SECTION FIVE : MAINTENANCE

WARNING

When working on the 1650/6 it may be necessary for power to be applied. In this circumstance normal precautions for safety MUST be observed. Attention must, in particular, be paid to the voltages present at the supply fuse and the mains transformer located under a protection cover at the rear of the receiver. The protection cover should remain fitted at all times.

5.1 ALIGNMENT AND FAULT FINDING

The 1650/6 is suitable for continuous use under arduous conditions and normally requires no routine maintenance. Re-alignment should only be attemped in absolute necessity and with suitable test equipment and tools. The 1650/6 is generally tested and aligned in it's completely assembled state. However, the VCO and front panel assemblies may be more conveniently tested when removed from the receiver and powered from the appropriate test boxes.

5.1.1 ALIGNMENT OF SYNTHESISER AND VCO

Equipment required:-

1) Digital Voltmeter.

2) VHF Oscilloscope with low capacity probes.

3) Digital Frequency Meter with low capacity input.

4) Distortion Factor Meter with 600ohm termination.

Procedure:-

Note the position of all wiring and the position of earth straps on a particular 1650/6.

1) Check the outputs of all voltage regulators

8IC1 = +5V	)	
8IC6 = +12V	)	
8IC12 = +5V	)	± 5%
8IC13 = +12V	)	
8IC14 = +12V	)	

2) Connect digital voltmeter to link pins 5 and 6 (near 8PL4) and adjust multi-turn pot 8RV2 for +3.5V dc.

3) Connect oscilloscope to 8IC15-1 and check that 5.6MHz oscillator output is approx. 5V p-p. Use a digital frequency meter to determine frequency of 5.6MHz crystal oscillator, adjusting trimmer in 8OSC1 if necessary. Accurate alignment is best carried out on a complete receiver and is detailed in Section 5.1.8.

Second Loop Alignment

4) Connect oscilloscope to junction 8D16 and 8R60 and check 14.935MHz oscillator is approx. 4-6V p-p.

5) Connect digital frequency meter via a 'low capacity' probe to 8TP17 and set to 1405kHz with trimmer 8C156. The signal level being approx. 800mV p-p.

6) Connect oscilloscope to 8PL7-1 and adjust 8RV3 for 300mV p-p.

7) Tune 1650/6 to 1001.000kHz.

8) Adjust trimmer 8C100 to mid-capacity. Connect oscilloscope to 8TP11 and peak trimmers 8C73 and 8C95 for maximum output.

9) Adjust 8RV5 for 500mV p-p at 8TP11.

10) Connect digital voltmeter to 8TP13 and adjust trimmer 8C100 for 5.6V dc

11) Iteratively peak 8C73, 8C95 and set 8C100 until interaction ceases.

12) Tune 1650/6 to 1000.005kHz and check voltage at 8TP13 is approx. +8.3V dc. Tune 1650/6 to 1000.000kHz and check voltage is +3.5V dc approx.

13) Monitor 7TP11 (RF/1st IF PCB 7) via low capacity probe and <u>good</u> <u>RF</u> <u>earth</u> and peak 8C85. Set 8RV4 for 300mV p-p. Note that signal at 7TP11 does not vary in amplitude when 1650/6 is tuned from 1000.005kHz to 1002.000kHz.

First Loop Alignment

14) Set 8RV1 1/8th of a turn from fully anti-clockwise and ensure that 8IC3-7 is approx. +14.5V dc. 8RV1 affects the 'lock-in time' of the

First Loop.

15) Monitor 8TP2 (divide by 10/11 prescaler I/P) via low capacity probe and good RF earth and check that the signal level is typically 400-800mV p-p when 1650/6 is tuned over the range 10kHz to 30MHz.

16) Check that the waveform at 7TP4 (RF/1st IF PCB 7) via low capacity probe and good RF earth is reasonably sinusoidal and at least 400mV p-p at 29MHz.

17) Tune 1650/6 to 5.793,995MHz and monitor dc voltage at 8PL1. Adjust to 11.5V with trimmer 9C4 in VCO box as detailed in Part 2 Figure 5.1. Tune 1650/6 to 5.794,000MHz and note dc voltage falls to between +3.5V to +5.5V.

18) Tune 1650/6 to 12.793,995MHz and monitor dc voltage at 8PL1. Adjust to 11.5V with trimmer 9C3 in VCO box as detailed in Part 2 Figure 5.1. Tune 1650/6 to 12.794,000MHz and note dc voltage falls to between +3.5V to +5.5V.

19) Tune 1650/6 to 20.793,995MHz and monitor dc voltage at 8PL1. Adjust to 11.5V with trimmer 9C2 in VCO box as detailed in Part 2 Figure 5.1. Tune 1650/6 to 20.794,000MHz and note dc voltage falls to between +3.5V to +5.5V.

20) Tune 1650/6 to 29.999,990MHz and monitor dc voltage at 8PL1. Adjust to 11.5V with trimmer 9C1 in VCO box as detailed in Part 2 Figure 5.1. Tune 1650/6 to 10kHz and note dc voltage falls to between +3.5V to +5.5V.

N.B. No trimmer screw should protude by more than 8mm. If this occurs retune the lowest frequency range, adjusting the tune of 9L1 to allow more capacity. Coil 9L1 should have approx. 12mm of clear thread, after adjustment repeat steps 17-20.

'Out of lock' Indication

21) Adjust 8RV5 for negligible signal at 8TP11 and observe two digits of the frequency display flashing. Restore 8TP11 to 500mV p-p with 1650/6 tuned to 1001.000kHz.

22) Disconnect 8PL2 and observe the same two digits flashing.

23) Reconnect 8PL2 and observe a steady display. Replace earth straps and position wiring and check by listening on a distortion factor meter for any

extraneous backround noise. See Part 2 Figure 5.2.

5.1.2 ALIGNMENT OF VCO BOARD

Where a VCO board has been repaired or a replacement is to be fitted it is advisable to initially align the circuit by itself as follows:-

Equipment required:-

1) Digital Voltmeter.

2) VCO Test Box 1650/6/D6248

3) VHF Oscilloscope with 50ohm inputs to load both VCO outputs simultaneously.

