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SERVICE MANUAL

FOR

PR155 MF/HF COMMUNICATIONS RECEIVER
TEST INSTRUCTIONS

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SECTION ISSUES

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FOREWORD

This volume contains test and alignment information for the complete PR155 MF/HF Receiver and its constituent modules where the necessary test equipment is available. The information is based upon factory production test specifications. Complete information for test and alignment of newly produced equipment is given, but only those parts applicable to the circuits affected by a repair or associated with a particular fault symptom need be applied, i.e. preset controls and trimmers not directly concerned with the affected circuits need not be reset, but may be slightly readjusted if necessary to achieve improved performance.

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1. PR155 RECEIVER

1.1 TEST EQUIPMENT REQUIRED

(1) Mains lead to supply single phase a.c. mains to Plessey Mk.IV connector on the receiver.

Pin A	–	Neutral
Pin B	–	Line
Pin C	–	Earth

(2) Voltmeter to measure -16V d.c. and -3V d.c., e.g. Avometer Model 8.

(3) 75 ohm ±5%, ¼ watt resistive load for connection to BNC chassis sockets (100 kHz O/P, Aerial I/P) 2 off.

(4) 600 ohm ±5%, ¼ watt resistive load. To connect across Line Output terminals, 1 off.

(5) 150 ohm ±5%, ¼ watt resistive load. To connect across Line Output Terminals, 1 off.

(6) 75 ohm coaxial attenuator to provide 20dB insertion loss between the signal source and the Receiver over the range 500 kHz to 30 MHz.

(7) Valve Voltmeter to measure up to 5V, over the frequency range 200 Hz to 100 kHz. Calibrated in dBm (OdBm = 1mW into 600 ohm).

(8) Panoramic Receiver to examine spectra over the range 30 mHz to 70 mHz. Input impedance nominally 60 ohm or 75 ohm, sensitivity 2uV for clear display about noise.

(9) Distortion factor meter to measure total harmonic distortion of up to 10% at 1 kHz at levels of 400mW in 15 ohm, 1mW in 600 ohm and 10mW in 600 ohm.

(10) Audio source to amplitude modulate signal source to a depth of 90% over the range 300 Hz to 3 kHz.

(11) Noise Generator 75 ohm impedance. Required to measure noise factor at 1 MHz and 30 MHz as detailed in Section 20.

(12) Two Tone Generator 1V r.m.s. per tone as detailed in Section 21.

(13) 70 dB attenuator, 75 ohm termination.

(14) 600/75 ohm matching pad to match 600 ohm line O/P to 75 ohm Spectrum Analyser input.

(15) Valve voltmeter to measure between 5mV and 1V at frequencies up to 70 MHz.

(16) Spectrum Analyser suitable for examining signals at 100 kHz and audio frequencies. Internal spurious responses to be greater than 60dB.

(17) HF signal source, 75 ohm output impedance. Frequency range 60 kHz to 37.3 MHz for outputs between 1µV and 2V e.m.f. Capable of internal modulation at 1000 Hz between 30% and 90% modulation depth and external modulation between 200 Hz and 3 kHz at 30% modulation depth.

(18) VHF signal source, 75 ohm output impedance to provide signals at 15.1 MHz, 30 MHz, 76.6 MHz, 89.1 MHz and 104.6 MHz at levels between 2µV and 20mV e.m.f., capable of internal modulation at 1000 Hz to a depth of 30%.

(19) Two tone signal source, each tone being capable of 30% modulation at 1000 Hz and being combined to feed both signals simultaneously from 75 ohm with 40dB isolation between the sources.

TONE A	19.050 MHz	40mV e.m.f. O/P
TONE B	18.760 MHz	4V e.m.f. O/P

The output levels given assume 26dB insertion loss in the combiner as with the circuit described in Section 21.

(20) Pulse modulator capable of modulating a signal of 15 MHz at a level of 2mV e.m.f., the pulse having a rise time of better than 0.1 ms, width between 25 ms and 30 ms and repetition rate of approximately 1 pulse per 2 secs.

(21) Storage oscilloscope capable of measuring d.c. inputs, having an external sync facility, an amplitude response between 100mV/cm and 5V/cm, and a time base range between 5 ms/cm and 200 ms/cm.

1.2 TEST PROCEDURE

1.2.1 Preliminary Test and Inspection

The test procedure assumes that all modules are functioning correctly and are free from faults which would otherwise cause the receiver to malfunction. Before testing commences, the top and bottom covers should be removed.

(a) Power Supply, Standby

Apply 240V a.c. 50 Hz mains to the equipment via the mains lead and switch to STAND BY on the function switch S1. Adjust RV1 on the regulator board so that -15.5V ±0.25V d.c. relative to chassis is present on pin 4 of module 10, using the d.c. voltmeter.

(b) Power Supply, On

Set switch S1 to ON and verify that the negative supply voltage is not less than 15.0V d.c. (This may be measured on any one of the supply leads to pin 4 or 6 on most modules).

(c) Isolating Amplifier

(i) Set the signal source to 50 MHz CW and load with 75 ohm. Adjust level to give 0.5V across load as measured on the valve voltmeter.

(ii) Disconnect the 75 ohm load and connect the generator output to SKT8 on the Isolating Amplifier. Connect the 75 ohm load to the amplifier output, PL6.

(iii) Measure the level across the 75 ohm load; it should be 0.75V $\pm$0.15V.

1.2.2 Initial Alignment

(a) RF Filters, Insertion Loss

(i) Set the signal source to 1 MHz CW and load with 75 ohm. Adjust the level to give 5mV across the load as measured on the valve voltmeter.

(ii) Disconnect the 75 ohm load and connect the generator to the aerial socket on the rear of the receiver.

(iii) Set the megahertz selector on the receiver to '0' and connect the 75 ohm load to cable 3 socket on the turret, having first removed cable 3.

(iv) Measure the voltage across the 75 ohm load using the valve voltmeter and record insertion loss, using dB scale on the valve voltmeter; it should be 5mV $\pm$0, -2dB.

(v) Set the megahertz selector to '1' and record the result as in (iv).

(vi) Repeat the procedure, given in (i) to (iv) inclusive, for the frequencies and megahertz selector positions listed below, recording the insertion loss at each position.

Table 1.1 Insertion loss test frequencies and Megahertz Selector positions

Signal Generator Frequency	Megahertz Selector
2.5 MHz	2
3.5 MHz	3
5.0 MHz	4, 5
7.0 MHz	6, 7, 8
11.0 MHz	9, 10, 11, 12, 13
17.0 MHz	14, 15, 16, 17, 18, 19, 20
25.0 MHz	21, 22, 23, 24, 25, 26, 27, 28, 29

The insertion loss should be 5mV +0, -2dB.

(vii) Remove the 75 ohm load and reconnect cable 3.

(b) Megahertz Selector Circuits

Verify the alignment of the Megahertz Selector circuits in the Turret using the procedure described in Section 17.

(c) Phase Lock Circuits

Verify the adjustment of the Phase Lock circuits using the procedure described in Section 16.

(d) 48 MHz Selector Circuits

Attach the panoramic receiver to the test point on Module 4, Board B (accessible through the handle of the module) and tune the receiver to display 48 MHz centre frequency. Adjust the core of L6 Module 4, Board B (accessible through the handle of the module) to give maximum output at 48 MHz. Adjust in turn, cores L1 and L2 on Module 10 Board B (accessible through the handle) and L6 on Board B of Module 4, until the sidebands on the 48 MHz signal are at a minimum level while maintaining maximum output at 48 MHz. Measure the rejection of the adjacent sidebands; it should be not less than 40dB.

1.2.3 Gain Adjustments

Note: In this test it is essential to ensure that the signal is centred in the receiver's passband, but tuning for maximum output at either i.f. or audio is not always satisfactory, if wide filter bandwidths are specified for a particular test, because of ripple in the passband. It is recommended that tuning is always carried out using an unmodulated carrier and the narrowest symmetrical filter fitted to the receiver (normally 300 Hz).

If a tunable signal source is used, the signal may be centred by tuning the receiver or the signal source, but it is generally easier to achieve the desired result by tuning the receiver. For certain tests, however, it is necessary to tune the signal source and not the receiver. The state of tune using the narrow filter is determined by tuning for maximum i.f. output at 100 kHz.

(a) Overall Gain of Modules 5 and 7

Set S4 (AGC OFF/F/S) to F and with S1 set to ON and no signal input to the receiver, measure the voltage on the a.g.c. line (pin 3 on module, 4, 5 or 7) relative to the chassis. Switch S4 to OFF and adjust the i.f. gain control over its full range. The voltage measure on the a.g.c. line should vary between 1.25V and 4.8V. Now adjust IF GAIN to give the same d.c. potential on the a.g.c. line as obtained previously.

Set S2 (mode selector) to AM, break cable 13, joining modules 4 and 5, and inject a signal at 10 MHz. unmodulated, at an e.m.f. of 30µV to module 5, using the signal source (1.1 (17)). Terminate the 100 kHz i.f. output socket with the 75 ohm load and connect the valve voltmeter across the load. If a tunable signal source is used, centre the carrier in the receiver's passband by tuning the signal source (see note above) and then select 6 kHz filter bandwidth. Adjust RV1 on Module 7 (accessible through handle) so that the output is between 38mV and 43mV r.m.s. Lock RV1, remove the signal source from the input to Module 5 and rejoin cable 13.

(b) <u>Gain of Module 4</u>

With the receiver controls set as in (a) break cable 11 connecting Modules 2 and 4, and inject a signal at 37 MHz, unmodulated, at an e.m.f. of 6µV, to Module 4, using the signal source (1.1 (17)). If a tunable signal source is used, the signal should be centred in the receiver's passband by tuning the signal source (see note above) then selecting 6 kHz filter bandwidth. Adjust RV1 on Module 4 (accessible through handle) so that the 100 kHz i.f. output is between 38mV and 43mV r.m.s. Remove the signal source from the input to Module 4 and rejoin cable 11.

1.2.4 Overall Receiver Gain

(a) <u>Gain at 1.1 MHz</u>

Apply a signal of approximately 1.1 MHz from the signal source (1.1(17)) at an e.m.f. of 2µV to the receiver 75 ohm input, with a.g.c. off, the i.f. gain control adjusted as in 1.2.3 (a) and the 100 kHz output still terminated with the 75 ohm load. Place the signal in the centre of the receiver's passband by tuning the receiver (see note 1.2.3). Select the 6 kHz filter position. Measure the 100 kHz output across the 75 ohm load, as measured on the valve voltmeter; it should be between 80mV r.m.s. and 140mV r.m.s.

(b) <u>Gain at 29.2 MHz</u>

Repeat (a) but at a frequency of approximately 29.9 MHz and at an e.m.f. of 5.0µV. The output across the load should be between 60mV and 120mV r.m.s.

(c) <u>Gain at 60 kHz</u>

Repeat (a) but at a frequency of approximately 60 kHz and at an e.m.f. of 2µV. The output across the load should be between 60mV and 120mV r.m.s.

(d) <u>Alignment of Image Rejector Coil</u>

(i) Set the receiver to 7.4 MHz. Leave the AGC OFF/F/S switch in the OFF position and remove the cover from the r.f. drum section of the turret.

(ii) Tune the signal source to 82 MHz, increase the output level and adjust tuning until a reasonable output is obtained from the 100 kHz output socket of the receiver.

(iii) Locate image rejector coil situated in the r.f. drum section of the turret and adjust for minimum reading on the valve voltmeter.

(iv) Increase signal source output and ensure that the correct tuning point has been obtained. Lock the core of the rejector coil with a suitable varnish and replace both top covers on turret.

(e) Gain Standardisation

Note: In this test, input frequencies corresponding to multiples of 1.000 MHz are specified e.g. 15.0 MHz. Where the precise value of the frequency is uncritical, i.e. the term "approximately" is used, care should be taken to ensure that the receiver is not inadvertently tuned to an internally generated spurious response, which will affect the test. In particular, these occur at whole megahertz points.

Displacing the receiver tune point by 10 kHz from any spurious response should ensure a valid measurement.

Repeat (a) but at a frequency of approximately 15.0 MHz and at an e.m.f. of 2µV. Adjust and lock RV1 on Module 4 to give 40mV ±2mV at 100 kHz.

(f) Detectors and Line Amplifier

(i) CW

With the AGC switch set to OFF, S2 set to CW mode, S3 set to the narrowest filter position, and the IF GAIN adjusted as in 1.2.3 (a), apply an input signal of 2µV e.m.f. at approximately 15 MHz. Connect 600 ohm load across the line output terminals on the rear connector block. Set the line output impedance link on the rear selector panel to the 600 ohm position. Tune the receiver to give maximum output at 100 kHz. Adjust the b.f.o. to give an audio output at approximately 1000 Hz (using the internal loudspeaker as a monitor). Connect the valve voltmeter across the 600 ohm load. Set RV1 on Module 9 (accessible through the handle) to the fully clockwise position and measure the audio output voltage obtained; it should be not less than 2.45V r.m.s.

(ii) AM

Switch S2 to the AM mode, and S3 to the 6 kHz filter position. Modulate the input signal at 1000 Hz, 30% modulation depth. Increase the input signal amplitude to 3µV e.m.f. and measure the audio output voltage obtained; it should be not less than 2.45V r.m.s.

(iii) SSB

Remove the modulation from the input signal. Switch S2 to USB, S3 to SSB, and reset the input signal to 2µV e.m.f. Tune the receiver to give an audio output at approximately 1000 Hz. Measure the audio output voltage obtained; it should be not less than 2.45V r.m.s.

(g) Sideband Symmetry

(i) USB

Switch S3 to the 6kHz position with conditions as in (f) (iii). Adjust RV1, Module 9B, to give 2.45V r.m.s. across the 600 ohm load.

(ii) Switch S2 to LSB mode. Measure the audio output voltage obtained. It should be not less than 2.45V r.m.s.

(iii) CW

Switch S2 to the CW mode and adjust the b.f.o. to give an audio output of approximately 1000 Hz. Measure the audio output voltage obtained which should be 2.45V r.m.s. ±10%.

(iv) Centre Top Continuity

Disconnect the valve voltmeter at one end of the 600 ohm load and connect to position 2 (CT) on rear connector block. Measure the voltage obtained; it should be 1.225V r.m.s. ±10%.

1.2.5 AGC Performance

(a) AGC Threshold

With the input signal of 15 MHz set to an e.m.f. of 2μV, ensure that the signal is still centred in the receiver's passband. Reconnect the valve voltmeter across the 600 ohm load and adjust the b.f.o. to give approximately 1000 Hz audio output frequency. Set RV1 on Module 8 (accessible through the handle) to the fully counter-clockwise position and set the AGC OFF/F/S switch to F (fast). Monitor the voltage on the a.g.c. line as before (1.2.3 (a)) and rotate RV1 on Module 8 clockwise until the a.g.c. voltage just changes. Lock RV1 on Module 8 in this position.

In order to verify the threshold setting, reduce the signal source output to 1μV e.m.f. and then gradually increase the signal until the a.g.c. voltage just changes. Ensure that the threshold input level is 2μV ±10%.

(b) AGC Range

With 2μV e.m.f. input from the signal source, adjust RV1 on Module 9 to give a convenient audio output level as measured on the valve voltmeter, across the 600 ohm line termination. Raise the r.f. input level by a total of 120dB in 10dB steps and observe the changes in audio output level. There should be not more than 4dB total variation above a.g.c. threshold.

(c) AGC Characteristic

(i) Fast

Set the signal source frequency to 15 MHz CW at a level of 2mV e.m.f. Connect the Pulse Modulator between the signal source and the receiver and connect the Modulator Trigger output to the oscilloscope. External Sync. Tune the receiver to 15 MHz and connect the oscilloscope probe to the a.g.c. line (1.2.3 (a)). With the oscilloscope deflection set to d.c., synchronize the trace to the pulse start and set the timebase and amplitude controls to obtain a convenient response for measurement of rise time, hang time and decay time.

Rise Time	15 to 20 ms
Hang Time	45 ±15 ms
Decay Time	Not more than 120 ms

(ii) Slow

Repeat 1.3.5 (c) (i) with the AGC switch set to S (slow).

Rise Time	15 to 20 ms
Hang Time	750 ±250 ms
Decay Time	Not more than 120 ms

Note:

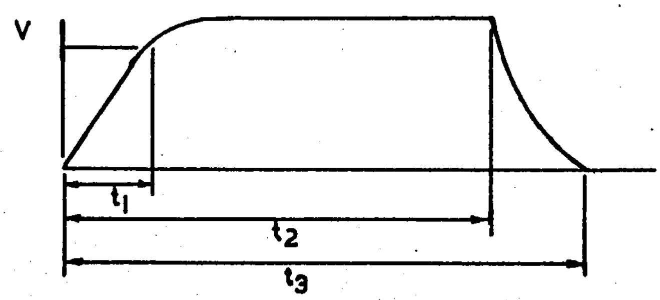

Fig. 1.1

Rise time is given by t1 secs.
Hang time is given by (t2 - pulse width) secs.
Decay time is given by (t3 - t2) secs.

(d) S Meter

Set S6 (AF/RF switch) to RF. Set the input signal level to 500μV e.m.f. Adjust the potentiometer RV3, on the tag-board adjacent to the meter, so that the meter needle is on the '9' mark. Lock RV3.

1.2.6 Noise Performance

Note: Unless otherwise stated, all measurements of audio output are made using the valve voltmeter and line output as in 1.2.4 (f).

(a) Noise Factor at 1 MHz

Tune the receiver to approximately 1.1 MHz, set S4 (AGC OFF/F/S) to OFF, S3 (Filter Selection) to 6 kHz, S2 (Mode Selector) to AM. Turn the IF and audio gain controls fully clockwise. Connect the noise generator to the 75 ohm aerial input terminal of the receiver and measure the noise figure in the manner described in Section 20. (See Note to 1.3.4 (e)). The noise figure should be not greater than 9dB (8 times).

(b) Noise Factor at 30 MHz

Repeat the noise factor measurement with the receiver tuned to approximately 30 MHz (see Note 1.2.4 (e)). The noise factor should not exceed 12dB (16 times).

(c) Low Frequency Signal/Noise Performance

With the mode selector set to CW and the AGC switch set to OFF, connect signal source (1.1 (17)) at a frequency of 60 kHz, unmodulated and at a level of 2µV e.m.f., to the 75 ohm aerial input of the receiver. Tune the receiver so that the signal is centred in the receiver's passband (see Note to 1.2.3) and S3 set to 300 Hz bandwidth. Adjust the b.f.o. to give an audio output of approximately 1000 Hz. Adjust RV1 in Module 9 to give 1 mW to line (0.775V). Remove the input signal and note the new audio output level. The audio output should decrease by at least 20dB.

