by C51. TR19 provides bias for the output transistors and R84 sets the quiescent current. Phase splitting is achieved by the use of complimentary transistors, TR20, TR21, which drive the single-ended push-pull output stage, TR24, TR25. The amplifier output, at board pin 18, is taken direct to the rear panel loudspeaker terminal and via dropper resistors to the two headphone jacks and the internal loudspeaker.

ISB IF/AF BOARD PM364/3 Fig. 26a

152s. This board is similar to the main IF/AF board except that it does not contain the loudspeaker amplifier components. The component layout for the board is given in Fig. 28a.

ANCILLARY BOARDS

AFC BOARD PM664 (For earlier versions, PM369 see page 2-34a) Figs. 29 & 30

153. For convenience, the circuit diagram of the AFC board is covered by two sheets, Fig. 29 on sheet 1 and Fig. 30 on sheet 2. A simplified block diagram of the board is given in Fig. 1.6 at the back of Chapter 1.

Input Attenuator and Amplifier

154. The 1.4 MHz carrier signal is applied to an automatic gain controlled IF amplifier stage, ML2, via a switched attenuator which is controlled by the front panel AFC switch. Transmission gate switching is used in the attenuator. When the AFC switch is set to PILOT CARRIER, the signal at C1 is fed via a transmission gate in ML1 to C4 un-attenuated. When the AFC switch is in the FULL CARRIER position, an earth is applied to board pin 14 which changes the state of the transmission gates to route the signal from C1 via attenuator resistor R1 to C4 and i.f. amplifier ML2.

155. The gain controlled amplifier ML2 has a gain of up to 38 dB and has a.g.c. applied to it via R12. The output at pin 5 of ML2 is fed via a 1.4 MHz crystal band-pass filter, with an insertion loss of approximately 2 dB, to the mixer ML3.

Mixer

156. The 1.4 MHz signal is applied to pin 1 of ML3 via C17 and R25. The 1 MHz reference frequency, at board pin 11, is applied via R9, C8, R13, buffer stage TR1, C21 and R35 to pin 7 of ML3. The resultant 400 kHz output at pin 6 of ML6 is tuned by L4 and C20 to this frequency. Resistors R31, R33, R35 and R36 provide bias to ML3. The variable preset resistor R29 is adjusted to remove the 1 MHz appearing at the output.

400 kHz Gain Controlled Amplifier

157. The 400 kHz signal from the mixer ML3 is fed via C22 to ML4 which has a gain of up to 38 dB and a.g.c. applied to it via R44.

Output Buffer

158. The output at pin 5 of ML4 is fed via C25 and R47 to a buffer stage TR3, TR4, with a gain of approximately 23 dB. Two outputs are provided by TR4, the first to the waveform shaper and the second to the a.g.c. detector.

Waveform Shaper

159. The waveform shaper is a long-tail pair TR5, TR6 and functions as a zero-crossing detector. The output from the collector TR6 is connected to the junction of R70 and R71 in the digital mixer.

AGC Detector

160. The diode detector D1 produces an output which is the sum of the peak voltage of the signal from the output buffer plus 6 volts derived from R42 and R43. The output from D1 is fed to the a.g.c. amplifier and the signal to noise detector.

AGC Amplifier

161. The input to operational amplifier ML5A is filtered by R6 and C5 to produce an amplified a.g.c. from the a.g.c. detector output. The d.c. offset is set by the preset potentiometer R5. The output appearing at pin 8 of ML5A is applied to gain controlled amplifiers ML2, ML4 and via the time constant circuit to ML5B.

162. The time constant components are R6 and C5, C16 and R22. C5 charges rapidly via R6 to provide an attack time of about 150 milliseconds and R22 provides a slow discharge path for C16 with a decay time of about 1.5 seconds. Transistor TR2 is controlled by ML9A from the front panel AFC switch (via R63, ML10C and ML11) such that in the OFF position, the transistor conducts and discharges C16.

AGC Distribution Amplifiers

163. The d.c. level shift stage consists of ML5, R37 and R41. The preset variable R37 determines the slope of the carrier a.g.c. characteristic and preset potentiometer R41 offsets the output voltage so that it is about 80 mV below the main a.g.c. voltage for the receiver. The carrier a.g.c. is fed to the main a.g.c. for the receiver via voltage follower distribution amplifiers ML5C and ML5D which only takes control when the peak signal level falls by 10 dB.

Signal to Noise Detector

164. The detector ML10 compares the peak signal voltage from the a.g.c. detector with the preset level set by R45 to the inverting input. The detector has a fast decay and slow attack characteristic, so that the a.f.c. is inhibited immediately if the carrier disappears or if extraneous signals pass through the carrier filter, and it is not enabled until about 70 milliseconds after the carrier is restored. R45 is adjusted for a.f.c. present at approximately 2.0 μV e.m.f. antenna signal. The AFC LOCK lamp should definitely be illuminated for a 3 μV input and extinguished for 1 μV input.

7 MHz VCO

165. The 7 MHz VCO consists of transistor TR8 connected into a crystal controlled Colpitts circuit with the parallel combination of preset trimmer C35 and varactor diode D4 in series with the crystal, XL2. The VCO is driven to a frequency which is equal to 7 MHz $\pm \frac{7D}{34}$, where D is the deviation of the received signal. The output signal is coupled by C42 to a shaper stage, TR9 and NAND gate ML6A, and the square-wave output signal is applied to a divide-by-seven stage, ML7.

Divide-by-7 Stage

166. ML7 utilises a type of decade counter where the starting point of a count sequence may be preset. A '1' or a '0' at a data input (Da, Db, Dc, Dd) is transferred to the associated output (0a, 0b, 0c, 0d) when the strobe (S) input is at '0'. The counting operation is performed on the negative-going edge of the clock pulse.

167. In this application, the Da data input is connected up to logic '1' (approximately +5V) whilst the remaining data inputs (Db, Dc, Dd) are all taken to logic '0' (0V). The counter therefore starts counting at binary 1 and resets at binary 8, i.e. at binary 8 the logic '1' 0d output, inverted by ML6, resets or strobes the counter, binary 1 is again loaded in and the count sequence repeats.

168. The shaped output signal from the 7 MHz VCO is divided by seven and the resulting $1 \text{ MHz} \pm \frac{D}{34}$ output is taken from ML7 pin 2. This output is applied via a shaper stage TR10 to the phase comparator and via board pin 10 to the 34 MHz generator board where it is used in place of the 1 MHz reference frequency, derived from the frequency standard.

Phase Comparator

169. The digital phase comparator consists of a dual D-type flip-flop ML20A and ML20B, two input NAND gates ML19 and a varactor line driver ML16A. It compares the 1 MHz ± D signal from ML7 with the 1 MHz reference frequency from TR7; any error between these two frequencies is used to develop a d.c. voltage which is applied to the varactor line of the 7 MHz VCO.

170. The output signal from ML7 is applied via TR10 to the clock input of ML20B. The 1 MHz reference signal is applied to the clock input of ML20A. The D inputs of ML20 are held at logic '1'. The positive edge of the clock input to ML20B changes the Q output at pin 13 to '1' and the $\bar{Q}$ output at pin 12 changes to '0'. Similarly, ML20A Q output changes to '1' and the $\bar{Q}$ output changes to '0'. When both Q outputs are at '1' the outputs from NAND gates in ML19 reset the Q outputs to '0' and the $\bar{Q}$ outputs to '1'. The $\bar{Q}$ output of ML20A is inverted by NAND gate and applied via R90 and D5 to ML16A. The $\bar{Q}$ output of ML20B is applied via R91 and D6 to ML16A.

171. Consider the case of where the output frequency is from ML7 is high. This will mean that this positive edge will occur first. The resulting setting and resetting of the flip-flops causes the varactor line driver ML16A to increase the voltage applied to the varactor diode of the 7 MHz VCO thus increasing the frequency. Conversely if the output frequency from ML7 is low, the ML16A output will decrease and reduce the 7 MHz VCO frequency.

172. When the two signals are equal in frequency and phase, the varactor line voltage remains constant.

Divide-by-5 Stage

173. The 1 MHz reference frequency signal (from the 1 MHz buffer, sheet 1) is applied to ML18 which is a divide-by-10 ring counter with reset. A divide-by-5 ring counter is produced by connecting the Q5 output to the reset input. The 200 kHz outputs at Q1 and Q2, which have a phase difference of 72°, are taken to the clock inputs of ML17 in the digital mixer.

Digital Mixer

174. The digital mixer consists of dual D-type flip-flops ML17, EX OR gates ML12A, ML12B and a D-type flip-flop ML13A. ML17A and ML17B compare the 400 kHz carrier signal (from the waveform shaper, sheet 1) with the 200 kHz clock inputs from ML18, spaced at a constant phase difference of 72°. In timing diagrams Fig. 2.21 and Fig. 2.22 exagerated examples are given where the input frequencies of 500 kHz and 300 kHz are shown respectively. The actual range is plus or minus 50 Hz, but at this rate several hundred clock pulses would have to be given to show the generation of error pulses. In these timing diagrams, the Q outputs from ML17A and ML17B change state at the error frequency rate and are also 72° out of state with each other. The two EX OR gates ML12A and ML12B each give one pulse out when the respective Q output from ML17 goes from '0' to '1'. The width of the pulse produced is determined by R78, C44 and R79, C45 respectively. Resistors R70, R71, R74 and R75 provide hysteresis around ML17A and ML17B. The Q output from ML13A is fed via EX OR gate ML12D to the binary counter as up/down information.

175. In timing diagram Fig. 2.21 where the carrier frequency is higher than 400 kHz, i.e. 500 kHz, the D-input to ML13A is high and the Q output from ML13A is high.

176. In timing diagram Fig. 2.22 where the carrier frequency is lower than 400 kHz, i.e. 300 kHz, the D-input to ML13A is low and the Q output from ML13A is low.

2 kHz Oscillator

177. The oscillator consists of two inverting NOR gates ML14 biased into the linear region with C46 providing positive feedback. The oscillator is disabled by a '1' to pin 12 of ML14, when the AFC switch is in the FULL or PILOT CARRIER positions. When the AFC is in the OFF position the oscillator provides clock inputs to the binary counter.

Binary Counter

178. The counter consists of ML22, ML23 and ML24 connected as a 12-bit synchronous up/down counter.

179. The up/down information is derived via EX OR gate ML12 from ML13A when the AFC switch is in the FULL or PILOT CARRIER positions and from ML10D when the switch is set to OFF.

180. The clock input is derived via EX OR gate ML12C, NAND gates ML11C and ML11D from ML12A when the AFC switch is in the FULL or PILOT CARRIER position and from the 2 kHz oscillator when the AFC switch is in the OFF position.

181. The monostable ML15A produces 700 millisecond pulses at the error rate provided by the output from ML11D. The $\bar{Q}$ output from ML15A is slightly delayed by R88 and C53 before it is applied to the clock enable input of ML22, so that the counter is not clocked at the same time as the data changes at the up/down inputs. The counter chain is only allowed to count if another error pulse arrives whilst the monostable is still triggered by the previous pulse. If the monostable has time to relax between error pulses, no count will take place. Thus, if the error pulses are greater than 700 milliseconds apart, i.e. the error frequency is less than 1.4 Hz, the counters are not incremented and this prevents hunting.

182. When up/down input data is high the counter counts up and when the up/down input data is low the counter counts down. The ten most significant counter outputs are connected to the logic inputs of the digital to analogue converter.

Digital to Analogue Conversion

182. The digital to analogue converter ML21 is provided with ten inputs from the up/down counter, a reference voltage input and a feedback input to produce an output current at pin 1. This output is applied to operational amplifier ML16B which provides the feedback to an internal feedback resistor in ML21 and also inputs to operational amplifiers ML16C and ML16D. The output from ML16C is fed back to pin 15 of ML21 as the reference voltage and the output from ML16D is applied ML10D.

183. The ML21 output current I is proportional to the following two quantities:-

(1) The multiplying fraction k is dependent on the state of inputs from the up/down counter.

(2) The reference voltage applied to pin 15 of ML21.

184. The result is that the I out/k characteristic is made non-linear and the feedback proportion is used to compensate for the non-linear frequency/voltage curve of the 7 MHz VCO and achieve superior frequency accuracy. In this circuit, the voltage appearing at the output of ML16 is $\frac{3.8V \times k}{1-0.37k}$.

185. When the AFC switch is in the OFF position, ML10D compares the output from ML16D with the varactor line voltage to provide up/down information to the counters.

AFC LOCK Lamp

186. The lamp driver circuit consists of EX OR gate ML14, flip-flop ML13B, NAND gate ML9, transmission gate ML8A and transistor TR11. When the AFC switch is in the FULL or PILOT CARRIER positions, the error frequency is less than 1.4 Hz and the signal-to-noise ratio is satisfactory, a '0' on pin 9 of ML9 is inverted by the transmission gate ML8A to permit transistor TR11 to conduct and illuminate the AFC LOCK lamp.

AFC On/Off Switching

187. In either of the two AFC on positions of the AFC switch (FULL CARRIER and PILOT CARRIER), an earth (logic '0') is applied to board pin 13 and is routed to a switch anti-bounce circuit consisting of R63, C37 and ML10C.

188. The action of the anti-bounce circuit is as follows. Prior to the operation of the AFC switch, the input on pin 5 of ML10C is at logic '1' (pin 5 is connected to a +12V rail via R64 and board pin 13 is open circuit) and the output at pin 2 is logic '1', which is applied to ML13A, ML17B, ML19, ML8D and TR12. When the switch is in the FULL CARRIER or PILOT CARRIER positions, the logic '0' applied to pin 5 of ML10C provides a logic '0' output. This is applied to NAND gate ML11A to produce a logic '1'. This latter output is applied to ML14B, ML11B, ML20B, ML9A, ML9B, ML8C and TR13.

189. When the AFC switch is set to the OFF position, the carrier derived a.g.c. is removed to the i.f. board/s. ML17B is reset so that pin 2 of ML12D is at logic '0' and the clock pulses for the up/down counter are taken from the 2 kHz oscillator ML14A, ML14B and with a logic '0' on pin 12 the oscillator will operate.

190. A logic '1' on pin 10 of ML13A resets ML13A so that pin 2 of ML12D is at logic '0'. Transistor TR13 is switched off to produce a logic '1' which allows the ML10D up/down information to be applied to pin 1 of ML12D.

191. A logic '1' on pin 13 of ML19 allows reset pulses to arrive at ML20A and ML20B.

192. Transistor TR12 is switched on so that the varactor line is supplied only from the phase comparator and loop filter.

193. Transmission gates ML8C and ML8D switch the tuning indicator pulses to the meter.

194. When the AFC switch is set to FULL CARRIER or PILOT CARRIER, the carrier derived a.g.c. is allowed to pass to the i.f. board/s.

195. A logic '0' on reset pin 4 of ML17B sets pin 2 of ML12D to logic '1' so that clock pulses for the up/down counter are taken from ML13A. The 2 kHz oscillator ML14 is disabled by a logic '1' on pin 12.

196. Transistor TR12 is switched off by a logic '0' and a logic '1' on ML20B, sets ML20B and resets ML20A to allow only the digital to analogue converter to supply the varactor line.

197. Transistor TR13 is switched on to apply a logic '0' to pin 1 of ML10D and to pin 1 of ML12D, thus allows the up/down information to be taken from ML13A.

198. Transmission gates ML8C and ML8D switch the varactor voltage to the meter.

AFC BOARD PM369 (Fitted to earlier versions only) Figs. 29a & 30a

153. For convenience, the circuit diagram of the AFC board is covered by two sheets, Fig. 29a on sheet 1 and Fig. 30 on Sheet 2. A simplified block diagram of the board is given in Fig. 1.6a at the back of Chapter 1.

Input Attenuator and Amplifier

154. The 1.4MHz carrier signal is applied to an automatic gain controlled IF amplifier stage, ML3, via an attenuator which is controlled by the front panel AFC Switch. When this switch is set to FULL CARRIER, an earth is applied to board pin 14. Diode D3 becomes reverse biassed, diodes D2 and D4 become forward biassed and the carrier signal is routed to ML3 via C2, D2, attenuator resistors R4, R7, R8, R12, R14, D4 and C12. When the AFC switch is set to PILOT CARRIER, the earth is removed from board pin 14, diode D3 becomes forward biassed, diodes D2 and D4 become reverse biassed and the un-attenuated carrier signal is applied to ML3 via C5, D3 and C11.

155. The IF amplifier, ML3, contains two sections, which, in this application, are connected in cascade. The input signal to the first section is applied to pin 14, the output at pin 12 is coupled by C27 to the input of the second section, at pin 10, and the final output, at pin 7, is applied to a balanced mixer via a 200 Hz crystal band-pass filter.

Mixer

156. The mixer consists of transformer T1, diodes D5 to D8, C35, C36 and output transformer, T2. The 1.4MHz signal is applied to the primary winding of T1 and the 1MHz reference frequency, at board pin 11, is applied to the centre-tap of the secondary winding of T1 via R104, C18, shaper stage TR5, TR6, and C28. The resultant 400kHz output signal is applied to a cascaded two-stage amplifier, ML12, and is then buffered by emitter-follower, TR10, before being applied to a sample-hold phase comparator.

1.6MHz VCO

157. The second input signal to the phase comparator is derived from a 1.6 MHz VCO. This consists of transistors TR7 and TR8 with a varactor diode controlled tuned circuit D9, C30, C31, L8 and C34. The square-wave output from TR8 is applied to a divide-by-two stage consisting of a D-type flip-flop, ML11a. The Q output from ML11a is applied to a further divide-by-two stage, ML11b, and the resulting 400kHz output at ML11b pin 8 is applied as the sample pulse to the phase comparator via C58 and TR14.

Phase Comparator

158. The sample-hold phase comparator compares the 400kHz output signal from the mixer (via ML12 and TR10) with the 400kHz reference frequency output signal from ML11b.

Any frequency or phase error between these two signals is used to develop a d.c. voltage which is fed back to the 1.6MHz VCO to eliminate the error. The action of the circuit is as follows.

159. The square-wave output from ML11b pin 8 is applied to the differentiating components C58, R56, and the resulting sample pulse is applied to the base of TR14. When the base of this transistor is positive with respect to its emitter, it conducts and holds off TR13 by effectivly connecting the gate of TR13 to 0V. Thus the negative going edge of the sample pulse turns off TR14 and this allows TR13 to conduct for the duration of the sample pulse. The voltage level of the 400kHz signal at the source of TR13 is transferred to the drain and this voltage, which is held by C61, is applied to the varactor diode, D9 of the 1.6MHz VCO, via the loop amplifier, ML15, and the loop filter, R73, C67. A potential divider, R79, R80, and diode D13 prevent the level of the varactor line voltage falling below approximately +3V.

160. Incorrect phase-lock is prevented by the use of a quadri-correlator stage which comprises transistors TR15, TR16, TR24, TR25 and TR18. The 400 kHz reference frequency square wave output from ML8a, which is 90° out of phase with that from ML11b, is applied to the differentiating components C56 and R55. The resulting negative going sample pulse is applied to the base of TR16 to allow conduction of TR15 for the duration of the sample pulse. The voltage level of the 400kHz signal at the source of TR15 (from TR10) is transferred to the drain and this voltage, which is held by C62, is applied to a differential amplifier, TR24, TR25. Under phase-locked conditions, TR25 is on and both TR23 and TR24 are off. Thus TR18, which controls the phase comparator FET, is off, as is TR26 which feeds the out-of-lock circuitry on sheet 2.

161. The voltage C62 varies according to the instantaneous voltage from the source of TR15 seen at the time of the sampling pulse. Should this voltage fall too far, when a phase error exists, TR24 and TR25 will switch on and TR13 will be inhibited via TR18 and TR23 to prevent further sampling. This ensures that sampling can only occur when C62 sees the peak of the 400kHz signal at the source of TR15 and further ensures that a voltage variation arising from a phase error is always of the correct sense to restore lock (see timing diagram Fig. 2.14).

162. Under phase-locked conditions the amplitude of the quadri-correlator output waveform, at TP12, is proportional to the amplitude of the received carrier. This output, therefore, is used to generate an AGC voltage, and is also applied to the signal-to-noise ratio detector ML21.

AGC Stages

163. The quadri-correlator output voltage, held by C62, is applied via R71 to an operational amplifier, ML16. This feeds a voltage follower stage ML24, which in turn feeds a buffer stage, ML19, via the AGC time constant components, D12, R106, C81 and R109. C81 charges rapidly via D12 and R106 whilst a slow discharge path is provided by R109.

164. Transistor TR28 is controlled by the front panel AFC switch (via D1, G1 and G4-sheet 2) such that in the OFF position the transistor conducts and removes the input to ML24.

165. The output from ML19 is applied to output buffer stages ML22, ML23, and also to ML3 via R97, a d.c. level shift stage TR27, LK1 and L5.

Signal-to-Noise Ratio Detector

166. The signal-to-noise ratio detector consists of an operational amplifier, ML21. The output from the quadri-correlator is applied to the non-inverting input and the noise threshold potentiometer, R87, sets the voltage level to the inverting input. The output from ML21 for an acceptable signak-to-noise ratio (normally 10dB) consists of a positive voltage (clamped to +4.7V by R100 and D17) and this changes to 0V once the noise threshold is exceeded.

Divide-by-16 Stage

167. The 400kHz (plus or minus any frequency deviation, D) square-wave signal from ML8a pin 5 (Fig. 29a) is applied to the divide-by-two section of ML5 at pin 8 (Fig. 30a). The resulting 200kHz ± D/2 output is taken from ML5 pin 5; it is then applied (when the AFC is switched on) to the divide-by-8 section of ML6, at pin 6, to produce a 25kHz ± D/16 output at ML6 pin 12. This is applied via a NAND gate switch, G7, as one input to a digital phase comparator, ML9, at ML9a pin 3.

Divide-by-40 Stage

168. The 1MHz reference frequency signal (from R104 sheet 1) is coupled by C9 to a shaper stage consisting of TR2 and NAND gate G2. The square-wave output from G2 is applied to the divide-by-five section of ML5, at pin 6; the resulting 200kHz output is then fed to the divide-by-eight section of ML7, at pin 6, and the 25kHz output at ML7 pin 12 (when the AFC is switched on) is applied via a NAND gate switch, G9, as the second input to the digital phase comparator, ML9, at ML9b pin 11.

Digital Phase Comparator

169. The digital phase comparator consists of a dual D-type flip-flop, ML9a, ML9b, a two-input NAND gate, G10, and a voltage control circuit comprising transistors TR9, TR11 and TR12. It compares the 25kHz ± D signal from ML6 with the 25kHz reference frequency signal, from ML7 (which is derived from the 1MHz reference frequency). Any error existing between these two signals, due to a frequency deviation of the received signal, is used to develop a d.c. voltage which is applied via a hold switch, loop filter and loop amplifier (see Fig. 1.6a at the back of Chapter 1) to a 7 MHz VCO. The action of the circuit is described below, in conjunction with the timing diagram, Fig. 2.15.

170. The output signal from ML6, pin 12, is applied via a NAND gate switch G7, to

the clock input of ML9a. The output signal from ML7, pin 12, is applied via a NAND gate switch, G9, to the clock input of ML9b. The D inputs of ML9 are not connected and float up to logic '1'. Thus when the positive edge from G7 clocks ML9a, the Q output at pin 5 changes to '1' and the $\bar{Q}$ output at pin 6 changes to '0'. Similarly, when the positive edge from G9 clocks ML9b, the Q output changes to '1' and the $\bar{Q}$ output changes to '0'. When both Q outputs are at '1' the output from the NAND gate, G10, changes to '0' clearing both flip-flops via R44 and thus resets the Q outputs to '0' and the $\bar{Q}$ outputs to '1'.

171. Consider the case where the output frequency from the ML6 is high, due to an increase in the frequency of the received signal. This will mean that the positive edge from ML6 will occur before the positive edge from ML7. The resulting setting and resetting of the flip-flops causes increased conduction of TR9, due to the $\bar{Q}$ output waveform from ML9a (see timing diagram Fig. 2,15) as compared with the conduction of TR12; this causes the voltage at the collector of TR11 to become more positive, thereby increasing the voltage applied to the varactor diode of the 7MHz VCO. Thus the frequency of the 7MHz VCO is increased in proprotion to the increase in the frequency of the received signal.

172. If the output frequency from ML6 is low, due to a reduction in the frequency of the received signal, the positive edge from ML7 will occur before the edge from ML6. The $\bar{Q}$ output waveform from ML9b causes increased conduction of TR12, the voltage at the collector of TR11 becomes less positive, and the reduced voltage applied to the varactor diode of the 7MHz VCO causes a corresponding reduction in the VCO frequency.

173. When the two signals are equal in frequency and phase the two flip-flops of ML9 are clocked at the same time, the two $\bar{Q}$ output waveforms are equal and the varactor line voltage remains constant.

Loop Filter and Amplifier

174. The output voltage from the collector of TR11 is applied to a loop filter, R72, C63, C64, via a hold switch, TR19. This transistor is switched off by the conduction of TR20 when either a loss of phase-lock of the 1.6MHz VCO occurs (see page 34a, paragraph 157) or a poor signal-to-noise ratio exists at the receiver input.

175. A guard ring, which is connected to the collector of TR22, is fitted around the loop filter components to prevent the inadvertant discharge of C63, as could otherwise occur, for example, due to moisture on the printed circuit board.

176. The loop filter is followed by a buffer amplifier, TR21, and a d.c. level shift stage consisting of variable resistor R74 and TR22. The varactor line voltage output, at TP4, is applied to the 7MHz VCO and also to the meter switching board for carrier tuning purposes via R81, RLA/1 and board pin 7.

7MHz VCO

177. This consists of transistor TR1 connected into a crystal controlled Colpitts circuit with the parallel combination of preset trimmer C3 and varactor diode D11 in series

with the crystal, XL1. The VCO is driven to a frequency which is equal to 7MHz $\pm \frac{7D}{34}$, where D is the deviation of the received signal. The output signal is coupled by C10 to a shaper stage, TR3 and NAND gate G3, and the square-wave output signal is applied to a divide-by-seven stage, ML4.

Divide-by-7 Stage

178. ML4 ultilises a type of decade counter where the starting point of a count sequence may be preset. A '1' or a '0' at a data input (Da, Db, Dc, Dd) is transferred to the associated output (Ao, Bo, Co, Do) when the strobe (S) input is at '0'. The counting operation is performed on the negative-going edge of the clock pulse.

179. In this application, the Da data input is not connected and thus floats up to logic '1' (approximately +5V) whilst the remaining data inputs (Db, Dc, Dd) are all taken to logic '0' (0V). The counter therefore starts counting at binary 1 and resets at binary 8, i.e. at binary 8 the logic '1' Do output, inverted by G5, resets or strobes the counter, binary 1 is again loaded in and the count sequence repeats.

180. The shaped output signal from the 7MHz VCO is divided by seven and the resulting 1MHz $\pm \frac{D}{34}$ output is taken from ML4 pin 2. This is applied via board pin 10 to the 34MHz generator board where it is used in place of the 1MHz reference frequency derived from the frequency standard.

Carrier Tuning Indicator

181. The 200kHz $\pm \frac{D}{2}$ square wave output from ML5 pin 5 is applied to the D input of flip-flop ML8b, whilst the 200kHz reference frequency square wave from ML5 pin 12 is applied to the clock input of ML8b. The resultant square wave output from ML8b pin 9, the frequency of which is equal to $\frac{D}{2}$, is applied to the negative edge-triggered inputs (Al and A2) of a monostable, ML10. The B1 and B2 inputs of ML10 (not shown on the circuit diagram) are not connected and thus float up to logic '1'.

182. The negative-going edges of the output waveform from ML8b, therefore, trigger ML10 to produce a negative-going pulsed output signal of a fixed pulse width at a repetion rate equal to the difference frequency, $\frac{D}{2}$. This signal is applied via G15, R94, RLA/1 and board pin 7 to the meter switching board where it is used for carrier tuning purposes.

AFC Lock Detector

183. The output from the signal-to-noise ratio detector (ML21, Sheet 1) is applied to the B1 input of ML18 and also to pin 11 of NAND gate G16 via R92, D15. The input to B2 of ML18 is from the 1.6MHz VCO phase-locked loop lock detection circuit via

TR26 (Sheet 1), and this signal is also fed to pin 10 of NAND gate G16, via R95, D16.

184. ML18 is a retriggerable monostable. A positive edge input applied to one of the B inputs will trigger the monostable provided the AI and A2 inputs are at logic '0' (0V) and the remaining B input is at logic '1'. When the monostable is triggered, the $\bar{Q}$ output, which is normally at logic '1', will pulse to logic '0' for a period of time determined by the timing components R83, D14 and C69 (approximately 500 mS).

185. The purpose of the monostable is to allow time for the circuitry (shown on Sheet 2) to stabilize following phase-lock of the 1.6MHz phase-locked loop; it also prevents the AFC lock circuit from being driven rapidly between the locked and unlocked states due to an indeterminate output from the signal-to-noise ratio detector. The operation of the monostable is given in the timing diagram, Fig. 2.16.

186. The output from G16 ('0' for in-lock, '1' for out-of-lock) is inverted by G13 and is then applied as one input to each of the four-input NAND gates, G14 and G15. G14 controls the AFC lock lamp such that the lamp illuminates when all the inputs to G14 are at logic '1'. G15 applies the inverted form of the output signal from the tuning indicator (ML10 pin 6) to the meter switching board provided that the remaining inputs to G15 are at logic '1' and that the AFC switch is set to OFF (see page 2-34g, para. 194).

187. The lock detector for the 7MHz VCO phase-locked loop consists of buffer NAND gates, G11, G12, and a positive edge-triggered dual D-type flip-flop, ML14a, ML14b. The $\bar{Q}$ outputs of the phase comparator flip-flops, ML9a and ML9b, are applied to the D inputs of ML14a and ML14b respectively; the clock input of ML14a is fed from NAND gate switch, G7, and inverter G11, whilst the clock input of ML14b is fed from NAND gate switch, ML2, and inverter G12.

188. The operation of the lock detector is shown in the timing diagram, Fig. 2.17. From this diagram it can be seen that an alternating '0' - '1' output is produced for the out-of-lock condition and a steady logic '1' for the in-lock condition.

AFC On/Off Switching

189. In either of the two AFC on positions of the AFC switch (FULL CARRIER and PILOT CARRIER), an earth (logic '0') is applied to board pin 13. This is routed to relay RLA/1 and also to a switch contact bounce eliminator, GI, TR4.

190. Relay RLA/1 is energised and contact RLA1 connects the varactor line voltage for the 7MHz VCO to the meter switching board via R81 and board pin 7.

191. The action of the AFC switch contact bounce eliminator is as follows. Prior to the operation of the AFC switch the two inputs to G1 (ML1 pins 12 and 13) are both at logic '1' (pin 12 is connected to the +5V rail via R26 and the open circuit at board pin 13 causes ML1 pin 13 to float up to approximately +5V). When the AFC switch is set to FULL CARRIER or PILOT CARRIER, the logic '0' applied to ML1 pin 13 causes the output, at ML1 pin 11, to change to logic '1'. The positive-going edge of this transistion causes

TR4 to conduct and this connects ML1 pin 12 to the 0V line (logic '0'). Thus the output from G 1 is held at logic '1' regardless of a subsequent change in the state of the input applied to ML1 pin 13, until such time as C13 charges and TR4 turns off.

192. The logic '1' output from G1 is applied to an inverter, NAND gate G4, and the resulting logic '0' output is applied to G6 (ML1 pin 4), G8 (ML2 pin 1) and to the base of TR17. The logic '1' output from G6 opens gate G7 for the 25kHz square-wave output from ML6, and the logic '1' output from G8 opens gate G9 for the 25kHz square-wave output from ML7.

193. TR17 is held off unless either a loss of phase-lock of the 1.6 MHz VCO occurs (see page 2-34a, para. 157) or a poor signal-to-noise ratio exists at the receiver input (see page 34c, para. 166). Should either of these two conditions exist a logic '1' output from G16 (see page 2-34e, para. 183) causes TR17 to conduct. This in turn causes conduction of TR20 and the normally-on hold switch transistor, TR19, is turned off.

194. The logic '1' output from G1 (ML1 pin 11) is also applied to G17 (ML17 pins 1 and 2); should either a loss of phase-lock of the 1.6MHz VCO occur or a poor signal-to-noise ratio exist at the receiver input, a logic '1', from G16 (ML17 pin 8), will be applied to G17 at M17 pin 13. The resulting logic '0' output, at ML17 pin 12, is applied as an inhibit signal to the reset (RD) inputs of dividers ML6 and ML7 and also the preset (PR) inputs of the digital phase comparator flip-flops, ML9a and ML9b.

195. When the AFC switch is set to the OFF position, the earth (logic '0') is removed from board pin 13. Relay RLA/1 is de-energised and contact RLA1 connects the output from G15 to the meter switching board via R94 and board pin 7 (see page 1-34e, paras. 181/182).

196. Pin 13 of ML1 floats up to logic '1' (approximately +5V) and the resulting logic '0' output is applied to the following:-

(1) Inverting NAND gate, G4

(2) The strobe (S) input of ML6; this forces the Do output, at ML6 pin 12, to logic '1'.

(3) The strobe (S) input of ML7; this forces the Do output, at ML7 pin 12, to logic '1'.

(4) G14 (ML20 pin 2) to extinguish the AFC LOCK lamp.

(5) G17 (ML17 pins 1 and 2); this holds the output from G17 (ML17 pin 12) at logic '1' and prevents a logic '1' out-of-lock output from G16 (ML17 pin 8) from inhibiting dividers ML6 and ML7, and the digital phase comparator, ML9.

197. The logic '1' output from G4 opens gates G6 and G8, the logic '1' from ML6 pin 12 opens gate G7 and the logic '1' from ML7 pin 12 opens gate G9. The 1MHz square-wave reference output from G2 is now applied via G6 and G7 to the digital phase comparator flip-flop, ML9a, and also via G11 to the lock detector flip-flop, ML14a. The output signal from the divide-by-seven stage, ML4 at pin 2, is applied via G8 and G9 to

ML9b of the digital phase comparator and also via G12 to ML14b of the lock detector. Thus when the AFC switch is in the OFF position, the 7MHz VCO is phase locked to the reference 1MHz signal.

198. The logic '1' output from G4 is also used to switch off the AGC via R101 (sheet 1), and it causes conduction of TR19, via TR20, TR17, to phase-lock the 7MHz VCO to the 1MHz reference frequency.

LOGIC BOARD PS365 Fig. 34

199. The logic board contains the front panel operated MHz switch, numerous steering diodes and eight buffer AND gates. It provides MHz frequency and range information for a number of circuits within the receiver.

200. The MHz switch has three wafers. Wafer SA1 provides frequency range information for the RF unit (board pins 26 to 32) and the First Mixer board (board pins 2 and 3); wafer SA2 provides MHz frequency setting information in nines complement coded form for the programmed dividers of the Upper Transfer Loop PS338 and the HF loop PS337 (board pins 7 to 14), whereas wafer SA3 provides oscillator selection information for the HF loop (pins 4, 5 and 6).

201. The outputs controlled by wafers SA1 and SA2 are given in the following Tables. The wiper of wafer SA3 is connected to the LO INT/EXT switch. When this switch is set to INT, an earth (0V) is applied via SA3 to board pin 4 (01 output) for MHz switch settings from 0 to 7 inclusive, to board pin 6 (02output) for settings from 8 to 17 inclusive or to board pin 5 (03 output) for settings from 18 to 29 inclusive, to select the appropriate oscillator. When the LO switch is set to EXT, the wiper of SA3 is open-circuited and all three oscillators on the HF Loop board are switched off.

MHz SWITCH SETTING	BOARD PIN NUMBERS								
	2	3	26	27	28	29	30	31	32
0		0						0	
1		0					0		0
2 - 3		0				0			0
4 - 7	0				0				0
8 - 14	0			0					0
16 - 29	0		0						0

OUTPUT TABLE: WAFER SA1

MHz SWITCH SETTING	BOARD PIN NUMBERS								DECIMAL
	10	9	8	7	14	13	12	11	
00	1	0	0	1	1	0	0	1	99
01	1	0	0	0	1	0	0	1	98
02	0	1	1	1	1	0	0	1	97
03	0	1	1	0	1	0	0	1	96
04	0	1	0	1	1	0	0	1	95
05	0	1	0	0	1	0	0	1	94
06	0	0	1	1	1	0	0	1	93
07	0	0	1	0	1	0	0	1	92
08	0	0	0	1	1	0	0	1	91
09	0	0	0	0	1	0	0	1	90
10	1	0	0	1	1	0	0	0	89
11	1	0	0	0	1	0	0	0	88
12	0	1	1	1	1	0	0	0	87
13	0	1	1	0	1	0	0	0	86
14	0	1	0	1	1	0	0	0	85
15	0	1	0	0	1	0	0	0	84
16	0	0	1	1	1	0	0	0	83
17	0	0	1	0	1	0	0	0	82
18	0	0	0	1	1	0	0	0	81
19	0	0	0	0	1	0	0	0	80
20	1	0	0	1	0	1	1	1	79
21	1	0	0	0	0	1	1	1	78
22	0	1	1	1	0	1	1	1	77
23	0	1	1	0	0	1	1	1	76
24	0	1	0	1	0	1	1	1	75
25	0	1	0	0	0	1	1	1	74
26	0	0	1	1	0	1	1	1	73
27	0	0	1	0	0	1	1	1	72
28	0	0	0	1	0	1	1	1	71
29	0	0	0	0	0	1	1	1	70

OUTPUT TABLE: WAFER SA2

SHAFT ENCODER (RA.1772 only) Fig. 36

202. The shaft encoder is an optical displacement transducer of the incremental type. A graticule, of a transparent material with opaque stripes, is attached to the encoder spindle and is made to rotate between a pair of lamps and a pair of photo-transistors. As the graticule rotates, the photo-transistors are alternately darkened and illuminated, thereby producing two sinusoidal output waveforms (outputs A and B at pins 1 and 3). The two photo-transistors are physically displaced such that these two output waveforms are 90° out of phase, with output A leading output B for one direction of rotation and lagging output B for the reverse direction of rotation. The two outputs, preset by potentiometers R1, R2, are applied to the display board.

DISPLAY BOARD PM371 (RA.1772 only) Fig. 37

203. The display board consists of a reversible counter chain and associated digital display which provides 100kHz, 10kHz, 1kHz, 100Hz and 10Hz frequency setting information, in BCD form, for the programmed dividers of the LF, lower transfer and upper phase-locked loops.

204. The A output signal from the shaft encoder, at board pin 32, is applied to a shaper stage, TR2, and a schmitt trigger, G1. The B output signal from the shaft encoder is applied to a similar circuit comprising TR3 and G2.

205. The square-wave output from G1, at ML27 pin 8, is applied to three monostables, ML28a, ML28b, and ML33a, which is used to inhibit the out-of-lock detector (see para. 223). ML28a and ML28a are retriggerable monostables. A positive edge applied to the B input will trigger the monostable provided the A input is at logic '0' (0V). Alternatively, a negative edge applied to the A input will trigger the monostable provided the B input is at logic '1' (approximately +5V). When the monostable is triggered, the Q output, which is normally at logic '0', will pulse to logic '1' for a period of time determined by the timing components connected to the C and R pins (in this case approximately 7 microseconds). A logic '0' applied to the clear input (CL) overrides the A and B inputs and resets the Q output to logic '0'.

206. The positive oing output pulses from ML28b and ML28a (in the fast tune mode only, see para. 207) are applied to a series of pulse steering NAND gates, G4 to G11. Also applied to these gates is the square-wave output from G2(ML27 pin 6) together with the inverted output, via G3 (ML17 pin 8).

Fast Tuning Mode

207. When the fast tuning mode is selected (at the front panel), an earth (0V) is applied to board pin 29. This is routed to two OR gates, G13, G14, and also to an inverter, NAND gate G12. The resultant logic '1' output from G12, at ML8 pin 12, is applied to the clear inputs (CL) of monostable ML28a and the 10Hz up/down counter, ML6. As stated para. 205, a logic '0' is required to clear ML28a and the monostable is

therefore enabled. ML6 however, is cleared and under this condition the + and - outputs, at pins 12 and 13, are forced to logic '1', thereby opening AND gates G16 and G17 for positive-going output pulses from either of the two OR gates, G13, G14. Thus in the fast tune mode, positive-going pulses are produced from both ML28a (positive edge triggered) and ML28b (negative edge triggered) by the square-wave output from G1, whilst ML6 is inhibited. In this mode, one revolution of the shaft encoder spindle produces 500 pulses, i.e. a tuning rate of 50kHz per turn. A timing diagram for the fast tune mode is given in Fig. 2.18.

Slow Tuning Mode

208. The earth is removed from board pin 29 when the slow tuning mode is selected; the +5V memory supply (A) is applied via R16 to the two OR gates, G13, G14, and to the inverter, NAND gate G12. The resultant logic '0' output from G12 (ML8 pin 12) is applied to the clear inputs (CL) of monostable ML28a and the 10Hz up/down counter, ML6. Thus ML28a is cleared, the Q output is forced to logic '0' and this is inverted by gates G4 and G6 to open gates G8 and G9 for the outputs from G5 and G7. ML6 is enabled and the output pulses from ML28b, at a rate of 250 per revolution of the shaft encoder spindle, are applied to either the up or the down input of ML6 via G10 or G11. The slow tuning rate is equal to 2.5kHz per turn.

Tuning Lock

209. When the tuning rate switch is set to the LOCK position, an earth (0V) is applied to board pin 30. This inhibits gates G10 and G11 and stops the counting action of the up/down counter chain, ML1 to ML6.

Up/Down Counters

210. The output pulses from either G16 (up pulses) or G17 (down pulses) are applied to a chain of cascaded up/down BCD counters, ML1 to ML6. Each counter is triggered by a low-to-high level transistion of either count input and the direction of counting is determined by which count input is pulsed while the other count input is at logic '1'.

211. A logic '0' load pulse is provided by TR4 when the receiver is first switched on. The memory +5V supply, at board pin 23, charges capacitor C27; TR4 conducts and effectively connects the load input of each counter to the 0V rail. Capacitor C27 discharges via R23 and TR4 is subsequently turned off.

212. The load pulse presets each counter to zero by transferring the 0V(logic '0') at the input pins (A, B, C, D) to the corresponding output pins (QA, QB, QC, QD). Thus the kHz portion of the receiver frequency is reset to zero each time the +5V memory supply is interrupted i.e. each time the receiver is switched on or following an interruption in the main source of a.c. power. To prevent this loss of frequency setting information, an external +12V supply may be connected to the rear panel STD/+12V terminal.

213. A timing diagram depicting the operation of a single up/down counter is given in Fig. 2.19. This diagram shows the following sequence:

(1) Load (preset) to zero.
(2) Count up to nine, carry, zero, one and two.
(3) Count down to zero, borrow, nine, eight and down to two.

Range Blanking

214. A negative going range blanking pulse is applied to the upper loop board via board pin 27, each time a 9 - to - 0 or a 0 - to - 9 transistion of the 10kHz digit occurs (see paragraph 39). The borrow (-) and carry (+) lines between ML4 and ML3 are connected to a two - input AND gate, G23. When a logic '0' borrow or carry pulse occurs (see Fig. 2.19) the resultant logic '0' output from G23 triggers a monostable, ML33b, which produces a negative - going output pulse (duration approximately 25 mS) at ML33b pin 12.

Overspill

215. The overspill circuitry comprises ML1, gates G26 to G32 inclusive and lamp switching transistors TR5, TR6 and TR7. It extends the tuning range of the selected 1MHz band by 20kHz at each end of the band. For example, if the MHz switch is set to, say, 5MHz, the receiver frequency range covered by the kHz tuning control is from 4.97999 to 6.02000MHz. For frequencies below 5.00000MHz, lamp 'L' illuminates numeral 4 and for frequencies above 5.99999MHz, lamp 'H' illuminates numeral 6.

216. Using our example frequency of 5MHz, for any kHz control setting between 5.00000 and 5.99999MHz, the QA output from ML1 will be at logic '0'. This is inverted by NAND gate G27 and TR6 conducts to complete the circuit for lamp 'N' via board pin 25.

217. When the kHz control setting passes beyond 5.99999 into the overspill region, a carry pulse from ML2, at pin 12, is applied to the UP input of ML1. The QA output, at ML1 pin 3, changes to logic '1' and this is applied to AND gate G29. The logic '0' QD output at ML1 pin 7, inverted by G28, is also applied to G29 and the resulting logic '1' output causes TR7 to conduct and switch on lamp 'H' via board pin 26.

218. The logic '1' output from G29 is also applied as one input to NAND gate G24. The second input to this gate is fed from the QB output from the 10kHz up/down counter, ML3. Thus when, in the overspill condition, ML3 reaches a count of binary 2, the QB output changes to logic '1', the output from G24 changes to '0' and the resultant '1' output from G10 stops the count-up sequence at 02000.

219. When the kHz control setting passes into the overspill region at the opposite end of the 1MHz band, i.e. settings below 5.00000MHz, a borrow pulse from ML2, at pin 13, is applied to the DN (down) input of ML1. This causes both the QA and the QD outputs, at ML1 pins 3 and 7, to change to logic '1' and lamp 'L' is illuminated via TR5 and board pin 24.

220. The logic '1' output at ML1 pin 7 is also applied as one input to NAND gate G25. The second input to this gate is fed from the QB output of the 10kHz up/down counter, ML3. Thus when, in the overspill condition, ML3 counts down to binary 7, the QB output changes to logic '1', the output from G25 changes to logic '0' and the resultant '1' output from G11 stops the count-down sequence at 97999.

221. Gates G26, G30, G31 and G32 are connected as a monostable to provide a positive going output pulse each time a '0' - to - '1' or a '1' - to - '0' transition occurs at its input. Pin 28 is fed from the A1 output at pin 7 of the logic board. With reference to the output table for wafer SA2 of the MHz switch, on page 2-36, it can be seen that the logic level at pin 7 alternates as the switch is rotated. Thus each time the MHz switch is moved to an adjacent position, a logic level transistion occurs at board pin 28 and a positive going pulse is applied to the clear (CL) input of ML1. When in the overspill condition therefore, the QA and/or the QD outputs are reset to logic '0' and lamp 'N' illuminates behind the numeral selected by the MHz switch.

Out-of-Lock Detector

222. The lock detector lines at board pins 33 (from PM454), 34 (from PS337) and 35 (from PS338) are applied to a diode OR gate, D1, D2, D3, and the out-of-lock lamp switching transistor, TR1. The collector of TR1 is taken to earth (0V) via D6 and board pin 40.

223. ML33a is a re-triggerable monostable which inhibits the out-of-lock lamp switching transistor, TR1, whilst receiver tuning is in progress. The positive-going output pulse period is approximately 50mS.

OUT OF LOCK INDICATOR BOARD PS423 (RA.1771 only) — Fig. 39

224. This board contains a diode OR gate, D1, D2, D3, and a lamp switching transistor, TR1. Should a logic '0' out of lock signal appear at any of the input pins, 4, 5 or 6, TR1 conducts and the out of lock lamp illuminates via R2 and board pin 3.

METER SWITCHING BOARD — Fig. 40

225. A double-pole, ten-way switch, SA, connects the front panel meter, M1, to various metering points within the receiver, via the meter board circuitry, as follows:-

226. (1) Position 1: Tune Carrier This metering facility is used in conjunction with the AFC switch and is, therefore, only applicable to versions fitted with the AFC board. When the AFC switch is set to OFF, the output signal from the carrier tuning indicator on the AFC board (paragraph. 181) is applied to the meter via board pin 23, R12 and SA2. This is a positive-going pulsed signal of a fixed pulse width where the pulse repetition rate is equal to the difference in frequency between the received carrier and an internally derived reference frequency. For precise carrier tuning the receiver tuning control is adjusted for a minimum meter reading. When the AFC switch is set to either FULL CARRIER or PILOT CARRIER,

the meter is connected to the varactor line of the 7MHz VCO on the AFC board and provides an indication of the available AFC hold range (AFC + 0 - scale). It may be used to determine whether a slight adjustment of the receiver tuning is required (due to a drift in the transmission frequency) to maintain AFC lock.

(2) Position 2: RF This provides an indication of the strength of the received signal and is derived from the AGC output signal from the main IF/AF board (SSB receivers) or the differential AGC output from the main and ISB IF/AF boards (ISB receivers). The AGC output signal from the main IF/AF board is applied to the base of emitter follower TR2 and thence to the meter via R4 and R14. For ISB versions the AGC output signal from the ISB IF/AF board is applied to the base of TR1 and the output is applied to the meter.

(3) Position 3: LSB The audio line output signal from the ISB IF/AF board (ISB versions only) is applied to the meter via board pins 11 and 12, R3 and bridge rectifier, D5 to D8.

(4) Position 4: AM/USB The audio line output signal from the main IF/AF board (which carries all modes generally, but not LSB in ISB receivers) is applied to the meter via board pins 15 and 16, R2 and bridge rectifier, D1 to D4.

(5) Position 5: DRIVE LEVEL This provides an indication of the local oscillator output drive level applied to the first mixer. A preset variable resistor on the first mixer board allows for adjustment to obtain a meter indication within the 'V' portion of the meter scale.

(6) Positions 6, 7, 8 and 9: Voltage rail monitoring The regulated +20V, +12V, +5V and -7V outputs from the power supply regulator board are applied to the meter switch via suitable dropping resistors to provide, in each case, a meter indication within the 'V' portion of the meter scale.

(7) Position 10: FSK O/P The mark and space FSK output signal from the FSK board is applied to the meter via board pin 9 and resistor R5.

POWER SUPPLIES

Fig. 46

227. The power supply section of the receiver comprises a supply input filter, voltage selector unit, mains transformer 1T1, regulator board PM370 and three series-pass power transistors mounted on a heatsink attached to the rear panel of the receiver. Stabilised supplies of -7V, +5V, +12V and +20V are provided together with an 80-0-80V telegraph supply. Additional circuitry, mounted on the AF and memory board (para. 236), contains a +14.5V regulator for the audio amplifiers, and, for the RA.1772 only, a +5V memory supply. The smoothing capacitors, 1C1 to 1C6, are mounted on the inside of the rear panel.

Supply Input Filter

228. The supply input, at 1PL1, is fed via a supply fuse, 1FS3, and a double pole ON/OFF switch, to the supply input filter, 1L1, 1L2 and capacitors C18 to C21. The filtered output is connected to the mains transformer, 1T1, via the voltage selector unit

1VS1.

Regulator Board PM370

229. This utilises four identical integrated circuit regulators, ML1 to ML4. This device consists of a temperature compensated reference amplifier, error amplifier, series pass transistor and current limit circuitry. An equivalent circuit of the device is given below (page. 2- 43).

230. The error amplifier is used to compare the reference voltage (maximum approximately +7V) with a sample of the final stabilised output voltage (via a potential divider if greater than the reference voltage) and the output of the error amplifier is then used to control the series pass transistor. This transistor is also controlled by a current limiting stage which itself is controlled by the current drawn from the supply by the external circuitry.

-7V Regulator

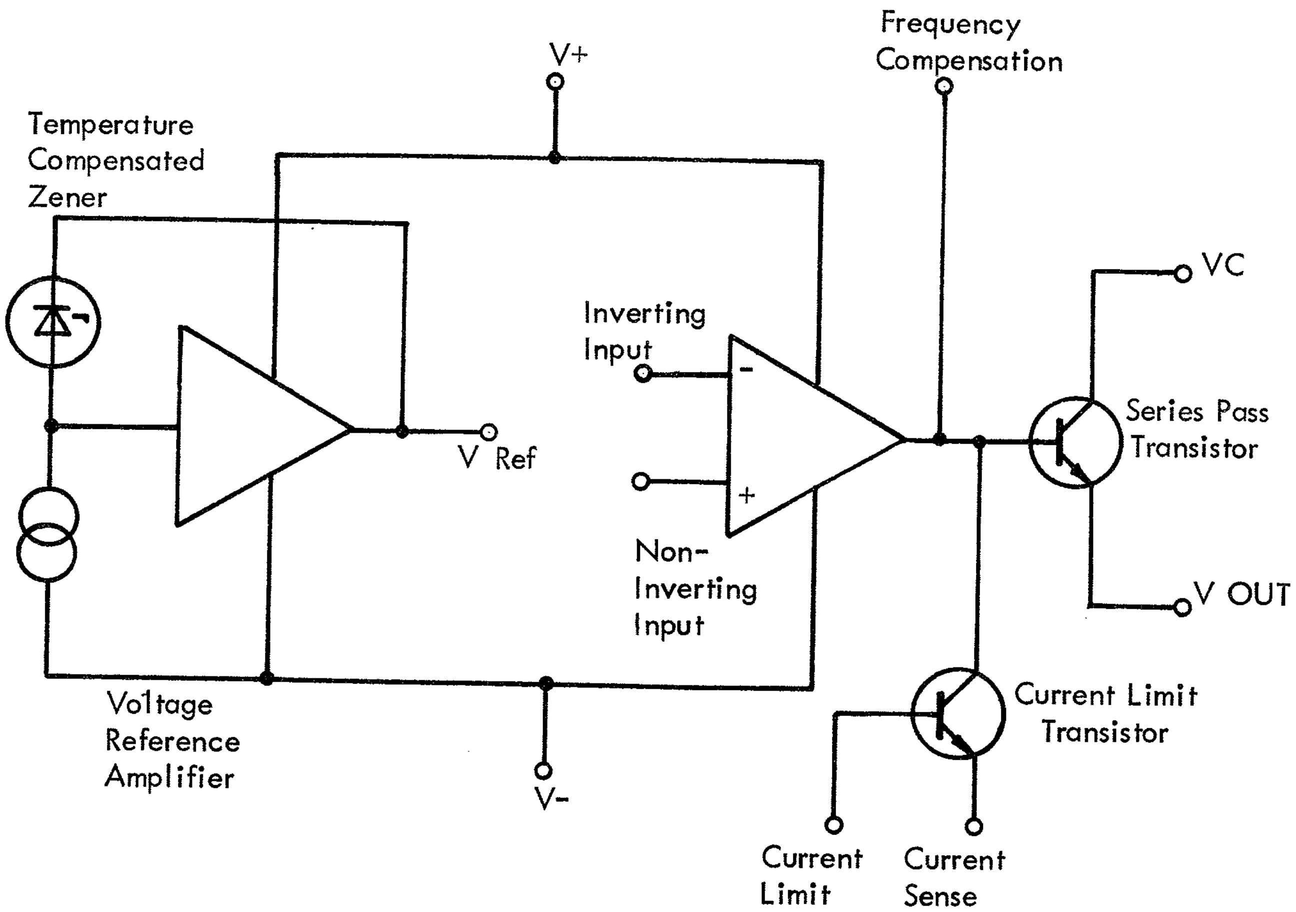
231. A 10.5V secondary winding of 1T1 is connected to a full wave bridge rectifier, D1, via board pins 49 and 50 and link LK1. The positive output from D1 is applied to the collector of the external series pass transistor, 1TR1, via board pin 1, whereas the emitter of 1TR1 is returned to the negative output of D1 via pin 4, R21 and R14. The positive supply voltage for ML1 (V+) and also the collector voltage (VC) for the internal series pass transistor are taken from the +12 regulated supply. The output from the reference amplifier (V REF) is applied via R1 to the non-inverting input of the error amplifier whilst the inverting input is connected to the -7V regulated output via a potential divider R13, R9, preset voltage adjust potentiometer R8, and R7. Current foldback is provided by R14, R21, 1R12 and 1R14.

+5V Regulator

232. Bridge rectifier D2 is fed from a 10.5V secondary winding of transformer 1T1 via board pins 45 and 46 and link LK6. The positive output from D2 is applied to the collectors of the two series pass transistors, TR1 and 1TR2. The positive supply voltage for ML2 (V+) and also the collector voltage (VC) of the internal series pass transistor are taken from the +20V regulated supply. The reference voltage level applied to the non-inverting input of the error amplifier is preset by the potentiometer, R3, and the inverting input is taken from the 5V output via R15. Current foldback is provided by R16, R22, 1R13 and 1R15.

+12V Regulator

233. This supply is derived from a 16.5V secondary winding of transformer 1T1. The positive output from the bridge rectifier, D3, is applied to the collectors of the two series pass transistors, TR2 and 1TR3, whereas the positive supply voltage for ML3 and the collector voltage for the internal series pass transistor are taken from the +20V regulated supply. The reference voltage is applied via R5 to the non-inverting input of the error amplifier whilst potentiometer R17 presets the voltage level applied to the inverting input. The regulated +12V output is taken to board pins 16, 17 and 18, and to the oven of the



Equivalent Circuit: Voltage Regulator IC frequency standard via R32, D6 and pin 20. Current foldback is provided by R18, R24 and 1R16.

+20V Regulator

234. This stage, which is similar to the +12V regulator, is fed from a 23V secondary winding of 1T1 and bridge rectifier D4. The regulated output is preset by potentiometer R19. Current foldback is provided by R12, R20, R28 and R34.

Telegraph Supply

235. The 80-0-80V telegraph supply is provided by a centre-tapped secondary winding of 1T1 and a full wave bridge rectifier, D5. Smoothing is provided by 1R10, 1C5 and 1R9, 1C6.

AF AND MEMORY REGULATOR BOARD PS427/1 Fig. 48

236. This board may contain two circuits. A regulator circuit provides a +14.5V supply for the main IF/AF board and also for the ISB IF/AF board, where fitted. The 5V memory supply circuit is fitted to the RA.1772 only and relies for its operation on an externally derived +12V supply. Its purpose is to maintain the +5V supply to the display board and so prevent the loss of frequency setting information as would otherwise occur following a power failure.

14.5V Regulator

237. This consists of a three-terminal positive voltage regulator, ML2, together with a buffer amplifier, ML1, and a preset output level adjust potentiometer, R3. It is fed from an unregulated 23V supply from the power supply regulator board PM370.

Memory Supply

238. An unregulated 14V supply from the regulator board PM370 is applied to board pin 9, whilst the +12V frequency standard oven supply is applied to board pin 8. The oven supply (see fig. 46) is taken from the regulated +12V supply via a resistor and a diode (R32, D6) or, in the event of a power failure, from an external +12 supply (connected to the rear panel STD/+12V terminal) via two series connected diodes (D7, D8).

239. The unregulated 14V supply at board pin 9 is routed by diode D2 to a three-terminal +5V regulator, ML3, and also to the base of TR1 via potential divider, R5, R6. TR1 is turned on and thus holds off the regulator transistors TR2 and TR3 to isolate the +12V supply.

240. Should the main source of a.c. power subsequently fail, the 14V supply at board pin 9 is removed, TR1 is turned off and the +12V oven supply is routed via TR2 and D1 to the +5V regulator, ML3.

FSK DEMODULATOR PM368

Fig. 32

Mixer

241. The 1.4MHz IF output signal (± the FSK shift) at board pins 18 and 17, from the main IF/AF board, is applied via a bandpass filter to a mixer, ML1. The second input to the mixer is derived from a crystal oscillator.

Crystal Oscillator

242. A 1398kHz crystal oscillator (Clapp circuit) is formed by TR1, TR2 and associated components. Fine tuning to 1398kHz ± 1Hz is achieved by C17.

Limiting Amplifier

243. The difference output from the mixer ML1 (2kHz ± Df, where 2Df is equal to the FSK shift) is fed to a limiting amplifier consisting of ML2, ML3 and associated components. The output from the limiting amplifier is a clipped sinewave signal, which is fed to two active filters.

Active Filters

244. Two active filters are formed by ML4, ML5 and associated components. They are both bandpass filters, with the upper one (ML4) centred on 2600Hz and the lower one (ML5) centred on 1400Hz.

245. The output from each filter is an amplitude modulated signal. Frequencies in the pass-band are not attenuated as much as frequencies outside the pass-band, and as the FSK signal is frequency modulated (2kHz ± Df), the envelope shape of the output will be a series of pulses.

246. The output from the 2600Hz filter is of large amplitude for the FSK signal, 2kHz + Df, and of small amplitude for the FSK signal, 2kHz - Df. The output from the 1400 Hz filter is the complement of this. The output from each filter is full-wave rectified.

Full Wave Rectifiers

247. ML6 and ML7 are connected as full-wave rectifiers. The operation of each is as follows. During the negative half-cycle output from the active filter, diode D2 (or D5) becomes reverse biased. The - input to ML6 (or ML7) is clamped to a reference voltage, set by zener D1 to be approximately 9V above -7V i.e. +2V, and approximately half way between +12V and -7V. The negative signal is inverted and amplified in the unity gain amplifier ML6/ (or ML7) and passed to the input of the differential amplifier ML8.

248. During the positive half-cycle output from the active filter, diode D2 (or D5) becomes forward biased. The signal is thus passed to the output of ML6 (or ML7) with inversion.

Differential Amplifier

249. ML8 and associated components form a differential amplifier. To balance the inputs, R45 is inserted into the signal line from ML7, and is set such that with a 1.4MHz input (no shift), the inputs to ML8 are of maximum amplitude without the output of ML8 switching. The output from ML8 is compared, in ML10, with the reference voltage (as set by zener D1). The pulse output from ML10 is clamped to between 0V and 5V approximately by zener diode D7 before being applied as the FSK output at board pins 6 and 19, and to the diversity signal comparator and switch.

Diversity Signal Comparator and Switch

Note: For the purposes of this description, the 'parent' receiver is the receiver which contains the FSK circuits under discussion.

250. This circuit consists of schmitt NAND gates G2 and G7, NAND gates G1, G3, G4, G5, G6, G8, G9 and G10 and JK flip-flop ML13.

251. According to the state of the output from the AGC comparator ML9, the FSK signal from either the parent (main channel) receiver or the second (diversity) receiver (FSK IN) is routed to the output (of G9). Both FSK signals are phase compared, and switching will not occur until either one adopts the same logical state as the other.

252. The AGC comparator consists of a differential amplifier, ML9, which is used to compare the diversity AGC input voltage with a voltage derived from the main channel AGC voltage. The output from ML9 is at logic '1' when the + input is more positive than the - input.

253. The function of the JK flip-flop ML13 is as follows:-

State before CK edge		State after CK edge
J	K	Q
0	0	Qn
0	1	0
1	0	1
1	1	$\overline{Qn}$

Where:- J = J1, J2, $\overline{J3}$
K = K1, K2, $\overline{K3}$
Qn = State of Q before clock edge
$\overline{Qn}$ = State of $\overline{Q}$ before clock edge.

254. A timing diagram to show the operation of the diversity signal comparator and switch is shown in Figure 2-20. The top two waveforms show example FSK signal

outputs from the parent receiver and the second receiver. It can be seen that the signals, although the same, are out-of-phase with each other.

255. Up to point A, the output from the AGC comparator (input to ML13/$\overline{J3}$/K2) is approximately 0V, indicating that the AGC voltage from the parent receiver is more positive than that from the second receiver. The circuit has already switched the FSK output of the parent receiver to the output of the switch (shown as the inverse of the FSK input at G9/11). The condition of the J and K inputs to flip-flop ML13 causes the Q and $\overline{Q}$ outputs from ML13 to remain unchanged when the flip-flop is clocked. The clock pulses are not shown as they occur at a high speed relative to the FSK signal; for the purposes of the timing diagram, flip-flop operation occurs as soon as the input conditions are changed. The $\overline{Q}$ output is at logic '0', which holds the output from NAND gate G10 at logic '1', irrespective of the conditions of its second input. The Q output is at logic '1' which enables NAND gate G8 to act as an invertor for the signal appearing on its second input; this second input is derived from the FSK signal from the parent receiver. As the output from G8 is at logic '1', NAND gate G9 acts as an inverter to the input from G10. The output from G9 is thus the same as the FSK signal from the parent receiver.

256. At point A, the AGC level changes to indicate that the second receiver is carrying the stronger FSK signal. The condition of the J and K inputs is changed, and at the next clock pulse, the Q output goes to logic '0', thereby inhibiting the FSK signal flow from the parent receiver, and the Q output goes to logic '1' to enable the FSK signal flow from the second receiver. The output at G9/11 is the FSK signal from the second receiver.

257. At point B, the AGC level changes to indicate that the parent receiver is carrying the stronger FSK signal. However, the FSK signal from the parent receiver is out-of-phase with that from the second receiver. The inputs to the JK flip-flop are arranged such that the outputs will not switch until the FSK signals are in-phase, as at point B1. On receipt of the next clock pulse, the FSK signal fromthe parent receiver is switched to the output.

258. The operation at points C and C1 is similar to that at points B and B1, the difference being that at B/B1, switching did not occur until the FSK signal from the parent receiver gained a logic '1' state (to agree with the FSK signal from the second receiver).

FSK Inhibit Switch

259. The FSK signal is clocked through the D-type flip-flop ML16 while the preset (PR) input is at logic '1' (FSK normal or reverse position of the receiver MODE switch has been selected and a logic '0' (0V) is applied to board pin 10). For the remaining positions of the MODE switch, the logic '0' at pin 10 is removed and the flip-flop is preset (Q output goes to logic '1').

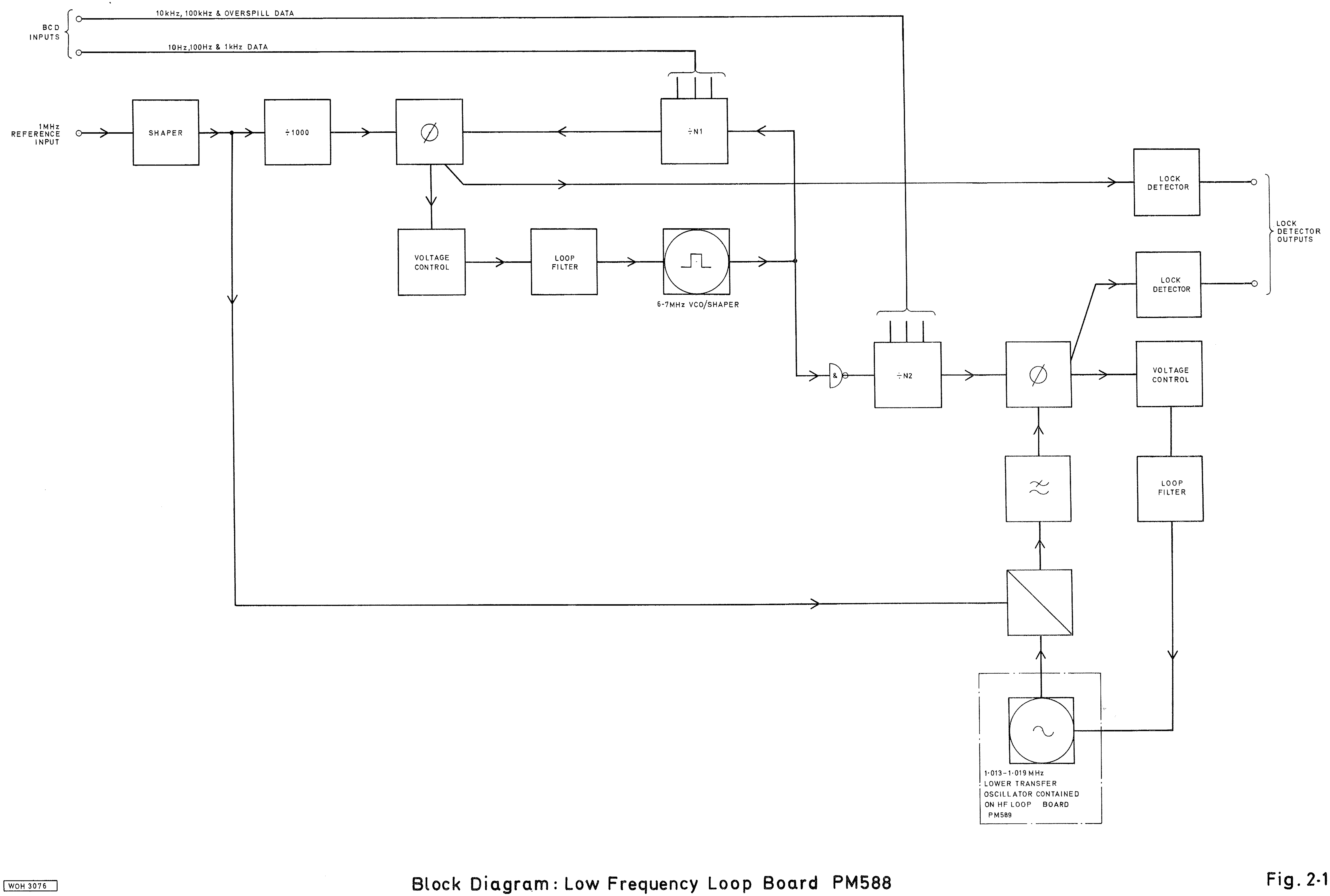
Note: The clock frequency is very high compared to the FSK signal frequency, thus there is only a small time delay between the input and output of ML16.

