SECTION 3

F.M. DRIVE EQUIPMENT EP7/4 AND EP7/4A

3.1. Introduction

The drive equipment accepts an audio signal input of +12 dB and produces at its output a frequency-modulated carrier, deviated to 75 kHz, in Band II. The EP7/4 has an r.f. output of 5 watts into 50 ohms and is intended to drive a higher-powered transmitter. The EP7/4A contains identical equipment, except that the output amplifier has an output of 16 watts in 50 ohms and can be used as a low-power transmitter.

This equipment uses transistors and replaces the valve-type drive EP7/2, described in Section 1. The use of miniature components assembled on printed-wiring boards, mounted in plug-in units, and a miniature crystal-and-oven assembly has made it possible to contain a single-channel drive unit on a PN3/23 chassis. Fig. 3.1 shows the general form of this equipment.

The single-drive block schematic shown in Fig. 3.2, is basically similar in form to the EP7/2 drive illustrated in Fig. 1.2. The core of the system, a variable-inductance frequency modulator MD3/1A, accepts an a.f. signal and provides the 1st mixer with 2·6 MHz deviated up to ±75 kHz. When mixed with the 1st-oscillator signal at 13·3 MHz, the frequency is raised to 10·7 MHz. This intermediate frequency, after filtration and further amplification, is mixed with the output of a 2nd oscillator operating at approximately 80 MHz, to produce the final carrier signal in Band II. The r.f. output amplifiers provide either 5 watts or 16 watts into a 50-ohms load.

Fig. 3.1. EP7/4 and EP7/4A Drives: Typical Assembly

Left-right Sequence of Units
Frequency Modulator and Oven Unit UN1/34
A.F. Input and First R.F. Mixer UN1/33
Second Mixer and Oscillator Unit UN1/40
First Oscillator and Oven Control Unit UN1/48
Power Supplier (PS1/4 or PS2/37)
R.F. Power Amplifier (AM14/3 or AM14/5)

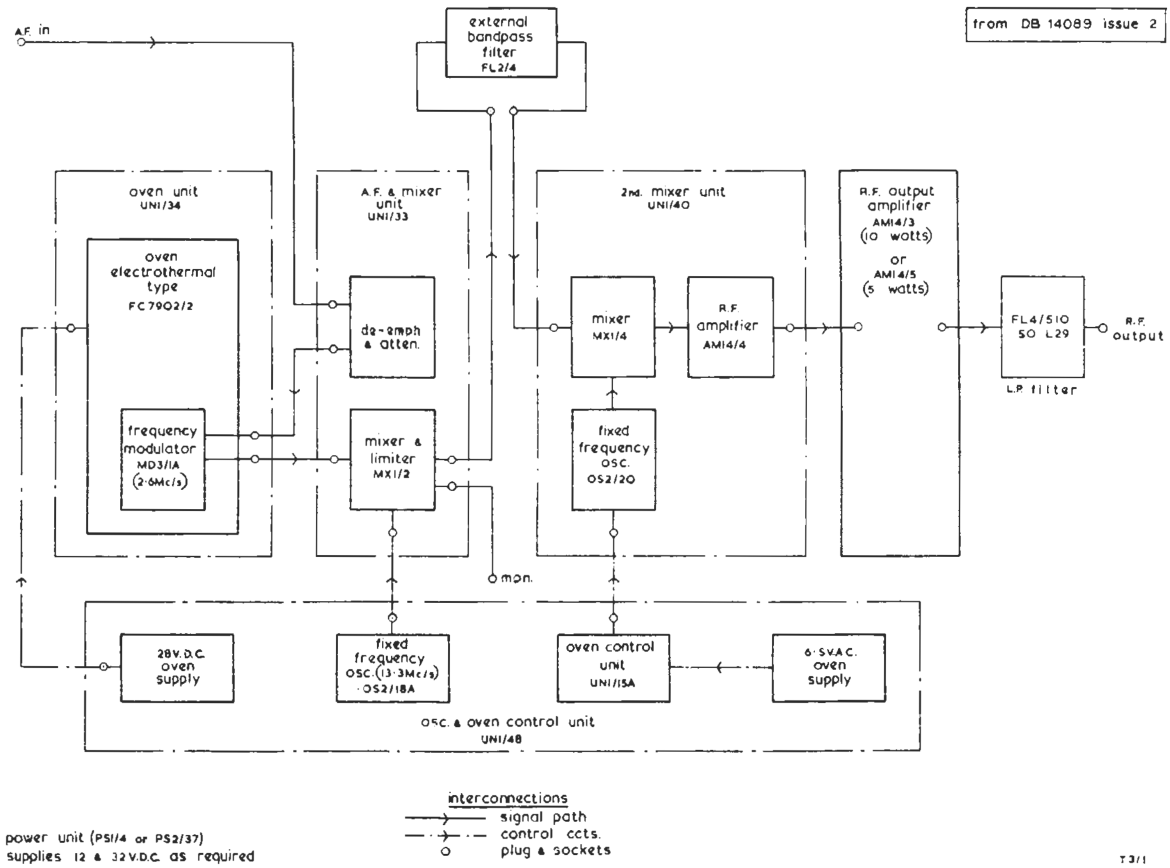


Fig. 3.2. EP7/4 and EP7/4A: Block Schematic

3.2. Assembly

Each drive comprises six book-type, plug-in, sub-units mounted in a standard panel PN3/23. An additional 19-in. by 3½-in. panel, SH2/5, carries the i.f. bandpass filters. Sub-units are constructed on CH1/27, CH1/28 or CH1/12 chassis and are further divided into sub-sub-units, which are contained in screened boxes type BX1/4 or BX1/5. Mains-input and unit-interconnection sockets are mounted on termination panels at the rear of the PN3/23, with separate *In* and *Out* sockets for i.f. filter connections. Figs. 3.3 and 3.4 show typical assemblies of boxes and sub-units.

The units contained in an EP7/4 and EP7/4A are as follows:

UN1/34	Modulator Oven Unit; containing the 2·6-MHz modulator-oscillator MD3/1A and its associated Electrothermal Oven and Control unit.
UN1/33	A.F. Input and 1st R.F. Mixer unit; containing a repeater coil, a switchable de-emphasis network, fixed and variable attenuators and 1st mixer MX1/2.
UN1/40	2nd Mixer and Oscillator unit; containing 2nd crystal oscillator OS2/20, mixer MX1/4 and r.f. amplifier AM14/4.
UN1/48	1st Oscillator and Oven Control unit; containing temperature control unit UN1/15A, oscillator OS2/18A and a supply unit for the UN1/34.
AM14/5,	Output amplifier for EP7/4.
or AM14/3	Output amplifier for EP7/4A.
PS1/4,	Power Supplier used with EP7/4.
or PS2/37	Power Supplier used with EP7/4A.