1.2.7 Audio Performance

(a) Audio Output Levels

(i) Internal speaker output

Apply a signal from the signal source (1.1 (17)) of approximately 15.0 MHz and at a level of 3µV e.m.f., to the 75 ohm input of the receiver. Tune the receiver to centre the signal in the receiver's passband (see Note to 1.2.3). Amplitude modulate the signal 30% with 1000 Hz tone. Select AM mode and switch the a.g.c. on. Switch the speaker OFF/F/S switch to OFF, so that the audio amplifier is loaded by R6 (15 ohms). Connect the valve voltmeter across R6 and with the audio gain control fully clockwise, measure the audio voltage obtained; it should be not less than 2.45V r.m.s.

(ii) Headphones

Load each headphone jack in turn by 600 ohms and measure the output voltage obtained; it should be not less than 2.0V r.m.s.

(iii) External line, low impedance

Temporarily remove the 600 ohm line load and replace it by the 150 ohm load. Transfer the valve voltmeter to this load and select 150 ohms on the line impedance selector panel. Measure the output voltage obtained; it should be not less than 2.45V r.m.s.

Remove the 150 ohm load, restore the 600 ohm load previously removed and reselect 600 ohms on the line impedance selector panel. Reconnect the valve voltmeter as before.

(b) Audio Distortion

(i) Speaker output, a.m.

Increase the signal input to 200µV e.m.f., increase the modulation depth to 90% and adjust the audio gain control to give 2.45V r.m.s. as measured by the voltmeter across R6. Remove the voltmeter and replace it by the distortion factor meter. Measure the total harmonic distortion; it should be not more than 5%.

Note: It is essential that where 90% modulation depth is quoted, an accurate measurement of modulation depth is made using an oscilloscope.

$$\text{Mod. Depth} = \frac{V_{\text{Pk to Pk}} - V_{\text{Trough to Trough}}}{V_{\text{Pk to Pk}} + V_{\text{Trough to Trough}}} \times 100\%$$

(ii) Line output, a.m.

With the same r.f. input as in (b) (i) and the audio gain control RV2 adjusted fully clockwise, adjust the preset gain control on Module 9 to give 2.45V r.m.s. (10mW in 600 ohms) on the line output valve voltmeter. Remove the voltmeter and measure the total harmonic distortion using the distortion factor meter. The total harmonic distortion should be not more than 5%.

(iii) Line output - s.s.b.

Remove the distortion factor meter and replace by valve voltmeter.

With the signal source output unmodulated, set the receiver function switches to USB, SSB, and tune receiver to give approximately 1 kHz output. Set RV1 on Module 9 to give 0.775V (1mW into 600 ohm). Remove voltmeter and measure total harmonic distortion using the distortion factor meter. The total harmonic distortion should be not more than 5%.

(c) Audio Frequency Response (Overall)

(i) I.F. response

With the same r.f. input level as before, i.e. 200µV e.m.f. at approximately 15 MHz, but arranged to be amplitude modulated 30% over the frequency range 300 Hz to 3kHz, set the modulating frequency to 1 kHz and adjust the audio output level to line to 775mV r.m.s.(1mW). Change the modulation frequency to 300 Hz and measure the audio output to line; it should be not more than 4dB down on the 1 kHz level.

(ii) H.F. response

Change the modulation frequency to 3000 Hz and again measure the audio output to line; it should be not more than 4dB down on the 1kHz level.

(d) Check on Panel Meter

Reset the modulation frequency to 1 kHz. Adjust the preset gain control on Module 9 to give 1mW as indicated on the panel meter, with the AF/RF switch set to AF. Measure the audio output to line; it should be 1mW ±1.5dB (775mV ±125mV).

(e) Hum and Other Outputs to Line

Re-adjust the preset gain control on Module 9 to give 1mW (775mV) to line, for 30% modulated signal. Remove the modulation from the r.f. input signal and measure the new output to line; it should be not less than 30dB below 775mV (1mW).

1.2.8 Calibrate Facility

(a) Interpolating Oscillator

Switch the function selector S1 to the 'CAL' position, the mode selector switch S2 to USB, the filter selector switch S3 to 6 kHz and AGC OFF/F/S switch S4 on. Verify that the calibration pips can be heard every 100 kHz when the receiver is tuned over the frequency range 29 MHz to 30 MHz and verify also that the adjustable cursor can be set to the appropriate scale marking, at each zero beat condition of the pips, over this frequency range.

(b) Calibrate B.F.O.

Connect an unmodulated signal source, of any convenient level at a frequency of approximately 15 MHz, to the 75 ohm input of the receiver. Set the function selector S1 to ON, the mode selector switch S2 to USB, and the AGC OFF/F/S switch S4 on. Tune the receiver to centre the signal in the receiver's passband (see Note 1.2.3) and reselect 6 kHz filter bandwidth. There should be no audio output. Set the BFO control to '0' and then switch S2 to the CW position. The zero audio output condition should be maintained. If it is not, adjust L1 on the b.f.o. module to obtain a zero beat condition (the inner side cover of the b.f.o. must be removed to gain access to L1).

1.2.9 Single Signal Responses

Note: This class of response is, in general, concerned with the response of the receiver to signals other than that to which the receiver is tuned. The level of such signals is generally very high in relation to threshold sensitivity of the receiver and care has to be taken that limiting, or operation of the r.f. amplifier a.g.c. does not occur during the measurement. Freedom from such conditions can be established in the following manner. With the AGC switch set to OFF, adjust the high level signal to give a convenient audio output level and verify that the audio output increases linearly, as the r.f. signal level is raised. If not, reduce the signal level further until the requirement is met. Finally set to a convenient audio level and note both the audio and r.f. input signal levels.

During the following tests 1.2.9 (a) to (c), turn the IF gain control fully clockwise. Select AM mode and measure the receiver output to line as in 1.2.4 (f).

(a) Image

(i) 2 MHz

Apply an unmodulated input signal of approximately 76.6 MHz, at an e.m.f. of 10mV to the receiver's 75 ohm input. With the AGC switch set to F, tune the receiver to approximately 2 MHz and re-adjust to centre the carrier in the receiver's passband (see Notes to 1.2.3 and 1.2.4 (e)). Select 6 kHz filter bandwidth and amplitude modulate the input signal 30% at 1000 Hz. Now with AGC switch set to OFF, adjust the r.f. signal level to obtain a convenient audio output level, checking for linearity. Note the audio and r.f. signal input levels. Now replace the signal source by one of approximately 2.0 MHz, unmodulated, at an e.m.f. of approximately 2µV and tune the signal source to centre the signal in the receiver's passband (see Note to 1.2.3).

Select 6 kHz filter bandwidth and amplitude modulate the input signal 30% at 1000 Hz. Adjust the r.f. input signal level to give the same audio output level as obtained previously. The ratio of the two r.f. input signal levels is the image response ratio at 2.0 MHz. The image response ratio should be not less than 80dB.

(ii) 15 MHz

Measure the image response ratio when the receiver is tuned to approximately 15 MHz. The image frequency will then be 89.6 MHz. The image response ratio should be not less than 80dB.

(iii) 30 MHz

Measure the image response ratio when the receiver is tuned to approximately 30 MHz. The image frequency will then be 104.6 MHz. The image response should be not less than 70dB.

(b) I.F. Rejection

(i) 1st I.F. (37.300) MHz

Tune the receiver to approximately 30.0 MHz, avoiding any spurious response. Apply an unmodulated signal of 37.300 MHz at an e.m.f. of 10mV., to the receiver's 75 ohm input. With the AGC switch set to F, tune the signal source to centre the signal in the receiver's passband (see Note to 1.2.3). Select 6 kHz filter bandwidth and amplitude modulate the input signal 30% at 1000 Hz. Now with the AGC switch OFF, adjust the r.f. input signal to obtain a convenient audio output level, verifying linearity as in the note to 1.2.9. Note the audio and r.f. signal input levels. Verify also that the signal-plus-noise to noise ratio is greater than 6dB.

Now replace the signal source by one of approximately 5µV and tune the receiver to centre the signal in the receiver's passband.

Select 6 kHz filter and amplitude modulate the input signal 30% at 1000 Hz. Adjust the r.f. input signal to give the same audio output level as obtained previously. The ratio of the two signals is the first i.f. rejection ratio, when the receiver is tuned to 30.0 MHz. The i.f. rejection ratio should be not less than 70dB.

(ii) 2nd IF (10.700 MHz)

Repeat the measurement described in (b) (i) but with the receiver tuned to approximately 10.2 MHz and using r.f. input signals at 10.700 MHz and approximately 10.2 MHz respectively; the i.f. rejection ratio should be not less than 70dB.

(c) Second Order Distortion, A

Repeat the measurement described in (b) (i) but with the receiver tuned to approximately 18.9 MHz and using r.f. input signals at 18.650 MHz (one half of the first i.f.) and approximately 18.9 MHz; the response ratio should be not less than 55dB.

1.2.10 Multiple Signal Responses

(a) Blocking

Set the mode selector S2 to AM and the AGC switch to F.

Connect two signal sources set to any convenient frequency around 19.0 MHz and separated by approximately 290 kHz (i.e. signal source 1.1 (19), 18.76 MHz and 19.05 MHz) to the receiver's 75 ohm input. Reduce the 18.76 MHz signal input to zero and set the 19.05 MHz signal level, unmodulated, to 2mV e.m.f. Tune the receiver to centre this signal in the receiver's passband (see note to 1.2.3) and then select the 6 kHz filter bandwidth. Modulate the signal 30% at 1000 Hz. Connect the spectrum analyser to the 600 ohm line output load and tune to the 1000 Hz audio output. Adjust the spectrum analyser controls to obtain a convenient level of response. Now increase the level of the 18.76 MHz signal (unmodulated) to give 200mV e.m.f. into the receiver input terminal. Verify that the audio output due to the 19.05 MHz signal does not fall by more than 3dB.

(b) Intermodulation

(i) In band two-tone test (100 kHz)

Set the mode selector to AM, the filter selector to 6 kHz and the AGC OFF/F/S switch to the F or S position. Using the method described in Section 21 for testing intermodulation products, measure the third order intermodulation products at an input level of 1V r.m.s. per tone, with the receiver tuned to 18.760 MHz and apply the i.f. output at 100 kHz to the spectrum analyser. The intermodulation products should be at least 34dB down on the wanted tones.

(ii) In band two-tone test (audio) high level input

Adjust the line output control RV1, on Module 9, to give 0.775V output (1mW into 600 ohms), for an unmodulated 200µV e.m.f. signal, having set the receiver to USB and 6 kHz filter before applying the tones. Remove the 600 ohm load and connect the 600/75 ohm matching pad between Line O/P and the Spectrum Analyser. Apply tones and measure the intermodulation products, which should be at least 26dB down.

Note: Care must be taken to avoid including 2nd and 3rd harmonic responses in intermodulation measurement. However, 2nd and 3rd order intermodulation products must be measured i.e. F1 $\pm$F2, F2 $\pm$F1, 2F1 $\pm$F2, 2F2 $\pm$F1. Tone frequencies of 0.75 kHz and 1.75 kHz at audio are suitable, as their intermodulation products and harmonics do not clash.

(iii) In band two-tone test (audio) low level input

Insert the 70dB attenuator between the tone source and the receiver input and repeat (i). The intermodulation products should be at least 30dB down.

Disconnect the 600/75 ohm matching pad and reconnect the 600 ohm load.

1.2.11 Spurious Responses

(a) Internally generated

(i) 1000 MHz

Connect the 20dB 75 ohm pad to the 75 ohm aerial input socket, and to the pad connect the signal source (1.1 (17)). Set S3 to CW Mode and S2 to the narrow band filter position. Set the signal source to 20µV e.m.f. and set the b.f.o. to approximately 1 kHz. Set the receiver to a frequency of approximately 1.010 MHz and tune the signal source to produce maximum audio output voltage at this frequency. Note the audio output level obtained. Disconnect the signal source leaving the pad connected to receiver, and tune the receiver to 1.000 MHz which should coincide with a spurious response. The receiver should be tuned so that the spurious response (if present) produces maximum audio output, which should not exceed the level obtained previously. It should be not more than 2µV equivalent e.m.f. (20µV signal source e.m.f.).

(ii) Others

Repeat the above test at each of the frequencies and corresponding input levels shown in Table 1.2:

Table 1.2 Spurious response test frequencies and input levels

Frequency (MHz)	Signal Source (e.m.f. from 75 ohm) (µV)
2.000	5
5.350	5
5.400	5
8.025	5
10.600	5
10.800	5
13.040	5
16.050	5
21.200	5
21.400	50
25.000	5
27.000	5
29.000	5

1.2.12 Line Output Setting

Remove the 20dB pad from the aerial input socket. Set the signal source to 15 MHz 200µV e.m.f. output and connect to the receiver aerial socket. Tune the receiver to the signal (see 1.2.3) and set the AGC switch to F, select AM mode and 6 kHz filter. Apply 1 kHz modulation to a depth of 30% and monitor Line Output across the 600 ohm load.

Adjust RV1 on Module 9B to give 0.775V (1mW into 600 ohm) and lock in this position.

2. R.F. AMPLIFIER (MODULE NO.1)

2.1 TEST EQUIPMENT REQUIRED

(1) Multimeter, e.g. Avometer Model 8

(2) Stabilised power supply to provide −15.25V ±0.25V at approximately 50mA

(3) Valve voltmeter to measure between 5mV and 25mV at 1 MHz and 30 MHz

(4) Unmodulated signal source capable of providing 1mV r.m.s., e.m.f., from a 75 ohm source, at frequencies of 1 MHz and 30 MHz and also capable of providing 3V r.m.s., e.m.f., controllable in 1/2dB steps from 1mV upwards, at the same frequencies.

(5) Equipment to measure noise factor at 1 MHz and 30 MHz (Section 20).

(6) Equipment to measure third order intermodulation products at 1 MHz and 30 MHz (Section 21).

(7) 75 ohm ±5%, ¼ watt resistive load to connect to r.f. output cable 10.

2.2 TEST PROCEDURE

2.2.1 Identification of d.c. connections

This module corresponds to Type 1 of Section 19.

Terminal 4 − 15V
3 − Not used
2 − Not used
1 Earth (Supply +ve)

2.2.2 Current consumption

Connect the 75 ohm load to the r.f. output socket cable 10. Apply the 15V d.c. power supply between terminals 1 and 4 (positive to terminal 1) via the ammeter. The current drawn by the module should be 50mA to 70mA.

2.2.3 Voltage gain

(a) With the signal source set to 1mV e.m.f. at 1 MHz and connected to the module input, cable 3, connect the valve voltmeter across the 75 ohm load; the r.f. output should be not less than 5mV.

(b) Repeat (a), but at a frequency of 30 MHz. The r.f. output should be not less than 4mV.

2.2.4 Large Signal A.G.C. Performance

(a) Maintaining conditions as in 2.2.3 (b), raise the r.f. input level in 10dB steps up to 3V r.m.s. The r.f. output should limit at an output level of between 30mV and 50mV.

(b) Repeat (a) at a frequency of 1 MHz. Limiting should occur at an input level between 40mV and 60mV.

2.2.5 Noise Factor

(a) Remove the valve voltmeter and signal input. Measure the noise factor of the module at 1 MHz using the method described in Section 20. A noise factor of not more than 5 times should be obtained.

(b) Repeat (a) but at 30 MHz. A noise factor of not more than 5 times should be obtained.

2.2.6 Third Order Intermodulation Performance

(a) Measure the third order intermodulation products at 1 MHz using the method described in Section 21. The third order intermodulation should be at least 30dB down.

(b) Repeat test (a) but at 30 MHz. The third order intermodulation should be at least 28dB down.

2.2.7 A.G.C. Thresholds

(a) Adjust the signal source for an output of 1 MHz at 1mV e.m.f. and connect to the module. Connect the d.c. voltmeter across L5 and earth. Increase signal input until the voltmeter reading just starts to change. The output level from the signal source at which this occurs should be 20mV to 40mV.

(b) Repeat (a), but at a frequency of 30 MHz. The signal source output level should be 35 mV to 65 mV.

(c) Repeat (a) at a frequency of 1 MHz but with the voltmeter connected between L3 and earth. The signal level should be 3.5 mV to 6.5 mV.

(d) Repeat (c), but at a frequency of 30 MHz. The signal level should be 3.5mV to 10mV.

3. FIRST MIXER (MODULE NO.2)

3.1 TEST EQUIPMENT REQUIRED

(1) Valve voltmeter to measure r.f. voltages of between 0.5mV and 20mV at frequencies over the range 15 MHz to 105 MHz.

(2) Signal source to provide inputs for filter alignment at 37.30 MHz, 42.78 MHz and 68.58 MHz at 1V r.m.s., e.m.f. from a 75 ohm source; also at 15 MHz and 30 MHz to 105 MHz for filter performance check.

(3) Signal source to provide r.f. signal inputs at 100 kHz, 1 MHz, 14 MHz, 15 MHz, 16 MHz, 30 MHz and 37.3 MHz at 100mV r.m.s., e.m.f. from a 75 ohm source.

(4) Second signal source, required at the same time as the source (3), to provide local oscillator inputs at frequencies of 37.4 MHz, 38.3 MHz, 52.3 MHz and 67.3 MHz at 1.0V r.m.s., e.m.f. from a 75 ohm source.

(5) Panoramic receiver of 75 ohm input impedance to display module outputs at 36.3 MHz, 37.3 MHz and 38.3 MHz, the outputs at 36.3 MHz and 38.3 MHz being approximately 50dB down on the output at 37.3 MHz. Level at 37.3 MHz is approximately 15mV. The receiver is also required to measure outputs at 67.3 MHz of approximately 200µV.

(6) 75 ohm ±5%, ¼ watt resistive load to terminate input filter during alignment.

(7) 75 ohm ±5%, ¼ watt resistive load to terminate output cable 10.

(8) 75 ohm ±5%, ¼ watt resistive load to terminate input cable 11.

(9) Module screening can, modified to provide access to coils L1, L2 and L3 for alignment purposes.

3.28 TEST PROCEDURE

3.2.1 Alignment of 30 MHz Low Pass Filter

(a) Ensure that the links connecting capacitors C1, C3, C5 and C7 to earth are removed. The link connecting the filter output to T1 must also be removed, and the 75 ohm load connected between the filter output and earth. Connect the valve voltmeter across the load resistor. Place the module in the modified screening can.

(b) Apply the signal source (3.1.2) at a level of 1V e.m.f. and at a frequency of 37.3 MHz to the module input cable 10. Adjust the core of L2 to give minimum output as observed on the valve voltmeter.