Normal/Reverse Switch

260. The FSK signal and its inverse appear at the output of ML16 (Q and $\bar{Q}$ respectively). According to the level at the input of NAND gate G13 (wired as an inverter), either the FSK signal or its inverse are routed through to ML18, a relay driver. The input to G13 (earth to reverse) is at logic '0' when the FSK reverse position on the receiver MODE switch has been selected, and at logic '1' for other modes.

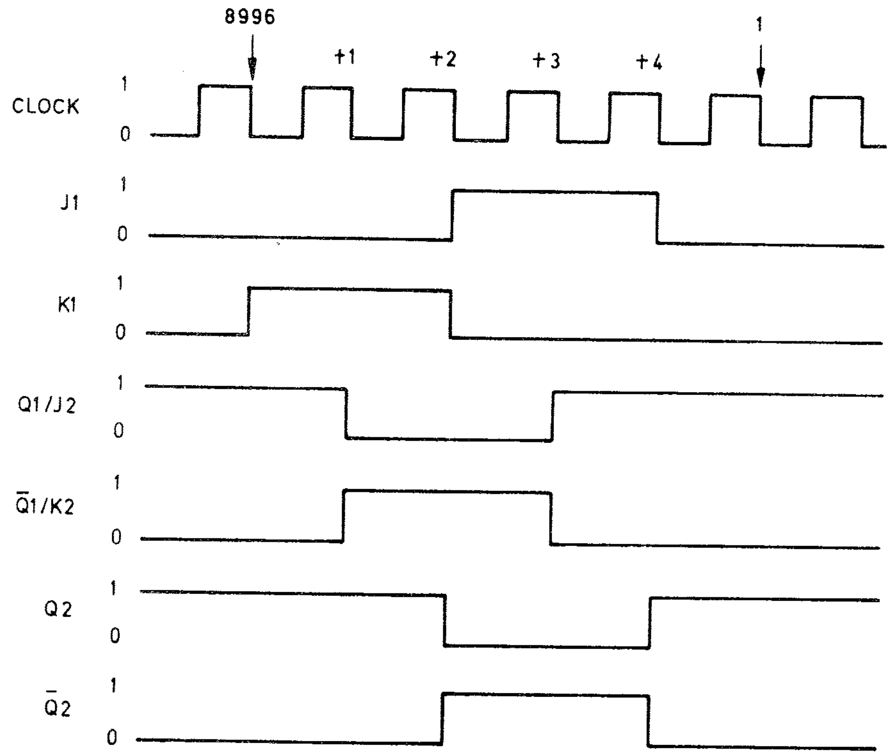
261. When board pin 11 (earth to reverse) is at logic '0' the output from G13 is at logic '1' causing NAND gate G14 to act as an inverter to the FSK signal from ML16. The output from NAND gate G15 is held at logic '1' by the logic '0' input, therefore, NAND gate G16 acts as an inverter to the output from G14. When board pin 11 is at logic '1' the output from G14 is held at logic '1' and G15 acts as an inverter to the inverted FSK signal from ML16.

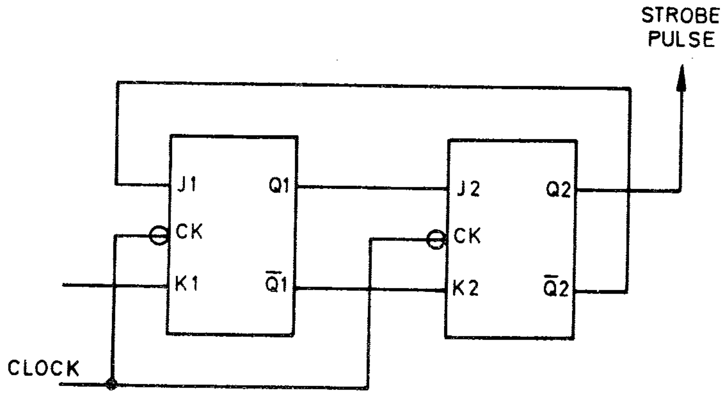
262. The FSK signal from the normal/reverse switch is amplified by ML18 before being applied to the FSK relay.



Block Diagram: Low Frequency Loop Board PM588

Fig. 2·1



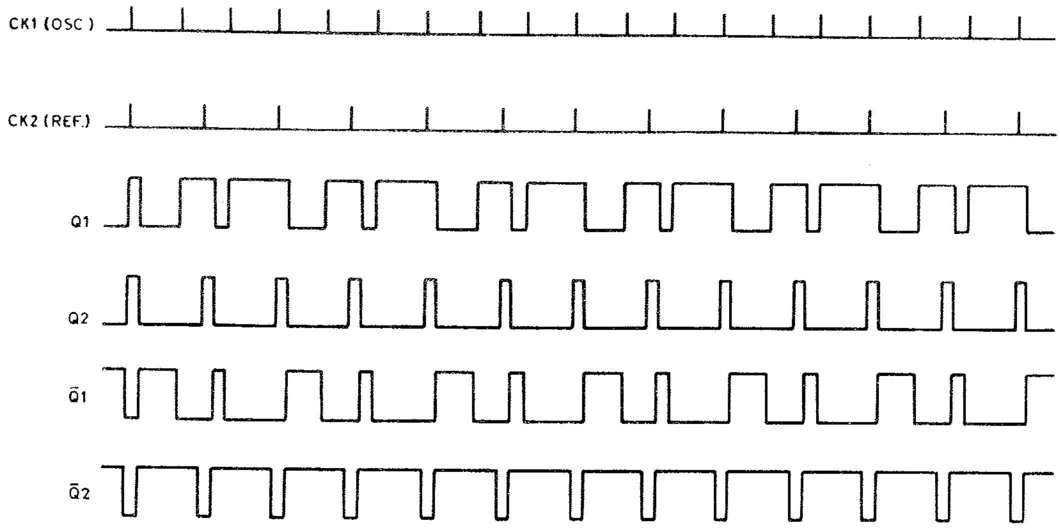


TRUTH TABLE (Each Section)		
tn		tn + 1
J	K	Q
0	0	Qn
0	1	0
1	0	1
1	1	Q̄n

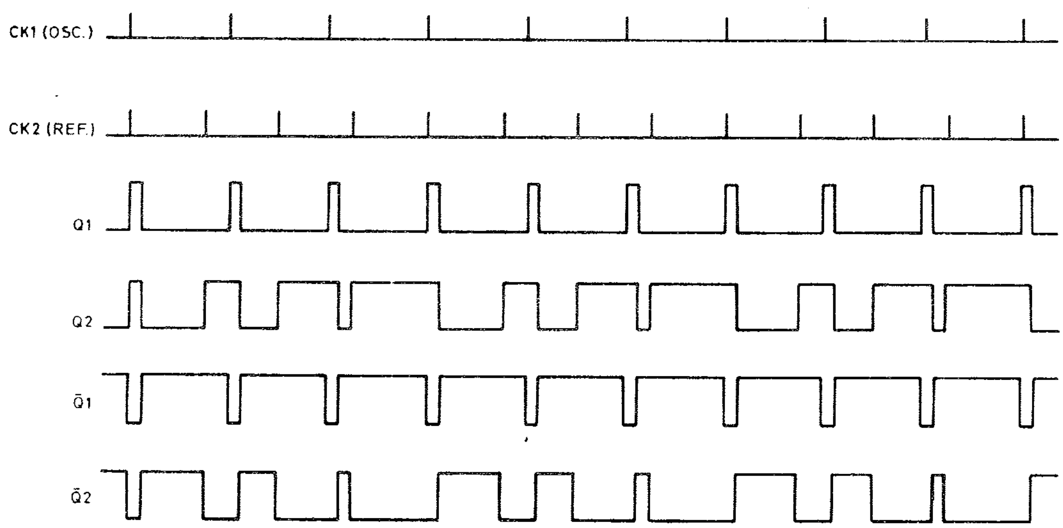
WOH3076

Timing Diagram: Strobe Pulse Generation LF Loop PM588

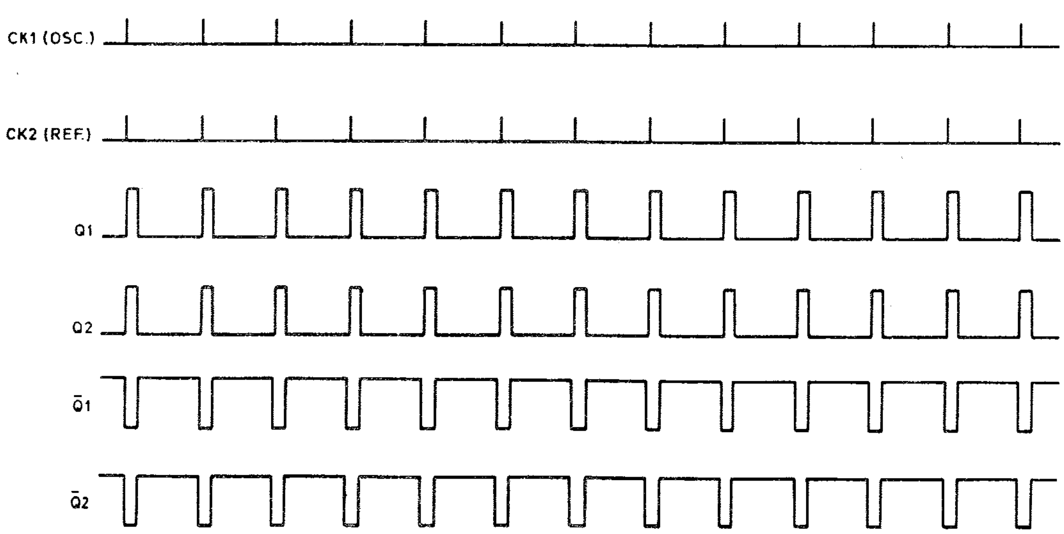
Fig. 2·2



OSCILLATOR LEADING (FREQUENCY HIGH)



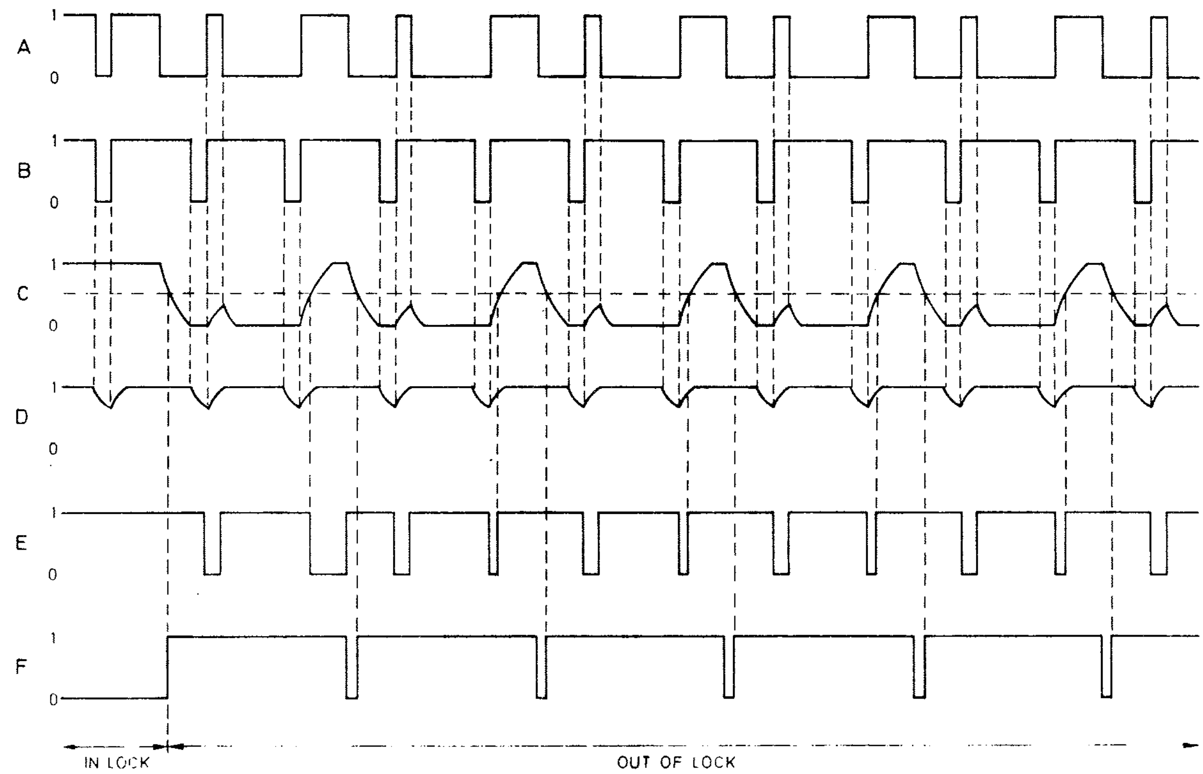
OSCILLATOR LAGGING (FREQUENCY LOW)

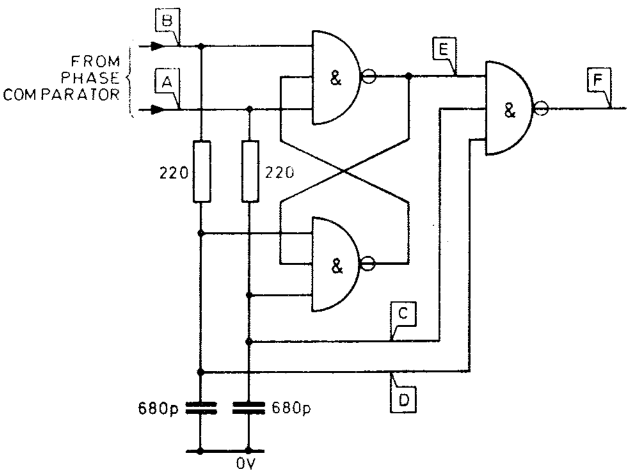


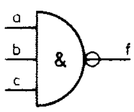
OSCILLATOR AND REFERENCE IN PHASE

WOH 3076/2

Timing Diagram : Phase Comparator Fig. 2·3





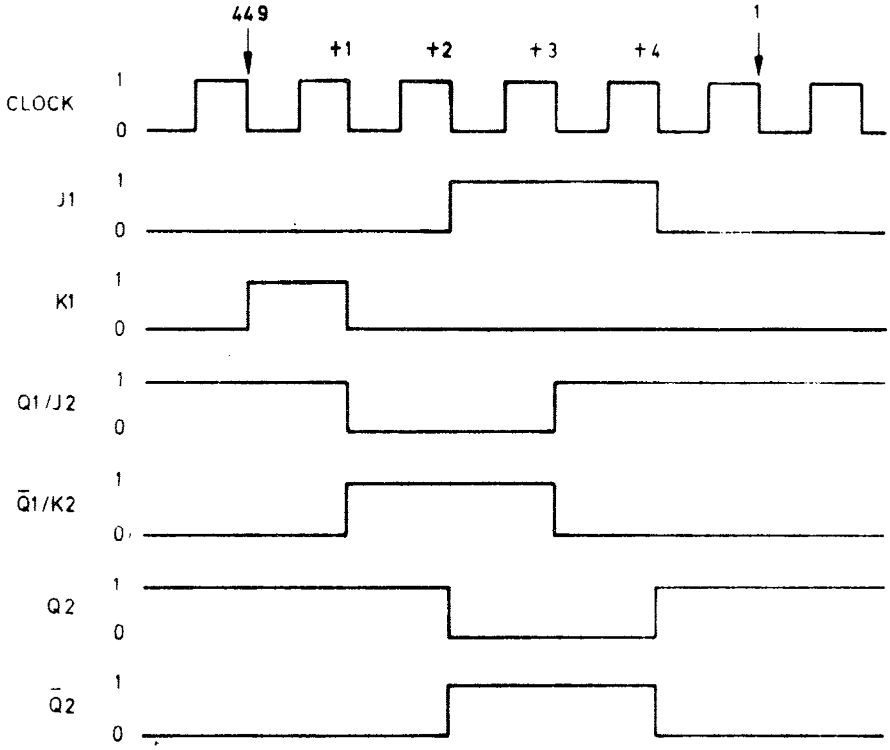


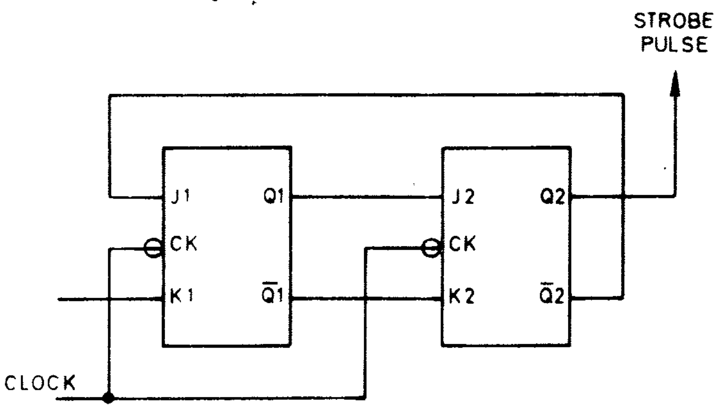
TRUTH TABLE 3-INPUT NAND GATE			
a	b	c	f
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

WOH 3076

Timing Diagram Lock Detector

Fig. 2·4





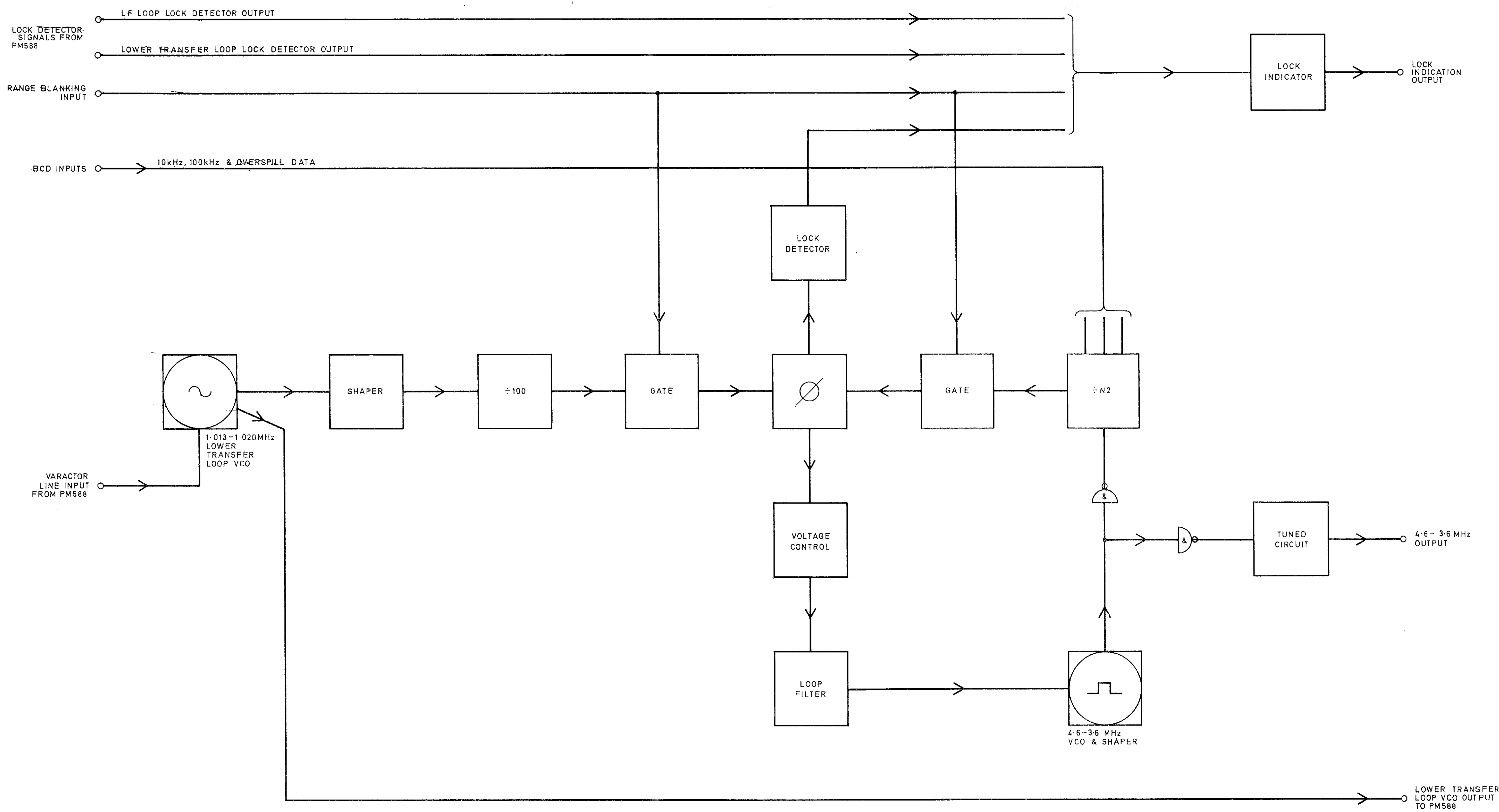
TRUTH TABLE (Each Section)

tn		tn + 1
J	K	Q
0	0	Qn
0	1	0
1	0	1
1	1	Q̄n

WOH3076

Timing Diagram: Strobe Pulse Generation Lower Transfer Loop

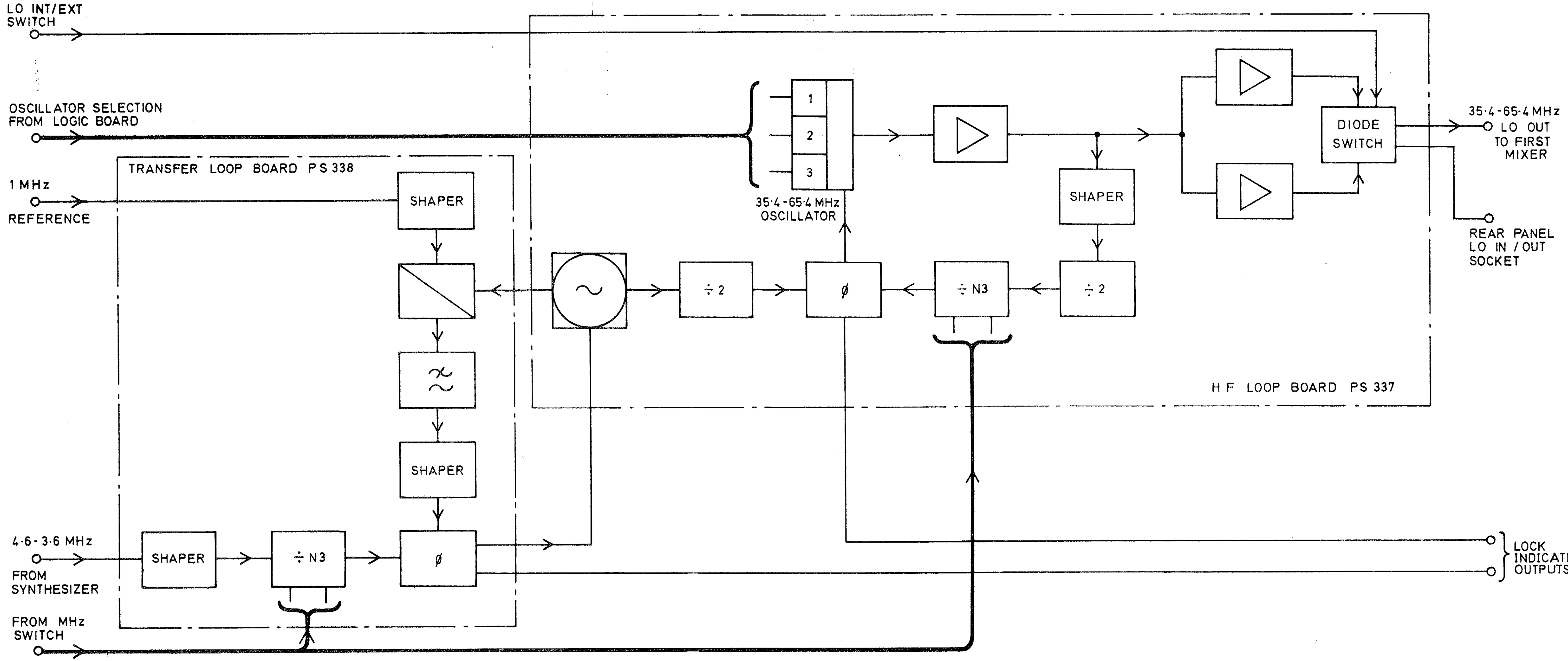
Fig 2·5



WOH 3076

Block Diagram: Upper Loop Board PM589

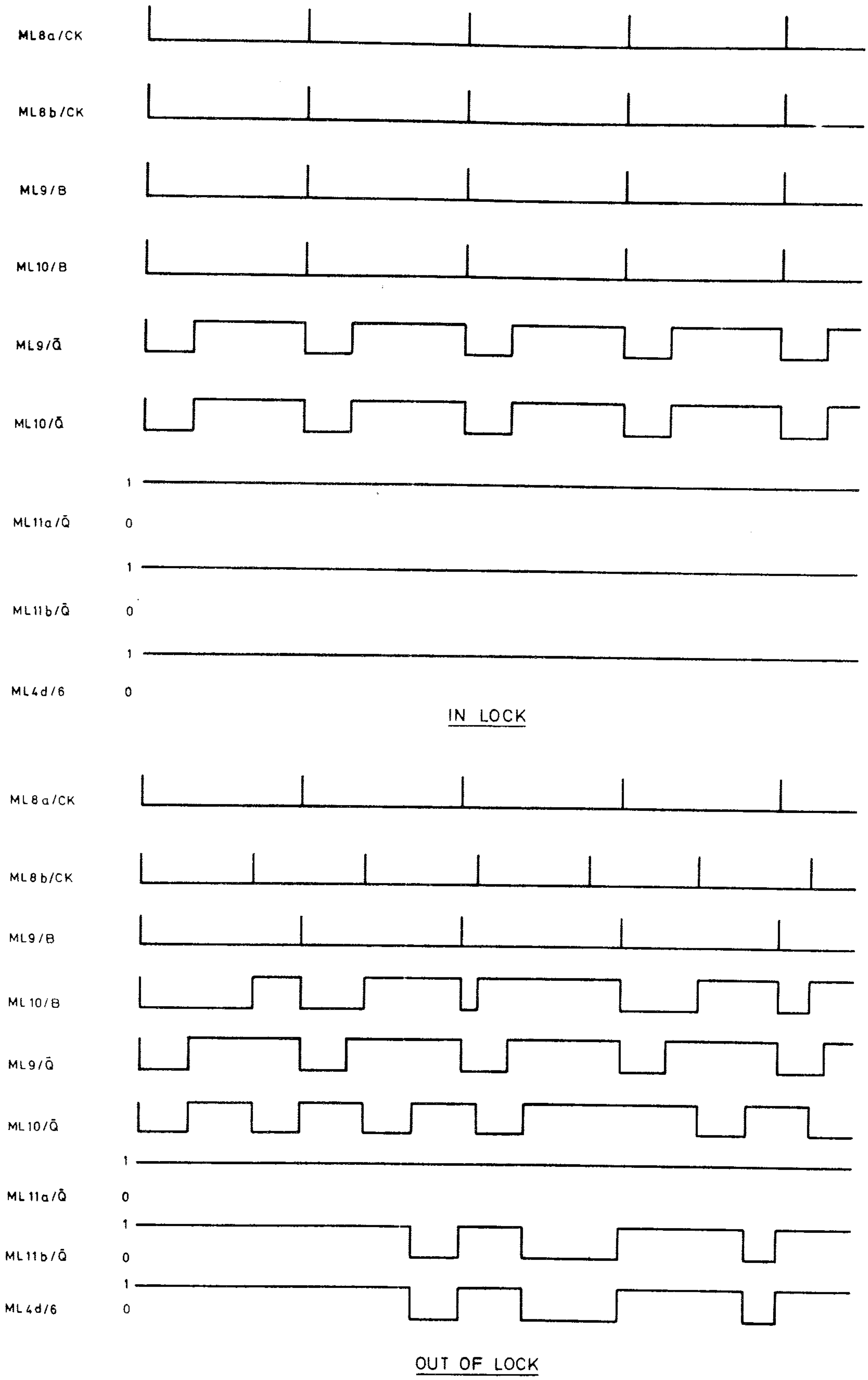
Fig. 2



WOH 3076/2

Block Diagram: Upper Transfer & HF Loop Boards (PS338 & PS337)

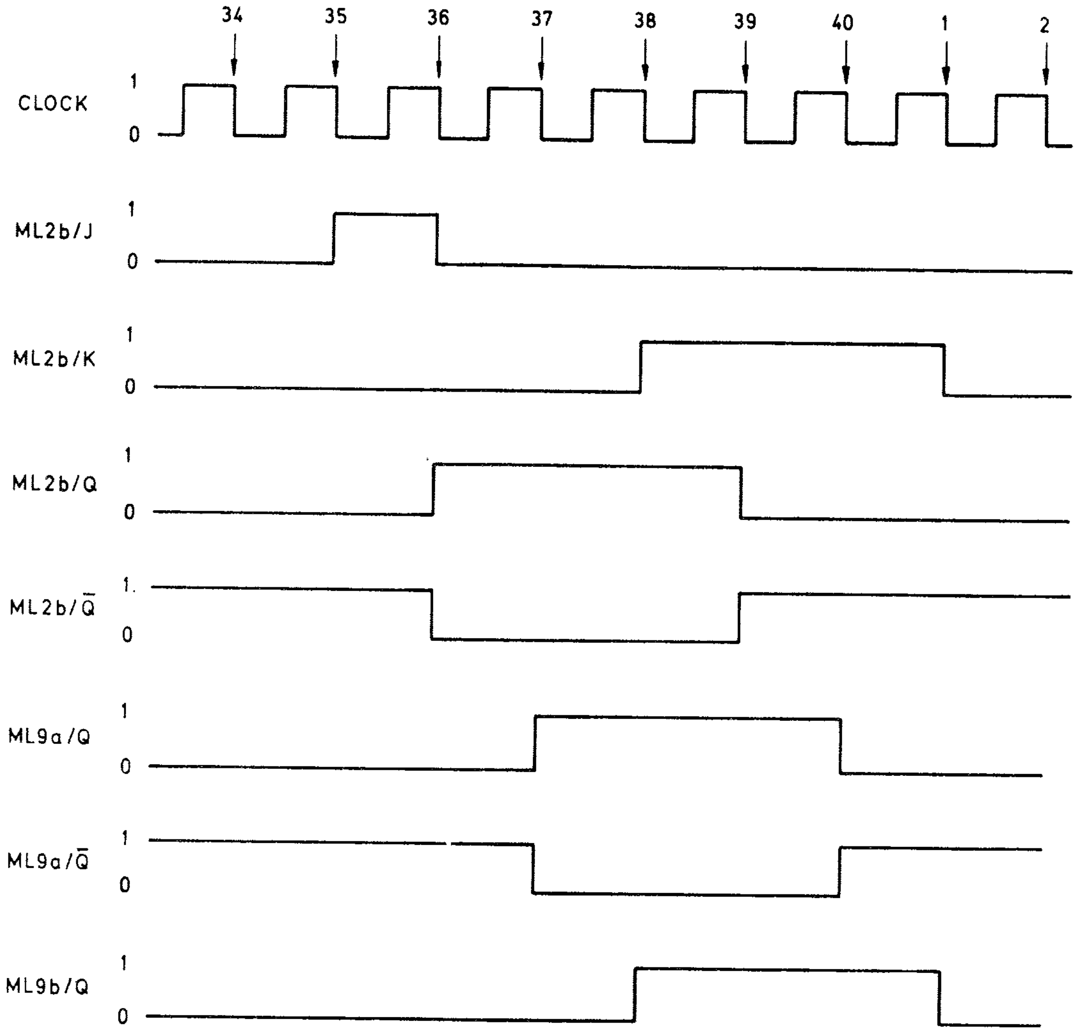
Fig. 2·7

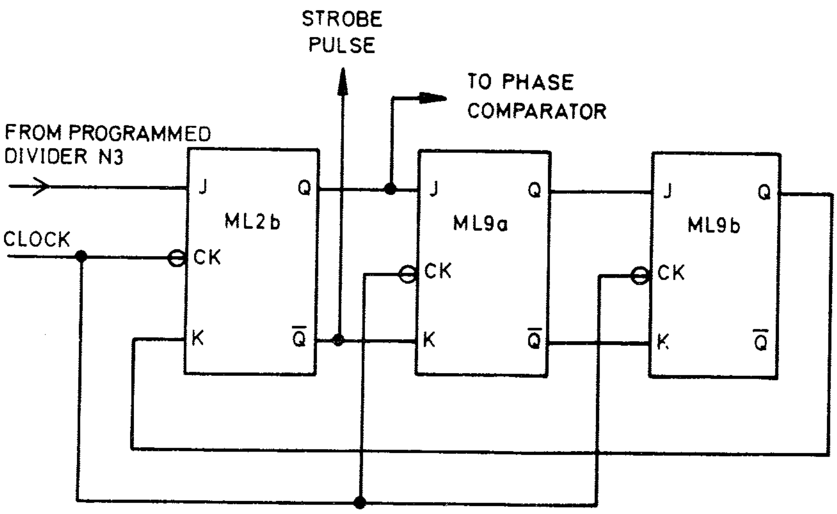


WOH 3076/2

Timing Diagram : Fast Lock and Indicator
Upper Transfer Loop PS338

Fig. 2·8



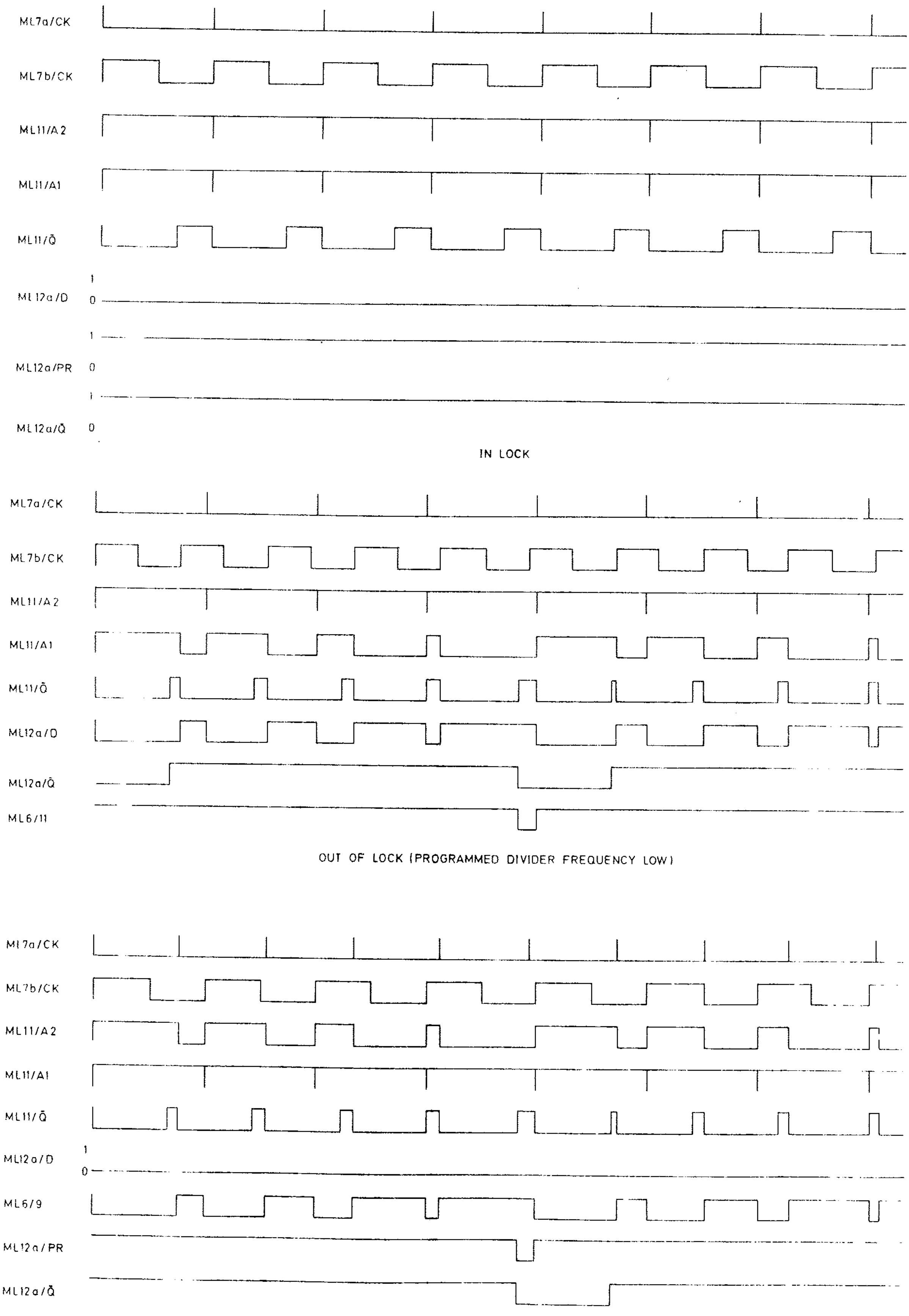


TRUTH TABLE (Each Section)		
tn		tn+1
J	K	Q
0	0	Qn
0	1	0
1	0	1
1	1	$\overline{Q}$n

WOH3076

Timing Diagram: Strobe Pulse Generation HF Loop (PS337)

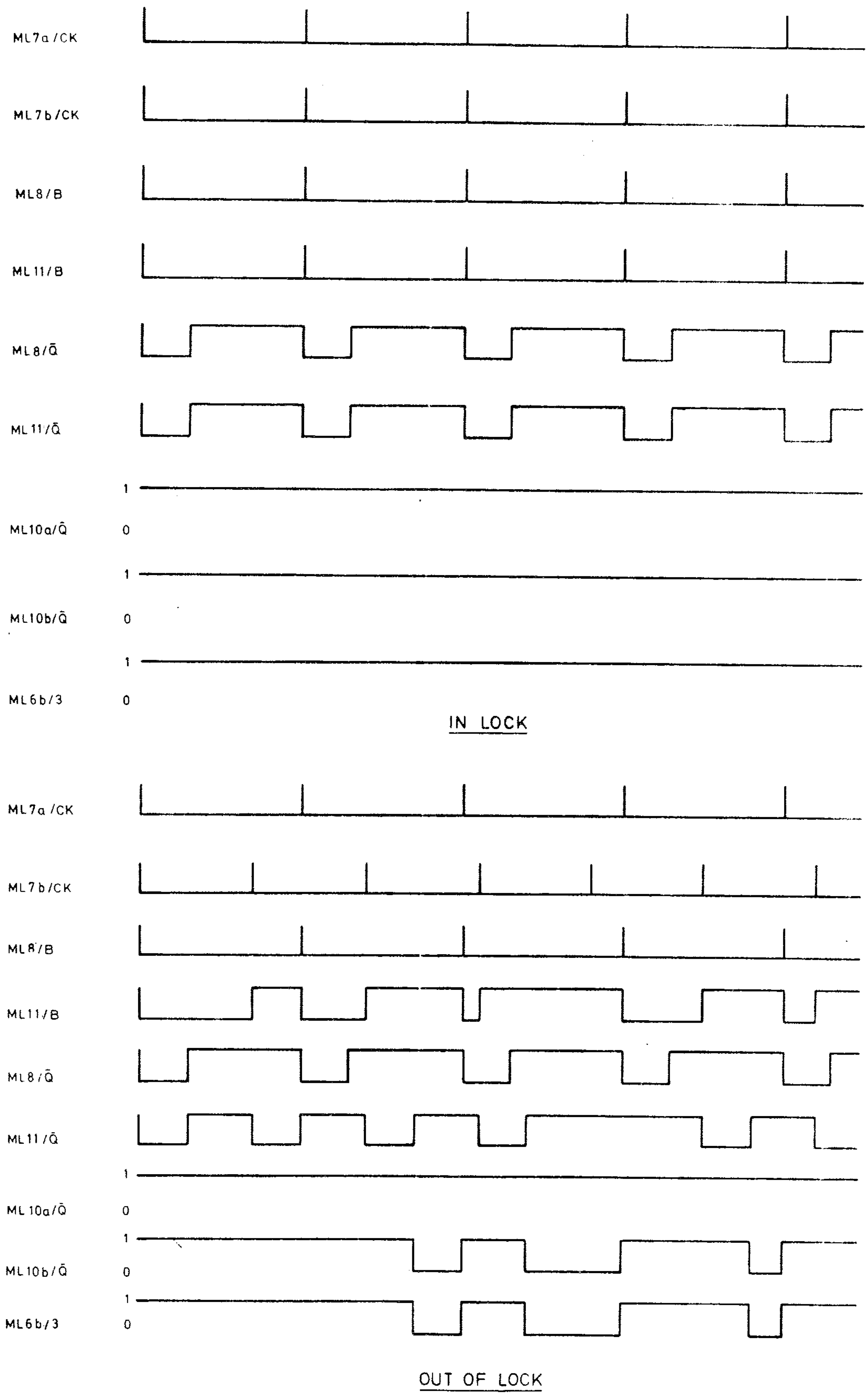
Fig. 2·9



OUT OF LOCK (PROGRAMMED DIVIDER FREQUENCY HIGH)

Timing Diagram : Fast Lock and Indicator
HF Loop PS337

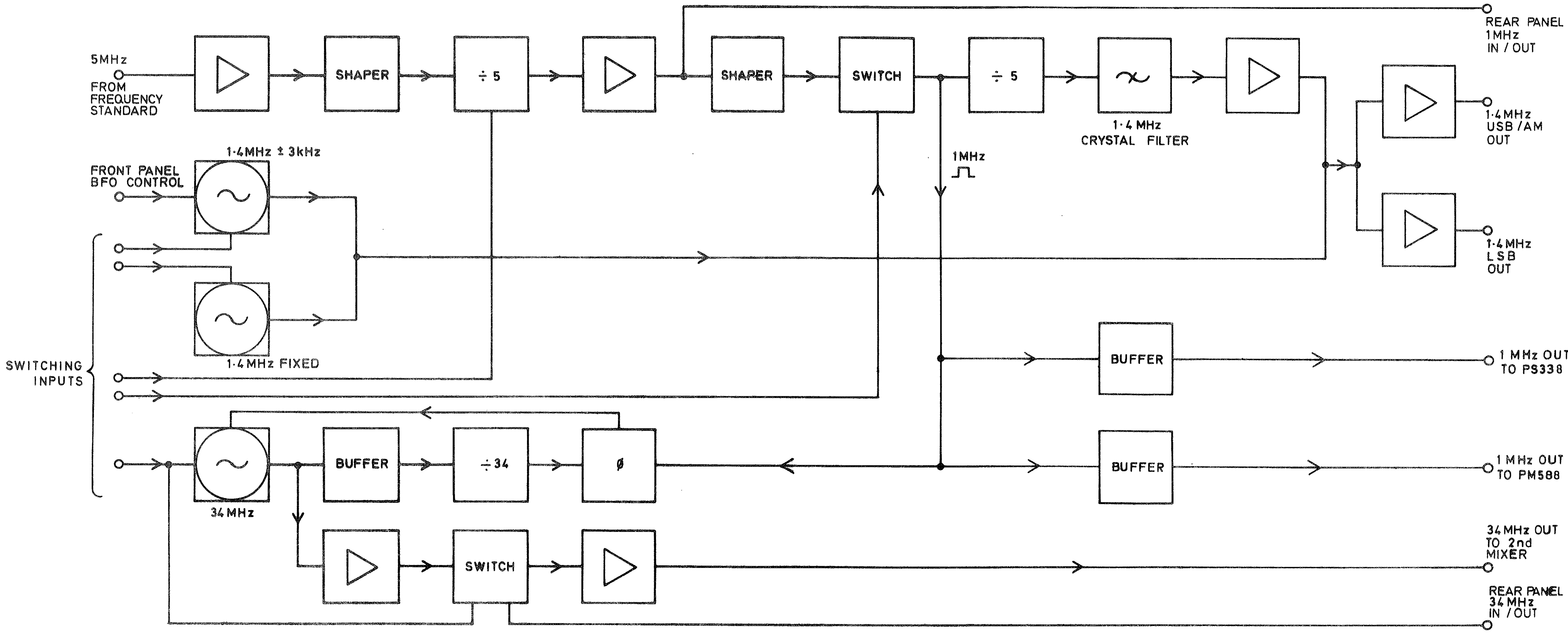
WOH3076 **Fig. 2·10**



WOH 3076/2

Timing Diagram: Fast Lock and Indicator HF Loop PS337

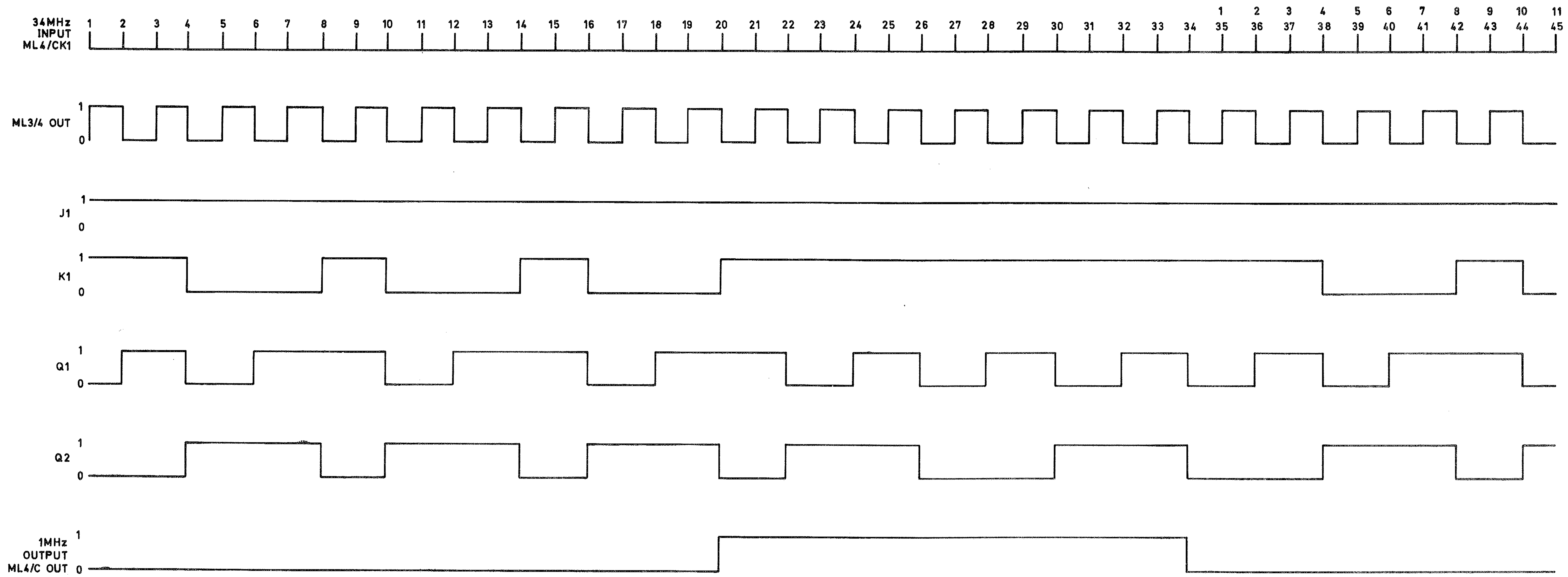
Fig. 2·10a

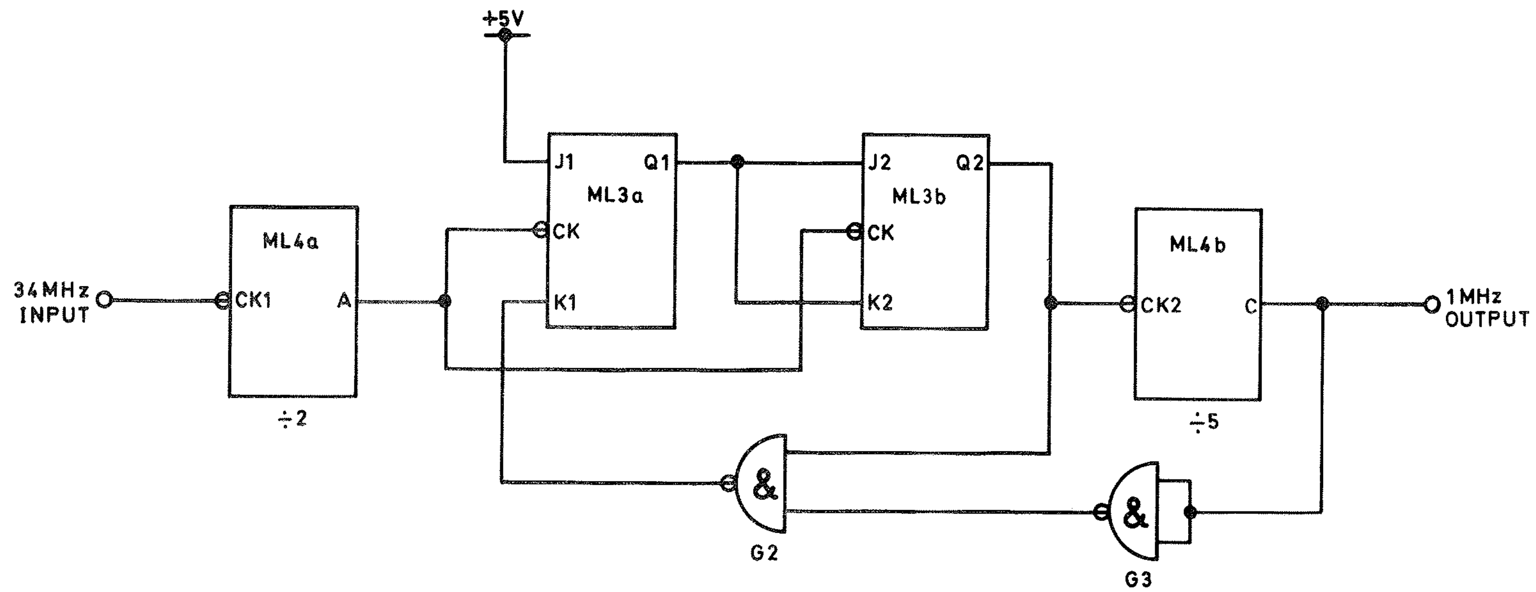


WOH 3076 / 2

Block Diagram : 34 MHz Generator Board PM 339

Fig. 2·11



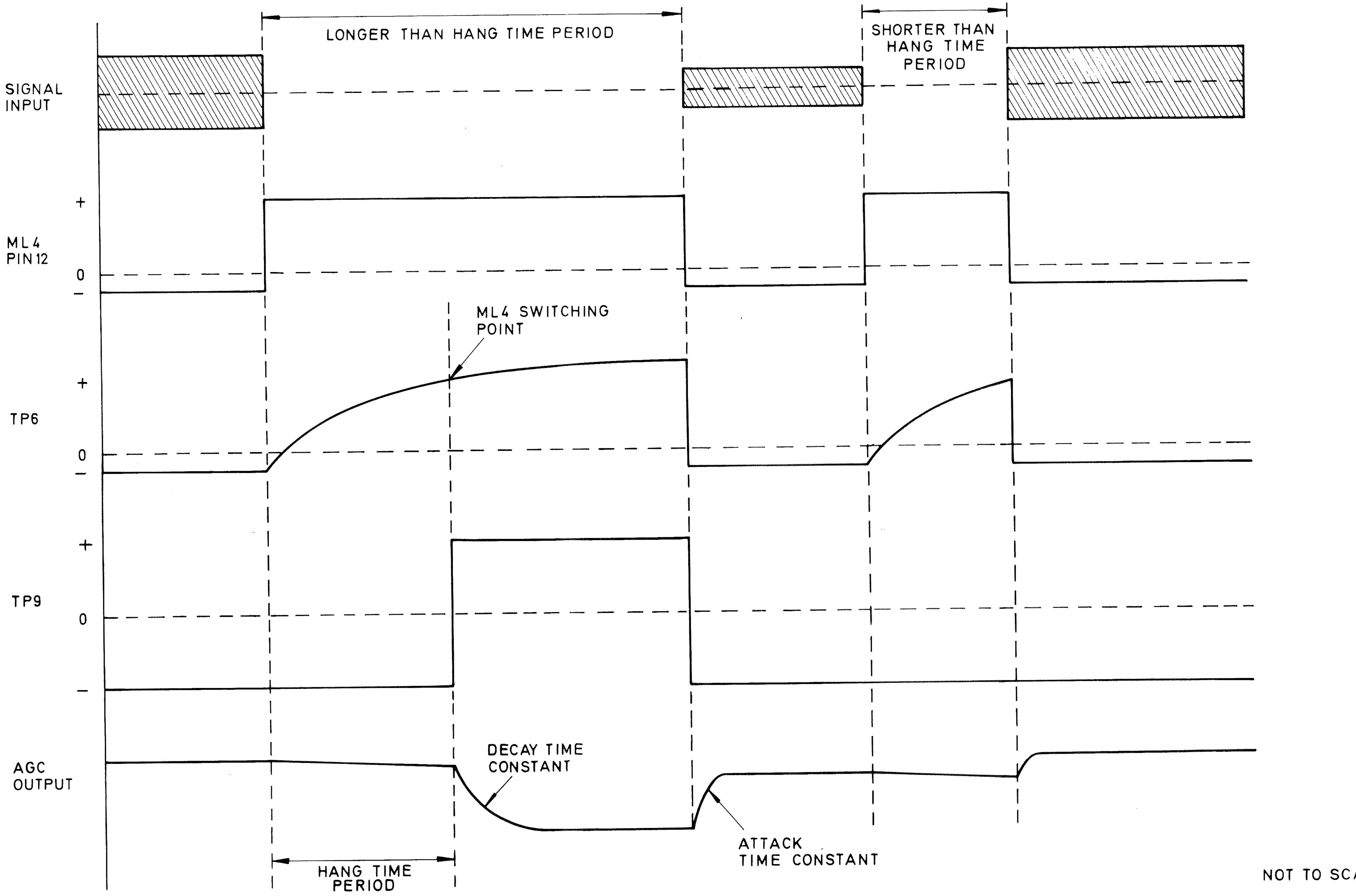


J-K Truth Table		
tn		tn + 1
J	K	Q
0	0	Qn
0	1	0
1	0	1
1	1	$\bar{Q}n$

WOH3076

Timing Diagram : Divide-by-34 Stage

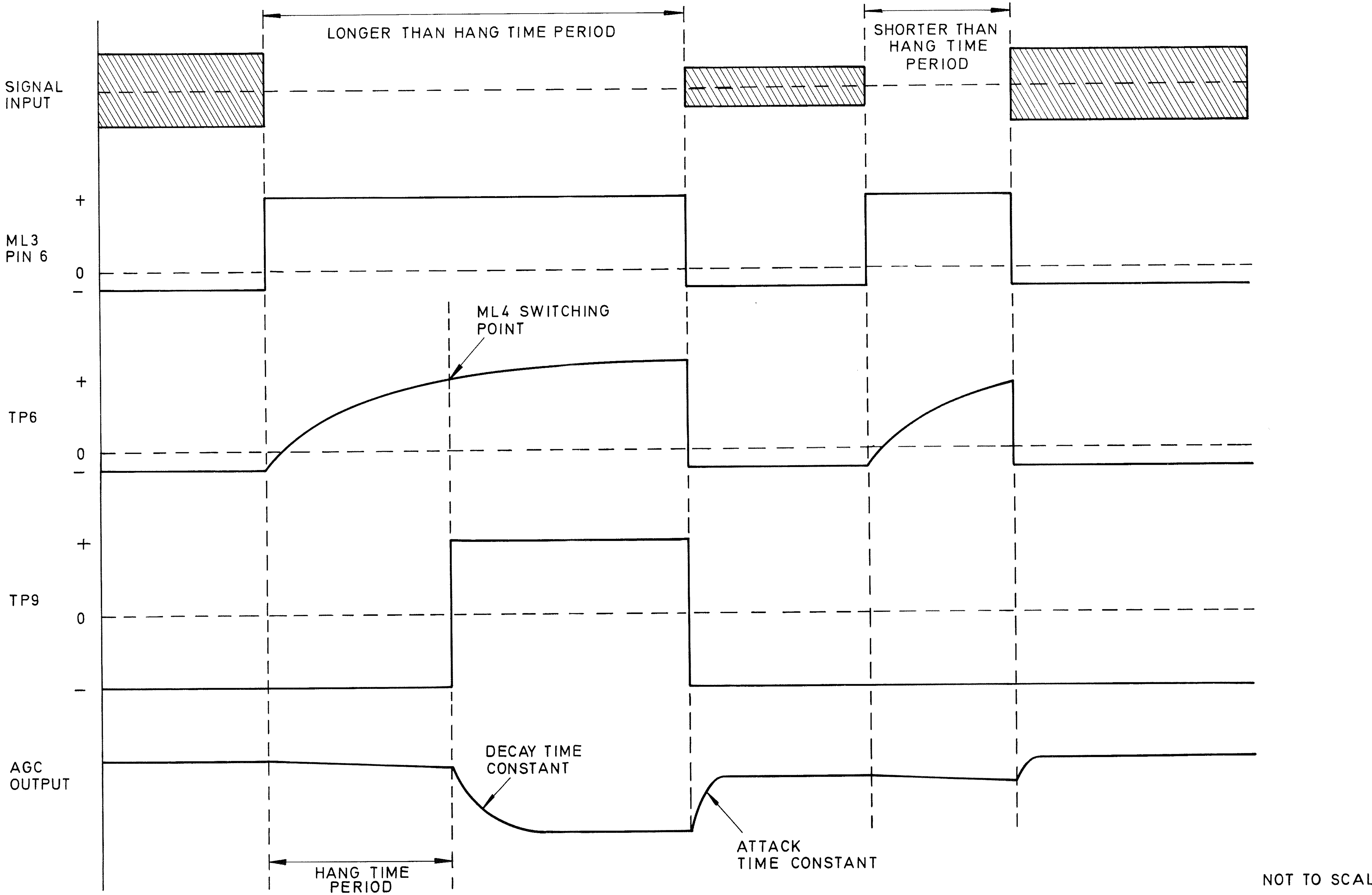
Fig. 2·1



WOH 3076

Timing Diagram : AGC Hang Detector

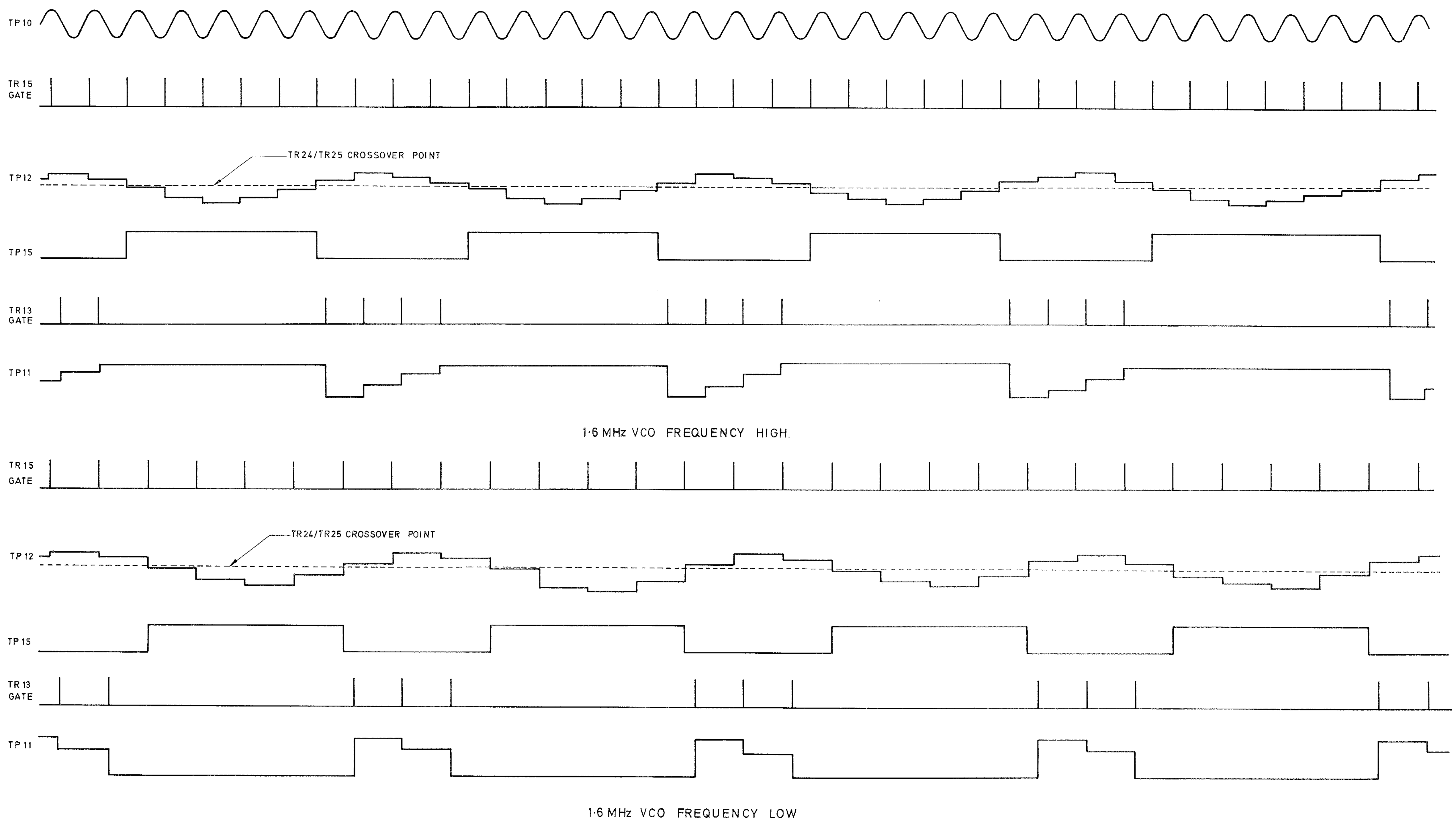
Fig. 2



WOH 3076

Timing Diagram : AGC Hang Detector

Fig.2-

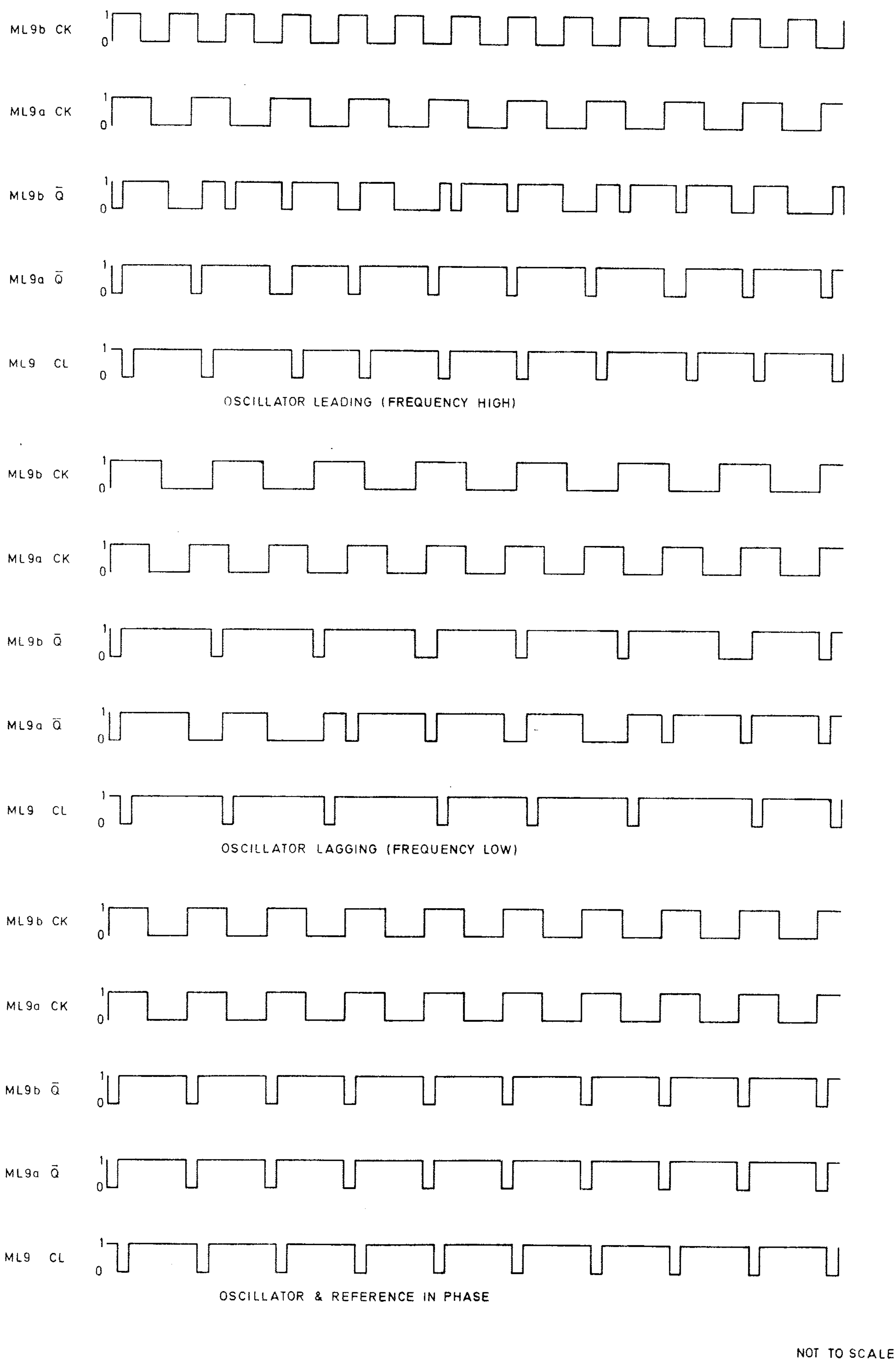


NOT TO SCALE

WOH 3076

Timing Diagram : Sample-Hold Phase Comparator (AFC Board)

