

**SOUND AUTOMATIC MONITORS**

**MN2M/2, MN2M/3A TO MN2M/6A, AND MN2M/3 TO MN2M/6**

**See Also**

AM1/14, 16	FL4/48	PS2/81
AM1/35	GE1/3	UN1/61
DM1/1	PS2/21	UN1/67
FL3/8-14	PS2/49	UN1/99
FL4/23-29	PS2/50	UN14/7
FL4/47	PS2/67	UN20/2

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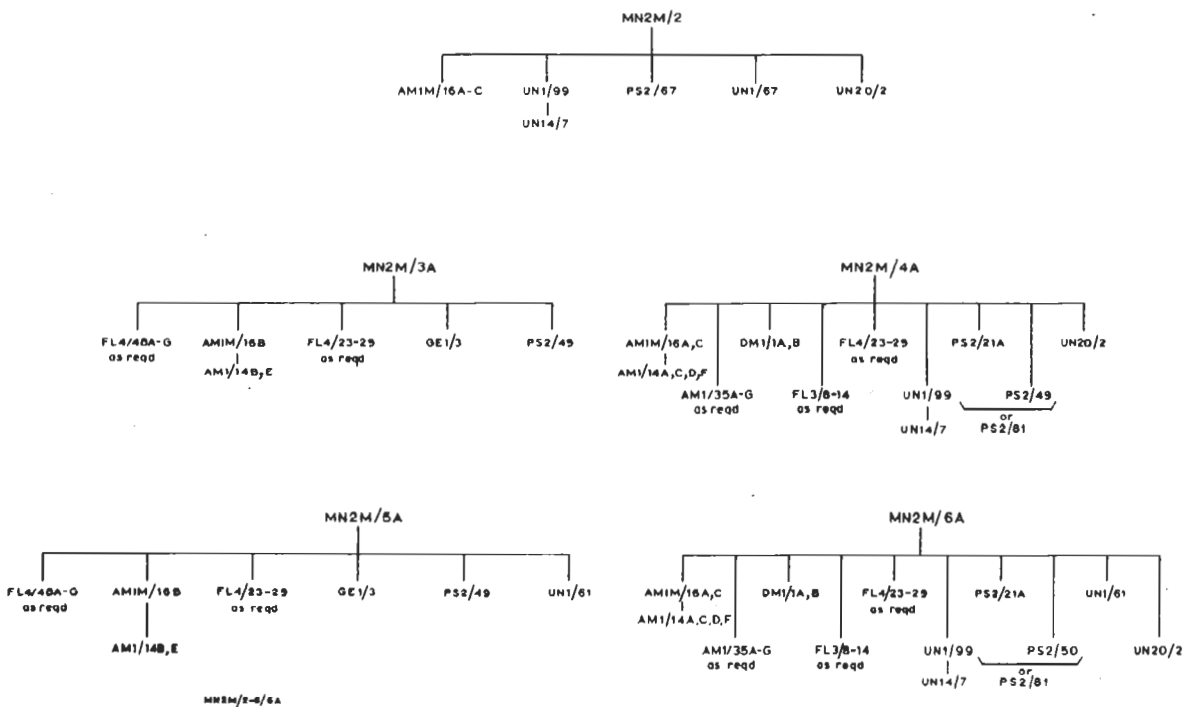


Fig. 1. Monitors MN2M/2 and MN2M/3A to MN2M/6A: Subunit Codes

### Introduction

The MN2M/2 and MN2M/3A to MN2M/6A (Fig. 1) compose a range of comparison monitoring equipments which covers the requirements for the main sound distribution links of both the Sound and the Television Service, and also provides for local monitoring, e.g. at transmitters, if required. The MN2M/3 to 6 are obsolescent versions of the MN2M/3A to 6A.

The MN2M/2 is used where the reference and compared signals\* are available at the same point. (More recently, the MN2M/7 has been installed in these circumstances.) The MN2M/3A and 4A are used where the reference and compared signals are at the two ends of a link. The MN2M/5A and 6A are used for monitoring links, generally over 200 miles long, over which difficulties may be experienced due to phase delay.