(c) Change the input frequency to 42.78 MHz and adjust the core of L3 to give minimum output.

(d) Change the input frequency to 68.58 MHz and adjust the core of L1 to give minimum output.

(e) Remove the screening can and reconnect the links joining capacitors C1, C3, C5 and C7 to earth. Replace the screening can and, with the voltmeter still connected across the load, change the input frequency to 15 MHz and note the reading on the valve voltmeter. Change the input frequency to 30 MHz and note that the valve voltmeter reading is not more than 2dB down on the level at 15 MHz.

(f) Change the input frequency slowly over the range 30 MHz to 105 MHz, maintaining a constant e.m.f. of 1V and observe the valve voltmeter readings, which should be as follows:

(i) at 37.5 MHz, not less than 42dB down on the level at 15 MHz.

(ii) at 40 MHz to 70 MHz, not less than 35dB down on the level at 15 MHz.

(iii) at 71 MHz to 105 MHz, not less than 30dB down on the level at 15MHz.

Note: Due to the high frequencies and high levels involved in these tests, extreme care must be taken to shield the valve voltmeter connections from the signal input.

(g) Remove the screening can, valve voltmeter, and 75 ohm filter load and reconnect the filter output to transformer T1. Replace the screening can.

3.2.2 Mixer and 37.3 MHz Band Pass Filter

(a) Terminate the module output cable 11 with the 75 ohm resistive load. Apply the signal source (2.1. (3)), at a frequency of 1 MHz and at a level of 100mV r.m.s., e.m.f., to r.f. input cable 10. Apply also the signal source (2.1 (4)) at a frequency of 38.3 MHz and at a level of 1V r.m.s., e.m.f. to the local oscillator input cable 9. Connect the valve voltmeter across the 75 ohm resistive load and measure the r.f. output at 37.3 MHz. If necessary, adjust one or other of the two signal inputs to give maximum output at 37.3 MHz. The output obtained should be not less than 12mV.

(b) Setting the input and local oscillator signal source frequencies to those listed in Table 3.1, verify that the output obtained at each setting is as given:

Table 3.1 Input and Local Oscillator Test Frequencies

Input	Local Oscillator	Output
30 MHz	67.3 MHz	Not less than 7mV
100 kHz	37.4 MHz	Not less than 12mV
15 MHz	52.3 MHz	Not less than 8mV

(c) With the input frequencies as in (b) remove the valve voltmeter and the 75 ohm load from cable 11. Connect cable 11 to the panoramic receiver. Tune the receiver to display the module output at 37.3 MHz and note the receiver attenuator settings.

(d) Change the signal input frequency to approximately 14 MHz and measure the amplitude of the output at 38.3 MHz on the panoramic receiver; it should be not less than 55dB down on the level obtained in (c).

(e) Change the signal input frequency to approximately 16 MHz and measure the amplitude of the output at 36.3 MHz on the panoramic receiver; it should be not less than 55dB down on the level obtained in (c).

(f) Change the signal input frequency to 37.3 MHz and measure the amplitude of the output at 37.3 MHz on the panoramic receiver; it should be not less than 45dB down on the level obtained in (c).

Note: The maximum input frequency must be adjusted to give maximum output at 37.3 MHz.

3.2.3 Local Oscillator Breakthrough

(a) Remove the signal input. Terminate cable 10 with a 75 ohm load. With cable 11 still connected to the panoramic receiver, change the local oscillator input to 67.3 MHz and tune the panoramic receiver to display 67.3 MHz. The amplitude of the output at 67.3 MHz should be not more than 200µV.

Note: The panoramic receiver may be calibrated by applying the local oscillator directly to the receiver and noting the attenuator settings for the nominal input of 500mV. The results specified above then read at least 60dB down on the calibrated input.

(b) Transfer the panoramic receiver to cable 10 (remove the 75 ohm load), reconnect the 75 ohm load to cable 11, with the local oscillator input at 67.3 MHz and the panoramic receiver set to display 67.3 MHz as in (a); the output at 67.3 MHz should be not more than 200µV.

(c) Transfer the panoramic receiver to cable 4 and repeat (a). The same output level should be obtained.

4. FIRST LOCAL OSCILLATOR (MODULE NO.3)

4.1 TEST EQUIPMENT REQUIRED

(1) Ammeter to measure 0 to 1A

(2) Stabilised power supply to provide −15.25V ±0.25V at approximately 55mA

(3) Valve voltmeter to measure 0 to 800mV r.m.s. at 37 MHz and 67 MHz

(4) Frequency counter to measure frequencies 37 MHz and 67 MHz

(5) 75 ohm ±5%, ¼ watt resistive loads (2 off) to connect to r.f. output cables 8 and 9

(6) Control circuit comprising 250 ohm potentiometer connected between −15V and earth. The potentiometer wiper should be capable of carrying approximately 80mA

(7) Module screening can

(8) Oscilloscope to examine waveforms at 67.6 MHz

4.2 TEST PROCEDURE

4.2.1 Identification of d.c. connections

This module conforms to type 1 of Section 19.

Terminal	4	−15V
	3	Control Turret 1
	2	Control Turret 2
	1	Earth (supply positive)

Place the module in the screening can.

4.2.2 Current Consumption

Connect 75 ohm loads to the r.f. output cables 8 and 9. Apply the 15V d.c. supply between terminals 1 and 4 (positive to terminal 1) via the ammeter and measure the supply current which should be 45mA to 65mA.

4.2.3 R.F. Output Voltage

(a) Connect the control circuit (4.1.6) with the ammeter between wiper and terminal 3, adjust the control current to 0mA. Connect the valve voltmeter across the 75 ohm load terminating cable 8. Measure the r.f. output voltage which should be not less than 500mV.

(b) Transfer the valve voltmeter to the 75 ohm resistive load terminating cable 9. The r.f. output voltage should be not less than 500mV.

4.2.4 Frequency Range

(a) With the valve voltmeter still connected across cable 9, connect the frequency counter across cable 8 output termination. With control current still set to 0mA, adjust trimmer C5 to obtain a frequency of 36.000 MHz ±100 kHz.

(b) Adjust the control current to give an output frequency of 67.6 MHz as measured by the counter. The current should be not more than 75mA.

(c) Measure the output voltage at 67.6 MHz on the valve voltmeter. It should be not less than 500mV.

4.2.5 Visual Examination

Replace the valve voltmeter by the oscilloscope. Examine the output at 67.6 MHz and verify that the waveform is sinusoidal and free from clipping and other obvious distortion.

5. AMPLIFIER/SECOND MIXER ASSEMBLY (MODULE NO.4)

5.1 TEST EQUIPMENT

(1) Multimeter, e.g. Avometer Model 8

(2) Stabilised Power Supply to provide −15.25V ±0.25V at approximately 30mA

(3) Valve Voltmeter to measure r.f. voltages of between 30mV and 70mV over the range 10 MHz to 48 MHz

(4) Signal source to provide EMF's of between 2mV and 400mV over the range 37 MHz to 59 MHz from a 75 ohm source.

(5) Variable a.g.c. bias supply to provide up to 2.3mA at approximately −3.4 volts.

(6) Reference supply, comprising the following components connected between −15V and earth

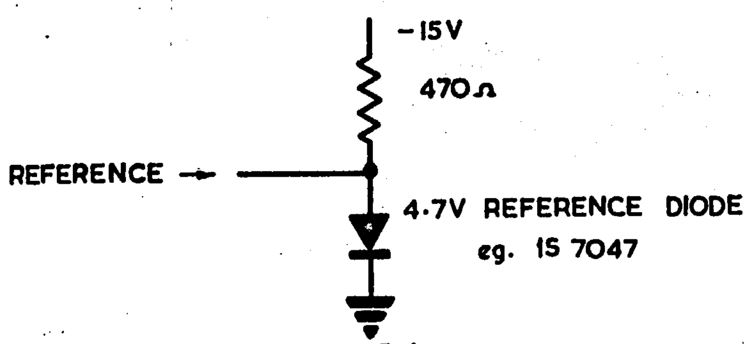

Fig. 5.1

(7) 75 ohm ±5%, ¼ watt resistive load to connect to r.f. output cable 13

(8) Slave Module 10 fully tested

(9) Panoramic receiver of 75 ohm input impedance to display 48 MHz centre frequency, two to three megahertz on either side.

(10) Module screening can, modified to allow access to the core of L3.

(11) 75 ohm ±5%, ¼ watt resistive load for terminating filter elements L3 and L4.

(12) Spectrum analyser to examine r.f. signals at 10.7 MHz and at 10.65 MHz and 10.75 MHz, where the levels are approximately 60dB down relative to 10.7 MHz.

(13) Equipment to measure third order intermodulation products (Section 21)

(14) Equipment to measure noise factor (Section 20)

5.2 TEST PROCEDURE

5.2.1 Identification of d.c. connections

This module consists of two boards, designated A and B. Board A conforms to type 3 and Board B to type 1 of Section 19.

Board A	Terminal	1	Earth (supply +ve)
		2	Reference
		3	AGC
		4	−15V
Board B	Terminal	4	−15V
		3	
		2	
		1	Earth (supply +ve)

5.2.2 Current Consumption

(a) Connect the 75 ohm load to r.f. output cable 13. Apply the 15V d.c. supply to terminals 1 and 4 of Board A (positive to terminal 1) via the ammeter and measure the supply current which should be 7mV to 14mA.

(b) Apply 15V d.c. power supply to terminals 1 and 4 of Board B (positive to terminal 1) via the ammeter and measure the supply current which should be 16mV to 25mA.

5.2.3 48 Megahertz Selector

(a) With slave module fully operative, join the two number 12 cables on the slave module and module under test. Attach the panoramic receiver to the test point (capacitor C32 3.3pF) and tune the receiver to display 48 MHz centre frequency. Adjust the core of L6 to give maximum output at 48 MHz, which should coincide with maximum sideband rejection. Measure the rejection of adjacent sidebands; it should be not less than 40dB.

(b) Remove the panoramic receiver and connect the valve voltmeter to the Harwin pin feeding the 48 MHz output to Board A. Measure the r.f. output at 48 MHz, which should be 225mV to 325mV.

5.2.4 37.3 MHz Amplifier Gain

(a) Remove the 15V d.c. supply from Board B and reconnect to terminals 1 and 4 on Board A. Connect the reference supply to the reference terminal as shown in Fig.5.1. Connect the a.g.c. bias supply via the ammeter, between terminals 3 and 1 (positive to terminal 1) and adjust the a.g.c. current to 2.3mA. Connect the valve voltmeter across R16. Connect the signal source at an e.m.f. of 2mV to input cable 11 and adjust RV1 for maximum gain. Measure the r.f. output at 37.3 MHz on the valve voltmeter; it should be not less than 25mV r.m.s.

(b) Adjust the a.g.c. current to zero. With other conditions as in (a) measure the r.f. output at 37.3 MHz; it should be at least 16dB down on the level obtained in (a).

5.2.5 37.3 MHz Low Pass Filter

(a) Remove the valve voltmeter and the four links interconnecting the various elements of the filter. Connect a signal source of 400mV r.m.s., e.m.f. at a frequency of 58.7 MHz to the input of L3 and terminate L3 with 75 ohms termination to earth. Connect the valve voltmeter across the 75 ohm termination and adjust the core of L3 to give minimum output as measured on the valve voltmeter.

(b) Repeat the process for L4 at an input frequency of 43.76 MHz, with the signal input and 75 ohm termination connected to L4. Remove the 75 ohm load, valve voltmeter and signal input and reconnect all links.

5.2.6 Second Mixer

(a) Place the module in the screening can. Reconnect the power supply to Board B, so that 48 MHz is now injected to the mixer on Board A. Reconnect the signal source at an e.m.f. of 13mV and at a frequency of 37.3 MHz to the r.f. input cable 11. Reset the a.g.c. current to 2.3mA and connect the valve voltmeter across the load connected to cable 13. Measure the r.f. output at 10.7 MHz on the valve voltmeter; it should be not less than 35mV.

Note: Adjust the signal input to give maximum output at 10.7 MHz.

(b) Temporarily remove the signal input to the module and measure the output at 48 MHz, which should be not more than 8mV.

(c) Restore the signal input and ensure that the signal is still correctly tuned to give maximum output . Remove the 75 ohm load and valve voltmeter from cable 13 and connect cable 13 directly to the spectrum analyser. Tune the analyser to display the output at 10.7 MHz and note the attenuator settings. Change the signal input to 37.25 MHz at 13mV e.m.f. Return spectrum analyser to 10.75 MHz and measure the output at 10.75 MHz relative to that at 10.7 MHz; it should be more than 50dB down.

(d) Repeat (c) at a signal frequency of 37.35 MHz and 10.65 MHz output; it should be more than 50dB down.

(e) Change the signal input to 58.7 MHz at 13mV e.m.f. and adjust to give maximum output at 10.7 MHz as viewed on the analyser. Adjust the core of L3 (accessible through the modified screening can) to give minimum output at 10.7 MHz.

5.2.7 Third Order Intermodulation Performance

The third order intermodulation products for Module 4 should be measured, using the method and levels described in Section 21. Before making the measurements, the module gain must be correctly set as follows:

Restore the signal input of 13mV e.m.f. at 37.3 MHz and with the a.g.c. current set to 2.3mA, adjust RV1 to give an output of 33mV at 10.7 MHz as measured on the spectrum analyser. Now adjust the a.g.c. current to give an output 16dB below 33mV. The spectrum analyser will require calibration to determine the attenuator settings appropriate to 33mV input. Remove the signal input to cable 11 and replace by the two tone input at 6.5mV r.m.s. per tone nominal applied voltage. The intermodulation products should be more than 40dBdown.

5.2.8 Noise Factor

Using the method described in Section 20, measure the noise factor of the module with the a.g.c. current set to 2.3mA; it should be not more than 17 times.

6. 10.7 MHz AMPLIFIER AND 3RD MIXER (MODULE NO.5)

6.1 TEST EQUIPMENT REQUIRED

(1) Ammeter to measure 0 to 18 mA

(2) Stabilised Power Supply to provide −15.25V ±0.25V at approximately 18mA

(3) Valve voltmeter to measure r.f. voltages of up to 250mV at frequencies of 10.7 MHz and 100 kHz.

(4) Signal source to provide an e.m.f. of 2mV and 10mV r.m.s. at 10.7 MHz from a 75 ohm source

(5) Second signal source to provide an e.m.f. of 200mV r.m.s. at 10.6 MHz from a 75 ohm source

(6) Variable a.g.c. bias supply to provide up to 1.3mA at approximately −3.4 volts.

(7) Equipment to measure third order intermodulation products at 10.7 MHz (Section 21)

(8) Equipment to measure noise factor at 10.7 MHz (Section 20)

(9) Reference supply, comprising the following components connected between −15V and earth

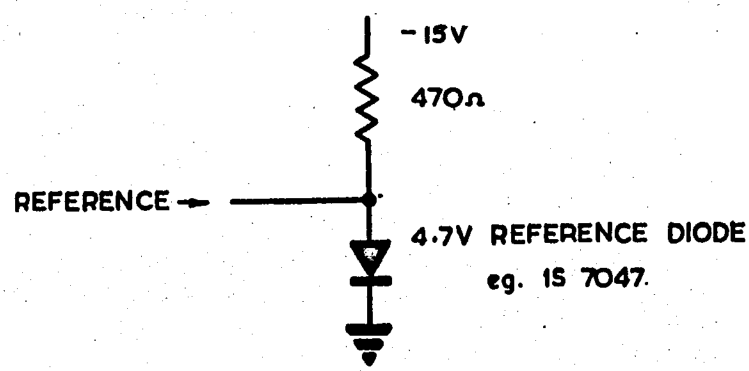

Fig. 6 ·1

(10) 100 kHz bandpass filter e.g. Plessey 422/8/00055

(11) 75 ohm ±5%, ¼ watt resistive load to connect to the output of filter (10)

6.2 TEST PROCEDURE

6.2.1 Identification of d.c. connections

This module conforms to type 1 of Section 19.

Terminal 4	−15V
3	AGC

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2 Reference

1 Earth (supply positive)

6.2.2 Current Consumption

Connect the 75 ohm load via the bandpass filter to r.f. output cable 14. Apply the 15V d.c. power supply between terminals 1 and 4 (positive to terminal 1) and using the ammeter, measure the current drawn by the module; it should be 15mA to 20mA.

6.2.3 10.7 MHz Amplifier Gain

(a) Connect the reference supply to the reference terminal as shown in Fig.6.1. Connect the a.g.c. bias supply via the ammeter, between terminals 3 and 1 (positive to terminal 1), and adjust the a.g.c. current to 1.3mA. Connect the valve voltmeter between the junction of R16 and C12 and earth. Connect the signal source (6.1.4) at an e.m.f. of 10mV r.m.s. to module input cable 13. Measure the r.f. output at 10.7 MHz on the valve voltmeter; it should be not less than 24mV.

(b) Adjust a.g.c. current to zero (i.e. less than 10μA). With other conditions as in (a), measure the r.f. output at 10.7 MHz; it should be at least 16dB down on the level obtained in (a).

6.2.4 Third Mixer

(a) Remove the valve voltmeter from its position in 6.2.3 (a) and connect it across the 75 ohm load resistor at the module output. Reset the a.g.c. current to 1.3mA and apply the second signal source at an e.m.f. of 200mV to the local oscillator input cable 15. Reduce the signal input at 10.7 MHz to 2mV r.m.s., e.m.f. Measure the output at 100 kHz on the valve voltmeter; it should be not less than 13.5mV.

Note 1: Adjust either signal input to give maximum output at 100 kHz.

Note 2: The output specified in this test assumes a 7.5dB loss in the 100 kHz bandpass filter. If a filter other than that recommended in 6.1.10 is used, allowance must be made for its insertion loss in the above test.

(b) Out of Band Signals (oscillator rejection)

Reduce signal input to zero, connect the valve voltmeter between the junction of C18 and R27 (emitter of VT6) and pin 1. Measure the residual output; it should be not more than 35mV.

6.2.5 Third Order Intermodulation Products

The third order intermodulation products should be measured using the method and levels described in Section 21. Before making the measurement, the module gain, as determined by a.g.c., must be correctly set as follows. With the valve voltmeter still connected across the 75 ohm load, reset the signal input to cable 13 at a level of 10mV r.m.s. e.m.f. Adjust the a.g.c.current to give a reading of 10mV on the valve voltmeter (this figure assumes 7.5dB insertion loss in the 100 kHz bandpass filter).