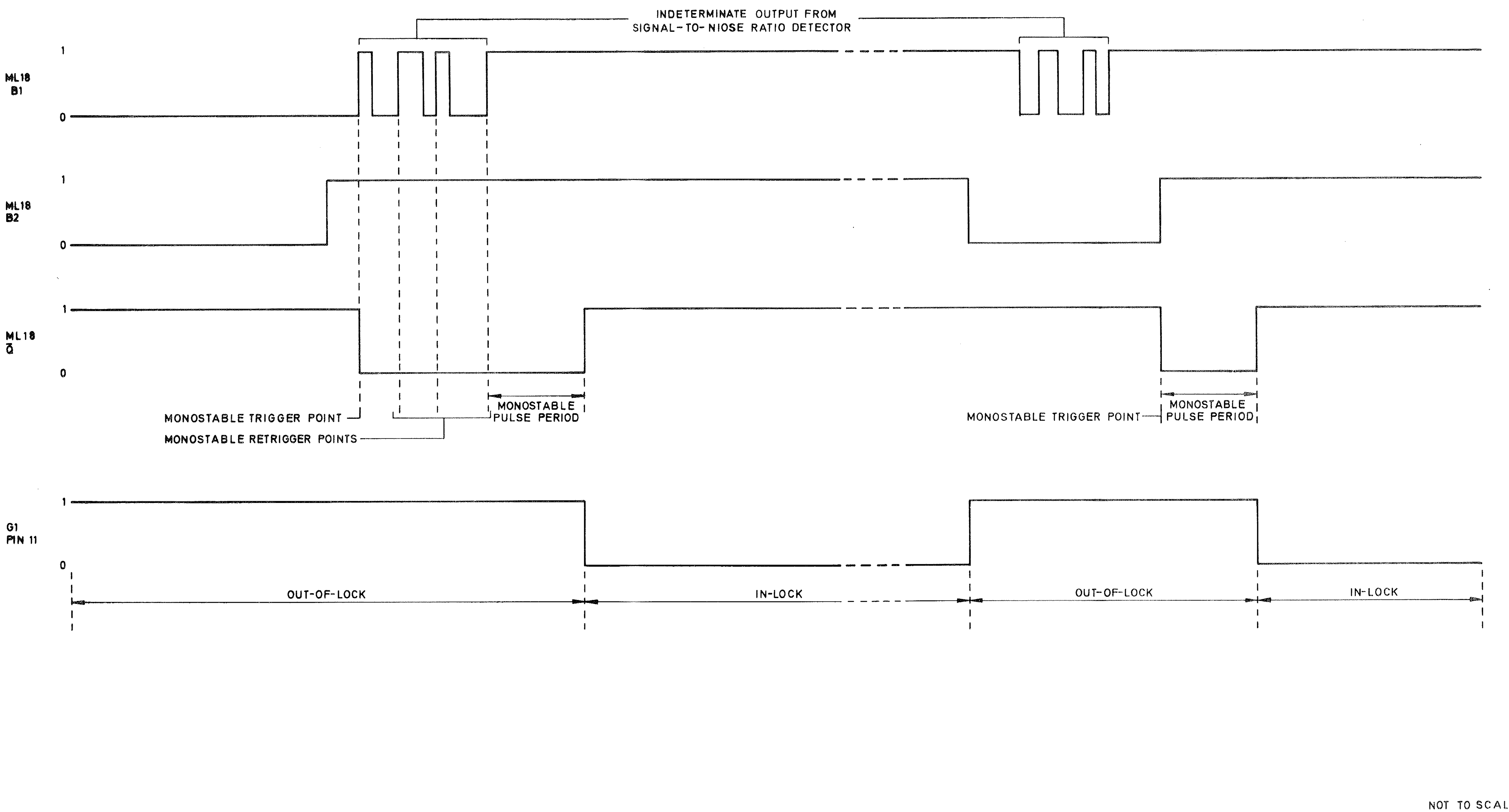
Fig. 2



Timing Diagram
AFC Digital Phase Comparator

WOH 3076

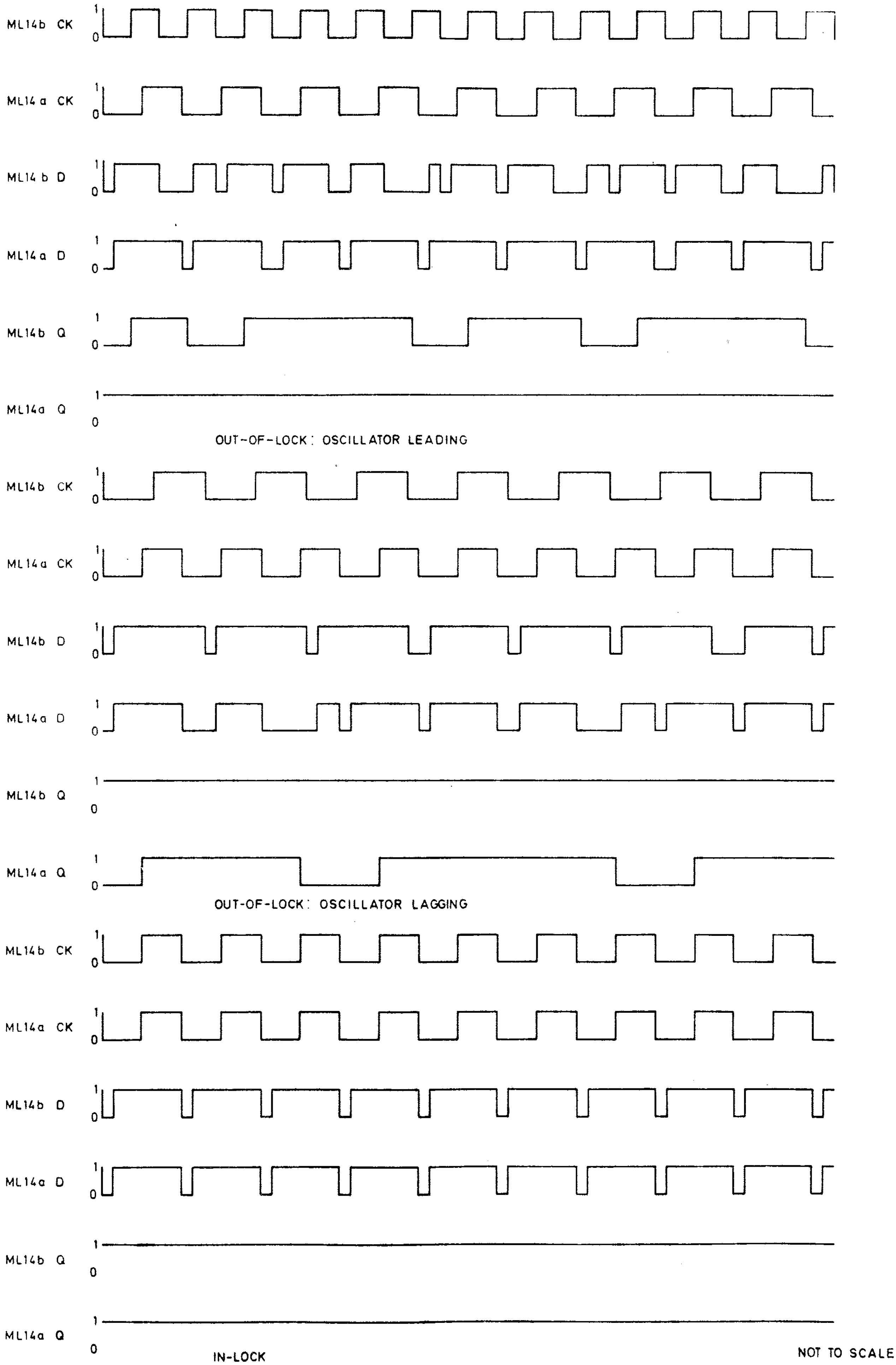
Fig.2·15



WOH 3076

Timing Diagram : AFC Lock Detector Monostable

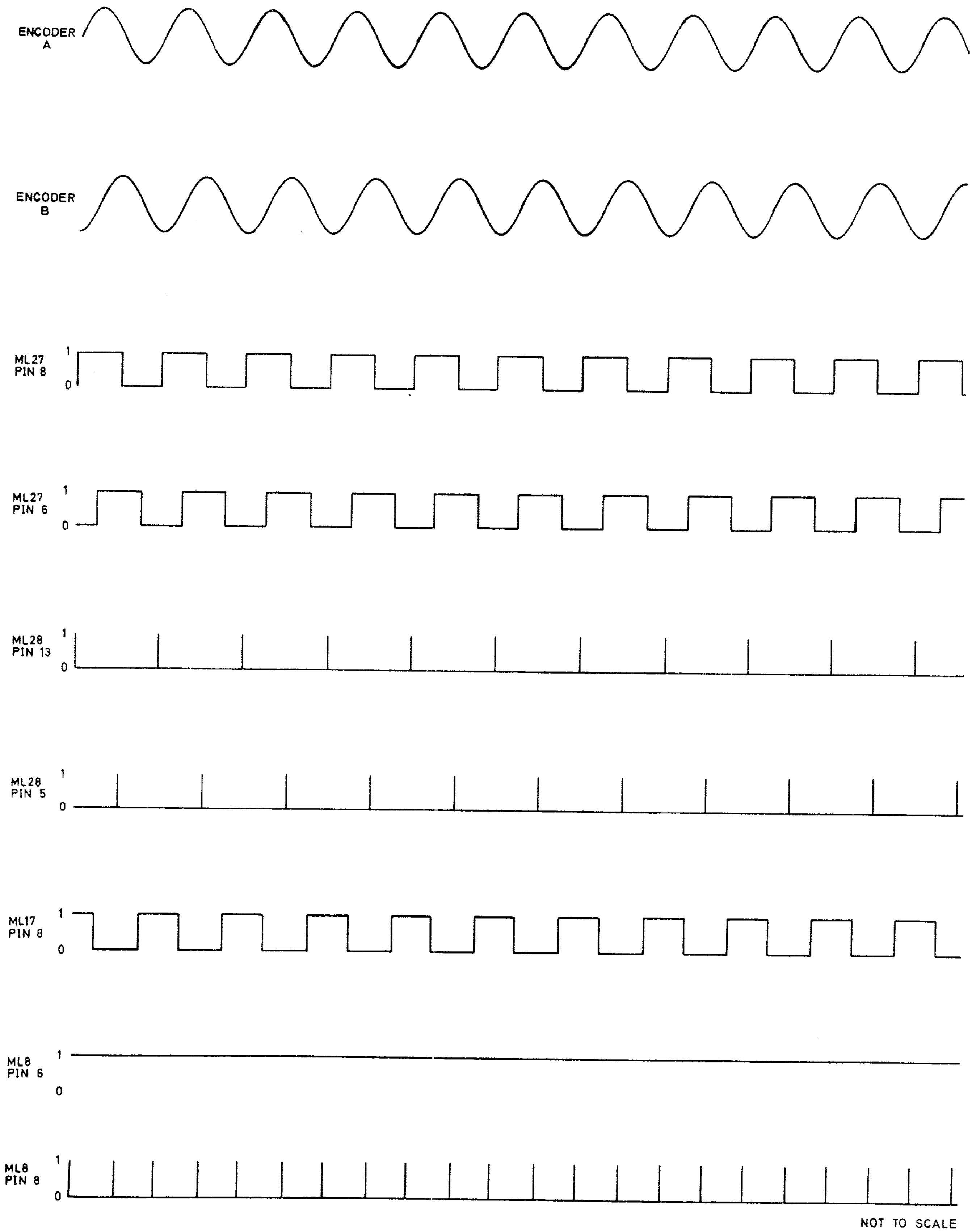
Fig.2·1



WOH 3076

Timing Diagram
AFC 7MHz VCO Lock Detector

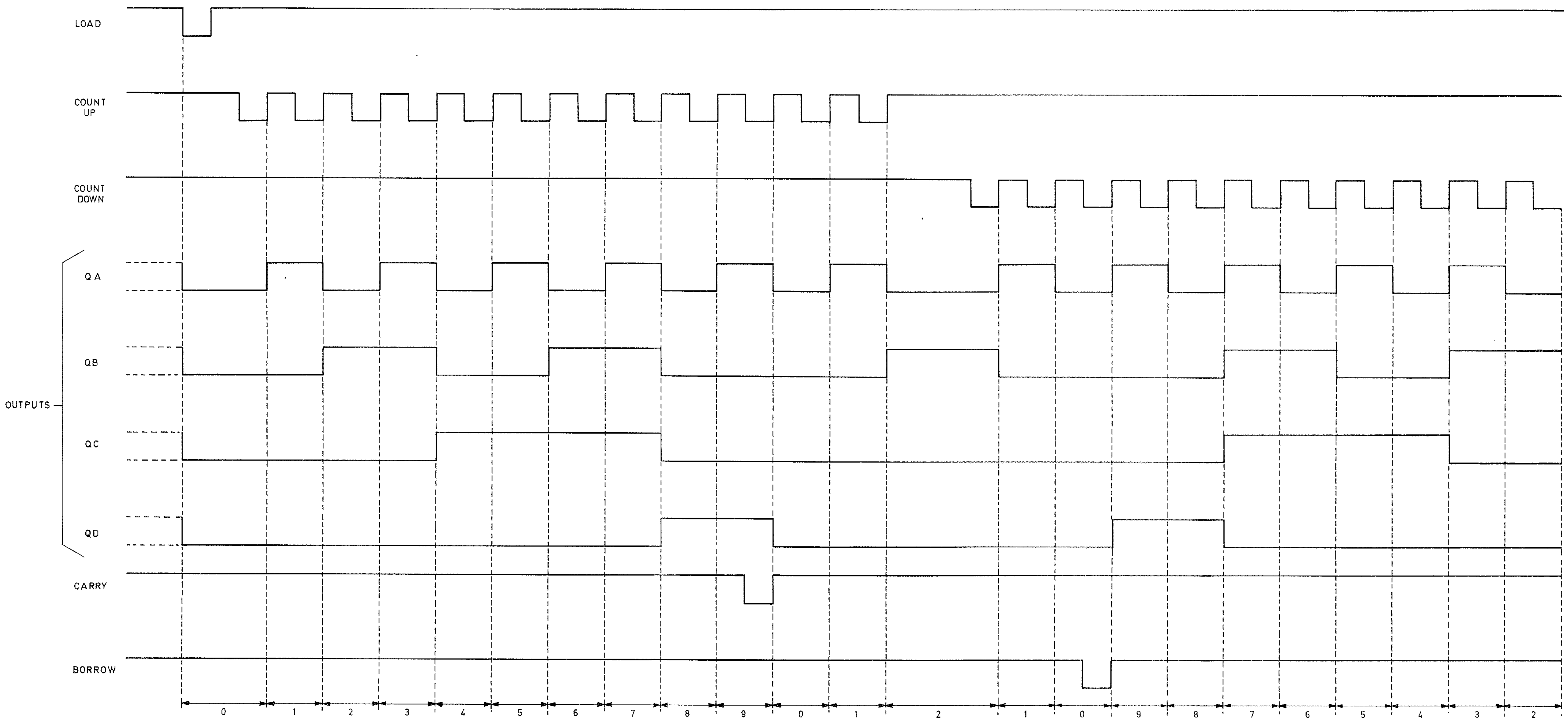
Fig.2·17



WOH3076

Timing Diagram : Fast Tune Mode

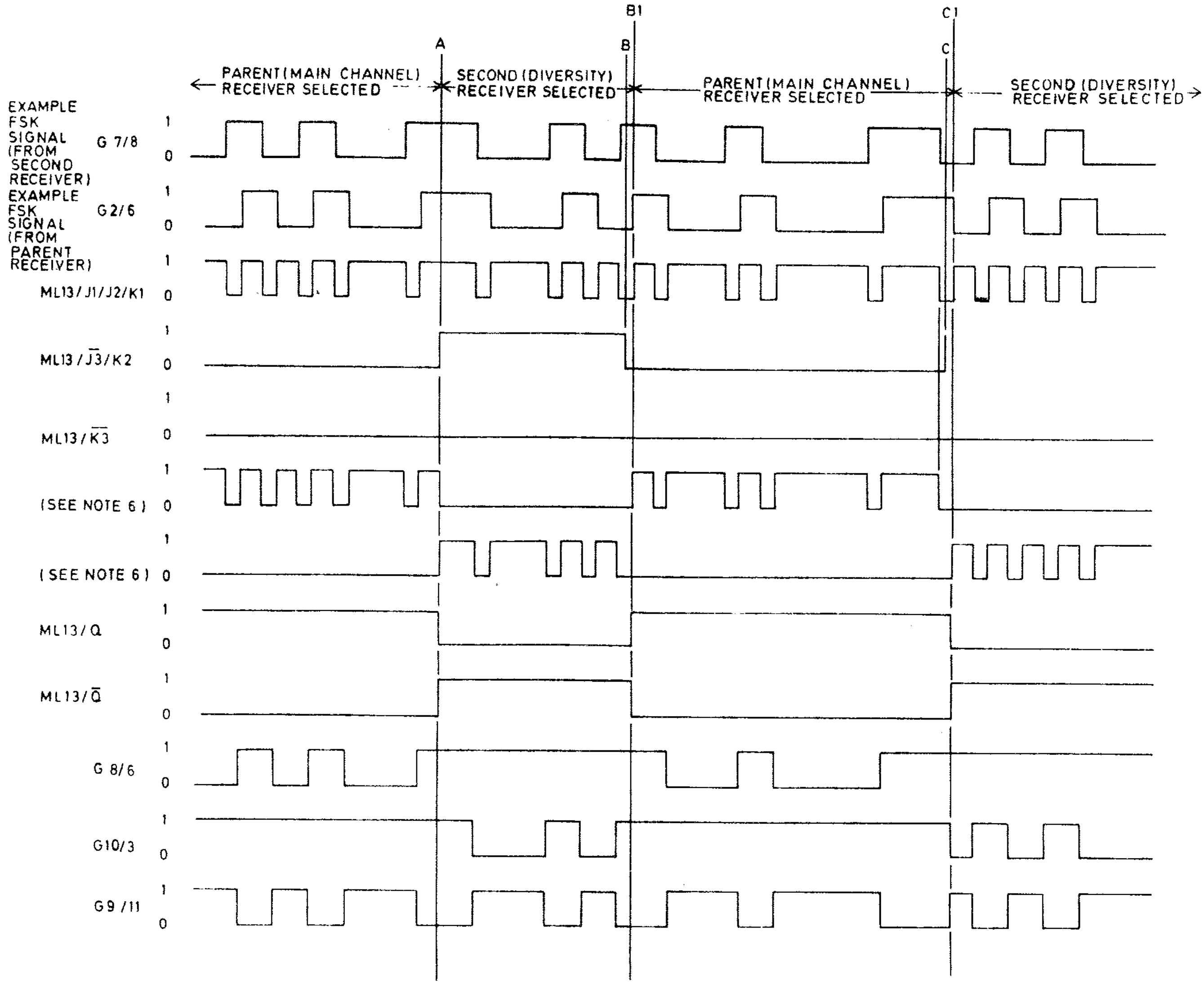
Fig. 2·18



WOH 3076

Timing Diagram: Up/Down Counter - Display Board

Fig. 2·19



NOTES

1. G 7/8 SHOWS INVERTED FSK SIGNAL FROM THE SECOND (DIVERSITY) RECEIVER
2. G2/6 SHOWS INVERTED FSK SIGNAL FROM THE PARENT (MAIN CHANNEL) RECEIVER
3. ML13/$\overline{J3}$/K2 IS OUTPUT FROM AGC COMPARATOR
4. G9/11 IS THE OUTPUT FROM THE DIVERSITY SIGNAL COMPARATOR AND SWITCH
5. CLOCK (CK) PULSES ARE NOT SHOWN AS THEY OCCUR AT A HIGH SPEED RELATIVE TO THE OTHER WAVEFORMS (AT 1·4 MHz $^+$ THE FSK SHIFT)
6. THE TRUTH TABLE FOR THE JK FLIP-FLOP IS :—

BEFORE CLOCK PULSE		AFTER CLOCK PULSE
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

WHERE :— J = J1, J2. $\overline{J3}$

K = K1, K2. $\overline{K3}$

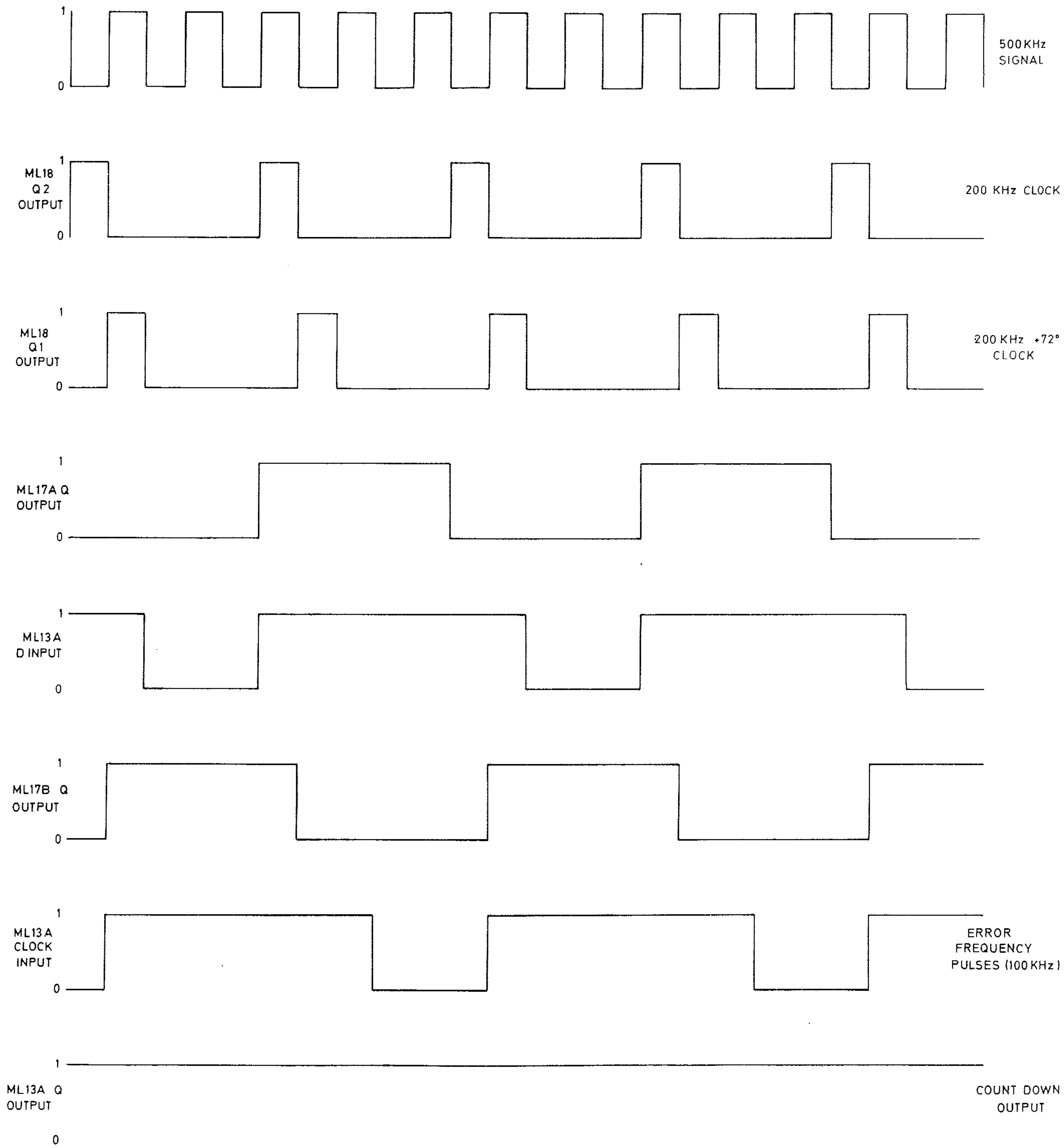
Q_n = STATE OF Q BEFORE CLOCK PULSE

$\overline{Q}_n$ = STATE OF $\overline{Q}$ BEFORE CLOCK PULSE

WOH 3076/2

Timing Diagram
Diversity Signal Comparator and Switch

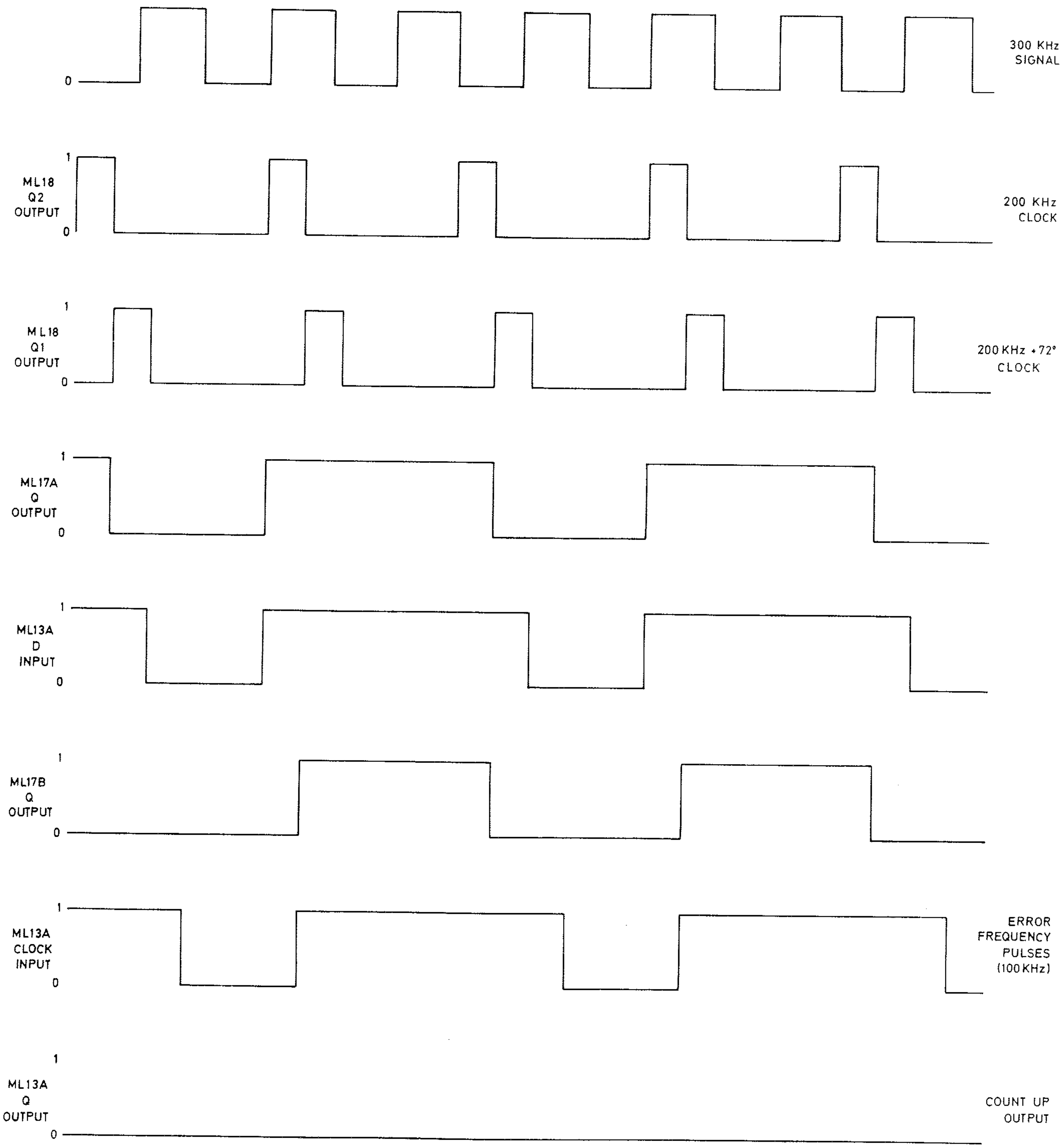
Fig. 2.20



WOH 3076

Timing Diagram : Digital Mixer Frequency High

Fig. 2.21



WOH 3076

Timing Diagram : Digital Mixer Frequency Low

Fig. 2.22

CHAPTER 3

DISMANTLING AND RE-ASSEMBLY

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'POZIDRIV' SCREWDRIVERS

Metric thread cross-head screws fitted to Racal equipment are of the 'Pozidriv' type. Phillips type and 'Pozidriv' type screwdrivers are not interchangeable, and the use of the wrong screwdriver will cause damage. POZIDRIV is a registered trade mark of G.K.N. Screws and Fasteners Limited. The 'Pozidriv' screwdrivers are manufactured by Stanley Tools Limited.

CHAPTER 3

DISMANTLING AND RE-ASSEMBLY

INTRODUCTION

1. This chapter provides instruction for gaining access to the printed circuit boards, receiver sub-assemblies and chassis-mounted components. Should it be necessary to completely remove a printed circuit board, colour code tables for the cableform connections to each board are given. In general, the re-assembly is the reversal of the dismantling procedure.

INITIAL PROCEDURE

2. (1) Set the front panel POWER switch to OFF.

   (2) Disconnect all the cable connectors at the rear of the receiver.

   (3) Remove the two transit screws, if fitted, through the rear panel flange (see Fig. 3 at the back of Part 2).

   (4) Remove the four screws securing the receiver to the rack or table-top cabinet.

   (5) Withdraw the receiver and place it on a flat clean working surface.

   (6) Remove the receiver top cover plate, if fitted, held in place with Dzus fasteners.

RF BOARD

3. To gain access to the RF board proceed as follows:

   (1) Remove the top screening cover from the RF compartment.

   (2) For tuned versions only, locate the coupling on the RF TUNE control spindle and slacken the two screws. Withdraw the RF TUNE control spindle to disengage the coupling.

   (3) Disconnect the coaxial RF input connector.

   (4) Release the two bracket fixing screws within the RF compartment (left-hand side).

   (5) The board may now be raised from the rear to hinge at the cableform (front) end. Once the board is vertical it may be held in position by sliding the nylon bush into the slot in the compartment side member.

4. To completely remove the RF board from the receiver unsolder the cableform connections to the board pins. The cableform colour code for the RF board is given in Table 1 on page 3 -7.

PRINTED CIRCUIT BOARDS - MAIN COMPARTMENT

5. The compartment box structure mounted on the receiver chassis contains up to seven printed circuit boards, dependent upon the options fitted (see Fig. 4). After the top screening cover has been removed, each of these boards may be raised from the rear to hinge at the cableform (front) end. Once a board is vertical it may be held in position by sliding the nylon bush into the slot in the compartment side member. To completely remove any board unsolder the cableform connections to the board pins. The boards fitted within the main compartment are listed below, together with the respective cableform colour code Table number.

ISB IF/AF Board PM364/3	Table 2 (page 3 - 8)
Main IF/AF Board PM364/1	Table 3 (page 3 - 9)
IF Filter Board PS367	Table 4 (page 3 - 10)
AFC Board PM369	Table 5 (page 3 - 11)
LF Loop Board PM588	Table 6 (page 3 - 12)
Upper Loop Board PM589	Table 7 (page 3 - 13)
FSK Board	Table 8 (page 3 - 14)

The position of each board is indicated on the main compartment top cover.

PRINTED CIRCUIT BOARDS - MAIN CHASSIS

6. Five printed circuit boards are contained within compartments in the die-cast receiver chassis (see Fig. 5). To gain access to a board, remove the screening cover from the respective compartment. Each board may be lifted clear of the chassis by removing the securing screws and washers. To completely remove a board from the receiver, unsolder the cableform connections from the board pins. The boards contained within the chassis are listed below, together with the respective cableform colour code Table number.

34 MHz Generator Board PM339	Table 9 (page 3 - 15)
Transfer Loop Board PS338	Table 10 (page 3 -16)
HF Loop Board PS337	Table 11 (page 3 -17)
First Mixer Board PM335	Table 12 (page 3 -18)
Second Mixer Board PM336	Table 13 (page 3 -19)

REMOVAL OF FRONT PANEL AND FRONT SUB-PANEL

7. The front panel together with the front sub-panel may be lowered as a complete assembly (para. 8) to gain access to the front panel controls and associated compartments, the logic board, the meter switching board, the shaft encoder and display board (RA1772 only), the decade frequency selection switches and out-of-lock indicator board (RA1771 only) and the components mounted on the front top face of the die-cast chassis. Note that the receiver may be safely operated with the front panel assembly lowered.

To Lower Front Panel Assembly

8. (1) For tuned versions only, remove the top screening cover from the RF compartment. Locate the coupling on the RF TUNE control spindle and slacken the two screws. Withdraw the RF TUNE control spindle to disengage the coupling.

(2) Slide the receiver forward such that the bottom edge of the front panel is clear of the working surface.

(3) Remove the six screws, each fitted with a nylon washer, securing the front panel to the receiver (three at each edge, adjacent to each handle).

(4) Support the front panel assembly and remove the two recessed screws, each with a spring washer, located one adjacent to each handle.

(5) The front panel assembly may now be lowered to 'hinge' on the connecting cableform.

To Remove Front Panel

9. (1) Use the larger (1/16 in.) of the two socket wrenches provided (located in a clip attached to the right-hand side member) to remove all the front panel control knobs. Use the smaller socket wrench (1.5mm) to remove the BFO slow-motion dial.

(2) Disconnect the two wires to the front panel meter, using a 7mm spanner. Replace the nuts and washers for safe keeping.

(3) Remove the eight screws, each fitted with a nylon washer, securing the front panel to the receiver (two in the centre of the front panel and three at each edge, adjacent to each handle).

(4) Lift off the front panel.

10. The front sub-panel may now be lowered by disconnecting the RF TUNE control spindle (Tuned versions only, see Step (1) of Para. 8), and removing the two screws, each with a spring washer, one at each edge of the sub-panel.

REAR PANEL

11. The rear panel may be lowered to 'hinge' on the connecting cableform. It is secured by seven screws, each with a spring washer, three at each side and one in the centre, below the transistors on the heat sink. Note that the receiver may be safely operated with the rear panel lowered.

12. It is necessary to lower the rear panel to gain access to the regulator board PM370, the power supply smoothing capacitors 1C1 to 1C6 and resistors 1R9, 1R10. Two zener diodes, D5 and D6, are mounted on the inside of the rear panel. To gain access to these diodes it is first necessary to remove the regulator board PM370 (see Para. 20).

LOGIC BOARD

13. To gain access to the logic board it is necessary to lower the front panel and front sub-panel together as one assembly (see Para. 8). Should it be necessary to completely remove the logic board from the receiver, proceed as follows.

14. (1) Remove the front panel (Para. 9).

(2) Remove the MHz dial.

(3) Lower the front sub-panel assembly (Para. 10).

(4) On the RA.1772 only remove the MHz lamp block, secured by two knurled nuts (on earlier versions unclip the three MHz lamp holders).

(5) Remove the four screws securing the MHz switch plate to the front sub-panel.

(6) Remove the two screws securing the logic board spacing pillars to the front sub-panel.

(7) The logic board together with the MHz switch may now be lifted clear. To completely remove the logic board from the receiver, unsolder the cableform connecting wires to the board pins and also the green/black wire connected to the wiper of switch wafer SA3. The cableform colour code for the logic board is given in Table 14 (page 3-20).

Alignment of the MHz Dial

15. When the MHz switch is set to 0MHz, the switch wipers are almost in line with but slightly to the right of the top spacing pillars (viewed from the front of the receiver). With the switch in this position, the 0MHz digit on the MHz dial should be in line with the centre of the three MHz lamps (RA.1772) or positioned such that it appears centrally in the front panel MHz window (RA.1771).

METER SWITCHING BOARD

16. To gain access to the meter switching board it is necessary to lower the front panel and front sub-panel together as one assembly (see Para. 8). To completely remove the meter switching board and switch, proceed as follows.

17. (1) Remove the front panel (Para. 9).

(2) Lower the front sub-panel (Para. 10).

(3) Remove the nut and washer securing the meter switch to the front sub-panel.

(4) Withdraw the meter switching board and switch.

(5) Unsolder the cableform connections to the board pins. The cableform colour code for the meter switching board is given in Table 15 (page 3-21).

DISPLAY BOARD (RA.1772)

18. To gain access to the display board, lower the front panel and front sub-panel as one assembly (Para. 8). To completely remove the display board from the receiver, proceed as follows.

19. (1) Unsolder the cableform connecting wires to the board pins. The cableform colour code for the display board is given in Table 16 (page 3 - 22).

(2) Remove five nuts, each with a spring washer, securing the board to the inside of the front sub-panel.

(3) Lift out the board.

POWER SUPPLY REGULATOR BOARD PM370

20. To gain access to the regulator board, lower the rear panel (Para. 11). To completely remove the regulator board from the receiver proceed as follows.

21. (1) Unsolder the cableform connections to the board pins. The cableform colour code for the regulator board is given in Table 17 (page 3 -23).

(2) Remove the four screws, each with a flat and a spring washer, securing the board to the inside of the rear panel.

(3) Lift out the board.

AF AND MEMORY REGULATOR BOARD

22. To gain access to the AF and memory regulator board, remove the sub-panel assembly containing the frequency standard module and, if fitted, the FSK relay and barretter. This assembly is secured to the cast chassis with four screws, each with a spring washer. To completely remove the board, proceed as follows.

23. (1) Unsolder the cableform connections to the board pins. The cableform colour code for the AF and memory regulator board is given in Table 18 (page 3 -24).

(2) Remove the four securing screws, each with a spring washer.

(3) Lift out the board.

POWER TRANSFORMER

24. To gain access to the connections to the power transformer and the supply input filter components, proceed as follows:

(1) Lower the rear panel (Para. 11).

(2) Remove the four screws securing the transformer connection cover plate.

(3) Remove the cover plate.

25. To completely remove the power transformer from the receiver, proceed as follows:

(1) Unsolder the cableform connections to the transformer. The cableform colour code for the transformer is given in Table 19 (page 3 - 25).

(2) Turn the receiver onto its side (left-hand as viewed from the rear panel).

(3) Remove the screening cover from the chassis compartment containing the 34MHz board.

(4) Remove the nine screws, each with a spring washer, securing the 34MHz board.

(5) Hinge out the 34MHz board on its cableform to reveal the four transformer securing screws.

(6) Support the transformer and remove the four securing screws.

SHAFT ENCODER (RA.1772 only)

26. To remove the shaft encoder proceed as follows:

(1) Remove the kHz control knob.

(2) Lower the front panel and front sub-panel together as one assembly (Para. 8).

(3) Remove the three screws securing the shaft encoder lugs to the inside of the front sub-panel.

(4) To remove the shaft encoder completely, disconnect the wires from the potentiometer board at the rear of the shaft encoder.

(5) The cableform colour code for the potentiometer board is given in Table 21 (page 3 - 26).

27. To gain access to the sensor board and the graticule carriage, proceed as follows:

(1) Remove the black tape from the outer cover.

(2) Locate the opening in the outer cover. Spring out the cover and slide off.

(3) The graticule carriage is secured by two screws through the front flange plate (see Fig. 36). Do not release these screws unless is is absolutely necessary. To do so may upset the 90 degree phase relationship between the two output signals from the shaft encoder.

OUT-OF-LOCK INDICATOR BOARD (RA.1771 only)

28. This board is fitted to the inside of the front panel assembly and is held in place by two nuts, each with a spring washer. The cableform colour code for this board is given in Table 20 (page 3 - 26).

NOTE: CABLEFORM COLOUR CODING

Wire colours given in the following tables are intended as a guide only. Colours may occasionally differ from those given and in such cases it is recommended that the user amends the respective tables accordingly.

BOARD PIN NO.	COLOURS	FUNCTIONS
1	Orange	+12V
2	Black	V (earth)
3	White/Grey	Mute
4	White/Red/Blue	MHz Select
*5	Blue/Grey	2-3 MHz Select
*6	Orange/Black	1 MHz Select
*7	Orange/White	16-29 MHz Select
*8	Brown/Red/Violet	8-15 MHz Select
*9	White/Red/Grey	4-7 MHz Select
10	Two Orange	+12V
11	Black and Screen for 12	V (earth)
12	Coaxial	RF Out
13	Blue/Green	Wideband Select
14	Violet	-7V

*Tuned Versions Only.

TABLE 1: CABLEFORM COLOUR CODE RF BOARD

TABLE 2: CABLEFORM COLOUR CODE ISB IF/AF BOARDS PM674/3 AND PM364/3

BOARD PIN NO.	COLOUR	FUNCTION
1	NO CONNECTION	
2	COAXIAL — BROWN/BLACK SLEEVES	IF OUTPUT
3	SCREEN — BROWN/BLACK SLEEVES	IF OUTPUT
4	SCREEN FOR PIN 24	EARTH
5	COAXIAL — RED/RED SLEEVES	1.4MHz INJECTION INPUT
6	RED/BLACK	SSB SELECT
7	NO CONNECTION	
8	RED — 2-CORE SCREENED	AUDIO PRE-AMPLIFIER OUTPUT
9	TWO SCREENS	EARTH
10	GREY/WHITE	MUTE
11	BLUE	LINE AMPLIFIER INPUT
12	NO CONNECTION	
13	ORANGE	+12V
14	RED/BLUE	+14.5V
15	BLUE — 2-CORE SCREENED GREY SLEEVE BLUE — 2-CORE SCREENED ORANGE/GREY SLEEVES	AUDIO LINE OUTPUT
16	RED RED	AUDIO LINE OUTPUT
17	TWO SCREENS	EARTH
18	NO CONNECTION	
19	NO CONNECTION	
20	NO CONNECTION	
21	VIOLET	-7V
22	NO CONNECTION	
23	NO CONNECTION	
24	RED SINGLE CORE SCREENED GREEN/YELLOW SLEEVES, SCREEN PIN 4	AGC HANG
25	RED — 2-CORE SCREENED YELLOW/VIOLET SLEEVES	AGC SHORT SELECT
26	BLUE	AGC LONG SELECT
27	NO CONNECTION	
28	SCREEN — 2-CORE SCREENED YELLOW SLEEVE	EARTH
29	BLUE — 2-CORE SCREENED YELLOW/GREY SLEEVES	AGC OUTPUT
30	BLUE RED	AGC INPUT
31	BLACK	EARTH
32	NO CONNECTION	
33	RED	SPECIAL AGC INPUT
34	COAXIAL	1.4MHz IF INPUT
35	TWO SCREENS	EARTH
36	SCREEN	EARTH

TABLE 3: CABLEFORM COLOUR CODE MAIN IF/AF BOARDS PM674/1 AND PM364/1

BOARD PIN NO.	COLOUR		FUNCTION
1	RED/BLUE/ORANGE		IF GAIN CONTROL
2	TWO COAXIAL	RED/VIOLET & BROWN/BROWN SLEEVES	IF OUTPUT
3	TWO COAXIAL SCREENS		
4	SCREEN FOR PIN 24		
5	COAXIAL	RED/RED SLEEVES	
6	TWO RED/BLACK		SSB SELECT
7	BLUE/GREEN		AM SELECT
8	RED	2-CORE SCREENED	AUDIO PRE-AMPLIFIER OUTPUT
9	TWO SCREENS		EARTH
10	TWO GREY/WHITE		MUTE
11	BLUE		LINE AMPLIFIER INPUT
12	NO CONNECTION		
13	THREE ORANGE		+12V
14	RED/BLUE		+14.5V
15	BLUE	2-CORE SCREENED VIOLET SLEEVE	AUDIO LINE OUTPUT
	BLUE	2-CORE SCREENED ORANGE/VIOLET SLEEVES	
16	RED		
	RED		
17	TWO SCREENS		EARTH
18	RED	2-CORE SCREENED BLUE SLEEVE	AUDIO OUTPUT TO LOUDSPEAKER
	RED	2-CORE SCREENED ORANGE/RED SLEEVES	
19	BLUE		
	BLUE		
	TWO SCREENS		
20	VIOLET		-7V
21	VIOLET WITH BROWN SLEEVE		-7V
22	SCREEN	SINGLE CORE SCREENED GREEN/VIOLET SLEEVES	INPUT TO LOUDSPEAKER AMPLIFIER
23	RED		
24	RED	SINGLE CORE SCREENED GREEN/ORANGE SLEEVES, SCREEN PIN 4	AGC HANG
25	RED	2-CORE SCREENED YELLOW/YELLOW SLEEVES	AGC SHORT SELECT
26	BLUE		AGC LONG SELECT
27	RED	SINGLE CORE SCREENED RED/WHITE SLEEVES	AGC INPUT (AFC BOARD)
28	SCREEN	2-CORE SCREENED YELLOW SLEEVE	EARTH
29	RED	SINGLE CORE SCREENED RED/GREEN SLEEVES	AGC OUTPUT
	BLUE	2-CORE SCREENED YELLOW/GREEN SLEEVES	
30	RED		AGC INPUT
	RED		
31	BLACK		EARTH
32	SCREEN		EARTH
33	BLUE		SPECIAL AGC INPUT
34	COAXIAL		1.4MHz IF INPUT
35	SCREEN		EARTH
	SCREEN		
36	TWO SCREENS		EARTH

TABLE 4: CABLEFORM COLOUR CODE IF FILTER BOARD PS367

BOARD PIN NO.	COLOUR		FUNCTION	
1	ORANGE		+12V	
2	COAXIAL		USB/AM OUTPUT	
3	SCREEN			
4	COAXIAL		LSB OUTPUT ISB VERSIONS	
5	SCREEN			
6	COAXIAL	YELLOW/BLACK SLEEVES	CARRIER OUTPUT AFC VERSIONS	
7	SCREEN			
8	RED/BLUE/ORANGE		CARRIER FILTER SELECT	
9	GREY/ORANGE		LSB FILTER SELECT	
10	RED/GREEN/WHITE		0.3kHz	STANDARD RECEIVER BANDWIDTHS
11	RED/GREEN/GREY		1kHz	
12	GREY/BLUE/WHITE		8kHz	
13	SCREEN	RED/BLUE SLEEVES	1.4MHz IF INPUT	
14	COAXIAL			
15	WHITE/BLACK		USB SELECT	
16	WIRE LINKS (16–24)		AFC FITTED	AFC NOT FITTED
17				
18				
19			SSB ONLY	ISB
20				
21				
22			AFC FITTED	AFC NOT FITTED
23				
24				
25	BLACK		0V (EARTH)	

TABLE 5: CABLEFORM COLOUR CODE AFC BOARD PM664

BOARD PIN No.	COLOUR	FUNCTION
1	RED	+20V
2	TWO ORANGE one with green sleeve	+12V
3	BROWN and WHITE/BLUE/ORANGE	+5V
4	RED — green/green sleeves	USB AGC OUTPUT
5	BLUE	LSB AGC OUTPUT
6	BROWN/RED/WHITE	TO AFC LAMP
7	RED/BLUE/GREY	OUTPUT TO METER
8	VIOLET	-7V
9	BLACK	EARTH (0V)
	SCREEN	EARTH
10	COAXIAL — black/red sleeves	AFC 1 MHz OUTPUT
12	SCREEN	EARTH
11	COAXIAL — orange/white sleeves	1 MHz INPUT
13	BROWN/RED/GREEN	AFC ON/OFF
14	ORANGE/RED/BLUE	ATTENUATOR ON/OFF
15	SCREEN	EARTH
16	COAXIAL — yellow/black sleeves	CARRIER INPUT
17	NO CONNECTION	
18	NO CONNECTION	
19	SCREEN	EARTH
20	SCREEN	EARTH

TABLE 5a: CABLEFORM COLOUR CODE AFC BOARD PM369

BOARD PIN NO.	COLOUR	FUNCTION
1	RED	+20V
2	TWO ORANGE one with green sleeve	+12V
3	BROWN	+5V
4	RED ← green/green sleeves	USB AGC OUTPUT
5	BLUE ← (green/green sleeves)	LSB AGC OUTPUT
6	BROWN/RED/WHITE	TO AFC LAMP
7	RED/BLUE/GREY	OUTPUT TO METER
8	VIOLET	-7V
9	BLACK	EARTH (0V)
9	SCREEN ← (black/red sleeves)	EARTH
10	COAXIAL ← black/red sleeves	AFC 1MHz OUTPUT
12	TWO SCREENS ← (orange/white sleeves; green/green sleeves)	EARTH
11	COAXIAL ← orange/white sleeves	1MHz INPUT
13	BROWN/RED/GREEN	AFC ON/OFF
14	ORANGE/RED/BLUE	ATTENUATOR ON/OFF
15	SCREEN ← (yellow/black sleeves)	EARTH
16	COAXIAL ← yellow/black sleeves	CARRIER INPUT
17	ORANGE	+12V

TABLE 6: CABLEFORM COLOUR CODE LOW FREQUENCY LOOP BOARD PM588

BOARD PIN NO.	COLOUR	FUNCTION	BOARD PIN NO.	COLOUR	FUNCTION
1	GREEN/BLACK	LOCK INDICATION OUTPUT 1	26	TWO VIOLET	-7V
2	ORANGE/BLACK	1kHz DATA 'C' LINE	27	TWO BROWN	+5V
3	NO CONNECTION		28	RED/BLUE/ORANGE	10kHz DATA 'C' LINE
4	ORANGE/RED	1kHz DATA 'A' LINE	29	RED/BLUE/GREEN	10kHz DATA 'A' LINE
5	NO CONNECTION		30	WHITE/RED/GREY	10kHz DATA 'B' LINE
6	GREY/BROWN	1kHz DATA 'B' LINE	31	WHITE/BLUE/BROWN	10kHz DATA 'D' LINE
7	NO CONNECTION		32	WHITE/BLUE/RED	100kHz DATA 'C' LINE
8	GREY/RED	1kHz DATA 'D' LINE	33	WHITE/BLUE/GREY	100kHz DATA 'A' LINE
9	NO CONNECTION		34	WHITE/BLUE/GREEN	100kHz DATA 'B' LINE
10	RED/BLACK	100kHz DATA 'C' LINE	35	RED/BROWN/ORANGE	100kHz DATA 'D' LINE
11	NO CONNECTION		36	BLUE	OVERSPILL DATA LINES
12	RED/BROWN	100kHz DATA 'A' LINE	37	WHITE	
13	NO CONNECTION		38	TWO RED	+20V
14	WHITE/BLACK	100Hz DATA 'B' LINE	39	TWO BLACK	0V (EARTH)
15	NO CONNECTION		40	SCREEN FOR 41	0V (EARTH)
16	WHITE/GREEN	100Hz DATA 'D' LINE	41	COAXIAL GREEN/BLACK SLEEVES	VARACTOR LINE OUTPUT
17	NO CONNECTION		42	ORANGE/GREEN	LOCK INDICATION OUTPUT 2
18	WHITE/RED	10Hz DATA 'C' LINE	43	SCREEN FOR 44	EARTH
19	NO CONNECTION		44	COAXIAL GREEN/RED SLEEVES	INPUT FROM TRANSFER OSCILLATOR
20	WHITE/GREEN	10Hz DATA 'A' LINE	45	TWO SCREENS FOR 46	EARTH
21	NO CONNECTION		46	TWO COAXIALS RED/ORANGE & ORANGE/WHITE SLEEVES	1MHz INPUT
22	GREEN/BROWN	10Hz DATA 'B' LINE	47	NO CONNECTION	
23	NO CONNECTION		48	TWO RED	+20V
24	GREEN/RED	10Hz DATA 'D' LINE	49	NO CONNECTION	
25	NO CONNECTION		50	BLACK	0V (EARTH)

TABLE 7: CABLEFORM COLOUR CODE UPPER LOOP BOARD PM589

BOARD PIN NO.	COLOUR		FUNCTION	BOARD PIN NO.	COLOUR	FUNCTION
1	SCREEN	BROWN/BLUE SLEEVES	4.6-3.6MHz OUTPUT	24	NO CONNECTION	
2	COAXIAL			25	TWO WHITE/BLUE/GREEN	100kHz DATA 'B' LINE
3	BLACK		0V (EARTH)	26	NO CONNECTION	
4	TWO RED		+20V	27	NO CONNECTION	
5	TWO BROWN		+5V	28	TWO WHITE/BLUE/GREY	100kHz DATA 'A' LINE
6	THREE VIOLET		-7V	29	NO CONNECTION	
7	COAXIAL	GREEN/BLACK SLEEVES	VARACTOR LINE INPUT	30	NO CONNECTION	
8	SCREEN			31	TWO WHITE/BLUE/RED	100kHz DATA 'C' LINE
9	COAXIAL	GREEN/RED SLEEVES	TRANSFER OSCILLATOR OUTPUT	32	NO CONNECTION	
10	SCREEN			33	NO CONNECTION	
11	GREY		RANGE BLANKING INPUT	34	TWO WHITE/BLUE/BROWN	10kHz DATA 'D' LINE
12	RED/ORANGE/WHITE		LOCK INDICATION OUTPUT	35	NO CONNECTION	
13	GREEN/BLACK		LOCK INDICATION INPUTS FROM PM453	36	NO CONNECTION	
14	GREEN/ORANGE			37	TWO WHITE/RED/GREY	10kHz DATA 'B' LINE
15	NO CONNECTION			38	NO CONNECTION	
16	TWO WHITE		OVERSPILL DATA 'D' LINE	39	NO CONNECTION	
17	NO CONNECTION			40	TWO RED/BLUE/GREEN	10kHz DATA 'A' LINE
18	NO CONNECTION			41	NO CONNECTION	
19	TWO BLUE		OVERSPILL DATA 'A' LINE	42	NO CONNECTION	
20	NO CONNECTION			43	TWO RED/BLUE/ORANGE	10kHz DATA 'C' LINE
21	NO CONNECTION			44	NO CONNECTION	
22	TWO BROWN/RED/ORANGE		100kHz DATA 'D' LINE	45	BLACK	0V (EARTH)
23	NO CONNECTION					

TABLE 8: CABLEFORM COLOUR CODE FSK BOARD PM368

BOARD PIN NO.	COLOUR		FUNCTION
1	BLUE	2-core screened green sleeve, screen to pin 19	FSK INPUT
2	VIOLET		-7V
3	ORANGE		+12V
4	BROWN		+5V
5	RED		+20V
6	RED		FSK OUTPUT
7	RED	2-core screened brown/orange sleeves	+6V TELEGRAPH
8	SCREEN		TEL E SUPPLY
9	BLUE		-6V OUTPUT
10	GREEN/BLACK		FSK SELECT
11	GREY/BLUE		FSK REVERSE
12	RED	Single core screened red/green sleeves, screen to pin 20	RELAY DRIVE
13	RED	Single core screened orange/black sleeves, screen to pin 20	OUTPUT TO METER
14	RED	Single core screened red/white sleeves	AGC INPUTS
15	RED	Single core screened red/grey sleeves	AGC INPUTS
16	TWO SCREENS		0V (EARTH)
17	BLACK		0V (EARTH)
17	SCREEN	RED/VIOLET SLEEVES	1.4MHz IF INPUT
18	COAXIAL	RED/VIOLET SLEEVES	1.4MHz IF INPUT
19 & 20	THREE SCREENS (for pins 1 - 6, 12 and 13)		EARTH

TABLE 9: CABLEFORM COLOUR CODE 34MHz GENERATOR BOARD PM339

BOARD PIN NO.	COLOUR	FUNCTION	BOARD PIN NO.	COLOUR	FUNCTION
1	BROWN	+5V	18	COAXIAL RED/BLACK SLEEVES, SCREEN PIN 33	AFC 1MHz
2	RED	+20V	19	BROWN/RED/GREEN	AFC EARTH
3	SCREEN (with pin 8: NO SLEEVES)	0V (EARTH)	20	COAXIAL (with pin 21: NO SLEEVES)	34MHz OUTPUT
4	COAXIAL (with pin 7: WHITE SLEEVES)	1MHz INPUT	21	TWO SCREENS	0V (EARTH)
5	SCREEN (with pin 6: RED/ORANGE SLEEVES)	0V (EARTH)	22	COAXIAL (with pin 21: NO SLEEVES)	34MHz OUTPUT
6	COAXIAL	1MHz OUTPUT	23	WHITE/BROWN/BLUE	BFO CONTROL
7	SCREEN	0V (EARTH)	24	ORANGE/BLACK	
8	COAXIAL	1MHz OUTPUT	25	GREEN/BROWN	
9	TWO ORANGE, ONE WITH GREEN SLEEVE	+12V	26	SCREEN — RED/YELLOW SLEEVES	5MHz INPUT
10	COAXIAL RED/RED SLEEVES, SCREEN PIN 31	1.4MHz OUTPUT (USB/AM)	27	COAXIAL	
11	COAXIAL RED/BROWN SLEEVES, SCREEN PIN 32	1.4MHz OUTPUT (LSB)	28	TWO BROWN, ONE WITH WHITE SLEEVE	+5V
12	BLUE/WHITE	SLAVE EARTH	29	TWO ORANGE, ONE WITH GREEN SLEEVE	+12V
13	NO CONNECTION	CRYSTAL EARTH	30	ORANGE	+12V
14	ORANGE/GREEN	BFO EARTH	31	SCREEN FOR PIN 10	0V (EARTH)
15	BROWN/BLUE	1.4MHz EARTH	32	SCREEN FOR PIN 11	0V (EARTH)
16	ORANGE/BROWN	1 MHz EARTH	33	SCREEN FOR PIN 18	0V (EARTH)
17	NO CONNECTION		34 & 35	BLACK	0V (EARTH)

TABLE 10: CABLEFORM COLOUR CODE TRANSFER LOOP BOARD PS338

BOARD PIN NO.	COLOUR		FUNCTION
1	NO CONNECTION		
2	TWO RED, ONE WITH WHITE SLEEVE		+20V
3	TWO BROWN, ONE WITH WHITE SLEEVE		+5V
4	COAXIAL	BROWN/VIOLET SLEEVES	VARACTOR LINE OUTPUT
5	SCREEN		
6	WHITE/RED/GREEN		LOCK INDICATION OUTPUT
7	TWO VIOLET		-7V
8	TWO BLUE/RED/GREEN		MHz DATA 'D' LINE (TENS)
9	TWO BLUE/WHITE/BROWN		MHz DATA 'C' LINE (TENS)
10	TWO BLUE/WHITE/GREEN		MHz DATA 'B' LINE (TENS)
11	TWO RED/ORANGE/GREY		MHz DATA 'A' LINE (TENS)
12	TWO WHITE/RED/ORANGE		MHz DATA 'D' LINE (UNITS)
13	TWO WHITE/RED/BROWN		MHz DATA 'C' LINE (UNITS)
14	TWO RED/GREY/BLUE		MHz DATA 'B' LINE (UNITS)
15	TWO RED/GREY/GREEN		MHz DATA 'A' LINE (UNITS)
16	SCREEN	BROWN/BLUE SLEEVES	4.6 - 3.6MHz INPUT
17	COAXIAL		
18	SCREEN	BROWN/GREY SLEEVES	INPUT FROM TRANSFER LOOP OSCILLATOR
19	COAXIAL		
20	SCREEN	NO SLEEVES	1MHz INPUT
21	COAXIAL		

TABLE 11: CABLEFORM COLOUR CODE HF LOOP BOARD PS337

BOARD PIN NO.	COLOUR		FUNCTION
1	GREY/RED/GREEN		MHz DATA 'A' LINE (UNITS)
2	GREY/RED/BLUE		MHz DATA 'B' LINE (UNITS)
3	BROWN/RED/WHITE		MHz DATA 'C' LINE (UNITS)
4	ORANGE/RED/WHITE		MHz DATA 'D' LINE (UNITS)
5	ORANGE/RED/GREY		MHz DATA 'A' LINE (TENS)
6	BLUE/GREEN/WHITE		MHz DATA 'B' LINE (TENS)
7	BLUE/BROWN/WHITE		MHz DATA 'C' LINE (TENS)
8	RED/GREEN/BLUE		MHz DATA 'D' LINE (TENS)
9	BROWN		+5V
10	ORANGE		+12V
11	RED		+20V
12	BROWN/VIOLET/RED WITH TWO FERRITE BEADS (FB2,FB3)		LOCK INDICATION OUTPUT
13	COAXIAL	BROWN/GREY SLEEVES	TRANSFER LOOP OSCILLATOR OUTPUT
14	SCREEN		
15	NO CONNECTION		
16	VIOLET WITH SINGLE FERRITE BEAD (FB1)		-7V
17	SCREEN	BROWN/VIOLET SLEEVES	VARACTOR LINE INPUT
18	COAXIAL		
19,20	NO CONNECTIONS		
21	SCREEN	NO SLEEVES	LOCAL OSCILLATOR OUTPUT
22	COAXIAL		
23	SCREEN	BROWN/WHITE SLEEVES	LOCAL OSCILLATOR
24	COAXIAL		INPUT/OUTPUT SOCKET
25	RED/BLUE		LO INT/EXT SWITCH
26	WHITE		OSCILLATOR 1 SELECT
27	GREY		OSCILLATOR 2 SELECT
28	BLUE		OSCILLATOR 3 SELECT

TABLE 12: CABLEFORM COLOUR CODE FIRST MIXER BOARD PM335

BOARD PIN NO.	COLOUR		FUNCTION
1	ORANGE		+12V
2	SCREEN	NO SLEEVES	35.4MHz IF OUTPUT
3	COAXIAL		
4	NO CONNECTION		
5	RED/ORANGE/GREEN		OUTPUT TO METER
6	NO CONNECTION		
7	VIOLET		-7V
8	WHITE/BLUE		4-29MHz SELECT
9	SCREEN	NO SLEEVES	LOCAL OSCILLATOR INPUT
10	COAXIAL		
11	ORANGE/BROWN		0-3MHz SELECT
12-18	NO EXTERNAL CONNECTIONS		
19	COAXIAL	NO SLEEVES	RF INPUT
20	SCREEN		

TABLE 13: CABLEFORM COLOUR CODE SECOND MIXER BOARD PM336

BOARD PIN NO.	COLOUR		FUNCTION
1	ORANGE		+12V
2	ORANGE		+12V
3	GREEN		OUTPUT
4	BLACK		EARTH
5	NO CONNECTION		
6	SCREEN	NO SLEEVES	34MHz INPUT
7	COAXIAL		
8	WHITE/BLUE		AGC 2
9	ORANGE/RED		AGC 1
10	BLACK		EARTH
11	VIOLET		-7V
12	SCREEN	NO SLEEVES	35.4MHz IF INPUT
13	COAXIAL		

TABLE 14: CABLEFORM COLOUR CODE LOGIC BOARD

BOARD PIN NO.	COLOUR	FUNCTION
1	BROWN	+5V
2	WHITE/BLACK	DF2 OUTPUT
3	ORANGE/BROWN	DF1 OUTPUT
4	BLUE	01 OUTPUT
5	WHITE	03 OUTPUT
6	GREY	02 OUTPUT
7	BROWN/WHITE	A1 OUTPUT
	GREY/GREEN/RED	
8	GREY/BLUE/RED	B1 OUTPUT
9	WHITE/BROWN/RED	C1 OUTPUT
10	WHITE/ORANGE/RED	D1 OUTPUT
11	ORANGE/VIOLET/RED	A2 OUTPUT
12	WHITE/GREEN/BLUE	B2 OUTPUT
13	WHITE/BROWN/BLUE	C2 OUTPUT
14	GREEN/BLUE/RED	D2 OUTPUT
15	BLACK	0V EARTH
16-25	NO EXTERNAL CONNECTIONS	
26	WHITE/ORANGE	RANGE SELECTION OUTPUTS
27	BROWN/RED/BLUE	
28	RED/GREY/WHITE	
29	GREY/BLUE	
30	ORANGE/BLACK	
31	WHITE/RED/BLUE	
32	BLUE/GREEN	RF MICROSWITCH
WIPER SA3	GREEN/BLACK	LO INT/EXT SWITCH

TABLE 15: CABLEFORM COLOUR CODE METER SWITCHING BOARD

BOARD PIN NO.	COLOUR	FUNCTION
1	RED ← 2-core screened orange/blue sleeves	ISB DIV AGC
2	TWO BLACK, ONE WITH BROWN SLEEVE	0V (EARTH)
3	ORANGE	+12V
4	BLUE ←	DIV AGC
5	SCREEN ←	0V (EARTH)
6	BROWN	+5V
7	RED	METER +
8	SCREEN ← Single core screened	FSK INPUT
9	RED ← Orange/black sleeves	
10	RED	+20V
11	BLUE ← 2-core screened	AUDIO LINE OUTPUT ISB IF
12	RED ← Orange/grey sleeves	
13	SCREEN ←	
14	NO CONNECTION	
15	RED ← 2-core screened	AUDIO LINE OUTPUT MAIN IF
16	BLUE ← Orange/violet sleeves	
17	SCREEN ←	
18	NO CONNECTION	
19	ORANGE/GREEN	LO DRIVE
20	NO CONNECTION	
21	BLACK	METER -
22	NO CONNECTION	
23	GREY/RED	TUNING INDICATION
24	NO CONNECTION	
25	VIOLET	-7V
26	NO CONNECTION	
27	NO CONNECTION	

TABLE 16: CABLEFORM COLOUR CODE DISPLAY BOARD PM371

BOARD PIN NO.	COLOUR	FUNCTION	BOARD PIN NO.	COLOUR	FUNCTION
1	WHITE/GREEN	10Hz DATA 'A' LINE	21	BLUE	OVERSPILL DATA 'A' LINE
2	BROWN/GREEN	10Hz DATA 'B' LINE	22	WHITE	OVERSPILL DATA 'D' LINE
3	BROWN/WHITE	10Hz DATA 'C' LINE	23	ORANGE/BROWN	MEMORY +5V SUPPLY
4	GREEN/RED	10Hz DATA 'D' LINE	24	GREY/GREEN	'L' MHz LAMP
5	BROWN/RED	100Hz DATA 'A' LINE	25	ORANGE/BROWN	'N' MHz LAMP
6	BLACK/WHITE	100Hz DATA 'B' LINE	26	GREEN/BLACK	'H' MHz LAMP
7	BLACK/RED	100Hz DATA 'C' LINE	27	GREY	RANGE BLANKING
8	WHITE/GREY	100Hz DATA 'D' LINE	28	BROWN/WHITE	MHz UNITS
9	ORANGE/RED	1kHz DATA 'A' LINE	29	BLUE/GREEN	TUNING FAST
10	GREY/BROWN	1kHz DATA 'B' LINE	30	GREEN/ORANGE	TUNING LOCK
11	ORANGE/BLACK	1kHz DATA 'C' LINE	31	ORANGE/BLUE	ENCODER 'B'
12	GREY/RED	1kHz DATA 'D' LINE	32	GREY/ORANGE	ENCODER 'A'
13	RED/BLUE/GREEN	10kHz DATA 'A' LINE	33	ORANGE/RED/WHITE	LOCK LINES
14	RED/GREY/WHITE	10kHz DATA 'B' LINE	34	BROWN/RED/VIOLET	LOCK LINES
15	RED/BLUE/ORANGE	10kHz DATA 'C' LINE	35	WHITE/RED/GREEN	LOCK LINES
16	WHITE/BLUE/BROWN	10kHz DATA 'D' LINE	36	GREEN	OUT-OF-LOCK LAMP
17	WHITE/BLUE/GREY	100kHz DATA 'A' LINE	37	TWO BLACK	0V (EARTH)
18	WHITE/BLUE/GREEN	100kHz DATA 'B' LINE	38	NO CONNECTION	
19	WHITE/BLUE/RED	100kHz DATA 'C' LINE	39	THREE BROWN	+5V
20	ORANGE/BROWN/RED	100kHz DATA 'D' LINE	40	BLACK	LO SWITCH

TABLE 17: CABLEFORM COLOUR CODE REGULATOR BOARD PM370

BOARD PIN NO.	COLOUR	FUNCTION
1	WHITE/BROWN	1TR1 COLLECTOR
2	GREEN/WHITE	1TR1 BASE
3	BLACK	0V (EARTH)
4	BLUE/WHITE	1TR1 EMITTER
5	VIOLET WITH BROWN SLEEVE	-7V OUTPUT
	BLUE ← 2-core screened brown/green sleeves	
6	TWO VIOLET	
7	NO CONNECTION	
8	WHITE/GREY	1TR2 COLLECTOR
9	GREEN/BROWN	1TR2 BASE
10	TWO BROWN ONE WITH WHITE SLEEVE	+5V OUTPUT
11	NO CONNECTION	
12	THREE BROWN	+5V OUTPUT
13	BLUE/GREEN	1TR2 EMITTER
14	WHITE/ORANGE	1TR3 COLLECTOR
15	ORANGE/GREEN	1TR3 BASE
16	RED ← (Screen not connected)	+12V OUTPUT
	TWO ORANGE, ONE WITH GREEN SLEEVE	
17	TWO ORANGE	
18	ORANGE WITH BROWN SLEEVE	
19	BLUE/ORANGE	EMITTER 1TR3
20	ORANGE/RED	+12V OVEN SUPPLY
21	GREY/ORANGE	STANDBY +12V INPUT
22	TWO RED	+20V OUTPUT
23	RED WITH WHITE SLEEVE	
24	BLACK	0V (EARTH)
25	RED ← 2-core screened brown sleeve	+80V OUTPUT
26	BLUE ←	-80V OUTPUT
27	SCREEN ←	TELEGRAPH EARTH

BOARD PIN NO.	COLOUR	FUNCTION
28	BROWN/BLUE	CONNECTION TO 1C5 and 1R10
29	GREEN	CENTRE-TAP 6-0-6V 1T1
30	ORANGE/BROWN	CONNECTIONS TO 1C6 AND 1R9
31	GREEN/BROWN	
32	WHITE/GREY	60-0-60V AC WINDING 1T1 (CENTRE-TAP PIN 29)
33	WHITE/GREY	
34	GREY/ORANGE	CONNECTION TO 1C5 and 1R10
35	BLUE/GREEN	CONNECTIONS TO 1C4
36	RED/ORANGE	
37	GREY/BROWN	23V AC WINDING 1T1
38	WHITE/ORANGE	
39	NO CONNECTION	
40	NO CONNECTION	
41	ORANGE/BROWN	16.5V AC WINDING 1T1
42	GREY/RED	
43	NO CONNECTION	
44	NO CONNECTION	
45	BLUE/GREY	10V AC WINDING 1T1
46	RED/BROWN	
47	BLUE/WHITE	CONNECTIONS TO 1C1
48	BLACK/WHITE	
49	BROWN/BLUE	10.5V AC WINDING 1T1
50	GREY/ORANGE	
D2 -	ORANGE/BLUE	← CONNECTIONS TO 1C2
D2 +	GREY/BROWN	UNREGULATED 14V SUPPLY
	RED/BLACK	←
D3 -	TWO BROWN/WHITE	CONNECTIONS TO 1C3 AND
D3 +	TWO RED/WHITE	UNREGULATED 23V OUTPUT

TABLE 18: CABLEFORM COLOUR CODE AF & MEMORY REGULATOR BOARD PS427/1

BOARD PIN NO.	COLOUR	FUNCTION
1	RED/BLACK	CONNECTIONS TO ML2
2	RED/ORANGE	
3	RED/BROWN	
4	RED/WHITE	UNREGULATED 23V SUPPLY
5	BROWN/WHITE	
6	TWO RED/BLUE	+14.5V OUTPUT
7	BLACK	0V (EARTH)
* 8	ORANGE/RED	+12V OVEN SUPPLY
* 9	GREY/BROWN	UNREGULATED 14V SUPPLY
*10	ORANGE/BROWN	MEMORY +5V OUTPUT
*11	ORANGE/BLUE	CONNECTIONS TO ML3
*12	ORANGE/BROWN	
*13	ORANGE/GREEN	

* RA.1772 ONLY.