Some of these units are also employed in the F.M. Translator EP7/5, described in Instruction T.12, Section 2, thus achieving a measure of standardisation.

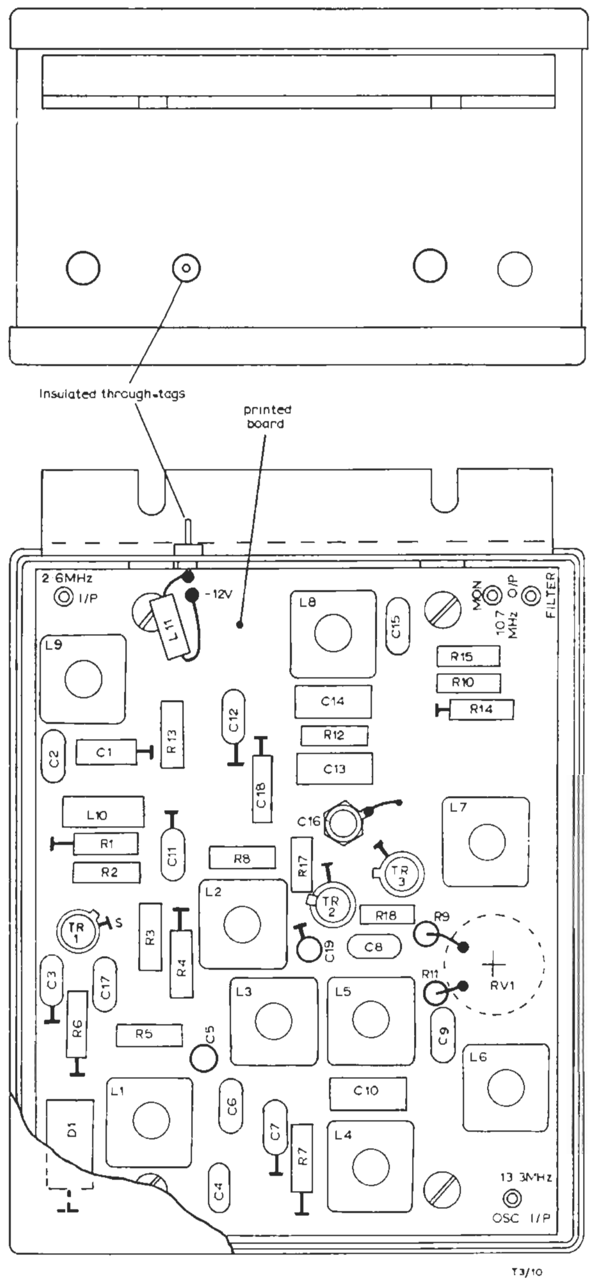


Fig. 3.3. Typical BX1/5 Assembly

3.3. General Specification

Audio input impedance	600 ohms (balanced).
Deviation	±75 kHz ±1 dB from input level of +12 dB (relative to 1 mW in 600 ohms) at 1 kHz; see 3.4.4.
A.F. response	Within 1 dB of the 50-μs pre-emphasis curve (see Fig. 1.10, Section 1). Flat response within ±2 dB from 30 Hz to 22 kHz obtainable by switchable de-emphasis circuit.
Output-carrier frequency range	87·5 – 97·5 MHz.
Frequency stability	±100 Hz in any 24 hours, and less than 25 Hz/day after 500 hours.
Carrier change due to modulation	Less than ±450 Hz for any deviation below 75 kHz and modulation frequency below 3 kHz. Less than ±1 kHz for any deviation below 75 kHz and any modulation frequency.
Output power	EP7/4: Nominally 5 watts into 50 ohms; variable, 4—5·5 watts approximately. EP7/4A: Nominally 16 watts into 50 ohms; variable, 10—18 watts approximately.
Output load impedance	50 ohms (unbalanced).
Harmonic distortion	Total harmonic distortion between 30 Hz and 60 Hz should not exceed 1·5 per cent at ±75 kHz and 3 per cent at ±100 kHz. Between 60 Hz and 4 kHz the distortion should not exceed 2 per cent at ±100 kHz deviation and 1 per cent at ±75 kHz deviation.
Noise (in demodulated output)	—60 dB weighted; —50 dB unweighted.
Unwanted terms in output	Spurious signals should not exceed: (a) —80 dB for any frequency less than 2 MHz from carrier output, (b) —70 dB for other frequencies. These figures are inclusive of the attenuation introduced by the FL4/510, and could be 20 dB lower in some early installations.

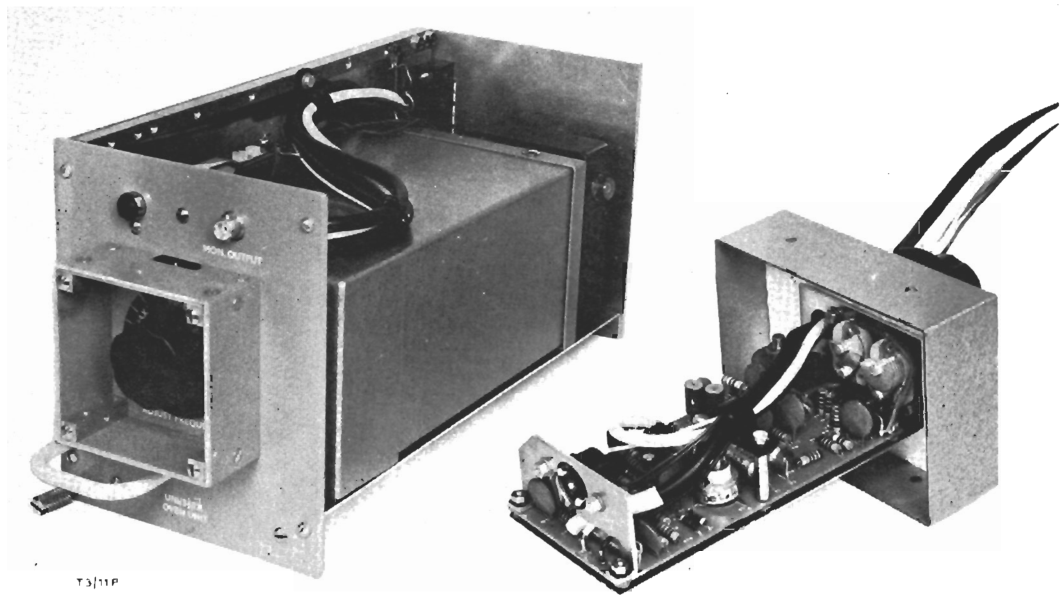


Fig. 3.4. Modulator and Oven Assembly on CH1/12B Chassis
Note bracket-mounted thermal cut-out

3.4. Unit Description

3.4.1. Oven Unit UN1/34

This is constructed on a chassis CH1/12B, on which is assembled a modulator MD3/1A and an Electrothermal oven chamber with associated control circuits. Fig. 3.4 shows the MD3/1A and oven assembly.