4) Digital Frequency Meter (100MHz) with low capacity input.

Procedure

1) Install the VCO board into VCO Test Box 1650/6/D6248 and connect to +15.5V regulated supply. Connect a digital frequency meter to the O/P socket. Select VCO range 'LF'.

2) If a new coil has been fitted set the output frequency to 46.2MHz (±50kHz) with +4.5V at9PL1 by adjusting the coil winding of 9L1(the screw adjuster should remain at approx. 12mm of clear thread).

3) Set the output frequency to 52MHz (±50kHz), with +11.5V at 9PL1, using 9C4.

4) Iterate 2 and 3 until satisfactory. (Note it is allowable if 46.2MHz is obtainable with the control voltage in the range +3.5V to +5.5V, especially if other VCO ranges do not align correctly or in the case where a coil is already 'araldited').

5) The remaining three ranges should be selected in turn and the HF end set with the appropriate trimmer (control voltage at +11.5V). The LF ends should then be obtainable within the control voltage range +3.5V to +5.5V. (See Section 5.1.1. for frequencies).

N.B. No trimmer screw should protrude by more than 8mm, if this occurs check the adjustment of the LF range.

6) Check the output level at 9PL4 and 9PL5, peaking these at 76.2MHz, with 9C5 and 9C6. These trimmers interact and the equalisation and peaking is best

carried out by observing each output, terminated in 50ohm, simultaneously on a double beam oscilloscope. (With correct adjustment both trimmers should be close to minimum capacity).

7) Check coil assembly and components around the varactor diode are fixed with 'twin pack slow setting ARALDITE' to prevent movement under vibration. See Part 2 Figure 5.1

5.1.3 ALIGNMENT OF MAIN IF/AUDIO BOARD

Equipment required:-

1) Digital Voltmeter.

2) VHF Oscilloscope with low capacity probes.

3) Digital Frequency Meter with low capacity input.

4) Distortion Factor Meter with 600ohm termination.

5) Audio Power Meter (4-8ohm).

6) Ancillaries Test Box 1650/6/D6245.

7) 1.4MHz IF Pad 1650/6/D6249.

8) Sensitive RF millivoltmeter.

9) 50ohm load

10) Signal Generator 10kHz - 110MHz/50ohm

Procedure:-

1) Connect the Distortion factor meter and the Audio power meter via the Ancillaries Test Box 1650/6/D6245 to the Ancillaries Connector 1SK3. Connect the Sensitive RF millivolt meter and the 50ohm load to the 100kHz IF output 1SK2 and select 'MANUAL GAIN/8kHz BANDWIDTH'.

IF AGC adjustment

2) Set 10RV1, 10RV4 midway and 10RV2 fully anti-clockwise.

3) Connect digital voltmeter to IF gain control 'slider' and with control fully clockwise, adjust 10RV8 for +2V. A convenient connection for the digital voltmeter is on the pad/track adjacent to 10C72 - allowing better access than the IF gain slider.

4) Rotate IF gain control fully anti-clockwise and adjust 10RV9 for approx. +3.8V.
Iterate 2 and 3 until the IF gain control extremes are set <u>ensuring +2V with the IF gain pot. fully clockwise.</u>

5) Disconnect 10PL1 and introduce a 50ohm signal generator via 1.4MHz IF Pad 1650/6/D6249. Adjust the generator to 1.4MHz/24uV emf.

6) Set IF gain control fully clockwise and adjust 10L1 and 10L2 for maximum output.

7) Monitor 10TP4 with oscilloscope - approx. 500mV p-p (use 500mV/cm. scale to avoid confusion by noise).

8) Set a reference output on the distortion factor meter (approx. 1mW) and adjust 10RV2 until the output falls by 1dB. Increase the generator output by 1dB (26.9uV emf) in order to restore the reference. This is the AGC threshold level.

9) Connect digital voltmeter to cathode of 10D12 and set to 2V with 10RV4.

10) Select 'AGC FAST' and check that the voltage remains at approx. +2V.

11) Select 'MANUAL GAIN' and with IF gain control fully clockwise, note generator level required to produce 500mV p-p at 10TP4 (AGC threshold level 26.9uV emf). Rotate IF gain control fully

anti-clockwise and increase generator level by 80dB (269mV emf).

12) Set 10RV9 to produce 100mV p-p at 10TP4. Reset generator to AGC threhold level, and with IF gain control fully clockwise, re-adjust 10RV8, if necessary, to produce +2V on IF gain control slider.

13) Iterate steps 11 and 12 until no more interaction takes place.

14) Set generator to AGC threshold level, IF gain control fully clockwise and recheck for +2V at IF gain pot. slider adjusting RV8 if necessary.

IF output level/frequency adjustment
----

15) Select 'AGC FAST'. Set generator to 100dBuV emf and note the 100kHz IF output level variation into a 50ohm load when adjusted by 10RV11 over the full extent of it's travel (typically 100mV ±3dB). Adjust IF output to 100mV rms in 50ohms.

16) Connect a digital frequency meter via a 'low capacity' probe to 10TP21 in order to measure the 1500.000kHz crystal oscillator which may be adjusted by 10C200. Typical level at 10TP21 is 300mV p-p.

17) Reconnect 10PL1 flying lead.

RF AGC adjustment

This is aligned with RF and 1st IF board

5.1.4 ALIGNMENT OF RF AND 1st IF BOARD

Equipment required:-
----

1) Digital Voltmeter.

2) VHF Double Beam Oscilloscope with low capacity probes.

3) Digital Frequency meter with low capacity input.

4) Distortion Factor Meter with 600ohm termination.

5) Audio Power Meter (4-8ohm).

6) Ancillaries Test Box 1650/6/D6245.

7) 1.4MHz IF Pad 1650/6/D6249.

8) Sensitive RF millivoltmeter.

9) 50ohm load.

10) Spectrum Analyser 10kHZ-110MHZ.

11) Signal Generator 10kHz-110MHz/50ohm output.

Procedure:-

1) Connect the Distortion Factor Meter and the Audio Power Meter via the Ancillaries Test Box 1650/6/D6245 to the Ancillaries Connector 1SK3. Connect the Sensitive RF millivoltmeter and the 50ohm load to the 100kHz IF O/P 1SK2 and tune 1650/6 to 2MHz selecting 'MANUAL GAIN/8kHz BANDWIDTH'. IF gain control maximum.

