SECTION 1

MODULATION MONITOR UNITS MMU/1A to MMU/1F

1.1 General Description

Modulation Monitor Unit MMU/1 was developed to provide the means for indicating visually the depth of modulation of the carrier wave at the final stage of a transmitter and also to provide facilities for the aural monitoring of the programme radiated by the transmitter.

Fig. 1.1 shows the face panel of the equipment.

The fundamental principle governing the design ensures that the measurements obtained at 100 per cent modulation are accurate, irrespective of carrier amplitude. The indication of true values of peak modulation below 100 per cent, however, solely depends upon the unit being accurately lined up on carrier and upon the carrier remaining steady.

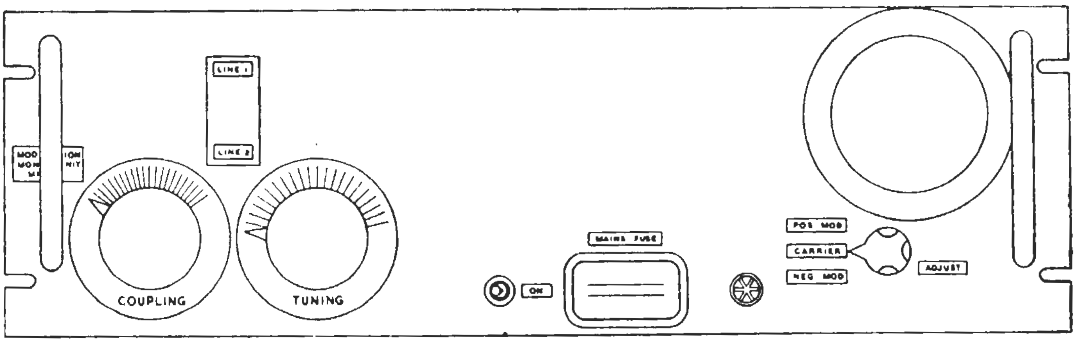

Fig. 1.1 Front Panel of Modulation Monitor Unit, MMU/1 Series

Versions covering various frequency ranges have been introduced since the original model was designed and these are identified by adding a suffix letter to the code as follows :—

Code	*Frequency Range (Mc/s)*
MMU/1A	0·15— 0·2
MMU/1B	0·5 — 2·0
MMU/1C	3·0 —12·5
MMU/1D	5·66—24·4
MMU/1E	40—67
MMU/1F	85—108

Previous methods of modulation monitoring involved the use of separate measurements for the modulated and unmodulated carrier amplitude. These measurements were dependent on constancy of carrier amplitude and were obviously dependent on the accuracy of two measuring systems. The modulation monitor unit, by combining the two measurements, not only simplifies the operation but also reduces the margin of error.

1.2 Fundamental Circuit

The basic circuit employed in the MMU/1 is given in Fig. 1.2.

The output of the transmitter is coupled through L1, L2, C5 to diode V1 followed by a smoothing circuit. This arrangement provides a steady voltage equal to the mean peak value of the carrier, across C3, and also a voltage which varies with modulation, across R2.

The voltage across R2 is again rectified by diode V2, to produce another voltage that varies with the peak value of the modulation envelope. Therefore across C3 and C4 severally are two voltages, one of steady value derived from the rectified carrier, and the other a varying voltage derived from the rectified modulation-envelope. To establish the relationship between maximum carrier amplitude and peak modulation it is necessary only to measure the difference between these two voltages. For this measurement a suitable meter is placed in the cathode circuit of a cathode-follower stage, V3. The V3 grid circuit is capable of being switched either across C3, to obtain a carrier-amplitude indication, or across C3 and C4 in series when indication of peak modulation is required.

The reason for using a cathode-follower is that it provides very great stability compared with the circuit used in the PPM/2, described in Instruction S.4. In fact it is an ideal circuit where a linear, as distinct from a logarithmic, response is required.

If the peak modulation is 100 per cent the mean amplitude of the carrier is equal to the modulation amplitude. Consequently the difference voltage is zero whether the carrier amplitude remains constant or not.

The accuracy of the measuring circuit as a whole depends mainly upon the accuracy of the meter itself, and of the load resistance with which it is in series, both of which are relatively stable components.

1.3 Circuit Description Fig. 1

1.3.1 General

The circuit of the MMU/1, Fig. 1, is basically similar to that in Fig.1.2 but incorporates two important modifications. Firstly, the circuit is designed to permit measurement of both positive and negative modulation peaks, particularly useful for determining whether these have the same amplitude. It is possible for positive modulation peaks to be more than double the mean carrier amplitude, but for negative peaks the carrier amplitude cannot be less than zero.