The oven temperature is thermostatically controlled at 45 degrees C and is maintained within 0·5 degree C by means of a mercury contact thermometer (MCT), operating in conjunction with a transistor electronic-switch shown in Fig. 3.5. The switching action is supplied by opening and closing of transistor TR2, which in turn is controlled by bias conditions determined by TR1 and the MCT contacts. Whilst the oven is warming up, these contacts are open and the 28-volt supply is applied, via TR2 (in the closed condition) and the closed thermal cut-out contacts, to the heater winding.

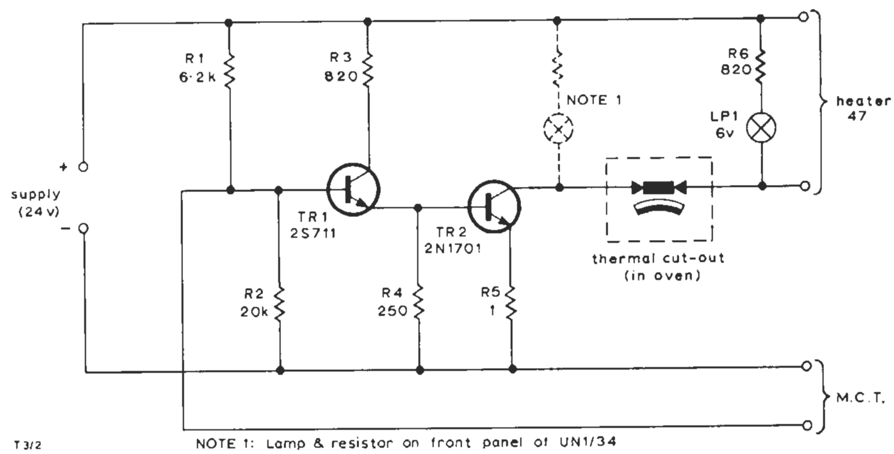


Fig. 3.5. Oven Control Circuit (UN1/34)

When normal oven temperature is reached, the MCT contacts are closed and the TR2 switch opens, removing the heater supply. The lamp LP1, mounted on the front panel, monitors the heating cycle. In the event of an MCT failure causing the oven heating to remain on, the thermal cut-out (which operates at 50 degrees C) prevents damage to the oven and modulator, and continuous operation of the lamp gives warning of a fault condition. Heating and control supplies are obtained from the UN1/48.

3.4.2. Variable Inductance Frequency Modulator MD3/1A (Fig. 11)

The modulator is supplied with an a.f. input from a 600-ohms source, and provides an output of 2·6 MHz, deviated up to ±125 kHz. The precise centre-frequency can be set by coarse and fine controls, giving ±100-kHz and ±3-kHz variations about the mid-point. These controls are available on the front panel. When operated under the stable-temperature conditions (±0·25 degree C) provided by the oven, the modulator-output centre frequency is stable to ±80 Hz.

Referring to Fig. 11, the 2·6-MHz oscillator is formed by the tuned amplifier TR1, the modulator TR2 and TR3, and the phase inverter TR4. Since the only phase shift in this circuit is produced in the tuned amplifier, the frequency of oscillation is given by the resonant frequency of Llp, C3, C4 and C22. Llp is the primary winding of a transformer having a centre-tapped secondary Lls, with mutual inductance M between the primary and each half-secondary. It can be shown that the effective primary inductance is:

$$L - M.a.m,$$

where L is the primary inductance (with open-circuit secondary), m is a factor proportional to the *unbalance* of the two secondary currents, and *a* is a real number relating primary and total secondary current.

In the MD3/1A circuit use is made of the basic fact that the effective primary inductance Llp is dependent upon the *degree of unbalance of the two secondary currents.* R3 is a large-value resistor and TR1 is therefore a current generator, pushing current into the emitters of TR2 and TR3. Most of the current flows into the emitters, through the collectors into the two secondary windings Lls, and out through the centre-tap. The *total* secondary current is largely controlled by TR1, but the distribution is determined by the relative values of the TR2 and TR3 input impedances. If under input-signal conditions these are equal, then the effective mutually-induced current introduced in Llp is zero and no frequency change occurs. Unbalance of TR2 and TR3 input impedances, due to modulation on the transistor bases, gives rise to unequal Lls currents and a change in the effective primary inductance of Llp. Frequency change, or deviation, therefore occurs.

It is clear therefore that the oscillator output can be frequency-modulated by a.f. input signals applied to TR2 and TR3. The circuit is completed by a ring-of-three buffer stage, comprising TR5-TR7. A pre-distorting network (D1, D4, R8 and R33) compensates for the non-linear deviation/inductance characteristic. Optimum overall linearity is achieved by adjustment of R33. Capacitors C8 and C9, effectively in parallel with the TR2 and TR3 emitter resistors, provide a 50-μs pre-emphasis characteristic.

3.4.3. 1st Oscillator and Oven Control Unit UN1/48

This unit has a modified CH1/27 chassis on which is mounted a 28-volt transformer-and-rectifier circuit and a transformer supplying 6·5 volts, together with a UN1/15A control unit and an oscillator OS2/18A constructed in BX1/4 copper boxes. The arrangement is shown in Fig. 3.6.

The *Set Oven Temperature* control, RV1, and the oven-supply indicating lamp ILP1 are mounted on the front panel. The 28-volt transformer feeds a conventional diode-rectifier bridge and supplies the modulator oven heater with 28 volts d.c. via PLA4 and PLA5.

The 6·5-volt a.c. supply is used in conjunction with the OS2/20's oven control unit UN1/15A, also employed in the translator EP7/5 and described in Instruction T.12, Section 2.

The OS2/18A oscillator comprises a printed-circuit board mounted in a copper box BX1/4. It supplies 13·3 MHz at 150 mV to the 1st mixer. Referring to Fig. 3.7, TR1 is a common-base-connected transistor with feedback between collector and emitter. Oscillation is maintained by the series-resonant AT-cut crystal operating at fundamental frequency. The resonant frequency can be in any one of four ranges, determined by the choice of inductor L1. TR2 is a buffer stage, and TR3 a tuned output amplifier, providing at least 150 mV into 75 ohms at the output terminals. L2 and C11 are selected to cover one of the four frequency ranges, as with L1.

The d.c. supply, 5 milliamperes at 12 volts, is obtained from the power supplier (PS1/4 or PS2/37).