The primary purpose of these automatic monitors is to draw attention to, or remedy automatically, faults which cause the entertainment value of the programme to be noticeably impaired. The impairment may be due to a fault in any part of the system embraced by the monitor, which acts at a 'rejection' level rather than at an 'acceptance' level.

The monitors operate an alarm when there is a defect in

- (a) transmission equivalent (including a complete break),
- (b) background noise (including crosstalk),
- (c) amplitude/frequency response,
- (d) overload or nonlinearity.

The maximum sensitivity of fault detection is  $\pm 3$  dB on transmission equivalent and 40 dB below peak programme on noise. For both these types of fault the incidence of alarms is dependent on the composition of the programme signal.

Inequalities in frequency characteristic are detected when suitable frequency components of sufficient magnitude occur, at either end of the programme volume scale. Overload is detected by the discrepancy in compared programme volume at high volumes.

### Principle of Operation

The monitors operate by comparing particular parameters of the programme signals at the input and output of a local system or a link as measured in terms of instantaneous levels.

The design principles of the MN2M/2 and the MN2M/3A to 6A are based in part on those of earlier

automatic monitors as set out in Instruction S.6, Sections 1 and 2. The MN2M/2 corresponds most nearly to the early sound automatic monitor minor, described in Instruction S.6. The pairs MN2M/3A and 4A and MN2M/5A and 6A resemble the early automatic monitor major. (See Reference 4.)

A limitation on the use of the MN2M/2 to compare signals existing at points separated by a distance is the need for a second path to bring together the compared and reference signals for comparison. This is overcome in the dual sending-end and receiving-end monitors MN2M/3A and MN2M/4A by allocating a narrow band of frequencies at the top end of the transmitted audio spectrum for a processed signal which conveys information relating to the programme levels at the sending end and therefore represents the reference signal.

The difference in delay of different components in a sound programme waveform over a transmission path may cause a discrepancy between the reference and compared signals although the entertainment value of the compared signal is not seriously impaired. Integration circuits in the monitors tend to prevent alarms due to this discrepancy, but are not a satisfactory solution where the transmission path is long, that is about 200 miles or more. The difficulty is overcome by the use of quadrature units in the sending and receiving-end monitors. The addition of these, with associated modifications, changes monitors MN2M/3A and 4A to the MN2M/5A and 6A respectively.

In all the monitors the range of signal levels at the sending end is divided into three parts:

- (a) below  $-35$  dB (low level),
- (b) between  $-35$  and  $-9$  dB (medium level),
- (c) above  $-9$  dB (high level).

Most of the information which can reveal a fault condition is obtained from levels (a) and (c), and it is sufficient for this purpose to know if the signal levels at the sending and receiving ends are, or are not, in the same bands. Since it is impracticable to make a precise comparison of the levels, a margin of  $\pm 3$  dB at each transition point is allowed.

At the receiving end, the range of levels is thus divided into five parts:

- (a) below  $-38$  dB,
- (b) between  $-38$  dB and  $-32$  dB,
- (c) between  $-32$  dB and  $-12$  dB,
- (d) between  $-12$  dB and  $-6$  dB,
- (e) above  $-6$  dB.

At each end of the audio spectrum the 3-dB margin is modified to take account of certain subjective factors.

\*The input to the monitored system or transmission link is called the 'reference signal' and the output is called the 'compared signal.'

Fig. 2 shows this comparison level arrangement in diagrammatic form.

In the MN2M/2 the reference and compared programme signals are both processed and fed to a comparator in a form which represents the various levels defined above.