RF amplifer adjustment

2) Turn 10RV5 and 10RV6 (Main IF/Audio board) fully clockwise.

3) Introduce a signal at the aerial input 1SK1 of 2MHz/6uV emf.

4) Connect a digital voltmeter between 7TP7 and 7TP8 and adjust 7RV3 for a 3V differential.

5) Adjust 7L1 and 7L2 for maximum output.

6) Adjust 7RV1/7RV2 to produce a S+N/N ratio of 17dB. Both pots should be similarly positioned about 1/4 turn from the fully anticlockwise position.

7) Two techniques for balancing the RF amplifer may be employed:-

Method-1:

Connect an oscilloscope with two low capacity probes to 7TP2 and 7TP3 and increase input signal to 100dB/uV emf. Display both traces on an oscilloscope and equalise the amplitudes by slight adjustment of 7RV1/7RV2.

N.B. As these signals are in 'anti- phase' the 'ADD' or 'SUM' facility may be utilised in order to produce a net zero result.

Method-2:

Introduce a signal at the aerial input 1SK1 of 23.102MHz/80dB/uV emf with the 1650/6 tuned to 2MHz

'MANUAL GAIN/8kHz BANDWIDTH'. The resulting second order intermodulation product in the RF amplifer produces the 1st IF frequency of 46.204MHz. This may be minimised by balancing the RF amplifier with a slight adjustment of 7RV1/7RV2.

Ensure that a S+N/N ratio of 17dB for an input of 6uV emf has not been degraded by the above adjustment.

RF AGC adjustment

8) Connect an oscilloscope to 10TP12 (Main IF/Audio board) and adjust input signal to produce a waveform 300mV p-p (typical input 53 to 55dB/uV).

9) Connect a digital voltmeter to 10TP13 and adjust 10RV6 for 2V. Increase the input signal to approx. 64dB/uV emf and adjust 10RV5 to restore a level of 300mV p-p at 10TP12.

Performance check

10) Check S+N/N ratio with an input signal of 60dB/uV emf is >54dB on both IF and 600ohm AF outputs.

11) Check S+N/N ratio at 22MHz is >12dB for 6uV emf input and 8kHz bandwidth (typically 14dB S+N/N).

12) Check AGC range from the threshold point. Typically a change in input of 90dB above the AGC threshold will produce less than a 3dB change in output.

The Front Panel meter RF2 indicates IF AGC threshold when 1-2 Bars are illuminated-similarly RF1 indicates RF AGC threshold.

13) In-band intermodulation measurement. Tune 1650/6 to 2MHz/8kHz bandwidth/AGC FAST. Inject two signals via a combining pad:-

Frequency	Input level at1650/6	
2.0005MHz	86dB/uV	200mV emf
1.99995MHz	86dB/uV	200mV emf

14) Measure in-band intermodulation products in AGC FAST and AGC SLOW using a spectrum analyser. (typically >-40dB). See Part 2 Figure 5.3.

N.B. Where the in-band intermodulation products are high some improvement may be gained by the following slight adjustments:-

i) RF AGC threshold 10RV5 may be lowered (rotate clockwise).

ii) IF gain distrubition pot 10RV1 may be changed from it's central position.

iii) IF AGC threshold may be lowered by up to 1dB. See Section 5.1.2.

5.1.5 REAR PANEL ASSEMBLY TEST PROCEDURE

Equipment required:-

1) Digital Voltmeter.

2) 1000V dc 'Megger' Insulation Tester.

3) AC Current Meter.

4) 10 Amp dc Constant Current Power Supply.

5) 4 off Variable Load Resistance for dc supply.

The following electrical safety checks should be carried out on a complete 1650/6 when any Mains Supply related part has been replaced and the results compared with the orignal test results.

N.B. Replacement parts related to the Mains Supply must be exactly as those specified in the Parts List.

Electrical Safety Checks

1) ELECTRICAL STRENGTH. The insulation between the mains connector live and neutral (joined together) and the mains connector earth is measured with a dc voltage of 1000v from a'Megger' insulation tester applied for ten seconds. The resistance must be greater than 100Mohm.

2) EARTH CONTINUITY. The earth continuity from the mains connector earth pin to the front and rear panel metalwork is tested with a current of at least 10 amps. The resistance must be less than 0.1ohm.

3) EARTH LEAKAGE. The earth leakage current must be measured, with all other earths disconnected, whilst powered from the normal mains supply. The leakage current should be less than 500uA under all conditions.

The dc supply capability may be checked by connecting loads to the four supply outputs and comparing the results as follows:-

Output	Idc	+Vout	Tolerance
14PL1	450mA	15.5V	± 5%
14PL2	650mA	15.5V	
14PL4	570mA	10.5V	
14PL5	560mA	10.5V	

A typical 1650/6 receiver set to 28888.880kHz, output 1Watt/8ohm and switched on for at least half an hour produces the following voltage analysis:-

V/Reg.	+O/P	+I/P	ref. pin
14IC1	15.3V	22.05V	14.05V
14IC2	15.25V	22.05V	14V
14IC3	10.55V	16.23V	9.31V
14IC4	10.52V	16.23V	9.28V

AC supply inputs to rectifier bridges:-

Connector	AC voltage (on load)	
14PL3	18.3V	)
		) ± 5%
14PL6	13.8V	)

The above assume a mains supply of 240V/50Hz.

5.1.6 Front Panel Assembly Microcomputer

Refer to circuit diagrams BP1556 and BP2025 in Part 2.

Equipment required

1) VHF Oscilloscope. Greater than 120MHz bandwidth, dual channel with 50 Ohm and high impedance inputs on both channels. High impedance approximately 10 Mohm in parallel with 7pF (using a 10x probe).

2) EP8000 EPROM Emulator. With BSC-8 Buffered Simulator Cable (G.P. Industrial Electronics) (EM/SC).

3) Front Panel Test Box 1650/6/D6247.

4) Regulated Power Supply +15.5V/5A.

Initial Checks

The following checks are of the basic Microcomputer Board 'internal' control signals.