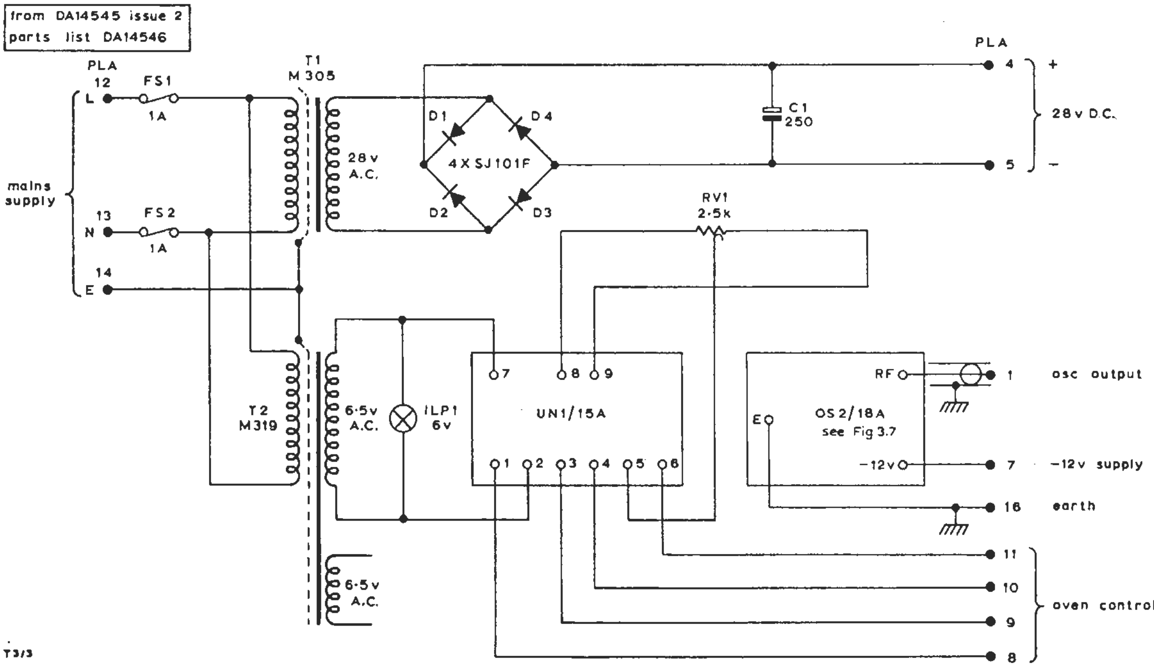
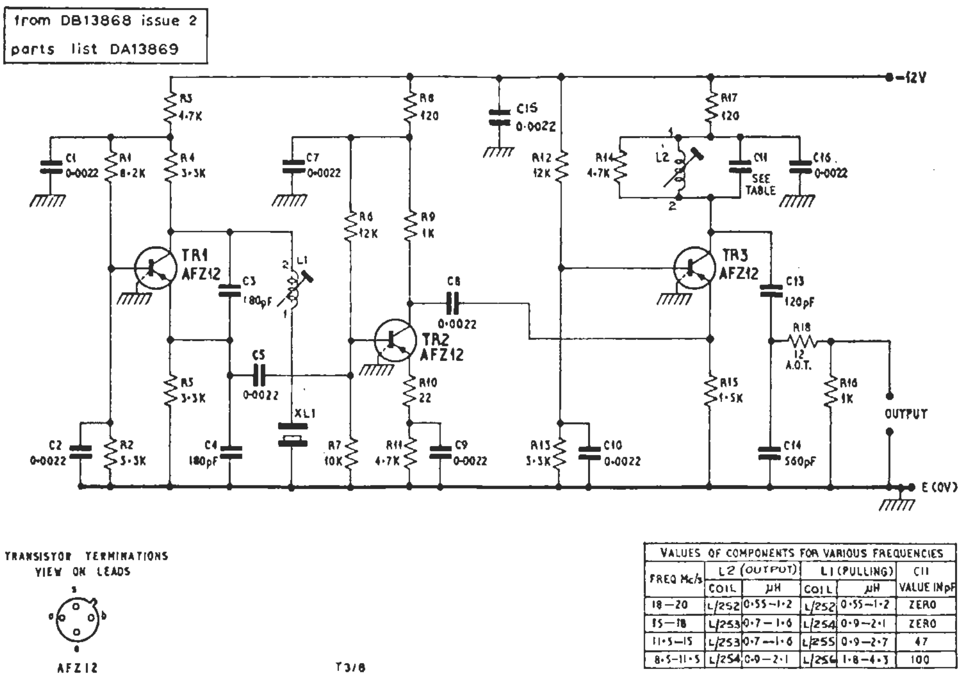


Fig. 3.6. Oscillator and Oven Control Unit UN1/48: Circuit



VALUES OF COMPONENTS FOR VARIOUS FREQUENCIES					
FREQ Mc/s	L2 (OUTPUT)		L1 (PULLING)		C11 VALUE IN pF
	COIL	μH	COIL	μH	
18—20	L/252	0·55—1·2	L/252	0·55—1·2	ZERO
15—18	L/253	0·7—1·6	L/254	0·9—2·1	ZERO
11·5—15	L/253	0·7—1·6	L/255	0·9—2·7	47
8·5—11·5	L/254	0·9—2·1	L/256	1·8—4·3	100

Fig. 3.7. Fixed-frequency Oscillator OS2/18A: Circuit

3.4.4. A.F. Attenuator and 1st Mixer Unit UN1/33 (Figs. 12 and 13)

This is a CH1/27 chassis on which is mounted an a.f. unit and a mixer MX1/2.

The a.f. unit contains a variable attenuator, a de-emphasis network, a fixed attenuator, and a repeater coil (LL/106A). Referring to Fig. 12, this circuit provides a 600-ohms balanced input and sensitivity control for the MD3/1A modulator. The switchable 50-μs de-emphasis network included can be used to neutralise the normal 50-μs pre-emphasis characteristic in the modulator.

The normal input to the UN1/33 is + 3·5 dB. The input range is +3·5 dB to +8·5 dB and is controlled by the variable attenuator. To accommodate a standard +12 dB input a fixed attenuator of suitable value is inserted.

The MX1/2 is constructed on a printed board and contained in a copper box, BX1/5. It is supplied with 12 volts negative, from the PS1/4 or PS2/37. At its two input terminals it receives 2·6 MHz from the modulator and 13·3 MHz from the first oscillator. Referring to Fig. 13, the mixer comprises two AFZ11 transistors, TR2 and TR3, driven in push-pull. The oscillator signal is applied to the emitters and the modulator output to the bases. The collectors of the two transistors feed into a common load comprising a bandpass-coupled tuned circuit with a stepped-down output, providing a 50-ohms output impedance when the *Mon. Output* is terminated in 50 ohms. This termination is provided by either an MN4/1 modulation monitor or a 50-ohm resistor mounted in a BNC plug. The output circuit includes an unbalanced 6-dB pad to improve the matching and provide the correct output level.