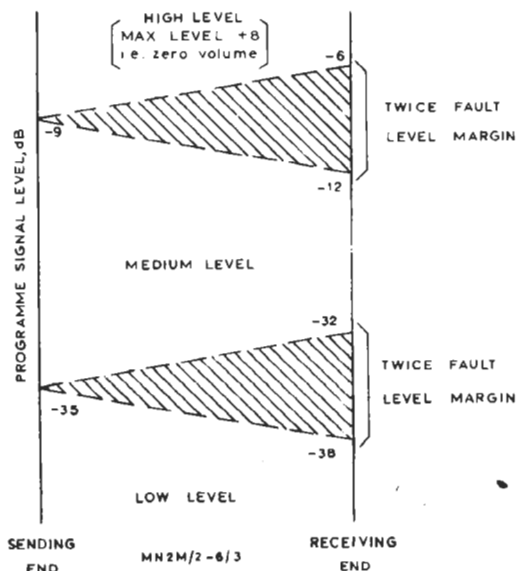


Fig. 2. Comparison Level Arrangement

In the other monitors, however, the reference programme signal is processed and used to switch a pair of tone generators so that the three ranges are indicated as follows:

- (a) low level: tone B,
- (b) medium level: tone A,
- (c) high level: tone A + tone B.

The choice of frequencies for these tones is dictated by the available bandwidth of the link. For the main distribution chain, this bandwidth may typically be 11 kHz, for which the appropriate A and B tone frequencies are 10.6 and 10.8 kHz. The transmission of these tones reduces the programme bandwidth by about 750 Hz. At the receiving end the tones are detected and operate transistor switches which present the information specifying the programme level to the comparator. The programme at the receiving end is similarly processed, and converted to a suitable form for comparison with the reference information. Any disagreement between these two sets of information is registered, but if momentary and in isolation it is not significant, and no action is required. The signals produced by the comparator representing these discrepancies are passed to an error signal unit which alarms after a series of brief discrepancies, or after one which is sustained.

The monitor has its maximum sensitivity (3 dB) when the reference programme level is around -9 or -35 dB. For example, if the reference level is just below -9 dB, an error signal is registered if a transmission fault raises the compared signal level above -6 dB. Similarly, noise is detected if it makes the compared signal level exceed -32 dB while the reference level is below -35 dB.

Tone failure, as distinct from a failure of the link, is indicated separately by the comparator.

**Monitor MN2M/2: Description**

The MN2M/2 is used where the reference and compared signals are available at the same point. It is therefore suitable for monitoring local equipment such as a transmitter, or a short link feeding a transmitter if the output from this can be received at the sending end of the line.

*Summary of Equipment*

The MN2M/2 equipment comprises the following units, mounted on a panel PN3/23.

- Isolating Unit UN1/67
- Processing Amplifier AM1M/16A
- Processing Amplifier AM1M/16B
- Processing Amplifier AM1M/16C
- Comparator Unit UN20/2
- Error Signal Unit UN1/99
- Power Supplier PS2/67

*Function of Units*

The units are arranged as shown in block diagram Fig. 3.

The reference and compared signals are fed at zero level to the isolating unit UN1/67 which consists of two LL/106 repeating-coils, one in each line. The reference signal is then taken to the processing amplifier AM1M/16B and the compared programme to the paralleled inputs of the processing amplifiers AM1M/16A and C. The outputs from the amplifiers operate the comparator unit UN20/2.

No part of the equipment is connected in series with the programme chain, and the two inputs may be connected at points selected to suit the particular installation. The impedances of both inputs are high, that across SKT.J tags 1 and 2 being about 50 kilohms and that across tags 10 and 11 being about 25 kilohms. Listen jacks are provided across both inputs, but to prevent possible interference with the programme line level, 3-kilohm isolating resistors are connected in series with each leg. The listen jacks therefore cannot be used for a direct measurement of the input level.

Lamp displays on the comparator UN20/2 indicate the instantaneous programme levels at the sending and receiving ends of the system and two coloured lamps indicate the state of the monitor at any instant.

Under normal conditions a green lamp should be lit; when a programme fault is detected by the comparator, the green lamp is extinguished and a yellow lamp lights. (In the MN2M/2, the red lamp which is on the comparator is not connected, and the conditions requiring the adjustment of the delay unit in the output of the comparator do not obtain.)