Step 1. Remove the front panel assembly from the receiver (see section 5.2.2).

Step 2. Access the Microcomputer Board (see section 5.2.4).

Step 3. Connect Front Panel Test Box 1650/6/D6247 to 12PL1 and a +15.5V regulated power supply.

Step 4. Check that the output of voltage regulator 13IC14 (MC7805CT) is in the range 4.75 to 5.25V dc.

Step 5. Check that pin 4 of 13IC15 (MCT2) goes high when the Microcomputer power supply, via pin 4 of 12PL1, exceeds a maximum of 9.8V and goes low when the supply falls below a minimum of 8.5V. Note that the supply to the Microcomputer Board is via diode 12D2.

Step 6. Check that each time the supply rises above the upper level found in step 5, an approximately 0.1 to 0.25 second low going RESET pulse is generated at the collector of 13TR1 (BC547B). Note that this level can be checked at pin 1 Of 13PL2. This is a useful initial check if a Microcomputer/control fault is suspected, since pin 1 of 13PL2 can easily be accessed by just removing the top dust cover of the complete receiver and then generating the RESET pulse by connecting the mains power supply.

Step 6. Check the enable pulses at 13TP1/2/3.

EPROM Verification

If a control fault is suspected, the programs stored in the two Microcomputer Board EPROMs can be checked as follows. Note that the Microcomputer Board has two EPROMs, 11898PA and 11899PA, each with a different stored program, and that to check these, a known good EPROM of each program type will be required. Generally three such EPROMs of each type should be retained to enable verification of the known good EPROMs themselves by comparison against each other (a faulty one would be recognised as being different from the other two).

Step 1. Remove the front panel assembly from the receiver (see section 5.2.2).

Step 2. Access the Microcomputer Board (see section 5.2.4).

Step 3. <u>OBSERVING THE USUAL ANTI-STATIC PRECAUTIONS</u> carefully remove the two EPROMs, 13IC8 and 13IC9, from their sockets and store them on conductive foam pads.

Step 4. Obtain a known good EPROM of each program type.

Step 5. Select 'A 2732' on the EP8000 by pressing <FN>, <DEV> and using its up and down cursor keys as necessary.

Step 6. Press <RST> on the EP8000 and ensure the green power indicator above the zero insertion force (ZIF) socket on the EP8000 is off.

Step 7. Carefully insert one of the known good EPROMS into the lower 24 pins of the 28 pin ZIF socket with pin 1 towards the top left-hand side. Press <FN>, <STOR> to transfer its contents into the EP8000.

Step 8. Press <RST> again and remove the known good EPROM replacing it with the equivalent suspect EPROM from the receiver.

Step 9. Press <FN>, <VFY> to check the contents of the suspect EPROM with that of the known good EPROM now stored in the EP8000. A 'PASS' display indicates the suspect EPROM is correct, a 'FAIL' display indicates it is faulty.

Step 10. Repeat with the other receiver EPROM and known good EPROM remembering to press <RST> each time before loading or unloading the ZIF socket to ensure power to the socket is first removed.

Address Strobe Checks

The Microcomputer generates strobe pulses for various control ICs on the Microcomputer Board itself and on the Interface Board. The functions of these ICs are detailed in 'SECTION 4 : CIRCUIT DESCRIPTION' and in the following section 5.1.4. The Interface Board circuit diagram BP2025, bound in Part 2, also indicates the general functions of the Interface Board control ICs (pins 10 to 15 inclusive of 13PL3/12SK2). If a fault occurs in a particular control operation, the address strobes to the associated ICs should be checked. For example, for faulty keyboard operation, the address strobes to 12IC11 and 12IC12 should be checked via pins 14 (READ KEYBOARD '1003') and 13 (WRITE KEYBOARD '1004'), respectively, of 13PL3/12SK2, through to pins 1/15 of 12IC11 or pin 11 of 12IC12. A method of generating regular address strobes, which can be easily monitored on an oscilloscope, is given as follows. Note that each control IC has a its own numerical address ('1003' and '1004' in the previous example) which is given on circuit diagram BP2025.

Step 1. Remove the front panel assembly from the receiver (see section 5.2.2).

Step 2. Access the Microcomputer Board (see section 5.2.4).

Step 3. <u>OBSERVING THE USUAL ANTI-STATIC PRECAUTIONS</u> carefully remove the two EPROMs, 13IC8 and 13IC9, from their sockets and store them on conductive foam pads.

Step 4. Ensuring that it is not switched on, connect the EP8000 via the BSC-8 buffered simulator cable to the EPROM socket for 13IC9. Note that the BSC-8 requires the 24 pin lead option and requires internal switch settings to be made for 2732 type EPROMS. Ensure, in particular, that the connector is fitted into the EPROM socket correctly (pin 1 of the cable plug to the marked end of the EPROM socket).

Step 5. Switch the EP8000 on and select 'A 2732' by pressing <FN>, <DEV> and using its up and down cursor keys as necessary. Press <RST> and enter the short program, given in Table 5.1, into the EP8000. The control IC function, the associated address and test points are given in Table 5.2.

Step 6. Press <DMA> on the EP8000 and apply +15.5V to 12PL1 pin 10, +10.5V to 12PL1 pins 4 and 6, ground returns to pins 9, 5 and 7 respectively (Interface Board). The Microcomputer should RESET and run just the short simple test program entered into the EP8000. This program just does a repetitive load from the specified address simply to obtain a repetitive address strobe pulse, the actual loading being inconsequential.

Step 7. Monitor the appropriate test point, in Table 5.2, where the waveforms shown in Part 2 Figure 5.4 or 5.5 should be found.

Step 8. If a check of another address strobe is required, first remove all power to the Interface Board, press <DMA> on the EP8000, replace the original address in the EP8000 program (xxyy) with the new address, press <DMA> again and re-apply power to the Interface Board.