Oscillator harmonics are removed and optimum emitter-input balance is obtained by the inclusion of L4, L5 and L6 in the input circuit. The 2·6-MHz modulator signal is fed to the mixer stages via a limiter TR1, coupling transformer L1 and bandpass coils L2 and L3, which, when correctly aligned, produce a bandpass response curve with a flat top which is 200 kHz wide.

3.4.5. 2nd Mixer Unit UN1/40

This contains an oscillator, OS2/20, supplying an output in the range 78—95 MHz. This signal and the i.f. signal at 10·7 MHz are applied to the 2nd mixer MX1/4, so producing the required carrier-frequency output in Band II. The mixer is followed by an r.f. amplifier AM14/4.

The UN1/40 is used also the F.M. Translator EP7/5; relevant information is in Section 2 of Instruction T.12.

3.4.6. R.F. Output Amplifiers AM14/3 and AM14/5

These alternative types are constructed on a CH1/28 chassis with connections through Thorn multi-way plugs and sockets. As a constituent of the EP7/5 translator, the 16-watt amplifier (AM14/3) is dealt with in Instruction T.12, Section 2. The 5-watt amplifier (AM14/5) has generally been used for drive equipment. The circuit is comprised of the first two of the AM14/3's three stages and a suitable output-coupling arrangement. The amplifier circuit is shown in Fig. 3.8.

3.4.7. Bandpass Filter FL2/4

The i.f. bandpass filter is intended to restrict the bandwidth of the system in order to reduce the level of unwanted components in the output. This filter, used also in the EP7/5 translator, is described in Instruction T.12, Section 3.

3.4.8. Low-pass Filter FL4/510

This filter is an essential part of the drive equipment and is mounted on the rear cover. It restricts the output to the required frequency range and suppresses unwanted intermodulation products that may be introduced in the drive-unit chain.

This filter design is used in t.v. and f.m. translators BA13/501 and EP7/1, and is described in Instruction T.13, Section 2.

3.4.9. Power Suppliers, PS1/4 and PS2/37

The PS1/4 supplier is used with EP7/4 drive units. It provides 12-volts d.c. at 350 milliamperes and 34-volts d.c. at 1 ampere; see Instruction G.2 for details.

The PS2/37 supplier is used with EP7/4A drive units; details are given in Instruction T.12, Section 2.

3.5. Testing and Alignment of Sub-units

A considerable amount of test equipment is required to cover complete tests on all units. It is assumed in this Instruction that the instruments are available, and therefore full tests are described. Chassis extenders CH1A/3 and CH1A/5 are supplied with the bay equipment to facilitate testing and maintenance of sub-units.

The tests on the UN1/15A, UN1/40, AM14/3 and FL2/4 are detailed in Instruction T.12, Section 2, and are therefore omitted.

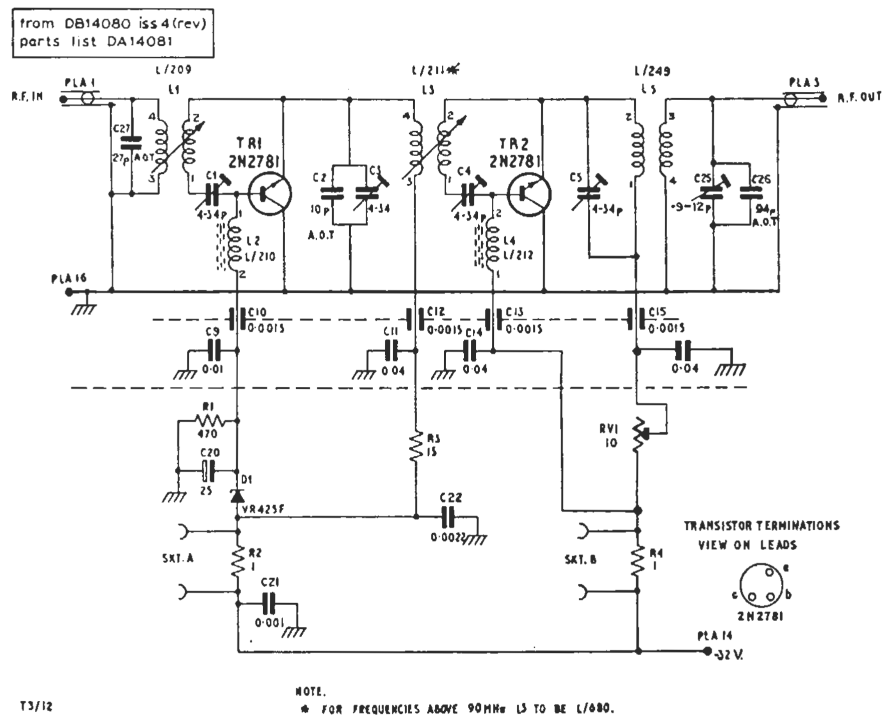


Fig. 3.8. R.F. Power Amplifier AM14/5: Circuit

3.5.1. Test Apparatus Required

Avometer Model 8.
Valve-voltmeter (Marconi TF 1041B).
Deviation meter (Marconi TF 991D).
Power meter (Marconi TF 1153/1, or equivalent)
F.M./A.M. signal generator (Marconi TF 995).
Wattmeter: 50 ohms (Marconi TF 1152/1).
Millivoltmeter (Rhode and Schwarz BN 1091, or equivalent).
Polyskop Mk. 2 (Rhode and Schwarz).
Selektomat (Rhode and Schwarz BN 1522/1).
Reflektometer: 50-ohms type (Rhode and Schwarz).
Electronic thermometer (45-55 degrees C, within 0·1 degree).
High-grade 100-MHz oscilloscope (Tektronix 585).
Frequency counter (Hewlett Packard, or equivalent).
Push-button attenuators (S.T.C., 0—100 dB in 1-dB steps).
Receiver (G.E.C. BRT 400K).
Receivers (Eddystone 770U and 770R).
Tone Source TS/10.
A.C. Test Meter ATM/1.
Aural Sensitivity Network ASN/4.
Portable Test Meter PTM/6.
High-pass Filter FHP/3A.
Notch Filter FL1/17.
De-emphasis circuit to DSKA.8604; see Fig. 3.9.
Test load (10 dB, 10 watts) to DA.13429; see Fig. 3.12.
Resistor, 75 ohms ±2 per cent (Erie N6 or 109).

3.5.2. UN1/34 and MD3/1A

Some of the tests described here depend upon the use of a de-emphasis circuit and variable attenuator. These are incorporated in a UN1/33, which will be available if tests are carried out on site. If that unit is not available, a de-emphasis circuit (Fig. 3.9) and a repeater coil should be mounted in a standard box, such as the standard Eddystone type.

(*a*) *D.C. Tests*

The 12-volt negative current-consumption should be approximately 20 milliamperes. Semiconductor voltages checked with a Model-8 Avometer on either the 10-volt or 25-volt range should be as in Table 1.