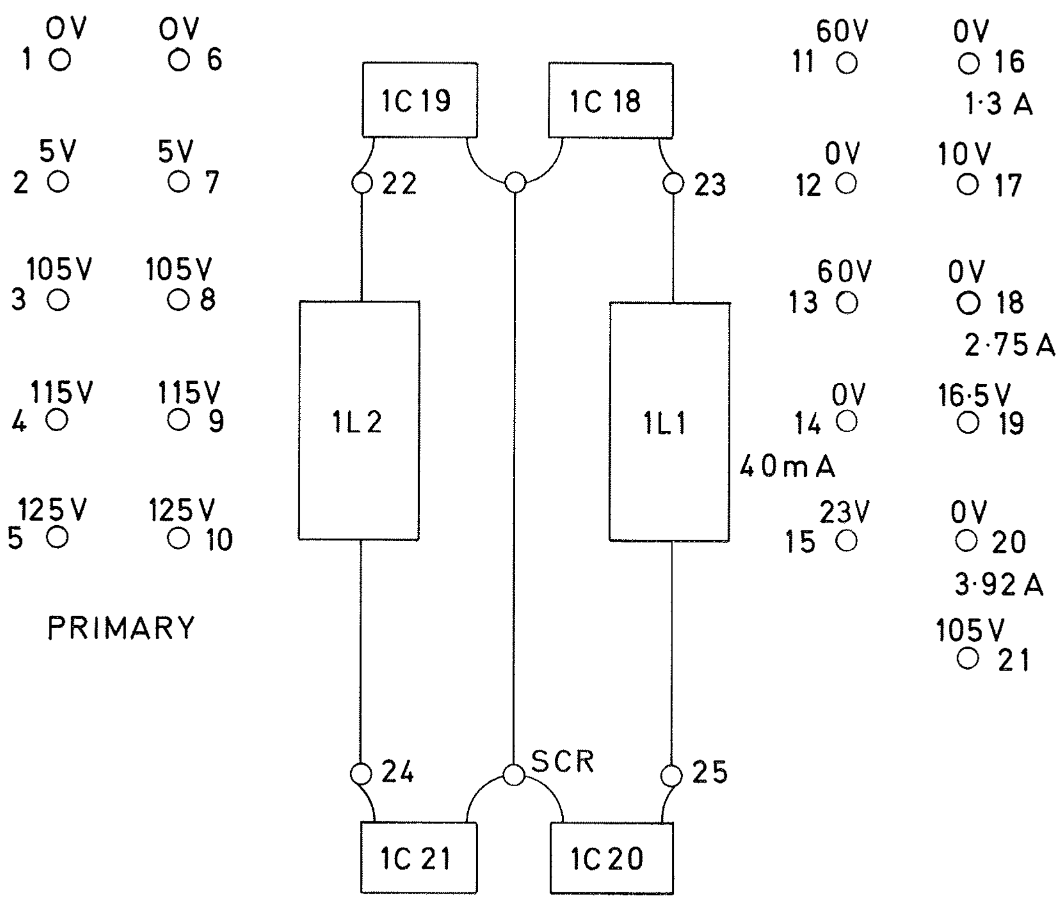

TABLE 19: CABLEFORM COLOUR CODE POWER TRANSFORMER

PIN NO.	COLOUR		FUNCTION
1	WHITE/BLUE		PRIMARY CONNECTIONS
2	ORANGE/GREEN		
3	ORANGE/BLUE		
4	RED/BLACK		
5	RED/ORANGE		
6	GREEN/WHITE		
7	WHITE/BROWN		
8	BLUE/GREEN		
9	BLACK/WHITE		
10	RED/WHITE		
11	WHITE/GREY		60-0-60V SECONDARY
12	GREEN		
13	WHITE/GREY		
14	GREY/BROWN		23V SECONDARY
15	WHITE/ORANGE		
16	BROWN/BLUE		10V SECONDARY
17	GREY/ORANGE		
18	ORANGE/BROWN		16.5V SECONDARY
19	GREY/RED		
20	GREY/BLUE		10.5V SECONDARY
21	RED/BROWN		
22	RED	TWISTED PAIR	AC SUPPLY IN
23	BLUE		
24	RED	TWISTED PAIR	AC SUPPLY OUT
25	BLUE		
SCR	BLACK		EARTH

TABLE 20: CABLEFORM COLOUR CODE OUT-OF-LOCK INDICATOR BOARD (RA.1771 only)

PIN NO.	COLOUR	FUNCTION
1	BROWN (5 OFF)	+5V
2	BLACK	0V
3	GREEN	TO OUT-OF-LOCK LAMP
4	WHITE/RED/ORANGE	FROM PM589
5	RED/BLUE/BROWN	FROM PS337
6	WHITE/RED/GREEN	FROM PS338

TABLE 21: CABLEFORM COLOUR CODE POTENTIOMETER BOARD (RA.1772 only)

PIN NO.	COLOUR	FUNCTION
1	BTC - PTFE SLEEVE	SENSOR OUTPUT B
2		EARTH
3	BTC - PTFE SLEEVE	SENSOR OUTPUT A
4	GREY/ORANGE	OUTPUT A
5	BLACK	EARTH
6	2 ORANGE	+12V
7	ORANGE	
8	ORANGE	
9	ORANGE	
10	ORANGE/BLUE	OUTPUT B

CHAPTER 4

FUNCTIONAL TEST PROCEDURE

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CHAPTER 4

FUNCTIONAL TEST PROCEDURES

INTRODUCTION

1. This Chapter contains detailed test procedures to check the performance of the receiver against the Specification. The tests may be carried out as part of a routine maintenance schedule or as an aid to the location of a fault. The tests should be carried out in the order given.

TEST EQUIPMENT

2. The items of test equipment listed below are required for the following tests:-

(1) Signal Generator (Two off)

Frequency Range:	15kHz to 70MHz
Output Impedance:	50 ohms
Amplitude Modulation:	400Hz 70%
Distortion:	Less than 1%

(Example: Marconi Type TF144H)

(2) HF Electronic Voltmeter

Input Impedance:	50 ohms
Range (0dB = 1.0V):	-50 to +10dB

(Example: Airmec Type 301 or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, Type TM6/4).

(3) LF Electronic Voltmeter

Input Impedance:	not less than 1MΩ
Range (0dB = 0.775V):	-50 to +10dB

(Example Advance Type 77)

(4) AC/DC Multimeter

Range:	0 to 300V
Accuracy:	2% of full scale

(Example: Avometer Model 8)

(5) Digital Frequency Meter

Frequency Range:	DC to 70MHz
Accuracy:	
Internal Standard:	1 part in 10^6 ± 1 count
External Standard:	Accuracy of standard ± 1 count.
Input Impedance:	1MΩ shunted with 15pF
Sensitivity:	50 millivolts r.m.s.

(Example: Racal Instruments Type 9822 or Type 9021)

(6) Output Power Meter

Frequency Range:	20Hz to 35kHz
Input Impedance:	600Ω and 8Ω
Power Range:	Not less than 2 watts FSD.

(Example: Marconi Type TF893A)

(7) Waveform Analyser

(Example: Wayne Kerr Type A321)

(8) Combiner

Impedance: Input and Output 50Ω
(Example: Racal Type CA.612 - see Appendix 1)

(9) Step Attenuator

Range:	0 to 10dB
Impedance:	50Ω

(10) Headphones

Impedance: 600Ω

(11) BNC Termination 50Ω

*(12) FSK Test Generator
(Example: Racal Type CA.496)

*(13) Teleprinter
Speed: 50 Bauds
(Example: Creed Type 28)

*(14) Resistor, fixed, 2kΩ, wirewound, 5%, 6W

*FSK Versions only.

PRELIMINARY

3. (1) Set the receiver POWER switch to OFF.

(2) Set the 1MHz, 34MHz, and LO switches on the rear panel to INT

(3) Ensure that the VOLTAGE SELECTOR on the rear panel is correctly set to suit the local supply voltage.

(4) Connect the receiver to a suitable source of AC power.

(5) Set the front panel POWER switch to ON.

(6) Ensure that:
(a) the MHz dial illuminates (RA.1772 only)

(b) the KHz display illuminates at 00000 (RA.1772 only).

(c) the POWER lamp illuminates (RA.1771 only).

(d) the synthesizer OUT OF LOCK lamp illuminates and then extinguishes.

(7) Set the front panel METER switch, in turn, to +20, +12, +5 and -7. Check that for each position the meter indication lies within the green portion of the meter scale.

NOTE: Due to the number of optional IF filter bandwidths available, SSB filters fitted may be other than 3kHz. It will therefore be necessary to select an alterntive bandwidth for some of the following tests. The signal plus noise/noise ratio and the inband intermodulation product measurements are both modified by the IF filter bandwidth. Where a filter of less than 3kHz is used to measure the intermodulation products, the input frequencies should be chosen such that the third order products lie within the filter passband. The signal plus noise/noise ratio may be computed from:

$$10 \log_{10} \times \frac{\text{Filter Bandwidth (kHz)}}{3}$$ and the result

added to or subtracted from the figures specified.

DISPLAY (RA.1772 only)

4. (1) Set the MHz control to 3.

(2) Set the TUNING RATE switch to SLOW.

(3) Slowly spin the kHz control clockwise; the kHz display should increase in 10Hz steps at a rate of 2.5kHz per turn.

(4) Slowly spin the kHz control counter-clockwise; the kHz display should decrease in 10Hz steps. As the display passes from 00000 to 99999, check that the lamp behind the 3 on the MHz dial extinguishes, and that the lamp behind the 2 illuminates.

(5) Continue to decrease the kHz display indication until it stops, at 97999.

(6) Turn the MHz control one position counter-clockwise; the illuminated 2 should move to the centre of the MHz scale and the kHz display should remain at 97999.

(7) Spin the kHz control counter-clockwise; the kHz display should decrease from 97999.

(8) Spin the kHz control clockwise; the kHz display should increase to 99999, change to 00000 and then stop at 02000. As the display passes through 00000, the lamp behind on the 2 on the MHz dial should extinguish, and the lamp behind the 3 should illuminate.

(9) Turn the MHz control one position clockwise; the illuminated 3 should move to the centre of the KHz scale and the kHz display should remain at 02000.

(10) Spin the kHz control clockwise; the kHz display should increase from 02000.

(11) Set the TUNING RATE switch to FAST

(12) Spin the kHz control in each direction in turn and check that the kHz display moves in 100Hz steps at a rate of 50kHz per turn. The '10Hz' figure should remain stationary at 0.

(13) Set the TUNING RATE switch to LOCK.

(14) Spin the kHz control in each direction in turn and ensure that the kHz display indication does not vary.

NOTE: A mechanical damper is fitted to the tuning shaft and may be adjusted to suit the users preference (see Fig. 4).

FREQUENCY STANDARD

5. (1) Ensure that the rear panel 1MHz and LO INT/EXT switches are set to INT.

(2) Connect the digital frequency meter to the 1MHz IN/OUT socket.

(3) Ensure that the digital frequency meter indicates 1000000 Hz plus or minus 1Hz. If the frequency standard fitted is of the TXCO type, adjust R1 on the frequency standard board to achieve a frequency within these limits.

(4) Disconnect the digital frequency meter from the 1MHz IN/OUT socket and connect in its place the HF electronic voltmeter (50Ω input impedance).

(5) Check that the HF electronic voltmeter indicates at least 180 millivolts.

(6) Set the 1MHz INT/EXT switch to EXT and ensure that the HF electronic voltmeter indication falls to zero.

(7) Set the 1MHz INT/EXT switch to INT.

LOCAL OSCILLATOR OUTPUT

6. (1) Set the MHz control to display 0.

(2) Set the kHz switches (RA.1771) or the kHz control (RA.1772) for a display of 000.00.

(3) Set the TUNING RATE switch to LOCK (RA.1772 only).

(4) Connect the 1MHz IN/OUT socket on the receiver to the External Standard socket on the digital frequency meter. Set the digital frequency meter to operate from an external 1MHz standard.

(5) Connect the digital frequency meter to the LO IN/OUT socket.

(6) Ensure that the digital frequency meter indicates 35 400 000 Hz plus or minus 1 Hz.

(7) Set the MHz switch to 1. Ensure that the digital frequency meter indicates 36 400 000 Hz plus or minus 1Hz.

(8) Set the MHz switch to each position in turn and ensure that the digital frequency meter indicates 35.4MHz plus the MHz setting.

(9) Reset the MHz switch to 0.

(10) Set the kHz switches (RA.1771) or the kHz control (RA.1772) to display the frequencies tabulated below and ensure that the corresponding output frequencies are indicated on the digital frequency meter.

kHz Display	Digital Frequency Meter Reading (Hz)
000.00	35 400 000
111.11	35 511 110
222.22	35 622 220
333.33	35 733 330
444.44	35 844 440
555.55	35 955 550
666.66	36 066 660
777.77	36 177 770
888.88	36 288 880
999.99	36 399 990
000.00 (MHz reads '1')	36 400 000

(11) Disconnect the digital frequency meter from the LO IN/OUT socket and connect in its place the HF electronic voltmeter (50Ω input impedance).

(12) Step the MHz switch through each position, i.e. 0 to 29, and check that the electronic voltmeter indication is not less than 180 millivolts for each position.

(13) Set the LO INT/EXT switch to EXT and ensure that the HF electronic voltmeter indication falls to zero.

(14) Set the LO INT/EXT switch to INT.

(15) Set the front panel METER switch to DRIVE LEVEL.

(16) Step the MHz switch through each position and check that the meter indication falls within the 'V' portion of the meter scale for each position except 0 where the meter should indicate approximately half deflection.

(17) Set the MHz switch to 0 and the kHz to 015.00. Check that the meter indication lies within the 'V' portion of the meter scale.

34 MHz OUTPUT

7. (1) Connect the digital frequency meter to the 34MHz IN/OUT socket. Ensure that the digital frequency meter indicates 34 000 000 Hz plus or minus 1 Hz.

(2) Disconnect the digital frequency meter from the LO IN/OUT socket and connect in its place the HF electronic voltmeter (50Ω input impedance).

(3) Check that the HF electronic voltmeter indication is not less than 180 millivolts.

(4) Set the 34MHz INT/EXT switch to EXT and ensure that the HF electronic voltmeter indication falls to zero.

(5) Set the 34MHz INT/EXT switch to INT and disconnect the HF electronic voltmeter.

IF AND AF GAIN CONTROL CHECK

8. (1) Set the following controls as indicated:

MHz	3
AGC	SHORT
MODE	USB
AFC (if fitted)	OFF
IF GAIN	Fully Clockwise
AF GAIN	Fully Counter-clockwise
LS	ON

(2) Turn the AF GAIN progressively clockwise and check that the noise in the loudspeaker increases.

(3) Set the AGC switch to OFF. Turn the IF GAIN counter-clockwise and check that the noise in the loudspeaker decreases.

(4) Set the AGC switch to SHORT. Check that the noise in the loudspeaker increases to full output and that the IF GAIN control is inoperative.

NOTE: In certain receivers the IF GAIN control may operate with AGC. See Appendix 1 in Operator's Manual.

(5) Connect the headphones to the left-hand PHONES jack. Check that the noise in the loudspeaker remains and that the noise can also be heard in the headphones.

(6) Transfer the headphones to the right-hand PHONES jack. Check that there is no output from the loudspeaker and that noise can be heard in the headphones.

LF SIGNAL PLUS NOISE/NOISE RATIO

9. (1) Set the receiver controls as follows:

TUNING RATE (RA.1772 only)	FAST
MHz	0
kHz	018.00
MODE	USB
AFC (if fitted)	OFF
LS	OFF
HEADPHONES	Plugged in

(2) Connect the output power meter to the LS and E Terminals of TS1 on the rear panel. Set the output power meter to 8 ohms.

(3) Connect the CW output from the signal generator, set to a frequency of 18 kHz and an output level of 10 microvolts e.m.f., to the antenna socket.

(4) Tune the signal generator to the receiver.

(5) Set the AGC switch to SHORT.

(6) Adjust the AF GAIN for an indication of 100 milliwatts on the output power meter.

(7) Set the AGC switch to OFF. Using the IF GAIN control restore the AF output to 100 milliwatts on the output power meter (0dB reference point).

(8) Off-tune the signal generator by at least 10kHz. Ensure that the AF output falls by not less than 15dB.

(9) Set the signal generator output level to 3 microvolts e.m.f.

(10) Repeat steps (4) to (8) with the receiver frequency set, in turn, to 50.00 kHz and 990.00kHz.

HF SIGNAL PLUS NOISE/NOISE RATIO - SSB

10. (1) Set the receiver controls as follows:-

TUNING RATE (RA.1772 only)	FAST
MHz	28
kHz	020.00
RF TUNE (if fitted)	WB
AGC	SHORT
MODE	USB
AFC (if fitted)	OFF
LS	OFF
HEADPHONES	Plugged in

(2) Connect the HF electronic voltmeter to the MAIN IF OUT socket on the rear panel (50 ohm input impedance).

(3) Connect the CW output from the signal generator, set to a frequency of 28.020 MHz and an output level of 2 microvolts e.m.f., to the antenna socket.

(4) Tune the signal generator to the receiver for maximum response in the receiver passband. Check that the HF electronic voltmeter indicates not less than 50 mV.

(5) For FSK versions only, adjust L1 on the FSK board for a maximum indication on the HF electronic voltmeter.

(6) Set the front panel AM/USB LINE LEVEL and AF GAIN controls fully clockwise.

(7) Use the output power meter to measure the audio output levels at the following points. The levels should not be less than those given.

PHONES JACK	600Ω	10mW
LOUDSPEAKER TERMINALS	8Ω	1W
LINE O/P MAIN IF	600Ω	8 mW

NOTE: Steps (8) to (13) inclusive apply to ISB Receivers only.

(8) Set the MODE switch to ISB-L.

(9) Connect the HF electronic voltmeter to the ISB IF OUT socket.

(10) Tune the signal generator for maximum response within the receiver passband and check that the HF electronic voltmeter indication is not less than 50 millivolts.

(11) If necessary (FSK versions only) slightly adjust L1 on the FSK board for a maximum indication on the HF electronic voltmeter.

(12) Set the LSB LINE LEVEL and AF GAIN controls fully clockwise.

(13) Use the output power meter to measure the audio output levels at the following points. The levels should not be less than those given.

PHONES JACK	600Ω	10 mW
LOUDSPEAKER TERMINALS	8Ω	1W
LINE O/P ISB	600Ω	8 mW

(14) Set the MODE switch to USB, and the receiver frequency to 29.95 MHz.

(15) Re-connect the output power meter, set to 8 ohms, to the loudspeaker terminals (TS1 LS and E).

(16) Set the signal generator frequency to 29.95 MHz and an output level to 1 microvolt e.m.f.

(17) Tune the signal generator to the receiver for maximum indication in the output power meter.

(18) Adjust the AF GAIN control for an indication of 100 mW on the output power meter.

(19) Set the AGC switch to OFF. Adjust the IF GAIN control to restore the AF output to 100 mW (0 dB reference point).

DO NOT RE-ADJUST THE AF OR IF GAIN CONTROLS FOR THE REMAINDER OF THIS TEST.

(20) Off-tune the signal generator by at least 10 kHz, and check that the AF output, as indicated on the output power meter, falls by not less than 15 dB.

(21) For receivers fitted with the RF TUNE control, retune the signal generator to the receiver. Peak the RF TUNE control for a maximum indication on the output power meter. Off-tune the signal generator by at least 10 kHz and check that the AF output falls by not less than 9 dB.

(22) Repeat at each of the following frequencies. DO NOT adjust the AF or IF GAIN controls.

15.02 MHz   3.02 MHz
8.02 MHz   1.02 MHz
4.02 MHz

HF SIGNAL PLUS NOISE/NOISE RATIO - AM

11. (1) Set the receiver controls as follows:

MHz	4
kHz	020.00
TUNING RATE (RA.1772 only)	LOCK
RF TUNE (if fitted)	WB
AGC	SHORT
MODE	AM
FILTER	0.3kHz
AFC (if fitted)	OFF
LS	OFF
HEADPHONES	Plugged in

(2) Connect HF electronic voltmeter (50Ω impedance) to the MAIN IF OUT socket on the rear panel.

(3) Set the signal generator output level to 1.5 microvolts e.m.f. CW.

(4) Tune the signal generator to the receiver for maximum indication on the HF electronic voltmeter.

(5) Set the FILTER switch to 3kHz.

(6) Set the signal generator to give 70 per cent amplitude modulation at 400Hz.

(7) Adjust the AF GAIN control for an indication of 100mW in the output power meter (connected between the LS and E terminals of TS1).

(8) Switch off the modulation at the signal generator and check that the AF output level falls by not less than 15dB.

AGC AND AF GAIN CONTROL RANGE CHECKS

12. (1) Set the receiver controls as follows:

MHz	4
kHz	020.00
TUNING RATE (RA.1772 only)	LOCK
RF TUNE (if fitted)	WB
AGC	SHORT
MODE	USB
AFC (if fitted)	OFF
LS	OFF
HEADPHONES	Plugged in.

(2) Set the output level from the signal generator (connected to the antenna socket) to 2 microvolts CW.

(3) Tune the signal generator to the receiver for maximum response within the receiver passband.

(4) Adjust the AF GAIN control for an indication of 100 milliwatts on the output power meter (connected between the LS and E terminals of TS1).

(5) Increase the output level from the signal generator to 200 millivolts e.m.f. (+100dB relative to 2 microvolts) and check that the AF output level does not increase by more than 5 dB

(6) Reset the signal generator output level to 2 microvolts.

(7) Set the AGC switch to LONG and repeat steps (4) and (5).

(8) Set the IF GAIN control fully counter-clockwise.

(9) Set the AGC switch to OFF.

(10) Check that the AF output level does not exceed 100 milliwatts.

(11) Set the AGC switch to SHORT.

RF METER CALIBRATION

13. (1) Set the METER switch to RF.

(2) Increase the output level from the signal generator to 200 millivolts e.m.f. (+100dB relative to 2 microvolts).

(3) Check that the meter needle coincides with the 100dB mark on the meter scale.

(4) Reduce the signal generator output level in 20dB steps down to 2 microvolts (0dB). Check that the dB reading on the meter is within plus or minus 15dB of the input level at each step.

ULTIMATE SIGNAL PLUS NOISE/NOISE RATIO (SSB)

14. (1) Set the receiver controls as follows:

MHz	4
kHz	020.00
TUNING RATE (RA.1772 only)	LOCK
RF TUNE (if fitted)	WB
AGC	SHORT
MODE	USB
AFC (if fitted)	OFF
LS	OFF
HEADPHONES	Plugged in.

(2) Increase the signal generator output level to 1 millivolt e.m.f. (+60dB relative to 1 microvolt).

(3) Adjust the AF GAIN control for an indication of 1 watt on the output power meter.

(4) Connect the LF electronic voltmeter across the output power meter and note the level indicated.

(5) Set the AGC switch to OFF.

(6) Adjust the IF GAIN control for an indication of 1 watt on the output power meter.

(7) Off tune the signal generator by at least 10kHz.

(8) Check that the reading on the LF electronic voltmeter falls by not less than 50 dB. Disconnect the LF electronic voltmeter.

<u>SINGLE SIGNAL SELECTIVITY</u> (Applicable to the filters fitted)

15. (1) Connect the HF electronic voltmeter (50Ω impedance) to the MAIN IF OUT socket.

(2) Connect the digital frequency meter, via the high impedance probe, across the HF electronic voltmeter.

(3) Set the AGC switch to OFF.

(4) Set the FILTER switch to 0.3kHz.

(5) Set the MODE switch to AM.

(6) Tune the signal generator to the receiver for maximum output as indicated on the HF electronic voltmeter.

(7) Adjust the IF GAIN control for an indication of 100 millivolts on the HF electronic voltmeter (0dB reference).

(8) Decrease the frequency of the signal generator until the HF electronic voltmeter indicates minus 5dB relative to the 0dB reference level established at step (7).

(9) Note the frequency displayed on the digital frequency meter. It should not be greater than 1399.90kHz.

(10) Increase the frequency of the signal generator until the HF electronic voltmeter again indicates minus 5dB relative to the 0dB reference level.

(11) Note the frequency displayed on the digital frequency meter. It should not be less than 1400.10kHz.

(12) Repeat the procedure detail in steps (4) to (11) for the remainder of the filters fitted to the receiver, setting the MODE and/or FILTER switches to the appropriate positions in accordance with the following table. Check that the 5dB limits are as specified.

Filter Type No.	Mode/Filter Switch Position	5dB Bandwidths (kHz)	
		Not Less Than	Not Greater Than
BD.45858	USB	1399.7	1397.00
BD.45859	LSB	1403.0	1400.30
BD.45274	USB	1399.7	1397.00
BD.45275	LSB	1403.0	1400.30
BD.45694	LSB	1406.0	1400.30
BD.45695	USB	1399.7	1394.00
BD.45806	AM 13kHz	1406.5	1393.5
BD.45248	AM 8kHz	1404.0	1396.0
BD.45249	AM 3kHz	1401.5	1398.5
BD.45250	AM 1kHz	1400.5	1399.5
BD.45251	AM 0.3kHz	1400.1	1399.9

BFO RANGE

16. (1) Set the receiver controls as follows:

MHz	3
kHz	500.00
TUNING RATE (RA.1772)	LOCK
RF TUNE (if fitted)	WB
AGC	SHORT
MODE	CW
FILTER	8kHz
AFC (if fitted)	OFF
LS	OFF
HEADPHONES	Plugged In

(2) Connect the digital frequency meter and the signal generator to the receiver antenna socket using a T connector.

(3) Set the signal generator frequency for a reading of 3 500.00kHz on the digital frequency meter.

(4) Disconnect the digital frequency meter and re-connect it across the output power meter (connected between the LS and E terminals of TS1).

(5) Set the AF GAIN control for a reading of 100mW on the output power meter.

(6) Set the BFO control to '+'

(7) Check that the frequency indicated on the digital frequency meter is within the limits 3000Hz to 4000Hz.

(8) Vary the BFO control over the range and check that a tone can be heard in the headphones that decreases in frequency to zero beat and then increase in frequency.

(9) Set the BFO control to '-'.

(10) Check that the frequency indicated on the digital frequency meter is within the limits 3000Hz to 4000Hz.

(11) Disconnect the digital frequency meter.

SPURIOUS RESPONSE TO EXTERNAL SIGNALS

17. (1) Set the receiver controls as follows:

MHz	3
kHz	5000.00
TUNING RATE (RA.1772 only)	LOCK
RF TUNE (if fitted)	WB
AGC	OFF
MODE	USB
AFC (if fitted)	OFF
AF GAIN	Mid-position
IF GAIN	Fully clockwise
LS	OFF
HEADPHONES	Plugged In

(2) Set the signal generator to a frequency of 3.5MHz CW and the output level to 1 microvolt e.m.f.

(3) Tune the signal generator to the receiver for maximum indication on the output power meter.

(4) Adjust the AF GAIN control for a reference level of 100 milliwatts on the output power meter.

(5) Increase the signal generator output level by 90dB.

(6) Tune the signal generator carefully from 50kHz to 3.48MHz and from 3.52MHz to 36MHz (ignore those frequencies which are direct sub-harmonics of 3.5MHz). Adjust the signal generator output level as necessary to restore the 100 milliwatt reference level for each spurious response encountered. Check that the signal generator output level required to restore the reference output exceeds plus 80dB relative to 1 microvolt.

INTERMODULATION (IN BAND)

18. (1) Set the receiver controls as follows:

MHz	3
kHz	500.00
TUNING RATE (RA.1772 only)	LOCK
RF TUNE (if fitted)	WB

AGC	LONG
MODE	USB
AFC (if fitted)	OFF
LS	OFF
HEADPHONES	Plugged In.

(2) Connect the two signal generators, designated A and B, to the combiner. Connect the combiner output to the step attenuator and connect the output of the step attenuator to the HF electronic voltmeter (50 ohms input impedance).

(3) Set the step attenuator to 6dB.

(4) Set signal generator A to CARRIER OFF and adjust the output level of signal generator B, set to CW, for a reading of 15 millivolts on the HF electronic voltmeter.

(5) Set signal generator B to CARRIER OFF, signal generator A to CW, and adjust the output level of signal generator A for a reading of 15 millivolts on the HF electronic voltmeter.

(6) Disconnect the HF electronic voltmeter and connect the step attenuator output to the receiver antenna socket.

(7) Connect the output power meter, set to 600 ohms, to the LINE OUTPUT MAIN IF terminals of TS1 on the rear panel of the receiver.

(8) Connect the waveform analyser across the output power meter.

(9) Set the LOAD switch on the waveform analyser to OUT.

(10) Connect the digital frequency meter across the waveform analyser.

(11) Set the frequency of signal generator A for a reading of 1100Hz on the digital frequency meter.

(12) Set signal generator A to CARRIER OFF.

(13) Set signal generator B to CW and adjust its frequency for a reading of 1700Hz on the digital frequency meter.

(14) Disconnect the digital frequency meter.

(15) Adjust the AM/USB LINE LEVEL control for an output of 4mW on the output power meter.

(16) Set signal generator A to CW.

(17) Tune the waveform analyser for maximum output at 1700Hz.

(18) Adjust the attenuator on the waveform analyser for an indication of 0dB on the wavefrom analyser meter.

(19) Tune the waveform analyser to the 1100Hz signal and check that the level indicated on the waveform analyser meter is 0dB plus or minus 1dB.

(20) Tune the waveform analyser to each of the following frequencies in turn and check that any intermodulation product measured is not less negative than minus 40dB

relative to the 0dB reference level of either tone.

500 Hz
600 Hz
2300 Hz
2800 Hz

(21) For ISB receivers only, set the MODE switch to ISB-L. Transfer the output power meter to the ISB LINE OUTPUT terminals of TS1. Repeat steps (10) to (20). At step (15) adjust the LSB LINE LEVEL control in place of the AM/USB LINE LEVEL control.

(22) Disconnect the waveform analyser and the output power meter.

CROSS MODULATION

19. (1) Set the receiver controls as follows:

TUNING RATE (RA. 1772 only)	FAST
MHz	5
kHz	000.00
AGC	SHORT
MODE	AM
FILTER	3kHz
AFC (if fitted)	OFF
AF GAIN	Mid-position
IF GAIN	Fully clockwise
LS	OFF
HEADPHONES	Plugged in

(2) Connect the two signal generators, designated A and B, to the combiner. Connect the combiner output to the step attenuator and connect the output of the step attenuator to the HF electronic voltmeter (50 ohms input impedance).

(3) Set the step attenuator to 6dB.

(4) Set signal generator A to CARRIER OFF and adjust the output level of signal generator B, set to CW, for a reading of 5 millivolts on the HF electronic voltmeter.

(5) Set signal generator B to CARRIER OFF, signal generator A to CW, and adjust the output level of signal generator A for a reading of 5 millivolts on the HF electronic voltmeter.

(6) Disconnect the HF electronic voltmeter and connect the step attenuator output to the receiver antenna socket.

(7) Set signal generator B to CW and reduce the output level of each signal generator by 30dB.

(8) Use the digital frequency meter to set up the signal generators as follows:

Signal Generator A (wanted signal)
5000.000 kHz, 30 per cent amplitude modulation at 400Hz.

Signal Generator B (unwanted signal)
5 020.000 kHz, 30 per cent amplitude modulation at 400 Hz.

(9) Connect the output power meter, set to 8 ohms impedance, between the LS and E terminals of TS1.

(10) Tune the receiver to the wanted signal (A) for a maximum indication in the output power meter.

(11) Adjust the AF GAIN control for an indication of 100 milliwatts on the output power meter (0 dB reference level).

(12) Switch off the modulation of the wanted signal (A) and check that the output power meter indication falls by not less than 30 dB.

(13) Increase the level of the unwanted signal (B) to obtain an indication on the output power meter of 1 milliwatt.

(14) Check that the level of the unwanted signal (B) is not less than 60 dB above signal (A), the wanted signal (to produce a cross modulation figure of 3 per cent).

AFC TESTS (AFC versions only)

Receivers Fitted with PM664 Board

20. (1) Set the receiver controls as follows:-

MHz	3
kHz	500.00
RF TUNE (if fitted)	WB
AGC	OFF
MODE	AM
AFC	OFF
IF GAIN	Fully clockwise
METER	TUNE CARRIER
LS	OFF

(2) Check that the front panel meter indicates full scale.

(3) Connect the signal generator, set to a frequency of 3.5 MHz and an output level of 1 millivolt e.m.f. CW, to the receiver antenna socket.

(4) Tune the receiver to the input signal and as the correct tuning position is approached, check that the meter reading decreases to the TUNE CARRIER mark, and beats at a low frequency.

(5) With the receiver correctly tuned to the input signal, set the AFC switch to FULL CARRIER.

(6) Check that the AFC LOCK lamp illuminates and the meter indicates zero on the AFC scale.

(7) Set the AFC switch to OFF and then to PILOT CARRIER. Check that the AFC LOCK lamp again illuminates.

(8) Note the receiver frequency.

(9) On the RA.1772 only, set the TUNING RATE switch to SLOW.

(10) Slowly increase the receiver frequency by 500 Hz.

(11) Ensure that the AFC LOCK lamp illuminates after awhile.

(12) Set the AFC switch to OFF.

(13) Retune the receiver to the frequency noted at step (8).

(14) Set the AFC switch to FULL CARRIER and ensure that the LOCK lamp illuminates.

(15) Slowly decrease the receiver frequency by 500 Hz.

(16) Ensure that the AFC LOCK lamp illuminates after awhile.

(17) Set the AFC switch to OFF.

(18) Retune the receiver to the frequency noted at step (8).

(19) Disconnect the signal generator at the receiver antenna socket.

(20) Increase the receiver frequency by 50 Hz.

(21) Set the AFC switch to FULL CARRIER.

(22) Reconnect the signal generator to the receiver antenna socket.

(23) Ensure that the AFC LOCK lamp illuminates within 13 seconds.

(24) Slowly retune the receiver to the frequency noted at step (8).

(25) Disconnect the signal generator at the receiver antenna socket.

(26) Decrease the receiver frequency by 50 Hz.

(27) Reconnect the signal generator to the receiver antenna socket.

(28) Ensure that the AFC LOCK lamp illuminates within 13 seconds.

(29) Set the AFC switch to OFF.

(30) Tune the receiver to the input signal and as the correct tuning position is approached, check that the meter indication decreases to the TUNE CARRIER mark.

(31) With the receiver correctly tuned to the input signal, set the AFC switch to FULL CARRIER.

(32) Check that the AFC LOCK lamp illuminates and the meter indicates zero on the AFC scale.

(33) On the RA.1772 only, set the TUNING RATE switch to LOCK.

(34) Disconnect the signal generator at the receiver antenna socket.

(35) After a period of one minute, reconnect the signal generator to the receiver antenna socket.

(36) Check that the AFC LOCK lamp is illuminated.

(37) Set the METER switch to RF.

(38) Reduce the signal generator output to 1 microvolt e.m.f.

(39) Check that the AFC LOCK lamp is extinguished and that the front panel meter indicates 0 dB.

(40) Increase the signal generator output by 10 dB and check that the AFC LOCK lamp is illuminated.

(41) Increase the signal generator output by a further 10 dB. Check that the front panel meter indicates 20 dB plus or minus 15 dB.

(42) Increase the signal generator output in 20 dB steps up to 100 dB. Check that at each output setting the meter indicates the correct level within plus or minus 15 dB and that the AFC LOCK lamp remains illuminated.

(43) Set the signal generator output to 30 microvolts e.m.f.

(44) Set the signal generator for 30 per cent amplitude modulation at 400 Hz.

(45) Check that the AFC LOCK lamp is illuminated.

(46) Note the front panel meter reading.

(47) Set the LS (loudspeaker) switch to ON and note the audio output level.

(48) Set the AFC switch to OFF and then to PILOT CARRIER.

(49) Check that the AFC LOCK lamp illuminates and that the meter reading increases by not less than 15 dB relative to the level noted at step (46). Check also that the audio level decreases relative to the level noted at step (47).

(50) Set the MODE switch to USB.

(51) Set the AFC switch to FULL CARRIER.

(52) Repeat steps (45) to (49) inclusive.

(53) Disconnect all test equipment.

Receivers Fitted with PM369 Board

20a. (1) Set the receiver controls as follows:-

MHz	3
kHz	500.00
RF TUNE (if fitted)	WB
AGC	OFF
MODE	AM
AFC	OFF
IF GAIN	Fully clockwise
METER	TUNE CARRIER
LS	OFF

(2) Check that the front panel meter indicates full scale.

(3) Connect the signal generator, set to a frequency of 3.5 MHz and an output level of 1 millivolt e.m.f. CW, to the receiver antenna socket.

(4) Tune the receiver to the input signal and as the correct tuning position is approached, check that the meter reading decreases to the TUNE CARRIER mark, and beats at a low frequency.

(5) With the receiver correctly tuned to the input signal, set the AFC switch to FULL CARRIER.

(6) Check that the AFC LOCK lamp illuminates and the meter indicates zero on the AFC scale.

(7) Set the AFC switch to OFF and then to PILOT CARRIER. Check that the AFC LOCK lamp again illuminates.

(8) Note the receiver frequency.

(9) On the RA.1772 only, set the TUNING RATE switch to SLOW.

(10) Slowly increase the receiver frequency until the meter indication coincides with the - mark on the AFC scale.

(11) Ensure that the AFC LOCK lamp is still illuminated.

(12) Note the receiver frequency and check that it is in excess of 500 Hz above the frequency noted at step (8).

(13) Retune the receiver to the frequency noted at step (8).

(14) Slowly decrease the receiver frequency until the meter indication coincides with the + mark on the AFC scale.

(15) Ensure that the AFC LOCK lamp is still illuminated.

(16) Note the receiver frequency and check that it is in excess of 500 Hz below the frequency noted at step (8).

(17) Retune the receiver to the frequency noted at step (8).

(18) Disconnect the signal generator at the receiver antenna socket.

(19) Increase the receiver frequency by 50 Hz.

(20) Set the AFC switch to OFF and then to FULL CARRIER.

(21) Reconnect the signal generator to the receiver antenna socket.

(22) Ensure that the AFC LOCK lamp is illuminated.

(23) Retune the receiver to the frequency noted at step (8).

(24) Disconnect the signal generator at the receiver antenna socket.

(25) Decrease the receiver frequency by 50 Hz.

(26) Set the AFC switch to OFF and then to FULL CARRIER.

(27) Reconnect the signal generator to the receiver antenna socket.

(28) Ensure that the AFC LOCK lamp is illuminated.

(29) Set the AFC switch to OFF.

(30) Check that the meter indicates full scale.

(31) Tune the receiver to the input signal and as the correct tuning position is approached, check that the meter indication decreases to the TUNE CARRIER mark.

(32) With the receiver correctly tuned to the input signal, set the AFC switch to FULL CARRIER.

(33) Check that the AFC LOCK lamp illuminates and the meter indicates zero on the AFC scale.

(34) On the RA.1772 only, set the TUNING RATE switch to LOCK.

(35) Disconnect the signal generator at the receiver antenna socket.

(36) After a period of one minute, reconnect the signal generator to the receiver antenna socket.

(37) Check that the AFC LOCK lamp is illuminated.

(38) Set the METER switch to RF.

(39) Reduce the signal generator output to 1 microvolt e.m.f.

(40) Check that the AFC LOCK lamp is extinguished.

(41) Increase the signal generator output by 6 dB and check that the AFC LOCK lamp is illuminated, and that the front panel meter indicates 0 dB.

(42) Increase the signal generator output by a further 20 dB. Check that the front panel meter indicates 20 dB plus or minus 15 dB.

(43) Increase the signal generator ouput in 20 dB steps up to 100 dB. Check that at each output setting the meter indicates the correct level within plus or minus 15 dB and that the AFC LOCK lamp remains illuminated.

(44) Set the signal generator output to 20 microvolts e.m.f. Check that the AFC LOCK lamp extinguishes, the meter indication slowly decreases for a period exceeding eight seconds and that the AFC LOCK lamp then re-illuminates.

(45) Set the signal generator for 30 per cent amplitude modulation at 400 Hz and an output level of 64 microvolts e.m.f.

(46) Check that the AFC LOCK lamp is illuminated.

(47) Note the front panel meter reading.

(48) Set the LS (loudspeaker) switch to ON and note the audio output level.

(49) Set the AFC switch to OFF and then to PILOT CARRIER.

(50) Check that the AFC LOCK lamp illuminates and that the meter reading increases by not less than 15 dB relative to the level noted at step (47). Check also that the audio level decreases relative to the level noted at step (48).

(51) Set the MODE switch to USB.

(52) Set the AFC switch to FULL CARRIER.

(53) Repeat steps (46) to (50) inclusive.

(54) Disconnect all test equipment.

FSK TESTS (FSK versions only)

21. (1) Connect a wire link between the FSK IN and FSK OUT terminals of TS1 on the rear panel.

(2) Connect the TEL O/P terminal of TS2, via a 2kΩ6 watt resistor, and the TEL E terminal of TS2 (on the rear panel) to the teleprinter.

(3) Set the 80V/6V and N+/P/N-switches to suit the teleprinter.

(4) Connect the OUTPUT 1 socket on the CA496 FSK Test Generator to the receiver antenna socket, via the 50 ohm step attenuator. Set the step attenuator to 0dB.

(5) Connect the digital frequency meter to the OUTPUT TO FREQUENCY METER socket on the CA496.

(6) Set the controls on the CA496 as follows:

MAINS	ON
FREQUENCY	RF
DATA RATE	VARIABLE
BAUDS	50
SHIFT	200Hz
ATTENUATION	-40dB (0dB is 1V in 75Ω)
MODULATION	1:1

(7) Set the FINE FREQUENCY control on the CA496 for an indication on the digital frequency meter of 3100 000Hz plus or minus 1Hz.

(8) Set the receiver controls as follows:

RF TUNE (if fitted)	WB
AFC (if fitted)	OFF
AGC	SHORT
MODE	FSK TUNE
FILTER	1kHz
MHz	3
kHz	100.000
LS	ON

(9) Check that the tones from the loudspeaker are at approximately the same frequency.

(10) Set the MODULATION switch on the CA496 to DATA.

(11) Set the DATA switch on the CA496 to GIBBERISH.

(12) Set the receiver MODE switch to FSK-N.

(13) Check that the teleprinter prints a line of characters where each character is printed twice, as below:

JJDDAAEECCNNII--KKFFUUSSGGOOLLTT??22--==..ØØFFXXQQYYRR

(14) Set the step attenuator to 80dB. Check that a good copy is still obtained on the teleprinter.

(15) Increase the step attenuator setting in 1dB steps until the teleprinter ceases to produce a good copy. Check that the attenuator setting is not less than 86dB (minus 126dB relative to 1 volt e.m.f.).

(16) Reset the step attenuator to 80dB.

(17) Disconnect the wire link between the FSK IN and FSK OUT terminals of TSI.

(18) Set the receiver AGC switch to OFF and set the IF GAIN control fully clockwise.

(19) Check that the teleprinter head remains stationary.

(20) Temporarily link the FSK IN and E terminals of TS1 and check that the teleprinter chatters without printing.

(21) Switch off and disconnect all test equipment.

CHAPTER 5

ALIGNMENT PROCEDURES

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CHAPTER 5

ALIGNMENT PROCEDURES

INTRODUCTION

1. This chapter contains alignment procedures for the receiver as a complete assembly. Instructions for checking the performance of the receiver are given in Chapter 4.

2. Under normal operating conditions the receiver will maintain the factory alignment over a long period of time. Re-alignment should, therefore, only be carried out following the replacement of a printed circuit board or other components which affect the alignment, or where a known mis-alignment exists.

3. Should it be necessary to re-align the complete receiver, the following procedures should be carried out in the order given. Before attempting to re-align an individual sub-assembly it must be ascertained, where applicable, that the preceeding assemblies are functioning correctly.

4. If the specified performance cannot be attained by alignment, then a fault must be suspected and reference should be made to Chapter 6.

5. A certain amount of dismantling is necessary to gain access to certain areas of the receiver. Details for dismantling and re-assembly are contained in Chapter 3. After alignment ensure that all dismantled assemblies are correctly reassembled and that all screening covers are replaced using all the screws provided.

6. The required trimming tools are provided with each receiver; one is mounted in a clip attached to the inside of the right-hand side panel and a second is mounted within the RF compartment (tuned versions only).

TEST EQUIPMENT

7. The following is a consolidated list of the test equipment required to carry out all the alignment procedures given in this chapter. The items of test equipment required for the alignment of any particular board or sub-assembly are given in the text under the appropriate sub-heading.

(1) Digital Voltmeter

Range:	0 to 100 volts d.c.
Accuracy:	To three figures

(Example: Racal Instruments Type 9071)

(2) Oscilloscope, single channel

Sensitivity:	10 millivolts per centimetre
Frequency Range:	DC to 10MHz

(Example: Tektronix Type 545B with L Plug-in unit)

(3) Oscilloscope, dual trace

Sensitivity: 100 millivolts per centimetre
Frequency range: DC to 1MHz
(Example: Tektronix Type 545B with CA Plug-in unit)

(4) Multimeter

(Example: Avometer Model 8)

(5) HF Electronic Voltmeter

Range: 300 Millivolts to 3 volts r.m.s.
Frequency Range: Up to 70MHz
Input impedance: 50 ohms, 75 ohms and high impedance
(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, Type TM6/4).

(6) LF Electronic Voltmeter

Range: -50 to +10dB (6dB = 0.775V)
Input Impedance: not less than 1 megohm.
(Example: Advance Type 77)

(7) Digital Frequency Meter

Frequency range: DC to 70MHz
Accuracy:
Internal standard: 1 part in 10^6 ± 1 count.
(Example: Racal Instruments Type 9822 or Type 9021)

(8) Signal Generator

Frequency range: 10kHz to 72MHz
Output level: 1 millivolt to 2 volts e.m.f.
Output Impedance: 75 ohms and 50 ohms
(Example: Marconi Type TF144H with 50 to 75 ohm matching pad).

(9) Signal Generator

Frequency range: 100kHz to 100MHz
Output level: 1 millivolt to 1 volt e.m.f.
Output Impedance: 75 ohms
(Example: Racal Instruments Type 9061/62 with 50 to 75 ohm matching pad)

(10) Signal Generator

Frequency range: 1 to 30MHz
Output level: 1 to 20 volts e.m.f.
Output Impedance: 75 ohms
(Example: Rohde and Schwarz Type BN41001)

(11) Valve Voltmeter

Range:	1 to 20 volts
Input Impedance:	Not less than 10 megohms
Frequency range:	Up to 70MHz

(Example: Racal Instruments Type 314A)

(12) Waveform Analyser

Frequency range:	5 to 100MHz
Input level:	5 microvolts to 15 millivolts

(Example: Airmec Type 248A)

(13) Output Power Meter

Frequency range:	20Hz to 35kHz
Input Impedance:	600 ohms and 8 ohms
Power range:	Not less than 2 watts FSD.

(Example: Marconi Type TF893A)

(14) Variable voltage stabilised power supply

Output voltage:	0 to 3 volts DC

(15) Attenuator, 10dB

Impedance:	50 ohms

(16) Step Attenuator

Range:	0 to 100dB in 1dB steps
Impedance:	50 ohms

(Example: Racal Instruments Type 9065L)

(17) 50 ohm BNC termination

(18) Capacitor, 0.01μF, 50 volts.

(19) Resistor, fixed, 1 kilohm, 5% 4 0.25 watt

(20) FSK Test Generator (FSK versions only)
(Example: Racal Type CA.496)

POWER SUPPLIES

Test Equipment

8. The items of test equipment listed below are required for the following tests.

(1) Digital Voltmeter

Range:	0 to 100 volts
Accuracy:	to three figures

(Example: Racal Instruments Type 9071)

(2) Oscilloscope

Sensitivity: 10 millivolts per centimetre
Frequency range: DC to 1 MHz
(Example: Tektronix Type 545B with L Plug-in unit)

(3) Multimeter

(Example: Avometer Model 8).

Procedure

9. (1) Lower the rear panel of the receiver.

(2) Connect the digital voltmeter between chassis (0V) and each of the following pins on the regulator board, in turn, and, if necessary, adjust the appropriate control until the voltage is within the limits specified. Use the oscilloscope to measure the AC ripple.

REGULATOR BOARD PIN	NOMINAL VOLTAGE	VOLTAGE LIMITS	ADJUST	AC RIPPLE (P-P)
22	+20	± 100mV	R19	5mV
16	+12	± 50mV	R17	5mV
10	+5	± 50mV	R3	5mV
5	-7	± 50mV	R8	5mV

(3) Connect the digital voltmeter between pin 14 on the main IF/AF board and chassis. If necessary, adjust R3 on the AF and memory regulator board for a reading of +14.5V ± 50mV. Use the oscilloscope to measure the AC ripple. This should not exceed 5 millivolts peak to peak.

(4) On the RA.1772 only, connect the digital voltmeter between pin 23 on the Display board (orange/brown wire) and chassis. Check that the digital voltmeter indicates +5V ± 50mV.

(5) Disconnect all test equipment and replace the rear panel.

NOTE: Throughout the receiver, the following cableform colours are used for DC power distribution:

+20V	RED
+12V	ORANGE
+5V	BROWN
-7V	VIOLET
+14.5V	RED/BLUE
Memory +5V	ORANGE/BROWN
0V	BLACK

SHAFT ENCODER & DISPLAY BOARD PM371 (RA.1772 only)

Test Equipment

10. The items of test equipment listed below are required for the following tests.

(1) Oscilloscope, dual trace

Sensitivity: 100 millivolts per centimetre
Frequency range: DC to 1 MHz
(Example: Tektronix Type 545B with CA Plug-in unit)

Procedure

11. (1) Using a dual trace oscilloscope, connect the probe for channel A to ML27 pin 8 (encoder A output) and the channel B probe to ML17 pin 8 (encoder B output) on the display board.

(2) Set the oscilloscope to display Channel A only.

(3) Ensure that the TUNING RATE switch is not in the LOCK position.

(4) Whilst rotating the kHz control, check that a square wave is displayed on the oscilloscope. If necessary, adjust R2 on the potentiometer board (attached to the shaft encoder) for unity mark-to-space ratio.

(5) Set the oscilloscope to display channel B only.

(6) Whilst rotating the kHz control, check that a square wave is displayed on the oscilloscope. If necessary, adjust R1 on the potentiometer board for unity mark-to-space ratio.

(7) Set the oscilloscope to display both channels. Trigger the oscilloscope on the A channel waveform.

(8) Whilst rotating the kHz control, check that waveform A leads waveform B by 90 degrees. Adjustment should not normally be required but should the displacement be other than 90 degrees, procede as follows.

(9) Remove the shaft encoder (Chapter 3) and remove its cover. Slacken the graticule carriage screws and adjust the position of the carriage until a 90 degree phase difference is achieved. Tighten the carriage screws whilst maintaining the phase difference.

(10) Replace the cover and refit the shaft encoder to the front panel assembly.

(11) Disconnect all test equipment.

SYNTHESIZER SECTION

LOWER LOOP BOARD PM588

Test Equipment

12. The items of test equipment listed below are required for the following tests.

(1) HF electronic voltmeter

Range: 300 millivolts to 1 volt r.m.s.
Frequency range: Up to 10MHz
Input impedance: High impedance
(Example: Airmec 301A or Farnell Type TM6)

(2) Multimeter

(Example: Avometer Model 8)

(3) Oscilloscope

Sensitivity: 100 millivolts per centimetre
Frequency range: DC to 10MHz
(Example: Tektronix Type 545B with L Plug-in unit)

Procedure

13. (1) Connect the HF electronic voltmeter (high impedance probe) between the junction of R1 with D2, and chassis (0V). Adjust the core of transformer T1 (1MHz input) for a maximum indication on the HF electronic voltmeter. The level should be approximately 1V r.m.s.

(2) Set the kHz portion of the receiver frequency to 000.00.

(3) Connect the multimeter, set to the 25V DC range, between TP1 (positive) and chassis (negative).

(4) Adjust L1 (6-7MHz VCO) for a reading of +14V on the multimeter.

(5) Measure the output signal level from the 6 - 7MHz VCO at TP2 using the HF electronic voltmeter (high impedance probe). The level should be approximately 1V r.m.s.

(6) Use the oscilloscope to monitor the test points listed below. Check that the signal levels displayed approximate those indicated.

TP3: 1MHz square wave, approximate 1:1 mark/space ratio, 3.5V p-p.
TP4: 1kpps, positive going, 3.5V p-p.
TP5: 1kpps, positive going, 3.5V p-p.
TP6: 1kpps, negative going strobe pulse, 3.5V p-p.
TP7: 13 to 20kHz, square wave, 3.5V p-p.
TP8: 13 to 20 kpps, negative going strobe pulse, 3.5V p-p.

(7) Disconnect all test equipment.

UPPER LOOP BOARD PM589

Test Equipment

14. The items of test equipment listed below are required for the following tests.

(1) HF Electronic Voltmeter

Range: 0 to 300 millivolts r.m.s.
Frequency range: Up to 5MHz
Input impedance: 50 ohms
(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adapter, 50 ohm terminated, Type TM6/4).

(2) Oscilloscope

Sensitivity: 100 millivolts per centimetre
(Example: Tektronix Type 545B with L Plug-in unit)

(3) Multimeter

(Example: Avometer model 8).

Procedure

15. (1) Set the kHz portion of the receiver frequency to 990.00.

(2) Connect the multimeter, set to the 25V DC range, between board pin 7 (positive) and chassis (negative).

(3) Adjust L4 for a reading of +14V on the multimeter.

(4) Set the kHz portion of the receiver frequency to 000.00.

(5) Connect the multimeter, set to the 25V DC range, between TP7 (positive) and chassis (negative).

(6) Adjust L1 for a reading of +16V on the multimeter.

(7) Connect the HF electronic voltmeter, 50 ohms input impedance, between board pin 2 and chassis (0V). Check that the level indicated is 225mV r.m.s. plus or minus 2dB, at kHz settings of 000.00, 500.00 and 990.00.

(8) Use the oscilloscope to monitor the test points listed below. Check that the signal levels displayed approximate those indicated.

TP1: 1.013 to 1.020MHz square wave, 3.5V p-p.
TP2: 4.6 to 3.6MHz square wave, 3.5V p-p.
TP3: 10.13 to 10.20 kpps, positive going, 3.5V p-p.
TP4: 10.13 to 10.20 kpps strobe pulse, negative going, 3.5V p-p.
TP5 and TP6: Phase comparator output pulses, positive going and in phase, 3.5V p-p.

(9) Disconnect all test equipment.

TRANSFER LOOP BOARD PS338

16. (1) There are no adjustments for this board. Use the oscilloscope to monitor the test points listed below. Check that the signal levels displayed approximate those indicated.

TP1: 4.6 to 3.6MHz square wave, 5V p-p.
TP2: 115 to 52kHz square wave, 3.5V p-p.
TP3: 115 to 52 kpps, negative going, 3.5V p-p.
TP4 and TP5: 115 to 52 kpps, 1.5 microsecond negative going, and in phase, 3.5V p-p.
TP6: 115 to 52 kpps strobe pulse, negative going, 3.5V p-p.

HF LOOP BOARD PS337

Test Equipment

17. The item of test equipment listed below are required for the following tests.

(1) Digital Frequency meter

Frequency range: 900kHz to 70MHz
(Example: Racal Instruments Type 9822 or Type 9021).

(2) HF Electronic Voltmeter

Range: 100 to 500 millivolts r.m.s.
Frequency range: Up to 70MHz
(Example: Airmec 301A or Farnell Type TM6)

(3) Multimeter

(Example: Avometer Model 8)

(4) Oscilloscope

Sensitivity: 100 millivolts per centimetre
(Example: Tektronix Type 545B with L Plug-in unit)

(5) 50 ohm BNC Termination.

Procedure

18. (1) Set the receiver MHz switch to 29.

(2) Set the receiver kHz control to 999.99.

(3) Connect the multimeter, set to the 25V DC range, between board pin 18 (positive) and chassis (negative).

(4) Connect the digital frequency meter between board pins 13 and 14 (0V).

(5) Adjust L20 for a reading of 8V on the multimeter. Check that the digital frequency meter indicates 947.826kHz plus or minus 10Hz. Disconnect the digital frequency meter.

(6) Connect the multimeter, set to the 25V DC range, between TP3 (positive) and chassis (0V). Check that the multimeter indicates approximately 14V.

(7) Set the MHz switch to 17 MHz. Transfer the positive lead of the multimeter to TP2. Check that the multimeter indicates approximately 14V.

(8) Set the MHz switch to 7MHz. Transfer the positive lead of the multimeter to TP1. Check that the multimeter indicates approximately 14V.

(9) Set the MHz switch to 29. Ensure that the kHz switch is set to display 999.99.

(10) Connect the HF electronic voltmeter, high impedance input, between TP4 and chassis (0V).

(11) Adjust R38 for a reading of 1V r.m.s. on the HF electronic voltmeter.

(12) Step the MHz switch through each position and check that the HF electronic voltmeter indication is 1V r.m.s. plus or minus 2.5dB at each switch position.

(13) Connect the HF electronic voltmeter, high impedance input, between TP5 and chassis (0V). Check that the HF electronic voltmeter indicates approximately 1V r.m.s.

(14) Connect the HF electronic voltmeter, high impedance input, between board pin 22 and chassis (0V).

(15) Adjust R44 for a reading of 320mV r.m.s. plus or minus 0.5dB on the HF electronic voltmeter.

(16) Connect the 50 ohm termination to the LO IN/OUT socket.

(17) Connect the HF electronic voltmeter, high impedance input, between board pin 24 and chassis (0V).

(18) Adjust R50 for a reading of 320mV r.m.s. plus or minus 0.5dB on the HF electronic voltmeter.

(19) Connect the multimeter, set to the 25V DC range, between the junction of L22 with L23 and chassis (0V).

(20) Adjust L4 for a reading of 14V on the multimeter.

(21) Set the MHz switch to 17.

(22) Ensure that the kHz control is set to display 999.99.

(23) Adjust L5 for a reading of 14V on the multimeter.

(24) Set the MHz switch to 7.

(25) Ensure that the kHz control is set to display 999.99.

(26) Adjust L6 for a reading of 14V on the multimeter. Disconnect the multimeter.

(27) Connect the multimeter, set to the 10V DC range, between TP10 (positive) and chassis (0V). Check that the multimeter indicates approximately 3.5V. Disconnect the multimeter.

(28) Use the oscilloscope to monitor the test points listed below. Check that the signal levels displayed approximate those indicated.

TP6: 442 to 474 kpps strobe pulses, negative going, 3.5V p-p.
TP7 and TP8: 442 to 474 kpps phase comparator output pulses, negative going and in phase, 3.5V p-p.
TP12: 885 to 948 kHz, approximate square wave, 2.8V p-p.

(29) Disconnect all test equipment.

34MHZ GENERATOR BOARD PM339

Test Equipment

19. The items of test equipment listed below are required for the following tests.

(1) HF Electronic Voltmeter

Input impedance:	50 ohms
Frequency range:	1 to 40 MHz
Range:	100 millivolts to 3 volts e.m.f.

(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, Type TM6/4)

(2) Oscilloscope

Sensitivity:	100 millivolts per centimetre.
Frequency:	Up to 34MHz

(Example: Tektronix Type 545B with L Plug-in unit).

(3) Digital Frequency Meter

Frequency range: 100kHz to 34MHz
(Example: Racal Instruments Type 9822 or Type 9021)

(4) Multimeter

(Example: Avometer Model 8).

Procedure

20. (1) Set the AFC switch (if fitted) to OFF.

(2) Ensure that the 34MHz INT/EXT switch is set to INT.

(3) Ensure that the 1MHz INT/EXT switch is set to INT.

(4) Connect the oscilloscope to TP3. Check that a 1MHz square wave is displayed, 2:3 mark to space ratio, at a level of not less than 2V p-p.

(5) Connect the HF electronic voltmeter, 50 ohms input impedance, to the 1MHz IN/OUT socket. Check that the level indicated on the HF electronic voltmeter is not less than 180 millivolts r.m.s.

(6) Connect the oscilloscope to board pins 6 and 5 (0V). Check that the amplitude

of the 1MHz waveform displayed is approximately 0.5V p-p.

(7) Connect the oscilloscope to board pins 8 and 7 (0V). Check that the amplitude of the 1MHz waveform displayed is approximately 0.2V p-p.

(8) Connect the oscilloscope to TP9. Check that the amplitude of the 1MHz square wave displayed exceeds 2V p-p.

(9) Set the MODE switch to USB.

(10) Connect the oscilloscope to TP7. Check that the frequency of the square wave displayed (3:2 mark/space ratio) is 200kHz and that the amplitude is approximately 3.5V p-p.

(11) Connect the oscilloscope to board pins 10 and 31 (0V).

(12) Tune T2 for maximum output, as displayed on the oscilloscope.

(13) Adjust R65 to set the amplitude of the displayed 1.4MHz waveform to 0.8V p-p.

(14) Connect the digital frequency meter to board pins 10 and 31 (0V). Check that the digital frequency meter indicates 1 400 000Hz plus or minus 1Hz. Disconnect the digital frequency meter.

(15) Connect the oscilloscope to board pins 11 and 32 (0V). Check that the amplitude of the 1.4MHz waveform displayed is 0.8V p-p.

(16) Connect the digital frequency meter to board pins 11 and 32 (0V).

(17) Set potentiometer R4 fully clockwise.

(18) Set the MODE switch to CW.

(19) Set the front panel BFO control to +.

(20) Adjust inductor L4 for a digital frequency meter indication of ~~1 397 000~~ [1403000] Hz plus or minus 100Hz.

(21) Set the BFO control to -.

(22) Adjust R4 for a digital frequency meter indication of ~~1 403 000~~ [1397000] Hz plus or minus 100Hz.

(23) Repeat steps (19) to (22) until there is no further improvement. Disconnect the digital frequency meter.

(24) Connect the oscilloscope to TP15. Check that the amplitude of the waveform displayed is approximately 400mV p-p.