Table 5.1
<u>Address Strobe Test Program</u>

Address	Code	Mnemonic
3000	B6	LDAA
3001	xx	see Table 5.2
3002	yy	see Table 5.2
3003	7E	JMP
3004	F0	back to prog-
3005	00	ram start
:		
:		
:		
3FFE	F0	RESET
3FFF	00	Vector

Table 5.2
<u>Function Address xxyy</u>

Function	xxyy	Monitor Points/Waveform
2Kbyte RAM	0000	pin 15 of 13IC13 / Fig 5.4 pin 18 of 13IC5 / Fig 5.5
Interface Board Decoder	1000	pin 14 of 13IC13 / Fig 5.4 pins 4/5 of 13IC3 / Fig 5.4
Tuning knob, Pre-selector motor control	2000	pin13 of 13IC13 / Fig 5.4 pin 15 of 13IC1 / Fig 5.4
2nd EPROM	E000	pin 9 of 13IC13 / Fig 5.4 pin 18 of 13IC8 / Fig 5.4
Pres. Rec. and Synth unlock sense. ON/STBY key.	1002	pin 13 of 13IC3 /Fig 5.5 pin 15 of 13PL3/12SK2 pins 1/15 of 12IC7 / Fig 5.5
Keyboard Read	1003	pin 12 of 13IC3 / Fig 5.5 pin 14 of 13PL3/12SK2 pins 1/15 of 12IC11 /Fig 5.5
Keyboard Write	1004	pin 11 of 13IC3 / Fig 5.5 pin 13 of 13PL3/12SK2 pin 11 of 12IC12 / Fig 5.5
Display and Remote output	1005	pin 10 of 13IC3 / Fig 5.5 pin 12 of 13PL3/12SK2 pin 11 of 12 IC10 / Fig 5.5
Synth. and receiver settings	1006	pin 9 of 13IC3 / Fig 5.5 pin 11 of 13PL3/12SK2 pin 11 of 12IC9 / Fig 5.5
Remote input	1007	pin 7 of 13IC3 / Fig 5.5 pin 10 of 13PL3/12SK2 pins 1/15 of 12IC8 /Fig 5.5

5.1.7 Front Panel Assembly Control Functions

Refer to circuit diagrams BP1556, BP2025 and BP1975 bound in part 2.

Front Panel Controls

Operation of all front panel controls (except 'AF GAIN' and 'LINE LEVEL') and displays can be verified with the front panel assembly removed from the receiver. Details of the operation of each control are given in section 3.1 'Controls'. Correct operation of the corresponding receiver circuitry however, can obviously only be verified with the assembly connected to the receiver. If correct operation is not obtained in this circumstance, then the fault may lie in the Interface Board control ICs or serial to parallel converters. Table 5.3 indicates the ICs used to control the various receiver sections. If a fault is suspected in the control of a section, the appropriate ICs can be checked for digital logic level activity at their outputs (inputs are generally in common). To gain better access to the Interface Board, the front panel assembly can be moved to its 'forward' test position (see section 5.2.1 Front Panel Access). It is important before any 'logic analysis' takes place on either the Interface or Display boards that the voltage regulator 12IC5 (5V) is checked and the supply to all associated integrated circuits.

Table 5.3
<u>Control Integrated Circuits</u>

Section	Control via -
Synthesiser	12IC9 and connector 12RS3
Pre-selector and RF/1st IF	12IC9, 12IC6, 12IC4. Pre-selector motor driven gang via pulse on pin 11 of 13PL2/12SK1 and pin 4 of connector 12RS4.
Main IF /Audio	12IC9, 12IC6, 12IC4, 12IC3 and 12IC2
Display and Remote output	12IC10
Remote input	12IC8
Synth. unlock, Pres. Rec. sense ON/STBY key	12IC7
Keyboard	12IC11 (Read), 12IC12 (Write)
Main Tuning Knob	Pulses from knob via pin 2 of 12RS5 and pin 7 of 13PL2/12SK1 when knob turned clockwise ('up'). Pulses from knob via pin 1 of 12RS5 and pin 4 of 13PL2/12SK1 when knob turned anti-clockwise ('down').

Output Control IC Tests

If faults are suspected in output control ICs 12IC9, 12IC10 or 12IC12 and the address strobes to them have been checked (see previous section 5.1.3), the test program given can be modified to check that the outputs of these ICs are functioning. The full procedure is as follows.

Step 1. Remove the front panel assembly from the receiver (see section 5.2.2).

Step 2. Access the Microcomputer Board (see section 5.2.4).

Step 3. <u>OBSERVING THE USUAL ANTI-STATIC PRECAUTIONS</u> carefully remove the two EPROMs, 13IC8 and 13IC9, from their sockets and store them on conductive foam pads.

Step 4. Ensuring that it is not switched on, connect the EP8000 via the BSC-8 buffered simulator cable to the EPROM IC socket for 13IC9. Note that the BSC-8 requires the 24 pin lead option and requires internal switch settings to be made for 2732 type EPROMS. Ensure, in particular, that the connector is fitted into the EPROM socket correctly (pin 1 of the cable plug to the marked end of the EPROM socket).

Step 5. Switch the EP8000 on and select 'A 2732' by pressing <FN>, <DEV> and using its up and down cursor keys as necessary. Press <RST> and enter the short program, given in Table 5.4, into the EP8000. The output control IC function, the associated address and test points are given in Table 5.5.

Step 6. Press <DMA> on the EP8000 and apply +15.5V to 12PL1 pin 10, +10.5V to 12PL1 pins 4 and 6, ground returns to pins 9, 5 and 7 respectively (Interface Board). The Microcomputer should RESET and run just the short simple test program entered into the EP8000. This program just does a repetitive load of alternating data into the selected IC's outputs.

Step 7. Monitor the appropriate test point, in Table 5.5, where the waveforms shown in Part 2 Figure 5.6 should be found.

Step 8. If a check of another output IC is required, first remove all power to the Interface Board, press <DMA> on the EP8000, replace the original address in the EP8000 program (xxyy) with the new address, press <DMA> again and re-apply power to the Interface Board.