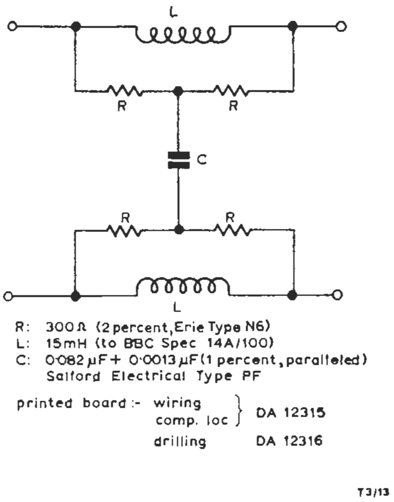


Fig. 3.9. De-emphasis Circuit

Table 1

Ref.	Voltage to Earth from: C	B	E	Base-emitter Voltage
TR1	−7·3	−10	−10·7	+0·7 ±0·1
TR2, TR3	−0·6	−6·4	−7·1	+0·7 ±0·1
TR4	0	−9·5	−10·3	+0·7 ±0·1
ZD1	−6·2 ±0·3			
TR5	−9	−2·9	−2·7	−0·2 ±0·1
TR6	−1·9	−9	−10	+0·7 ±0·1
TR7	−12	−1·9	−1·7	−0·2 ±0·1

Unless otherwise stated, tolerances are ±10 per cent.

(*b*) *R.F. Tests*

1. Arrange an input test circuit as in Fig. 3.10(a) and terminate the r.f. output in a 75-ohms resistor.
2. Check that the modulator is oscillating, by observing the output on an oscilloscope. Use the oscilloscope to measure the voltage across the output-load resistor. The value should be between 85 mV and 127 mV, p-p, and the waveform should be of reasonably sinusoidal shape.
3. Check the r.f. voltage across R11 (MD3/1A), which should be between 60 mV and 78 mV p-p.

(*c*) *Modulation Tests*

4. Using the deviation meter as a receiver, as shown in Fig. 3.10(b), measure the distortion levels with deviations of 19, 40 and 75 kHz. The figures should be as in Table 2.

Table 2

Deviation Frequency (kHz)	*Distortion Level (dB)*
19	Less than −43
40	Less than −43
75	Less than −40

Note: If the distortion level is high it may be possible to reduce it by adjustment of R33. In some circumstances, such as the replacement of a transistor, adjustment of R33 may be insufficient, and an improvement may be obtained by reversing the polarity of the diodes D1 and D4.

(*d*) *Noise-level Tests*

5. Measure the noise level by use of an ATM/1, as shown in Fig. 3.10(c). Unweighted noise and weighted noise, both relative to ±75-kHz deviation, should not be greater than −50 dB and −60 dB, respectively.
6. Measure spurious amplitude-modulation on the unit output, using the Tektronix oscilloscope as in Fig. 3.10(a). The value should not exceed 5 per cent.

(*e*) *Oven Tests*

The oven specification is given in Publication 400 issued by Electrothermal Engineering Ltd. The following checks can be made using an electronic thermometer, inside the oven, after a warming-up period of 1 hour.

(a) Mean operating temperature:	45 ±0·5 degrees C.
(b) Switching cycle temperature differential:	Less than ±0·3 degree C.

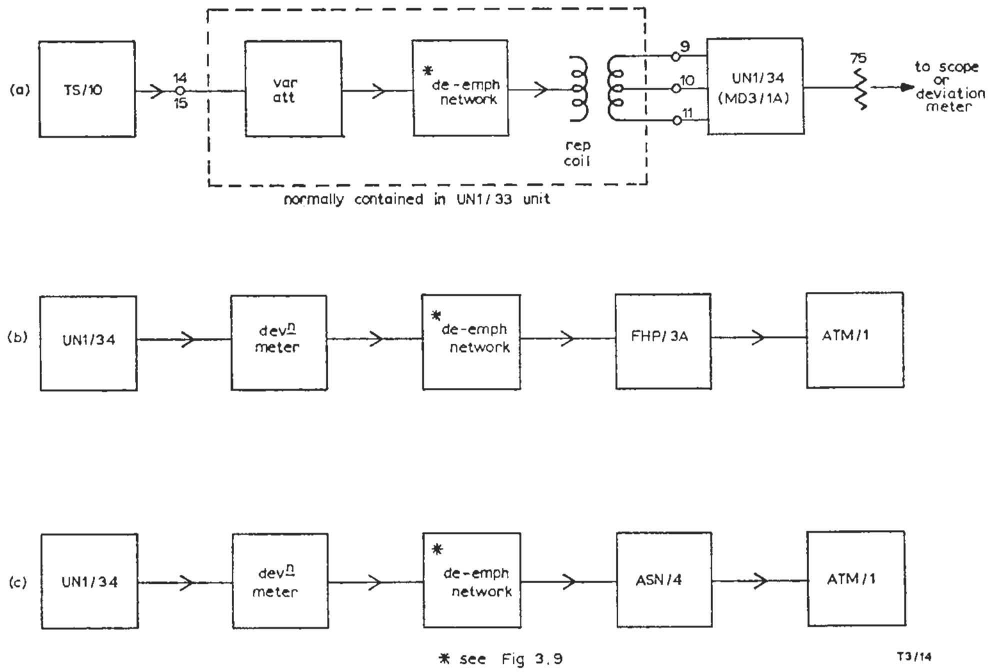


Fig. 3.10. Test Arrangements for UN1/34

(c) Excess-temperature cut-out: Occurs at 51 ±3 degrees C.

(d) Front-panel indication: Lamp should light when the oven heater is excited, and cycle with the heating cycle. Continuous illumination indicates that either the contact-thermometer circuit or the cut-out has failed.

(*f*) *Frequency-stability Tests*

These are described under 3.5.6. Note that measurements of distortion and change in centre frequency due to modulation are interdependent.

3.5.3. OS2/18A

(*a*) *Line-up Procedure*

1. Check the current taken from the 12-volt supply. It should be 5 mA ±0·5 mA.
2. Connect the valve-voltmeter across the crystal. If the stage is oscillating correctly, the meter reading should be between 0·3 volt and 1 volt.
3. Transfer the valve-voltmeter to the output lead and adjust the core of L2 for maximum reading. This should be between 300 mV and 400 mV.
4. Connect a 75-ohms load across the output, and note the reduction in output voltage. If the value of R17 is correct, the reduction should be 6 dB. The output voltage, with the 75-ohms termination, should not be less than 150 mV.

(*b*) *Frequency Adjustments*

5. Connect a frequency meter across the output and note the oscillator frequency. By adjustment of L1 it should be possible to set the output to the frequency marked on the crystal.

Note: If a new crystal has been fitted and the frequency is too low for correction to nominal, the crystal has been cut rather low and turns may have to be removed from L1.