To obtain this feature a 1 to 1 transformer, with three secondary windings, is interposed between the first and second rectifiers. Two identical secondaries are connected to the second rectifier, a double-diode. Thus both positive and negative peaks of the modulation envelope are rectified, and the separate voltages so produced made available for measurement. The third secondary is included to provide aural monitoring.

The second important modification is the inclusion of a resistor-shunted inductor (L1) in series with the load of the first rectifier. To ensure that the rectifier will respond accurately to 100 per cent modulation, it is essential for the impedance of its load to be the same at modulation frequency as it is at d.c. In this circuit the load of the first rectifier is shunted by the r.f. filter comprising L3, C7, and by the input to the second rectifier. With these conditions the impedance of the V1 load would obviously vary with frequency. The resistor-shunted inductor is therefore included to cancel out the error and maintain the load impedance substantially constant at all audio frequencies, including zero (that is, d.c.).

Later models of the MMU/1 incorporate a

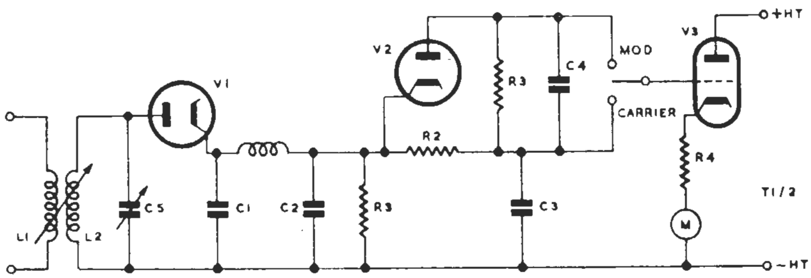

Fig. 1.2 MMU/1 : Basic Circuit Arrangement

resistor, R23, of relatively low value in the d.c. load circuit of V1. This is to provide a small d.c. voltage proportional to the r.f. carrier, for operating an external carrier-failure alarm circuit.

The type of transformer fitted in early models was AGG/4RC or AGG/104RC but this has been replaced by AGG/8RC to overcome inaccuracies at high audio frequencies and high modulation amplitudes. In addition the capacitor C9, which is adjusted on test, has been introduced to improve the capacitance balance of the transformer windings to give comparable readings for positive and negative modulation at the higher audio frequencies.

1.3.2 Timing Constants

From the output of the second rectifier, the circuit behaves in much the same way as that of a peak programme-meter amplifier. The meter deflection speed is sufficiently rapid to record peaks of a duration exceeding 5 milliseconds. It has long been established that peaks of a duration less than this do not produce audible distortion.

Unlike the PPM/2, the MMU/1 only operates on one half of the modulation cycle. The charging time-constant of the V2 diode circuit is therefore arranged to be only half that of the PPM/2, since it receives only half the number of impulses. It is determined by the values of C3, C4 and R6, R7, and the load impedance of V1. The discharge time, which controls the speed of the meter return or decay, is made twice as great as that of the PPM/2 and is conditioned by the setting of the resistors R8 to R17. This increased return time is necessary because the meter has a linear scale, whereas the scale of the PPM/2 is logarithmic. The movement of the pointer of the MMU/1 meter is therefore more rapid at the top end of the scale than that of the PPM/2 pointer.

It might seem that, when operating on the same programme, the modulation meter and a peak programme meter with a linear scale should give readings that always coincide. This is true provided peak modulation does not exceed 100 per cent. Otherwise the instantaneous value of the carrier is reduced, and that causes the modulation-meter reading to fall, whereas the peak programme meter is unaffected by carrier and registers the peaks.

Note that the MMU/1 was originally designed for use in conjunction with a linear PPM (PPM/5). Extension meters for the two instruments were arranged in an optical device (known as Pepper's Ghost), so that the meters appeared to be superimposed and, when correctly lined-up, their pointers appeared to move as one. The accuracy of such an arrangement depends upon correct relationship between the time-constant of the discharge circuit incorporated by the second rectifier. In order that this relationship should be correctly maintained, the resistors R11 to R16, which form part of the discharge circuit of the MMU/1, were made adjustable. Where the two instruments are used independently this adjustment is of no significance.

1.3.3 Input Circuit

The input circuit in MMU/1A to MMU/1D is so arranged that it can be connected to either of two balanced feeders associated with two points in the r.f. circuit of the transmitter, one of which may be the aerial. The required feeder is selected by a reversible input plug. This arrangement has the merit of providing means of checking the modulation of the transmitter itself against that from the aerial, the arrangement adopted being governed by local conditions. The circuit comprises a straightforward tuned assembly having sufficient selectivity to eliminate carrier harmonics. The coupling is variable and can be reduced to zero for the purpose of line-up.