Table 5.4
<u>Output Control IC Test Program</u>

Address	Code	Mnemonic
3000	86	LDAA
3001	55	01010101
3002	B7	STAA
3003	xx	see Table 5.5
3004	yy	see Table 5.5

3005	86	LDAA
3006	AA	10101010
3007	B7	STAA
3008	xx	as above
3009	yy	as above
300A	7E	JMP
300B	F0	back to prog-
300C	00	ram start
:		
:		
:		
3FFE	F0	RESET
3FFF	00	Vector

Table 5.5
Output IC Address xxyy

Function	xxyy	Monitor Points
Keyboard Write	1004	pins 5, 6, 9, 12, 15, 16, of 12IC12. Pins 1/6 inc. of 12PL5
Display and Remote output	1005	pins 2, 5, 6, 9, 12, 15, 16, 19, of 12IC10. Pins 1/2 of 12PL4. Test points TP4/5
Synth. and receiver settings	1006	pins 2, 5, 6, 9, 12, 15, 16, 19, of 12IC9 pins 1, 2, 5, 6, 8, 9 of 12IC6. Pins 3 and 5/10 inc of 12RS3

Input Control IC Tests

If faults are suspected in input control ICs 12IC7, 12IC8 or 12IC11 and the address strobes to them have been checked (see previous section 5.1.3), the test program given can be modified to check that the inputs of these ICs are functioning. The full procedure is as follows.

Step 1. Remove the front panel assembly from the receiver (see section 5.2.2).

Step 2. Access the Microcomputer Board (see section 5.2.4).

Step 3. OBSERVING THE USUAL ANTI-STATIC PRECAUTIONS carefully remove the two EPROMs, 13IC8 and 13IC9, from their sockets and store them on conductive foam pads.

Step 4. Ensuring that it is not switched on, connect the EP8000 via the BSC-8 buffered simulator cable to the EPROM IC socket for 13IC9. Note that the BSC-8 requires the 24 pin lead option and requires internal switch settings to be made for 2732 type EPROMS. Ensure, in particular, that the connector is fitted into the EPROM socket correctly (pin 1 of the cable plug to the marked end of the EPROM socket).

Step 5. Switch the EP8000 on and select 'A 2732' by pressing <FN>,<DEV> and using its up and down cursor keys as necessary. Press <RST> and enter the short program, given in Table 5.6, into the EP8000. The control IC function, the associated address and test points are given in Table 5.7.

Step 6. Press <DMA> on the EP8000 and apply +15.5V to 12PL1 pin 10, +10.5V to 12PL1 pins 4 and 6, ground returns to pins 9, 5 and 7 respectively (Interface Board). The Microcomputer should RESET and run just the short simple test program entered into the EP8000. This program just does a immediate repetitive transfer of an input IC's settings to the output of 12IC10 where they can be monitored.

Step 7. Monitor the 'D0' <u>output</u> of 12IC10 (pin 9) with the oscillocsope, and short the 'D0' input of the selected input IC to ground. The 'D0' output of 12IC10 should fall to a logic zero (less than 0.5V). Remove the short on the selected input IC and the 'D0' output of 12IC10 should immediately rise to a logic one (greater than 2.4V). Repeat this using the 'D1' to 'D5' inputs monitoring the 'D1' to 'D5' outputs respectively. Shorting points for specific control functions are given in Table 5.7.

Step 8. If a check of another input IC is required, first remove all power to the Interface Board, press <DMA> on the EP8000, replace the original address in the EP8000 program (xxyy) with the new address, press <DMA> again and re-apply power to the Interface Board.

Table 5.6

Input Control IC Test Program

Address	Code	Mnemonic
3000	B6	LDAA
3001	xx	see Table 5.2
3002	yy	see Table 5.2
3003	B7	STAA
3004	10	Output IC
3005	05	12IC10
3006	7E	JMP
3007	F0	back to prog-
3008	00	ram start
:		
:		
:		
3FFE	F0	RESET
3FFF	00	Vector

Table 5.7

Input IC Address xxyy

Function	xxyy	Shorting Points
On/Stdby key	1002	pin 10 of 12IC7 or pin 14 of 12PL5 ('D0' monitored at pin 9 of 12IC10)
Pres. Rec. sense	1002	pins 12/4 of 12IC7 or pins 1/2 of 12PL2 ('D2/D3' monitored at pins 12/15 of 12IC10)
Synth. unlock sense	1002	pins 14/2 of 12IC7 or pins 1/4 of 12RS3 ('D4/D5' monitored at pins 16/19 of 12IC10)
Keyboard Read	1003	pins 2, 14, 4, 12, 6 and 10 of 12IC11 or pins 13/8 inc. of 12PL5 ('D0/D5' inc. monitored at pins 9, 6, 12, 15, 16 and 19 of 12IC10
Remote Input	1007	pins 6/12 of 12IC8 or pins 2/3 of 12PL3 ('D1/D2' monitored at pins 6/12 of 12IC10)

5.1.8 ADJUSTMENT OF INTERNAL STANDARD OSCILLATOR

Equipment Required

1) 'Off Air' Standard.

2) Signal Generator 10kHz-30MHz/50ohm capable of being locked to 1).

3) Digital Frequency Meter (50MHz).

4) Ancillaries Test Box 1650/6/D6245.

Procedure

In order to allow the internal standard to be adjusted a reference source of better than ±0.1ppm is required. The 1650/6 must have been 'on' for at least half an hour and have temperature stabilised in it's operational environment. Both crystal oscillators (1405kHz, 1500kHz) must have already been adjusted.

1) Lock the signal generator to the 'Off Air' standard and set to 29.001,000MHz/1mV (60dB/uV).

2) Connect the digital frequency meter to the signal generator output and check the former's calibration.

3) Connect the 1650/6 to the signal generator and via the 600ohm audio output to the digital frequency meter using Ancillaries Test Box 1650/6/D6245.

4) Tune 1650/6 to 29.001,000MHz selecting 'AGC SHORT/8kHz BANDWIDTH'.

5) Observe 5000Hz on digital frequency meter and adjust 8RV2 through acces hole in Synthesiser cover if required.

6) Lock the signal generator to the 'Off Air' standard and set to 1.001,000MHz/1mV (60dB/uV).

7) Tune 1650/6 to 1.001,000MHz selecting 'AGC SHORT/8kHz BANDWIDTH'.

8) Check output on digital frequency meter is still 5000Hz.

5.1.9 REMOTE CONTROL SWITCHING TIME

Equipment Required

1) Signal Generator 10kHz-30MHz/50ohm.

2) 100kHz Discriminator (sensitivity 0.14Hz/mV).