Remove the 75 ohm load and valve voltmeter from the 100 kHz filter output and connect the module directly to the spectrum analyser. Remove the signal input to cable 13 and replace by the two-tone input at 5mV r.m.s. per tone nominal applied voltage. The intermodulation products should be more than 45dB down.

Remove 100 kHz bandpass filter

6.2.6 Noise Factor

Using the method described in Section 20, measure the noise factor of the module with the a.g.c. current set to 1.3mA; it should be not more than 15 times.

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7. 100 kHz AMPLIFIER AND DETECTORS (MODULE NO. 7)

7.1 TEST EQUIPMENT REQUIRED

(1) Multimeter, e.g. Avometer Model 8

(2) Stabilised power supply to provide −15.25V ±0.25V at approximately 60mA

(3) Valve voltmeter to measure r.f. voltage of up to 100mV at 100 kHz and audio frequencies of 300mV

(4) Signal source tunable over the range 90 kHz to 110 kHz and capable of delivering from 400µV e.m.f. to 20mV e.m.f. from a 75 ohm source and capable also of modulation at 1000 Hz to a depth of 30%

(5) Second signal source to provide an e.m.f. of 400mV r.m.s. from a 75 ohm source at 100 kHz

(6) A.G.C. bias supply to provide up to 1.6mA at approximately −3.4 volts

(7) 75 ohm ±5%, ¼ watt resistive load to connect to r.f. output cable 19

(8) 10 kilohm ±10%, ¼ watt resistive load to connect to r.f. output cable 18

(9) Oscilloscope to examine waveforms at 1 kHz

(10) Equipment to measure third order intermodulation products at 100 kHz (Section 21)

7.2 TEST PROCEDURE

7.2.1 Identification of d.c. connections

This module consists of two boards, designated A and B. Board A corresponds to type 3 and board B to type 2 of Section 19.

Board A	Terminal	1	Earth (supply +ve)
		2	Reference
		3	AGC
		4	−15V
Board B	Terminal	6	−15V
		5	−15V AM
		4	−15V SSB/CW
		3	Audio out
		2	Not used
		1	Earth (supply +ve)

7.2.2 Current Consumption

Connect the 75 ohm and 1 kilohm loads to the r.f. output cables 19 and 18 respectively. Apply the 15V d.c. power supply between the terminals 1 on both boards (supply positive) and terminals 4 (Board A) and terminals 4, 5 and 6 (Board B) strapped together, via the ammeter, and measure the supply current; it should be approximately 75mA. Remove the power supply.

7.2.3 100 kHz Amplifier Gain

(a) Apply the 15V d.c. power supply to terminals 1 and 4 on Board A. Measure the voltage between terminal 3 and earth; it should be between 4.6V and 5.3V.

(b) Connect the a.g.c. bias supply via the ammeter, between terminals 3 and 1 of Board A (positive to terminal 1) and adjust the a.g.c. current to 1.6mA. Connect the signal source (7.1 (4)) to the r.f. input (cable 16) and with the source tuned to 100 kHz, adjust the level to be 200μV across R1, i.e. an e.m.f. of 400μV. Connect the valve voltmeter across the 75 ohm load attached to cable 19. With RV1 adjusted to the fully clockwise position, i.e. maximum gain, measure the r.f. output at 100 kHz; it should be not less than 500mV r.m.s.

(c) Maintaining other conditions as in (b), adjust the a.g.c. current to zero and raise the r.f. input to an e.m.f. of 20mV. Measure the r.f. output at 100 kHz; it should be not more than 50mV.

(d) Return the r.f. input level and a.g.c. current to the conditions specified in (b). Adjust RV1 to give 50mV across cable 19 load. Transfer the valve voltmeter to the 10 kilohm load attached to cable 18 and measure the r.f. output at 100 kHz; it should be not less than 80mV.

7.2.4 AM Detector and Audio Output

(a) Connect the 15V d.c. supply between terminal 1 of Board B (supply positive) and terminals 5 and 6 together. With other conditions as in 7.2.3 (d), modulate the input signal 30% at 1000 Hz and transfer the valve voltmeter across the audio output (terminal 3) and earth on Board B. Measure the audio output voltage; it should be not less than 200mV.

(b) With conditions as in (a) switch off the modulation on the input signal and note the fall in the audio output voltage; it should be not less than 25dB.

(c) Examine the audio output on the oscilloscope. The waveform should be sinusoidal, free from clipping and other distortion. Raise the modulation depth to 90% and observe that the waveform is still true.

7.2.5 Product Detector

(a) Remove the 15V d.c. supply to terminal 5 and transfer it to terminal 4. Apply the second signal source (7.1 (5)) to cable 17 and adjust the level to 100mV, measured between the junction of C22 and C23 and earth using the valve voltmeter.

(b) Change the r.f. input (cable 16) to 101 kHz unmodulated and at an e.m.f. of 400µV, and measure the audio output at 1 kHz between terminal 3 and earth; it should be not less than 220mV.

(c) Adjust the r.f. input frequency to 110 kHz and measure the audio output at 10 kHz; it should be not more than 13dB down on the level obtained in (b).

(d) Adjust the r.f. input frequency to 90 kHz and again measure the audio output at 10 kHz; it should be not more than 13dB down on the level obtained in (b).

Note: During tests (a) to (d) it is important to ensure that the signal sources have the correct frequency relationship. The r.f. input signal can be calibrated, against the produce detector carrier input, by adjusting the r.f. input signals to give zero or minimum indication on the valve voltmeter, under which condition the two frequencies are identical, resulting in zero frequency output.

7.2.6 Third Order Intermodulation Products

(a) The third order intermodulation products should be measured using the method and levels described in Section 21.

When making the measurement, the module gain must be as set in 7.2.3(d)) and the a.g.c. current must be set to give an output of 50mV across the 75 ohm load (cable 19), for an input of 20mV e.m.f. Remove the 75 ohm load from cable 19 and connect the r.f. output directly to the spectrum analyser. The two tone input at 100 kHz is supplied to the module via cable 16. The intermodulation products should be more than 40dB down.

(b) Repeat (a), except that the outputs at audio should be examined (terminal 3, Board B); the intermodulation products should be more than 30dB down.

8. AGC AMPLIFIER AND DETECTOR (MODULE NO.8)

8.1 TEST EQUIPMENT REQUIRED

(1) Ammeter to measure 0 to 25mA

(2) Stabilised Power Supply to provide −15.25mV ±0.25mV at approximately 25mA

(3) Valve Voltmeter to measure up to 10V r.m.s. at 100 kHz

(4) Unmodulated Signal Source to provide the following inputs:

(a) Approximately 100mV e.m.f. from a source of 75 ohms adjustable over at least 90 kHz to 110 kHz

(b) Approximately 100mV e.m.f. at a frequency of 100 kHz, which can be raised 5dB in level.

Note: The module has a high input impedance.

(5) Oscilloscope to observe changes in d.c. level across the a.g.c. load with a time base of 0.2 secs/cm

(6) Pulse Generator capable of providing negative going pulses of pulse width 45 ms, separated by 1500 to 2000 ms

(7) PR155 Module 7A fully tested

(8) Switching circuit to enable a.g.c. response times to be examined, comprising the following components:

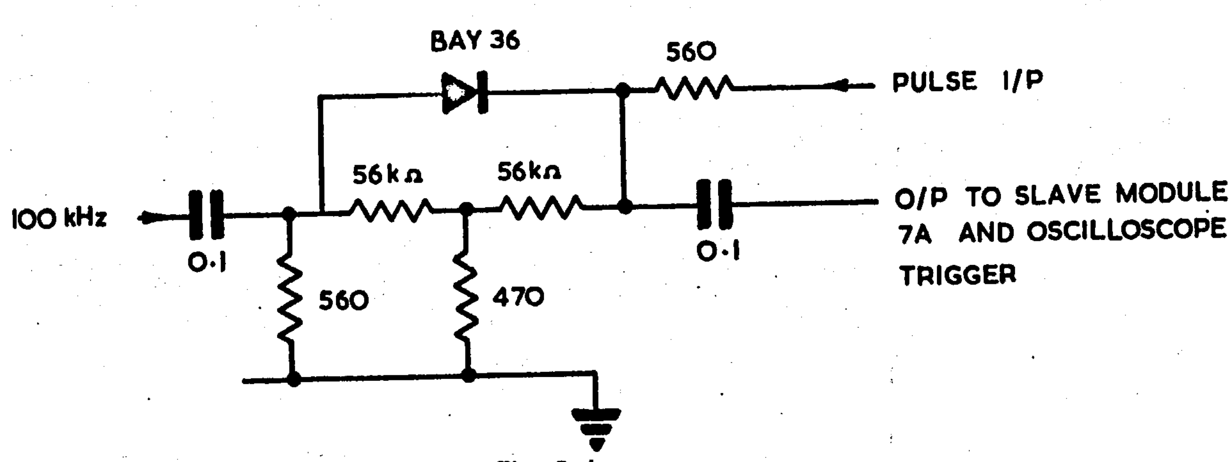

Fig. 8.1

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8.2 TEST PROCEDURE

8.2.1 Identification of d.c. connections

This module conforms to Type 1 of Section 19.

Terminal	4	−15V
	3	A.G.C. output
	2	Slow/Fast a.g.c.
	1	Earth (Supply +ve)

8.2.2 Current Consumption

(a) Apply the 15V d.c. power supply between terminals 1 and 4 (positive to terminal 1) via the ammeter and measure the current drawn by the module; it should be approximately 9mA.

(b) Connect the signal source, set to 100 kHz, to input cable 18. Using the valve voltmeter, adjust the level across the input to the module to 140mV. Set RV1 to mid-position and measure the current drawn by the module; it should be 25mA $\pm$10mA.

8.2.3 T1 Adjustment

(a) Connect signal source, set to 100 kHz, to input cable 18. Using the valve voltmeter, adjust the level across the input to the module to 100mV r.m.s. Adjust RV1 to maximum (fully clockwise). Transfer the valve voltmeter to T1 secondary, e.g. across C6 (2200pF), and adjust T1 to give maximum output on the valve voltmeter, which should be 6V to 11V r.m.s.

(b) Transfer the valve voltmeter to measure the voltage between VT3 base and earth; it should be 90% $\pm$0.3V of the reading in (a).

(c) Change the input frequency to 91 kHz and verify that the reading on the valve voltmeter is not more than 3dB down on the reading obtained in (b).

(d) Repeat (c) at an input frequency of 109 kHz; the reading on the valve voltmeter should be not more than 3dB down.

8.2.4 A.G.C. Control

Connect the a.g.c. load between terminals 3 and 1 with the ammeter inserted between terminal 3 and the 10 kilohm potentiometer. Remove the r.f. input to the module and adjust the 10 kilohm potentiometer to give a reading of 5mA on the ammeter. Re-apply the r.f. input at 100 kHz and adjust RV1 until the current reading just begins to change (reduce). If necessary, check that the measured input to the module is still 100mV r.m.s.

Raise the input level at 100 kHz by 5dB and measure the new a.g.c. load current; it should be not more than 2mA.

8.2.5 A.G.C. Characteristics

(a) Connect the r.f. input via the switching circuit Fig.8.1, to the slave module 7A (cable 16) and connect the pulse generator as shown. Connect the switching circuit to the oscilloscope external trigger and the oscilloscope d.c. input across the a.g.c. load terminals 1 and 3. Connect also the a.g.c. output of the module under test (terminal 3) to the a.g.c. input on the slave module (terminal 3) and apply power to the slave module 7. Do not interconnnect cable 18.

With the pulse input, width 45 ms separated by 1500 ms to 2000 ms, adjust the pulse amplitude so that the switching circuit is adequately switched. Adjust the r.f. input level to the switch so that 5mV is applied to the slave module. Adjust RV1 on the slave module so that the output on cable 18 consists of pulses, of amplitude 250mV e.m.f. Interconnect cables 18 and observe the a.g.c. characteristic displayed on the oscilloscope.

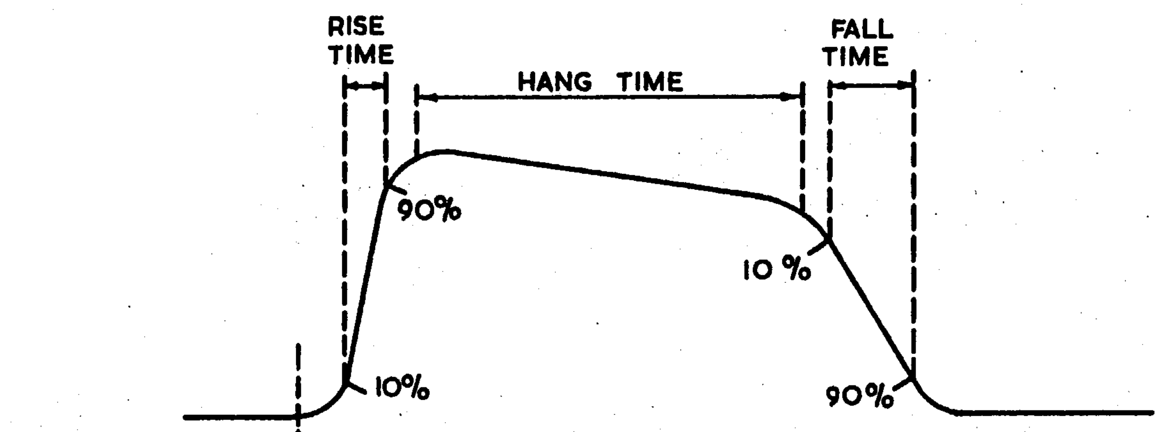

Fig. 8·2

The rise and fall times should be measured between 10% and 90% of the total change in level. The hang time should be measured as near as possible from the end of the rise time to the start of the fall time. The Rise Time, Hang Time and Fall Times should be as follows:

Rise Time	15 +5 / -0 ms
Hang Time	750 ±250 ms
Fall Time	Not more than 120 ms

If necessary RV2, on the module under test, should be adjusted to enable the specified rise time to be met.

Connect pin 3 of the module under test to earth. Repeat the measurements as in (a).

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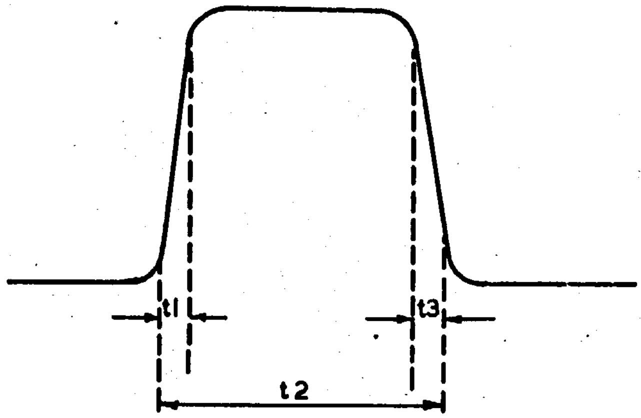

Fig. 8·3

Rise Time	=	tl
Hang Time	=	t2 −45 ms
Fall Time	=	t3

The Rise Time, Hang Time and Fall Time should be as follows:

Rise Time	15 +5 / −0 ms
Hang Time	60 ±15 ms
Fall Time	Not more than 120 ms

9. AUDIO AMPLIFIERS (MODULE NO.9)

9.1 TEST EQUIPMENT REQUIRED

(1) Multimeter, e.g. Avometer Model 8

(2) Stabilised Power Supply to provide −15.25V ±0.25V at 100mA

(3) Valve Voltmeter to measure audio voltages of 150mV r.m.s.

(4) Audio signal generator to provide 200mV from a 10 ohm source at frequencies from 200 Hz to 10 kHz. The total harmonic content should be not more than 1%

(5) Audio Frequency Output Power Meter to measure a maximum of 1 watt in 15 ohms, 30mW in 60 ohms and 3mW in 600 ohms

(6) Distortion Factor Meter of 600 ohm input impedance

(7) Potentiometer, 5 kilohm linear, ¼ watt

(8) Supply line filter, comprising 25mH audio choke and 1000μF 25VW electrolytic capacitor

(9) A.F. Matching Transformer 1:1.7

(10) 150 ohm ±10%, ¼ watt resistor

(11) Oscilloscope to examine waveforms at 1 kHz

(12) 39 ohm ±10%, ¼ watt resistor

9.2 TEST PROCEDURE

9.2.1 Identification of d.c. connections

This module consists of two boards designated A and B. Board A conforms to Type 4 and Board B to Type 2 of Section 19.

Board A	Terminal	1	Earth (supply positive)
		2	Audio input
		3	Earth
		4	Audio output
		5	Not used
		6	−15V
Board B	Terminal	6	−15V
		5	Not used
		4	Audio output
		3	Earth
		2	Audio input
		1	Earth (supply positive)

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9.2.2 Board Connections for Test

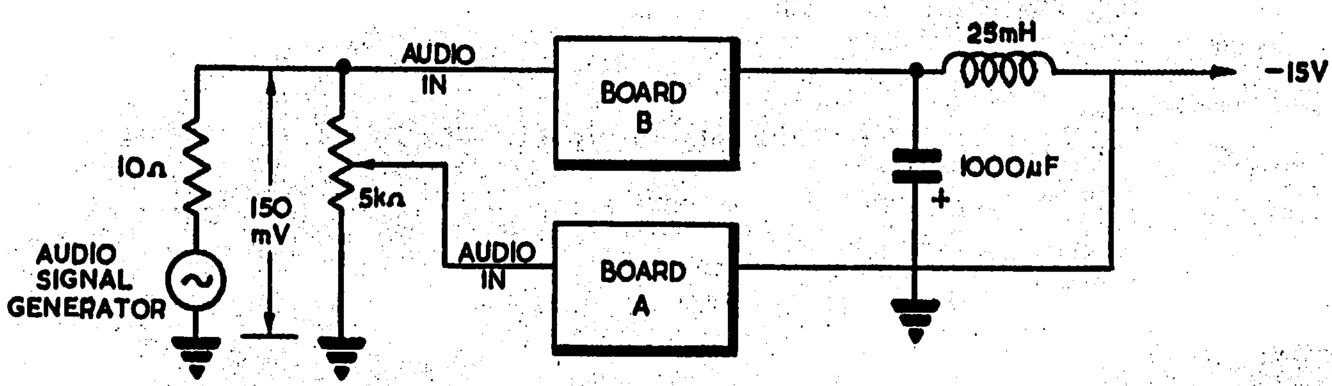

Fig. 9.1

The audio input terminals and the 5 kilohm potentiometer should be connected as shown in Fig.9.1. The -15V lines on both boards are connected via the supply line filter to the power supply as shown. The object of these connections is to reproduce the actual working conditions in the receiver. Do not connect audio generator or apply d.c. to boards A and B at this time.