(25) Connect the oscilloscope to board pins 10 and 31 (0V). Check that the amplitude of the waveform displayed exceeds 0.5Vp-p.

(26) Connect the oscilloscope to board pins 11 and 32 (0V). Check that the amplitude of the waveform displayed exceeds 0.5V p-p.

(27) Connect the digital frequency meter to board pins 20 and 21 (0V).

(28) Connect the 1 MHz IN/OUT socket on the rear panel to the external standard socket on the digital frequency meter. Set the digital frequency meter for external 1 MHz standard operation.

(29) Connect the multimeter, set to the 10V DC range, to TP1 (positive) and chassis (0V).

(30) Adjust L2 for a multimeter indication of 7V. Check that the digital frequency meter indicates 34 000 000 Hz. Disconnect the digital frequency meter.

(31) Disconnect the multimeter. Connect the HF electronic voltmeter, 50 ohms input impedance, to the 34 MHz IN/OUT socket on the rear panel.

(32) Check that the HF electronic voltmeter indication is not less than 180 millivolts r.m.s.

(33) Connect the HF electronic voltmeter, high input impedance, to board pins 20 and 21 (0V).

(34) Check that the HF electronic voltmeter indication is within the limits 800 millivolts to 1.4 volts r.m.s.

(35) Disconnect all test equipment.

NOTE: Typical signal levels at the test points not already covered are listed below.

TP2:	5 Mpps, oscilloscope, 3V p-p.
TP4:	34 MHz VCO output, HF electronic voltmeter, high impedance input, 750 mV r.m.s.
TP5:	34 MHz, HF electronic voltmeter, high impedance input, 400 mV r.m.s.
TP6:	34 MHz, HF electronic voltmeter, high impedance input, 1.4V r.m.s.
TP8:	HF electronic voltmeter, high impedance input, 1.4V r.m.s.
TP10:	Not fitted.
TP11:	AFC switch to OFF, 1 MHz square wave, 3:2 mark/space ratio, oscilloscope, 3.5V p-p.
TP12:	MODE switch to USB, 1 MHz square wave, 3:2 mark/space ratio, oscilloscope, 3.5V p-p.
TP13:	Not fitted.
TP14:	1 Mpps, negative going, oscilloscope, 3.5V p-p.

RF/IF/AF SECTION

MAIN IF/AF BOARD PM674

Test Equipment

21. The items of test equipment listed below are required for the following tests.

(1) Signal Generator

Frequency range:	1 to 2 MHz
Output:	60 microvolts to 1 volt e.m.f.
Output impedance:	50 ohms

(Example: Racal Instruments Type 9061/62)

(2) Digital Voltmeter

(Example: Racal Instruments Type 9071)

(3) Digital Frequency Meter

Frequency range:	1 kHz to 2 MHz

(Example: Racal Instruments Type 9822 or Type 9021)

(4) HF Electronic Voltmeter

Range:	10 millivolts to 1 volt r.m.s.
Frequency range:	Up to 2 MHz
Input impedance:	50 ohms and high impedance

(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, Type TM6/4)

(5) LF Electronic Voltmeter

Input impedance:	Not less than 1 Megohm

(Example: Advance Type 77)

(6) Output Power Meter

Frequency range:	20 Hz to 35 kHz
Input impedance:	600 ohms and 8 ohms
Power range:	Not less than 2 watts FSD

(Example: Marconi Type TF893A)

(7) Multimeter

(Example: Avometer Model 8)

(8) Resistor, fixed, 1 kilohm, 5%, 0.25 watt.

IMPORTANT NOTE

The following alignment procedures are carried out with the main IF/AF board isolated from the remainder of the receiver. Further minor adjustments are, therefore, required following the alignment of the RF, first mixer and second mixer boards. These adjustments are given in paragraphs 55, 56 and 57.

Procedure

22. (1) Set the receiver front panel controls as follows:-

AGC	OFF

RF TUNE (if fitted)	WB
AFC (if fitted)	OFF
IF GAIN	Fully counter-clockwise
MODE	USB
AF GAIN	Fully counter-clockwise

(2) Unsolder the coaxial lead connected to pin 2 on the filter board PS367 (the coaxial screen may be left connected to pin 3).

(3) Connect the 1 kilohm resistor in series with the coaxial lead connected to the 50 ohms output of the signal generator and connect the other end of this lead to the coaxial lead removed at step (2). Connect the screen to pin 3 on the filter board.

(4) Connect the digital frequency meter to the UNICAL socket on the signal generator (omit if Racal 9061/9062 signal generator is used).

(5) Set the frequency of the signal generator to 1.400 MHz, plus or minus 500 Hz and the output level to 60 microvolts e.m.f.

(6) Set the IF GAIN control fully clockwise.

(7) Ensure that the MODE switch is set to USB.

(8) Ensure that the AF GAIN control is set fully counter-clockwise.

(9) Set all potentiometers (R1, R6, R7, R9, R23, R45, R55) fully clockwise.

(10) Connect the HF electronic voltmeter, high impedance input, to TP3.

(11) Adjust inductors L1 and L2 for a maximum indication on the HF electronic voltmeter.

(12) Adjust R1 for a level of 200 millivolts at TP3 and then repeat step (11).

(13) Sweep the signal generator frequency from 1390 kHz to 1410 kHz. Note the frequency at which the peak output occurs. Also note the level of the peak output.

(14) Sweep the signal generator frequency again from 1390 kHz to 1410 kHz. Ensure that the output level remains within 1 dB of the level noted at step (13).

(15) Set the signal generator to the frequency noted at step (13).

(16) Adjust R1 for an indication of 200 millivolts r.m.s. on the HF electronic voltmeter (connected to TP3).

(17) Adjust R23 to reduce the HF electronic voltmeter indication to 100 millivolts and then reset the level to 200 millivolts with R1.

(18) Repeat steps (13) and (14). If the 1 dB tolerance of step (14) cannot be met repeat steps (11) to (18).

(19) Connect the digital voltmeter to board pins 29 (positive) and 28 (0V).

(20) Adjust R45 for an indication of 1.4 volts plus or minus 25 millivolts on the digital voltmeter.

(21) Reduce the signal generator output level by 4 dB.

(22) Connect the multimeter, set to the 25V d.c. range, between TP6 (positive) and the -7 volt supply at board pin 20.

(23) Adjust R55 until the indication on the multimeter changes from positive 14 volts ± 1 volt to positive 7 volts ± 2 volts.

(24) Decrease the signal generator output level by a further 1 dB and ensure that the original meter reading is restored.

(25) Reset the signal generator output level to 60 microvolts e.m.f. Set the AGC switch to LONG.

(26) Increase the signal output level by 65 dB and note the HF electronic voltmeter reading (connected to TP3).

(27) Adjust R9 for plus 2 dB above the reading noted in step (26).

(28) Set the AGC switch to SHORT and the signal generator output level to 1.1 millivolts e.m.f. (60 µV + 25 dB).

(29) Adjust R6 for an indication of 1.7 volts ± 10 millivolts on the digital voltmeter (connected to pin 29).

(30) Set the signal generator output level to 33.8 millivolts e.m.f. (1.1 mV + 30 dB) and adjust R7 for an indication of 1.95 volts ± 10 millivolts on the digital voltmeter.

(31) Repeat steps (28) to (30) until no further adjustment is necessary.

(32) Connect the HF electronic voltmeter, 50 ohms input impedance, to the MAIN IF OUT socket on the rear panel.

(33) Set the AGC switch to SHORT.

(34) Set the frequency of the signal generator to 1.400 MHz plus or minus 500 Hz and the output level to 60 microvolts e.m.f.

(35) Ensure that the IF output signal level, as indicated on the HF electronic voltmeter, is not less than 50 millivolts r.m.s.

(36) Increase the signal generator output level by 62 dB. Ensure that the increase in the IF output signal level is not greater than 5 dB.

(37) Reset the signal generator output level to 60 microvolt e.m.f. Set the AGC switch to LONG and repeat steps (35) and (36).

(38) Reset the signal generator output level to 60 microvolts e.m.f. and ensure that the IF output is restored within 4 to 8 seconds.

(39) Connect the LF electronic voltmeter to board pins 8 and 9 (0V).

(40) Tune the signal generator for a maximum indication on the LF electronic voltmeter. Ensure that the level indicated is not less than 150 millivolts r.m.s.

(41) Disconnect the LF electronic voltmeter. Connect the output power meter, set to 8 ohms input impedance, between the LS and E terminals of TS1.

(42) Set the AF GAIN control fully clockwise and ensure that the output power meter indication is not less than 1 watt.

(43) Set the AF GAIN control for an indication of 100 milliwatts on the output power meter.

(44) Increase the signal generator output level by 62 dB and ensure that the output power meter indication is not greater than 100 milliwatts plus 5 dB.

(45) Reduce the signal generator output level by 52 dB.

(46) Set the MODE switch to AM.

(47) Set the signal generator for 30 per cent amplitude modulation at 1 kHz.

(48) Set the AF GAIN control fully clockwise and ensure that the output power meter indication is not less than 1 watt.

(49) Set the AF GAIN control for an indication of 1 watt on the output power meter.

(50) Connect a wire link between the MUTE and E terminals of TS2. Ensure that the output power meter indication decreases by not less than 40 dB. Disconnect the wire link.

(51) Set the MODE switch to USB.

(52) Reset the signal generator output level to 60 microvolts e.m.f.

(53) Transfer the output power meter, set to 600 ohms input impedance, to the LINE OUTPUT MAIN IF terminals of TS1.

(54) Set the AM/USB LINE LEVEL control fully clockwise and ensure that the output power meter indication is not less than 10 milliwatts.

(55) Set the MODE switch to AM.

(56) Set the signal generator for 30 per cent amplitude modulation at 1 kHz.

(57) Increase the signal generator output level by 60 dB. Ensure that the output power meter indication is not less than 4 milliwatts.

(58) Switch off and disconnect all test equipment.

(59) Reconnect the coaxial lead to pin 2 on the filter board removed at step (2).

NOTE: See paragraph 25 for typical signal levels.

ISB IF/AF BOARD PM674/3

Test Equipment

23. The items of test equipment required for the following tests are as listed for the main IF/AF board, para. 21.

IMPORTANT NOTE

The following alignment procedures are carried out with the ISB IF/AF board isolated from the remainder of the receiver. Further minor adjustments are, therefore, required following the alignment of the RF, first mixer and second mixer boards. These adjustments are given in paragraphs, 55, 56 and 57.

Procedure

24. (1) Set the receiver front panel controls as follows:-

AGC	OFF
AFC (if fitted)	OFF
MODE	LSB
IF GAIN	Fully Clockwise
AF GAIN	Fully counter-clockwise

(2) Set all potentiometers (R1, R6, R7, R9, R23, R45, R55) fully clockwise.

(3) Unsolder the coaxial lead connected to pin 4 on the filter board PS367 (the coaxial screen may be left connected to pin 5).

(4) Connect the 1 kilohm resistor in series with the coaxial lead connected to the 50 ohm output of the signal generator. Connect the other end of this lead to the coaxial lead removed at step (3). Connect the screen to pin 5 on the filter board.

(5) Connect the digital frequency meter to the UNCAL socket on the signal generator (omit if Racal 9061/62 signal generator is used).

(6) Set the frequency of the signal generator to 1.400 MHz, plus or minus 500 Hz, and the output level to 60 microvolts e.m.f.

(7) Connect the HF electronic voltmeter, high input impedance, to TP3.

(8) Adjust inductors L1 and L2 for a maximum indication on the HF electronic voltmeter.

(9) Adjust R1 for a level of 100 millivolts r.m.s. at TP3, then repeat step (8).

(10) Sweep the signal generator frequency from 1390 kHz to 1410 kHz. Note the frequency at which the peak output occurs. Also note the level of the peak output.

(11) Sweep the signal generator frequency again from 1390 kHz to 1410 kHz. Ensure that the output level remains within 1 dB of the level noted at step (10).

(12) Set the signal generator to the frequency noted at step (10).

(13) Adjust R1 for an indication of 200 millivolts r.m.s. on the HF electronic voltmeter (connected to TP3).

(14) Adjust R23 to reduce the HF electronic voltmeter indication to 100 millivolts and then reset the level to 200 millivolts with R1.

(15) Repeat steps (10) and (11). If the 1 dB tolerance of steps (11) cannot be met repeat steps (8) to (15).

(16) Connect the digital voltmeter to board pins 29 (positive) and 28 (0V).

(17) Adjust R45 for an indication of 1.4 volts plus or minus 25 millivolts on the digital voltmeter.

(18) Reduce the signal generator output level by 4 dB.

(19) Connect the multimeter, set to the 25V d.c. range, between TP6 (positive) and the -7 volt supply at board pin 20.

(20) Adjust R55 until the indication on the multimeter changes from positive 14 volts ± 1 volt to positive 7 volts ± 2 volts.

(21) Decrease the signal generator output level by a further 1 dB and ensure that the original meter reading is restored.

(22) Reset the signal generator output level to 60 microvolts e.m.f. Set the AGC switch to LONG.

(23) Increase the signal output level by 65 dB and note the HF electronic voltmeter reading (connected to TP3).

(24) Adjust R9 for plus 2 dB above the reading noted in step (23).

(25) Set the AGC switch to SHORT and the signal generator output level to 1.1 millivolts e.m.f. (60 μV + 25 dB).

(26) Adjust R6 for an indication of 1.7 volts ± 10 millivolts on the digital voltmeter (connected to pin 29).

(27) Set the signal generator output level to 33.8 millivolts e.m.f. (1.1 mV + 30 dB) and adjust R7 for an indication of 1.95 volts ± 10 millivolts on the digital voltmeter.

(28) Repeat steps (25) to (27) until no further adjustment is necessary.

(29) Connect the HF electronic voltmeter, 50 ohms input impedance, to the ISB IF OUT socket on the rear panel.

(30) Set the AGC switch to SHORT.

(31) Set the frequency of the signal generator to 1.400 MHz, plus or minus 500 Hz, and the output level to 60 microvolts e.m.f.

(32) Ensure that the IF output signal level, as indicated on the HF electronic voltmeter, is not less than 50 millivolts r.m.s.

(33) Increase the signal generator output level by 62 dB. Ensure that the increase in the IF output signal level is not greater than 5 dB.

(34) Reset the signal generator output level to 60 microvolts e.m.f. Set the AGC switch to LONG and repeat steps (32) and (33).

(35) Reset the signal generator output level to 60 microvolts e.m.f. and ensure that the IF output is restored within 4 to 8 seconds.

(36) Connect the LF electronic voltmeter to board pins 8 and 9 (0V).

(37) Tune the signal generator for a maximum indication on the LF electronic voltmeter. Ensure that the level indicated is not less than 150 millivolts r.m.s.

(38) Disconnect the LF electronic voltmeter.

(39) Connect the output power meter, set to 600 ohms input impedance, to the ISB LINE OUTPUT terminals of TS1.

(40) Set the LSB LINE LEVEL control fully clockwise and ensure that the output power meter indication is not less than 4 milliwatts.

(41) Set the LSB LINE LEVEL control for an indication of 1.0 milliwatt on the output power meter.

(42) Increase the signal generator output level by 62 dB and ensure that the output power meter indication is not greater than 1.0 milliwatt plus 5 dB.

(43) Connect the LF electronic voltmeter across the output power meter terminals.

(44) Adjust the LSB LINE LEVEL control for an output indication of 1.0 milliwatt.

(45) Connect a wire link between the MUTE and E terminals of TS2. Ensure that the output level is reduced by not less than 40 dB. Remove the wire link.

(46) Switch off and disconnect all test equipment.

(47) Reconnect the coaxial lead to pin 4 on the filter board removed at step (3).

TYPICAL SIGNAL LEVELS (IF/AF PM674 Boards)

25. The typical signal levels listed below were measured under the following test conditions unless stated otherwise:-

(1) Signal generator, output level set to 40 microvolts e.m.f. CW, connected to the IF input, pins 34 and 35 (filter board output open circuit).

(2) Receiver front panel controls set as follows:-

MODE	
Main IF/AF board:	USB
ISB IF/AF board:	LSB
AGC	OFF
IF GAIN	Fully clockwise

(3) Measurements at TP2, TP3 and TP4 were made using the HF electronic voltmeter, high input impedance.

(4) Measurements at TP7, pins 8/9 and TP6 were made using the LF electronic voltmeter.

TP2	200 millivolts r.m.s.
TP3	200 millivolts r.m.s. (set by R1).

TP4	Between 90 and 130 millivolts r.m.s.
TP7	Between 50 and 90 millivolts r.m.s.
Pins 8 and 9	Not less than 150 millivolts, typically between 170 and 250 millivolts r.m.s.
TP6	Signal generator output increased to 120 microvolts, amplitude modulated 30 per cent at 1 kHz: Between 50 and 90 millivolts r.m.s.

MAIN IF/AF BOARD PM364/1

Test Equipment

25a. The items of test equipment listed below are required for the following tests.

(1) Signal Generator

Frequency range:	1 to 2 MHz
Output:	60 microvolts to 1 volt e.m.f.
Output impedance:	50 ohms

(Example: Racal Instruments Type 9061/62)

(2) Digital Voltmeter

(Example: Racal Instruments Type 9071)

(3) Digital Frequency Meter

Frequency range:	1kHz to 2MHz

(Example: Racal Instruments Type 9822 or Type 9021)

(4) HF Electronic Voltmeter

Range:	10 millivolts to 1 volt r.m.s.
Frequency range:	Up to 2MHz
Input impedance:	50 ohms and high impedance.

(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, Type TM6/4)

(5) LF Electronic Voltmeter

Input impedance:	Not less than 1 Megohm

(Example: Advance Type 77)

(6) Output Power Meter

Frequency range:	20Hz to 35kHz
Input impedance:	600 ohms and 8 ohms
Power range:	Not less than 2 watts FSD.

(Example: Marconi Type TF893A)

(7) Multimeter

(Example: Avometer Model 8)

(8) Resistor, fixed, 1 kilohm, 5%, 0.25 watt.

IMPORTANT NOTE

The following alignment procedures are carried out with the main IF/AF board isolated from the remainder of the receiver. Further minor adjustments are, therefore, required following the alignment of the RF, first mixer and second mixer boards. These adjustments are given in paragraphs 57a, 57b and 57c.

Procedure

25b. (1) Set the receiver front panel controls as follows:

AGC	OFF

RF TUNE (if fitted)	WB
AFC (if fitted)	OFF
IF GAIN	Fully counter-clockwise
MODE	USB
AF GAIN	Fully counter-clockwise.

(2) Remove link 1 from the main IF/AF board.

(3) Connect the multimeter, set to the 100 milliamp d.c. range, between the pins of link 1, with the negative lead of the multimeter connected to the pin nearest the edge of the board.

(4) Adjust potentiometer R84 for a reading of 15 milliamps on the multimeter.

(5) Disconnect the multimeter and replace link 1.

(6) Unsolder the coaxial lead connected to pin 2 on the filter board PS367 (the coaxial screen may be left connected to pin 3).

(7) Connect the 1 kilohm resistor in series with the coaxial lead connected to the 50 ohm output of the signal generator and connect the other end of this lead to the coaxial lead removed at step (6). Connect the screen to pin 3 on the filter board.

(8) Connect the digital frequency meter to the UNCAL socket on the signal generator (omit if Racal 9061/9062 signal generator is used).

(9) Set the frequency of the signal generator to 1.400 MHz, plus or minus 500Hz and the output level to 60 microvolts e.m.f.

(10) Set the IF GAIN control fully clockwise.

(11) Ensure that the MODE switch is set to USB.

(12) Ensure that the AF GAIN control is set fully counter-clockwise.

(13) Set potentiometers R3, R4 and R42 full counter-clockwise.

(14) Set potentiometer R9 fully clockwise.

(15) Connect the HF electronic voltmeter, high impedance input, to TP3.

(16) Adjust inductors L1 and L2 for a maximum indication on the HF electronic voltmeter.

(17) Adjust R9 for a level of 200 millivolts at TP3 and then repeat step (16).

(18) Sweep the signal generator frequency from 1390kHz to 1410kHz. Note the frequency at which the peak output occurs. Also note the level of the peak output.

(19) Sweep the signal generator frequency again from 1390kHz to 1410kHz. Ensure that the output level remains within 1dB of the level noted at step (18).

(20) Set the signal generator to the frequency noted at step (18).

(21) Adjust R9 for an indication of 200 millivolts r.m.s. on the HF electronic voltmeter (connected to TP3).

(22) Adjust R3 to reduce the HF electronic voltmeter indication to 100 millivolts and then reset the level to 200 millivolts with R9.

(23) Repeat steps (18) and (19). If the 1dB tolerance of step (19) cannot be met repeat steps (16) to (23).

(24) Connect the digital voltmeter to board pins 29 (positive) and 28 (0V).

(25) Adjust R31 for an indication of 1.4 volts plus or minus 25 millivolts on the digital voltmeter.

(26) Transfer the digital voltmeter to board pins 30 (positive) and 28 (0V).

(27) Adjust the IF GAIN control for an indication of 1.4 volts plus or minus 10 millivolts on the digital voltmeter.

(28) Adjust R4 until the signal level at TP3, as indicated on the HF electronic voltmeter, decreases by 1dB. Disconnect the HF electronic voltmeter.

(29) Reduce the signal generator output level by 4dB.

(30) Connect the multimeter, set to the 25V d.c. range, between TP6 (positive) and the -7 volt supply at board pin 20.

(31) Adjust R42 until the indication on the multimeter changes from positive 7 volts ± 1 volt to positive 14 volts ± 1 volt.

(32) Connect the HF electronic voltmeter, 50 ohms input impedance, to the MAIN IF OUT socket on the rear panel.

(33) Set the AGC switch to SHORT.

(34) Set the frequency of the signal generator to 1.400MHz plus or minus 500Hz and the output level to 60 microvolts e.m.f.

(35) Ensure that the IF output signal level, as indicated on the HF electronic voltmeter, is not less than 50 millivolts r.m.s.

(36) Increase the signal generator output level by 70dB. Ensure that the increase in the IF output signal level is not greater than 5dB.

(37) Reset the signal generator output level to 60 microvolts e.m.f. Set the AGC switch to LONG and repeat steps (35) and (36).

(38) Reset the signal generator output level to 60 microvolts e.m.f. and ensure that the IF output is restored within 4 to 8 seconds.

(39) Connect the LF electronic voltmeter to board pins 8 and 9 (0V).

(40) Tune the signal generator for a maximum indication on the LF electronic voltmeter. Ensure that the level indicated is not less than 150 millivolts r.m.s.

(41) Disconnect the LF electronic voltmeter. Connect the output power meter, set to 8 ohms input impedance, between the LS and E terminals of TSl.

(42) Set the AF GAIN control fully clockwise and ensure that the output power meter indication is not less than 1 watt.

(43) Set the AF GAIN control for an indication of 100 milliwatts on the output power meter.

(44) Increase the signal generator output level by 70dB and ensure that the output power meter indication is not greater than 100 milliwatts plus 5dB.

(45) Reduce the signal generator output level by 60dB.

(46) Set the MODE switch to AM.

(47) Set the signal generator for 30 per cent amplitude modulation at 1kHz.

(48) Set the AF GAIN control fully clockwise and ensure that the output power meter indication is not less than 1 watt.

(49) Set the AF GAIN control for an indication of 1 watt on the output power meter.

(50) Connect a wire link between the MUTE and E terminals of TS2. Ensure that the output power meter indication decreases by not less than 40dB. Disconnect the wire link.

(51) Set the MODE switch to USB.

(52) Reset the signal generator output level to 60 microvolts e.m.f.

(53) Transfer the output power meter, set to 600 ohms input impedance, to the LINE OUTPUT MAIN IF terminals of TS1.

(54) Set the AM/USB LINE LEVEL control fully clockwise and ensure that the output power meter indication is not less than 10 milliwatts.

(55) Set the MODE switch to AM.

(56) Set the signal generator for 30 per cent amplitude modulation at 1kHz.

(57) Increase the signal generator output level by 60dB. Ensure that the output power meter indication is not less than 4 milliwatts.

(58) Switch off and disconnect all test equipment.

(59) Reconnect the coaxial lead to pin 2 on the filter board removed at step (6).

NOTE: See paragraph 25 for typical signal levels.

ISB IF/AF BOARD PM364/3

Test Equipment

25c. The items of test equipment required for the following test are as listed for the main

IF/AF board, para. 25a.

IMPORTANT NOTE

The following alignment procedures are carried out with the ISB IF/AF board isolated from the remainder of the receiver. Further minor adjustments are, therefore, required following the alignment of the RF, first mixer and second mixer boards. These adjustments are given in paragraphs, 57a, 57b and 57c.

Procedure

25d. (1) Set the receiver front panel controls as follows:

AGC	OFF
AFC (if fitted)	OFF
MODE	LSB
IF GAIN	Fully Clockwise
AF GAIN	Fully counter-clockwise

(2) Set potentiometers R3, R4 and R42 fully counter-clockwise.

(3) Set potentiometer R9 fully clockwise.

(4) Unsolder the coaxial lead connected to pin 4 on the filter board PS367 (the coaxial screen may be left connected to pin 5).

(5) Connect the 1 kilohm resistor in series with the coaxial lead connected to the 50 ohm output of the signal generator. Connect the other end of this lead to the coaxial lead removed at step (4). Connect the screen to pin 5 on the filter board.

(6) Connect the digital frequency meter to the UNCAL socket on the signal generator (omit if Racal 9061/62 signal generator is used).

(7) Set the frequency of the signal generator to 1.400MHz, plus or minus 500Hz, and the output level to 60 microvolts e.m.f.

(8) Connect the HF electronic voltmeter, high input impedance, to TP3.

(9) Adjust inductors L1 and L2 for a maximum indication on the HF electronic voltmeter.

(10) Adjust R9 for a level of 200 millivolts r.m.s. at TP3 and then repeat step (9).

(11) Sweep the signal generator frequency from 1390kHz to 1410kHz. Note the frequency at which the peak output occurs. Also note the level of the peak output.

(12) Sweep the signal generator frequency again from 1390kHz to 1410kHz. Ensure that the output level remains within 1dB of the level noted at step (11).

(13) Set the signal generator to the frequency noted at step (11).

(14) Adjust R9 for an indication of 200 millivolts r.m.s. on the HF electronic voltmeter (connected to TP3).

(15) Adjust R3 to reduce the HF electronic voltmeter indication to 100 millivolts and then reset the level to 200 millivolts with R9.

(16) Repeat steps (11) and (12). If the 1dB tolerance of step (12) cannot be met repeat steps (9) to (16).

(17) Connect the digital voltmeter to board pins 29 (positive) and 18 (0V).

(18) Adjust R31 for an indication of 1.4 volts plus or minus 10 millivolts on the digital voltmeter.

(19) Transfer the digital voltmeter to board pins 30 (positive) and 28 (0V).

(20) Adjust the IF GAIN control for an indication of 1.4 volts plus or minus 10 millivolts on the digital voltmeter.

(21) Adjust R4 until the signal level at TP3, as indicated on the HF electronic voltmeter, decreases by 1dB. Disconnect the HF electronic voltmeter.

(22) Reduce the signal generator output level by 4dB.

(23) Connect the multimeter, set to the 25V d.c. range, between TP6 (positive) and the - 7 volt supply at board pin 20.

(24) Adjust R42 until the indication on the multimeter changes from positive 7 volts ± 1 volt to positive 14 volts ± 1 volt.

(25) Connect the HF electronic voltmeter, 50 ohms input impedance, to the ISB IF OUT socket on the rear panel.

(26) Set the AGC switch to SHORT.

(27) Set the frequency of the signal generator to 1.400MHz, plus or minus 500Hz, and the output level to 60 microvolts e.m.f.

(28) Ensure that the IF output signal level, as indicated on the HF electronic voltmeter, is not less than 50 millivolts r.m.s.

(29) Increase the signal generator output level by 70dB. Ensure that the increase in the IF output signal level is not greater than 5dB.

(30) Reset the signal generator output level to 60 microvolts e.m.f. Set the AGC switch to LONG and repeat steps (28) and (29).

(31) Reset the signal generator output level to 60 microvolts e.m.f. and ensure that the IF output is restored within 4 to 8 seconds.

(32) Connect the LF electronic voltmeter to board pins 8 and 9 (0V).

(33) Tune the signal generator for a maximum indication on the LF electronic voltmeter. Ensure that the level indicated is not less than 150 millivolts r.m.s.

(34) Disconnect the LF electronic voltmeter.

(35) Connect the output power meter, set to 600 ohms input impedance, to the

ISB LINE OUTPUT terminals of TS1.

(36) Set the LSB LINE LEVEL control fully clockwise and ensure that the output power meter indication is not less than 4 milliwatts.

(37) Set the LSB LINE LEVEL control for an indication of 1.0 milliwatt on the output power meter.

(38) Increase the signal generator output level by 70dB and ensure that the output power meter indication is not greater than 1.0 milliwatt plus 5dB.

(39) Connect the LF electronic voltmeter across the output power meter terminals.

(40) Adjust the LSB LINE LEVEL control for an output indication of 1.0 milliwatt.

(41) Connect a wire link between the MUTE and E terminals of TS2. Ensure that the output level is reduced by not less than 40dB. Remove the wire link.

(42) Switch off and disconnect all test equipment.

(43) Reconnect the coaxial lead to pin 4 on the filter board removed at step (4).

TYPICAL SIGNAL LEVELS (IF/AF Boards)

25e The typical signal levels listed below were measured under the following test conditions unless stated otherwise:

(1) Signal generator, output level set to 40 microvolts e.m.f. CW, connected to the IF input, pins 34 and 35 (filter board output open circuit).

(2) Receiver front panel controls set as follows:

MODE:	
Main IF/AF board:	USB
ISB IF/AF board:	LSB
AGC	OFF
IF GAIN	fully clockwise.

(3) Measurements at TP2, TP3 and TP4 were made using the HF electronic voltmeter, high input impedance.

(4) Measurements at TP7, pins 8/9 and TP6 were made using the LF electronic voltmeter.

TP2	100 millivolts r.m.s.
TP3	200 millivolts r.m.s. (set by R9)
TP4	Between 90 and 130 millivolts r.m.s.
TP7	Between 50 and 90 millivolts r.m.s.
Pins 8 & 9	Not less than 150 millivolts, typically between 170 and 250 millivolts r.m.s.
TP6	Signal generator output increased to 120 microvolts, amplitude modulated 30 per cent at 1kHz: Between 50 and 90 millivolts r.m.s.

FILTER BOARD PS367

26. There are no adjustments to be made to the filter board. Since the filters are sealed units, any filter that fails to meet the performance figures given in the following paragraphs should be replaced.

Filter Identification

27. A total of six filters may be fitted to the filter board. The symmetrical filters fitted (up to a total of five) are as indicated by the front panel FILTER switch markings. To ascertain which sideband filters are fitted, physically check the drawing numbers marked on FL1 and FL5 (see Fig. 25) against the following table. Note that on some receivers, for example, those equipped with USB only, a filter fitted at FL5 will be a symmetrical filter. A carrier filter is only fitted (at FL6) in receivers equipped for AFC.

DRAWING NO.	FILTER
BD45806	13kHz Symmetrical
BD45248	9kHz Symmetrical
BD45249	3kHz Symmetrical
BD45250	1kHz Symmetrical
BD45251	300 Hz Symmetrical
BD602856	2.7kHz USB Marine
BD45858	3kHz USB
BD45695	6kHz USB
BD45859	3kHz LSB
BD45694	6kHz LSB
BD45274	3kHz USB (ISB)
BD45275	3kHz LSB (ISB)
BD45253	Carrier

NOTE: Due to the inversion within the receiver, the filter selected for USB operation will have LSB characteristics and that selected for LSB operation will have USB characteristics.

Test Equipment

28. The items of test equipment listed below are required for the following tests;

(1) Signal Generator

Frequency range:	1 to 2MHz
Output level:	150 microvolts e.m.f.
Output impedance:	50 ohms

(Example: Racal Instruments Type 9061/62)

(2) HF Electronic Voltmeter

Frequency range:	1 to 2MHz
Voltage range:	10 to 100 millivolts r.m.s.
Input impedance:	50 ohms

(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, type TM6/4)

(3) Digital Frequency Meter

Frequency range: 1 to 2 MHz

(Example: Racal Instruments Type 9822 or Type 9021)

Procedure

Symmetrical Filters

29. (1) Remove the coaxial socket from the chassis - mounted second mixer output connector (right-hand front, see Fig. 4).

(2) Connect the output of the signal generator to the filter board input via the coaxial socket disconnected at step (1).

(3) Connect the digital frequency meter to the UNCAL output socket on the signal generator (omit if Racal 9061/62 signal generator is used).

(4) Connect the HF electronic voltmeter, 50 ohm input impedance, to the MAIN IF OUT socket on the rear panel.

(5) Set the receiver front panel controls as follows:

IF GAIN	Fully clockwise
AGC	OFF
MODE	AM
FILTER	Widest bandwidth
AFC (if fitted)	OFF

(6) Set the signal generator frequency to 1.4MHz and the output level to 150 microvolts e.m.f.

(7) From the following paragraphs, 30 to 35 inclusive, perform the tests that are applicable to the symmetrical filters fitted to the receiver, setting the FILTER switch in each case to the appropriate position.

13kHz Symmetrical Filter

30. (1) Tune the signal generator for maximum output as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts e.m.f.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolts level. Ensure that the frequency indicated on the digital frequency meter is less than 1 393 500Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 406 500Hz.

8kHz Symmetrical Filter

31. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 396 000Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 404 000Hz.

3kHz Symmetrical Filter

32. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the ouput level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB realtive to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 398 500Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 401 500Hz.

1kHz Symmetrical Filter

33. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 399 500Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 400 500Hz.

300Hz Symmetrical Filter

34. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 399 900 Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 400 100.

Sideband Filters

35. For SSB versions of the receiver set the MODE switch to USB to check the USB filter, and to LSB to check the LSB filter (if fitted). For ISB versions of the receiver set the MODE switch to ISB-L. Connect the HF electronic voltmeter, 50 ohms input impedance, to the MAIN IF OUT socket to check the USB-ISB filter, to the ISB IF OUT socket to check the LSB-ISB filter. Carry out the checks for the sideband filters fitted in accordance with the following respective paragraphs.

2.7kHz USB Filter

36. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 397 300Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 399 650Hz.

3kHz USB Filter

37. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 397 000Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 399 700Hz.

3kHz LSB Filter

38. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 400 300Hz.

(4) Increase the frequency of the signal generator until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 403 000Hz.

6kHz LSB Filter

39. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 400 300Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 406 000Hz.

3kHz USB ISB Filter

40. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 397 000Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 399 700Hz.

3kHz LSB ISB Filter

41. (1) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is greater than 50 millivolts r.m.s. with the IF GAIN control fully clockwise.

(2) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(3) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is less than 1 400 300Hz.

(4) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 403 000Hz.

Carrier Filter (AFC Versions Only)

42. (1) On the filter board remove the link between board pins 22 and 24. Reconnect the link between board pins 22 and 23.

(2) Connect a temporary link between board pins 7 and 8.

(3) Unsolder and remove the white/black wire from pin 15 on the filter board.

(4) Set the MODE switch to USB.

(5) Ensure that the AFC switch is set to OFF.

(6) Ensure that the AGC switch is set to OFF.

(7) Connect the HF electronic voltmeter, 50 ohms input impedance, to the MAIN IF OUT socket on the rear panel.

(8) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter.

(9) Set the IF GAIN control fully clockwise and ensure that the HF electronic voltmeter is greater than 50 millivolts r.m.s.

(10) Set the IF GAIN control for an indication of 50 millivolts on the HF electronic voltmeter.

(11) Decrease the signal generator frequency until the output falls by 3dB relative to the 50 millivolt output level. Ensure that the frequency indicated on the digital frequency meter is less than 1 399 950Hz.

(12) Increase the signal generator frequency until the output falls by 3dB relative to the 50 millivolt level. Ensure that the frequency indicated on the digital frequency meter is greater than 1 400 050Hz.

(13) Switch off and disconnect all test equipment.

(14) Remove the link between board pin 22 and 23. Reconnect the link between board pins 22 and 24.

(15) Reconnect the white/black wire to board pin 15 removed at step (3).

(16) Reconnect the coaxial socket to the chassis mounted second mixer output plug.

SECOND MIXER BOARD PM336

Test Equipment

43. The items of test equipment listed below are required for the following tests:-

(1) Signal Generator

Frequency range:	34 to 35.4 MHz
Output:	1 millivolt to 2 volts e.m.f.
Output impedance:	50 ohms

(Example: Racal Instruments Type 9061/62)

(2) HF Electronic voltmeter

Range:	0.1 millivolt to 1 volt r.m.s.
Frequency:	Up to 40MHz
Impedance:	50 ohms and high impedance

(Example: Airmec Type 301A or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, Type TM6/4)

(3) Multimeter

(Example: Avometer Model 8)

(4) Variable voltage stabilised power supply

Output: 0 to 3 volts d.c.

(5) Capacitor 0.01μF, 50V

Procedure

44. (1) Remove links 1 and 2 from the board.

(2) Set the front panel AGC switch to OFF.

(3) Set the IF GAIN control fully counter clockwise.

(4) Ensure that the 34 MHz INT/EXT switch is set to INT.

(5) Connect the HF electronic voltmeter, 50 ohms input impedance between link 2 (pin adjacent to the screen) and TP2 (0V).

(6) Adjust inductors L10, L12, L13 and L14 for a maximum indication on the HF electronic voltmeter.

(7) Repeat step (6) until there is no increase in output.

(8) Check that the HF electronic voltmeter indication is not less than 600 millivolts r.m.s.

(9) Disconnect the HF electronic voltmeter and replace link 2.

(10) Set the MODE switch to USB.

(11) Connect the HF electronic voltmeter, 50 ohms impedance, to the MAIN IF OUT socket on the rear panel.

(12) Connect the signal generator via the 0.01μF capacitor between link 1 (pin farthest from the screen) and TP2 (0V) on the second mixer board.

(13) Set the signal generator to a frequency of 35.399MHz plus or minus 500Hz.

(14) Set the output level of the signal generator for an indication on the HF electronic voltmeter of 50 millivolts r.m.s.

(15) Tune L15 for a maximum indication on the HF electronic voltmeter, adjusting the output of the signal generator as necessary to maintain an indication of 50 millivolts r.m.s.

(16) Check that the signal generator output level does not exceed 8 microvolts e.m.f.

(17) Disconnect the signal generator and capacitor.

(18) Replace link 1 on the second mixer board PM336.

(19) Remove link 1 on the first mixer board PM335. Set R8 fully clockwise.

(20) Connect the output of the signal generator, set to a frequency of 35.399MHz, to the T3 end of link 1 on the first mixer board PM335.

(21) Set the signal generator output level for an indication on the HF electronic voltmeter of 50 millivolts r.m.s.

(22) Tune inductors L1, L6, L7, L8, L9 and L11 for maximum IF output as indicated on the HF electronic voltmeter. Repeat until there is no further improvement.

(23) Reset the signal generator output level for an indication of 50 millivolts on the HF electronic voltmeter.

(24) Check that the signal generator output level is less than 1.5 microvolts e.m.f.

(25) Set the receiver POWER switch to OFF and carefully unsolder the externally connected lead (orange/red) from pin 9 on the second mixer board.

(26) Connect the positive lead of the variable voltage stabilised power supply to pin 9 on the second mixer board. Connect the negative lead to chassis (0V).

(27) Set the receiver POWER switch to ON and switch on the variable voltage power supply and set the output to 2.25 volts.

(28) Adjust potentiometer R8 for an IF output of 45 millivolts, as indicated on the HF electronic voltmeter.

(29) Set the output of the variable voltage power supply to 2.9 volts.

(30) Increase the signal generator output level by 38dB.

(31) Ensure that the IF output level, as indicated on the HF electronic voltmeter, is not greater than 50 millivolts r.m.s.

(32) Decrease the signal generator output level by 38dB.

(33) Disconnect the variable voltage power supply and reconnect the orange/red lead to pin 9 on the second mixer board.

(34) Unsolder the externally connected lead (white/blue) from pin 8 on the second mixer board.

(35) Connect the positive lead of the variable voltage power supply to pin 8 on the second mixer board. Connect the negative lead to chassis (0V).

(36) Switch on the variable voltage power supply and set the output to 2.25 volts.

(37) Ensure that the IF output level, as indicated on the HF electronic voltmeter, is between 40 and 50 millivolts r.m.s.

(38) Set the output of the variable voltage power supply to 2.9 volts.

(39) Increase the signal generator output level by 38dB.

(40) Ensure that the IF output level, as indicated on the HF electronic voltmeter, is not greater than 50 millivolts r.m.s.

(41) Disconnect the variable voltage power supply and reconnect the white/blue lead to pin 8 on the second mixer board.

(42) Replace link 1 on the first mixer board PM335.

(43) Disconnect all remaining test equipment.

FIRST MIXER BOARD PM335

Test Equipment

45. The items of test equipment listed below are required for the following tests:

(1) Signal Generator

Frequency range:	1 to 65MHz
Output:	1 microvolt to 0.5 volt e.m.f.
Impedance:	50 ohms

(Example: Racel Instruments Type 9061/62)

(2) HF Electronic Voltmeter

Range:	1 millivolt to 1 volt r.m.s.
Input impedance:	High
Frequency range:	Up to 70MHz

(Example: Airmec Type 301A or Farnell Type TM6)

(3) Valve Voltmeter

Range:	1 to 20 volts r.m.s.
Input impedance:	Not less than 10 megohm
Frequency range:	Up to 70MHz

(Example: Racal Instruments Type 314A)

Procedure

46. (1) Set the receiver controls as follows:

MHz	1
RF TUNE (if fitted)	WB
LO INT/EXT	EXT
MODE	USB
AFC (if fitted)	OFF
AGC	OFF
IF GAIN	Fully clockwise

(2) Connect the signal generator to the LO IN/OUT socket on the rear panel. Set the frequency of the signal generator to 36MHz and the output level to 880 millivolts e.m.f. (+6dBm).

(3) Connect the HF electronic voltmeter, high impedance input, to TP3.

(4) Sweep the frequency of the signal generator from 36 to 40 MHz. Note the level of the peak response as indicated on the HF electronic voltmeter.

(5) Set the signal generator to a frequency of 35.415MHz.

(6) Tune T1, L6 and T2 to obtain an output on the HF electronic voltmeter of minus 5dB relative to the peak response noted at step (4).

(7) Connect the HF electronic voltmeter to TP5.

(8) Sweep the frequency of the signal generator from 35.415 to 39.4MHz. Check that the level indicated on the HF electronic voltmeter remains within minus 6dB of the peak output level.

(9) Set the signal generator to a frequency of 35.400MHz. Check that the level indicated on the HF electronic voltmeter falls by not less than 25dB.

(10) Set the front panel MHz switch to 4.

(11) Connect the HF electronic voltmeter,high input impedance, to TP4.

(12) Set the signal generator to a frequency of 35.400MHz.

(13) Adjust L5 and L7 for a minimum indication on the HF electronic voltmeter.

(14) Set the signal generator to a frequency of 50.600MHz.

(15) Adjust L4, L8 and L9 for a maximum indication on the HF electronic voltmeter.

(16) Sweep the frequency of the signal generator from 39.400 to 65.400MHz. Check that the level indicated on the HF electronic voltmeter remains within minus 6dB of the peak output level.

(17) Disconnect the HF electronic voltmeter.

(18) Connect the valve voltmeter to board pin 30.

(19) Sweep the frequency of the signal generator from 39.4 to 65.4MHz. Check that the indication on the valve voltmeter remains within the limits 6 to 15 volts over the frequency range. If necessary re-adjust L4, L5, L7 and L8.

(20) Set t he MHz switch on the front panel to 1.

(21) Sweep the frequency of the signal generator slowly from 35.415 to 39.400MHz. Check that the indication on the valve voltmeter remains within the limits 6 to 15 volts over the frequency range. Disconnect the valve voltmeter.

(22) Set the front panel METER switch to DRIVE LEVEL.

(23) Set the LO INT/EXT switch on the rear panel to INT and disconnect the signal generator from the LO IN/OUT socket.

(24) Adjust potentiometer R39 to set the front panel meter needle to the centre of the V portion of the scale.

(25) Set the receiver MHz switch to 1.

(26) Set the kHz control for a display of 000.00.

(27) Connect the output of the signal generator to the chassis mounted first mixer input BNC connector (see Fig. 4). Set the signal generator frequency to 1.000 MHz and the output level to 5 microvolts e.m.f.

(28) Connect the HF electronic voltmeter, 50 ohms input impedance, to the MAIN IF OUT socket on the rear panel.

(29) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is not less than 50 millivolts r.m.s.

(30) Set the receiver frequency to 3.999 MHz.

(31) Set the signal generator frequency to 4MHz.

(32) Tune the signal generator for maximum output, as indicated on the HF electronic voltmeter. Ensure that the output level is not less than 50 millivolts r.m.s.

(33) Set the receiver MHz switch to 4.

(34) Tune the signal generator for maximum output. Ensure that the output level is not less than 50 millivolts r.m.s.

(35) Set the receiver frequency to 29.999MHz.

(36) Set the signal generator frequency to 29.9MHz.

(37) Tune the signal generator for maximum output. Ensure that the output level is not less than 50 millivolts.

NOTE 1: Typical signal levels at the remaining test points not already covered are listed below:

TP1: MHz switch settings 4 to 29, HF electronic voltmeter, high impedance input, 1V r.m.s.

TP2: MHz switch settings 0 to 3, HF electronic voltmeter, high input impedance, 1.2V r.m.s.

TP6: HF electronic voltmeter, high input impedance, 900mV to 1.2V r.m.s. dependent on MHz switch setting.

NOTE 2: If the output signal from the first mixer is very low, i.e. in the order of minus 10 dB, a failure of one or more of the matched field-effect transistors, TR3, TR4, TR6, TR7, should be suspected. Use the following procedure to ascertain whether or not the mixer transistors are functioning correctly.

NOTE 3: To prevent unbalance of the matched quad transistors, any replacement field-effect transistor must have the same colour spot on the can as those already fitted.

47. (1) Set the receiver POWER switch to OFF.

(2) Unsolder and remove the bare tinned copper (BTC) wire link from board pin 15.

(3) Connect the positive output from a 5 volt supply via a multimeter, set to the 100 milliamp d.c. range, to the BTC link wire removed at step (2). Connect the negative lead from the 5 volt supply to chassis (0V).

(4) Set the receiver POWER switch to ON.

(5) Switch on the 5 volt supply. The current drawn from the 5 volt supply should be between 20 and 35 milliamps. If the current drawn is less than 15 milliamps or greater than 40 milliamps, TR3 and/or TR4 should be replaced.

(6) Switch off and disconnect the 5 volt supply.

(7) Set the receiver POWER switch to OFF.

(8) Replace the BTC wire link to board pin 15.

(9) To check transistors TR6 and TR7, proceed as follows:

(10) Disconnect the BTC wire link from board pin 17.

(11) Connect the positive output of the 5 volt supply via the multimeter, set to the 100 milliamp range, to the link wire removed from board pin 17. Connect the negative lead of the 5 volt supply to chassis (0V).

(12) Set the receiver POWER switch to ON.

(13) Switch on the 5 volt supply. The current drawn from the 5 volt supply should be between 20 and 35 milliamps. If the current drawn is less than 15 milliamps or greater than 40 milliamps, TR 6 and/or TR7 should be replaced.

NOTE: Before removing a (possibly serviceable) field-effect transistor from the board, wrap a piece of thin BTC wire round the transistor leads (between the base of the transistor and the board). A new field-effect transistor should be supplied with a shorting conductive-rubber ring over the transistor leads. The transistor leads should remain short-circuited until all the leads are soldered to the printed circuit board.

RF BOARD PM582

Test Equipment

48. The items of test equipment listed below are required for the following tests;

(1) Signal Generator A

Frequency range:	10kHz to 72MHz
Output level:	1mV to 2V e.m.f.
Output impedance:	75 ohms

(Example: Marconi Type TF144H with 50 to 75 ohm matching pad)

(2) Signal Generator B

Frequency range:	30 to 100MHz
Output level:	1mV to 1V e.m.f.
Output impedance:	75 ohms

(Example: Racal Instruments Type 9061/62 with 50 to 75 ohms matching pad).

(3) Signal Generator C

Frequency range:	1 to 30MHz
Output level:	1 to 20V e.m.f.
Output impedance:	75ohms

(Example: Rohde and Schwarz Type BN41001)

(4) Digital Frequency Meter

Frequency range: 10kHz to 100MHz
(Example: Racal Instruments Type 9822 or Type 9021)

(5) HF Electronic Voltmeter

Frequency range: 50kHz to 100MHz
Range: 1mV to 1V
Input impedance: 75 ohm and high impedance
(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adaptor, 75 ohm terminated).

(6) Valve Voltmeter

Range: 1 to 20V
Input impedance: Not less than 10MΩ
(Example: Racal Instruments Type 314A)

(7) Waveform Analyser

Frequency range: 5 to 100MHz
Input: 5 Microvolts to 15 Millivolts
(Example: Airmec 248A)

(8) Multimeter

(Example: Avometer Model 8)

Procedure

49. (1) Raise the RF board to the upright position.

(2) On tuned versions, set the RF TUNE control fully counter-clockwise (the WB position).

(3) Set the front panel MHz switch to any position other than 0.

(4) Connect the output from signal generator A to the RF input socket on the board.

(5) Connect the digital frequency meter to monitor the output from signal generator A.

(6) Connect the HF electronic voltmeter, high impedance input, between TP1 and chassis (0V).

(7) Set signal generator A to a frequency of 36.2 MHz plus or minus 50kHz and set the output level to 1.0 volt e.m.f.

(8) Tune L9 for a minimum indication on the HF electronic voltmeter.

(9) Set signal generator A to a frequency of 30.0MHz plus or minus 20kHz.

(10) Tune L7 for a maximum indication on the HF electronic volmeter.

(11) Set signal generator A to a frequency of 20MHz plus or minus 1MHz. Note the level indicated on the HF electronic voltmeter.

(12) Sweep the frequency of signal generator A from 35.4 to 65MHz. Check that the HF electronic voltmeter indication is not less than 20dB below the level noted at step (11).

(13) Disconnect the HF electronic voltmeter from TP1.

(14) Disconnect the RF output BNC plug from the chassis mounted first mixer input connector (see Fig. 4).

(15) Connect the waveform analyser to the RF output BNC plug.

(16) Set signal generator A to a frequency of 35.52MHz plus or minus 20kHz. Tune the waveform analyser to this signal, adjusting its attenuator, as necessary, to obtain maximum sensitivity.

(17) Tune inductor L17 for a minimum indication on the waveform analyser.

(18) Set signal generator A to the following frequencies in turn. Repeat steps (16) and (17), in each case tuning the appropriate inductors for a minimun indication on the waveform analyser.

Frequency	Inductor
36.88 MHz ± 50kHz	L18
40.74 MHz ± 50kHz	L16

(19) Disconnect the waveform analyser and connect in its place the HF electronic voltmeter, 75 ohm input impedance.

(20) Set the frequency of signal generator A to 30MHz ± 20kHz and the output level to 10 millivolts e.m.f.

(21) Tune inductors L15 and L19 for a maximum indication on the HF electronic voltmeter.

(22) Repeat steps (15) to (21) inclusive.

(23) Set the frequency of signal generator A to 1MHz. Note the level indicated on the HF electronic voltmeter.

(24) Sweep the frequency of signal generator A from 1 to 30MHz. Ensure that the output level remains within 2.5dB of the level noted at step (23).

(25) Disconnect signal generator A and substitute signal generator B. Set signal generator B to a frequency of 30MHz and an output level of 1.0 millivolt e.m.f.

(26) Disconnect the HF electronic voltmeter from the RF output BNC plug and connect in its place the waveform analyser.

(27) Set the waveform analyser for maximum sensitivity and tune it to the frequency of signal generator B. Adjust the waveform analyser attenuator to obtain a convenient reference level on the meter. Note the attenuator setting.

(28) Set signal generator B to a frequency of 35.4MHz and an output level of 1.0 volt e.m.f.

(29) Tune the waveform analyser to the frequency of signal generator B and set the waveform analyser attenuator to obtain the reference level set at step (27). Note the new setting of the attenuator. Ensure that the difference in the attenuator settings is not less than 25dB.

(30) Set the frequency of signal generator B to 70 and 100MHz, in turn, and repeat step (29). Ensure that in each case the difference in attenuator settings is not less than 25dB.

(31) Disconnect signal generator B and the waveform analyser.

(32) Connect the output of signal generator A set to a level of 10 millivolts e.m.f., to the 75 ohm input of the HF electronic voltmeter. Note the level as indicated on the HF electronic voltmeter as a reference level.

(33) Disconnect signal generator A from the HF electronic voltmeter and re-connect it to the RF input socket on the RF board.

(34) Connect the HF electronic voltmeter to the RF output BNC plug.

(35) Set signal generator A to the following frequencies, in turn, and check that the output level, in each case, is as stated.

Frequency (MHz)	Output level relative to the reference level (dB)
0.015	Plus 7.0 ± 1.0
0.100	Plus 15.0± 2.0
1.000	Plus 15.0 ± 2.0
2.000	Plus 15.0 ± 2.0
4.000	Plus 15.0 ± 2.0
8.000	Plus 15.0 ± 2.0
16.000	Plus 15.0 ± 2.0
30.000	Plus 15.0 + 2.0

(36) Set the frequency of signal generator A to 2.2MHz and set the output level to 100 millivolts e.m.f.

(37) Set the receiver MHz switch to 0.

(38) Tune inductor L10 for a minimum indication on the HF electronic voltmeter.

(39) Set the frequency of signal generator A to 100kHz. Ensure that the output level, as indicated on the HF electronic voltmeter, is plus 15dB ± 1dB relative to the signal generator output level. Note the output level.

(40) Sweep the frequency of signal generator A from 50kHz to 1MHz. Ensure that the output level remains within 1dB over the frequency range.

(41) Sweep the frequency of signal generator A from 2 to 6MHz. Ensure that the attenuation over the band, with respect to the output level noted at step (39),

is not less than 27dB.

NOTE: The following steps, (42) to (59) inclusive and paragraph 52 complete, apply to tuned versions only.

(42) Set the MHz switch to 1.

(43) Set the tuning capacitor (C22/C23) control spindle fully counter clockwise (capacitors fully enmeshed).

(44) Carefully turn the tuning capacitor spindle clockwise until the microswitch, SA, operates. Check that the variable capacitor is out of mesh by exactly 6 millimetres. This is equal to 18 degrees of rotation from the fully enmeshed reference point (see Fig. 5.1).

(45) Set signal generator A to a frequency of 0.98MHz and set the output level to 100 millivolts e.m.f.

(46) Tune the cores of T5 for maximum output, as indicated on the HF electronic voltmeter. Ensure that the top and bottom cores of T5 are near to the top and bottom ends respectively of the windings.

(47) Set signal generator A to a frequency of 2.0MHz.

(48) Adjust the tuning capacitor (C22/C23) for a maximum indication on the HF electronic voltmeter.

(49) Tune trimmer capacitors C28 and C38 for a maximum output indication.

(50) Repeat steps (44) to (49) inclusive until no further increase in output can be obtained.

(51) Set the tuning capacitor fully counter clockwise.

(52) Set signal generator A to a frequency of 1.0MHz. Note the output level indicated on the HF electronic voltmeter.

(53) Set the tuning capacitor for a maximum output indication. Ensure that the output level indicated is within 3dB of the level noted at step (52).

(54) Set the frequency of signal generator A to 1MHz plus 125kHz and, in turn, to 1MHz minus 125kHz. Ensure that the attenuation, in each case, is not less than 16dB relative to the level at 1MHz.

(55) Set the frequency of signal generator A to 2MHz.

(56) Set the tuning capacitor fully counter clockwise and note the output level indicated.

(57) Set the tuning capacitor for a maximum output indication. Ensure that the level indicated is within 6dB of the level noted at step (56).

(58) Ensure that the attenuation 250kHz above and below 2MHz is not less than 16dB relative to the output level at 2MHz.

(59) Repeat the procedures from step (43) to step (58) inclusive for the remaining transformers and trimmer capacitors in accordance with the following table:

MHz Switch Setting	Signal Generator MHz	Transformer	Capacitor	Output dB Relative to Step (52)	Attenuation	
					at MHz	Not less than -dB
2	2	T4	-	Within 6.0	±0.25	16
	4	-	C27+C37	Within 6.0	±0.5	16
4	4	T3	-	Within 6.0	±0.5	17
	8	-	C26+C36	Within 6.0	±1	17
8	8	T2	-	Within 6.0	±1	17
	16	-	C25+C35	Within 6.0	±2	17
16	16	T1	-	Within 6.0	±2	17
	30	-	C24+C34	Within 6.0	±3.75	17

Protection Stage (Tuned Versions)

50. (1) Disconnect signal generator A from the RF input connector and substitute signal generator C.

(2) Connect the multimeter, set to the 25 volt d.c. range, between the collector of TR8 (positive) and chassis (0V).

(3) Connect the valve voltmeter to TP2.

(4) Set C31 to maximum capacity.

(5) Set the frequency of signal generator C to 30MHz and set the output level for a valve voltmeter indication of 2.0 volts.

(6) Adjust C33 until the multimeter indication changes from +1 or +2 volts to +12 volts.

(7) Reduce the output level from signal generator C to 1 volt e.m.f. Check that the indication on the valve voltmeter is approximately 0.5 volt.

(8) Slowly increase the output level from signal generator C until the valve voltmeter indication falls to zero. Ensure that the signal generator output level is between 2.5 and 4.0 volts e.m.f.

(9) Connect the multimeter, set to the 25V d.c. range, between the collector of TR3 (positive) and chassis (0V).

(10) Connect the valve voltmeter to TP1.

(11) Set the output level of signal generator C for a valve voltmeter indication of 4.0V.

(12) Adjust C31 until the multimeter indication changes from +1 or +2 volts to +12 volts.

(13) Reduce the output level from signal generator C to 1 volt e.m.f. Check that the indication on the valve voltmeter is approximately 0.5 volt.

(14) Slowly increase the output level from signal generator C until the valve voltmeter indication falls to zero. Ensure that the signal generator output level is between 7 and 14 volts e.m.f.

(15) Disconnect the multimeter.

NOTE: Paragraph 51 applies to untuned versions only.

Protection Stage (Wideband)

51. (1) Set the receiver MHz switch to any position other than 0.

(2) Disconnect signal generator A from the RF input connector and substitute signal generator C.

(3) Connect the multimeter, set to the 25 volt d.c. range, between the collector of TR3 (positive) and chassis (0V).

(4) Connect the valve voltmeter to TP1.

(5) Set the frequency of signal generator C to 30MHz and set the output level for a valve voltmeter indication of 2.0 volts.

(6) Adjust C31 until the multimeter indication changes from +1 to +2 volts to +12 volts.

(7) Reduce the output level of signal generator C to 1 volt e.m.f. Check that the indication on the valve voltmeter is approximately 0.5 volt.

(8) Slowly increase the output level of signal generator C until the valve voltmeter indication falls to zero. Ensure that the signal generator output level is between 2.5 and 4.0 volts e.m.f.

(9) Disconnect the multimeter.

Mute Circuit

52. (1) Set the output level of signal generator C to 1 volt e.m.f.

(2) Ensure that the indication on the valve voltmeter (connected to TP1) is approximately 0.5 volt.

(3) Connect a wire link between the MUTE and E terminals of TS2. Ensure that the valve voltmeter indication falls to zero.

(4) Remove the wire link from the MUTE terminal and ensure that the valve voltmeter again indicates approximately 0.5 volts.

(5) Switch off and disconnect all test equipment.

(6) Replace the coaxial RF output connect to the chassis mounted first mixer input connector.

AFC BOARD PM664

Test Equipment

53. The items of test equipment listed below are required for the following tests:-

(1) Signal Generator
Frequency: 1.4 MHz
Output level: 1 microvolt to 3 volts e.m.f.
Output impedance: 50 ohms
(Example: Racal Instruments Tyep 9061/62)

(2) HF Electronic Voltmeter
Range: 300 millivolts to 1 volt r.m.s.
Frequency range: Up to 5 MHz
Input impedance: High
(Example: Racal Instruments Type 301A or Farnell Type TM6)

(3) Digital Voltmeter
(Example: Racal Instruments Type 9071)

(4) Oscilloscope
Sensitivity: 100 millivolts per centimetre
Frequency range: DC to 5 MHz
(Example: Tektronix Type 545 with L plug-in unit)

Procedure

54. (1) Set the receiver controls as follows:-

RF TUNE (if fitted)	WB
AGC	SHORT
MODE	CW
MHz	01
kHz	020.00
POWER	ON
FILTER	Widest Available
AFC	OFF
METER	TUNE CARRIER

(2) Remove the bookcase cover and stand the AFC board vertically.

(3) Unsolder the coaxial lead connected to pin 16, leaving the screen connected to pin 15.

(4) Connect the digital voltmeter between TP17 and earth. Adjust C35 for a reading of 8.0 volts ± 0.1 volts. Ensure that the digital voltmeter reading changes as C35 is adjusted.

(5) Measure the voltage between TP17 and TP18 with the digital voltmeter and ensure that the reading is less than 50 millivolts.

(6) Set the potentiometers as follows:-

R5	fully clockwise
R34	mid position
R37	fully clockwise
R41	fully counterclockwise
R45	fully clockwise

(7) Connect the electronic voltmeter to TP4 set to 3 volts AC range. Adjust R29 for a minimum reading, increasing the sensitivity of the electronic voltmeter as necessary.

(8) Set the electronic voltmeter, connected to TP4, to the 1 volt range. Connect the signal generator to pin 16.

(9) Set the frequency of the signal generator to 1.400 MHz, plus or minus 20 Hz and an output level of 60 microvolts p.d.

(10) Connect a temporary link between pin 14 and earth. Adjust L4 for a maximum indication on the electronic voltmeter and then set R34 for an indication of 800 millivolts plus or minus 100 millivolts. Remove the temporary link from pin 14.

(11) Increase the signal generator output level to 90 microvolts p.d. Adjust R5 in a counter clockwise direction until the signal level at TP4 as indicated on the electronic voltmeter, decreases by 1 dB.

(12) Increase the signal generator output level by 3 dB and note the electronic voltmeter indication.

(13) Increase the signal generator output level by 60 dB. Ensure that the increase in the level at TP4 does not increase by more than 3.5 dB above the indication noted in step (12).

(14) Reduce the signal generator output level by 63 dB and disconnect the electronic voltmeter.

(15) Connect the oscilloscope, set to monitor 12 volt CMOS levels, to TP6 and adjust R45 until the logic level at TP6 flickers between '1' and '0'.

(16) Reduce the signal generator output level by 2 dB and ensure that the logic level is a '0'.

(17) Increase the signal generator output level by 4 dB and ensure that the logic level is a '1'.

(18) Connect the electronic voltmeter to TP5 and adjust T1 for a maximum indication on the electronic voltmeter. Ignore any slow beat of the meter needle.

(19) Observe the tuning meter and ensure that a beat is seen that is equal to the difference between the input signal and 1.400 MHz.

(20) Set the AFC switch to FULL CARRIER and ensure that the LOCK lamp illuminates within 13 seconds. Ignore any flashing of the AFC LOCK lamp.

(21) Set the POWER switch to OFF and disconnect all test equipment.

AFC BOARD PM369

Test Equipment

54a The items of test equipment listed below are required for the following tests:

(1) Signal Generator

Frequency:	3.5MHz
Output level:	1 microvolt to 1 volt e.m.f.
Output impedance:	50 ohms

(Example: Racal Instruments Type 9061/62)

(2) Step Attenuator

Range:	0 to 100dB in 1dB steps
Impedance:	50 ohms

(Example: Racal Instruments Type 9065L)

(3) HF Electronic Voltmeter

Range:	300 millivolts to 1 volt r.m.s.
Frequency range:	Up to 5MHz
Input impedance:	High

(Example: Airmec Type 301A or Farnell Type TM6)

(4) Digital Voltmeter

(Example: Racal Type 9071)

(5) Variable Voltage Stabilised Power Supply

Output:	0 to 3V d.c.

(6) Resistor, fixed, 10 kilohm $\frac{1}{4}$ watt.

Procedure

54b (1) Set the receiver controls as follows:

MHz	3
kHz	500.00
RF TUNE (if fitted)	WB
AGC	OFF
IF GAIN	Fully Clockwise

MODE	AM
AFC	OFF
METER	TUNE CARRIER

(2) Connect the signal generator via the step attenuator to the receiver antenna socket.

(3) Set the signal generator to a frequency of 3.5MHz and a CW output level of 10 millivolts e.m.f.

(4) Set the receiver POWER switch to OFF and remove link LK1 from the AFC board.

(5) Set the receiver POWER switch to ON.

(6) Set the step attenuator to 0dB (receiver input level 10 millivolts e.m.f.).

(7) Tune the receiver to the signal generator for a minimum indication on the front panel meter (the meter needle may 'beat' slowly).

(8) Set R50 and R87 fully counter-clockwise.

(9) Connect the variable voltage power supply negative lead to chassis (0V) and the positive lead, via the 10kΩ resistor, to the LK1 connection furthest from the edge of the AFC board.

(10) Connect the HF electronic voltmeter, high impedance input, to TP10.

(11) Switch on an adjust the output of the variable voltage power supply for an indication of 750 millivolts plus or minus 0.5dB on the HF electronic voltmeter.

(12) Set the AFC switch to PILOT CARRIER. Check that the AFC LOCK lamp is illuminated.

(13) Connect the digital voltmeter between TP17 (positive) and chassis.

(14) Adjust R82 for a digital voltmeter indication of 1.54 volts plus or minus 100 millivolts.

(15) Connect the digital voltmeter between TP16 (positive) and chassis and check that it indicates 1.4 volts plus or minus 100 millivolts.

(16) Set the AFC switch to OFF. Tune the signal generator for a minimum indication on the front panel meter (the meter needle may 'beat' slowly).

(17) Set the AFC switch to PILOT CARRIER and adjust C3 until the front panel meter indicates zero on the AFC scale. Check that the AFC LOCK lamp is illuminated (if the AFC LOCK lamp extinguishes, set the AFC switch to OFF and then to PILOT CARRIER).

(18) Set the receiver POWER switch to OFF. Switch off and disconnect the variable voltage power supply.

(19) Set the receiver POWER switch to ON. Check that the receiver is correctly tuned to the signal generator frequency.

(20) Set the step attenuator to 80dB (receiver input level 1 microvolt e.m.f.).

(21) Set the AFC switch to FULL CARRIER.

(22) Adjust R50 for an indication on the HF electronic voltmeter (connected to TP10) of 750 millivolts plus or minus 100 millivolts.

(23) Check that the AFC LOCK lamp is illuminated.

(24) Set the receiver POWER switch to OFF and refit link LK1 to the AFC board.

(25) Set the AFC switch to OFF and the POWER switch to ON.

(26) Set R97 fully counter-clockwise.

(27) Check that the receiver is correctly tuned to the signal generator frequency.

(28) Set the AFC switch to PILOT CARRIER and check that the AFC LOCK lamp is illuminated.