3) Storage Oscilloscope with low capacity input.

4) Remote Breakout Box 1650/6/D6250.

5) Remote Control Facility.

Procedure

The remote Control Switching Time is considered to be the time taken for the 1650/6 to change from one frequency (i.e. the start of the Remote Control Word) to within 200Hz of a new frequency.

1) Connect the 1650/6 to the signal generator and via the Remote Breakout Box 1650/6/D6250 to the Remote Control Facility. The Remote Control is described in Section 3.3.

2) Connect the Storage Oscilloscope to the 100kHz discriminator connected to 1650/6 IF O/P. Arrange for the storage oscilloscope to be triggered from the rising edge of the first CLOCK PULSE sent at the start of the 40 Bit DATA WORD.

3) Tune the receiver and generator to the desired frequency f1 and calibrate the discriminator for f1 ±200Hz.

4) Connect the remote control facility and switch to a new frequency f2.

5) Switch to f1 and observe, on the storage oscilloscope, the time the receiver takes to tune to within ±200Hz of f1. This time will vary as to whether f1 and f2 are within the same VCO range or not. Times will vary between 40-75mS. See Part 2 Figure 5.7.

6) It is important to check the operation of the two AGC 'quench transistors' 10TR18 and 7TR20 as these only operate under remote control. This may be shown by switching from a strong signal (110dB/uV) in slow AGC. The noise should rise straight away. Contrast this with a similar situation in 'local' control. 1mS 'Quench' pulses may be measured at 10STC1-6 for IF AGC and 7STC1-10 for RF AGC under remote control.

5.1.10 AGC ATTACK AND DECAY TIME

Equipment Required

1) Signal Generator 10kHz-30MHz/50ohm.

2) Ancillaries Test Box 1650/6/D6245.

3) Storage Oscilloscope with low capacity input.

4) Distortion Factor Meter with 600ohm termination.

5) Sensitive RF millivoltmeter.

6) 50ohm load.

Procedure

AGC 'attack' and 'decay' times are measured by viewing the receiver waveform envelope, at IF or AF, on a storage oscilloscope at the instantaneous onset or absence of signal.

Attack time

1) Connect the 1650/6 to the signal generator and via the 600ohm audio output to the storage oscilloscope using Ancillaries Test Box 1650/6/D6245. Connect the RF millivoltmeter and 50ohm load to the 1650/6 IF O/P.

2) Tune the receiver and generator to the desired frequency and observe the waveform envelope when the RF signal is switched on. See Part 2 Figure 5.8.

3) Repeat 2) observing IF O/P.

Decay time

4) Tune the receiver and generator to the desired frequency and observe the waveform envelope when the RF signal is switched off. See Part 2 Figure 5.9.

5) Repeat 4) observing IF O/P.

N.B. If a digital storage osilloscope is used it is important not to confuse RF envelope distortion with aliasing. A small change in the input frequency will usually identify an alias, even causing it to dissappear. Beware of relay switching on some signal generators modulating the RF output at switch on (relay 'bounce') over part of the output range.

5.1.11 SYNTHESISER PURITY

Equipment Required

1) Signal Generator 10kHz-30MHz/50ohm.

2) Ancillaries Test Box 1650/6/D6245.

3) Distortion Factor Meter with 600ohm termination.

4) 3M Mincom 8300A-W Flutter Meter.

Procedure

This test examines the short term stability of the 1650/6 synthesiser and should only be carried on a fully covered receiver as earth straps and wiring position are critical.

1) Connect the 1650/6 to the signal generator and via the 600ohm audio output to the 3M Mincom 8300A-W Flutter Meter using Ancillaries Test Box 1650/6/D6245.

2) Tune the 1650/6 to frequency f1/AGC SHORT/8kHz BANDWIDTH. Tune the signal generator to frequency f1-1.62kHz so producing an audio output of 3.38kHz. Set the input level 1mV (60dB/uV).

3) Operate flutter meter as per the following instructions:-

Operation of 3M MINCOM 8300A-W FLUTTER METER

For 1650/6 Synthesiser Purity Test

Control Settings

1)	Power	ON.
2)	Test/Cal	TEST.
3)	Drift BW	FAST.
4)	Test Frequency	3.38KHz. *

5) Drift Zero Set 0%.

6) Drift Full Scale 1%.

7) Flutter Peak to Peak 1%.

8) Flutter Bandwidth 0.625KHz. *

9) PK Time 3 Sigma.

10) Meter Select DEMOD

* These controls are ganged

Connections

1) INPUT — 3.38KHz signal from 600 ohm line. Level to bring LEVEL lamp to NORM

2) FLUTTER — Output may be viewed on an oscilloscope. NOT REQUIRED FOR MEASUREMENT PURPOSES.

3) OSC OUTPUT — NOT USED

4) DRIFT OUTPUT — NOT USED

5) EXT INPUT — NOT USED

Operation

1) Using DRIFT ZERO SET tune DRIFT meter to Centre Zero. NORM LEVEL lamp should be on.

2) After 10 seconds observe Flutter level on FLUTTER meter. Consider both peak and average readings.

Specification to ME 0634 Issue 1.4.1 Clause 13

Limit 2% on primary AF output.

5.2 MODULE ACCESS AND REMOVAL

5.2.1 FRONT PANEL ACCESS

1) Remove top and bottom dust covers.

2) Loosen M4 fixing screw in either sidepanel slot and remove the other two allowing the front panel to slide forward into it's 'forward test position'. Tighten fixing screw in either sidepanel slot.

3) This position is also recommended for use when inserting or removing connections to this assembly.

5.2.2 FRONT PANEL ASSEMBLY

1) See section 5.2.1.

2) Disconnect all leads to the assembly and remove both sidepanel M4 fixing screws.

3) Slide front panel forward clear of receiver and support either on it's handles or on the side panel brackets.

N.B. Take care not to damage the membrain switch top or bottom edge.

5.2.3 INTERFACE BOARD

1) See section 5.2.2.

2) Carefully disconnect membrain switch tail at 12PL5 keeping the connector faces parallel throughout.

3) Disconnect ribbon connectors 12RS5 and 12RS6 and remove five M3X16 fixing pillars and washers.