9.2.3 Board A

(a) Set RV1 and RV2 fully clockwise. Connect the output power meter, set to measure 1 watt at 15 ohms, between terminal 4 and earth on Board A. Temporarily short circuit input terminal 2 to earth. Apply the -15V d.c. filtered supply between terminals 6 and 1 (positive to terminal 1) via the ammeter, and measure the supply current; it should be not more than 5mA.

(b) Set ammeter to 1A range. Remove the short circuit applied to the input terminal. Adjust the 5 kilohm input potentiometer to give maximum input to the board. Apply the audio generator to the audio input circuit as in Fig.9.1, set to 1 kHz and zero output. Apply the oscilloscope across the audio output terminals with the power meter still connected. Increase the output from the audio generator until clipping of the audio output waveform is observed on the oscilloscope. Now adjust RV2 and the audio input level alternately until a waveform is obtained which is just clipped equally top and bottom.

Reduce the audio generator input to zero and adjust RV2 to give a current drain of 5mA to 15mA (adjust ammeter range appropriately). Remove the ammeter.

(c) Using the valve voltmeter, set the audio generator to give 200mV r.m.s. across the 5 kilohm potentiometer (frequency 1 kHz). Measure the output power obtained; it should be not less than 400mW.

(d) Using the 5 kilohm input potentiometer, adjust the output power to 400mW. Maintaining constant audio input voltage of 200mV, measure the audio output power at 200 Hz and 10 kHz with respect to the output at 1 kHz. At 200 Hz it should be not more than 1.5dB down with respect to 1 kHz, and at 10 kHz it should be not more than 7.5dB down with respect to 1 kHz.

(e) With conditions as in (d) measure the harmonic content, in the audio output at 1 kHz, using the distortion factor meter connected directly across the 15 ohm power meter termination; it should be not more than 3.5%.

(f) Repeat (e) but adjust the 5 kilohm input potentiometer to give an output of 10mW; it should now be not more than 2.5%.

(g) Remove the -15V filtered supply, distortion factor meter and output power meter but leave the audio input circuit connected.

9.2.4 Board B

(a) Connect the audio output (terminal 4), via the a.f. matching transformer, to the output power meter which should be set to measure 50mW at 150 ohms. Set RV1 fully counterclockwise and RV2 to mid-position. Apply the -15V d.c. filtered supply between terminals 6 and 1 (positive to terminal 1) via the ammeter and measure the supply current; it should be between 15mA and 35mA.

(b) Remove the ammeter. Connect the voltmeter between VT4 emitter (C8, 50μF, negative end) and the -15V filtered supply (positive to VT4 emitter) and after allowing 5 minutes for the transistors to reach operating temperature, adjust RV2 to give a reading of 8V d.c. Remove the voltmeter.

(c) Connect the 39 ohm resistor in series with the 1 kHz audio input set as in 9.2.3 (c), turn RV1 to the fully clockwise position and measure the output power in 150 ohms; it should be not less than 40mW.

(d) Adjust RV1 to give an output power of 40mV in 150 ohms. Maintaining constant audio input voltage of 150mV, measure the audio output power at 200 Hz and 10 kHz with respect to the output at 1 kHz. At 300 Hz it should be not more than 1.5dB down with respect to 1 kHz and at 10 kHz it should be not more than 4dB down with respect to 1 kHz.

(e) With conditions as in (d) measure the harmonic content in the audio output at 1 kHz using the distortion factor meter connected directly across the power meter terminals; it should be not more than 2%.

(f) Remove the -15V d.c. filtered supply, distortion factor meter and 39 ohm resistor. Connect the 180 ohms resistor in series with the a.f. matching transformer and pin 4 on the module. Set the power meter to measure 10mW in 600 ohms. Re-apply the -15V d.c. filtered supply and adjust RV1 for maximum output with the audio input still set to 150mV at 1 kHz; it should be not less than 10mW.

(g) Connect the distortion factor meter across the output power meter terminals and measure the harmonic content in the audio output at 1 kHz; it should be not more than 2%.

(h) Adjust RV1 to give an output power of 1 mW, and measure the harmonic content in the audio output at 1 kHz; it should be not more than 2%.

10. SPECTRUM GENERATOR (MODULE NO. 10)

10.1 TEST EQUIPMENT REQUIRED

(1) Multimeter, e.g. Avometer Model 8.

(2) Stabilised Power Supply to provide −15.25V ±0.25V at approximately 70mA.

(3) Valve Voltmeter to measure RF voltages of up to 500mV at between 1 MHz and 48 MHz.

(4) Frequency Counter to measure frequency over the range 1 MHz to 48 MHz; accuracy of reading, 1 part in 10^6 at signal input levels between 200mV and 600mV r.m.s.

(5) Panoramic Receiver of 75 ohm input impedance to examine harmonics of 1 MHz at frequencies over the range 35 MHz to 64 MHz. The receiver should be calibrated to indicate 15mV at 35 MHz and 8mV at 64 MHz and calibrated to indicate clearly the harmonic at 48 MHz.

(6) 75 ohm ±5%, ¼ watt resistive load for terminating cable 12 without adding additional cable length.

(7) 75 ohm ±5%, ¼ watt resistive load to connect to cable 5.

(8) Module screening can.

(9) Capacitor 3.3pF ±0.5pF.

(10) 75 ohm stepped attenuator for inclusion between cable 12 and frequency counter.

10.2 TEST PROCEDURE

10.2.1 Identification of d.c. connections

This module consists of two boards designated A and B. Board A has no d.c. connections. Board B conforms to type 1 of Section 19.

Board B	Terminal	4	−15V switched
		3	−15V
		2	not used
		1	earth (supply positive)

10.2.2 D.C. performance

(a) Connect the 75 ohm load to cable 5. Apply the 15V d.c. power supply, via the ammeter, between terminals 3 and 4 together and terminal 1 (positive to terminal 1) and measure the supply current; it should be between 60mA and 80mA.

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(b) Measure the voltage across C7 (Board B) (0.1μF) using the voltmeter; it should be between 9.5V and 10.5V.

10.2.3 Megahertz Oscillator

(a) Remove the d.c. connections, place the module in the screening can and restore the 15V d.c. supply between terminals 4 and 1. Connect the frequency counter to cable 23. Adjust C19 to give a frequency of 1000.000 kHz indicated on the counter.

(b) Remove the frequency counter and replace by the valve voltmeter. Measure the r.f. output at 1 MHz; it should be not less than 400mV r.m.s.

(c) Switch the 15V d.c. supply on and off several times to ensure that the oscillator starts readily and continues to produce the output measured in (b).

10.2.4 Spectrum Generator

(a) Remove the load and valve voltmeter attached to cable 23. Re-apply -15V d.c. supply to terminal 3. Connect cable 5 directly to the panoramic receiver and tune the receiver to display 35 MHz. Measure the amplitude of the output at 35 MHz; it should be not less than 26mV.

(b) Repeat (a), examining the output at 64 MHz; it should be not less than 12mV.

10.2.5 48 MHz Selector

(a) Connect the 75 ohm load to cable 12. Attach the panoramic receiver, via the 3.3pF capacitor (10.2.(9)), across the 75 ohm load and tune the receiver to display 48 MHz. Adjust the cores of L1 and L2 to approximately mid-travel and adjust L1 until one harmonic is clearly displayed with respect to the other harmonics.

By either calibrating the panoramic receiver or by applying the output to the frequency counter, verify that the selected harmonic is 48 MHz. If not, re-adjust L1 until 48 MHz is obtained. Using the panoramic receiver, adjust the cores of L1 and L2 to give maximum rejection of the other megahertz side-bands. The rejection should be 25dB with respect to 48 MHz.

Note: If the counter is used to measure the output at 48 MHz, the high 1 MHz content can affect the working of the counter. It is advisable to use a 75 ohm stepped attenuator between the selector output and the counter, the attenuator being set to give the minimum usable level to the counter. The 75 ohm resistive load should be removed.

(c) Remove the panoramic receiver or counter and with the valve voltmeter now connected across the 75 ohm load, measure the output at 48 MHz; it should be not less than 250mV.

11. 10.6/10.8 MHz OSCILLATORS (MODULE NO. 11)

11.1 TEST EQUIPMENT REQUIRED

(1) Ammeter, to measure 0 to 13mA.

(2) Stabilised Power Supply to provide −15.25V ±0.25V at approximately 13mA.

(3) Frequency counter to measure frequency at 10.6 MHz and 10.8 MHz accuracy 1 part in 10^6 at signal input levels between 100mV and 200mV r.m.s.

(4) Valve voltmeter to measure RF voltages of between 100mV and 200mV r.m.s., at frequencies of 10.6 MHz and 10.8 MHz.

(5) Oscilloscope to examine waveforms at frequencies between 10.6 MHz and 10.8 MHz, signal input levels between 100mV and 200mV r.m.s.

(6) 75 ohm ±5%, ¼ watt resistive load to connect to r.f. output cable 15.

11.2 TEST PROCEDURE

11.2.1 Identification of d.c. connections

This module conforms to Type 1 of Section 19.

Terminal 4	−15V
3	−15V LSB, CW, AM
2	−15V USB
1	Earth (supply +ve)

11.2.2 Current Consumption

(a) Connect the 75 ohm load to r.f. output socket (socket 15). Apply the 15V d.c. supply between terminals 1 and 4 (positive to terminal 1), via the ammeter, and measure current drawn by the module; it should be between 10mA and 16mA.

(b) Maintaining conditions as in (a), connect the 15V d.c. supply to terminals 2 and 3 in turn and measure the total current drawn by the module; it should be between 10mA and 16mA.

11.2.3 10.8 MHz Oscillator

(a) Connect the frequency counter across the 75 ohm load. With the 15V d.c. supply connected to terminals 2 and 4, adjust C3 to give a reading of 10800.00 kHz.

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(b) Remove the counter and connect the valve voltmeter across the 75 ohm load. Measure the output voltage; it should be not less than 100mV r.m.s.

Remove the valve voltmeter and connect the oscilloscope across the 75 ohm load. Observe the RF waveform at 10.8 MHz and verify that the waveform is free from clipping and other obvious distortion.

11.2.4 10.6 MHz Oscillator

Repeat 11.2.3 but with the 15V d.c. supply connected to terminals 3 and 4. Adjust C9 to give a frequency of 10600.00 kHz.

12. 100 kHz DIVIDER AND CALIBRATE CIRCUIT (MODULE NO. 12)

12.1 TEST EQUIPMENT REQUIRED

(1) Ammeter to measure 0 to 10mA.

(2) Stabilised Power Supply to provide −15.25V ±0.25V at approximately 10mA.

(3) Frequency counter, accuracy better than 0.005% at 1 MHz.

(4) Valve voltmeter to measure r.f. voltages of 300mV r.m.s. at 100 kHz.

(5) Signal source, range 100 kHz to 1 Mhz at e.m.f's between 39mV and 200mV, from a 75 ohm source.

(6) Oscilloscope to examine waveform between 800 kHz and 100 kHz.

(7) 22 ohm ±10%, ¼ watt resistive load to connect to r.f. output cable 21.

(8) 75 ohm ±5%, ¼ watt resistive load to connect to r.f. output cable 22.

(9) 0.1µF capacitor 30VW or greater.

12.2 TEST PROCEDURE

12.2.1 Identification of d.c. connections

This module conforms to Type 1 of Section 19.

Terminal 4	−15V
3	−15V CAL
2	Not used
1	Earth (supply +ve)

12.2.2 Current Consumption

(a) Connect the 22 ohm and 75 ohm loads to r.f. output sockets 21 and 22 respectively. Connect the 15V d.c. power supply to terminals 1 and 4 (positive to terminal 1), via the ammeter, and measure the current drawn by the module; it should be between 5mA and 10mA.

(b) Maintaining conditions as in (a) connect the 15V d.c. supply to terminal 3 and measure the total current drawn by the module; it should be between 8mA and 15mA.

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12.2.3 Alignment of Transformers T1, T2 and T3

(a) With 15V d.c. supply connected to terminal 4, connect the signal source at 800 kHz, input level 100mV to cable 28. Attach the oscilloscope to the junction of C4 (1000pF) and VT2 collector. Adjust T1 to resonance, i.e. maximum output as observed on the oscilloscope.

(b) Change the input frequency to 200 kHz at an input level of 30mV and attach the oscilloscope to the junction of R8 (27 kilohm) and VT3 collector. Adjust T2 to resonance.

(c) Change the input frequency to 100 kHz at an input level of 200mV and connect via the 0.1μF capacitor (12.2 (9)) to the base of VT4. Transfer the oscilloscope to the junction of C11 (3900pF) and VT4 collector and adjust T3 to resonance.

12.2.4 Performance Check

(a) Remove the oscilloscope and apply 1 MHz at 700mV to cable 28. Set the frequency to 1000.00 kHz as measured on the frequency counter. Connect the oscilloscope across the 22 ohm load attached to cable 21 and observe the waveform. This should be sinusoidal, free from jitter, slipping and other obvious distortion. A light adjustment of transformers T1, T2 and T3 may be necessary to achieve this condition. Marks corresponding to 200 kHz and 800 kHz may be observed on the waveform.

(b) Remove the oscilloscope and using the counter connected across the 22 ohm load, verify that the frequency is 100.00 kHz.

(c) Remove the oscilloscope and connect the valve voltmeter across the 22 ohm load. Measure the r.f. output at 100 kHz; it should be not less than 100mV r.m.s.

(d) Using the frequency counter, verify that 1 MHz is present at the output of cable 23, e.g. connect the 75 ohm load to cable 23 and measure the r.f. output at 1 MHz across the load; it should be not less than 300mV r.m.s.

12.2.5 Calibrate Circuit

With the 75 ohm load connected to cable 22, apply the 15V d.c. supply to terminal 3. Connect the oscilloscope across the 75 ohm load and observe the pulses. Measure the amplitude and rise time of the pulses (Fig.12.1).

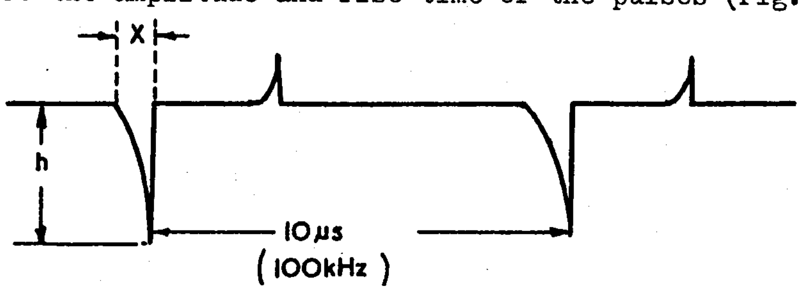

Fig. 12.1

h should be not less than 50mV and x should be between 0.1μs and 0.3μs.

13. SATURABLE REACTOR

13.1 TEST EQUIPMENT REQUIRED

(1) Q meter to resonate at frequencies between 30 MHz and 80 MHz.

(2) Power Supply to provide from 0 to 100mA into a 75 ohm load.

13.1 TEST PROCEDURE

13.1.1 Connect the start and finish ends of the secondary core assembly to the Q meter. Set the capacity of the Q meter to 12pF. Connect the power supply to the primary winding and adjust the current to 80mA. Tune the Q meter generator to resonance and note the frequency; it should be not less than 70 MHz.

13.1.2 Switch off the power supply, tune the Q meter generator to 35 MHz and adjust the capacity to obtain resonance; the capacity should be 12pF ±4pF.

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14. BFO ASSEMBLY

14.1 TEST EQUIPMENT REQUIRED

(1) Ammeter, to measure 0 to 20mA.

(2) Stabilised Power Supply to provide −15.25V ±0.25V at approximately 20mA.

(3) Frequency Counter to measure frequency at 100 kHz ±10 kHz. Signal input level 500mV.

(4) Valve Voltmeter to measure r.f. voltages of 500mV at a frequency of 100 kHz.

(5) Oscilloscope to examine waveforms at 100 kHz and level of 500mV.

(6) 75 ohm ±5%, ¼ watt resistive load to connect to r.f. output socket.

14.2 TEST PROCEDURE

14.2.1 Identification of d.c. connections

Terminal 1	−15V
2	Earth (supply +ve)

14.2.2 Current consumption

Connect the 75 ohm load to r.f. output socket 20. Apply the 15V d.c. power supply between terminals 1 and 2 (positive to terminal 2) via the ammeter and measure the current drawn by the module; it should be between 14mA and 21mA.

14.2.3 Oscillator Adjustment

(a) Adjust C9 to mid-position. Connect the valve voltmeter across the 75 ohm load resistor and adjust RV1 to give an output of 500mV r.m.s.

(b) Remove the valve voltmeter and replace by the frequency counter. With C9 still in mid-position, adjust L1 to give a frequency of 100.000 kHz.

(c) Rotate C9 fully counter-clockwise as viewed from the spindle end and measure the output frequency; it should be not more than 92 kHz.

(d) Rotate C8 fully clockwise and measure the output frequency; it should be not less than 108 kHz.

(e) Remove the frequency counter and replace by the oscilloscope. Examine the waveform at all settings of C8 and verify that the waveform is sinusoidal, without clipping or other obvious distortion.

15. INTERPOLATING OSCILLATOR

15.1 TEST EQUIPMENT REQUIRED

(1) Multimeter, e.g. Avometer Model 8.

(2) Stabilised Power Supply to provide −15.25V ±0.25V at approximately 45mA.

(3) Frequency Counter to measure frequency between 2.2 MHz and 3.4 MHz, accuracy 1 part in 10^6. Signal input level approximately 400mV.

(4) Valve Voltmeter to measure RF voltages of approximately 400mV between 2.2 MHz and 3.4 MHz.

(5) Oscilloscope to examine waveforms at frequencies between 2.2 MHz and 3.4 MHz signal input levels approximately 400mV.

(6) 75 ohm ±5%, ¼ watt resitive load (2 off) to connect to r.f. output sockets.

(7) Jig (Fig.15.1) to provide a means of connection to the Oldham coupler of the module, for measurement of the rotation of the module shaft in 0.5 degree increments. Each incremental mark should be accurate to within a total error of ±0.2 degree from the datum of 0°. Coupling should be subject to not more than 8 minutes of arc backlash. A static marker should be provided to facilitate angular measurements of the module shaft rotation.

15.2 TEST PROCEDURE

Note: The module is aligned and tested with the right hand cover removed (as viewed from the driven end).

15.2.1 Identification of d,c. connections

Terminal 1	Earth (supply +ve)
2	−15V

15.2.2 Current Consumption

Connect the 75 ohm load to the r.f. output socket. Apply the 15V d.c. power supply to terminals 1 and 2 (positive to terminal 1), via the ammeter, and measure the current drawn by the module; it should be approximately 45mA.