(29) Set the step attenuator to 0dB, and set the signal generator output level to 1 microvolt e.m.f.

(30) Connect the digital voltmeter between TP16 (positive) and chassis.

(31) Check that the digital voltmeter indicates 1.45 volts plus or minus 30 millivolts. If the voltmeter indication exceeds 1.48 volts, adjust R50 for an indication of 1.45 volts.

(32) Adjust R97 for a digital voltmeter indication of 1.4 volts.

(33) Set the step attenuator to 5dB. Check that HF electronic voltmeter (connected to TP10) indication falls by not less than 3dB.

(34) Set the signal generator output level to 20 millivolts e.m.f. and set the step attenuator to 80dB (receiver input level of 2 microvolts e.m.f.).

(35) Set the AFC switch to FULL CARRIER and check that the AFC LOCK lamp illuminates.

(36) Set the AGC switch to SHORT and the MODE switch to USB.

(37) Connect the digital voltmeter between the DIV AGC terminal on the rear panel (positive) and chassis.

(38) Adjust R97 for a digital voltmeter indication of 1.50 volts plus zero or minus 30 millivolts.

(39) Set the AFC switch to OFF and tune the signal generator to the receiver (upper sideband) for a minimum indication on the front panel meter.

(40) Set the step attenuator to 50dB (receiver input level of 64 microvolts e.m.f.) and record the DIV AGC level as indicated on the digital voltmeter.

ISB Versions only:

(41) Set the MODE switch to LSB and transfer the digital voltmeter to the ISB DIV AGC terminal on the rear panel. Tune the signal generator to the receiver (lower sideband) and record the ISB DIV AGC level as indicated on the digital voltmeter. Set the MODE switch to USB and reconnect the digital voltmeter to the DIV AGC terminal on the rear panel.

All Versions:

(42) Tune the signal generator to the receiver for a minimum indication on the front panel meter. Set the AFC switch to FULL CARRIER and check that the AFC LOCK lamp illuminates.

(43) Adjust R50 for a digital voltmeter indication which is within plus or minus 30 millivolts of the lower of the two voltage readings recorded at steps (40) and (41).

(44) Set the step attenuator to 80dB (receiver input level of 2 microvolts e.m.f.).

(45) Re-adjust R97 for a digital voltmeter indication of 1.50 volts plus or minus 30 millivolts.

(46) Set the signal generator output level to 10 millivolts e.m.f. and set the step attenuator to 80dB (receiver input level of 1 microvolt e.m.f.).

(47) Set the AGC switch to OFF and set the MODE switch to CW. Check that the AFC LOCK lamp is illuminated. If the lamp is not illuminated, repeat steps (34) to (45) inclusive.

(48) Set the step attenuator to 76dB (receiver input level to 1.5 microvolts e.m.f.).

(49) Adjust R87 until the AFC LOCK lamp just extinguishes.

(50) Set the step attenuator to 80dB and check that the AFC LOCK lamp is completely extinguished.

(51) Set the signal generator output level to 20 millivolts e.m.f. (receiver input level of 2 microvolts e.m.f.) and check that the AFC LOCK lamp is fully illuminated.

(52) Disconnect the lead connected to the receiver antenna socket and check that the AFC LOCK lamp extinguishes.

(53) After a period of approximately one minute, re-connect the lead to the antenna socket. Check that the AFC LOCK lamp illuminates.

(54) Set the signal generator output level to 10 millivolts e.m.f. (receiver input level of 1 microvolt e.m.f.).

(55) Note the HF electronic voltmeter indication (connected to TP10).

(56) Set the step attenuator to 0dB and check that the HF electronic voltmeter indication does not increase by more than 4dB.

(57) Set the step attenuator to 80dB and check that the HF electronic voltmeter indication equals that noted at step (55) after a period of not less than ten seconds.

(58) Set the step attenuator to 60dB.

(59) Set the AFC switch to OFF.

(60) Set the signal generator frequency to 10Hz above the receiver frequency and check that the front panel meter indication beats at 5Hz.

(61) Continue to increase the signal generator frequency and check that the front panel meter indicates full scale deflection at approximately 200Hz above the receiver frequency.

(62) Set the AFC switch to FULL CARRIER. Check that the front panel meter indication decreases to the zero mark on the AFC scale and that the AFC LOCK lamp is extinguished.

(63) Decrease the signal generator frequency towards the receiver frequency and check that AFC lock is achieved when the signal generator frequency is not less than 50Hz above the receiver frequency.

(64) Repeat steps (59) to (63) inclusive but with the signal generator tuned to frequencies below the receiver frequency.

(65) With the AFC LOCK lamp illuminated, slowly tune the signal generator until the front panel meter indicates the - mark on the AFC scale.

(66) Check that the signal generator frequency is lower than 3499 500 Hz.

(67) With the AFC LOCK lamp illuminated, slowly tune the signal generator until the front panel meter indicates the + mark on the AFC scale.

(68) Check that the signal generator frequency is higher than 3500 500 Hz.

(69) Switch off and disconnect all test equipment.

FINAL SETTING-UP PROCEDURE IF/AF PM674 BOARD(S)

Test Equipment

55. The items of test equipment listed below are required for the following procedures:-

(1) Signal Generator

Frequency range:	1 to 4 MHz
Output level:	1 microvolt to 1 volt e.m.f.
Output impedance:	50 ohms

(Example: Racal Instruments Type 9061/62).

(2) Output Power Meter

Frequency range:	20 Hz to 35 kHz
Input impedance:	600 ohms and 8 ohms
Power range:	Not less than 2 watts FSD

(Example: Marconi Type TF893A)

(3) HF Electronic Voltmeter

Range:	10 millivolts to 1 volt r.m.s.
Frequency range:	Up to 2 MHz
Input impedance:	50 ohms and high impedance

(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, Type TM6/4).

(4) Digital Frequency Meter

Frequency range: 1 to 2 MHz
(Example: Racal Instruments Type 9822 or Type 9021)

(5) Multimeter

(Example: Avometer Model 8)

MAIN IF/AF BOARD (PM674)

Procedure

56. (1) Connect the output of the signal generator to the receiver antenna socket.

(2) Connect the output power meter, set to the 8 ohm range, between the LS and E terminals of TS1.

(3) Set the frequency of the signal generator to 1.02 MHz and set the output level to 1 microvolt e.m.f. Tune the signal generator to the receiver.

(4) Set the AGC switch to OFF, the AFC switch (if fitted) to OFF, the MODE switch to USB and the IF GAIN control fully clockwise.

(5) Using the HF electronic voltmeter, high impedance input, monitor TP3 and adjust R1 for an indication of 200 millivolts r.m.s.

(6) Connect the multimeter, set to the 5V d.c. range, between board pin 29 (positive) and chassis. Ensure that the multimeter indicates 1.4 volts plus or minus 150 millivolts.

(7) Disconnect the multimeter and the HF electronic voltmeter.

(8) Set the AGC switch to SHORT and set the AF GAIN control fully clockwise. Ensure that the output power meter indication is greater than 1 watt.

(9) Set the AF GAIN control for an indication of 100 milliwatts on the output power meter.

(10) Set the AGC switch to OFF and set the IF GAIN control to restore the output power meter indication to 100 milliwatts.

(11) Detune the signal generator by at least 10 kHz and ensure that the signal plus noise to noise ratio exceeds 15 dB.

(12) Retune the signal generator to the receiver.

(13) Transfer the output power meter, set to the 600 ohms range, to the LINE OUTPUT MAIN IF terminals of TS1.

(14) Set the front panel METER switch to AM/USB.

(15) Adjust the AM/USB LINE LEVEL control for an output of 1 milliwatt on the front panel meter. Ensure that the output power meter indication is 1 milliwatt plus or minus 1 dB.

(16) Set the AGC switch to SHORT.

(17) Increase the output level of the signal generator in 1 dB steps until the AGC knee is reached, i.e. where a further increase in the signal generator output level does not result in an increase in audio power output. Ensure that the signal generator output level is less than 1.7 microvolts e.m.f.

(18) Set the signal generator output level 2 microvolts e.m.f.

(19) Adjust the AM/USB LINE LEVEL control for a convenient reference level on the output power meter.

(20) Increase the output level of the signal generator by 100 dB above 2 microvolts.

(21) Ensure that the increase in the output power level is not greater than 5 dB relative to the reference level established at step (19).

(22) Set theAGC switch to LONG and repeat steps (18) to (21) inclusive.

(23) Set the AGC switch to SHORT and the METER switch to RF.

(24) Set the signal generator output level to 2 microvolts e.m.f.

(25) Tune the signal generator to the receiver.

(26) Adjust R17 on the meter switching board for an indication of 0 dB on the front panel meter.

(27) Increase the output level of the signal generator by 100 dB above 2 microvolts.

(28) Adjust R14 on the meter switching board for an indication of 100 dB on the front panel meter.

(29) Repeat steps (24) to (28) for optimum results.

ISB IF/AF BOARD (PM674/3)

Procedure

57. (1) Connect the output of the generator to the receiver antenna socket.

(2) Connect the output power meter, set to the 8 ohms range, between the LS and E terminals of TS1.

(3) Set the frequency of the signal generator to 1.02 MHz and set the output level to 1 microvolt e.m.f.

(4) Set the AGC switch to OFF, the AGC switch (if fitted) to OFF, the MODE switch to ISB-L and the IF GAIN control fully clockwise.

(5) Using the HF electronic voltmeter, high impedance input, monitor TP3 and adjust R1 for an indication of 200 millivolts r.m.s.

(6) Connect the multimeter, set to the 5V d.c. range, between board pin 29 (positive) and chassis. Ensure that the multimeter indicates 1.4 volts plus or minus 150 millivolts.

(7) Disconnect the multimeter and the HF electronic voltmeter.

(8) Set the AGC switch to SHORT and set the AF GAIN control fully clockwise. Ensure that the output power meter indication is greater than 1 watt.

(9) Set the AF GAIN control for an indication of 100 milliwatts on the output power meter.

(10) Set the AGC switch to OFF and set the IF GAIN control to restore the output power meter indication to 100 milliwatts.

(11) Detune the signal generator by at least 10 kHz and ensure that the signal plus noise to noise ratio exceeds 15 dB.

(12) Retune the signal generator to the receiver.

(13) Transfer the output power meter, set to the 600 ohm range, to the ISB LINE OUTPUT terminals of TS1.

(14) Set the front panel METER switch to LSB.

(15) Adjust the LSB LINE LEVEL control for an output of 1 milliwatt on the front panel meter. Ensure that the output meter indication is 1 milliwatt plus or minus 1 dB.

(16) Set the AGC switch to SHORT.

(17) Increase the output level of the signal generator in 1 dB steps until the AGC knee is reached i.e. where a further increase in the signal generator output level does not result in an increase in audio power output. Ensure that the signal generator output level is less than 1.7 microvolts e.m.f.

(18) Set the signal generator output level to 2 microvolts e.m.f.

(19) Adjust the LSB LINE LEVEL control for a convenient reference level on the output power meter.

(20) Increase the output level of the signal generator by 100 dB above 2 microvolts.

(21) Ensure that the increase in the output power level is not greater than 5 dB relative to the reference level established at step (19).

(22) Set the AGC switch to LONG and repeat steps (18) to (21) inclusive.

FINAL SETTING-UP PROCEDURE IF/AF PM364 BOARD(S)

Test Equipment

57a The items of test equipment listed below are required for the following procedures:

(1) Signal Generator

Frequency range :	1 to 4MHz
Output level :	1 microvolt to 1 volt e.m.f.
Output impedance :	50 ohms

(Example: Racal Instruments Type 9061/62).

(2) Output Power Meter

Frequency range : 20Hz to 35kHz.

Input impedance:	600 ohms and 8 ohms
Power range:	Not less than 2 watts FSD

(Example: Marconi Type TF893A)

(3) HF Electronic Voltmeter

Range:	10 millivolts to 1 volt r.m.s.
Frequency range:	Up to 2MHz
Input impedance:	50 ohms and high impedance

(Example: Airmec 301A or Farnell Type TM6 with probe-to-N type adaptor, 50 ohm terminated, Type TM6/4.)

(4) Digital Frequency Meter

Frequency range:	1 to 2 MHz

(Example: Racal Instruments Type 9822 or Type 9021)

(5) Multimeter

(Example: Avometer Model 8)

MAIN IF/AF BOARD (PM364)

Procedure

57b (1) Connect the output of the signal generator to the receiver antenna socket.

(2) Connect the output power meter, set to the 8 ohm range, between the LS and E terminals of TS1.

(3) Set the frequency of the signal generator to 1.02MHz and set the output level to 1 microvolt e.m.f. Tune the signal generator to the receiver.

(4) Set the AGC switch to OFF, the AFC switch (if fitted) to OFF, the MODE switch to USB and the IF GAIN control fully clockwise.

(5) Using the HF electronic voltmeter, high impedance input, monitor TP3 and adjust R9 for an indication of 200 millivolts r.m.s.

(6) Connect the multimeter, set to the 5V d.c. range, between board pin 29 (positive) and chassis. Ensure that the multimeter indicates 1.4 volts plus or minus 150 millivolts.

(7) Disconnect the multimeter and the HF electronic voltmeter.

(8) Set the AGC switch to SHORT and set the AF GAIN control fully clockwise. Ensure that the output power meter indication is greater than 1 watt.

(9) Set the AF GAIN control for an indication of 100 milliwatts on the output power meter.

(10) Set the AGC switch to OFF and set the IF GAIN control to restore the output power meter indication to 100 milliwatts.

(11) Detune the signal generator by at least 10kHz and ensure that the signal plus noise to noise ratio exceeds 15dB.

(12) Retune the signal generator to the receiver.

(13) Transfer the output power meter, set to the 600 ohms range, to the LINE OUTPUT MAIN IF terminals of TS1.

(14) Set the front panel METER switch to AM/USB.

(15) Adjust the AM/USB LINE LEVEL control for an output of 1 milliwatt on the front panel meter. Ensure that the output power meter indication is 1 milliwatt plus or minus 1dB.

(16) Set the AGC switch to SHORT.

(17) Increase the output level of the signal generator in 1dB steps until the AGC knee is reached, i.e. where a further increase in the signal generator output level does not result in an increase in audio power output. Ensure that the signal generator output level is less than 1.7 microvolts e.m.f.

(18) Set the signal generator output level 2 microvolts e.m.f.

(19) Adjust the AM/USB LINE LEVEL control for a convenient reference level on the output power meter.

(20) Increase the output level of the signal generator by 100dB above 2 microvolts.

(21) Ensure that the increase in the output power level is not greater than 5dB relative to the reference level established at step (19).

(22) Set the AGC switch to LONG and repeat steps (18) to (21) inclusive.

(23) Set the AGC switch to SHORT and the METER switch to RF.

(24) Set the signal generator output level to 2 microvolts e.m.f.

(25) Tune the signal generator to the receiver.

(26) Adjust R17 on the meter switching board for an indication of 0dB on the front panel meter.

(27) Increase the output level of the signal generator by 100dB above 2 microvolts.

(28) Adjust R14 on the meter switching board for an indication of 100dB on the front panel meter.

(29) Repeat steps (24) to (28) for optimum results.

ISB IF/AF BOARD (PM364/3)

Procedure

57c (1) Connect the output of the generator to the receiver antenna socket.

(2) Connect the output power meter, set to the 8 ohms range, between the LS and E terminals of TS1.

(3) Set the frequency of the signal generator to 1.02MHz and set the output level to 1 microvolt e.m.f.

(4) Set the AGC switch to OFF, the AFC switch (if fitted) to OFF, the MODE switch to ISB-L and the IF GAIN control fully clockwise.

(5) Using the HF electronic voltmeter, high impedance input, monitor TP3 and adjust R9 for an indication of 200 millivolts r.m.s.

(6) Connect the multimeter, set to the 5V d.c. range, between board pin 29 (positive) and chassis. Ensure that the multimeter indicates 1.4 volts plus or minus 150 millivolts.

(7) Disconnect the multimeter and the HF electronic voltmeter.

(8) Set the AGC switch to SHORT and set the AF GAIN control fully clockwise. Ensure that the output power meter indication is greater than 1 watt.

(9) Set the AF GAIN control for an indication of 100 milliwatts on the output power meter.

(10) Set the AGC switch to OFF and set the IF GAIN control to restore the output power meter indication to 100 milliwatts.

(11) Detune the signal generator by at least 10kHz and ensure that the signal plus noise to noise ratio exceeds 15dB.

(12) Retune the signal generator to the receiver.

(13) Transfer the output power meter, set to the 600 ohm range, to the ISB LINE OUTPUT terminals of TS1.

(14) Set the front panel METER switch to LSB.

(15) Adjust the LSB LINE LEVEL control for an output of 1 milliwatt on the front panel meter. Ensure that the output meter indication is 1 milliwatt plus or minus 1dB.

(16) Set the AGC switch to SHORT.

(17) Increase the output level of the signal generator in 1dB steps until the AGC knee is reached, i.e. where a further increase in the signal generator output level does not result in an increase in audio power output. Ensure that the signal generator output level is less than 1.7 microvolts e.m.f.

(18) Set the signal generator output level to 2 microvolts e.m.f.

(19) Adjust the LSB LINE LEVEL control for a convenient reference level on the output power meter.

(20) Increase the output level of the signal generator by 100dB above 2 microvolts.

(21) Ensure that the increase in the output power level is not greater than 5dB relative to the reference level established at step (19).

(22) Set the AGC switch to LONG and repeat steps (18) to (21) inclusive.

MODE and FILTER SWITCHES

58. (1) Connect the output power meter, set to the 8 ohm range, between the LS and E terminals of TS1.

(2) Set the receiver control as follows:

MHz	3
kHz	020.00
TUNING RATE (RA.1772)	LOCK
RF TUNE (if fitted)	WB
AGC	SHORT
AFC (if fitted)	OFF
IF GAIN	Fully clockwise
LS	ON

(3) Connect the output of the signal generator to the receiver antenna socket. Set the signal generator frequency to 3MHz and set the output level to 10 microvolts e.m.f.

(4) Set the MODE switch to LSB and, in turn, to ISB-L if fitted. Tune the signal generator from 3.00 to 3.05MHz on each mode. Ensure that at 3.02MHz a high note is heard in the loudspeaker which reduces in pitch to zero beat and then disappears.

(5) Set the MODE switch to USB and, in turn, to ISB-U if fitted. Tune the signal generator from 3.05 to 3.00MHz on each mode. Ensure that at 3.02MHz a high note is heard in the loudspeaker which reduces in pitch to zero beat and then disappears.

(6) Set the MODE switch to CW.

(7) Turn the receiver onto its side and connect the digital frequency meter between pins 11 and 32 (0V) on the 34MHz generator board PM339.

(8) Set the front panel BFO control to -.

(9) Adjust L4 on the 34MHz generator board until the frequency displayed on the digital frequency meter is 1 396 500Hz plus or minus 100Hz.

(10) Set the BFO control to +.

(11) Adjust R4 on the 34MHz generator board until the frequency displayed on the digital frequency meter is 1 403 500Hz plus or minus 100Hz.

(12) Repeat steps (8) to (11) inclusive until no further improvement can be obtained.

(13) Disconnect the digital frequency meter and turn the receiver onto its base.

(14) Connect the digital frequency meter to the UNCAL socket on the signal generator (omit if RACAL 9061/62 signal generator is used).

(15) Set the frequency of the signal generator to 3 020 00Hz and maintain it at this frequency.

(16) Set the BFO control to 0.

(17) Set the output level of the signal generator to 1 microvolt e.m.f.

(18) Set the FILTER switch to the widest bandwidth.

(19) Adjust the BFO control for a convenient tone in the loudspeaker.

(20) Set the FILTER switch to each position, in turn, and ensure that there is no change in the level of the tone and that the noise level decreases as the bandwidth is decreased.

(21) Reset the FILTER switch to the widest bandwidth.

(22) Tune the signal generator from 3.00 to 3.05MHz. Ensure that a high note is heard in the loudspeaker which reduces in pitch to zero beat at 3.02MHz and then rises again to a high note.

(23) Set the MODE switch to AM.

(24) Set the signal generator for 30 per cent amplitude modulation at 400Hz.

(25) Tune the signal generator to the receiver and ensure that a 400Hz tone can be heard in the loudspeaker.

(26) Switch off and disconnect all test equipment.

FSK BOARD PM368

Test Equipment

59. The items of test equipment listed below are required for the following tests;

(1) FSK Test Generator

(Example: Racal Type CA496)

(2) Digital Frequency Meter

Frequency range:	Up to 4MHz
Accuracy:	
Internal Standard:	1 part in 10^6 ± 1 count

(Example: Racal Instruments Type 9822 or Type 9021)

(3) Oscilloscope, single channel

(Example: Tektronix Type 545B with L Plug-in unit).

(4) Step Attenuator

Range:	0-100dB in 1dB steps
Impedance:	50 ohms

(Example: Racal Instruments Type 9065L)

Procedure

60. (1) Connect the OUTPUT 1 socket on the CA496 FSK test generator to the receiver antenna socket, via a 50 ohm step attenuator.

(2) Connect the digital frequency meter to the OUTPUT TO FREQUENCY METER socket on the CA496.

(3) Set the controls on the CA496 as follows:

MAINS	ON
FREQUENCY	RF
DATA RATE	VARIABLE
BAUDS	50
SHIFT	100Hz
ATTENUATION	-40dB (0dB in 1V in 75Ω)
MODULATION	1:1

(4) Set the FINE FREQUENCY control on the CA496 for an indication on the digital frequency meter of 3 100 000Hz plus or minus 1Hz.

(5) Set the receiver controls as follows:

RF TUNE (if fitted)	WB
AFC (if fitted)	OFF
AGC	SHORT
MODE	FSK TUNE
FILTER	1kHz
MHz	3
kHz	100.00

(6) Raise the FSK board to the upright position and secure.

(7) Connect the oscilloscope to pin 18 on the FSK board.

(8) Set the step attenuator for an oscilloscope display of 200 millivolts peak-to-peak plus or minus 10 millivolts.

(9) Connect the oscilloscope to TP1.

(10) Tune inductors L1 and L2 in turn for maximum output, as displayed on the oscilloscope.

(11) Use a T connector to connect the digital frequency meter and the oscilloscope to TP2. Check that the amplitude of the square wave displayed is not less than 2.5 volts peak-to-peak.

(12) Adjust trimmer capacitor C17 for an indication on the digital frequency meter of 1 398 000Hz plus or minus 1Hz.

(13) Disconnect the digital frequency meter and the oscilloscope.

(14) Set the 6V/80V and N+/P/N- switches on the rear panel of the receiver to 6V and P respectively.

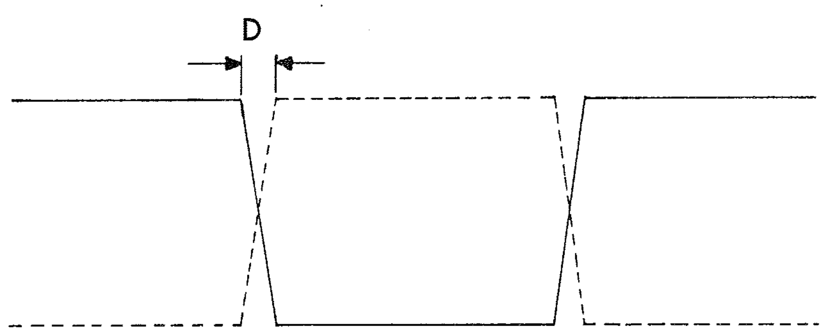
(15) Set the receiver MODE switch to FSK-N.

(16) Connect the oscilloscope to pin 6 on the FSK board.

(17) Set the oscilloscope to EXTERNAL TRIGGER and connect the EXT TRIG input socket on the oscilloscope to the BIT SYNC socket on the CA496.

(18) Adjust the oscilloscope time base speed until both a mark and a space are displayed, superimposed on each other.

(19) Adjust R45 on the FSK board for a minimum overlap of the two waveforms as below (minimum distance D).



One waveform shown dashed for clarity

(20) Set the SHIFT control on the CA496 to 600Hz.

(21) Repeat step (18) and check that the waveform overlap is similar to that obtained at step (19).

(22) Switch off and disconnect all test equipment.

DIVERSITY AGC ADJUSTMENT

NOTE: The following adjustment procedures are required only on receivers fitted with IF/AF Board(s) PM364 and AFC Board PM369.

Introduction

61. Receivers leaving the factory are set up for optimum performance such that two receivers may be interconnected for diversity reception without the need of further adjustment. To ensure continued optimum performance, however, it may be necessary to periodically adjust the diversity AGC output level (particularly after repair or re-alignment) in accordance with the following procedure.

Test Equipment

62. The items of test equipment listed below are required for the following procedures:

(1) Signal Generator

Frequency:	5.2MHz
Output level:	20 to 200 millivolts e.m.f.
Output Impedance:	50 ohms

(Example: Racal Instruments Type 9061/62)

(2) Digital Voltmeter

(Example: Racal Instruments Type 9071)

(3) Step Attenuator

Range:	0 to 100dB in 10dB steps
Impedance:	50 ohms

(Example: Racal Instruments Type 9065L)

Preliminary

63. (1) Set the receiver controls as follows:

MHz	5
kHz	200
TUNE (RA.1772 only)	LOCK
RF TUNE (if fitted)	WB
AGC	SHORT
IF GAIN	Fully Clockwise
MODE	USB
AFC (if fitted)	OFF
POWER	ON

(2) Connect the output of the signal generator, set to a frequency of 5.2MHz and and output level of 20 millivolts e.m.f., via the step attenuator to the receiver antenna socket.

(3) Set the step attenuator to 80dB (receiver input level of 2 microvolts e.m.f.).

(4) Connect the digital voltmeter between the DIV AGC (positive) and E terminals of TS2 on the receiver rear panel.

Main IF/AF Board Adjustment

64. (1) Raise the main IF/AF board and secure in the vertical position.

(2) Tune the signal generator for a maximum indication on the digital voltmeter.

(3) Adjust R4 on the main IF/AF board for an indication of 1.50 volts plus or minus 30 millivolts on the digital voltmeter.

(4) Set the step attenuator to 50dB (receiver input level of 64 microvolts e.m.f.) and record the level indicated on the digital voltmeter.

(5) Reset the step attenuator to 80dB.

(6) Replace the Main IF/AF board.

ISB IF/AF Board Adjustment (where fitted)

65. (1) Transfer the digital voltmeter to the ISB DIV AGC (positive) and E terminals of TS2 on the receiver rear panel.

(2) Set the MODE switch to LSB.

(3) Raise the ISB IF/AF board and secure in the vertical position.

(4) Tune the signal generator for a maximum indication on the digital voltmeter.

(5) Adjust R4 on the ISB IF/AF board for an indication of 1.50 volts plus or minus 30 millivolts on the digital voltmeter.

(6) Set the step attenuator to 50dB (receiver input level of 64 microvolts e.m.f.) and record the level indicated on the digital voltmeter.

(7) Reset the step attenuator to 80dB.

(8) Replace the ISB IF/AF board.

AFC Board Adjustment (where fitted)

66 (1) Connect the digital voltmeter between the DIV AGC (positive) and E terminals of TS2 on the receiver rear panel.

(2) Set the MODE switch to USB and the METER switch to TUNE CARRIER.

(3) Raise the AFC board and secure in the vertical position.

(4) Tune the signal generator for a minimum indication on the front panel meter.

(5) Set the AFC switch to FULL CARRIER and check that the AFC LOCK lamp illuminates.

(6) Adjust R97 on the AFC board for an indication of 1.50 volts plus or minus 30 millivolts on the digital voltmeter.

(7) Set the step attenuator to 50dB (receiver input level of 64 microvolts e.m.f.) and check that the AFC LOCK lamp is illuminated (slightly adjust the signal generator tuning, if required, to achieve AFC lock).

(8) Adjust R50 on the AFC board for a digital voltmeter indication which is within plus or minus 30 millivolts of the lower of the two voltage readings recorded at steps 64 (4) and 65 (6).

(9) Set the step attenuator to 80dB and check that the AFC LOCK lamp is illuminated.

(10) Repeat steps (6) to (9) inclusive until no further improvement can be obtained.

(11) Replace the AFC board.

RF Meter Calibration

67. (1) Set the AFC switch to OFF and the METER switch to RF.

(2) With the step attenuator set to 80dB (receiver input level of 2 microvolts e.m.f.), tune the signal generator for a maximum indication on the digital voltmeter (connected to the DIV AGC terminal).

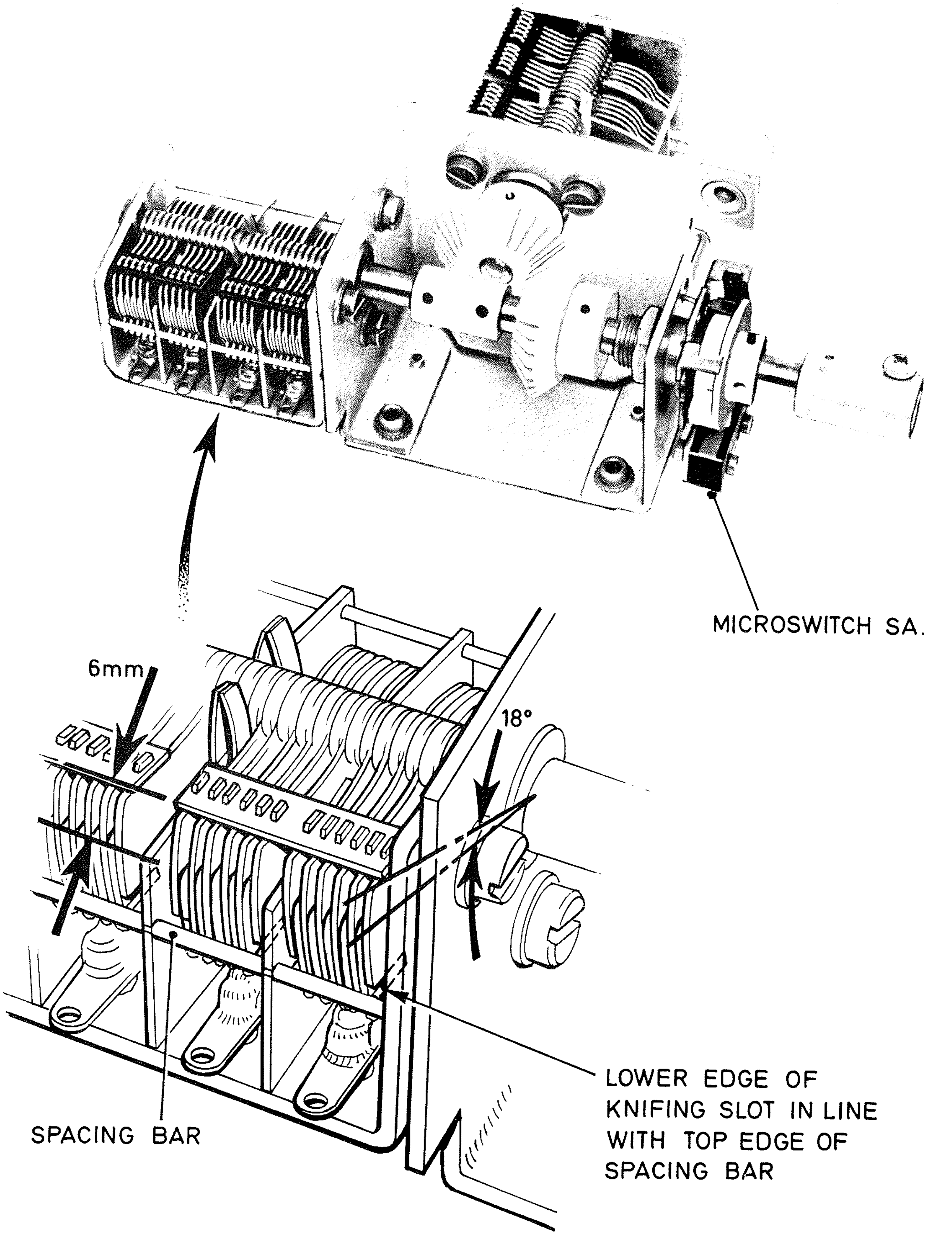
(3) Ensure that the digital voltmeter indicates 1.50 volts plus or minus 30 millivolts.

(4) Adjust R17 on the meter switching board (nearest edge of board) for a reading of 0dB on the front panel meter.

(5) Set the step attenuator to 0dB and increase the signal generator output level to 200 millivolts e.m.f. (receiver input level of 2 microvolts plus 100dB).

(6) Adjust R14 on the meter switching board (near centre of board) for a reading of 100dB on the front panel meter.

(7) Switch off and disconnect all test equipment.



WOH3076

Tuning Capacitor Setting :
18 Degree Point

Fig. 5·1

CHAPTER 6

FAULT DIAGNOSIS

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CHAPTER 6

FAULT DIAGNOSIS

INTRODUCTION

1. This chapter provides information to assist in the location of a faulty component or sub-assembly. The information is presented in the form of flow charts and these are supplemented with typical voltage and/or signal levels for the main printed circuit boards.

2. A certain amount of dismantling is necessary to gain access to certain areas of the receiver. Procedures for dismantling and re-assembly are contained in Chapter 3. Following repair and subsequent re-alignment (where necessary) ensure that all dismantled assemblies are correctly re-assembled and that all screening covers are replaced using all the screws provided.

FLOW CHARTS

3. A flow chart consists of a number of logical steps to check for the correct operation of an assembly or sub-assembly, where the route taken through the chart is dependent upon the result of each step. Since this method of fault diagnosis, in general, will localise only one fault at a time, once a fault has been diagnosed and rectified, the flow chart in use should be recommenced at step 1 and followed through until no further fault is apparent.

Use of Flow Charts

4. Where the faulty area is completely unknown, reference should be made initially to flow chart 1 for the RA.1771 or to flow chart 2 for the RA.1772. These charts isolate the fault either to a chassis mounted component or to a printed circuit board (or group of boards) in which case reference should be made to the chart for that board (or group of boards).

5. Where the likely area of a fault is known, direct reference may be made to the respective chart for that area. It must be noted, however, that certain charts assume correct operation of associated boards. For example, flow chart 9 for the two mixer boards assumes that the main IF/AF board is functioning correctly.

6. A list of the flow charts is given below:-

Flow Chart	Title	Page
1.	RA.1771 Overall Receiver	6-14
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3.	Synthesizer Section	6-38
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TYPICAL VOLTAGE/SIGNAL LEVELS

7. Typical voltage and/or signal levels at test and other pertinent points on the main printed circuit boards are given below. Frequency measurements are accurate to within plus or minus 10 Hz unless otherwise stated.

Low Frequency Loop Board PM588 (fig. 6)

8. (1) The test point signal levels listed below were measured with the kHz portion of the receiver frequency set to 000.00 and the TUNING RATE switch (RA.1772 only) set to LOCK. Ensure that the 1 MHz, 34 MHz and LO INT/EXT switches on the rear panel are all set to INT. Set the MHz switch to 1.

TP1: +15V d.c. measured with multimeter (negative to 0V).

(2) The following test point signals were measured using the oscilloscope.

TP2: 7 MHz square wave, 3.5V p-p.
TP3: 1 MHz square wave, approximate 1:1 mark/space ratio, 3.5V p-p.
TP4: 1 kpps, positive going, 3.5V p-p.
TP5: 1 kpps, positive going, 3.5V p-p.

TP6: 1kpps, negative going strobe pulse, 3.5V p-p.

TP7: 13 to 20kHz, square wave, 3.5V p-p.

TP8: 13 to 20kpps, negative going strobe pulse, 3.5V p-p.

Board pin 46: 1MHz, 1.5V p-p.

Board pin 44: 1.01545MHz, 2.2V p-p.

Junction C26/L3: 15.45kHz, 5.2V p-p.

Emitter TR19: 15.45kHz, less than 0.8V to greater than 1.6V p-p, sine wave.

Board pin 1: Logic '0' in-lock; logic '1' out-of-lock.

Board pin 42: Logic '0' in-lock; logic '1' out-of-lock.

(3) The following d.c. voltages were measured using the multimeter (negative to 0V).

Junction R55/R56: +4.7V

ML13 pin 5: +2V

Upper Loop Board PM589 (Fig. 8)

9. (1) The following test point signals were measured using the oscilloscope.

TP1: 1.01545MHz square wave, 3.5V p-p.

TP2: 4.6MHz, square wave, 3.5V p-p.

TP3: 10.154kpps, positive going, 3.5V p-p.

TP4: 10.154kpps, strobe pulse, negative going, 3.5V p-p.

TP5 and TP6: Phase comparator output pulses, positive going and in phase, 3.5V p-p.

Board pin 9: 1.01545MHz, 2.2V p-p.

ML4 pin 11: 101.54kHz, 3.5V p-p.

Board pin 2: 4.6MHz, 800mV p-p.

ML7 pin 8: 10.154kpps, 3.5V p-p.

Board pin 12: Logic '1' in-lock, logic '0' out-of-lock.

Board pin 11: Normally logic '1'; pulses to '0', approximately 25mS, for range blanking, when tuning past a 10kHz digit change.

(2) The following d.c. voltages were measured using the multimeter (negative to 0V).

Board pin 7: +6.5V.

Emitter TR1: +5V ± 0.5V.

TP7: +15V.

Transfer Loop Board PS338 (Fig. 10)

10. (1) The following signal levels were measured using the oscilloscope.

TP1: 4.6MHz square wave, 5V p-p.

TP2: 112.195kHz square wave, 3.5V p-p.

TP3: 112.195kpps, negative going, 3.5V p-p.

TP4 and TP5: 112.195kpps, 1.5 microsecond negative going, and in phase, 3.5V p-p.

TP6: 115 to 52kpps strobe pulse, negative going, 3.5V p-p.

Board pin 21: 1MHz, 750mV p-p.

Collector TR2: 1MHz, 500mV p-p.

Junction C2/R6: 887.805kHz, 1V p-p.

ML3 pin 4: 887.805kHz, 1V p-p.

Board pin 17: 4.6MHz, 800mV p-p.

Junction C35/L11: 400mV p-p.

Board pin 6: Logic '1' in-lock; logic '0' out-of-lock.

(2) The following d.c. voltages were measured using the multimeter (negative to 0V).

Junction D4/R24: +12V ± 1V.

HF Loop Board PS337 (Fig. 12)

11. (1) Use a multimeter, set to the 25V d.c. range to monitor TP1, TP2 and TP3 (negative to 0V).

TP1: MHz switch set to 7MHz, +14V ± 1V.

TP2: MHz switch set to 17MHz, +14V ± 1V.

TP3: MHz switch set to 27MHz, +14V ± 1V.

(2) Set the MHz switch to 27. Use the multimeter to measure the following d.c. voltages with respect to chassis (0V). Observe correct polarity. (Ensure LO, 34MHz and 1MHz switches are set to INT).

Emitter TR9: -0.7V

Base TR10: +2.4V

Emitter TR10: +2.0V

Junction D16/R55: +7.5V

Junction D17/R56: +3.3V

Junction D16/D18: +8.2V

Junction D17/D18: +4.0V

(3) Use the oscilloscope to monitor the collector of TR9.

Collector TR9: 62.5MHz, 75mV p-p.

(4) Set the kHz control to display 999.99. Set the TUNING RATE switch to LOCK (RA.1772 only). Monitor TP4 using the HF electronic voltmeter, high impedance input. Step the MHz switch through each position and check that the HF electronic voltmeter indication is as below:

TP4: 1V r.m.s. $\pm$ 2.5dB.

(5) Use the oscilloscope to monitor the test points listed below. Check that the signal levels displayed approximate those indicated.

TP5: approximately 3.5V p-p.

TP6: 473kpps strobe pulses, negative going, 3.5V p-p.

TP7 and TP8: 473kpps phase comparator output pulses, negative going and in phase, 3.5V p-p.

(6) Connect the multimeter, set to the 10V d.c. range, between TP10 (positive) and chassis (0V).

TP10: +3.5V d.c.

(7) Use the oscilloscope to monitor the following:

TP12: 947kHz, approximate square wave 2.8V p-p.

ML12 pin 5: Half of transfer oscillator frequency, 3.5V p-p.

Board pin 13: 947kHz, 1V p-p.

Board pin 12: Logic '1' in-lock; logic '0' out-of-lock.

34MHz Generator Board PM339 (Figs 14 and 15)

12. TP1: multimeter, +7V d.c.

TP2: 5Mpps, oscilloscope, 3V p-p.

TP3: 1MHz, square wave, 2:3 mark/space ratio, oscilloscope, 2V p-p.

TP4: 34MHz VCO output, oscilloscope, approximately 3.5V p-p.

TP5: 34MHz, HF electronic voltmeter, high impedance, input, 400mV r.m.s.

TP6: 34MHz, HF electronic voltmeter, high impedance, input, 1.4V r.m.s.

TP7: 200kHz square wave, 3:2 mark/space ratio, oscilloscope, 3.5V p-p.

TP8: HF electronic voltmeter, high impedance input, 1.4V r.m.s.

TP9: 1MHz square wave, oscilloscope, 3.5V p-p.

TP10: not fitted.

TP11: AFC switch to OFF (where fitted), 1MHz square wave, 3:2 mark/space ratio, oscilloscope, 3.5V p-p.

TP12: MODE switch to USB, 1MHz square wave, 3:2 mark/space ratio, osc oscilloscope, 3.5V p-p.

TP13: not fitted.

TP14: 1Mpps, negative going, oscilloscope, 3.5V p-p.

TP15: oscilloscope, 400mV p-p.

Board pin 27: 5MHz, oscilloscope, 400mV p-p.

Base TR2: Multimeter, +1.8V d.c.

Collector TR2: 5MHz, oscilloscope, 400mV p-p.

Collector TR9: 1MHz sine wave, oscilloscope, 1V p-p.

Board pin 4: 180mV p.d. loaded with 50 ohm load

2V p-p, not loaded.

Collector TR13: 1MHz, oscilloscope, 3.5V p-p.

Collector TR15: Multimeter, +1.5V d.c.

Board pin 6: 1MHz, oscilloscope, 3.5V p-p.

Board pin 8: 1MHz, oscilloscope, 3.5V p-p.

Board pins 10 and 11: 1.4MHz, oscilloscope, 700mV p-p.

NOTE: Ensure 34MHz switch is set to INT.

Emitter TR1: multimeter, +5V d.c.

Junction D6/R27: multimeter, +5.1V d.c.

Junction D5/R25: multimeter, +8.5V d.c.

Junction D6/D7: multimeter, +5.8V d.c.

Junction D5/D7: multimeter, +9.2V d.c.

Base TR11: multimeter, 2.8V d.c.

Board pin 20: 34MHz, HF electronic voltmeter, high impedance input, 1V r.m.s.

Main and ISB IF/AF Boards PM674 (Fig. 26)

13. The typical signal levels listed below were measured under the following test conditions unless stated otherwise:-

(1) Signal generator, frequency 1.4 MHz, output level set for 200 millivolts e.m.f. at TP3 (signal generator output level should not exceed 100 microvolts e.m.f.), connected to the IF input, pins 34 and 35 (filter board output open circuit).

(2) Receiver front panel controls set as follows:-

MODE:	USB for Main IF/AF board. LSB for ISB IF/AF board.
AGC:	OFF
IF GAIN:	fully clockwise.

(3) Measurements at TP2, TP3 and TP4 were made using the HF electronic voltmeter, high input impedance.

TP2: 200 millivolts r.m.s.
TP3: 200 millivolts r.m.s.
TP4: Between 90 and 130 millivolts r.m.s.

(4) Measurements at TP7 and pins 8/9 were made using the LF electronic voltmeter.

TP7: Between 50 and 90 millivolts r.m.s.
Pins 8 and 9: Not less than 150 millivolts, typically between 170 and 250 millivolts r.m.s.
TP7: Signal generator output increased by 10 dB, amplitude modulated 30 percent at 1 kHz: Between 50 and 90 millivolts r.m.s.

(5) Disconnect the signal generator and use the multimeter to measure the following d.c. voltages with respect to chassis. (Observe correct polarity).

TP5: +0.25V
Junction R11/R12: +9.9V
Emitter TR1: +4.1V
Base TR1: +4.6V
Collector TR1: +10V
Board pin 1: +5V
Base TR4: +0.6V
Base TR3: +6V

Emitter TR3: +5.4V
Junction C36/D10: AM: +4V)
SSB: +3.3V) Voltmeter sensitivity
Junction C37/D11: AM: +3.3V) 20 000 ohms per volt
SSB: +4V)
Emitter TR12: +2V
Emitter TR13: +1.4V
Collector TR13: +3V
Junction R44/R47: +0.5V ± 0.6V
Junction R46/R47: -0.5V ± 0.6V
Junction R61/R62: +5.5V
Junction R82/D12: +5.6V
Junction R83/D14: +9.4V

Main and ISB IF/AF Boards PM364 (Fig.26a)

13a. The typical signal levels listed below were measured under the following test conditions unless stated otherwise:

(1) Signal generator, frequency 1.4MHz, output level set for 200 millivolts e.m.f. at TP3 (signal generator output level should not exceed 100 microcolts e.m.f.), connected to the IF input, pins 34 and 35 (filter board output open circuit).

(2) Receiver front panel controls set as follows:

MODE: USB for Main IF/AF board.
LSB for ISB IF/AF board.

AGC: OFF

IF GAIN: fully clockwise.

(3) Measurements at TP2, TP3 and TP4 were made using the HF electronic voltmeter, high input impedance.

TP2: 100 millivolts r.m.s.

TP3: 200 millivolts r.m.s.

TP4: Between 90 and 130 millivolts r.m.s.

(4) Measurements at TP7, pins 8/9 and TP6 were made using the LF electronic voltmeter.

TP7: Between 50 and 90 millivolts r.m.s.

Pins 8 and 9: Not less than 150 millivolts, typically between 170 and 250 millivolts r.m.s.

TP6: Signal generator output increased by 10dB, amplitude modulated 30 percent at 1kHz: Between 50 and 90 millivolts r.m.s.

(5) Disconnect the signal generator and use the multimeter to measure the following d.c. voltages with respect to chassis. (Observe correct polarity.)

TP5: +0.25V

ML1 pin 1: +4.2V

ML1 pin 2: +4.2V

ML1 pin 6: +3.5V

ML1 pin 7: +11.5V

ML1 pin 8: +11.5V

ML1 pin 9: 0V

ML1 pin 10: +4.2V

ML1 pin 11: +11.5V

ML1 pin 12: +10V

ML1 pin 13: +6.5V

ML1 pin 14: +4.2V

Board pin 1: +5V

Base TR4: +0.6V

Base TR6: +6V

Emitter TR6: +5.4V

Junction C36/D10:	AM:	+4V	)	Voltmeter sensitivity 20 000 ohms per volt
	SSB:	+3.3V	)	
Junction C37/D11:	AM:	+3.5V	)	
	SSB:	+4V	)	

Emitter TR14: +2V

Emitter TR15: +1.4V

Collector TR15: +3V

Junction R33/R34: +0.5V ± 0.6V

Junction R32/R34: -0.5V ± 0.6V

Junction C45/R74: +7.25V

ML5 pin 3: +7.25V

ML5 pin 2: +7.25V

ML5 pin 6: +7.25V

Base TR22: +7.75V

Base TR23: +6.8V

Junction R93/R94: +7.25V

(6) The following d.c. measurements apply to the main IF/AF board only (loudspeaker amplifier), with no signal present.

Junction C42/R69: +5.6V

Junction R65/R66: +12.5V

Junction R69/R72: +5.5V

Base TR17: +5.4V

Collector TR18: +6.4V

TP10: +7.1V

Second Mixer Board PM336 (Fig. 22)

14. (1) The following measurements were made using the HF electronic voltmeter, high impedance input. Connect the signal generator, set to a frequency of 35.400MHz and a CW output level of 20mV e.m.f., 50 ohms impedance, to the T3 side of link LK1 on the first mixer board PM335, with the link removed. Set the 34MHz INT/EXT switch to EXT, the MODE switch to USB and the AGC switch to OFF. Connect the multimeter, set to the 10V d.c. range, between board pin 9 and chassis (0V). Set the IF GAIN control for an indication on the multimeter of +2.25V.

Junction C1/R2: 35.4MHz input, 12mV r.m.s.

Junction C6/R3: 45mV r.m.s.

Junction D1/D2: 45mV r.m.s.

TP1: 100mV r.m.s.

LK1: 60mV r.m.s., using TP2 as earth connection.

(2) The following d.c. voltages were measured using the multimeter, with respect to chassis (0V). Observe correct polarity.

Collector TR2:	+11.5V
Junction R7/R8:	+3V
Emitter TR6:	+2.4V
Emitter TR7/TR8:	+1.65V
Base TR5:	-5.5V
Junction L6/R5:	+8.5V

(3) The following measurements were made using the HF electronic voltmeter, high impedance input, with the 34MHz INT/EXT switch set to INT.

Board pin 7: 34MHz input, 1V r.m.s.

Between LK2 and TP2 (earth): 600mV r.m.s.

First Mixer Board PM335 (Fig. 20)

15. (1) Set the MHz switch to 27MHz. The following measurements were made using a high input impedance, 65MHz oscilloscope.

Board pin 10: 62.4MHz, 750mV p-p.

TP1: 750 mV p-p
TP4: 600 mV p-p
TP5: 400 mV p-p
TP6: 2V p-p
Board pin 26: 20V p-p

(2) The following d.c. voltages were measured using the multimeter, with respect to chassis (0V), with the MHz switch set to 27 MHz.

Junction R3/R4:	+2V
Board pin 8:	+0.6V
Junction R1/R2:	+8.5V
TP2:	+11V
Base TR1:	-3.7V
Junction R20/21:	-4.7V
Collector TR1:	+11.5V
TP6:	-2V
Junction R29/R30:	-7V
Base TR5:	-2V

AFC Board PM664 (Figs. 29 and 30)

16. (1) Connect a signal generator set to a frequency of 3.5 MHz and a CW output level of 10 mV e.m.f., to the receiver antenna socket. Set the MODE switch to USB, AFC switch to OFF, IF GAIN fully clockwise, and the METER switch to TUNE CARRIER. Set the receiver frequency to 3.5 MHz and tune the signal generator to the receiver for a minimum indication on the front panel meter (the meter indication may beat slowly as the minimum is reached).

(2) The following measurements were made, using the oscilloscope, with the AFC switch set to FULL CARRIER and the AFC LOCK lamp illuminated.

Board pin 16:	1.4 MHz IF input, 40 mV p-p
ML1 pin 2:	4 mV p-p
Board pin 11:	1 MHz input, 1.5V p-p
TP3:	400 kHz equal to or greater than 200 mV p-p
TP4:	400 kHz, 800 mV p-p
Collector TR6:	400 kHz square wave 12V p-p
Collector TR8:	7 MHz sine wave 6V p-p
ML6 pin 6:	7 MHz square wave 4V p-p
ML7 pin 2:	1 MHz square wave 4V p-p
Collector TR10:	1 MHz square wave 12V p-p
ML18 pin 2:	200 kHz square wave 12V p-p
TP6:	Logic '1'
ML11 pin 3:	Logic '1'
ML11 pin 2:	Logic '0'

(3) The following d.c. voltages were measured using the multimeter, with respect to chassis, with the AFC switch set to FULL CARRIER and the AFC LOCK lamp illuminated.

Board pin 1:	+20V
Board pin 2:	+12V
Board pin 3:	+5V
Board pin 8:	-7V
TP1:	+5.75V
TP2:	+2.0V
TP17:	+8.0V
ML10 pin 11:	+4.5V
ML16 pin 7:	-2.27V
ML16 pin 14:	+7.8V
ML16 pin 8:	+4.7V

(4) The following measurements were made using the oscilloscope with the AFC switch set to OFF.

ML11 pin 2:	Logic '1'
ML11 pin 3:	Logic '0'
ML14 pin 11:	2 kHz square wave 12V p-p
ML15 pin 9:	6 ms pulses at error frequency

AFC Board PM369 (Figs. 29a and 30a)

16a. (1) Connect a signal generator set to a frequency of 3.5 MHz and a CW output level of 10 mV e.m.f., to the receiver antenna socket. Set the MODE switch to USB, AFC switch to OFF, IF GAIN fully clockwise, and the METER switch to TUNE CARRIER. Set the receiver frequency to 3.5 MHz and tune the signal generator to the receiver for a minimum indication on the front panel meter (the meter indication may beat slowly as the minimum is reached).

(2) The following measurements were made, using the oscilloscope, with the AFC switch set to FULL CARRIER and the AFC LOCK lamp illuminated.

Board pin 16:	1.4 MHz IF input, 40 mV p-p
ML3 pin 14:	40 mV p-p
ML3 pin 12:	40 mV p-p
Junction R36/T1:	40 mV p-p
Board pin 11:	1 MHz input, 1.5V p-p
TP4:	1V p-p
TP8:	1.6 MHz, 3.5V p-p
ML8 pin 5:	400 kHz, 3.5V p-p
Base TR10:	400 kHz, 2.6V p-p
Collector TR14:) Collector TR16:)	400 kHz, positive-going pulses, approximately 10V p-p

ML1 pin 11:	Logic '1'	
ML1 pin 3:	Logic '0'	
ML5 pin 5:	200 kHz)	
ML6 pin 12:	25 kHz)	
ML5 pin 6:	1 MHz)	Approximately 3.5V p-p
ML5 pin 12:	200 kHz)	
ML7 pin 12:	25 kHz)	
ML9 pin 5:)	Very narrow, positive-going pulses, at 25 kpps.	
ML9 pin 9:)		
ML20 pins 1, 2, 5 & 4:	Logic '1'	
ML20 pin 6:	Logic '0'	
TP6 & TP7:	25 kHz, approximately 3.5V p-p	

(3) The following d.c. voltages were measured using the multimeter, with respect to chassis, with the AFC switch set to FULL CARRIER and the AFC LOCK lamp illuminated.

ML3 pin 7:	+10.5V
Base TR5:	+1.5V (oscilloscope, 1 MHz, 1.5V p-p)
Base TR6:	+1.5V
TP4:	+8.5V (oscilloscope, 1 MHz square wave, 1V p-p)
ML12 pin 13:	+5.8V
ML12 pin 6:	+2.4V
ML12 pin 8:	+7.6V
Junction R50/R51:	+0.5V
Junction R49/R50:	+3.0V
Junction R59/R64:	+9.5V
Junction R79/R80:	+4.5V
Junction R77/R83:	+16.5V
Junction R82/R88:	+11V
Base TR9:	+3.0V

(4) The following measurements were made using the oscilloscope with the AFC switch set to OFF.

ML6 pin 1:	logic '0'
ML6 pin 12:	logic '1'
ML1 pin 6:	1 MHz, 3.5V p-p
ML7 pin 12:	logic '1'
ML5 pin 12:	200 kHz, approximately 3.5V p-p
ML5 pin 5:	200 kHz, approximately 3.5V p-p
TP6:	1 MHz, approximately 3.5V p-p
TP7:	1 MHz, approximately 3.5V p-p

FSK Board PM368 (Fig. 32)

17. (1) Set the MODE switch to FSK-N, the AGC switch to OFF and the IF GAIN fully clockwise. Ensure no connections are made to the FSK IN and FSK OUT terminals on the rear panel.

(2) The following measurements were made using the oscilloscope with no input signal at the antenna socket.

TP2:	1398 kHz, 5V p-p

(3) The following d.c. voltages were measured using the multimeter with respect to chassis, with no input signal at the antenna socket.

ML13 pin 8:	logic '1'
ML13 pin 11:	logic '0'
TP1:	-4.2V
Junction R2/R3:	-1.6V
Junction R1/R2:	+5.0V
ML1 pin 9:	+9.3V
ML1 pin 4:	-4.2V
Junction R18/D1:	+2.1V ± 0.5V

Power Supplies (Fig. 46)

18. The following d.c. voltages were measured using the multimeter, with respect to chassis (0V) unless otherwise stated.

ML4 pins 7 and 8: +28V

ML4 pin 4: +7.15V ± 0.5V

ML4 pin 3: +7.15V ± 0.5V

ML4 pin 2: +7.15V ± 0.5V

Board pins 22 and 23: +20V output

Board pin 14: +23V

ML3 pin 4: +7.15V ± 0.5V

ML3 pin 3: +7.15V ± 0.5V

ML3 pins 7 and 8: +20V

ML3 pin 6: +14.5V

ML3 pin 2: +7.15V ± 0.5V

Board pins 16, 17 and 18: +12V output

Board pin 8: +14V

ML2 pin 4: +7.15V ± 0.5V

ML2 pin 3: +5V

ML2 pins 7 and 8: +20V

ML2 pin 6: +8V

Board pins 10 and 12: +5V output

Board pins 1 and 47: +10V

ML1 pin 4: +7.15V ± 0.5V relative to board pin 5

ML1 pins 7 and 8: +12V

Board pins 5 and 6: -7V output

Between board pins 25 (positive) and 27: +85V

Between board pins 26 (negative) and 27: -85V.

RA.1771 OVERALL RECEIVER

FLOW CHART 1

NOTE: This chart describes a fault finding procedure for SSB versions of the RA.1771. For ISB versions of the receiver the relevant steps should be repeated for the LSB channel.

STEP 1

Set the RF TUNE control (if fitted) to WB, the AGC switch to OFF, the MODE switch to USB and the AFC switch (if fitted) to OFF. Set the rear panel 1MHz, 34MHz and LO switches to INT. Ensure that no antenna is connected to the antenna socket, and that the voltage selector on the rear panel is correctly set. Connect the receiver to a suitable source of a.c. power and set the POWER switch to ON. Set the front panel METER switch, in turn, to +20, +12, +5 and -7. Does the meter indicate within the green portion of the meter scale at each switch position?

Action

YES: Step 2
NO: Step 23

STEP 2

Connect the receiver 1MHz IN/OUT socket to the external standard socket on the digital frequency meter. Set the digital frequency meter to operate from an external 1MHz standard. Connect the digital frequency meter to the LO IN/OUT socket on the rear panel. Set the kHz decade frequency switches to 0. Step the MHz switch from 0 to 29. Does the digital frequency meter indicate 35.400MHz plus the MHz switch setting?

Action

YES: Step 3
NO: Suspect a synthesizer fault (Chart 3)

STEP 3

Does the OUT-OF-LOCK indicator lamp remain extinguished for each position of the MHz switch?

Action

YES: Step 4
NO: Step 26

STEP 4

Set the METER SWITCH to DRIVE LEVEL. Set the kHz switches to display 015.00. Step the MHz switch through each position. Does the meter indication lie within the V portion of the meter scale for each switch position?

Action

YES: Step 5
NO: Step 27

STEP 5	Set the MHz switch to 0 and set the kHz switches to display 000.00. Does the front panel meter indicate half scale?
Action	YES: Step 6 NO: Suspect a fault on the first mixer board PM335, in the area of the notch filter (Chart 9)
STEP 6	Connect the digital frequency meter to the 34MHz IN/OUT socket on the rear panel. Does the frequency meter indicate 34 000 000Hz plus or minus 1Hz?
Action	YES: Step 7 NO: Suspect a fault on the 34MHz generator board PM339 (Chart 6)
STEP 7	Set the receiver IF GAIN control fully clockwise, the MODE switch to USB, the METER switch to AM/USB, the FILTER switch to the widest bandwidth, the AF GAIN control fully counter-clockwise and the loudspeaker to ON. Set the RF TUNE control (if fitted) to WB, the AGC switch to OFF and the AFC switch (if fitted) to OFF. Turn the AF GAIN control progressively clockwise. Can noise be heard in the loudspeaker?
Action	YES: Step 8 NO: Step 33
STEP 8	Set the MODE switch to AM. Can noise be heard in the loudspeaker?
Action	YES: Step 9 NO: Suspect a faulty AM detector circuit on the main IF/AF board, or a faulty AM selection circuit.
STEP 9	Set the MODE switch to CW. Does the level of noise in the loudspeaker increase?
Action	YES: Step 10 NO: Suspect a faulty 1.4MHz BFO on the 34MHz generator board PM339 or a faulty CW selection circuit
STEP 10	Set the FILTER switch to each position in turn. Does the noise level in the loudspeaker decrease as the bandwidth is reduced?
Action	YES: Step 11 NO: Step 44

STEP 11	Connect a pair of headphones (600 ohms) to the left-hand PHONES jack. Can noise be heard in the headphones?
Action	YES: Step 12 NO: Suspect a fault in the area of the PHONES jacks, or faulty wiring
STEP 12	Connect the headphones to the right-hand PHONES jack. Can noise be heard in the headphones?
Action	YES: Step 13 NO: Suspect a fault in the area of the PHONES jacks, or faulty wiring
STEP 13	Can noise still be heard in the loudspeaker?
Action	NO: Step 14 YES: Suspect a faulty right-hand phones jack or faulty wiring
STEP 14	Connect the CW output of the signal generator, set to a frequency of 1.02MHz and an output level of 10 milli-volts e.m.f., to the receiver antenna socket. Connect the output power meter, set to 8 ohms impedance, to the loudspeaker terminals (TS1, LS and E). Set the receiver frequency to 1.02MHz, set the MODE switch to USB, and set the AGC switch to SHORT. Tune the signal generator through 1.02MHz. Is a response heard in the loudspeaker?
Action	YES: Step 15 NO: Step 39
STEP 15	Tune the signal generator to give a steady tone in the loudspeaker. Reduce the signal generator output level to 1 microvolt e.m.f. Can the tone still be heard in the loudspeaker?
Action	YES: Step 16 NO: Step 39
STEP 16	Using the AF GAIN control, can the reading on the output power meter be set to 1 watt?
Action	YES: Step 17 NO: Suspect low gain in the first or second mixer (Chart 9) or the RF amplifier (Chart 10)

STEP 17	Readjust the AF GAIN for an indication of 100 milliwatts on the output power meter. Set the AGC switch to OFF and adjust the IF GAIN to restore the output power meter indication to 100 milliwatts. Off-tune the signal generator by at least 10kHz. Has the output power meter indication fallen by not less than 15dB?
Action	YES: Tuned versions (RF TUNE control fitted = Step 18) Wideband versions (RF TUNE control not fitted = Step 20) NO: Step 39
STEP 18	Retune the signal generator to give a steady tone in the loudspeaker. Rotate the RF TUNE control out of the WB position and adjust for a maximum indication on the output power meter. Is the indication greater than 25 milliwatts?
Action	YES: Step 19 NO: Suspect faulty RF range selection at 1MHz
STEP 19	Repeat steps 15 to 18 inclusive for receiver frequencies of 2.02MHz, 4.02MHz, 8.02MHz, 16.02MHz and 29.02MHz. Is the receiver response within the limits quoted for these steps?
Action	YES: Step 20 NO: Suspect faulty RF range switching at the appropriate MHz setting
STEP 20	Set the receiver frequency to 3.5MHz, the RF TUNE control (if fitted) to WB, the AGC switch to SHORT, the MODE switch to USB and the AFC switch, if fitted, to OFF. Set the CW output level from the signal generator (connected to the antenna socket) to 2 microvolts e.m.f. Tune the signal generator to the receiver for maximum response within the receiver passband. Adjust the AF GAIN control for an indication of 100 milliwatts on the output power meter (connected to the LS and E terminals of TS1). Increase the output level from the signal operator to 200 millivolts e.m.f. (+100dB relative to 2 microvolts). Is the increase in audio output level 5dB or less?
Action	YES: Step 21 NO: Step 42

STEP 21	Set the AGC switch to OFF and set the IF GAIN control fully counter-clockwise. Is the audio output level 100 milliwatts or less?
Action	YES: Step 22 NO: Suspect a faulty IF GAIN control or associated components
STEP 22	Connect the output power meter, 600 ohms impedance, to the LINE OUTPUT, MAIN IF terminals of TS1. Set the AM/USB LINE LEVEL control fully clockwise. Is the audio output level at least 4 milliwatts?
Action	YES: No fault apparent. To fully check the performance of the receiver, carry out the procedures given in Chapter 4 NO: Suspect a fault on the main IF/AF board, in the area of the line amplifier
STEP 23	Does the front panel meter indicate within the green portion of the meter scale for any of the voltage positions of the meter switch?
Action	NO: Step 24 YES: Step 25
STEP 24	Is the POWER fuse serviceable?
Action	YES: Step 26 NO: Replace POWER fuse
STEP 25	Connect the digital voltmeter between chassis (0V) and each of the following pins in turn, on the meter switching board. Pin 10 (Red) +20V Pin 3 (Orange) +12V Pin 6 (Brown) +5V Pin 25 (Violet) -7V Are all the voltages correct?
Action	YES: Suspect a fault on the meter switching board, a faulty meter switch or meter, or a wiring fault. NO: Suspect a power supply fault or a wiring fault.

STEP 26	Is the OUT-OF-LOCK indicator lamp extinguished for any of the following ranges of MHz switch settings? 0 to 7MHz inclusive 8 to 17MHz inclusive 18 to 29MHz inclusive
Action	YES: Suspect a malfunction of one or more of the HF loop oscillators. See Chart 5 NO: Suspect a faulty synthesizer (Chart 3)
STEP 27	Connect the HF electronic voltmeter, high input impedance, between pins 22 and 21 (0V) on the HF loop board PS337. Step the MHz switch through each position. Does the HF electronic voltmeter indicate at least 225 millivolts r.m.s. plus or minus 5dB at each switch position?
Action	YES: Step 28 NO: Suspect a faulty synthesizer (Chart 3)
STEP 28	Transfer the HF electronic voltmeter, high input impedance, to pins 10 and 9 (0V) on the first mixer board PM335. Does the voltmeter indicate 225 millivolts r.m.s. plus or minus 5dB?
Action	YES: Step 29 NO: Suspect a wiring fault between the HF loop board PS337 and the first mixer board PM335
STEP 29	Connect the multimeter, set to the 5 volt d.c. range, between pin 11 on the first mixer board PM335 and chassis (0V). Does the multimeter indicate approximately +1.0V for the 0, 1, 2 and 3 settings of the MHz switch?
Action	YES: Step 30 NO: Suspect a faulty logic board or faulty wiring
STEP 30	Transfer the positive lead of the multimeter to pin 8 on the first mixer board. Does the multimeter indicate approximately 1.0V for MHz switch settings 4 to 29 inclusive?
Action	YES: Step 31 NO: Suspect a faulty logic board or faulty wiring

STEP 31	Connect the HF electronic voltmeter, high input impedance, to pin 30 on the first mixer board PM335. Does the voltmeter indicate between 6 and 15V r.m.s. for all settings of the MHz switch?
Action	YES: Step 32 NO: Suspect a faulty first mixer board PM335
STEP 32	Connect the positive lead of the multimeter, set to the 250 microamp d.c. range, to pin 5 on the first mixer board. Connect the negative lead to chassis. Does the multimeter indicate approximately 80 microamps for all settings of the MHz switch?
Action	YES: Suspect a fault on the meter switching board or faulty wiring NO: Suspect a fault on the first mixer board PM335, between D5 and pin 5
STEP 33	Set the AGC switch to SHORT. Can noise be heard in the loudspeaker?
Action	NO: Step 34 YES: Suspect a faulty IF GAIN control or associated components
STEP 34	Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and pin 14 on the main IF/AF board. Does the multimeter indicate +14.5V?
Action	YES: Step 35 NO: Step 39
STEP 35	Set the AGC switch to OFF. Set the MODE switch to AM. Can noise be heard in the loudspeaker?
Action	NO: Step 36 YES: Step 47
STEP 36	Connect a pair of headphones (600 ohms) to the right-hand PHONES jack. Can noise be heard in the headphones?
Action	NO: Step 37 YES: Suspect a faulty loudspeaker, loudspeaker switch, R4 or associated wiring

STEP 37

Connect the output power meter, 8 ohms impedance, between the LS and E terminals of TS1. Does the power meter indicate a noise level?