The signals from the UN20/2 are fed into the error signal unit UN1/99, the action of which is described later under the heading Monitors MN2M/3A and MN2M/4A: Description.

of  $\pm 0.5$  dB. In each instance, when a lamp has lit, reduce the 1-kHz input to a level at which the lamp just goes out and check that this is  $3.5 \pm 1$  dB below the level of increasing input which caused the lamp to light. The green lamp on the UN20/2 should remain lit throughout.

3.

With inputs at 100 Hz and 8 kHz, repeat the check on the operation of the UN20/2 level lamps, as in step 2 but measuring only the levels which switch on the lamps. The levels at which an increasing input at each frequency

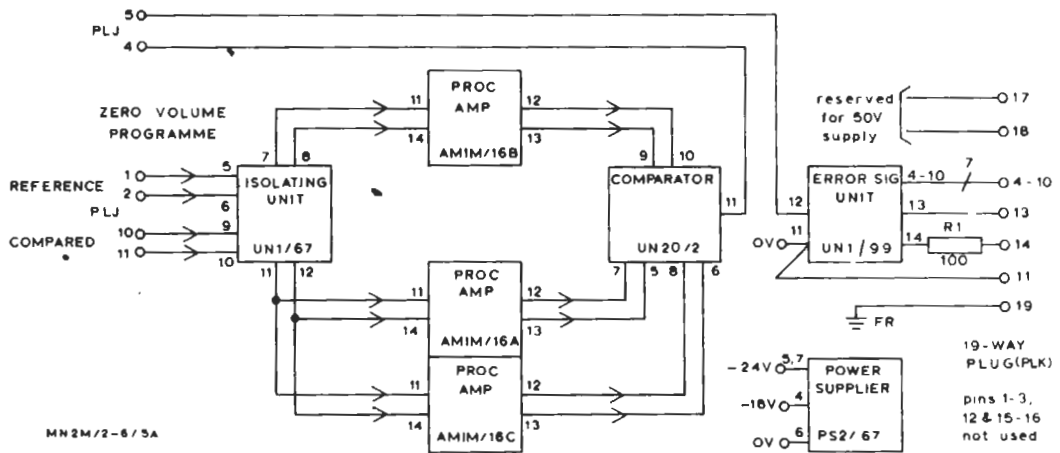


Fig. 3. Monitor MN2M/2

**MN2M/2: Testing**

*Power Supplies*

- 24 volts, 525  $\pm$  25 mA d.c.
- 6 volts, 350  $\pm$  50 mA d.c.

*Apparatus Required*

- A.C. test meter ATM/1
- Tone source TS/10

*Procedure*

1. Strap in parallel the pairs of reference and compared programme input connectors and apply a common input to them from a TS/10 tone source. Connect an ATM/1 in parallel with this input arrangement to measure level and use the ATM/1, or an external termination, to load the tone source with 600 ohms.
2. Commence with a 1-kHz input signal at less than -38 dB, so that the two bottom level-indicating white lamps on the UN20/2 are lit. Increase the input and check that the other white lamps are switched on as the level rises to the values marked on them, with an accuracy

4. Remove the tone from the reference and compared programme input of the monitor in turn. The yellow lamp on the UN20/2 should light in place of the green lamp for levels of tone above -32 dB, and the red alarm lamp on the UN1/99 should light about 1.5 seconds after the yellow lamp.
5. Apply a 1-kHz tone signal to both the reference and compared programme inputs together, at zero level. Cut the 1-kHz signal and observe that the UN20/2 level-indicating lamps are momentarily lit in the correct descending sequence, until the lamps at the bottom of the columns are finally lit. There should be no momentary alarm indication by the yellow lamp on the UN20/2. If there is, it may be caused by an amplifier with an incorrect time constant and careful observation of the lamp sequence should reveal which one is incorrect. This fault results in false alarms on certain types of programme and the amplifier should be returned to Equipment Department for adjustment.