15.2.3 Zener Reference

(a) Remove left hand cover.

(b) Using the voltmeter, measure the voltage across C9 (0.1µF situated between L2 and C10 trimmer); it should be 10V ±10%.

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15.2.4 Preliminary Performance Test

To avoid the possibility of having to remove the printed circuit board for fault finding after the coil has been adjusted, a test on the oscillator should be made at this stage.

(a) Connect the valve voltmeter across one of the 75 ohm loads. Adjust RV1 and verify that an output of at least 450mV is obtainable at all settings of the module shaft. Ensure that for a fixed setting of RV1, corresponding to 400mV output at mid-position of the shaft, the output does not vary by more than $\pm$1dB for any other shaft setting.

(b) Remove the valve voltmeter and replace it by the oscilloscope. Examine the waveform over the full working range of the shaft and verify that the waveform is free from clipping and other obvious distortion. Remove the oscilloscope.

(c) Replace the left hand cover.

15.2.5 Oscillator Adjustment

(a) The oscillator law is required to be linear, 1 turn representing 60 kHz increase or decrease of frequency. To achieve the required law, the turns of L1, the main oscillator inductance, need to be adjusted. The module must be operational for at least 30 minutes before any adjustment is carried out.

(b) Couple the test jig (15.1 (7)) to the module. Adjust L2 to mid-position and lock. Adjust C7 to mid-position of total travel. Rotate the module shaft to fully clockwise (as viewed from the driven end) and then rotate 270° counter-clockwise. For convenience, this angular setting is known as top dead centre (TDC). Alignment of the oscillator starts at this point. Turn the coupler 10 turns in a counter-clockwise direction and connect the frequency counter across the 75 ohm load. With the tuning coil cover in position, adjust the core of the tuning coil to give a reading of 2800.000 kHz $\pm$1 kHz. Lock the core securely with the nut.

(c) It may be found that because of eccentricity between the core and the threaded insert, the core is binding against the side of the former. If so, the core should be adjusted to be a free fit in the former and the winding adjusted to meet the frequency limit.

(d) Ensure that the frequency change corresponds to the direction of rotation from the start of rotation. A test should also be made on the mechanical backlash of the module.

Choose two positions, one approaching minimum and one approaching maximum core insertion. Approach these points from both clockwise and counter-clockwise directions, record frequencies obtained at both settings; there should be not more than 100 Hz difference.

Note: This measurement includes the backlash in the Oldham coupler assembly, which at 8 minutes of arc represents 22 Hz. If the requirement is not met, slight adjustments may be made to the anti-backlash spring tension.

(e) Reset shaft position to alignment-of-oscillator starting point as detailed in (b).

(f) If the measured frequency is not 3400.000 kHz $\pm$1 kHz, raise the coil cover and adjust the coil turn nearest the end of the slug. Close the coil cover and measure the new frequency obtained. Repeat the process if necessary, until the measured frequency is within 1 kHz of 3400.000 Hz.

(g) Rotate the module shaft 2 turns counter-clockwise to T.D.C., at which position the frequency reading on the counter should be 3400 kHz - 2x60 kHz. If the measured frequency is not within 1 kHz of this value, raise the coil cover and adjust the coil turn nearest the end of the slug. Close the coil cover and measure the new frequency obtained. Repeat the process, if necessary, until the measured frequency is within 1 kHz of 3280 kHz.

Note: Frequency measurements must always be made with the coil cover in position.

(h) Carry out this procedure every two turns for the full twenty turns of the shaft, adjusting the coil winding as necessary to give 120 kHz reduction in frequency for each two turns of the shaft. Return the shaft to the fully clockwise position, minus 270°.

(j) It may be found that after 10 turns or so the errors in frequency may be too large to be taken out readily by turn adjustment. The possibility of this occurring is dependent on the initial accuracy of the wind. The solution is to return to the beginning and repeat the process until such time as the whole coil can be aligned.

(k) The alignment procedure is then repeated, except that adjustments are made for every turn of the module shaft, which should result in 60 kHz decrease in frequency for each turn. Return the shaft to the fully clockwise position, minus 270°. Repeat the alignment procedure but adjust the windings to give the correct frequency of 300 Hz.

Note: It may be of assistance, during the adjustment process, to connect an indicator to the carriage assembly, which shows as accurately as possible the position of the end of the dust core in the former, so that the turn or turns of the winding to be adjusted may be more readily identified.

15.2.6 Oscillator Law

(a) Starting at the fully clockwise position, minus 270°, measure the frequency, which should be 3400 kHz $\pm$300 Hz.

(b) Rotate the shaft 180° counter-clockwise and again measure the frequency. Repeat this process every half turn. The frequency should be within $\pm$300 Hz of nominal at each half turn.

(c) When the law is satisfactory, the turns should be varnished for an H2 environment, extreme care being taken to avoid moving the turns of the winding. A final check on the law should be made every turn of the module shaft; it should be within $\pm$300 Hz of nominal at each turn.

(d) Secure the coil cover in position.

Note: Once this stage has been reached, the coil and core must be regarded as an integrated assembly, since it is unlikely that a second core would result in the linearity requirement being met. This is because of variations of permability from core to core and also because of variations along the length of the core. On no account, therefore, should a new core be fitted to a coil which has been aligned and sealed.

15.2.7 Oscillator Performance

(a) Remove the counter from the 75 ohm load and replace it by the valve voltmeter. Adjust RV1 to give an output of 400mV r.m.s. at approximately mid-position of the shaft. Rotate the shaft over the full working range and verify that the oscillator output does not vary by more than ±1dB with respect to 400mV.

(b) Remove the valve voltmeter and replace it by the oscilloscope. Examine the waveform over the full working range of the shaft and verify that the waveform is free from clipping and other obvious distortion.

(c) Repeat (a) and (b) with the valve voltmeter across the other 75 ohm load.

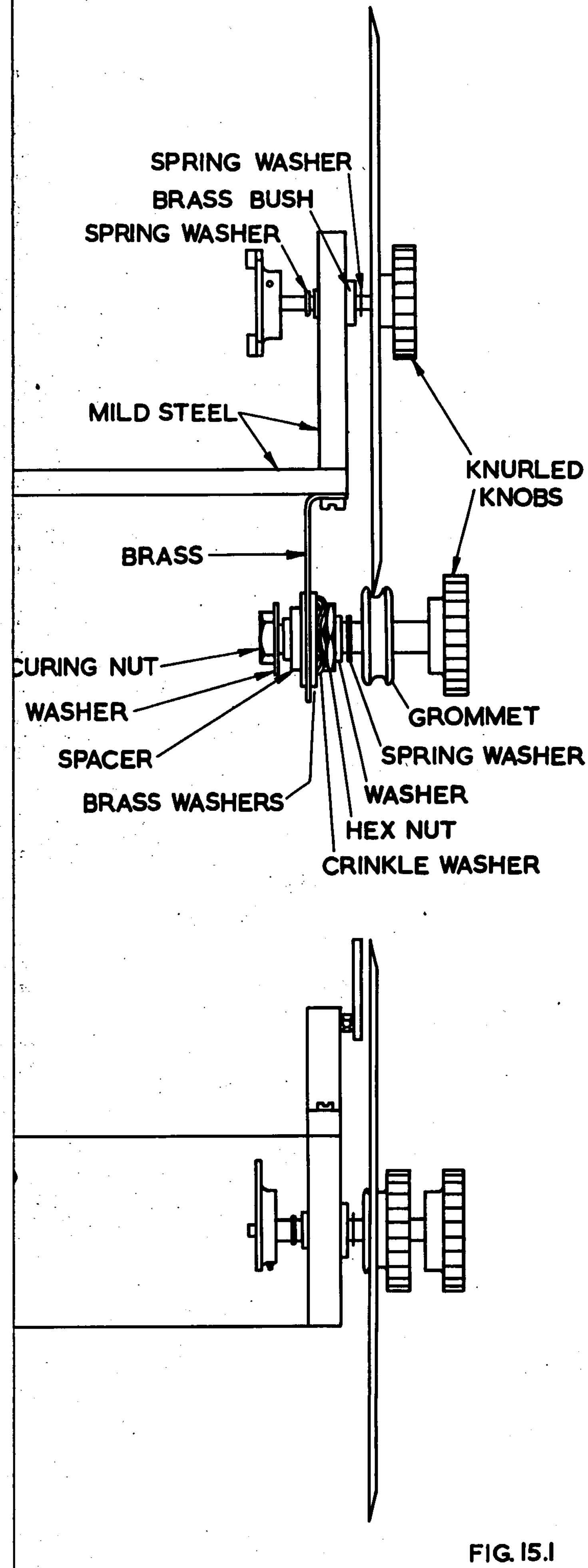
(d) Replace and secure the right-hand side cover.

(e) Check that top and bottom frequencies are within limits at both output sockets; if not, carry out the procedure given in 15.2.8.

15.2.8 Re-adjustment of Oscillator Law

If it is found that the oscillator law is no longer within specification, the following procedure should be adopted:-

Couple the module to the test jig and set to fully clockwise position minus 270°. Adjust L2 to give a frequency of 3400 kHz as measured on the counter. Rotate the shaft counter-clockwise 20 turns and adjust C7 to give a frequency of 2200 kHz ±300 Hz. Reset to the initial position and verify that the frequency is within ±300 Hz of 3400 kHz. If this requirement is not met, repeat the above process, adjusting L2 and C7 in turn until both frequencies are within specification.



SPRING WASHER
BRASS BUSH
SPRING WASHER
MILD STEEL
KNURLED KNOBS
BRASS
CURING NUT
WASHER
SPACER
BRASS WASHERS
GROMMET
SPRING WASHER
WASHER
HEX NUT
CRINKLE WASHER

FIG. 15.1

16. PHASE LOCK BOARDS

16.1 TEST EQUIPMENT REQUIRED

(1) Multimeter, e.g. Avometer Model 8

(2) Stabilised Power Supply to provide −15.25V ±0.25V at approximately 150mA.

(3) Signal source to provide 500mV r.m.s., e.m.f. from a 75 ohm source at a frequency of 2.5 MHz.

(4) Signal source to provide 200mV r.m.s., e.m.f. from a 75 ohm source at frequencies of 49 MHz and 57 MHz.

(5) Signal generator to provide up to 1V r.m.s., e.m.f. over the frequency range 36 MHz to 68 MHz.

(6) Valve voltmeter capable of measuring 500mV to 4V over the range 2.5 MHz to 70 MHz.

(7) Oscilloscope for comparing the phase of sine waves at a frequency of 2.5 MHz and amplitude approximately 350mV r.m.s.

(8) Panoramic receiver to analyse spectra centred on 40 MHz and 57 MHz with sidebands spaced at 2.5 MHz.

(9) 68 kilohm ±10%, ¼ watt, composition, resistive load.

(10) 150 ohm ±10%, ½ watt, composition, resistive load.

(11) 5 kilohm, ¼ watt, composition, potentiometer.

16.2 TEST PROCEDURE

16.2.1 Phase Splitters and Modulators. Board G

(a) Identification of Connections

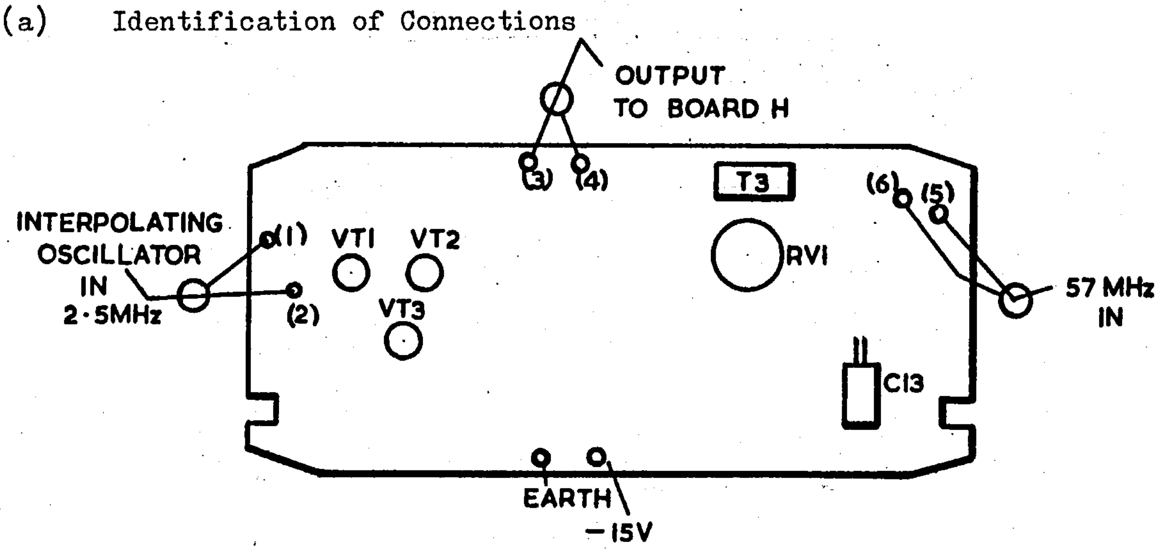


Fig. 16.1 BOARD G, VIEWED FROM COMPONENT SIDE

(b) Current Consumption

Connect the 15V d.c. power supply between the -15V and earth pins, via the ammeter, and measure the current drawn by the module; it should be 50mA ±10mA.

(c) 2.3 MHz to 3.3 MHz Phase Splitter

Connect the 2.5 MHz signal source (16.1 (3)) to pin (1) on Board G (Fig.16.1). Use the oscilloscope to check that the signals at the bases of VT2 and VT3 are 90° out of phase.

Use the valve voltmeter to measure the signal levels at the collectors of VT2 and VT3. The levels should be between 500µV and 1000mV.

(d) Sideband Selection

(i) Connect the 57 MHz signal source (16.1 (4)) to pin (5) on Board G (Fig.16.1), keeping the 2.5 MHz signal source connected as before. Connect the panoramic receiver to the output, pin (3) on Board G (Fig.16.1). Tune the receiver to 57 MHz. Signals should be received at 54.5 MHz, 57 MHz and 59.5 MHz. The amplitudes of the 54.5 MHz and 57 MHz signals should be at least 10dB below the level of the 59.5 MHz signal. Alter the level of the 54.5 MHz signal by adjusting RV1 and C13. Set RV1 and C13 to give minimum output at 54.5 MHz. If adjustment of RV1 alters the level of the 59.5 MHz signal instead of the 54.5 MHz signal the output connections of TR3 should be reversed. Measure the level of the 59.5 MHz signal; it should be not less than 5mV r.m.s.

(ii) Verify that the levels of the 54.5 MHz and 57 MHz signals are not less than 15dB below the level of the 59.5 MHz signal.

(iii) Change the 57 MHz input to 40 MHz and tune the receiver to 40MHz. Verify that the 37.5 MHz and 40 MHz signals are not less than 15dB below the level of the 42.5 MHz signal.

16.2.2 Phase Detector. Board H

(a) Identification of Connections

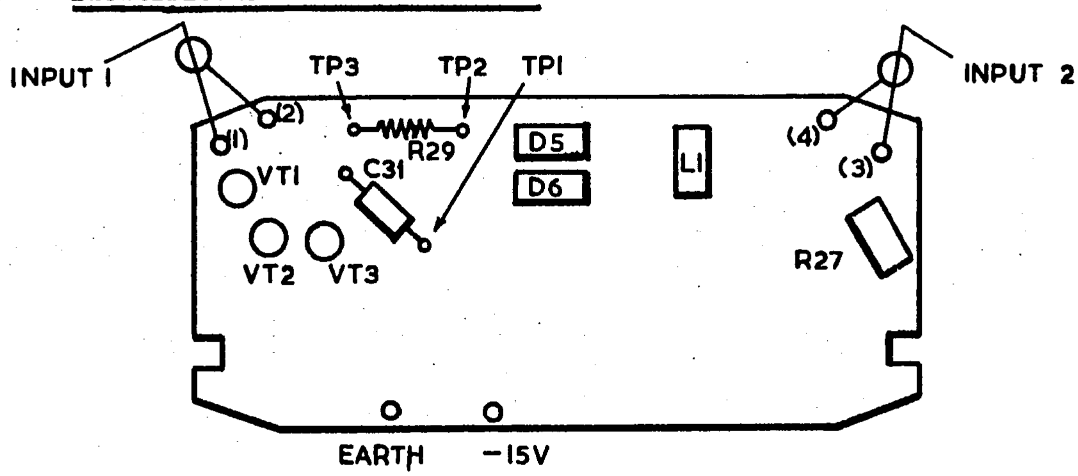


Fig. 16·2 BOARD H, VIEWED FROM COMPONENT SIDE.

(b) Current Consumption

Connect the 15V d.c. power supply between the −15V and earth pins, via the ammeter, and measure the current drawn; it should be 120mA to 160mA.

(c) Voltage Gain

(i) Apply a signal at an input level of 0.5V r.m.s. and a frequency of 40 MHz to input 1 pin (1) board H (Fig.16.2). Measure the voltage between the emitter of VT3 and earth; it should be between 0.5V and 1.0V r.m.s.

(ii) Swing the frequency over the band 38 MHz to 65 MHz. The output should increase with frequency with a 2dB rise over the band. Record output obtained at 60 MHz; it should be +2dB on the reading obtained in (i) −2dB.

(iii) Remove the signal from input 1, and apply it to input 2 pin (3) board H (Fig.16.2). Set the level to 100mV r.m.s. at the input, and adjust L1 so that the voltage across R27 varies by not more than 2dB over the frequency range 40 MHz to 65 MHz.

(iv) Reduce the level of the signal at input 2mV to 30mV and check the voltage across diodes D5 and D6 at all frequencies in the range 37 MHz to 65 MHz; it should be between 0.35V and 0.9V r.m.s.

(d) Phase Detector Bridge

(i) Apply a signal at an input level of 0.5V r.m.s. and a frequency of 40 MHz to input 1. Apply a second signal at a frequency of 40 MHz and at a level of 30mV r.m.s. to input 2. Connect the oscilloscope to the phase detector at point TP1, with the earth lead connected to TP2. By adjustment of the oscilloscope and signal generator frequency dial, arrange for the phase detector output to be displayed at a frequency of approximately 500 Hz. Measure the amplitude of the displayed signal; it should be between 250 mV and 1000 mV peak-to-peak.

(ii) Observe the shape of the displayed waveform on the oscilloscope; it should approximate to a sinewave, be clean, with no r.f. on it and free from jitter.

(iii) Disconnect the oscilloscope from the phase detector and connect the ammeter across R29 (TP2 and TP3). The meter should read not more than 7µA.