The number of turns required on the two coils of the coupling unit for various frequency ranges are tabled in Fig. 1. For the v.h.f. ranges covered by MMU/1E and MMU/1F equipments a small preset capacitor is connected in series with the coupling coil, and a coaxial input is provided as shown by sketch A in Fig. 1. Also the first diode valve is fitted inside the radio-frequency compartment to reduce the effects of wiring capacitance, and a double capacitor (C10) is connected between the V1 heater and earth to eliminate r.f. coupling between the V1 and V2 heaters.

Where divergence is found while using steady tone to check the readings of an MMU/1 against an oscilloscope, it may well indicate that the feeder is introducing impedance errors because the a.c./d.c. load ratio of the first rectifier is not exactly unity. The error can be corrected by suitably altering the value for R3, which is part of the resistor-inductor combination referred to earlier. To make the first rectifier work efficiently, the pick-up arrangements must be such that about 80 volts r.m.s. are developed across the tuned circuit.

1.3.4. Monitoring Circuit (Aural)

The MMU/1 has an aural monitoring facility which, as stated earlier, is provided through one of three secondary windings on transformer T2. The output level is 0 dB when the transmitter is modulated at 40 per cent, assuming the modulation monitor is correctly lined up. The output impedance of the winding is approximately 40 ohms, and correct working of the rest of the unit is conditional on the terminating load being not less than 600 ohms.

Later models of the MMU/1 include a resistor, R22, in the cathode path of V2. This is to reduce the likelihood of distortion being produced in the aural monitoring circuit owing to V2 causing peak-clipping when C3 or C4 becomes charged by a sudden rise in programme volume, as may occur with piano music. It is effective only with the selector switch in the *Carrier* position, and so the switch should be left there except when modulation measurements are actually in progress.

1.3.5 External Meter Terminals

The external meter terminals were originally provided to permit use of an additional meter, and were wired at the earthy end of the cathode circuit of V3. In later models the terminals have been altered, as shown in Fig. 1, to give direct access to the cathode of V3 so that an external thermistor may be connected to provide a certain amount of automatic gain control in the aural monitoring circuit.

1.3.6 Power Supply

The mains-operated supply section of the MMU/1 serves the heaters of all valves and includes a full-wave rectifier providing h.t. needed by the cathode-follower stage only. The h.t., smoothed by L2,C1, is stabilised with two neon lamps series-connected across the supply. The voltage available is insufficient to cause these lamps to strike on their own, to overcome which one lamp is shunted by a high-value resistor R18. This addition enables one lamp to strike first and then, owing to the potential across the resistor, the other lamp is induced to strike.

1.4 Valve Data

Valve	*Anode*		*Heater*	
	Current (mA)	*Volts*	*Volts*	*Current (A)*
V1	—	—	4	0·6
V2	—	—	4	0·3
V3	0·265	260 approx.	4	1·0
V4	—	—	4	2·2

Total H.T. Feed, including neons : 7·5 mA.
H.T. Voltage : 300 volts approx.
Heater Supply : 4 volts a.c.

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COMPONENT TABLE: FIG. 1

Comp.	Loc.	Type	Tolerance per cent
C1	G9	B.E.C. CE15129 (or CE511/15)	
C2	F6	T.C.C.87 (In special case)	15
C3	J4	T.C.C. CP37S	2
C4	J5	T.C.C. CP37S	2
C5	D8	T.C.C. CP33S	
C6	D8	T.C.C. CP33S	
C7	D5	T.C.C. CM20N	
C9	G5	Fitted on test	
C10	D3	T.C.C. 2CTH 315/W	
L1	F5	BBC R/3C	
L2	J7	BBC R/4C	
L3	E4	BBC D1/6	
M1	K6	Special rapid (to Spec. ED. 1461)	
R2	E5	Erie 2 (2 x 20 k. in parallel)	5
R3	E5	Erie 8	10
R4	G4	Erie 108	2
R5	G5	Erie 108	2
R6	H4	Erie 108	2
R7	H5	Erie 108	2
R8	L4	Welwyn SA3635	

Comp.	Loc.	Type	Tolerance per cent
R9	L5	Welwyn SA3635	
R10	L4	Erie 8	5
R11	K4	Erie 8	5
R12	K4	Erie 8	5
R13	J4	Erie 8	5
R14	J5	Erie 8	5
R15	K5	Erie 8	5
R16	K5	Erie 8	5
R17	L5	Erie 8	5
R18	K9	Erie 8	5
R19	H8	Erie 2	10
R20	K6	Erie 2	5
R21	K6	Morganite-Stackpole MNAP 50350, 28800	
R22	H5	Erie 9	
R23	E5	Erie 9	
SWA	H4	Arrow 20902	
SWB	C8	Yaxley B	
T1	E7	BBC M27C	
T2	F4	BBC AGG/8RC	
V5	L8	BBC S.2 (Osglim 5 W. without resistor)	
V6	L9	BBC S.2 (Osglim 5 W. without resistor)	