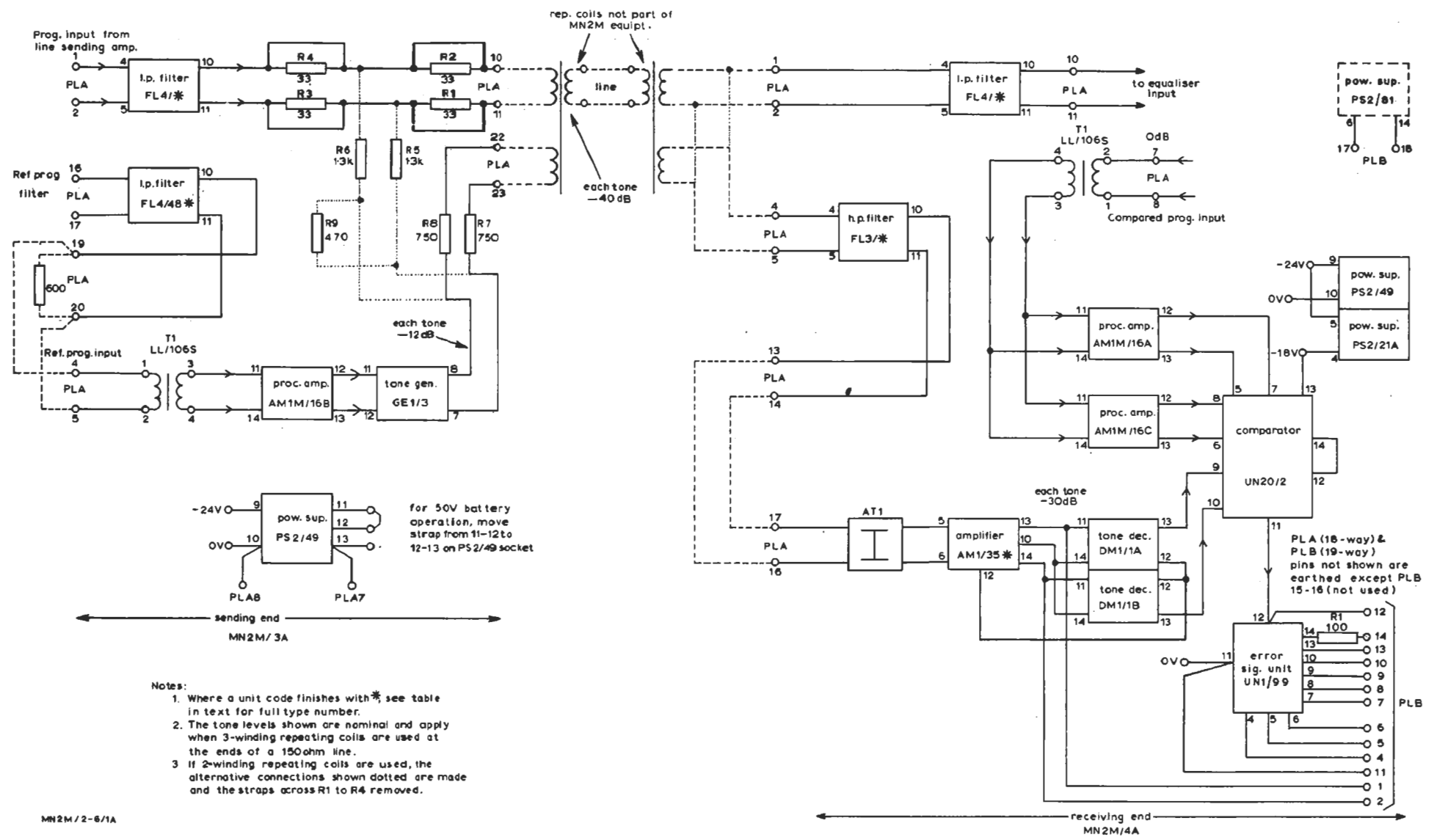


Fig. 4. Monitors MN2M/3A and MN2M/4A: Sending-end and Receiving-end Systems

MN2M/2-6/1A

TABLE 1

Levels at Which a Rising Programme Input  
Should Operate UN20/2 Lamps in an MN2M/2