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16.2.3 D.C. Amplifier. Board J

(a) Identification of Connections

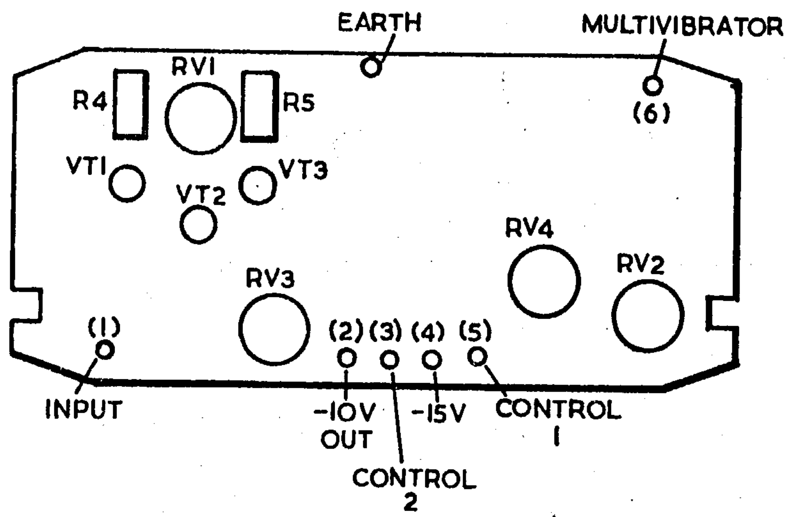

Fig. 16.3 BOARD J. VIEWED FROM COMPONENT SIDE

(b) Voltage Checks

(i) Connect the 15V d.c. power supply, negative to pin 4 and positive to the earth pin (Fig.16.3). Measure the voltage at the -10V OUT pin (2) (Fig.16.3); it should be 10V ±1V.

(ii) Connect the -10V OUT pin (2) to the input pin (1) (Fig.16.3), via the 6.8 kilohm resistor. Set RV3 to mid-range and adjust RV1 so that the voltages at the collectors of VT1 and VT3 are equal (approximately -2V).

(c) Current Checks

(i) Connect the 150 ohm resistor, via the ammeter, between the -15V supply (pin 4), and the pin shown as CONTROL 1, pin (5) (Fig.16.3). Connect the pin labelled MULTIVIBRATOR, pin (6) (Fig.16.3) to the slider of the 5 kilohm potentiometer and connect one end of the potentiometer to earth. Set the potentiometer to give minimum resistance. Adjust RV3 observing the ammeter reading which should be varying about a mean value at a rate of approximately 1 Hz.

Adjust RV3 to make the meter swing about a mean value of 60mA. By adjustment of the 5 kilohm potentiometer verify that the mean current indicated by the meter can be varied between 0 and 60mA.

(ii) Connect the multimeter between 'control 2' and earth.

Verify, that by adjustment of RV4, the voltage can be varied from 15V to 5V. Set RV4 for a voltage of 6V.

17. TURRET

17.1 TEST EQUIPMENT REQUIRED

(1) Multimeter, e.g. Avometer Model 8.

(2) Stabilised power supply to provide −15.25V ±0.25V at approximately 250mA.

(3) Spectrum generator Module 10, fully tested.

(4) Oscillator Module 3, fully tested.

(5) Frequency counter to measure frequencies in the range 35 MHz to 68 MHz.

(6) Panoramic receiver to examine spectra from 35 MHz to 64 MHz with sidebands at 1 MHz increments.

(7) D.C. Storage oscilloscope with sensitivity of between 2V/cm and 5V/cm and sweep rate of approximately 200ms/cm.

(8) Signal source to provide a signal from a 75 ohm source at a frequency of 2.500 MHz and at a level of 400mV r.m.s.

(9) Signal source to provide from a 75 ohm source the following frequencies in turn, at a level of 10mV e.m.f: 1 MHz, 2.5 MHz, 3.5 MHz, 7.0 MHz, 11.0 MHz, 17.0 MHz, 25.0 MHz.

(10) Valve voltmeter to measure up to 1V r.m.s. at frequencies between 1 and 68 MHz.

(11) 75 ohm ±5%, ¼ watt resistive load.

(12) Capacitor 4.7pF, ceramic.

(13) 100 kilohm ±5%, ¼ watt resistive load.

17.2 TEST PROCEDURE

17.2.1 R.F. Filter Section

(a) Apply a signal to the r.f. input socket (socket 2) at a frequency of 1 MHz and at a level of 10mV e.m.f. Connect the valve voltmeter across the 75 ohm termination connected to the filter output socket (socket 3, nearest front of turret). Switch the turret to position 0 and check that an r.f. output of 5mV +0, −2dB, is obtained. Position '0' of the turret is the position in which the sector marked '1' is under the switch contact. Alternatively, rotate the switch until the printed circuit spot is under the switch. This is position 5. Rotate the switch five positions counterclockwise to reach '0'.

Switch the turret to position '1' and check that the same output is obtained. Repeat this procedure for the frequencies and turret positions listed below:-

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Frequency MHz	Turret position
2.5	2
3.5	3
5.0	4, 5
7.0	6, 7
11.0	9, 10, 11, 12, 13
17.0	14, 15, 16, 17, 18, 19, 20
25.0	21, 22, 23, 24, 25, 26, 27, 28,29

17.2.2 Megahertz Selector Circuits

(a) Connect the 15V d.c. power supply to the turret with the negative lead connected to the d.c. supply pin nearest the front of the turret and the positive lead connected to the pin nearest the rear of the turret. Connect the output of the spectrum generator to the input of the Megahertz Selector compartment (socket 5). Connect the panoramic receiver, via a coaxial cable and the 4.7pF capacitor (at the remote end of the lead), to trimmer C13 on board 'G'. It is necessary to remove the turret bottom cover to obtain access to this point.

(b) Set the turret to position '0' and tune the panoramic receiver to 35MHz. Adjust L1 and L2 in turn to give maximum response at 35 MHz with minimum sidebands. The top cover should be removed in order that the trimming tool may be located in the tuning cores. Measure the amplitude of the sidebands relative to the amplitude of the selected megahertz (35 MHz). It should be not less than 25dB below the selected frequency.

(c) Repeat the procedure for each of the other turret positions, at each step tuning for maximum response at a frequency 1 MHz higher than that used at the previous step. At each step measure the amplitude of the sidebands relative to the selected megahertz; it should be not less than 25dB below the selected frequency.

(d) Verify that when the turret is stepped through all the positions from '0' to '29' the selected megahertz changes in steps of 1 MHz from 35 MHz at position '0' to 64 MHz at position '29'. Lock the cores with a suitable varnish and recheck that the sidebands are still not less than 25dB down.

(e) Using the valve voltmeter, measure the level of the selected megahertz at the input to Phase Lock Board G; it should be not less than 250mV r.m.s.

17.2.3 Phase Lock Circuits

(a) Connection of Test Equipment

Connect the turret and test equipment as shown in Fig.17.1.

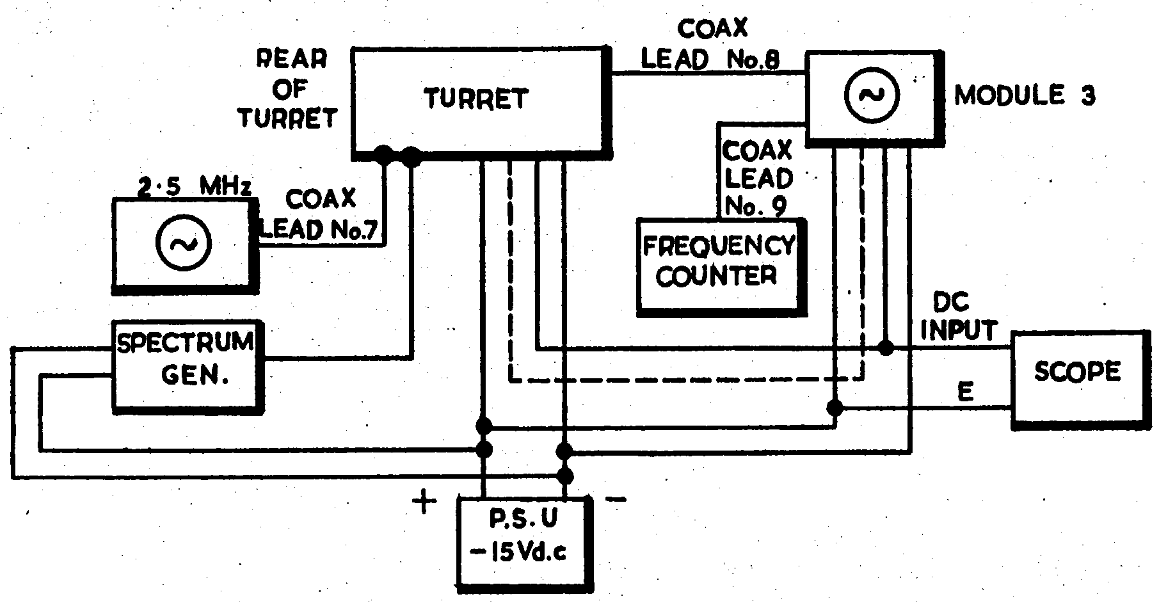


Fig. 17.1 ARRANGEMENT OF TEST EQUIPMENT

(b) Setting Up

Switch on the 15V d.c. power supply and adjust RV4 on phase lock board 'J' to give -6V between slider and chassis.

Connect a 100 kilohm resistor in series with the lead shown dotted in Fig.17.1 (diode control lead). Connect the storage oscillope as shown in Fig.17.1.

Adjust RV3 on board 'J' so that the sweep displayed on the oscilloscope is not clipped either on the top or bottom. Connect the link on board 'J' which connects the input of VT4 to R4 or R5 in both positions and note the amplitude of sweep obtained in each position. (It may be necessary to adjust RV3 to obtain the same d.c. level). Set the link in the position which gives the greatest sweep amplitude. Set RV2 on board 'J' fully counter-clockwise.

Set the turret to position '15' and adjust RV3 on board 'J' so that the waveform obtained on the storage oscilloscope is as shown in Fig.17.2.

Fig. 17.2

Note: If the locking response is not visible, the diode control lead should be reconnected to make the turret lock, i.e. short out the 100 kilohm resistor. With the set locked, adjust the oscilloscope Y-shift control to make the displayed line coincide with the graticule centre line. Disconnect the diode lead (remove short from resistor) and adjust RV3 to make the sweep symmetric about the centre line.

Connect the voltmeter between the link pins on board 'J' and measure the voltage. Adjust RV1 on board 'J' whilst observing the voltmeter reading and set the control in the position which gives zero voltage.

Set the turret to position '20'. Adjust RV3 so that the sweep waveform is just clipping the 15V line.

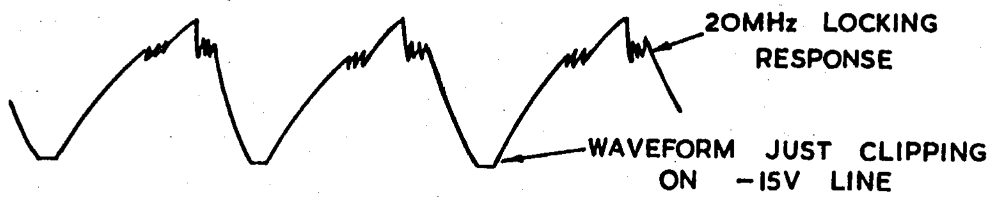


Fig. 17.3

Observe that the 20 MHz locking response is present on the waveform, Fig.17.3. (if not, short out the 100 kilohm resistor to make the set lock). If the locking response is visible, or the set locks, this proves that the sweep amplitude is sufficient to cause a frequency change of 20 MHz. If not, adjust RV2 in a counter-clockwise direction to increase the sweep amplitude and achieve this condition. Lock RV2 in this position.

Set the turret to position '28'. Adjust RV3 on board 'J' to give the following waveform on the oscilloscope.

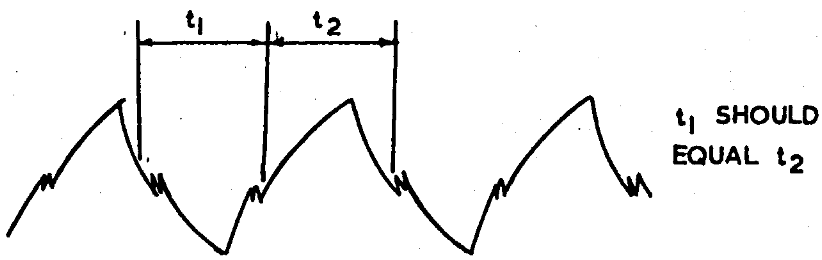


Fig. 17.4

Reset the turret to position '21' and '22' in turn, adjusting RV1 on wafer 'E' to place the locking response as near as possible in the centre of the sweep, i.e. $t_1 = t_2$ as in Fig.17.4

Set the turret to '13' and '14' in turn, adjusting RV2 on wafer 'E' for optimum (Fig.17.5).

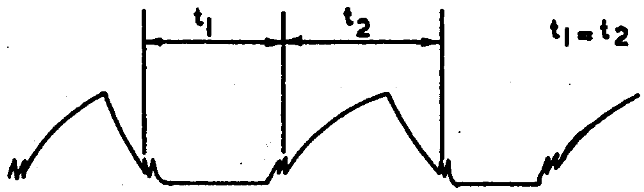


Fig. 17.5

Set the turret to '5' and '6' and adjust RV3 on wafer 'E' for optimum.

Set the turret to position '2' and adjust RV4 on wafer 'E' for optimum. Lock RV1 to RV4 on wafer 'E' and RV3 on board 'J'.

(c) Setting Test

Set the turret to position '29' and observe the sweep waveform, ensuring that it is symmetrical about the locking response. Set the turret to each megahertz position in turn down to '0', checking that the sweep waveform goes to either side of the locking response by a satisfactory margin.

(d) Locking Test

Short out the 100 kilohm resistor. Set the turret to position '0' and observe the trace on the oscilloscope. The trace should be a horizontal line. Check that the frequency recorded by the counter is 37.500 MHz. Rotate the turret shaft clockwise one position at a time and at each position ensure that the counter shows a frequency 1 MHz higher than that measured at the previous position.

If the turret is being aligned in the equipment, on position '0' the interpolating oscillator should be set to -100 kHz to ensure that the turret locks at the bottom end of the band.

18. PR155 - MAIN CHASSIS

18.1 TEST EQUIPMENT REQUIRED

(1) Ammeter to measure 0 to 1A.

(2) Voltmeter to measure 15V d.c.

(3) Valve Voltmeter to measure ripple voltages of 10mV.

(4) Audio Generator to provide approximately 1.2V r.m.s. over the range of 100 Hz to 10 kHz from a 10 ohm source.

(5) Output Power Meter to measure 50mW at 150 ohms and 10mW at 600 ohms.

(6) Resistive load, variable from 10 ohms to 20 ohms approximately, capable of dissipating 25 watts.

(7) Signal source to provide 50 MHz at a level of 1V e.m.f. from a 75 ohm source.

(8) 75 ohm termination (miniature Belling Lee socket).

18.2 TEST PROCEDURE

18.2.1 Preliminary Procedure

Set the links on the rear panel to 600 ohms, Internal VFO and Internal Megahertz. Set the switches on the front panel as follows:

S1	-	OFF
S2	-	USB
S3	-	300 Hz
S4	-	ON (AGC)
S5	-	OFF (Speaker)
S6	-	AF (Meter)

18.2.3 Wiring

The wiring of the equipment should be tested, consisting of a point to point test to ensure the accuracy of wiring. Switches and controls should be moved through their full range to ensure proper functioning.

18.2.4 Power Supply

(a) Connect the voltmeter between terminal 5 of the regulator and chassis and adjust RV1 for a voltage of 15.5V.

(b) Connect the variable resistive load in series with the ammeter between terminal 5 on the regulator assembly and chassis. Apply the mains input to the receiver, after ensuring that the correct tapping on the mains transformer has been selected for the supply in use. Switch S1 to STAND BY and adjust the resistive load to give a current drain of 800mA. Using the voltmeter measure the voltage between terminal 5 of the regulator and chassis; it should be 15.5V ±0.75V.

(c) Verify that the film scale lamp is on.

(d) Using the voltmeter measure the supply line ripple voltage; it should be not more than 10mV.

(e) Remove the power supply line resistive load, ammeter and voltmeter.

18.2.5 Audio Circuits

(a) Check the meter zero and adjust if necessary. Connect the power meter, set to measure 1mW at 600 ohms, to terminals 8 and 9 of the rear output terminal block. Connect the audio generator, set to 1 kHz, to pin 4 of Module 9B connector block and adjust the audio input to give 1mW output power. Verify that the meter indicates on the 1 mW mark on the scale.

(b) Select 150 ohms on the rear panel selector, adjust the power meter to 150 ohms impedance and measure the output power; it should be 9mW ±0.5mW.

(c) Transfer the audio generator to pin 4 of Module 9A connector block, at a level of 1.2V at 1 kHz. Set the speaker switch to ON and verify that an audio note at 1 kHz is obtained from the speaker.

(d) Vary the input frequency over the range 100 Hz to 10 kHz and verify that the loudspeaker is free from obvious distortion or other audible faults. Verify that the speaker ON/OFF switch is functioning correctly.

(e) With any convenient input frequency and gain setting, verify that an audio signal is available at both telephone jacks.

18.2.6 Manual Gain Control and 'S' Meter

(a) Connect the voltmeter between any a.g.c. terminal (pin 3 of Modules 4, 5, 6 or 7A connector blocks) and chassis (positive to chassis). Set S1 to 'ON', S4 to 'OFF' and verify that the a.g.c. voltage varies between -2V and -5V approximately as the IF gain control is rotated from fully clockwise to fully counter-clockwise.

(b) Set AGC OFF/F/S to one of the on positions and verify that no voltage appears on the AGC terminal used in (a).

(c) Restore the AGC switch to OFF. Set the meter switch to 'RF'. Verify that as the 'IF GAIN' control is varied through its range, the meter varies over at least S0 to S9, freely and without sticking.

18.2.7 Isolating Amplifier

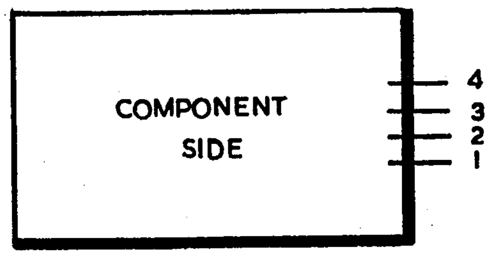
Connect the signal source to the input socket of the Isolating Amplifier and connect the 75 ohm termination to the output plug. Remove the cover of the module and measure the r.f. voltage on the output coaxial lead; it should be not less than 0.5V r.m.s.