Action

NO: Step 38
YES: Suspect a fault in the area of the PHONES jacks, a faulty loudspeaker, or a wiring fault

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STEP 38

Connect the output power meter, 600 ohms impedance, to the LINE OUTPUT MAIN IF terminals of TS1. Set the AM/USB LINE LEVEL control fully clockwise. Does the power meter indicate a noise level?

Action

YES: Suspect a fault on the main IF/AF board, in the area of the loudspeaker amplifier
NO: Suspect a fault on the main IF/AF board, in the area of the audio pre-amplifier, or a faulty AM/USB LINE LEVEL control and associated wiring

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STEP 39

Transfer the positive lead of the multimeter to pin 6 on the AF and memory regulator board. Does the multimeter indicate +14.5V?

Action

NO: Step 40
YES: Suspect a wiring fault between the AF and memory regulator board and the main IF/AF board

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STEP 40

Transfer the positive lead of the multimeter to pin 4 on the AF and memory regulator board. Does the multimeter indicate approximately +23V?

Action

YES: Suspect a fault on the AF and memory regulator board, in the area of the 14.5V regulator circuit
NO: Suspect a wiring fault between diode D3 on the regulator board PM370 and the AF and memory regulator board, pin 4

STEP 41

Set the AGC switch to OFF. Set the IF GAIN control fully clockwise. Set the CW output level of the signal generator (connected to the antenna socket) to 2 microvolts e.m.f. Tune the signal generator to the receiver for maximum indication on the output power meter. Adjust the AF GAIN control for an indication of 100 milliwatts on the output power meter. Disconnect the signal generator from the antenna socket and connect it to the chassis mounted first mixer input socket (see Fig. 4). Increase the signal generator output level to restore the output power meter indication to 100 milliwatts. Is the increase in the signal generator output level 10dB or greater?

Action

YES: Step 42
NO: Suspect a fault on the RF amplifier board

STEP 42	Remove the cover from the first mixer board compartment in the base of the receiver (see Fig. 5). Unsolder and disconnect link LK1 from the first mixer board. Connect the signal generator, set to a frequency of 35.400MHz and an output level of 1 microvolt e.m.f., to the T3 side of LK1. Set the AGC switch to SHORT. Adjust the AF GAIN control for a reference level of 100 milliwatts on the output power meter. Set the AGC switch to OFF. Adjust the IF GAIN control to restore the output power meter indication to 100 milliwatts. Off-tune the signal generator frequency by at least 10kHz. Has the audio output level, as indicated on the output power meter, fallen by not less than 17dB?
Action	YES: Suspect a fault on the first mixer board PM335 NO: Suspect a fault on the second mixer board or, possibly, a fault on the main IF/AF board
STEP 43	Unsolder and disconnect the AGC input lead to the second mixer board, at pin 9. Connect the positive lead of the variable output power supply to pin 9 on the second mixer board, negative lead to chassis. Set the output of the variable voltage power supply to 1.4V d.c. Set the CW output level of the signal generator to 2 microvolts e.m.f. Set the AGC switch to OFF and set the IF GAIN control fully clockwise. Adjust the AF GAIN control for an indication of 100 milliwatts on the output power meter. Increase the output of the variable voltage power supply to 3.0V and increase the CW output level of the signal generator to restore the output power meter indication to 100 milliwatts. Is the increase in the signal generator output level at least 38dB?
Action	YES: Suspect a fault on the main IF/AF board, in the area of the AGC circuit NO: Suspect a fault on the second mixer board, in the area of the gain control circuit
STEP 44	Set the FILTER switch to the widest bandwidth position. Set the 34MHz INT/EXT switch on the rear panel to EXT. Does the noise output level decrease?
Action	YES: Suspect a faulty filter selection circuit, wiring or switch NO: Step 45

STEP 45	Set the 34MHz INT/EXT switch to INT. Remove the cover from the second mixer board compartment in the base of the chassis (Fig. 5). Connect the HF electronic voltmeter, high impedance input, between LK2 and TP2 (earthy) on the second mixer board. Does the voltmeter indicate approximately 600 milliwatts e.m.f.?
Action	YES: Step 46 NO: Suspect a faulty output amplifier on the 34MHz generator board PM339
STEP 46	Disconnect the coaxial plug from the chassis-mounted second mixer output socket (Fig. 4). Connect the signal generator, set to a frequency fo 1.4MHz and an output level of 10 millivolts e.m.f., to the disconnected coaxial plug (via a back-to-back connector). Set the receiver MODE switch to USB and the AGC switch to SHORT. Carefully tune the signal generator until a steady tone is heard in the loudspeaker. Reduce the signal generator output level to 64 microvolts e.m.f. Can the AF GAIN be adjusted for an indication on the output power meter of 1 watt?
Action	YES: Suspect a fault in the second mixer board PM336 (Chart 9) NO: Suspect a fault on the filter board PS367 or the main IF/AF board PM364 (Chart 7)
STEP 47	Set the MODE switch to CW. Can noise be found in the loudspeaker?
Action	YES: Suspect a fault on the 34MHz generator board in the area of the 1.4MHz generator NO: Step 48
STEP 48	Connect the HF electronic voltmeter, high impedance input, between pins 5 and 4 (earthy) on the main IF/AF board. Does the voltmeter indicate approximately 250 milliwatts, r.m.s. in all MODE switch positions except AM?
Action	YES: Suspect a fault on the main IF/AF board in the area of the product detector or a faulty SSB selection circuit NO: Suspect a fault on the 34MHz generator board in the area of the 1.4MHz output buffer stages

RA.1772 OVERALL RECEIVER

FLOW CHART 2

NOTE: This chart describes a fault finding procedure for SSB versions of the RA.1772. For ISB versions of the receiver the relevant steps should be repeated for the LSB channel.

STEP 1	Set the RF TUNE control (if fitted) to WB, the AGC switch to OFF, the TUNING RATE switch to LOCK, the MODE switch to USB and the AFC switch (if fitted) to OFF. Set the rear panel 1MHz, 34MHz and LO switches to INT. Ensure that no antenna is connected to the antenna socket, and that the voltage selector on the rear panel is correctly set. Connect the receiver to a suitable source of a.c. power and set the POWER switch to ON. Set the front panel METER switch, in turn, to +20, +12, +5 and -7. Does the meter indicate within the green portion of the meter scale at each switch position?
Action	YES: Step 2 NO: Step 41
STEP 2	Is the MHz display window illuminated?
Action	YES: Step 3 NO: Step 44
STEP 3	Is the kHz display illuminated with each digit at zero?
Action	YES: Step 4 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 4	Set the MHz switch to 3. Set the TUNING RATE switch to SLOW. Slowly rotate the kHz control clockwise. Does the kHz display increase in 10Hz steps at a rate of 2.5kHz per turn?
Action	YES: Step 5 NO: Step 48
STEP 5	Slowly rotate the kHz control counter-clockwise. Does the display decrease in 10Hz steps at a rate of 2.5kHz per turn?
Action	YES: Step 6 NO: Suspect a fault on the display board PM371 (Chart 11)

STEP 6	Set the TUNE RATE switch to FAST. Repeat steps 4 and 5. Does the display now increase and decrease in steps of 100Hz?
Action	YES: Step 7 NO: Suspect a fault on the display board (Chart 11, begin at step 4)
STEP 7	As the display passes from 00000 to 99990, does the lamp behind the 3 on the MHz dial extinguish and the lamp behind the 2 illuminate?
Action	YES: Step 8 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 8	Continue to decrease the kHz display indication. Does it decrease to 97990 and then stop?
Action	YES: Step 9 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 9	Set the MHz switch one position counter-clockwise. Has the illuminated 2 moved to the centre of the MHz dial?
Action	YES: Step 10 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 10	Does the kHz display still indicate 97990?
Action	YES: Step 11 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 11	Rotate the kHz control counter-clockwise. Does the kHz display decrease from 97990?
Action	YES: Step 12 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 12	Rotate the kHz control clockwise. Does the display increase to 99990, change to 00000 and then stop at 02000?
Action	YES: Step 13 NO: Suspect a fault on the display board PM371 (Chart 11)

STEP 13	As the kHz display passed through 00000 did the lamp behind the 2 extinguish and the lamp behind the 3 illuminate?
Action	YES: Step 14 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 14	Set the MHz switch one position clockwise. Has the illuminated 3 moved to the centre of the MHz dial?
Action	YES: Step 15 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 15	Does the kHz display still indicate 02000?
Action	YES: Step 16 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 16	Rotate the kHz control clockwise. Does the kHz display increase from 02000?
Action	YES: Step 17 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 17	Rotate the kHz control in each direction one turn. Does the kHz display change at a rate of 50kHz per turn?
Action	YES: Step 18 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 18	Does the 10Hz digit remain at zero?
Action	YES: Step 19 NO: Suspect a fault on the display board PM371 (Chart 11)
STEP 19	Set the TUNING RATE switch to LOCK. Rotate the kHz control in each direction in turn. Does the kHz display remain static?
Action	YES: Step 20 NO: Suspect a fault in the wiring to the TUNING RATE switch

STEP 20	Connect the receiver 1MHz IN/OUT socket to the external standard socket on the digital frequency meter. Set the digital frequency meter to operate from an external 1MHz standard. Connect the digital frequency meter to the LO IN/OUT socket on the rear panel. Set the kHz control to display 000.00. Step the MHz switch from 0 to 29MHz. Does the digital frequency meter display 35.400MHz plug the MHz switch setting?
Action	YES: Step 21 NO: Suspect a synthesizer fault (Chart 3)
STEP 21	Does the OUT-OF-LOCK indicator lamp remain extinguished for each position of the MHz switch?
Action	YES: Step 23 NO: Step 51
STEP 22	Set the METER SWITCH to DRIVE LEVEL. Set the kHz control to display 015.00. Step the MHz switch through each position. Does the meter indication lie within the V portion of the meter scale for each switch position?
Action	YES: Step 23 NO: Step 52
STEP 23	Set the MHz switch to 0 and set the kHz control to display 000.00. Does the front panel meter indicate half scale?
Action	YES: Step 24 NO: Suspect a fault on the first mixer board PM335, in the area of the notch filter
STEP 24	Connect the digital frequency meter to the 34MHz IN/OUT socket on the rear panel. Does the frequency meter indicate 34 000 000 Hz plus or minus 1Hz?
Action	YES: Step 25 NO: Suspect a fault on the 34MHz generator board PM339 (Chart 6)

STEP 25	Set the receiver IF GAIN control fully clockwise, the MODE switch to USB, the METER switch to AM/USB, the FILTER switch to the widest bandwidth, the AF GAIN control fully counter-clockwise and the loudspeaker to ON. Set the RF TUNE control (if fitted) to WB, the AGC switch to OFF and the AFC switch (if fitted) to OFF. Turn the AF GAIN control progressively clockwise. Can noise be heard in the loudspeaker?
Action	YES: Step 26 NO: Step 58
STEP 26	Set the MODE switch to AM. Can noise be heard in the loudspeaker?
Action	YES: Step 27 NO: Suspect a faulty AM detector circuit on the main IF/AF board, or a faulty AM selection circuit
STEP 27	Set the MODE switch to CW. Does the level of noise in the loudspeaker increase?
Action	YES: Step 28 NO: Suspect a faulty 1.4MHz BFO on the 34MHz generator board PM339 or a faulty CW selection circuit
STEP 28	Set the FILTER switch to each position in turn. Does the noise level in the loudspeaker decrease as the bandwidth is reduced?
Action	YES: Step 29 NO: Step 69
STEP 29	Connect a pair of headphones (600 ohms) to the left-hand PHONES jack. Can noise be heard in the headphones?
Action	YES: Step 30 NO: Suspect a fault in the area of the PHONES jacks, or faulty wiring
STEP 30	Connect the headphones to the right-hand PHONES jack. Can noise be heard in the headphones?
Action	YES: Step 31 NO: Suspect a fault in the area of the PHONES jacks, or faulty wiring

STEP 31	Can noise still be heard in the loudspeaker?
Action	NO: Step 32 YES: Suspect a faulty right-hand phones jack or faulty wiring
STEP 32	Connect the CW output of the signal generator, set to a frequency of 1.02MHz and an output level of 10 millivolts e.m.f., to the receiver antenna socket. Connect the output power meter, set to 8 ohms impedance, to the loudspeaker terminals (TS1, LS and E). Set the receiver frequency to 1.02MHz, set the MODE switch to USB, and set the AGC switch to SHORT. Tune the signal generator through 1.02MHz. Is a response heard in the loudspeaker?
Action	YES: Step 33 NO: Step 64
STEP 33	Tune the signal generator for a steady tone in the loudspeaker. Reduce the signal generator output level to 1 microvolt e.m.f. Can the tone still be heard in the loudspeaker?
Action	YES: Step 34 NO: Step 64
STEP 34	Using the AF GAIN control, can the output power meter indication be set to 1 watt?
Action	YES: Step 35 NO: Step 66
STEP 35	Readjust the AF GAIN control for an indication of 100 milliwatts on the output power meter. Set the AGC switch to OFF and adjust the IF GAIN control to restore the output power meter indication to 100 milliwatts. Off-tune the signal generator by at least 10kHz. Has the output power meter indication fallen by not less than 15dB?
Action	YES: Tuned versions (RF TUNE control fitted) Step 36 Wideband versions (RF TUNE control not fitted) Step 37 NO: Step

STEP 36	Retune the signal generator to give a steady tone in the loudspeaker. Rotate the RF TUNE control away from the WB position and adjust for a maximum indication on the output power meter. Is the indication greater than 25 milliwatts?
Action	YES: Step 37 NO: Suspect faulty RF range switching at 1MHz
STEP 37	Repeat steps 33 to 36 inclusive for receiver frequencies of 2.02MHz, 4.02MHz, 8.02MHz, 16.02MHz and 29.02MHz. Is the receiver response within the limits quoted for these steps?
Action	YES: Step 38 NO: Suspect faulty RF range switching at the appropriate MHz setting
STEP 38	Set the receiver frequency to 3.5MHz, the TUNING RATE switch to LOCK, the RF TUNE control (if fitted) to WB, the AGC switch to SHORT, the MODE switch to USB and the AFC switch, if fitted, to OFF. Set the CW output level from the signal generator (connected to the antenna socket) to 2 microvolts e.m.f. Tune the signal generator to the receiver for maximum response within the receiver passband. Adjust the AF GAIN control for an indication of 100 milliwatts on the output power meter (connected to the LS and E terminals of TS1). Increase the output level from the signal generator to 200 millivolts e.m.f. (+100dB relative to 2 microvolts). Is the increase in audio output level 5dB or less?
Action	YES: Step 39 NO: Step 68
STEP 39	Set the AGC switch to OFF and set the IF GAIN control fully counter-clockwise. Is the audio output level 100 milliwatts or less?
Action	YES: Step 40 NO: Suspect a faulty IF GAIN control or associated components

STEP 40	Connect the output power meter, 600 ohms impedance, to the LINE OUTPUT, MAIN IF terminals of TS1. Set the AM/USB LINE LEVEL control fully clockwise. Is the audio output level at least 4 milliwatts?
Action	YES: No fault apparent. To fully check the performance of the receiver, carry out the procedures given in Chapter 4. NO: Suspect a fault on the main IF/AF board, in the area of the line amplifier (Chart 7)
STEP 41	Does the front panel meter indicate within the green portion of the meter scale for any of the voltage positions of the meter switch?
Action	NO: Step 42 YES: Step 43
STEP 42	Is the POWER fuse serviceable?
Action	YES: Step 43 NO: Replace POWER fuse
STEP 43	Connect the digital voltmeter between chassis (0V) and each of the following pins in turn, on the meter switching board. Pin 10 (Red) +20V Pin 3 (Orange) +12V Pin 6 (Brown) +5V Pin 25 (Violet) -7V Are all the voltages correct?
Action	YES: Suspect a fault on the meter switching board, a faulty meter switch or meter, or a wiring fault NO: Suspect a power supply fault or a wiring fault
STEP 44	Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and pin 6 on the potentiometer board (attached to the shaft encoder). Does the multimeter indicate +12V?
Action	YES: Step 45 NO: Suspect a wiring fault between the +12V supply and the MHz lamps
STEP 45	Are the MHz lamps serviceable?
Action	YES: Step 46 NO: Replace unserviceable lamps

STEP 46	Is there continuity between the MHz lamps and pins 24 (L), 25 (N) and 26 (H) on the display board?
Action	YES: Suspect a faulty on the display board PM371 NO: Trace and repair faulty wiring
STEP 47	Are the shaft encoder lamps illuminated? (These lamps may be under-powered and thus may not glow brightly.)
Action	YES: Step 48 NO: Step 50
STEP 48	Connect the oscilloscope, in turn, to pins 4 and 10 on the potentiometer board. Observe the oscilloscope whilst rotating the kHz control. Is a quasi-sinusoidal waveform displayed, approximate amplitude 1.8V peak-to-peak, in each case?
Action	YES: Step 49 NO: Suspect a faulty shaft encode (sensor board)
STEP 49	Connect the oscilloscope, in turn, to pins 31 and 32 on the display board. Observe the oscilloscope whilst rotating the kHz control. Is the waveform displayed, in each case, the same as in the previous step?
Action	YES: Suspect a fault on the display board PM371 (Chart 11) NO: Suspect a wiring fault between the shaft encoder and the display board
STEP 50	Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and pin 4 on the shaft encoder. Does the multimeter indicate +12V?
Action	YES: Suspect unserviceable shaft encoder lamps or an open circuit 0V return wire from the shaft encoder NO: Suspect a wiring fault between the +12V supply and the shaft encoder lamps
STEP 51	Is the OUT-OF-LOCK indicator lamp extinguished for any of the following ranges of MHz switch settings? 0 to 7MHz inclusive 8 to 17MHz inclusive 18 to 29MHz inclusive
Action:	YES: Suspect a malfunction of one or more of the HF loop oscillators. See Chart 5 NO: Suspect a faulty synthesizer (Chart 3)

STEP 52	Connect the HF electronic voltmeter, high input impedance, between pins 22 and 21 (0V) on the HF loop board PS337. Step the MHz switch through each position. Does the HF electronic voltmeter indicate 225 millivolts r.m.s. plus or minus 5dB at each switch position?
Action	YES: Step 53 NO: Suspect a faulty synthesizer (Chart 3)
STEP 53	Transfer the HF electronic voltmeter, high input impedance, to pins 10 and 9 (0V) on the first mixer board PM335. Does the voltmeter indicate 225 millivolts r.m.s. plus or minus 5dB?
Action	YES: Step 54 NO: Suspect a wiring fault between the HF loop board PS337 and the first mixer board PM335
STEP 54	Connect the multimeter, set to the 5 volt d.c. range, between pin 11 on the first mixer board PM335 and chassis (0V). Does the multimeter indicate approximately +1.0V for the 0, 1, 2 and 3 settings of the MHz switch?
Action	YES: Step 55 NO: Suspect a faulty logic board or faulty wiring
STEP 55	Transfer the positive lead of the multimeter to pin 8 on the first mixer board. Does the multimeter indicate approximately 1.0V for MHz switch settings 4 to 29 inclusive?
Action	YES: Step 56 NO: Suspect a faulty logic board or faulty wiring
STEP 56	Connect the HF electronic voltmeter, high input impedance, to pin 30 on the first mixer board PM335. Does the voltmeter indicate between 6 and 15V r.m.s. for all settings of the MH switch?
Action	YES: Step 57 NO: Suspect a faulty first mixer board PM335 (Chart 9)

STEP 57	Connect the positive lead of the multimeter, set to the 250 microamp d.c. range, to pin 5 on the first mixer board. Connect the negative lead to chassis. Does the multimeter indicate approximately 80 microamps for all settings of the MHz switch?
Action	YES: Suspect a fault on the meter switching board or faulty wiring NO: Suspect a fault on the first mixer board PM335, between D5 and pin 5
STEP 58	Set the AGC switch to SHORT. Can noise be heard in the loudspeaker?
Action	NO: Step 59 YES: Suspect a faulty IF GAIN control or associated components
STEP 59	Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and pin 14 on the main IF/AF board. Does the multimeter indicate +14.5V?
Action	YES: Step 60 NO: Step 64
STEP 60	Set the AGC switch to OFF. Set the MODE switch to AM. Can noise be heard in the loudspeaker?
Action	NO: Step 61 YES: Step 72
STEP 61	Connect a pair of headphones (600 ohms) to the right-hand PHONES jack. Can noise be heard in the headphones?
Action	NO: Step 62 YES: Suspect a faulty loudspeaker, loudspeaker switch, R4 or associated wiring
STEP 62	Connect the output power meter, 8 ohms impedance, between the LS and E terminals of TS1. Does the power meter indicate a noise level?
Action	NO: Step 63 YES: Suspect a fault in the area of the PHONES jacks, a faulty loudspeaker, or a wiring fault

STEP 63	Connect the output power meter, 600 ohms impedance, to the LINE OUTPUT MAIN IF terminals of TS1. Set the AM/USB LINE LEVEL control fully clockwise. Does the power meter indicate a noise level?
Action	YES: Suspect a fault on the main IF/AF board, in the area of the loudspeaker amplifier NO: Suspect a fault on the main IF/AF board, in the area of the audio pre-amplifier, or a faulty AM/USB LINE LEVEL control and associated wiring
STEP 64	Transfer the positive lead of the multimeter to pin 6 on the AF and memory regulator board. Does the multimeter indicate +14.5V.
Action	NO: Step 65 YES: Suspect a wiring fault between the AF and memory regulator board and the main IF/AF board
STEP 65	Transfer the positive lead of the multimeter to pin 4 on the AF and memory regulator board. Does the multimeter indicate approximately +23V?
Action	YES: Suspect a fault on the AF and memory regulator board, in the area of the 14.5V regulator circuit NO: Suspect a wiring fault between diode D3 on the regulator board PM370 and the AF and memory regulator board, pin 4
STEP 66	Set the AGC switch to OFF. Set the IF GAIN control fully clockwise. Set the CW output level of the signal generator (connected to theantenna socket) to 2 microvolts e.m.f. Tune the signal generator to the receiver for maximum indication on the output power meter. Adjust the AF GAIN control for an indication of 100 milliwatts on the output power meter. Disconnect the signal generator from the antenna socket and connect it to the chassis mounted first mixer input socket (see Fig. 4). Increase the signal generator output level to restore the output power meter indication to 100 milliwatts. Is the increase in the signal generator output level 10dB or greater?
Action	YES: Step 67 NO: Suspect on the RF amplifier board (Chart 10)

STEP 67	Remove the cover from the first mixer board compartment in the base of the receiver (see Fig. 5). Unsolder and disconnect link LK1 from the first mixer board. Connect the signal generator, set to a frequency of 35.400MHz and an output level of 1 microvolt e.m.f., to the T3 side of LK1. Set the AGC switch to SHORT. Adjust the AF GAIN control for a reference level of 100 milliwatts on the output power meter. Set the AGC switch to OFF. Adjust the IF GAIN control to restore the output power meter indication to 100 milliwatts. Off-tune the signal generator frequency by at least 10kHz. Has the audio output level, as indicated on the output power meter, fallen by not less than 17dB?
Action	YES: Suspect a fault on the first mixer board PM335 (Chart 9) NO: Suspect a fault on the second mixer board (Chart 9)
STEP 68	Unsolder and disconnect the AGC input lead to the second mixer board, at pin 9. Connect the positive lead of the variable output power supply to pin 9 on the second mixer board, negative lead to chassis. Set the output of the variable voltage power supply to 1.4V d.c. Set the CW output level of the signal generator to 2 microvolts e.m.f. Set the AGC switch to OFF and set the IF GAIN control fully clockwise. Adjust the AF GAIN control for an indication of 100 milliwatts on the output power meter. Increase the output of the variable voltage power supply to 3.0V and increase CW output level of the signal generator to restore the output power meter indication to 100 milliwatts. Is the increase in the signal generator output level at least 38dB?
Action	YES: Suspect a fault on the main IF/AF board, in the area of the AGC circuit NO: Suspect a fault on the second mixer board, in the area of the gain control circuit
STEP 69	Set the FILTER switch to the widest bandwidth position. Set the 34MHz INT/EXT switch to EXT. Does the noise output level decrease?
Action	YES: Suspect a faulty filter selection circuit, wiring or switch NO: Step 70

STEP 70	Set the 34MHz INT/EXT switch to INT. Remove the cover from the first mixer board compartment in the base of the chassis (Fig.5). Connect the HF electronic voltmeter, high impedance input, between LK2 and TP2 (earthy) on the second mixer board. Does the voltmeter indicate approximately 600 millivolts r.m.s.?
Action	YES: Step 71 NO: Suspect a faulty output amplifier on the 34MHz generator board PM339
STEP 71	Disconnect the coaxial plug from the chassis-mounted second mixer output socket (Fig. 4). Connect the signal generator, set to a frequency of 1.4MHz and an output level of 10 millivolts e.m.f., to the disconnected coaxial plug (via a back-to-back connector). Set the receiver MODE switch to USB and the AGC switch to SHORT. Carefully tune the signal generator until a steady tone is heard in the loudspeaker. Reduce the signal generator output level to 64 microvolts e.m.f. Can the AF gain be adjusted for an indication on the output power meter of 1 watt?
Action	YES: Suspect a fault on the second mixer board PM336 (Chart 9) NO: Suspect a fault on the filter board PS367 or the main IF/AF board PM364 (Chart 7)
STEP 72	Set the MODE switch to CW. Can noise be heard in the loudspeaker?
Action	YES: Suspect a fault on the 34MHz generator board in the area of the 1.4MHz generator NO: Step 73
STEP 73	Connect the HF electronic voltmeter, high impedance input, between pins 5 and 4 (earthy) on the main IF/AF board. Does the voltmeter indicate approximately 250 millivolts r.m.s. in all MODE switch positions except AM?
Action	YES: Suspect a fault on the main IF/AF board in the area of the product detector or a faulty SSB selector circuit NO: Suspect a fault on the 34MHz generator board in the area of the 1.4MHz output buffer stages

SYNTHESIZER SECTION

FLOW CHART 3

STEP 1	Set the front panel AFC switch to OFF. Set the POWER switch to ON. Set the rear panel 1MHz, 34MHz and LO switches to INT. Connect the HF electronic voltmeter, 50 ohms input impedance, to the 1MHz IN/OUT socket. Does the voltmeter indicate at least 180 millivolts r.m.s.?
Action	YES: Step 2 NO: Step 9
STEP 2	Disconnect the HF electronic voltmeter and connect in its place the digital frequency meter. Is the frequency displayed 1 000 000Hz plus or minus 1Hz?
Action	YES: Step 3 NO: Step 13
STEP 3	Disconnect the digital frequency meter. Connect the HF electronic voltmeter, 50 ohm input impedance, to the 34MHz IN/OUT socket. Does the voltmeter indicate at least 180 millivolts r.m.s.?
Action	YES: Step 4 NO: Step 14
STEP 4	Disconnect the HF electronic voltmeter and connect in its place the digital frequency meter. Is the frequency displayed 34 000 000Hz plus or minus 10Hz?
Action	YES: Step 5 NO: Suspect a fault on the 34MHz generator board PM339.
STEP 5	Disconnect the digital frequency meter. Is the OUT-OF-LOCK indicator lamp extinguished?
Action	YES: Step 6 NO: Step 15
STEP 6	Connect the digital frequency meter to the LO IN/OUT socket. Set the receiver MHz switch to 0. Set the kHz control to display 000.00. Is the frequency displayed 35 400 000Hz?
Action	YES: Step 7 NO: Step 19

STEP 7	Rotate the MHz switch through each position, i.e. 0 to 29. Is the frequency displayed on the digital frequency meter 35.4MHz plus the MHz switch setting?
Action	YES: Step 8 NO: Suspect a fault on the transfer loop board PS338, the HF loop board PS337, or the logic board PS365.
STEP 8	Rotate the kHz control (RA.1772) or select various settings of the decade frequency selection switches (RA.1771). Does the digital frequency meter indication follow the receiver frequency?
Action	YES: No fault apparent NO: Suspect a fault on the LF loop board PM588, upper loop board PM589, display board (RA.1772) or decade switches (RA.1771).
STEP 9	Connect the HF electronic voltmeter, 50 ohms input impedance, to pin 3 on the frequency standard board. Does the voltmeter indicate approximately 250 millivolts r.m.s.?
Action	YES: Step 10 NO: Step 12
STEP 10	Connect the HF electronic voltmeter, 50 ohms input impedance to pin 27 on the 34MHz generator board PM339. Does the voltmeter indicate approximately 250 millivolts r.m.s.?
Action	YES: Step 11 NO: Suspect a faulty connection between the frequency standard board and the 34MHz generator board PM339.
STEP 11	Connect the HF electronic voltmeter, 50 ohms input impedance, to pin 4 on the 34MHz generator board PM339. Does the voltmeter indicate at least 180 millivolts r.m.s.?
Action:	YES: Suspect a faulty connection between the 34MHz generator board PM339 and the 1MHz IN/OUT socket. NO: Suspect a fault on the 34MHz generator board PM339.
STEP 12	Connect a multimeter, set to the 25 volt d.c. range, between pins 1 (positive) and 2 on the frequency standard board. Does the multimeter indicate +12 volts?
Action	YES: Suspect a faulty frequency standard. NO: Suspect a wiring or a power supply fault.

STEP 13	Connect the digital frequency meter to pin 3 on the frequency standard board. Is the frequency displayed 1 000 000Hz plus or minus 1Hz?
Action	YES: Suspect a fault on the 34MHz generator board PM339. NO: Suspect a faulty frequency standard.
STEP 14	Connect the HF electronic voltmeter, 50 ohms input impedance, to pin 22 on the 34MHz generator board PM339. Does the voltmeter indicate at least 180 millivolts r.m.s.?
Action	YES: Suspect a faulty connection between the 34MHz generator board PM339 and the 34MHz IN/OUT socket. NO: Suspect a fault on the 34MHz generator board PM339.
STEP 15	Use the oscilloscope to monitor, in turn, pins 33, 34 and 35 on the display board (RA.1772) or pins 4, 5 and 6 on the out-of-lock indicator board (RA.1771). Is approximately +3V present at each pin?
Action	YES: Suspect a fault on the display board, TR1, ML33a area (RA.1772) or on the out-of-lock indicator board (RA.1771). NO: Step 16
STEP 16	Is approximately +3V present at pin 33 (display board) or pin 4 (out-of-lock indicator board)?
Action	YES: Step 17 NO: Suspect a fault on the LF loop board PM588 or the upper loop board PM589.
STEP 17	Is approximately +3V present at pin 34 (display board) or pin 5 (out-of-lock indicator board)?
Action	YES: Step 18 NO: Suspect a fault on the HF loop board PS337.
STEP 18	Is approximately +3V present at pin 35 (display board) or pin 6 (out-of-lock indicator board)?
Action	NO: Suspect a fault on the transfer loop board PS338.

STEP 19	Connect the digital frequency meter to TP2 on the upper loop board PM589. Does the meter indicate 4.6MHz?
Action	YES: Suspect a fault on the transfer loop board PS338 or the HF loop board PS337. NO: Suspect a fault on the LF loop board PM588 or the upper loop board PM589.

FLOW CHART 4

STEP 1	Set the AFC switch (if fitted) to OFF. Set the rear panel 1MHz, 34MHz and LO switches to INT. Connect a multimeter, set to the 25 volt d.c. range, between chassis (0V) and each of the following board pins in turn.

PM588	PM589	VOLTAGE
27	5	+5
38	4	+20
26	6	-7

	Are all the voltages correct?
Action	YES: Step 2 NO: Check the power supply and the connections to each board.
STEP 2	Connect the oscilloscope to ML10 pin 4 on PM589. Is 0V indicated?
Action	YES: Step 3 NO: Step 8
STEP 3	Connect the oscilloscope to ML10 pin 12 on PM589. Is 0V indicated?
Action	YES: Step 4 NO: Step 5
STEP 4	Connect the oscilloscope to ML10 pin 10 on PM589. Is 0V indicated?
Action	YES: Step 5 NO: Step 15
STEP 5	Connect the digital frequency meter to TP3 on PM588. Does the frequency meter indicate 1MHz?
Action	YES: Step 6 NO: Step 19
STEP 6	Connect the digital frequency meter to TP4 on PM588. Does the frequency meter indicate 1kHz?
Action	YES: Step 7 NO: Suspect a fault on PM588 in the area of ML2, ML4, ML7.

STEP 7	Connect the digital frequency meter to TP2 on PM588. Does the frequency meter indicate 7MHz minus the 1kHz, 100Hz and 10Hz digits of the receiver frequency multiplied by 100?
Action	YES: Step 8 NO: Step 20
STEP 8	Connect the oscilloscope to pin 44 on PM588. Is the transfer loop oscillator output signal present?
Action	YES: Step 9 NO: Suspect a fault on PM589, in the area of the transfer loop oscillator (TR4, TR5, TR6) or faulty wiring to PM588.
STEP 9	Connect the oscilloscope to TP7 on PM588. Is a square wave signal displayed?
Action	YES: Step 10 NO: Suspect a fault on PM588, in the area of the mixer and low-pass filter (ML13, TR18, TR19, ML17, TR20, D3).
STEP 10	Connect the oscilloscope to TP8 on PM588. Is the negative-going strobe pulse train signal displayed?
Action	YES: Step 11 NO: Suspect a fault on PM588, in the area of the programmed divider N2 (ML14, ML15, ML18, ML19).
STEP 11	Connect the universal counter-timer, set to measure frequency ratio, between TP2 and TP8 on PM588. Is the ratio displayed equal to the division ratio of programmed divider N2? (N2 = 453 minus selected 100kHz and 10kHz digits of the receiver frequency).
Action	YES: Step 12 NO: Step 24
STEP 12	Connect the oscilloscope to ML16 pin 5 on PM588. Is a narrow fixed-width pulse signal displayed?
Action	YES: Step 13 NO: Suspect a fault on PM588, in the area of the phase comparator (ML16, ML17), the voltage control circuit (TR21, TR22, TR23) or an incorrect voltage/frequency characteristic of the transfer loop oscillator on PM589.

STEP 13	Connect the oscilloscope to ML16 pin 9 on PM588. Is a narrow fixed-width pulse signal displayed?
Action	YES: Step 14 NO: Suspect a fault on PM588, in the area of the phase comparator (ML16, ML17), the voltage control circuit (TR21, TR22, TR23) or an incorrect voltage/frequency characteristic of the transfer loop oscillator on PM589.
STEP 14	Connect the oscilloscope to ML10 pin 4 on PM589. Is 0V indicated?
Action	YES: Step 15 NO: Suspect a fault on PM588, in the area of the lock indication circuit (ML21, R72, R73, C30, C31).
STEP 15	Connect the digital frequency meter to TP1 on PM589. Note the frequency displayed. Transfer the frequency meter to TP3 on PM589. Is the frequency displayed equal to that noted above divided by 100?
Action	YES: Step 16 NO: Suspect a fault on PM589, in the area of the fixed divider (ML4, ML6).
STEP 16	Connect the digital frequency meter to TP2 on PM589. Is the frequency displayed equal to 4.6MHz minus the 100kHz and 10kHz digits of the receiver frequency?
Action	YES: Step 17 NO: Step 25
STEP 17	Connect the oscilloscope to ML10 pin 10 on PM589. Is 0V indicated?
Action	YES: Step 18 NO: Suspect a fault on PM589, in the area of the lock detector circuit (ML11, R48, R51, C31, C32).
STEP 18	Connect the oscilloscope to board pin 12 on PM589. Is 0V indicated?
Action	YES: Suspect a fault on PM589, in the area of ML10, ML12 NO: No fault apparent.
STEP 19	Connect the oscilloscope to pin 46 on PM588. Is a 1MHz signal displayed?
Action	YES: Suspect a fault on PM588, in the area of T1, TR2. NO: Suspect a fault on the 34MHz generator board PM339, or a wiring fault.

STEP 20		Connect the universal counter-timer, set to measure frequency ratio, between TP2 and TP6 on PM588. Is the ratio displayed equal to the division ratio of programmed divider N1? (N1 = 7000 minus the selected 1kHz, 100Hz and 10Hz digits of the receiver frequency).
Action	YES:	Step 21
	NO:	Step 23
STEP 21		Connect the oscilloscope to ML8 pin 5 on PM588. Is a narrow fixed-width pulse signal displayed?
Action	YES:	Step 22
	NO:	Suspect a fault on PM588, in the area of the phase comparator (ML1, ML8), the voltage control circuit (TR4, TR5) or an incorrect voltage/frequency characteristic of the 7MHz VCO.
STEP 22		Connect the oscilloscope to ML8 pin 9 on PM588. Is a narrow fixed-width pulse signal displayed?
Action	YES:	Suspect a fault on PM588, in the area of the lock indication circuit (ML12, R51, R52, C19, C20).
	NO:	Suspect a fault on PM588, in the area of the phase comparator (ML1, ML8), the voltage control circuit (TR4, TR5) or an incorrect voltage/frequency characteristic of the 7MHz VCO.
STEP 23		Are the coding inputs (1kHz, 100Hz, 10Hz data inputs) from the display board (RA.1772) or the decade switches (RA.1771) correct?
Action	YES:	Suspect a fault on PM588, in the area of the programmed divider N1 (ML3, ML5, ML6, ML10).
	NO:	Suspect a fault on the display board (RA.1772) or the decade switches (RA.1771) or wiring fault.
STEP 24		Are the coding inputs (100kHz and 10kHz data inputs) to PM588 from the display board (RA.1772) or the decade switches (RA.1771) correct?
Action	YES:	Suspect a fault on PM588, in the area of the programmed divider N2 (ML14, ML15, ML18, ML19).
	NO:	Suspect a fault on the display board (RA.1772) or the decade switches (RA.1771) or a wiring fault.

STEP 25	Connect the universal counter/timer, set to measure frequency ratio, between TP2 and TP4 on PM589. Is the ratio displayed equal to the division ratio of programmed divider N2? (N2 = 453 minus the selected 100kHz and 10kHz digits of the receiver frequency).
Action	YES: Step 26 NO: Step 28
STEP 26	Connect the oscilloscope to TP6 on PM589. Is a narrow fixed-width pulse signal displayed?
Action	YES: Step 27 NO: Suspect a fault on PM589, in the area of the phase comparator (ML9, G5), the voltage control circuit (TR16, TR17, TR18) or an incorrect voltage/frequency characteristic of the 4.6 to 3.6MHz VCO.
STEP 27	Connect the oscilloscope to ML9 pin 5 on PM589. Is a narrow fixed-width pulse signal displayed?
Action	YES: Step 17 NO: Suspect a fault on PM589, in the area of the phase comparator (ML9, G5), the voltage control circuit (TR16, TR17, TR18) or an incorrect voltage/frequency characteristic of the 4.6 to 3.6MHz VCO.
STEP 28	Are the coding inputs (100kHz and 10kHz data inputs) to PM589 from the display board (RA.1772) or the decade switches (RA.1771) correct?
Action	YES: Suspect a fault on PM589, in the area of programmed divider N2 (ML2, ML3, ML5, ML7). NO: Suspect a fault on the display board (RA.1772) or the decade switches (RA.1771) or a wiring fault.

SYNTHESIZER BOARDS PS337 AND PS338

FLOW CHART 5

STEP 1

Set the front panel AFC switch (if fitted) to OFF. Set the rear panel 1MHz, 34MHz and LO switches to INT. Connect a multimeter, set to the 25 volt d.c. range, between chassis (0V) and the following board pins, in turn.

PS337	PS338	VOLTAGE
9	3	+5
10	-	+12
11	2	+20
16	7	-7

Are all the voltages correct?

Action

YES: Step 2
NO: Check power supply and connections to each board.

STEP 2

Connect the oscilloscope to pin 6 on PS338. Is approximately +3V indicated?

Action

YES: Step 3
NO: Step 4

STEP 3

Connect the oscilloscope to pin 12 on PM337. Is approximately 3V indicated?

Action

YES: Step 4
NO: Step 12

STEP 4

Connect the oscilloscope to pin 21 on PS338. Is a 1MHz signal displayed?

Action

YES: Step 5
NO: Suspect a fault on the 34MHz generator board PM339 or faulty wiring.

STEP 5

Connect the oscilloscope to pin 19 on PS338. Is the 835 to 948kHz transfer loop oscillator signal displayed?

Action

YES: Step 6
NO: Suspect a fault on PS337, in the area of the transfer loop oscillator (TR17, TR20-TR22) or faulty wiring.

STEP 6	Connect the oscilloscope to TP2 on PS338. Is an approximate square wave signal displayed? *	
Action	YES:	Step 7
	NO:	Suspect a fault on PS338, in the area of the mixer (TR1, TR2, TR3, ML3) or TR6, ML7a.
STEP 7	Connect the oscilloscope to TP1 on PS338. Is a 4.6 to 3.6MHz signal displayed?	
Action	YES:	Step 8
	NO:	Suspect a fault on PS338, in the area of TR4, TR5, or faulty wiring.
STEP 8	Connect the universal counter-timer, set to measure frequency ratio, between TP1 and TP6 on PS338. Is the ratio displayed equal to the division ratio of programmed divider N3? (N3 = 40 plus the selected setting of the receiver MHz switch).	
Action	YES:	Step 9
	NO:	Step 27
STEP 9	Connect the oscilloscope to TP3 on PS338. Is a narrow fixed-width pulse signal displayed?	
Action	YES:	Step 10
	NO:	Suspect a fault on PS338, in the area of the phase comparator (ML8, ML7b), the voltage control circuit (TR7, TR8, TR9, TR10), or an incorrect voltage/frequency characteristic of the transfer loop oscillator on PS337.
STEP 10	Connect the oscilloscope to ML8 pin 6. Is a narrow fixed-width pulse signal displayed?	
Action	YES:	Step 11
	NO:	Suspect a fault on PS338, in the area of the phase comparator (ML8, ML7b), the voltage control circuit (TR7, TR8, TR9, TR10) or an incorrect voltage/frequency characteristic of the transfer loop oscillator on PS337.
STEP 11	Is the OUT OF LOCK indicator lamp extinguished?	
Action	YES:	Step 12
	NO:	Suspect a fault on PS338, in the area of the lock indicator circuit (ML9, ML10, ML11, ML4c, ML4d).

*The frequency of the signal at Step 5 must be correct for it to pass through filter L11,L12.

STEP 12	Connect the oscilloscope to ML7 pin 11 on PS337. Is a square wave signal displayed?
Action	YES: Step 13 NO: Suspect a fault on PS337 in the area of ML12 or ML7b.
STEP 13	Connect the oscilloscope to TP4 on PS337. Set the receiver MHz switch to 0MHz. Is the HF loop oscillator output signal displayed?
Action	YES: Step 14 NO: Step 28
STEP 14	Set the receiver MHz switch to 8MHz. Is the HF loop oscillator output signal displayed?
Action	YES: Step 15 NO: Step 30
STEP 15	Set the receiver MHz switch to 18MHz. Is the HF loop oscillator output signal displayed?
Action	YES: Step 16 NO: Step 31
STEP 16	Connect the oscilloscope to pin 22 on PS337. Is the local oscillator (LO) output signal displayed?
Action	YES: Step 17 NO: Suspect a fault on PS337, in the area of the output amplifier (TR14) or the diode switch (D16, D17, D18).
STEP 17	Connect the oscilloscope to pin 24 on PS337. Is the LO output signal displayed?
Action	YES: Step 18 NO: Suspect a fault on PS338, in the area of the output amplifier (TR15) or the diode switch (D16, D17, D18).
STEP 18	Connect the oscilloscope to TP5 on PS337. Is an approximate square wave signal displayed?
Action	YES: Step 19 NO: Suspect a fault on PS337, in the area of TR11, TR12, ML2a.

STEP 19	Connect the oscilloscope to ML7 pin 3 on PS337. Is a positive-going pulse signal displayed?
Action	YES: Step 20 NO: Suspect a fault on PS337, in the area of the programmed divider N3 (ML3, ML5, ML4, ML2b, ML9, ML6).
STEP 20	Connect the oscilloscope to TP7 on PS337. Is a varying-width pulse signal displayed?
Action	NO: Step 21 YES: Step 32
STEP 21	Connect the oscilloscope to TP8 on PS337. Is a varying-width pulse signal displayed?
Action	NO: Step 22 YES: Step 23
STEP 22	Connect the oscilloscope to TP7 on PS337. Is a narrow fixed-width pulse signal displayed?
Action	YES: Step 23 NO: Suspect a fault on PS337, in the area of the phase comparator (ML6, ML7) or an incorrect voltage/frequency characteristic of the HF loop oscillator.
STEP 23	Connect the oscilloscope to TP8 on PS337. Is a narrow fixed-width pulse signal displayed?
Action	YES: Step 24 NO: Suspect a fault on PS337, in the area of the phase comparator (ML6, ML7) or an incorrect voltage/frequency characteristic of the HF loop oscillator.
STEP 24	Is the OUT OF LOCK indicator lamp extinguished?
Action	YES: Step 25 NO: Suspect a fault on PS337, in the area of the lock indicator circuit (ML8*, ML10*, ML11, ML6).
STEP 25	Are the coding inputs (MHz data inputs) from the logic board correct for the MHz switch position selected?
Action	YES: Step 26 NO: Suspect a fault on the logic board or a wiring fault.

* Earlier versions only

STEP 26	Set the kHz portion of the receiver frequency to 000.00. Connect the digital frequency meter, in turn, to TP5 and TP6 on PS337 and record the frequencies displayed for each position of the receiver MHz switch. Compute the frequency ratio (N3) for each switch position, which should equal 40 plus the MHz switch setting. Is the frequency ratio correct?
Action	YES: No fault apparent. NO: Suspect a fault on PS337, in the area of the programmed divider N3 (ML3, ML5, ML9, ML2, ML6).
STEP 27	Are the coding inputs (MHz data inputs) from the logic board correct for the MHz switch position selected?
Action	YES: Suspect a fault on PS338, in the area of the programmed divider N3 (ML1, ML2, ML4, ML5, ML6). NO: Suspect a fault on the logic board or a wiring fault.
STEP 28	Connect the oscilloscope to the junction of diodes D10, D11 and D12 on PS337. Is the HF loop oscillator output signal displayed?
Action	YES: Suspect a fault on PS337, in the area of TR10. NO: Step 29
STEP 29	Set the front panel MHz switch to 18. Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and TP3 on PS337. Does the multimeter indicate approximately +12V?
Action	YES: Suspect a fault on PS337, in the area of oscillator 1 (TR6, TR9). NO: Suspect a fault on PS337, in the area of ML1, or TR3, or faulty logic board, or faulty wiring.
STEP 30	Set the front panel MHz switch to 8. Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and TP2 on PS337. Does the multimeter indicate approximately +12V?
Action	YES: Suspect a fault on PS337, in the area of oscillator 2 (TR5, TR8). NO: Suspect a fault on PS337, in the area of TR2, or faulty logic board, or faulty wiring.

STEP 31	Set the front panel MHz switch to 0. Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and TP1 on PS337. Does the multimeter indicate approximately +12V?
Action	YES: Suspect a fault on PS337, in the area of oscillator 3 (TR4, TR7). NO: Suspect a fault on PS337, in the area of TR1, or faulty logic board, or faulty wiring.
STEP 32	Connect the multimeter, set to the 10 volt d.c. range, between chassis (negative) and the junction of L21, L22 and L23 on PS337. Does the multimeter indicate a static voltage level of approximately +3V?
Action	YES: Suspect a fault on PS337, in the area of the varactor diode of the selected HF loop oscillator, or incorrect coil adjustment. NO: Suspect a fault on PS337, in the area of TR19.
STEP 33	Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and the junction of L21, L22 and L23 on PS337. Does the multimeter indicate a static voltage level of approximately +18V?
Action	YES: Suspect a fault on PS337, in the area of the varactor diode of the selected HF loop oscillator, or incorrect coil adjustment. NO: Suspect a fault on PS337, in the area of TR16, TR18.

34MHz GENERATOR BOARD PM339

FLOW CHART 6

STEP 1	Set the AFC switch, if fitted, to OFF. Set the rear panel 1MHz and 34MHz switches to INT. Connect the negative lead of the multimeter, set to the 25 volt d.c. range, to chassis and connect the positive lead, in turn, to the following board pins.

PIN	VOLTAGE
1	+5
2	+20
9	+12

	Are all the voltages correct?
Action	YES: Step 2 NO: Suspect a power supply fault or faulty wiring.
STEP 2	Connect the oscilloscope to TP3. Is a 1MHz square wave, 3:2 mark/space ratio, approximate amplitude 2V peak-to-peak displayed?
Action	YES: Step 3 NO: Step 19
STEP 3	Connect the HF electronic voltmeter, 50 ohms impedance, to the 1MHz IN/OUT socket. Does the voltmeter indicate at least 180 millivolts r.m.s.?
Action	YES: Step 4. NO: Suspect a fault in the area of amplifier stage TR9 or faulty wiring.
STEP 4	Connect the oscilloscope to the collector (can) of TR13. Is a 1MHz approximate square wave signal of 3V peak-to-peak amplitude displayed?
Action	YES: Step 5 NO: Suspect a faulty shaper stage, TR13, or a faulty gate, G8, G9, G10 or G11.
STEP 5	Connect the oscilloscope to board pin 6. Is a 1MHz approximate square wave signal of approximately 3V peak-to-peak amplitude displayed?
Action	YES: Step 6 NO: Suspect a fault in the area of G8.

STEP 6	Connect the oscilloscope to board pin 8. Is a 1MHz approximate square wave signal of approximately 0.2V peak-to-peak amplitude displayed?
Action	YES: Step 7 NO: Suspect a fault in the area of G9.
STEP 7	Connect the oscilloscope to TP9. Is a 1MHz approximate square wave signal of at least 2V peak-to-peak in amplitude displayed?
Action	YES: Step 8 NO: Suspect a fault in the area of G10.
STEP 8	Set the MODE switch to USB. Connect the oscilloscope to TP7. Is a 200kHz 3:2 mark/space ratio square wave of approximately 3.5V peak-to-peak amplitude displayed?
Action	YES: Step 9 NO: Step 21
STEP 9	Connect the oscilloscope to TP15. Is the amplitude of the 1.4MHz waveform displayed approximately 400 millivolts peak-to-peak?
Action	YES: Step 10 NO: Suspect a fault in the area of the crystal filter (XL2, XL3), TR15, TR16, or incorrect setting of T2 or R65 (see Chapter 5).
STEP 10	Connect the oscilloscope to board pin 10. Is a 1.4MHz signal of approximately 0.8V peak-to-peak amplitude displayed?
Action	YES: Step 11 NO: Suspect a fault in the area of TR20.
STEP 11	Connect the oscilloscope to board pin 11. Is a 1.4MHz signal of approximately 0.8V peak-to-peak amplitude displayed?
Action	YES: Step 12 NO: Suspect a fault in the area of TR21.
STEP 12	Connect the digital frequency meter to board pin 10. Is a frequency of 1 400 000Hz plus or minus 1Hz displayed?
Action	YES: Step 13 NO: Suspect a fault in the area of ML8 or the 1.4MHz crystal filter (XL2, XL3).

STEP 13	Set the MODE switch to CW. Connect the oscilloscope to board pin 10. Is a 1.4MHz signal of approximately 0.5V peak-to-peak amplitude displayed?
Action	YES: Step 14 NO: Step 24
STEP 14	Connect the digital frequency meter to board pin 11. Set the BFO control to +. Is a frequency of 1 397 000Hz plus or minus 100Hz displayed?
Action	YES: Step 15 NO: Suspect an incorrect setting of R4 or L4 (see Chapter 5), a faulty BFO control or associated components, or an incorrect voltage/frequency characteristic of the 1.4MHz VCO (TR8).
STEP 15	Set the BFO control to -. Is a frequency of 1 403 000Hz plus or minus 100Hz displayed?
Action	YES: Step 16 NO: Suspect an incorrect setting of R4 or L4 (see Chapter 5), a faulty BFO control or associated components, or an incorrect voltage/frequency characteristic of the 1.4MHz VCO (TR8).
STEP 16	Connect the HF electronic voltmeter, high impedance input, to board pin 20. Does the voltmeter indicate between 800 millivolts and 1.4 volts r.m.s.?
Action	YES: Step 17 NO: Step 25
STEP 17	Connect the HF electronic voltmeter, 50 ohms impedance input, to the 34MHz IN/OUT socket. Does the voltmeter indicate at least 180 millivolts r.m.s.?
Action	YES: Step 18 NO: Suspect a fault in the area of the diode switch (D5, D6) or a wiring fault.
STEP 18	Connect the digital frequency meter to board pin 20. Connect the 1MHz IN/OUT socket on the rear panel to the external 1MHz input socket on the digital frequency meter and set the meter to operate from an external standard. Is a frequency of 34 000 000Hz displayed?
Action	YES: No fault apparent. NO: Step 30

STEP 19	Connect the oscilloscope to TP2. Is an approximate 5MHz square wave signal, 3V peak-to-peak amplitude, displayed?
Action	NO: Step 20 YES: Suspect a fault in the area of the divide-by-five stage (ML1) or TR9.
STEP 20	Connect the oscilloscope to board pin 27. Is a 5MHz signal of approximately 700 millivolts peak-to-peak amplitude displayed?
Action	YES: Suspect a fault in the area of the amplifier/shaper stage TR2, TR4. NO: Suspect a faulty 5MHz frequency standard module or a wiring fault.
STEP 21	Connect the oscilloscope to TP12. Is a 1MHz 3:2 mark/space ratio square wave signal of approximately 3.5V peak-to-peak displayed?
Action	NO: Step 22 YES: Suspect a fault in the area of the divide-by-five stage ML8.
STEP 22	Connect the oscilloscope to the collector (can) of TR14. Does the oscilloscope indicate a d.c. voltage level of approximately +5V?
Action	NO: Step 23 YES: Suspect a fault in the area of G11, or faulty wiring to board pin 15.
STEP 23	Connect the oscilloscope to board pin 15. Does the oscilloscope indicate 0V?
Action	YES: Suspect a fault in the area of TR14. NO: Suspect a faulty MODE switch or a wiring fault.
STEP 24	Connect the oscilloscope to board pin 15. Does the oscilloscope indicate 0V?
Action	YES: Suspect a fault in the area of the 1.4MHz VCO, TR8. NO: Suspect a faulty MODE switch or a wiring fault.
STEP 25	Connect the HF electronic voltmeter, high impedance input, to TP5. Does the voltmeter indicate approximately 400 millivolts r.m.s.?
Action	NO: Step 26 YES: Suspect a fault in the area of the output amplifier stage TR11, TR12.

STEP 26	Connect the HF electronic voltmeter, high impedance input, to the collector (can) of TR5. Does the voltmeter indicate approximately 400 millivolts r.m.s.?
Action	NO: Step 27 YES: Suspect a fault in the area of the diode switch (D5,D6).
STEP 27	Connect the HF electronic voltmeter, high impedance input, to TP4. Does the voltmeter indicate approximately 750 millivolts r.m.s.?
Action	NO: Step 28 YES: Suspect a fault in the area of the amplifier stage TR3, TR5.
STEP 28	Connect the multimeter, set to the 10 volt d.c. range, to the junction of C4 and the emitter of TR1. Does the multimeter indicate approximately +5V?
Action	NO: Step 29 YES: Suspect a fault in the area of the 34MHz VCO (TR6/TR7).
STEP 29	Connect the oscilloscope to board pin 12. Does the oscilloscope indicate 0V?
Action	YES: Suspect the 34MHz switch is not set to INT, or suspect a faulty 34MHz switch or switch wiring. NO: Suspect a fault in the area of the voltage regulator transistor TR1.
STEP 30	Connect the oscilloscope to TP11. Is a 1MHz 3:2 mark/space ratio square wave signal of approximately 3.5V peak-to-peak displayed?
Action	YES: Step 31 NO: Suspect a faulty gate, G5, G6, G7 or G8.
STEP 31	Connect the oscilloscope to ML4 pin 2. Is a 1MHz 3:2 mark/space ratio square wave signal of approximately 3.5V peak-to-peak displayed?
Action	YES: Step 32 NO: Suspect a fault in the area of the divide-by-34 stage (ML3, ML4, G2, G3).

STEP 32	Connect the oscilloscope to TP14. Is a narrow fixed-width negative-going pulse signal of approximately 3.5V peak-to-peak displayed?
Action	YES: Step 33 NO: Suspect a fault in the area of the phase comparator, ML6, G12, or incorrect voltage/frequency characteristic of the 34MHz VCO, a faulty varactor diode (D4) or incorrect adjustment of L2 (Chapter 5).
STEP 33	Connect the oscilloscope to ML6 pin 6. Is a narrow fixed-width negative-going pulse signal of approximately 3.5V peak-to-peak displayed?
Action	YES: Step 34 NO: Suspect a fault in the area of the phase comparator, ML6, G12, or incorrect voltage/frequency characteristic of the 34MHz VCO, a faulty varactor diode (D4) or incorrect adjustment of L2 (Chapter 5).
STEP 34	Connect the multimeter, set to the 10 volt d.c. range to TP1. Does the multimeter indicate approximately +7V?
Action	YES: No fault apparent. NO: Suspect fault in the area of the voltage control circuit (TR17, TR18, TR19), D4 or the loop filter (C62, C64, R70).

MAIN IF/AF BOARD PM674

FLOW CHART 7

STEP 1

Connect the multimeter, set to the 25 volt d.c. range, between chassis (0V) and the following board pins, in turn (observe correct polarity).

Pin No.	Voltage
13	+12
14	+14.5
20	-7

Are all the voltages correct?

Action

YES: Step 2
NO: Check power supply and connections to the board.

STEP 2

Unsolder the coaxial lead connected to pin 2 on the filter board PS367 (the screen may be left connected to pin 3). Connect the 1 kilohm resistor in series with the coaxial lead connected to the 50 ohm output of the signal generator and connect the other end of this lead to the coaxial lead removed from pin 2 of the filter board. Set the signal generator frequency to 1.4 MHz plus or minus 500 Hz and set the output level to 64 microvolts e.m.f. Connect the HF electronic voltmeter, high impedance input, to TP2. Does the voltmeter indicate approximately 200 millivolts r.m.s.?

Action

YES: Step 3
NO: Step 17

STEP 3

Connect the HF electronic voltmeter, high impedance input, to TP3. Does the voltmeter indicate approximately 200 millivolts r.m.s.?

Action

YES: Step 4
NO: Suspect a fault in the area of TR2, the 1.4 MHz band pass filter (L1, L2 etc.), or an incorrect setting of R23 (see Chapter 5).

STEP 4	Connect the HF electronic voltmeter, high impedance input, to TP4. Does the voltmeter indicate between 90 and 130 millivolts r.m.s.?
Action	YES: Step 5 NO: Suspect a fault in the area of TR6.
STEP 5	Connect the HF electronic voltmeter, 50 ohms impedance input, to the MAIN IF OUT socket on the rear panel. Ensure that the signal generator output level is set to 64 microvolts e.m.f. CW. Does the voltmeter indicate approximately 50 millivolts r.m.s.?
Action	YES: Step 6 NO: Suspect a fault in the area of TR4, TR3.
STEP 6	Connect the LF electronic voltmeter to TP7. Does the voltmeter indicate between 50 and 90 millivolts r.m.s.?
Action	YES: Step 7 NO: Suspect a fault in the area of the product detector.
STEP 7	Set the MODE switch to AM. Set the signal generator for 30 percent amplitude modulation at 1 kHz and an output level of 180 microvolts e.m.f. Connect the LF electronic voltmeter to TP7. Does the voltmeter indicate between 50 and 90 millivolts r.m.s.?
Action	YES: Step 8 NO: Suspect a fault in the area of the AM detector.
STEP 8	Set the MODE switch to USB. Set the signal generator output level to 64 microvolts e.m.f. CW. Connect the LF electronic voltmeter to board pin 8. Ensure that the MUTE terminal on the rear panel is not earthed. Does the voltmeter indicate at least 150 millivolts r.m.s.?
Action	YES: Step 9 NO: Suspect a fault in the area of the audio pre-amplifier.

STEP 9	Connect the output power meter, 600 ohms impedance input, to the LINE OUTPUT MAIN IF terminals of TS1. Set the AM/USB LINE LEVEL control fully clockwise. Does the output power meter indicate at least 4 milliwatts?
Action	YES: Step 10 NO: Suspect a fault in the area of the line amplifier ML5.
STEP 10	Connect the output power meter, 8 ohms impedance input, to the LS and E terminals of TS1. Set the AF GAIN control fully clockwise. Does the output power meter indicate at least 1 watt?
Action	YES: Step 11 NO: Suspect a fault in the area of the loudspeaker amplifier ML6.
STEP 11	Connect the HF electronic voltmeter, high impedance input, to TP3 and adjust the signal generator output level for an indication of 200 millivolts r.m.s. Connect the multimeter, set to the 10 volt d.c. range, between board pin 29 (positive) and chassis. Does the multimeter indicate +1.40 volts plus or minus 100 millivolts?
Action	YES: Step 12 NO: Step 18
STEP 12	Increase the signal generator output level by 4 dB. Does the multimeter (connected to board pin 29) indicate at least 3.0V d.c.?
Action	YES: Step 13 NO: Step 18
STEP 13	Connect the multimeter to board pin 30 (positive) and chassis. Connect the HF electronic voltmeter, high impedance input, to TP3 and record the level indicated (IF GAIN control fully clockwise). Adjust the IF GAIN control for an indication of 1.4V plus or minus 30 millivolts on the multimeter. Has the signal level at TP3 fallen by not more than 1 dB?
Action	YES: Step 14 NO: Suspect an incorrect setting of R6, R7 and R9 (See Chapter 5).

STEP 14	Connect the multimeter, set to the 25 volt d.c. range, between TP6 (positive) and the -7 volt rail at board pin 20. Does the multimeter indicate approximately +14V?
Action	YES: Step 15 NO: Suspect a fault in the area of ML4A, TR10, or an incorrect setting of R55 (See Chapter 5).
STEP 15	Reduce the signal generator output level until the multimeter indication changes to approximately +7 volts. Does the reduction in the signal generator output level approximate 4 dB?
Action	YES: Step 16 NO: Suspect a fault in the area of ML4A, TR10, or an incorrect setting of R55 (See Chapter 5).
STEP 16	Connect the multimeter, set to the 25 volt d.c. range, between TP9 (negative) and chassis. Does the multimeter indicate approximately -6V?
Action	YES: No fault apparent. NO: Suspect a fault in the area of TR5 or ML4B.
STEP 17	Set the IF GAIN control fully clockwise. Connect the multimeter, set to the 10 volt d.c. range, between TP1 (positive) and chassis. Does the multimeter indication exceed 4 volts?
Action	YES: Suspect a fault in the area of the AGC LEVEL control, ML3A or incorrect setting of R6, R7 and R9. NO: Suspect a fault in the area of ML1, ML2.
STEP 18	Connect the digital voltmeter between the positive lead of C22 and chassis. Does the voltmeter indicate approximately +80 millivolts d.c.?
Action	YES: Step 19 NO: Suspect a fault in the area of TR7/TR8 or an incorrect setting of R45 (See Chapter 5).

<u>STEP 19</u>	Increase the signal generator output level by 4 dB. Has the digital voltmeter indication increased to approximately +160 millivolts?
<u>Action</u>	YES: Suspect a fault in the area of ML3B. NO: Suspect a fault in the area of TR7/TR8 or an incorrect setting of R45 (See Chapter 5).

MAIN IF/AF BOARD PM364/1

FLOW CHART 7a

STEP 1

Connect the multimeter, set to the 25 volt d.c. range, between chassis (0V) and the following board pins, in turn (observe correct polarity).

PIN NO.	VOLTAGE
13	+12
14	+14.5
20	-7

Are all the voltages correct?

Action

YES: Step 2
NO: Check power supply and connections to the board

STEP 2

Set the receiver AGC switch to OFF, the RF TUNE control (if fitted) to WB, the AFC switch (if fitted) to OFF, and the MODE switch to USB. Set the IF GAIN fully clockwise and the AF GAIN control fully counter-clockwise. Set the POWER switch to OFF. Unsolder and remove link LK1 from the board. Connect the multimeter, set to the 100 milliamp d.c. range, between the pins of LK1, with the negative lead of the multimeter connected to the pin nearest to the edge of the board Set the POWER switch to ON. Does the multimeter indicate approximately 15 milliamps?

Action

YES: Replace LK1 and proceed to Step 3.
NO: Suspect an incorrect setting of R84 or a faulty loudspeaker amplifier circuit.

STEP 3

Unsolder the coaxial lead connected to pin 2 on the filter board PS367 (the screen may be left connected to pin 3). Connect the 1 kilohm resistor in series with the coaxial lead connected to the 50 ohm output of the signal generator and connect the other end of this lead to the coaxial lead removed from pin 2 of the filter board Set the signal generator frequency to 1.4MHz plus or minus 500Hz and set the output level to 64 microvolts e.m.f. Connect the HF electronic voltmeter, high impedance input, to TP2. Does the voltmeter indicate approximately 100 millivolts r.m.s?

Action	YES: Step 4 NO: Step 18
STEP 4	Connect the HF electronic voltmeter, high impedance input, to TP3. Does the voltmeter indicate approximately 200 millivolts r.m.s.?
Action	YES: Step 5 NO: Suspect a fault in the area of TR2, the 1.4MHz band pass filter (L1, L2 etc.), or an incorrect setting of R9 (see Chapter 5).
STEP 5	Connect the HF electronic voltmeter, high impedance input, to TP4. Does the voltmeter indicate between 90 and 130 millivolts r.m.s.?
Action	YES: Step 6 NO: Suspect a fault in the area of TR8.
STEP 6	Connect the HF electronic voltmeter, 50 ohms impedance input, to the MAIN IF OUT socket on the rear panel. Ensure that the signal generator output level is set to 64 microvolts e.m.f. CW. Does the voltmeter indicate approximately 50 millivolts r.m.s.?
Action	YES: Step 7 NO: Suspect a fault in the area of TR4, TR6.
STEP 7	Connect the LF elctronic voltmeter to TP7. Does the voltmeter indicate between 50 and 90 millivolts r.m.s.?
Action	YES: Step 8 NO: Suspect a fault in the area of the product detector.
STEP 8	Set the MODE switch to AM. Set the signal generator for 30 percent amplitude modulation at 1kHz and an output level of 180 microvolts e.m.f. Connect the LF electronic voltmeter to TP7. Does the voltmeter indicate between 50 and 90 millivolts r.m.s.?
Action	YES: Step 9 NO: Suspect a fault in the area of the AM detector.