3.5.4. UN1/33

(a) A.F. Amplifier

1. Remove the plug PLA from the rear of the unit and connect the TS/10 to pins 14 and 15. Set the tone source to 400 Hz at zero level. Connect the ATM/1 input to pins 9 and 11.

2. Check that each step of the attenuator is within 0·1 dB of its nominal value. With the attenuator in the fully-clockwise position, the overall loss of the UN1/33 should not exceed 1 dB.
3. Check the frequency response of the unit with the pre-emphasis switch set to *Out*. The response should coincide with the curve of Fig. 1.10 (Section 1) within the following limits:
   60 Hz to 3 kHz: ±0·5 dB,
   3 kHz to 15 kHz: ±1 dB, and
   15 kHz to 20 kHz: ±3 dB
   relative to the level at 400 Hz.
4. Check that the frequency response after moving the pre-emphasis switch to *In* is:
   60 Hz to 3 kHz: ±0·5 dB,
   3 kHz to 20 kHz: ±1 dB,
   relative to the level at 400 Hz.

Note: The difference in loss at 400 Hz with the pre-emphasis switch in the two positions should be less than 0·5 dB.

(b) MX1/2

5. Set RV1 to mid-range.
6. Fit a 56-ohms resistor as R4, and 150 ohms as R5.
7. Terminate all unused 2·6-MHz and 13·3-MHz inputs and outputs in 75 ohms.
8. Terminate the filter and monitor outputs in 50 ohms.

10·7-MHz Filter

9. Connect a 50-ohms Polyskop, with its attenuators set to 30 dB, to the 10·7-MHz filter output.
10. Connect the Polyskop probe to pin 1 of L7, and adjust L7, L8 and C16 for maximum output at 10·7 MHz, using an external marker. The core of L8 should be at the tuning position nearest to the printed board.

Oscillator Input Stage (13·3 MHz)

11. Connect a 75-ohms Polyskop, with its attenuators set to 20 dB, to the 13·3-MHz input. Set the external marker to 13·3 MHz.
12. Connect two Polyskop probes Y1 and Y2 to test point A. Equalise the gains of the Y1 and Y2 amplifiers, and check that the responses are within 0·1 dB of each other.
13. Transfer probe Y2 to test point B.
14. Adjust the core of L4 to obtain maximum amplitude at 13·3 MHz.
15. Adjust the L5 and L6 cores to give equal responses at A and B.
16. Readjust L4 to centre the response. The bandwidth at the 3-dB point should be 500 kHz ±150 KHz. The amplitudes of the outputs at A and B should not differ by more than 0·5 dB.

2·6-MHz Stage

17. Connect a 75-ohms Polyskop, with its attenuators set to 30 dB, to the 2·6-MHz input. Set an external marker to 2·6 MHz.
18. Connect a 10-ohms resistor between test points C and D.
19. Connect the Polyskop probe to pin 1 of L1, and adjust the cores of L1 and L9 to give a maximum amplitude at 2·6 MHz.
20. Check, by rocking the core of L1, that L9 is centrally tuned to 2·6 MHz.
21. Remove the 10-ohms resistor. Connect the previously-equalised probes (item 12) to test points C and D.
22. Adjust the cores of L2 and L3 to give equal responses, with a pass-band of 200 kHz (±0·1 dB). Adjust the value of R4, if necessary.
23. Readjust L1 to centre the response. Increase input level until the circuit limits firmly. The Polyskop attenuator setting should not be less than 23 dB.
24. Set the input to 10-dB below limiting. The response curve should still be within limits. If any slope occurs, L9 should be trimmed.
25. Connect a 2·6-MHz oscillator, with output set to 80 mV r.m.s., to the 2·6-MHz input.
26. Examine the waveform at TR1 collector, using a low-capacitance probe. The amplitude should be approximately 130 mV p-p and should be peak-clipped.

10·7-MHz Output Stage

27. Connect an OS2/18A to the 13·3-MHz input. Connect a 75-ohms Polyskop, with attenuators set to 30 dB, to the 2·6-MHz input.
28. Display the 10·7-MHz output, terminated in 50 ohms.
29. Adjust the core of L7 for maximum amplitude.
30. Adjust the core of L8 and the value of C16 for a critically-coupled bandpass response at 200 kHz (± 0·2 dB).

Note: When the MX1/2 is used with a UN1/78 stereo unit, the bandwidth becomes 250 kHz (±0·2 dB).

31. Vary the input level by ± 5 dB. The output response should remain within limits.

Tests on Aligned MX1/2

32. Substitute a 1·5-kilohms resistor for the 150-

ohms resistor used as R5, and connect an MD3/1A to the 2·6-MHz input. Connect the G.E.C. receiver to the 10·7-MHz output.

33. Adjust RV1 for minimum 13·3-MHz modulation of the 10·7-MHz waveform. The 13·3-MHz rejection should be greater than 20 dB.
34. With the MX1/2 correctly terminated, measure the following voltages:

Test points A and B	50 mV minimum, balanced within 3 mV. If the unbalance is greater than 3 mV, repeat the procedure under heading (d).
Test points C and D (with 13·3-MHz oscillator removed)	6 mV $\pm$ 1 mV. Adjust R5, if necessary, to obtain this value. If the unbalance is greater than 1 mV, repeat the procedure under heading (e).
10-MHz filter output	150 mV $\pm$2 mV, with the output terminated in 50 ohms.
10-MHz mon. output	25 mV $\pm$ 2·5 mV, with the output terminated in 50 ohms.

35. Connect a Rhotector to the 13·3-MHz input and measure the v.s.w.r. This should be between 1·65 : 1 and 1·2 : 1. If the v.s.w.r. is outside these limits, adjust the L4 coupling and recheck the bandwidth.

3.5.5. AM14/5

Note that this amplifier must not be powered without a 50-ohms load on the output. Failure to observe this procedure may result in damage to the transistors. The tests described can be carried out on an extended chassis, using a standard Thorn extender. Care must be taken during adjustments, to avoid accidental short-circuits across wiring, which can cause serious damage to transistors.

All inductors are sealed after initial setting-up in Equipment Department, and Station adjustments must therefore be restricted to capacitance trimmers.

1. Extend the amplifier and connect a 50-ohms power meter across the output.
2. With the r.f. input at zero, power the amplifier and check the feeds with a PTM/6. The reading for TR1 should be 27 $\pm$5, and for TR2, TR3 and TR4 there should be zero readings.
3. Allow one hour for the unit to reach normal temperature, before continuing testing with the TF 995 generator connected to the filter output socket at the rear of the EP7/4. Adjust the generator to 10·7 MHz and 10 millivolts; this provides the required 0·5-watt input to the amplifier.
4. If a reading is visible on the power meter, adjust the trimmers C1, C3, C4, C5, C6, C7 and C25 for maximum output. If there is insufficient output to register on the meter, connect a valve-voltmeter between TR1 emitter and chassis, and adjust C1 and C3 for maximum reading. Then move the valve-voltmeter to TR2 and adjust C4 and C5.