4) Withdraw interface board and microcomputer assembly from studs.

5.2.4 MICROCOMPUTER ASSEMBLY

1) See section 5.2.3.

2) Remove cover held by two M3X6 hexscrews.

3) Disconnect 13PL1 and remove two M3X20 fixing pillars and washers holding PCB and one locating heatsink.

4) Very gently prise apart 13PL2/12SK1 and 13PL3/12SK2 keeping the connector faces parallel throughout.

N.B. Sockets 12SK1 and 12SK2 must remain at right angles to the printed circuit board at all times in order to avoid strain and possible 'track fracture'.

5) Withdraw microcomputer board from studs.

Re-assembly

Re-assembly is the reverse of the above <u>except where the microcomputer board is to be fitted to another interface board.</u>This will require the microcomputer box to be re-aligned (see Part 2 Figure 5.10/11/12) as follows:-

6) Loosen four M3 hexscrews allowing microcomputer box to'float'.

7) Install microcomputer board taking care that the connector faces 13PL2/12SK1 and 13PL3/12SK2 are parallel throughout and at right angles to the interface board.

8) Orientate microcomputer box so that the board fixing studs are centralised in the fixing holes.

9) Tighten four M3 hexscrews fixing microcomputer box.

10) Replace two M3X20 fixing pillars and washers holding PCB and one locating heatsink and connect 13PL1.

11) Reconnect 13PL1 and replace microcomputer box lid.

5.2.5 DISPLAY BOARD

1) See section 5.2.3.

2) Remove front panel control knobs.

3) Remove connector 11PL3.

3) Remove five M3X8 fixing pillars and washers and three M3X6 hexscrews and washers.

4) Withdraw display board from studs.

N.B. Take care not to lay the display board on it's LED face in order to avoid damage to the latter.

5.2.6 REAR PANEL ASSEMBLY

1) Remove top and bottom dust covers.

2) Disconnect 10PL10 and 7PL1 (removing covers on these board sections first).

3) Disconnect power supply connectors 14PL1/2 and 14PL4/5.

4) Remove fixings completely from 15 way connector 1SK3 and from 9 way connector 1PL1 and ease back through their apertures to clear rear panel. Take care not to damage the wiring in the process.

5) Remove six M4 fixing screws and two protection brackets and withdraw rear panel assembly, 'easing out' grommet from the centre screen cut-away carrying the mains transformer-secondary leads.

5.2.7 POWER SUPPLY BOARD

1) Remove top and bottom dust covers.

2) Disconnect all leads from the power supply board.

3) Remove three M4 fixing screws and washers which 'sandwich' rear panel between the power supply heatsinks.

4) Ease out power supply board and heatsink bracket through the top of the receiver.

5) Remove four voltage regulator fixings and one board fixing and carefully part heatsink contact surface taking care not to strain voltage regulator soldered joints.

Re-assembly

Re-assembly is the reverse of the above. However, it is important that all 'heatsink compound' is replaced with new (Dow Corning DC340) and similarly any damaged insulating items.

5.2.8 MAIN IF AND AUDIO BOARD

1) Remove top and bottom dust covers.

2) Disconnect all connectors from the main IF and audio board removing covers over board sections as required.

3) Remove ten M3X6 and one M3X8 fixing screws and washers.

N.B. The M3X8 fixing screw has an M3 overlapping tooth washer associated with it. This ensures proper 'single point earthing ' of the audio stage and <u>must</u>

be replaced in the same position i.e. fixing adjacent to 10PL7.

4) Withdraw main IF and audio board upwards clearing leads and noting position of cable harness underneath.

Re-assembly

Re-assembly is the reverse of the above. However, it is important that all pillars are tightened before the printed circuit board is replaced in the chassis and that subsequently no leads are trapped .

5.2.9 RF AND 1st IF BOARD

1) Remove top and bottom dust covers.

2) Disconnect all connectors from the RF and 1st IF board removing covers over board sections as required.

3) Remove twelve M3X6 fixing screws and washers.

4) Withdraw RF and 1st IF board upwards clearing leads and chassis.

Re-assembly

Re-assembly is the reverse of the above. However, it is important that all pillars are tightened before the printed circuit board is replaced in the chassis and that subsequently no leads are trapped .

5.2.10 SYNTHESISER BOARD

1) Remove top and bottom dust covers.

2) Remove synthesiser cover and note position of any earth straps removed.

3) Disconnect all connectors from the synthesiser board removing covers over board sections as required. Extract ribbon cable connector from interface board 12RS3 and note lead positions.

4) Remove six M3X6 fixing screws, four M3X20 pillar/studs and associated washers.

5) Withdraw synthesiser board upwards clear of synthesiser box. Take care not to disturb leads in close proximity to the VCO box.

Re-assembly

Re-assembly is the reverse of the above. However, it is important that all pillars are tightened before the printed circuit board is replaced in the chassis and that subsequently no leads are trapped.

N.B. Where the 'first loop' below board screen has been disturbed it must be re-aligned before the synthesiser board is replaced.

6) Refering to Part 2 Figure 5.13/14 remove below board screen.

7) Loosen four M3X6 screws in screen allowing earthing bars to 'float'.

8) Re-assemble four pillar/studs and 'first loop' cover and then tighten earthing bars in the attitude adopted.

9) Disassemble four pillar/studs and 'first loop' cover and refit below board screen to synthesiser box.

10) Replace synthesiser board.

5.2.11 VCO MODULE

1) Remove top and bottom dust covers.

2) Remove synthesiser cover and note position of any earth straps removed.

3) Remove VCO cover and note position of any earth straps removed.

4) Disconnect all leads from the VCO board removing the adhesive as necessary.

5) Remove five M3X6 fixing screws and washers.

6) Remove VCO board.

N.B. An access hole is provided to allow removal of the synthesiser box obviating the need to remove the VCO box.

The VCO box is supported on flexible mounts insulating the former both mechanically and electrically.

7) Remove four slotted head screws saving eight bushes and withdraw VCO box.

Re-assembly

Re-assembly is the reverse of the above. The flexible mounts should be firm but not distorted. All leads should be re-positioned and adhesive applied as Part 2 Figure 5.2.