STEP 9	Set the MODE switch to USB. Set the signal generator output level to 64 microvolts e.m.f. CW. Connect the LF electronic voltmeter to board pin 8. Ensure that the MUTE terminal on the rear panel is not earthed. Does the voltmeter indicate at least 150 millivolts r.m.s.?
Action	YES: Step 10 NO: Suspect a fault in the area of the audio pre-amplifier.
STEP 10	Connect the output power meter, 600 ohms impedance input, to the LINE OUTPUT MAIN IF terminals of TS1. Set the AM/USB LINE LEVEL control fully clockwise. Does the output power meter indicate at least 4 milliwatts?
Action	YES: Step 11 NO: Suspect a fault in the area of the line amplifier.
STEP 11	Connect the output power meter, 8 ohms impedance input, to the LS and E terminals of TS1. Set the AF GAIN control fully clockwise. Does the output power meter indicate at least 1 watt?
Action	YES: Step 12 NO: Suspect a fault in the area of the loudspeaker amplifier.
STEP 12	Connect the LF electronic voltmeter to TP3 and adjust the signal generator output level for an indication of 200 milliwatts r.m.s. Connect the multimeter, set to the 10 volt d.c. range, between board pin 29 (positive) and chassis. Does the multimeter indicate +1.40 volts plus or minus 100 millivolts?
Action	YES: Step 13 NO: Step 19
STEP 13	Increase the signal generator output level by 4dB. Does the multimeter (connected to board pin 29) indicate at least 3.0V d.c.?
Action	YES: Step 14 NO: Step 19

STEP 14		Connect the multimeter to board pin 30 (positive). Connect the HF electronic voltmeter, high impedance input, to TP3 and record the level indicated (IF GAIN control fully clockwise). Adjust the IF GAIN control for an indication of 1.4V plus or minus 30 millivolts on the multimeter. Has the signal level at TP3 fallen by not more than 1dB?
Action		YES: Step 15 NO: Suspect an incorrect setting of R4 (see Chapter 5).
STEP 15		Connect the multimeter, set to the 25 volt d.c. range, between TP6 (positive) and the -7 volt rail at board pin 20. Does the multimeter indicate approximately +6V?
Action		YES: Step 16 NO: Suspect a fault in the area of ML3, TR11, or an incorrect setting of R42 (see Chapter 5).
STEP 16		Reduce the signal generator output level until the multimeter indication changes to approximately +14 volts. Does the reduction in the signal generator output level approximate 4dB?
Action		YES: Step 17 NO: Suspect a fault in the area of ML3, TR11, or an incorrect setting of R42 (see Chapter 5).
STEP 17		Connect the multimeter, set to the 25 volt d.c. range, between TP9 (negative) and chassis. Does the multimeter indicate approximately -6V?
Action		YES: No fault apparent. NO: Suspect a fault in the area of TR3 or ML4.
STEP 18		Set the IF GAIN control fully clockwise. Connect the multimeter, set to the 2.5 volt d.c. range, between TP1 (positive) and chassis. Does the multimeter indication exceed 1.2 volts?
Action		YES: Suspect a fault in the area of the IF GAIN control, TR1, R4. NO: Suspect a fault in the area of ML1.

STEP 19	Connect the digital voltmeter between the positive lead of C20 and chassis. Does the voltmeter indicate approximately +80 millivolts d.c.?
Action	YES: Step 20 NO: Suspect a fault in the area of TR7/TR9 or an incorrect setting of R31 (see Chapter 5).
STEP 20	Increase the signal generator output level by 4dB. Has the digital voltmeter indication increased to approximately +160 millivolts?
Action	YES: Suspect a fault in the area of ML2. NO: Suspect a fault in the area of TR7/TR9 or an incorrect setting of R31 (see Chapter 5).

ISB IF/AF BOARD PM674

FLOW CHART 8

NOTE: This chart applies to ISB versions only. Before proceeding, check that the main IF/AF board is functioning correctly.

STEP 1

Connect the multimeter, set to the 25 volt d.c. range, between chassis (0V) and the following board pins, in turn (observe correct polarity).

Pin No.	Voltage
13	+12
14	+14.5
20	-7

Are all the voltages correct?

Action

YES: Step 2
NO: Check power supply and connections to the board.

STEP 2

Set the receiver AGC switch to OFF, the RF TUNE control (if fitted) to WB, the AFC switch (if fitted) to OFF, and the MODE switch to LSB. Set the IF GAIN fully clockwise and the AF GAIN control fully counter-clockwise. Unsolder the coaxial lead connected to pin 4 on the filter board PS367 (the screen may be left connected to pin 5). Connect the 1 kilohm resistor in series with the coaxial lead connected to the 50 ohm output of the signal generator and connect the other end of this lead to the coaxial lead removed from pin 4 of the filter board. Set the signal generator frequency to 1.4 MHz plus or minus 500 Hz and set the output level to 64 microvolts e.m.f. Connect the HF electronic voltmeter, high impedance input, to TP2. Does the voltmeter indicate approximately 200 millivolts r.m.s?

Action

YES: Step 3
NO: Step 16

STEP 3	Connect the HF electronic voltmeter, high impedance input, to TP3. Does the voltmeter indicate approximately 200 millivolts r.m.s?	
Action	YES: Step 4 NO: Suspect a fault in the area of TR2, the 1.4 MHz bandpass filter (L1, L2 etc.), or an incorrect setting of R23 (see Chapter 5).	
STEP 4	Connect the HF electronic voltmeter, high impedance input, to TP4. Does the voltmeter indicate between 90 and 130 millivolts r.m.s.?	
Action	YES: Step 5 NO: Suspect a fault in the area of TR6.	
STEP 5	Connect the HF electronic voltmeter, 50 ohms impedance input, to the ISB IF OUT socket on the rear panel. Ensure that the signal generator output level is set to 64 microvolts e.m.f. CW. Does the voltmeter indicate approximately 50 millivolts r.m.s.?	
Action	YES: Step 6 NO: Suspect a fault in the area of TR4, TR3.	
STEP 6	Connect the LF electronic voltmeter to TP7. Does the voltmeter indicate between 50 and 90 millivolts r.m.s.?	
Action	YES: Step 7 NO: Suspect a fault in the area of the product detector.	
STEP 7	Connect the LF electronic voltmeter to board pin 8. Ensure that the MUTE terminal on the rear panel is not earthed. Does the voltmeter indicate at least 150 millivolts r.m.s.?	
Action	YES: Step 8 NO: Suspect a fault in the area of the audio pre-amplifier.	
STEP 8	Connect the output power meter, 600 ohms impedance input, to the ISB LINE OUTPUT terminals of TS1. Set the LSB LINE LEVEL control fully clockwise. Does the output power meter indicate at least 4 milliwatts?	
Action	YES: Step 9 NO: Suspect a fault in the area of the line amplifier ML5.	

STEP 9	Connect the output power meter, 8 ohms impedance input, to the LS and E terminals of TS1. Set the AF GAIN control fully clockwise. Set the MODE switch, in turn, to ISB-L and ISB-U. Does the output power meter indicate at least 1 watt for each position?
Action	YES: Step 10 NO: Suspect a fault in the area of the MODE switch or a wiring fault.
STEP 10	Set the MODE switch to LSB. Connect the HF electronic voltmeter, high impedance input, to TP3 and adjust the signal generator output level for an indication of 200 millivolts r.m.s. Connect the multimeter, set to the 10 volt d.c. range, between board pin 29 (positive) and chassis. Does the multimeter indicate +1.40 volts plus or minus 100 millivolts?
Action	YES: Step 11 NO: Step 17
STEP 11	Increase the signal generator output level by 4 dB. Does the multimeter (connected to board pin 29) indicate at least 3.0V d.c.?
Action	YES: Step 12 NO: Step 17
STEP 12	Connect the multimeter to board pin 30 (positive) and chassis. Connect the HF electronic voltmeter, high impedance input, to TP3 and record the level indicated (IF GAIN control fully clockwise). Adjust the IF GAIN control for an indication of 1.4V plus or minus 30 millivolts on the multimeter. Has the signal level at TP3 fallen by not more than 1 dB?
Action	YES: Step 13 NO: Suspect an incorrect setting of R6, R7 and R9 (see Chapter 5).
STEP 13	Connect the multimeter, set to the 25 volt d.c. range, between TP6 (positive) and the -7 volt rail at board pin 20. Does the multimeter indicate approximately +14V?
Action	YES: Step 14 NO: Suspect a fault in the area of ML4A, TR10, or an incorrect setting of R55 (see Chapter 5).

STEP 14	Reduce the signal generator output level until the multimeter indication changes to approximately +7 volts. Does the reduction in the signal generator output level approximate 4 dB.
Action	YES: Step 15 NO: Suspect a fault in the area of ML4A, TR10, or an incorrect setting of R55 (see Chapter 5).
STEP 15	Connect the multimeter, set to the 25 volt d.c. range between TP9 (negative) and chassis. Does the multimeter indicate approximately -6V?
Action	YES: No fault apparent. NO: Suspect a fault in the area of TR5 or ML4B.
STEP 16	Set the IF GAIN control fully clockwise. Connect the multimeter, set to the 10 volt d.c. range, between TP1 (positive) and chassis. Does the multimeter indication exceed 4 volts?
Action	YES: Suspect a fault in the area of the AGC LEVEL control ML3A or incorrect setting of R6, R7 and R9. NO: Suspect a fault in the area of ML1, ML2
STEP 17	Connect the digital voltmeter between the positive lead of C22 and chassis. Does the voltmeter indicate approximately +80 millivolts d.c.?
Action	YES: Step 18 NO: Suspect a fault in the area of TR7/TR8 or an incorrect setting of R45 (see Chapter 5).
STEP 18	Increase the signal generator output level by 4 dB. Has the digital voltmeter indication increased to approximately +160 millivolts?
Action	YES: Suspect a fault in the area of ML3B. NO: Suspect a fault in the area of TR7/TR8 or an incorrect setting of R45 (see Chapter 5).

ISB IF/AF BOARD PM364/3

FLOW CHART 8a

NOTE: This chart applies to ISB versions only. Before proceeding, check that the main IF/AF board is functioning correctly.

STEP 1

Connect the multimeter, set to the 25 volt d.c. range, between chassis (0V) and the following board pins, in turn (observe correct polarity).

PIN NO.	VOLTAGE
13	+12
14	+14.5
20	-7

Are all the voltages correct?

Action

YES: Step 2
NO: Check power supply and connections to the board.

STEP 2

Set the receiver AGC switch to OFF, the RF TUNE control (if fitted) to WB, the AFC switch (if fitted) to OFF, and the MODE switch to LSB. Set the IF GAIN fully clockwise and the AF GAIN control fully counter-clockwise. Unsolder the coaxial lead connected to pin 4 on the filter board PS367 (the screen may be left connected to pin 5). Connect the 1 kilohm resistor in series with the coaxial lead connected to the 50 ohm output of the signal generator and connect the other end of this lead to the coaxial lead removed from pin 4 of the filter board. Set the signal generator frequency to 1.4MHz plus or minus 500Hz and set the output level to 64 microvolts e.m.f. Connect the HF electronic voltmeter, high impedance input, to TP2. Does the voltmeter indicate approximately 100 millivolts r.m.s?

Action

YES: Step 3
NO: Step 16

STEP 3	Connect the HF electronic voltmeter, high impedance input, to TP3. Does the voltmeter indicate approximately 200 millivolts r.m.s.?
Action	YES: Step 4 NO: Suspect a fault in the area of TR2, the 1.4MHz bandpass filter (L1, L2 etc.), or an incorrect setting of R9 (see Chapter 5).
STEP 4	Connect the HF electronic voltmeter, high impedance input, to TP4. Does the voltmeter indicate between 90 and 130 millivolts r.m.s.?
Action	YES: Step 5 NO: Suspect a fault in the area of TR8.
STEP 5	Connect the HF electronic voltmeter, 50 ohms impedance input, to the ISB IF OUT socket on the rear panel. Ensure that the signal generator output level is set to 64 microvolts e.m.f. CW. Does the voltmeter indicate approximately 50 millivolts r.m.s.?
Action	YES: Step 6 NO: Suspect a fault in the area of TR4, TR6.
STEP 6	Connect the LF electronic voltmeter to TP7. Does the voltmeter indicate between 50 and 90 millivolts r.m.s.?
Action	YES: Step 7 NO: Suspect a fault in the area of the product detector.
STEP 7	Connect the LF electronic voltmeter to board pin 8. Ensure that the MUTE terminal on the rear panel is not earthed. Does the voltmeter indicate at least 150 millivolts r.m.s.?
Action	YES: Step 8 NO: Suspect a fault in the area of the audio pre-amplifier.
STEP 8	Connect the output power meter, 600 ohms impedance input, to the ISB LINE OUTPUT terminals of TS1. Set the LSB LINE LEVEL control fully clockwise. Does the output power meter indicate at least 4 milliwatts?
Action	YES: Step 9 NO: Suspect a fault in the area of the line amplifier.

STEP 9	Connect the output power meter, 8 ohms impedance input, to the LS and E terminals of TS1. Set the AF GAIN control fully clockwise. Set the MODE switch, in turn, to ISB-L and ISB-U. Does the output power meter indicate at least 1 watt for each position?
Action	YES: Step 10 NO: Suspect a fault in the area of the MODE switch or a wiring fault.
STEP 10	Set the MODE switch to LSB. Connect the LF electronic voltmeter to TP3 and adjust the signal generator output level for an indication of 200 millivolts r.m.s. Connect the multimeter, set to the 10 volt d.c. range, between board pin 29 (positive) and chassis. Does the multimeter indicate +1.40 volts plus or minus 100 millivolts?
Action	YES: Step 11 NO: Step 17
STEP 11	Increase the signal generator output level by 4dB. Does the multimeter (connected to board pin 29) indicate at least 3.0V d.c.?
Action	YES: Step 12 NO: Step 17
STEP 12	Connect the multimeter to board pin 30 (positive). Connect the HF electronic voltmeter, high impedance input, to TP3 and record the level indicated (IF GAIN control fully clockwise). Adjust the IF GAIN control for an indication of 1.4V plus or minus 30 millivolts on the multimeter. Has the signal level at TP3 fallen by not more than 1dB?
Action	YES: Step 13 NO: Suspect an incorrect setting of R4 (see Chapter 5).
STEP 13	Connect the multimeter, set to the 25 volt d.c. range, between TP6 (positive) and the -7 volt rail at board pin 20. Does the multimeter indicate approximately +6V?
Action	YES: Step 14 NO: Suspect a fault in the area of ML3, TR11, or an incorrect setting of R42 (see Chapter 5).

STEP 14	Reduce the signal generator output level until the multimeter indication changes to approximately +14 volts. Does the reduction in the signal generator output level approximate 4dB,
Action	YES: Step 15 NO: Suspect a fault in the area of ML3, TR11, or an incorrect setting of R42 (see Chapter 5).
STEP 15	Connect the multimeter, set to the 25 volt d.c. range between TP9 (negative) and chassis. Does the multimeter indicate approximately -6V?
Action	YES: No fault apparent. NO: Suspect a fault in the area of TR3 or ML4.
STEP 16	Set the IF GAIN control fully clockwise. Connect the multimeter, set to the 2.5 volt d.c. range, between TP1 (positive) and chassis. Does the multimeter indication exceed 1.2 volts?
Action	YES: Suspect a fault in the area of the IF GAIN control, TR1, R4. NO: Suspect a fault in the area of ML1.
STEP 17	Connect the digital voltmeter between the positive lead of C20 and chassis. Does the voltmeter indicate approximately +80 millivolts d.c.?
Action	YES: Step 18 NO: Suspect a fault in the area of TR7/TR9 or an incorrect setting of R31 (see Chapter 5).
STEP 18	Increase the signal generator output level by 4dB. Has the digital voltmeter indication increased to approximately +160 millivolts?
Action	YES: Suspect a fault in the area of ML2. NO: Suspect a fault in the area of TR7/TR9 or an incorrect setting of R31 (see Chapter 5).

FIRST AND SECOND MIXER BOARDS

PM335 AND PM336

FLOW CHART 9

NOTES:

1. Before proceeding with this flow chart ensure that the main IF/AF board is functioning correctly (flow chart 7).

2. The signal plus noise/noise ratio figures given in this flow chart are for a 3kHz SSB filter. The signal plus noise/noise ratio figures for filters of bandwidths other than 3kHz may be computed from:

$$10 \log_{10} \times \frac{\text{Filter Bandwidth (kHz)}}{3}$$

and the result added to or subtracted from the figures specified.

STEP 1

Set the receiver controls as follows:

MHz	15
kHz	020.00
RF TUNE (if fitted)	WB
AGC	SHORT
MODE	USB
AFC (if fitted)	OFF
LS	OFF
Headphones	Plugged in

Connect the output power meter, 8 ohms impedance, between the LS and E terminals of TS1. Connect the signal generator, set to a frequency of 15.02MHz and a CW output level of 1 microvolt e.m.f., to the chassis mounted first mixer input connector in place of the existing lead (see Fig.4). Tune the signal generator for a maximum indication on the output power meter. Set the AF GAIN for a reading of 100mW on the output power meter. Set the AGC switch to OFF and adjust the IF GAIN to restore the output power meter indication to 100mW (0dB reference). Off-tune the signal generator by at least 10kHz. Does the output power meter indication fall by not less than 11dB?

Action

YES: Step 2
NO: Step 3

STEP 2	Set the receiver MHz switch to 3 and the AGC switch to SHORT. Set the signal generator frequency to 3.02MHz and tune it for a maximum indication on the output power meter. Set the AF GAIN for a reading of 100mW on the output power meter, set the AGC switch to OFF and set the IF GAIN to restore the output power meter indication to 100mW. Off-tune the signal generator by at least 10kHz. Does the output power meter indication fall by not less than 11dB?
Action	YES: No fault apparent NO: Suspect a high insertion loss in the 35.415 to 39.4MHz bandpass filter or faulty diode switching circuit on the first mixer board PM335
STEP 3	Set the receiver MHz switch to 8 and the AGC switch to SHORT. Set the signal generator frequency to 8.02MHz and tune it for a maximum indication on the output power meter. Set the AF GAIN for a reading of 100mW on the output power meter, set the AGC switch to OFF and set the IF GAIN to restore the output power meter indication to 100mW. Off-tune the signal generator by at least 10kHz. Does the output power meter indication fall by not less than 11dB?
Action	YES: Suspect a high insertion loss in the 39.4 to 69.4 bandpass filter or faulty diode switching circuit on the first mixer board PM335 NO: Step 4
STEP 4	Set the front panel METER switch to DRIVE LEVEL. Disconnect the signal generator from the first mixer input socket. Temporarily short circuit pins 9 and 10 on the first mixer board PM335. Does the front panel meter indication fall to approximately half-scale whilst the noise level in the headphones remains unchanged?
Action	YES: Step 5 NO: Suspect incorrect setting of R39 or faulty drive amplifier (TR2, TR5) on first mixer board

STEP 5	Unsolder and remove link LK1 from the first mixer board PM335. Connect the signal generator, set to a frequency of 35.400MHz and an output level of 1 microvolt e.m.f., to the T3 side of LK1. Set the AGC switch to SHORT and set the AF GAIN for a reading of 100mW on the output power meter. Set the AGC switch to OFF and set the IF GAIN to restore the output power meter indication to 100mW. Off-tune the signal generator by at least 10kHz. Does the output power meter indication fall by not less than 19dB?
Action	YES: Suspect faulty mixer (TR3, TR4, TR6, TR7), high insertion loss of FL1, or faulty transformer (T5, T7) on the first mixer board PM335 NO: Step 6
STEP 6	Disconnect the signal generator and replace LK1 on the first mixer board. Unsolder and remove link LK2 from the first mixer board. Connect the signal generator, set to a frequency of 35.400MHz and an output level of 1 microvolt e.m.f., to the FL1 side of LK2. Set the AGC switch to SHORT and set the AF GAIN for a reading of 100mW on the output power meter. Set the AGC switch to OFF and set the IF GAIN to restore the output power meter indication to 100mW. Off-tune the signal generator by at least 10kHz. Does the output power meter indication fall by not less than 15dB?
Action	YES: Suspect high insertion loss of filter FL1 on the first mixer board PM335 NO: Step 7
STEP 7	Replace link LK2 on the first mixer board PM335. Unsolder and remove LK1 from the second mixer board PM336. Connect the signal generator, set to a frequency of 35.400MHz and an output level of 10 microvolts e.m.f., via a 0.1uF capacitor to the base of TR9. Set the AGC switch to SHORT and set the AF GAIN for a reading of 100mW on the output power meter. Set the AGC switch to OFF and set the IF GAIN control to restore the output power meter indication to 100mW. Off-tune the signal generator by at least 10kHz. Does the output power meter indication fall by not less than 12dB?
Action	YES: Suspect a low gain first IF amplifier on the second mixer board PM336. Refer to step 8 to isolate faulty area NO: Step 9

STEP 8	Set the rear panel 34MHz INT/EXT switch to EXT. Unsolder and remove link LK2 from the first mixer board PM335. Replace link LK1 on the second mixer board PM336. Connect the output from the signal generator, set to a frequency of 35.400MHz and an output level of 20 millivolts e.m.f., to the FL1 side of LK2 on the first mixer board. Use the HF electronic voltmeter, high impedance input, to monitor the following points on the second mixer board PM336. The signal levels quoted are typical. Board pin 13 — 10mV r.m.s. Junction D1,D2 — 40mV r.m.s. TR5 base — 40mV r.m.s. TP1 — 100mV r.m.s. LK1 (earth of meter to TP2) 50mV r.m.s.
STEP 9	Ensure that the 34MHz INT/EXT switch is set to INT. Connect the HF electronic voltmeter, high impedance input, between LK2 and TP2 (meter earth) on the second mixer board. (Ensure that link LK1 on the second mixer board has been removed.) Is the HF electronic voltmeter indication greater than 600 millivolts?
Action	YES: Step 10 NO: Suspect faulty 34MHz generator board PM339, or faulty filter, L10 to L14, on the second mixer board PM336
STEP 10	Connect the 1MHz IN/OUT socket on the rear panel of the receiver to the external standard socket on the digital frequency meter. Set the digital frequency meter to operate from an external 1MHz standard. Connect the digital frequency meter to the 34MHz IN/OUT socket on the rear panel. Does the digital frequency meter indicate 34 000 000Hz plus or minus 1Hz?
Action	YES: Step 11 NO: Suspect faulty 34MHz generator board PM339
STEP 11	Connect the multimeter, set to the 10 volt d.c. range between TP1 (positive) and chassis on the 34MHz generator board PM339. Does the multimeter indicate between +6 and +8 volts?
Action	YES: Suspect faulty second mixer stage (TR9,TR10) or buffer stage (TR11) on the second mixer board NO: Suspect faulty 34MHz generator board PM339 (Chart 6)

RF AMPLIFIER BOARD

PM582

FLOW CHART 10

NOTES:

1. Before proceeding with this flow chart ensure that the first mixer board PM335, the second mixer board PM336 and the main IF/AF board are all functioning correctly.

2. The signal plus noise/noise ratio figures given in this flow chart are for a 3 kHz SSB filter. The signal plus noise/noise ratio figures for filters of bandwidths other than 3kHz may be computed from:

$$10 \log_{10} \times \frac{\text{Filter Bandwidth (kHz)}}{3}$$

and the result added to or subtracted from the figures specified.

STEP 1

Set the receiver controls as follows:

MHz	28
kHz	020.00
RF TUNE (if fitted)	WB
AGC	SHORT
MODE	USB
AFC (if fitted)	OFF
LS	OFF
Headphones	Plugged in

Connect the output power meter, 8 ohms impedance, between the LS and E terminals of TS1. Connect the signal generator 50 ohm output impedance, set to a frequency of 28.02MHz and a CW output level of 1 microvolt e.m.f., to the receiver antenna socket. Tune the signal generator for a maximum indication on the output power meter. Set the AF GAIN for a reading of 100mW on the output power meter. Set the AGC switch to OFF and set the IF GAIN to restore the output power meter indication to 100mW. Off-tune the signal generator by at least 10kHz. Does the output power meter indication fall by not less than 15dB?

Action

YES: Step 2 for tuned versions, Step 5 for un-tuned versions
NO: Step 7

STEP 2	Re-tune the signal generator to the receiver for a maximum indication on the output power meter. Set the AGC switch to SHORT and set the RF TUNE control for a maximum indication on the output power meter. Set the AF GAIN for a reading of 100mW on the output power meter and set the AGC switch to OFF. Set the IF GAIN to restore the output power meter indication to 100mW. Off-tune the signal generator by at least 10kHz. Does the output power meter indication fall by not less than 9dB?
Action	YES: Step 3 NO: Suspect incorrect coding input from logic board, faulty tuned circuit, micro-switch or relay
STEP 3	Connect a 50 ohm impedance, high-output level signal generator (up to 20V e.m.f.), set to a frequency of 30MHz and an output level of 1V e.m.f., to the RF input socket on the RF board. Connect a valve voltmeter to TP1 on the RF board and check that it indicates approximately 0.5 volt p.d. Slowly increase the signal generator output level until the valve voltmeter indication falls to zero. Is the signal generator output level between 7 and 14V e.m.f.?
Action	YES: Step 4 NO: Suspect faulty wideband protection stage or incorrect setting of C31 (see Chap.5) on the RF board
STEP 4	Set the RF TUNE control to WB. Connect the valve voltmeter to TP2 on the RF board. Set the signal generator output level to 1V e.m.f. and check that the valve voltmeter indicates approximately 0.5V p.d. Slowly increase the signal generator output level until the valve voltmeter indication falls to zero. Is the signal generator output level between 2.5 and 4.0V e.m.f.?
Action	YES: Step 6 NO: Suspect faulty tuned protection stage or incorrect setting of C33 (see Chap.5) on the RF board

STEP 5	Connect a 50 ohm impedance, high-output level signal generator (up to 20V e.m.f.), set to a frequency of 30MHz and an output level of 1V e.m.f., to the RF input socket on the RF board. Connect a valve voltmeter to TP1 on the RF board and check that it indicates approximately 0.5V p.d. Slowly increase the signal generator output level until the valve voltmeter indication falls to zero. Is the signal generator output level between 2.5 and 4.0 volts e.m.f.?
Action	YES: Step 6 NO: Suspect faulty wideband protection stage or incorrect setting of C31 (see Chap.5) on the RF board.
STEP 6	Set the output level of the signal generator to 1V e.m.f. and connect the valve voltmeter to TP1. Check that the valve voltmeter indicates approximately 0.5V p.d. Connect a wire link between the MUTE and E terminals of TS2. Does the valve voltmeter indication fall to zero?
Action	YES: No fault apparent NO: Suspect faulty wideband protection stage, or faulty wiring between MUTE terminal and pin 3 on the RF board
STEP 7	Connect the signal generator to the RF input socket on the RF board and repeat the signal plus noise/noise ratio check given in step 1. Does the output power meter indication fall by not less than 15dB?
Action	YES: Suspect faulty re-radiation filter NO: Step 8
STEP 8	Set the signal generator frequency to 30MHz and set the output level to 1.0V e.m.f. Connect the valve voltmeter to TP1. Does the valve voltmeter indicate approximately 0.5V p.d.?
Action	YES: Step 9 NO: Suspect faulty wideband protection stage, relay RLQ or 30MHz low-pass filter (L7, L9).

STEP 9	Connect the valve voltmeter to TP2. Check that the RF TUNE control is set to WB (tuned versions only). Does the valve voltmeter indicate approximately 0.5V p.d.?
Action	YES: Step 10 NO: Suspect faulty relays RLN, RLP (all versions), links Y, Z not made (untuned versions) or faulty tuned protection stage, relay RLR (tuned versions).
STEP 10	Connect the output of a signal generator, set to a frequency of 15MHz and an output level of 10 millivolts e.m.f., to the 50 ohm input of an HF electronic voltmeter. Note the level as indicated on the HF electronic voltmeter as a reference level. Disconnect the signal generator from the HF electronic voltmeter and re-connect it to the RF input socket on the RF board. Connect the HF electronic voltmeter to TP3 on the RF board. Is the output level, as indicated on the HF electronic voltmeter, within +13dB plus or minus 2.0dB of the previously established reference level?
Action	YES: Suspect a fault in 30MHz low-pass filter (L15 to L19) NO: Suspect a low gain RF amplifier stage TR5, TR6

DISPLAY BOARD PM371

FLOW CHART 11

STEP 1	Set the receiver POWER switch to OFF and then to ON. Connect a multimeter, set to the 10 volt d.c. range, between chassis (negative) and pins 23 and 39, in turn, on the display board. Does the multimeter indicate +5V in each case?
Action	YES: Step 2 NO: Check power supplies and/or connections to board pins.
STEP 2	Are all the frequency display digits illuminated and at zero?
Action	YES: Step 3 NO: Step 11
STEP 3	Set the TUNING RATE switch to SLOW. Rotate the kHz control clockwise. Does the display increase in 10Hz steps at a rate of 2.5kHz per turn?
Action	YES: Step 4 NO: Step 13
STEP 4	Set the TUNING RATE switch to FAST. Rotate the kHz control clockwise. Does the display increase in 100Hz steps (10Hz digit at zero) at a rate of 50kHz per turn?
Action	YES: Step 5 NO: Suspect a faulty monostable, ML28a, or a faulty gate, G12, G13, G14, G16 or G17.
STEP 5	Rotate the kHz control clockwise until the display stops. Has it stopped at 02000?
Action	YES: Step 6 NO: Suspect a faulty overspill count inhibit circuit, G24, G25.
STEP 6	Has the lamp in the centre of the MHz dial extinguished and the upper lamp of the MHz dial illuminated?
Action	YES: Step 7 NO: Suspect a faulty lamp, a faulty overspill indicator circuit (G27, G28, G29) or a faulty lamp driver transistor (TR5, TR6, TR7).

STEP 7	Rotate the kHz control counter-clockwise until the display stops. Has it stopped at 97999?
Action	YES: Step 8 NO: Suspect a faulty overspill count inhibit circuit, G24, G25.
STEP 8	Has the lamp in the centre of the MHz dial extinguished and the lower lamp of the MHz dial illuminated?
Action	YES: Step 9 NO: Suspect a faulty lamp, a faulty overspill indicator circuit (G27, G28, G29) or a faulty lamp driver transistor (TR5, TR6, TR7).
STEP 9	Rotate the MHz switch one position counter-clockwise. Has the illuminated figure moved to the centre of the MHz dial?
Action	YES: Step 10 NO: Suspect a fault in the overspill clear circuit, ML11 and associated components.
STEP 10	Connect the oscilloscope to board pin 27. Is a negative-going 25 millisecond pulse displayed when, whilst the kHz control is rotated, a 9-to-0 or a 0-to-9 transition of the 10kHz digit occurs?
Action	YES: No fault apparent. NO: Suspect a fault in the range blanking circuit, G23, ML33b.
STEP 11	Set the receiver kHz display to a figure other than 000.00. Set the POWER switch to OFF, wait ten seconds and then set the POWER switch to ON. Does the kHz display now read 000.00?
Action	YES: Step 12 NO: Suspect a fault in the initial zero circuit, TR4.
STEP 12	Check the data output codes for any digit not at zero, at the respective board pins. Are they all correct?
Action	YES: Any display not indicating zero is faulty and should be replaced (ML41 to ML45). NO: Suspect a faulty up/down counter (ML1 to ML6).

STEP 13	Connect the multimeter, set to the 10 volt d.c. range, to board pin 30. Does the voltmeter indicate approximately +5V?
Action	YES: Step 14 NO: Suspect a faulty TUNING RATE switch, faulty wiring or a faulty gate, G10, G11.
STEP 14	Connect the oscilloscope to ML28 pin 5. Is a positive-going pulse signal displayed whilst the kHz control is rotated?
Action	YES: Step 15 NO: Step 16
STEP 15	Connect the oscilloscope to ML6 pin 5. Rotate the kHz control clockwise. Is a positive-going pulse signal displayed?
Action	YES: Suspect a fault in the up/down counter chain, ML1 to ML6. NO: Suspect a faulty gate, G4 to G7.
STEP 16	Connect the oscilloscope to board pin 32. Is an approximately sinusoidal waveform displayed whilst the kHz control is rotated?
Action	YES: Step 17 NO: Step 19
STEP 17	Connect the oscilloscope to board pin 31. Is an approximately sinusoidal waveform displayed whilst the kHz control is rotated?
Action	YES: Step 18 NO: Step 19
STEP 18	Connect a dual-trace oscilloscope to ML27 pins 6 and 8. Are two waveforms displayed, 90 degrees out of phase with each other whilst the kHz control is rotated?
Action	YES: Suspect a faulty monostable, ML28. NO: Suspect faulty TR2, TR3 or ML27, or incorrect setting of R1 and R2 on shaft encoder (see Chapter 5).
STEP 19	Are the shaft encoder lamps illuminated? (These lamps may be under-run and hence may not glow brightly.)
Action	NO: Step 20 YES: Suspect a faulty shaft encoder.

<u>STEP 20</u>	Connect the multimeter, set to the 25 volt d.c. range, between chassis (negative) and pin 4 on the shaft encoder. Does the multimeter indicate +12V?
<u>Action</u>	NO: Suspect a fault in the power supply or a wiring fault. YES: Suspect a faulty shaft encoder.

AFC BOARD PM664

FLOW CHART 12

STEP 1	Set the receiver MODE switch to TUNE, the AGC switch to SHORT, FILTER switch to widest available, the AFC switch to OFF, the METER switch to TUNE CARRIER and the LOUDSPEAKER switch to ON. Set the rear panel 1 MHz, 34 MHz and LO switches to INT. Set the POWER switch to ON. Connect the multimeter, set to the 25 volt d.c. range, between the chassis and the following pins, in turn, on the AFC board PM664.

Board Pin	Voltage
3	+5
2	+12
1	+20
8	-7

Are all the voltages correct?

Action

YES: Step 2
NO: Suspect a power supply fault or faulty wiring.

STEP 2

Disconnect the input to pin 16 of the AFC board. Connect the HF electronic voltmeter to TP4 and ensure that R29 has been set for minimum reading. Reconnect the input to pin 16 and tune the receiver to 0.00002 MHz i.e. 20 Hz. A 20 Hz note should be heard on the loudspeaker. Is a 20 Hz beat indicated on the meter?

Action

YES: Step 16
NO: Step 3

STEP 3

Connect an oscilloscope to pin 16 of the AFC board. Is a 1.4 MHz signal displayed?

Action

YES: Step 4
NO: Check the carrier filter and ensure that the proper links have been made on the filter board.

STEP 4	Connect an oscilloscope to both ends of the 1.4 MHz crystal, XL1, in turn. Is a 1.4 MHz signal displayed?
Action	YES: Step 5 NO: Suspect a fault around ML1 or ML2. Check that link A has been made correctly.
STEP 5	Connect an oscilloscope to TP3. Is a clean 400 kHz signal displayed?
Action	YES: Step 8 NO: Step 6
STEP 6	Connect an oscilloscope to pin 11 on the AFC board. Is a 1 MHz signal displayed?
Action	YES: Step 7 NO: Suspect faulty wiring or fault on 34 MHz board.
STEP 7	Connect the oscilloscope to TR1 collector. Is a 1 MHz signal displayed?
Action	YES: Suspect fault in mixer ML3 NO: Suspect fault around 1 MHz buffer i.e. TR1
STEP 8	Connect the oscilloscope to TP4. Is a 400 kHz signal displayed?
Action	YES: Step 9 NO: Suspect a fault in the amplifier chain ML4, TR3, TR4
STEP 9	Connect the oscilloscope to TR6 collector. Is a 400 kHz square wave displayed? (N.B. It is normal for the amplitude to vary slightly).
Action	YES: Step 10 NO: Suspect a fault in the waveform shaper TR5/TR6
STEP 10	Connect the oscilloscope to TR7 collector. Is a 1 MHz signal displayed?
Action	YES: Step 11 NO: Suspect a fault around TR7

STEP 11	Connect the oscilloscope, set to monitor DC CMOS levels, to ML17 pins 3 and 11 in turn. Is a 200 kHz square wave displayed?
Action	YES: Step 12 NO: Suspect a fault in ML18
STEP 12	Connect the oscilloscope to ML12 pin 11. Is a 20 p.p.s. signal displayed?
Action	YES: Step 13 NO: Suspect a fault in the digital mixer ML17.
STEP 13	Connect the oscilloscope to ML15 pin 9. Are 6m sec pulses displayed at the error rate (20 Hz)?
Action	YES: Step 14 NO: Check the time constant C49/R84. Suspect a fault in ML15.
STEP 14	Connect the oscilloscope to pin 7 on the AFC board.. Are tuning pulses indicated?
Action	YES: Step 15 NO: Suspect a fault in meter switching circuit ML8, ML9.
STEP 15	Are tuning pulses displayed on the meter?
Action	YES: Step 16 NO: Suspect faulty wiring to meter board/meter switch.
STEP 16	Switch the AFC to FULL carrier. Does the AFC LOCK lamp illuminate within 10 seconds?
Action	YES: Step 17 NO: Step 20
STEP 17	Tune the receiver to 1.02 MHz. Connect a signal generator to the antenna socket and tune it to the receiver with an output level of 3 μV e.m.f., using the tuning meter with the AFC switched OFF. Switch ON the AFC. Does the AFC LOCK lamp illuminate within 13 seconds?
Action	YES: Step 18 NO: Step 19

STEP 18	Reduce the generator input to 1 μV e.m.f. Does the AFC LOCK lamp extinguish?
Action	YES: AFC board operates correctly. NO: Step 19
STEP 19	Set the generator to 2 μV e.m.f. Adjust R45 until the lamp flickers.
Action	Step 17
STEP 20	Connect the oscilloscope to TP6. Is this level "high"? (N.B. High = approximately +12V, Low = approximately 0V).
Action	YES: Step 23 NO: Step 21
STEP 21	Connect the oscilloscope to ML10 pin 11. Is a DC voltage of between 5 and 7 volts indicated?
Action	YES: Step 22 NO: Check AGC detector around D1.
STEP 22	Check setting of R45.
STEP 23	Connect the oscilloscope to ML9 pin 2. Is this level "high"?
Action	YES: Step 26 NO: Step 24
STEP 24	Connect the oscilloscope to ML11 pin 3. Is this pin "high"?
Action	YES: Suspect broken track, dry joint between ML11 pin 3 and ML9 pin 2. NO: Step 25
STEP 25	Connect the oscilloscope to AFC board pin 13. Is this pin "high"?
Action	YES: Suspect fault in AFC switch wiring. NO: Suspect fault in ML10C

STEP 26	Connect the oscilloscope to ML9 pin 8. Is this pin "high"?
Action	YES: Suspect a fault in the lock lamp driver circuit ML8, ML9, TR11. NO: Step 27
STEP 27	Connect the oscilloscope to ML13 pin 4. Is this pin "high"?
Action	YES: Step 28 NO: Step 38
STEP 28	Switch AFC OFF. Connect the oscilloscope to ML14 pin 11. Is a square wave of approximately 1.5 kHz displayed?
Action	YES: Step 29 NO: Ensure that ML14 pin 12 is 'low'. Suspect a fault in this oscillator.
STEP 29	Connect the oscilloscope to ML13 pin 4. Is this pin "high"?
Action	YES: Step 30 NO: Suspect a fault in UP/DOWN INFO i.e. ML13A, ML12.
STEP 30	Connect a digital voltmeter to TP17. Does this read 8.0V ± 0.5V?
Action	YES: Step 31 NO: Step 33
STEP 31	Connect the digital voltmeter between TP17 and TP18. Does this read less than 50 mV?
Action	YES: Step 32 NO: Suspect a fault in D/A converter or ML16B or ML16D.
STEP 32	Connect the oscilloscope to ML11 pin 6. Is a 1.5 kHz square wave observed?
Action	YES: Suspect a fault in UP/DOWN information i.e. ML10D, ML12 or ML22/23/23. NO: Suspect a fault in ML12.

STEP 33	Adjust C35 until the digital voltmeter reads 8V ± 0.1V. Can this be done?
Action	YES: Step 16 NO: Step 34
STEP 34	Connect the oscilloscope to TR8 collector. Is a 7 MHz signal displayed?
Action	YES: Step 35 NO: Suspect a fault in the 7 MHz XTAL oscillator.
STEP 35	Connect the oscilloscope to ML7 pin 2. Is a 1 MHz signal displayed?
Action	YES: Step 36 NO: Suspect a fault in TR6, ML6, ML7.
STEP 36	Connect the oscilloscope to ML20 pin 11. Is a 1 MHz signal displayed?
Action	YES: Step 37 NO: Suspect fault in TR10.
STEP 37	Connect the oscilloscope to ML20 pin 3. Is a 1 MHz signal displayed?
Action	YES: Suspect a fault in phase comparator ML19, loop filter R94, C55, C56 or ML16A. NO: Suspect fault in TR7.
STEP 38	Connect the oscilloscope to ML15 pin 4. Is an error frequency of 20 Hz or less displayed?
Action	YES: Step 39 NO: Suspect a fault in ML11/ML12.
STEP 39	Connect the oscilloscope to ML15 pin 6. Is this permanently high?
Action	YES: Step 38 NO: Suspect a fault in ML15, C48, R83.

AFC BOARD PM369

FLOW CHART 12a

STEP 1	Set the receiver MODE switch to USB, the AGC switch to LONG, the AFC switch to OFF, the METER switch to TUNE CARRIER and the LOUDSPEAKER switch to ON. Set the rear panel 1MHz, 34MHz and LO switches to INT. Set the POWER switch to ON. Connect the multimeter, set to the 25 volt d.c. range, between the chassis and the following pins, in turn, on the AFC board PM369.

BOARD PIN	VOLTAGE
3	+5
2	+12
1	+20
8	-7

	Are all the voltages correct?
Action	YES: Step 2 NO: Suspect a power supply fault or faulty wiring
STEP 2	Connect the CW output of the signal generator, set to a frequency of 3MHz and an output level of 100 millivolts e.m.f., to the receiver antenna socket. Tune the receiver to the signal generator whilst observing the front panel meter. Does the meter indication decrease to zero coincident with a zero beat in the loudspeaker?
Action	YES: Step 3 NO: Step 11
STEP 3	Set the AFC switch to PILOT CARRIER. Does the AFC LOCK lamp illuminate?
Action	YES: Step 4 NO: Step 39
STEP 4	Does the front panel meter indicate zero on the AFC scale?
Action	YES: Step 5 NO: Suspect a faulty relay RLA/1 or incorrect adjustment of C3 (see Chapter 5).

STEP 5	Set the signal generator output level to 100 millivolts e.m.f. Set the AFC switch to OFF, then to FULL CARRIER. Is the AFC LOCK lamp illuminated?
Action	YES: Step 6 NO: Suspect a fault in the input attenuator circuit (L1 to L4, D2 to D4, etc.)
STEP 6	Decrease the signal generator output level to 1 microvolt e.m.f. Does the AFC LOCK lamp extinguish?
Action	YES: Step 7 NO: Suspect incorrect adjustment of R87 (see Chapter 5) or a fault in the area of G14.
STEP 7	After a one minute time interval, increase the signal generator output level to 100 millivolts e.m.f. Does the AFC LOCK lamp illuminate?
Action	YES: Step 8 NO: Suspect a fault in the area of the hold switch (TR17, TR19, TR21) or a drift in the signal generator frequency.
STEP 8	Slowly tune the signal generator 500Hz each side of 3MHz. Does the AFC LOCK lamp remain illuminated?
Action	YES: Step 9 NO: Suspect that the frequency range of the 7MHz VCO (TR1) is incorrect, or the signal generator tuning too rapid.
STEP 9	Slowly tune the signal generator 500Hz each side of 3MHz whilst observing the front panel meter. Does the meter indication follow the tuning of the signal generator and remain within the AFC scale?
Action	YES: No fault apparent. NO: Suspect that the frequency range of the 7MHz VCO (TR1) is incorrect.
STEP 10	Use the oscilloscope to monitor board pin 16. Is a 1.4MHz signal displayed?
Action	YES: Step 11 NO: Suspect a fault on the filter board PS367 or faulty wiring.

STEP 11	Use the oscilloscope to monitor board pin 11. Is a 1MHz signal displayed?
Action	YES: Step 12 NO: Suspect a fault on the 34MHz generator board PM339 or faulty wiring.
STEP 12	Connect the oscilloscope to TP10. Is a 400kHz sine wave signal displayed, approximately 2.5V p-p?
Action	YES: Step 13 NO: Suspect a fault between board pin 16 and TP10 (input attenuator, ML3, mixer, ML12, TR10).
STEP 13	Disconnect the signal generator. Connect the 1MHz signal from the 1MHz IN/OUT socket to the antenna socket. Tune the receiver to 1MHz. Connect the oscilloscope to TP8. Is a 1.6MHz signal displayed?
Action	YES: Step 14 NO: Suspect a faulty 1.6MHz oscillator (TR7, TR8).
STEP 14	Connect the digital frequency meter to TP8. Is a frequency of 1 600 000Hz displayed?
Action	YES: Step 15 NO: Step 24
STEP 15	Connect the oscilloscope to ML8 pin 12. Is a 200kHz approximate square wave displayed?
Action	YES: Step 16 NO: Suspect fault in area of ML5
STEP 16	Connect the oscilloscope to ML8 pin 11. Is a 3:2 ratio square wave displayed?
Action	YES: Step 17 NO: Suspect fault in area of ML5, TR2 or G2
STEP 17	Disconnect the 1MHz signal from the antenna socket, and reconnect the signal generator. Set the signal generator to a frequency of 3MHz and set the output level to 100 millivolts r.m.s. Set the receiver frequency to 3 000.00 kHz. Connect the oscilloscope to ML8 pin 12 and adjust the signal generator frequency to display a 200kHz square wave. Connect the oscilloscope to ML8 pin 9. Is the difference frequency signal displayed?
Action	YES: Step 18 NO: Suspect faulty ML8

STEP 18	Connect the oscilloscope to ML10 pin 6. Are fixed-width pulses at the difference frequency displayed?
Action	YES: Step 19 NO: Suspect faulty ML10
STEP 19	Connect the oscilloscope to ML20 pin 8. Are fixed-width pulses at the difference frequency displayed?
Action	NO: Step 20 YES: Suspect faulty relay RLA/1, R94, or fault on meter switching board.
STEP 20	Connect the oscilloscope to ML20 pin 13. Is a steady +3V (approximately) indicated?
Action	NO: Step 21 YES: Step 30
STEP 21	Connect the oscilloscope to the anode of D17 (junction with R100). Is a steady +5V (approximately) indicated?
Action	NO: Step 22 YES: Suspect a fault in the area of ML18, G16, G13.
STEP 22	Connect the oscilloscope to the collector of TR16 (can). Are positive-going 400kHz pulses displayed?
Action	YES: Step 23 NO: Suspect faulty TR16
STEP 23	Connect the oscilloscope to TP12. Is a steady +11V (approximately) indicated?
Action	YES: Suspect incorrect setting of R87 (see Chapter 5) or faulty ML21. NO: Suspect a fault in the area of TR15.
STEP 24	Connect the oscilloscope to the collector (can) of TR16. Are positive going pulses displayed, approximately 10V peak-to-peak?
Action	YES: Step 25 NO: Suspect a fault in the area of ML8/ML11.
STEP 25	Connect the oscilloscope to TP12. Is a low frequency a.c. signal displayed?
Action	YES: Step 26 NO: Suspect a fault in the area of TR15.

STEP 26	Connect the oscilloscope to TP15. Is a square wave signal displayed?
Action	YES: Step 27 NO: Suspect a fault in the area TR23, TR24, TR25.
STEP 27	Connect the oscilloscope to the collector (can) of TR14. Are positive-going pulses, approximately 10V peak-to-peak, displayed?
Action	YES: Step 28 NO: Suspect a fault in the area of TR14.
STEP 28	Connect the oscilloscope to TP11. Is a low frequency a.c. signal displayed?
Action	YES: Step 29 NO: Suspect a fault in the area of TR13.
STEP 29	Connect the oscilloscope to TP5. Is a filtered version of the TP11 signal displayed?
Action	YES: Suspect a faulty 1.6MHz oscillator (TR7,TR8). NO: Suspect a fault in the area of ML15.
STEP 30	Connect the oscilloscope to ML20 pin 12. Is a steady +3V (approximately) level indicated?
Action	YES: Step 31 NO: Step 32
STEP 31	Connect the oscilloscope to ML20 pin 10. Is a steady +3V (approximately) level indicated?
Action	NO: Step 32 YES: Suspect faulty G15.
STEP 32	Connect the oscilloscope to TP6. Is a 1MHz square wave signal displayed?
Action	YES: Step 33 NO: Suspect a fault in the area of G1, G4, G6, G7.
STEP 33	Connect the oscilloscope to TP7. Is a 1MHz square wave signal displayed?
Action	YES: Step 34 NO: Step 36

STEP 34	Connect the oscilloscope to TP9. Are narrow fixed width pulses displayed?
Action	YES: Step 35 NO: Suspect a faulty phase comparator (ML9, G10), voltage control circuit (TR9, TR11, TR12), or incorrect 7MHz VCO voltage/frequency characteristic.
STEP 35	Connect the oscilloscope to ML9 pin 9. Are narrow fixed width pulses displayed?
Action	YES: Suspect a fault in the area of ML14, G11, G12. NO: Suspect a faulty phase comparator (ML9, ML10), voltage control circuit (TR9, TR11, TR12), or incorrect 7MHz VCO voltage/frequency characteristic.
STEP 36	Connect the oscilloscope to board pin 10. Is a 1MHz signal displayed?
Action	NO: Step 37 YES: Suspect a fault in the area of G1, G4, G8, G9, etc.
STEP 37	Connect the oscilloscope to TP1. Is a 7MHz signal displayed?
Action	YES: Suspect a fault in the area of ML4, G3, G5. NO: Suspect a faulty 7MHz VCO (TR1).
STEP 38	Connect the oscilloscope to ML20 pin 6. Is 0V indicated?
Action	NO: Step 39 YES: Suspect faulty R93, a wiring fault, or faulty lamp.
STEP 39	Connect the oscilloscope to ML20 pin 2. Is approximately +3V indicated?
Action	YES: Step 40 NO: Suspect a fault in the area of the ON/OFF switch, ML1, TR4.
STEP 40	Connect the oscilloscope to board pin 18 on the 34MHz generator board PM339. Is a 4:3 ratio 1MHz square wave displayed?
Action	YES: Step 41 NO: Suspect a wiring fault from pin 10 on the AFC board.

STEP 41	Set the 1MHz INT/EXT switch on the rear panel to EXT. Connect the oscilloscope to TP11 on the 34MHz generator board PM339. Is a 4:3 ratio 1MHz square wave displayed?
Action	YES: Step 42 NO: Suspect a fault on the 34MHz generator board PM339, in the area of ML5, or no earth applied to board pin 19.
STEP 42	Set the 1MHz INT/EXT switch to INT. Unsolder and remove the coaxial cable from board pin 16 on the AFC board (the screen may be left connected to pin 15). Connect the output of the signal generator, set to a frequency of 1.400MHz and an output level of 100 millivolts e.m.f., to pin 16. Connect the oscilloscope to TP10. Is a 400kHz signal displayed?
Action	YES: Step 43 NO: Suspect a fault between board pin 16 and TP10 (input attenuator, ML3, mixer, ML12, TR10).
STEP 43	Connect the oscilloscope to ML17 pin 12. Is approximately +3V indicated?
Action	YES: Step 44 NO: Suspect a fault in the area of the ON/OFF switch (ML1, TR4), ML17, or lock indicator circuit.
STEP 44	Connect the oscilloscope to TP6. Is a 25kHz approximate square wave signal displayed?
Action	YES: Step 45 NO: Suspect a fault in the area of G7, ML6, G6, G4.
STEP 45	Connect the oscilloscope to TP7. Is a 25kHz approximate square wave signal displayed?
Action	YES: Suspect a faulty lock indicator circuit (G11, G12, ML14), faulty G14, or phase comparator (ML9 to TP4). NO: Suspect a fault in the area of G8, G9, ML7.

POWER SUPPLY REGULATOR BOARD PM370

and associated external components

FLOW CHART 13

NOTES: 1. If the +20V supply fails, then the +12V, +5V and -7V supplies will also fail.

2. If the +12V supply fails, then the -7V supply will also fail.

3. Before proceeding with the following checks, ensure that the SUPPLY fuse is serviceable, the voltage selector VS1 is correctly set, and the POWER switch is set to ON.

STEP 1	Connect the multimeter, set to the 50V d.c. range, between board pin 22 (positive) and chassis (earth). Can R19 be set for an indication on the multimeter of +20V plus or minus 0.5V?
Action	YES: Step 14 NO: Step 2
STEP 2	Connect the multimeter between ML4 pin 7 (positive) and chassis. Does the multimeter indicate approximately +30V d.c.?
Action	YES: Step 3 NO: Suspect a faulty rectifier diode, D4, capacitor 1C4, faulty transformer 1T1, or a wiring fault between 1T1 and board pins 37 and 38.
STEP 3	Connect the multimeter between board pin 22 (positive) and chassis. Is the multimeter indication higher or lower than +20V?
Action	HIGHER: Step 10 LOWER: Step 4
STEP 4	Set the receiver power switch to OFF. Unsolder and disconnect all the leads connected to board pins 22 and 23. Set the POWER switch to ON. Connect the multimeter between board pin 22 and chassis. Can R19 now be set for an indication on the multimeter of +20V plus or minus 0.5V?
Action	NO: Step 5 YES: Suspect receiver drawing excessive current from the +20V supply (typically 175mA) or faulty current limit resistor, R28 or R34.

STEP 5	Set the receiver POWER switch to OFF. Reconnect the leads removed from board pins 22 and 23. Set the POWER switch to ON. Connect the multimeter, set to the 10 volt d.c. range, between ML4 pin 4 (positive) and chassis. Does the multimeter indicate +7.15V?
Action	YES: Step 6 NO: Suspect faulty ML4
STEP 6	Connect the multimeter between ML4 pin 3 (positive) and chassis. Does the multimeter indicate +7.15V plus or minus 0.5V?
Action	YES: Step 7 NO: Suspect faulty R6, C3 or ML4
STEP 7	Connect the multimeter, set to the 50V d.c. range, between ML4 pin 6 (positive) and chassis. Is the multimeter indication greater than +20V?
Action	YES: Step 8 NO: Suspect fault in the area of TR3
STEP 8	Connect the multimeter, set to the 25V d.c. range, to measure in turn the voltages at pins 2 and 3 of ML4 each with respect to chassis. Is the voltage at pin 2 lower than the voltage at pin 3?
Action	YES: Step 9 NO: Suspect faulty ML4
STEP 9	Isolate ML4 pin 2 from the remaining circuitry. Is the voltage at ML4 pin 2 still higher than the voltage at ML4 pin 3?
Action	YES: Suspect faulty ML4 NO: Suspect that a component or a short circuit is holding ML4 pin 2 at a high potential. Check for solder splashes, splayed wires, etc.
STEP 10	Connect the multimeter, set to the 10 volt d.c. range, between ML4 pin 4 (positive) and chassis. Does the multimeter indicate +7.15V?
Action	YES: Step 11 NO: Suspect faulty ML4

STEP 11	Connect the multimeter between ML4 pin 3 (positive) and chassis. Does the multimeter indicate +7.15V plus or minus 0.5V?
Action	YES: Step 12 NO: Suspect faulty R6, C4 or ML4
STEP 12	Connect the multimeter, set to the 50V d.c. range, between ML4 pin 6 (positive) and chassis. Does the multimeter indicate between approximately +23 and +30V?
Action	YES: Step 13 NO: Suspect faulty TR3 or associated components
STEP 13	Connect the multimeter, set the 25V d.c. range, to measure the voltages at pins 2 and 3 of ML4, each with respect to chassis. Is the voltage at pin 2 higher than the voltage at pin 3?
Action	YES: Suspect faulty ML4 NO: Suspect a fault in the feedback path between the emitter of TR3 and ML4 pin 2
STEP 14	Connect the multimeter between board pin 16 (positive) and chassis. Can R17 be set for an indication on the multimeter of +12V plus or minus 0.5V?
Action	YES: Step 27 NO: Step 15
STEP 15	Connect the multimeter, set to the 50V d.c. range, between the collector of TR2 (board pin 14) and chassis. Does the multimeter indicate approximately +23V?
Action	YES: Step 16 NO: Suspect a faulty rectifier diode D3, capacitor 1C3, faulty winding on transformer 1T1 or a wiring fault between 1T1 and board pins 41 and 42
STEP 16	Connect the multimeter, set to the 25V d.c. range, between board pin 16 (positive) and chassis. Is the multimeter indication higher or lower than +12V?
Action	HIGHER: Step 23 LOWER: Step 17

STEP 17	Set the receiver POWER switch to OFF. Unsolder and disconnect all the leads connected to board pins 16, 17, 18, 19, 20 and 21. Set the POWER switch to ON. Connect the multimeter between board pin 16 and chassis. Can R17 now be set for an indication on the multimeter of +12V plus or minus 0.5V?
Action	NO: Step 18 YES: Suspect receiver is drawing excessive current from the +12V supply (typically 1.1A) or faulty current limit resistor, 1R16
STEP 18	Set the receiver POWER switch to OFF. Reconnect the leads removed from board pins 16, 17, 18, 19, 20 and 21. Set the POWER switch to ON. Connect the multimeter, set to the 10V d.c. range, between ML3 pin 4 (positive) and chassis. Does the multimeter indicate +7.15V?
Action	YES: Step 19 NO: Suspect faulty ML3
STEP 19	Connect the multimeter between ML3 pin 3 (positive) and chassis. Does the multimeter indicate +7.15V plus or minus 0.5V?
Action	YES: Step 20 NO: Suspect faulty R5, C2 or ML3
STEP 20	Connect the multimeter, set to the 25V d.c. range, between ML3 pin 6 (positive) and chassis. Does the multimeter indicate lower than +12V?
Action	YES: Step 21 NO: Suspect faulty TR2 or 1TR3
STEP 21	Connect the multimeter to measure in turn the voltages at pins 2 and 3 of ML3, each with respect to chassis. Is the voltage at pin 2 lower than the voltage at pin 3?
Action	YES: Suspect faulty ML3 NO: Step 22

STEP 22	Isolate ML3 pin 2 from the remaining circuitry. Is the voltage at ML3 pin 2 still higher than the voltage at ML3 pin 3?
Action	YES: Suspect faulty ML3 NO: Suspect that a component or a short circuit is holding ML3 pin 2 at a high potential. Check for solder splashes, splayed wires etc.
STEP 23	Connect the multimeter, set to the 10V d.c. range, between ML3 pin 4 (positive) and chassis. Does the multimeter indicate +7.15V?
Action	YES: Step 24 NO: Suspect faulty ML3
STEP 24	Connect the multimeter between ML3 pin 3 (positive) and chassis. Does the multimeter indicate +7.15V plus or minus 0.5V?
Action	YES: Step 25 NO: Suspect faulty R5, C2 or ML3
STEP 25	Connect the multimeter, set to the 25V d.c. range, between ML3 pin 6 (positive) and chassis. Does the multimeter indicate between +15V and +20V?
Action	YES: Step 26 NO: Suspect faulty TR2 or 1TR3
STEP 26	Connect the multimeter to measure in turn the voltages at pins 2 and 3 of ML3, each with respect to chassis. Is the voltage at pin 2 higher than the voltage at pin 3?
Action	YES: Suspect faulty ML3 NO: Suspect a fault in the feedback path between the emitter of 1TR3 and ML3 pin 2
STEP 27	Connect the multimeter, set to the 10V d.c. range, between board pin 10 (positive) and chassis. Can R3 be set for an indication on the multimeter of +5V plus or minus 0.5V?
Action	YES: Step 40 NO: Step 28

STEP 28	Connect the multimeter, set to the 25V d.c. range, between the collector of TR1 (board pin 8) and chassis. Does the multimeter indicate approximately +14.5V?
Action	YES: Step 29 NO: Suspect faulty rectifier diode D2, capacitor 1C2, faulty transformer 1T1 or a wiring fault between 1T1 and board pins 45 and 46
STEP 29	Connect the multimeter, set to the 10V d.c. range, between board pin 10 (positive) and chassis. Is the multimeter indication higher or lower than +5V?
Action	HIGHER: Step 36 LOWER: Step 30
STEP 30	Set the receiver power switch to OFF. Unsolder and disconnect all the leads from board pins 10 and 12. Set the POWER switch to ON. Connect the multimeter between board pin 10 (positive) and chassis. Can R3 now be set for an indication on the multimeter of +5V plus or minus 0.5V?
Action	NO: Step 31 YES: Suspect receiver drawing excessive current from the +5V supply (typically 2.2A) or faulty current limit resistors 1R13, 1R15
STEP 31	Set the receiver POWER switch to OFF. Reconnect the leads removed from board pins 10 and 12. Set the POWER switch to ON. Connect the multimeter between ML2 pin 4 (positive) and chassis. Does the multimeter indicate +7.15V?
Action	YES: Step 32 NO: Suspect faulty ML2
STEP 32	Connect the multimeter between ML2 pin 3 (positive) and chassis. Does the multimeter indicate +5V plus or minus 0.5V?
Action	YES: Step 33 NO: Suspect faulty R2, R3, R4 or C4
STEP 33	Connect the multimeter between ML2 pin 6 (positive) and chassis. Does the multimeter indicate lower than +5V?
Action	YES: Step 34 NO: Suspect faulty TR1 or 1TR2

STEP 34	Connect the multimeter to measure in turn the voltages at pins 2 and 3 of ML2, each with respect to chassis. Is the voltage at pin 2 lower than the voltage at pin 3?
Action	YES: Suspect faulty ML2 NO: Step 35
STEP 35	Isolate ML2 pin 2 from the remaining circuitry. Is the voltage at ML2 pin 2 still higher than the voltage at ML2 pin 3?
Action	YES: Suspect faulty ML2 NO: Suspect that a component or a short circuit is holding ML2 pin 2 at a high potential. Check for solder splashes, splayed wires, etc.
STEP 36	Connect the multimeter between ML2 pin 4 (positive) and chassis. Does the multimeter indicate +7.15V?
Action	YES: Step 37 NO: Suspect faulty ML2
STEP 37	Connect the multimeter between ML2 pin 3 (positive) and chassis. Does the multimeter indicate +5V plus or minus 0.5V?
Action	YES: Step 38 NO: Suspect faulty R2, R3, R4 or C4
STEP 38	Connect the multimeter, set to the 25V d.c. range, between ML2 pin 6 (positive) and chassis. Does the multimeter indicate between approximately +8 and +20V?
Action	YES: Step 39 NO: Suspect faulty TR1 or 1TR2
STEP 39	Connect the multimeter, set to the 10V d.c. range, to measure the voltages at pins 2 and 3 to ML2, each with respect to chassis. Is the voltage at pin 2 higher than the voltage at pin 3?
Action	YES: Suspect faulty ML2 NO: Suspect a fault in the feedback path from the emitter of 1TR2 and ML2 pin 2

STEP 40	Connect the multimeter between board pin 5 (negative) and chassis. Can R8 be set for an indication on the multimeter of -7V plus or minus 0.5V?
Action	YES: Step 53 (FSK version only) otherwise no fault apparent NO: Step 41
STEP 41	Connect the multimeter, set to the 25V d.c. range, between board pin 1 (positive) and chassis. Does the multimeter indicate approximately +10V?
Action	YES: Step 42 NO: Suspect a faulty rectifier diode D1, capacitor 1C1, faulty transformer 1T1, or a wiring fault between 1T1 and board pins 49 and 50
STEP 42	Connect the multimeter between board pin 5 (negative) and chassis. Is the multimeter indication higher or lower than -7V?
Action	HIGHER: Step 49 LOWER: Step 43
STEP 43	Set the receiver power switch to OFF. Unsolder and disconnect all the leads connected to board pins 5 and 6. Set the POWER switch to ON. Connect the multimeter, set to the 10V d.c. range, between board pin 5 (negative) and chassis. Can R8 now be set for an indication on the multimeter of -7V plus or minus 0.5V?
Action	NO: Step 44 YES: Suspect receiver drawing excessive current from the -7V supply (typically 500mA) or faulty current limit resistor, 1R12,1R14
STEP 44	Set the receiver POWER switch to OFF. Reconnect the leads removed from board pins 5 and 6. Set the POWER switch to ON. Connect the multimeter between ML1 pin 4 (positive) and the case of ML1. Does the multimeter indicate +7.15V?
Action	YES: Step 45 NO: Suspect faulty ML1

STEP 45	Connect the multimeter between ML1 pin 3 (positive) and the case of ML1. Does the multimeter indicate +7.15V plus or minus 0.5V?
Action	YES: Step 46 NO: Suspect faulty R1, C11 or ML1
STEP 46	Connect the multimeter between ML1 pin 6 (positive) and the case of ML1. Does the multimeter indicate lower than +7V?
Action	YES: Step 47 NO: Suspect faulty 1TR1
STEP 47	Connect the multimeter in turn to measure the voltages at pins 2 and 3 of ML1, each with respect to the case of ML1. Is the voltage at pin 2 lower than the voltage at pin 3?
Action	YES: Suspect faulty ML1 NO: Step 48
STEP 48	Isolate ML1 pin 2 from the remaining circuitry. Is the voltage at ML1 pin 2 still higher than the voltage at ML1 pin 3?
Action	YES: Suspect faulty ML1 NO: Suspect that a component or a short circuit is holding ML1 pin 2 at a high potential. Check for solder splashes, splayed wires, etc.
STEP 49	Connect the multimeter between ML1 pin 4 (positive) and the case of ML1. Does the multimeter indicate +7.15V?
Action	YES: Step 50 NO: Suspect faulty ML1
STEP 50	Connect the multimeter between ML1 pin 3 (positive) and the case of ML1. Does the multimeter indicate +7.15V plus or minus 0.5V?
Action	YES: Step 51 NO: Suspect faulty R1, C11 or ML1

STEP 51	Connect the multimeter, set to the 25V d.c. range, between ML1 pin 6 (positive) and the case of ML1. Does the multimeter indicate between approximately +9 and +12V?
Action	YES: Step 52 NO: Suspect faulty 1TR1
STEP 52	Connect the multimeter, set to the 10V d.c. range to measure in turn the voltages at pins 2 and 3 of ML1, each with respect to the case of ML1. Is the voltage at pin 2 higher than the voltage at pin 3?
Action	YES: Suspect faulty ML1 NO: Suspect a fault in the feedback path from the emitter of 1TR1 and ML1 pin 2
STEP 53 (FSK Versions only)	Connect the multimeter, set to the 100V d.c. range, between board pin 25 (positive) and board pin 27. Does the multimeter indicate between +72 and +96V?
Action	YES: Step 54 NO: Suspect faulty rectifier diode D5, 1C5, 1R10, 1TR1 or wiring fault
STEP 54	Connect the multimeter between board pin 26 (negative) and board pin 27. Does the multimeter indicate between -72 and -96V?
Action	YES: No fault apparent NO: Suspect faulty rectifier diode D5, 1C6, 1R9 or wiring fault