Note: If either C6 or C7 is rotated by more than 30 degrees, C8 also should be adjusted for maximum output. Alternate tracking of C6 and C7, in addition to trimming of C8, should follow. Maximum power output should not be less than 5 watts, and should be set by means of the control RV1. Any adjustments to trimmers associated with the TR1 stage changes the input impedance, and the following procedure should be used to correct this.

5. Connect the Reflektometer in the r.f. input lead to the amplifier. Connect the 50-ohms power meter to the amplifier output. Connect the Selektomat to the Reflektometer receiver socket and tune it to the required operating output-frequency.
6. Trim C1 and C3 until the input reflection-coefficient is better than 16 dB. The input impedance will then have been restored to 50 ohms.
7. With the input circuit correctly matched, re-trim all other adjustments as in item 4.
8. Use the Tektronix oscilloscope (type 585) to check a.m. content. At the amplifier output the a.m. component should be less than 2 per cent with the input carrier deviated to $\pm$75 kHz.

3.5.6. Overall Tests

1. Connect a 50-ohms power meter to the drive output socket, and an a.f. oscillator (TS/10) to the audio input socket. Set the TS/10 to 400 Hz at +12 dB (with reference to 1 milliwatt in 600 ohms).
2. Check that all indicating lamps are illuminated. Check that the 12-volt d.c. supply is within $\pm$0·25 volt and that the 32-volt line is within limits of −0·5 volt and +4 volts.
3. Set the UN1/15A control to mid-scale. Then allow 2 hours to elapse for the oscillator ovens to reach working temperature.

4. Check the OS2/18 oscillator frequency, which should be within 250 Hz of its nominal frequency. Check the OS2/20 oscillator frequency, which should be within 200 Hz of its nominal frequency.
5. Adjust the MD3/1A frequency so that the final Band-II output frequency is within 250 Hz of nominal frequency.
6. Check that the power output reading is between 5 and 8 watts.
7. With test equipment connected to the drive output as in Fig. 3.10(b), feed the audio input with 1-kHz tone at +12 dB. Check that the deviation meter indicates 75 kHz; if not, make an adjustment by means of the variable input attenuator.
8. Using the distortion-test arrangement as shown, measure the distortion at the output of the deviation meter. It should be less than 1 per cent for inputs at 1 kHz and 100 Hz.
9. With the test circuit as in Fig. 3.10(c), remove modulation and check that the noise level weighted does not exceed —60 dB, and unweighted does not exceed —50 dB.
10. Restore modulation and examine the output on a type-585 oscilloscope. Measure the a.m. content, which should not exceed 2 per cent of the output voltage.

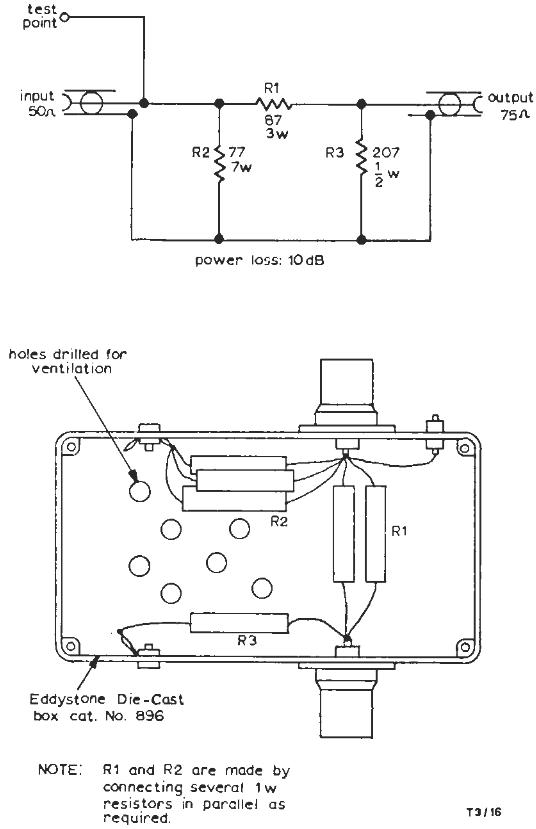


Fig. 3.12. Test Load: Circuit and Construction

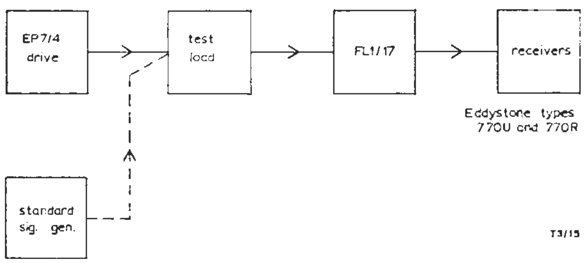


Fig. 3.11. Spurious-output Test Circuit

Spurious Signal Levels

These can be measured using the test circuit shown in Fig. 3.11.

The FL1/17 is a standard notch filter unit which should be tuned for maximum attenuation at the drive carrier frequency. This filter reduces harmonics generated in the receiver due to the presence of carrier input. The test load made to Fig. 3.12 is included to provide correct termination for the drive output circuit, which would otherwise look into a short-circuit at carrier frequency.

It is necessary, during these adjustments, to take into account the loss introduced by the test load and the FL1/17. This attenuation figure is variable with frequency. Procedure should therefore be as follows:

11. With normal drive output (5 watts) applied to the test load, explore the receiver bands and note the tuning position of each unwanted signal.

Note: The receiver gain controls should be adjusted in each instance, so that the S-meter needle is on the centre mark. Note the position of the controls.

12. Calibrate the receiver gain controls at each of the unwanted frequencies by substituting a standard signal generator for the drive output and noting the output required to produce the S-meter readings of item 11. Compare the unwanted signal levels with the 5-watt drive power applied to the 50-ohms test load. Any unwanted signal within 2 MHz of nominal drive frequency should not exceed —80 dB and any other signal should not exceed —60 dB relative to the wanted drive output.

Drive Frequency Stability

This is determined by the stability of the modulator MD3/1A and can be measured as follows:

Short-term. Measure output frequency on a frequency counter over a period of 24 hours. The drift over this period should not exceed ±100 Hz.

Long-term. This should be measured only after a minimum operational period of 1 week and the error should be less than 25 Hz per day.

Carrier Change due to Modulation

This should be measured at 50-kHz deviation and 1-kHz modulation frequency, and at 50-kHz deviation and 6-kHz modulation frequency. At 1 kHz the carrier change should be less than ±450 Hz. At 6 kHz the carrier change should be less than ±1 kHz.

Excessive carrier change can be reduced by adjustment of R33 in the MD3/1A. If this is altered, the procedure for distortion measurement as described in 3.5.2 should be repeated.

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