19. PR155 MODULE BOARDS TERMINAL IDENTIFICATION

19.1 INTRODUCTION

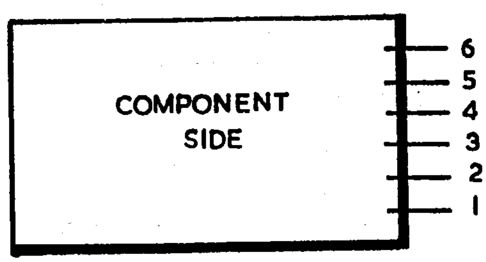
Module boards used in the PR155 receiver are not coded. In particular, the d.c. connecting terminals are not identified, except that the earth (d.c. positive) connection is usually obvious by the main run of printed circuit to which it is connected. To assist in the identification of these terminals, the various terminal layouts are classified into types and numbered appropriately.

19.2 TYPE 1



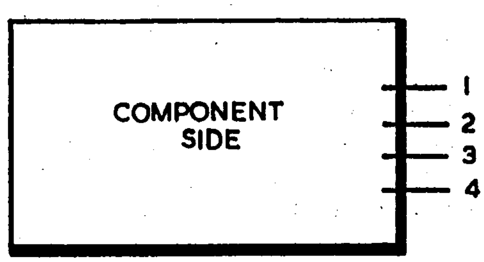
All single modules with d.c. connections conform to this type.

19.3 TYPE 2



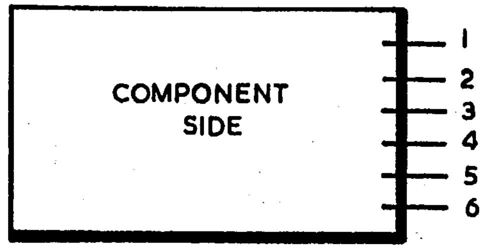
All 'B' boards of double modules which are not of Type 2 are of this type.

19.4 TYPE 3



Printed in Great Britain

19.5 TYPE 4



All 'A' boards of double modules conform to Type 3 or Type 4.

20. NOISE FACTOR MEASUREMENT

20.1 TEST EQUIPMENT REQUIRED

(1) Noise Generator of 75 ohm output impedance to measure noise factor up to 30 times, over the frequency range of 1 MHz to 37.3 MHz. The generator should be calibrated directly in noise factor.

(2) Receiver (or other detector) of noise factor less than 15 times (12dB), tunable to 1 MHz, 10.7 MHz and 30 MHz, and also of less than 100 times (20dB) at 100 kHz. There should be facility for monitoring the output power.

(3) Switchable 3dB pad, which must include matching, if necessary, between the 75 ohm output impedance of the module under test and the input impedance of the receiver (see Fig.20.1).

(4) Output power meter to be used with the receiver (2).

(5) 3dB pad with Belling Lee miniature coaxial terminations for insertion in cable 13 of the PR155 receiver.

21.2 TEST PROCEDURE

21.2.1 Modules

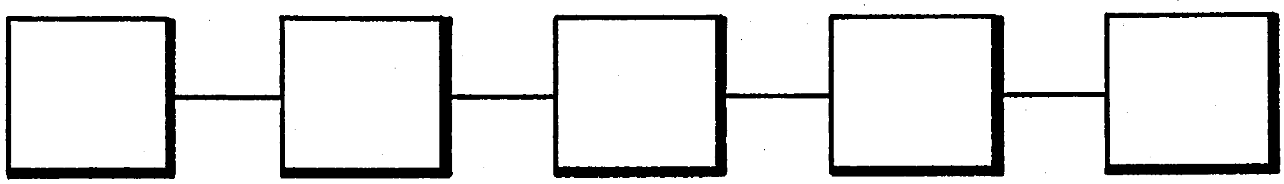


Fig. 20.1

(a) Connect the equipment as shown in Fig.20.1. With the noise generator connected, but switched off, the attenuator set to zero and the normal d.c. and r.f. connections made to the module, adjust the receiver on manual gain, i.e. a.g.c. off, to give a suitable output power at the specified frequency of test. Note the reading.

(b) Switch on the noise generator and set the attenuator to 3dB. Raise the output level of the noise generator to give the same level of output power as in (a). Read the noise factor of the module directly from the noise generator.

20.2.2 PR155 Receiver

The procedure is similar to that outlined in 20.2.1 except that in this case the PR155 Receiver replaces the module under test and the receiver in Fig.20.1. The 3dB attenuator is placed between Module 4 and Module 5 (cable 13) when required.

20.3 TEST FREQUENCIES

Noise factor measurements are required to be made at the following frequencies:

Module 1	–	Input and output frequencies of 1 MHz and 30 MHz.
Module 4	–	Input frequency 37.3 MHz. Output frequency 10.7 MHz.
Module 5	–	Input frequency 10.7 MHz. Output frequency 100 kHz.
Overall test	–	Input frequencies of 1 MHz and 30 MHz.

21. THIRD ORDER INTERMODULATION PRODUCTS MEASUREMENT

21.1 TEST EQUIPMENT REQUIRED

(1) Signal sources of 75 ohm output impedance capable of providing pairs of input frequencies as follows:

1.000 MHz }
1.001 MHz }

29.500 MHz }
29.499 MHz }

37.300 MHz }
37.301 MHz }

10.700 MHz }
10.701 MHz }

102 kHz }
103 kHz }

18.760 MHz }
18.761 MHz }

The required signal source e.m.f. is dependent on the form of combiner used. The input levels to the module under test are given in 21.2.4.

(2) Spectrum Analyser of 75 ohm input impedance to examine R.F. spectra at 1 kHz, 100 kHz, 1 MHz, 10.7 MHz and 30 MHz. Minimum input level 5mV for wanted tones, with intermodulation products greater than 40dB down. The analyser should be capable of resolving side-bands and wanted signals spaced 1 kHz apart.

(3) Signal source isolating and combining network. This network provides 40dB isolation between the signal sources, to avoid intermodulation between them. The signals must then be combined to provide a 75 ohm output impedance so as to provide a match to the modules under test. The arrangement is shown in Fig.21.1.

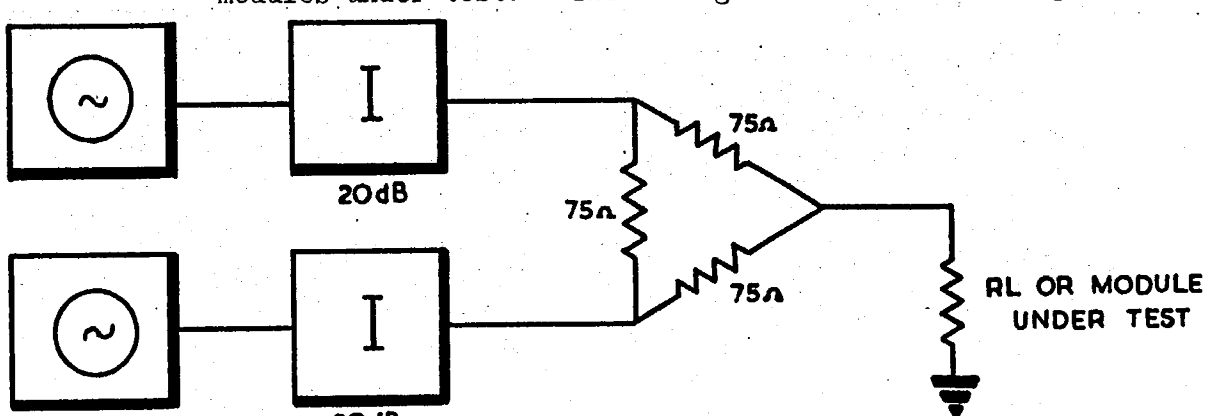


Fig. 21.1

This arrangement results in a 26dB loss in the voltage impressed across RL = 75 ohms, compared with the voltage that would be impressed by the generator directly across a 75 ohm load.

21.2 TEST PROCEDURE

21.2.1 General

Third order (and also higher odd order) intermodulation products are troublesome in communication equipment because certain of the products can fall near to the wanted signals. If f_1 and f_2 represent two equal signals, then the third order intermodulation products are of the form $2f_1 \pm f_2$ and $2f_2 \pm f_1$. It is the $2f_1 - f_2$ and $2f_2 - f_1$ terms that constitute in-band interference, if the spacing between f_1 and f_2 is small, as in multitone FSK types of transmission. For example:

$$f_1 = 100 \text{ kHz}$$
$$f_2 = 101 \text{ kHz}$$
$$2f_2 - f_1 = 102 \text{ kHz}$$
$$2f_1 - f_2 = 99 \text{ kHz}$$

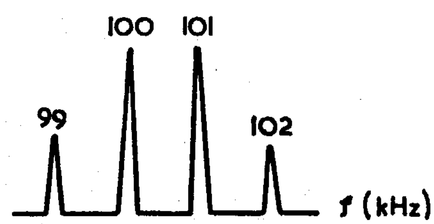


Fig. 21.2

The purpose of third order intermodulation testing is to measure the amplitudes of the tones in the above example at 99 kHz and 102 kHz, relative to the wanted tones at 100 kHz and 101 kHz. The input level at which the tests are performed has a direct bearing on the intermodulation performance achieved and is specified for each item under test.

21.2.2 Module Tests

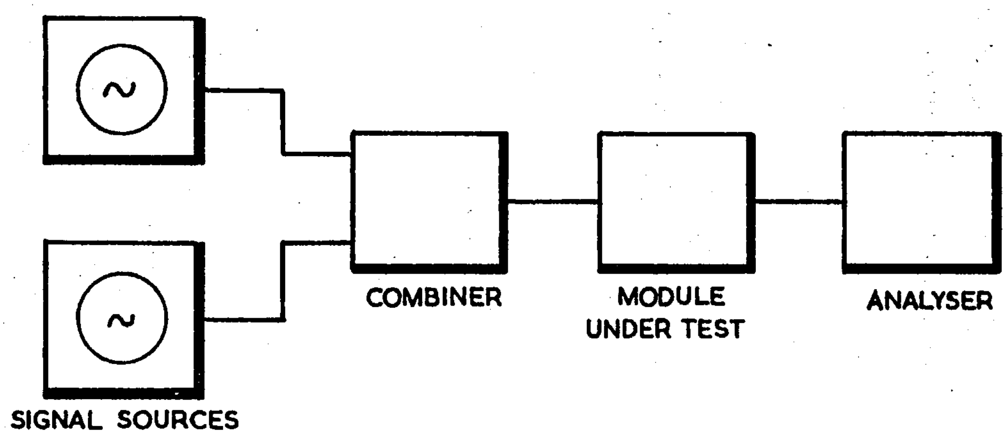


Fig. 21·3

The equipment should be connected as shown in Fig.21.3. For each module, the input level of the two tones is specified in terms of an r.m.s. voltage which appears across a load of 75 ohms, i.e. RL = 75 ohms in Fig.21.1. In practice the actual input to the module differs from this value, because of departures from the nominal 75 ohm input impedance.

The input levels should be adjusted by measuring the voltage developed across a 75 ohm load, which is then replaced by the module under test or, if the combiner shown in Fig.21.1 is used, by adjusting the signal source to give a level 26dB above the required level as measured across the input to the attenuator.

With the signal sources set to the required frequency and level and with the normal d.c. and r.f. connections made to the module, the analyser should be tuned to the required frequency (note that this is not necessarily the same as the input frequency) and the controls adjusted to present the two wanted tones and the two intermodulation products across the face of the display. The difference in level between the two sets of tones should then be measured.

21.2.3 PR155 Receiver Test

The procedure is exactly as described for the module test in 21.2.2.

21.2.4 Test Frequencies and Levels

Table 21.1 Test frequencies and levels

Module No.	Input frequencies		Output frequencies Wanted		Input Level r.m.s. per tone
	f_1	f_2			
1	1.000 MHz	1.001 MHz	1.000 MHz	1.001 MHz	300mV
1	29.500 MHz	29.499 MHz	29.500 MHz	29.499 MHz	300mV
4	37.300 MHz	37.301 MHz	10.700 MHz	10.699 MHz	6.5mV
5	10.700 MHz	10.701 MHz	100 kHz	101 kHz	5mV
7	102 kHz	103 kHz	102 kHz	103 kHz	5mV
7	102 kHz	103 kHz	2 kHz	3 kHz	5mV
PR155	18.760 MHz	18.761 MHz	100 kHz	101 kHz	1V

In each case the third order intermodulation products occur spaced 1 kHz on either side of the two wanted tones which are themselves spaced 1 kHz apart. It is important to ensure that the input frequencies are accurately centred in the passband of any narrow band filters employed. This applies particularly to Modules 4 and 5 and to the PR155 Receiver itself.

22. FORWARD IMPEDANCE OF HG1012 DIODES

22.1 INTRODUCTION

A matched set of four HG1012 diodes is required on the phase detector, board H, of each PR155 Receiver. The procedure for measuring and matching the forward impedances of these diodes is as follows.

22.2 TEST EQUIPMENT REQUIRED

(1) Signal source capable of providing a signal at 30 MHz at a level of 1 volt.

(2) Test jig (Fig.22.2) having a socket to accept an a.c. probe, a Belling-Lee co-ox. socket, two test clips and a single pole double-throw switch for changing the function of the valve voltmeter.

(3) A valve voltmeter capable of measuring at 30 MHz, with ranges of 0 to 300mV (for diode test) and 0.1V (for set level) and fitted with an a.c. probe to fit the test jig.

22.3 TEST PROCEDURE

22.3.1 General Description

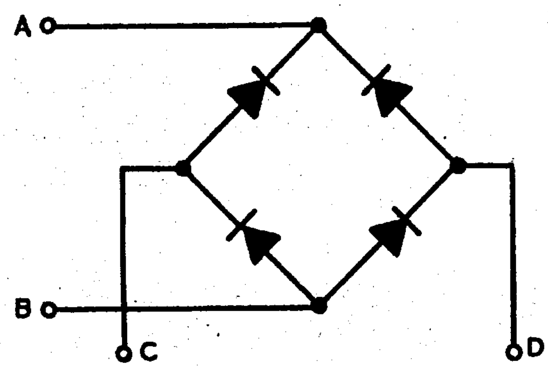


Fig. 22.1

The phase detector, board H, has a bridge network consisting of 4 HG1012 diodes as shown in Fig.22.1. The signal at AB can be up to 2 volts at a frequency of 30 MHz and it is essential that the level at CD is no greater than 100mV. This may be achieved by matching the forward impedances of the diodes to within ±5%.

A measure of the forward impedance of a diode may be obtained by putting a resistance in series with it and applying a potential across the two. The potential drop across the resistance can then be used to find the impedance of the diode, from the formula:-

$$Z = R \frac{V_1}{V_2} - 1$$

Where Z = diode forward impedance
R = series resistance
V_1 = potential drop across Z and R in series
V_2 = potential drop across R.

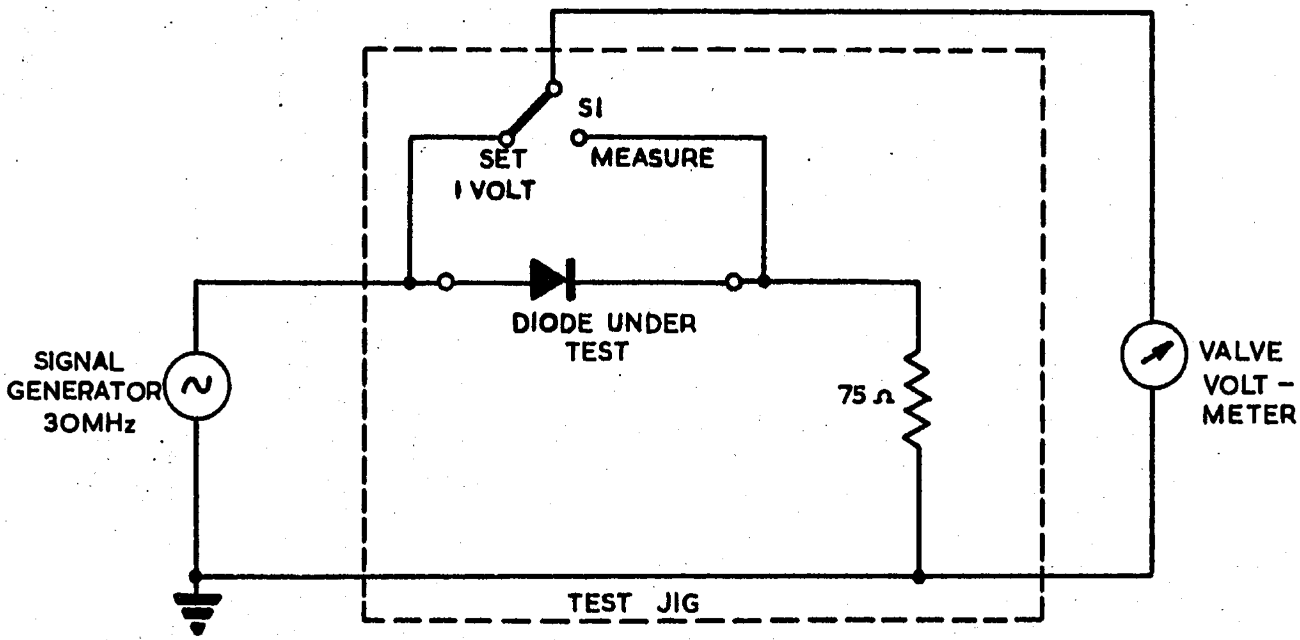


Fig. 22.2

22.3.2 Method

Connect the equipment as shown in Fig.22.2, but without a diode connected and with S1 set to "measure", so that the voltmeter can be zero set. Place the diode to be tested into the clips, ensuring that it is round the same way as shown on the jig, put the voltmeter on the 1 volt range and turn S1 to "set level". The meter is now monitoring the signal level which should be set to 1 volt. Turn S1 back to "measure" and put the voltmeter on the 300mV range. Note the reading.

This procedure is repeated in full for each diode.

Note: Where the colour coding of diodes is apparent, the following table and diagram indicate the method of coding used.

VOLTMETER READING mV	COLOUR CODE
100 - 209	Red
110 - 119	Blue
120 - 129	Grey
130 - 139	Yellow
140 - 149	Red-Red
150 - 164	Blue-Blue
165 - 179	Grey-Grey
180 - 194	Yellow-Yellow
195 - 214	Red-Blue
215 - 234	Red-Grey
235 - 254	Red-Yellow
255 - 274	Blue-Grey