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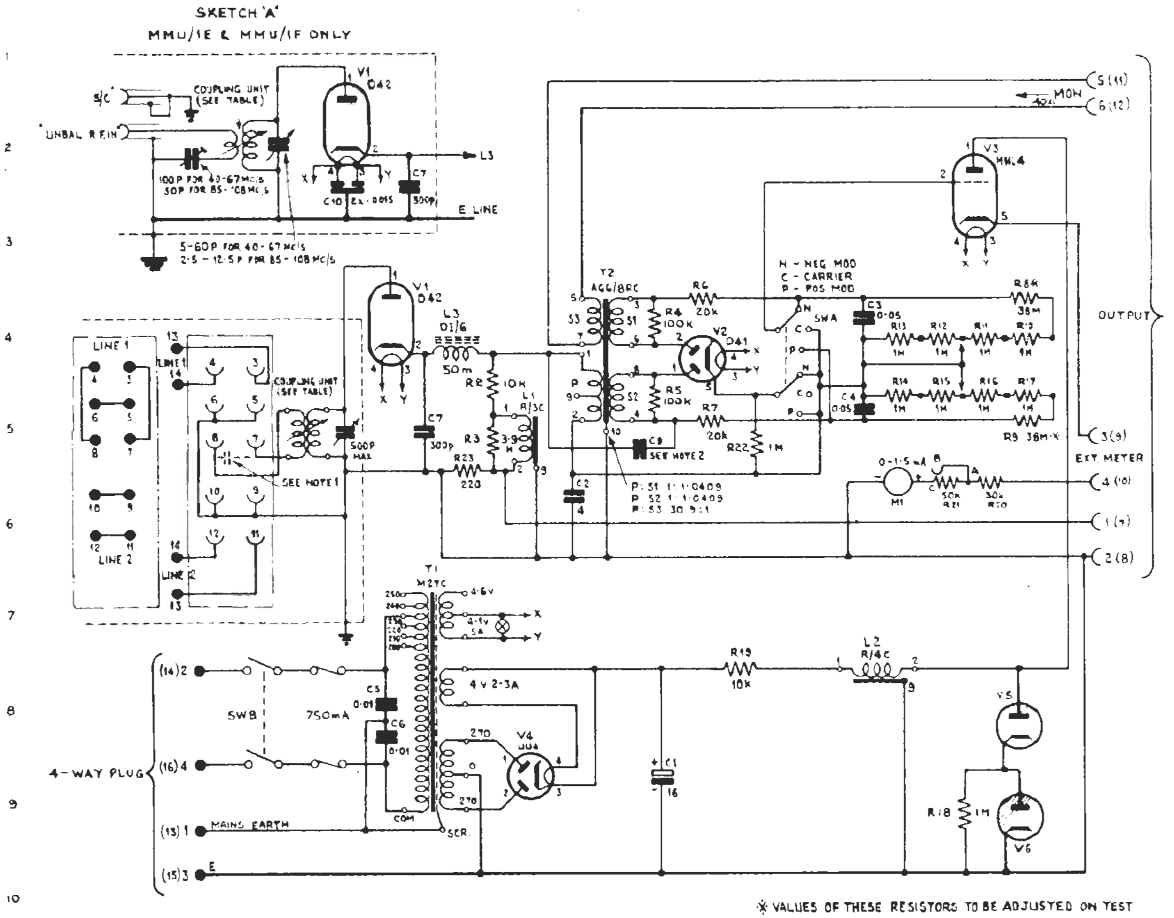
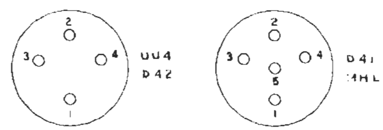


CODING	WAVE RANGE METRES	FREQUENCY RANGE MC/S	COILS (TURNS) TUNING	COUPLING
MMU/1A	1000 – 2000	0·15 – 0·2	150	100
MMU/1B	150 – 600	0·5 – 2·0	53	32
MMU/1C	24 – 100	3·0 – 12·5	8	2
MMU/1D	12·3 – 53	5·66 – 24·4	4	2
MMU/1E [illegible]	4·5 – 7·5	40 – 67	3	1
MMU/1F SEE SKETCH A	2·8 – 3·55	85 – 108	2	1

NOTES

1. SHUNT CAPACITOR 0·015µF TO BE FITTED ACROSS INPUT CIRCUIT FOR 200kc WORKING.
2. VALUE TO BE DECIDED ON TEST. IF TR2 IS AGG/4RC CONNECT C9 BETWEEN TAGS 1 & 6
3. TAG NUMBERS SHOWN IN BRACKETS REFER TO TAG NUMBERS ON CERTAIN UNITS

VALVE BASES



MODULATION MONITOR UNIT MMU/1A-F : CIRCUIT

FIG 1

MMU/1A T1