UN20/2 Lamp	Level at Programme Input, dB		
	1 kHz	100 Hz	8 kHz
-38 dB	-38 ±0.5	-37.5 ±1	-37.5 ±1
-35 dB	-35 ±0.5	-31.0 ±1	-33.0 ±1
-32 dB	-32 ±0.5	-25.0 ±1	-27.0 ±1
-12 dB	-12 ±0.5	-15.0 ±1	-15.0 ±1
-9 dB	-9 ±0.5	-10.5 ±1	-10.0 ±1
-6 dB	-6 ±0.5	-6.0 ±1	-5.5 ±1

#### Monitors MN2M/3A and MN2M/4A: Description

The sending and receiving equipments MN2M/3A and MN2M/4A are used for monitoring lines or links (except that if delay in the transmission path necessitates the use of quadrature units, the MN2M/5A and 6A are used instead).

#### Summary of Equipment

The MN2M/3A comprises the following units, mounted on a 5¼-inch panel PN3/23:

- Lowpass Filter in the FL4/23-29 series
- Processing Amplifier AM1M/16B
- Tone Generator GE1/3
- Power Supplier PS2/49
- Lowpass Filter in the FL4/48A-G series, if required

The MN2M/4A comprises the following units, mounted on two panels PN3/23:

- Lowpass Filter in the FL4/23-29 series
- Highpass Filter in the FL3/8-14 series
- Processing Amplifier AM1M/16A
- Processing Amplifier AM1M/16C
- Tone Decoder DM1/1A
- Tone Decoder DM1/1B
- Comparator Unit UN20/2
- Error Signal Unit UN1/99
- Amplifier in the AM1/35A-G series
- Power Supplier PS2/49 } or PS2/81
- Power Supplier PS2/21A }

The lowpass and highpass filters, and the AM1/35, are selected as shown in Table 2 to suit the upper frequency-limit of the link, and the tone generator and tone decoders are adjusted to the corresponding monitoring tone frequencies. Some further considerations in the choice of the lowpass filters are given in

the following description of the functions of the units.

The units are arranged as shown in the block diagram Fig. 4.

#### Reference Programme Level Coding

In the MN2M/3A, two tones are generated which represent, singly or together, different bands of levels of the reference programme signal.

Initially, the reference programme signal may be passed through a lowpass filter in the FL4/48A-G series. One of these is fitted if the monitored line or link appreciably limits the bandwidth of the compared programme obtained at the receiving end. The appropriate version of the FL4/48 is then fitted to similarly restrict the reference programme signal so that the bandwidth monitored at the sending end is comparable in content.

The reference programme signal, obtained through the FL4/48 if one is used, is applied to the processing amplifier AM1M/16B. This has two separate d.c. outputs which individually switch in voltage as the input passes through two predetermined levels (-35 dB and -9 dB).

The pair of two-state outputs from the AM1M/16B control the tone signals sent to line by the GE1/3.

#### Sent Programme Filtering

The programme signal to be sent by line or link is initially, as a rule, at zero level and 600 ohms impedance. It is firstly passed through a lowpass filter in the FL4/23-29 series. The filter chosen has a cut-off frequency 750 Hz below the upper limit of the line or link, and the band thus free is available for the reference programme monitoring tones.

A and C versions of the FL4/23-29 series have

TABLE 2

Tone Frequencies, Filters and Tone Amplifiers Used in Sending and Receiving End Monitors MN2M/3A and 4A, or MN2M/5A and 6A

Upper Limit of Link (kHz)	Reference Programme Monitoring Tones		Lowpass Filters*			Highpass Filter (Ref. Prog. Tones) (Receive End)		Tone Amplifier (Ref. Prog. Tones) (Receive End) Code
			Cut-off (kHz)	Ref. Prog. (Send End) Code	Compared Prog. (Each End) Code	Cut-off (kHz)	Code	
	A (kHz)	B (kHz)						
8	7.6	7.8	7.25	FL4/48F	FL4/28	7.5	FL3/13	AM1/35F
9	8.6	8.8	8.25	FL4/48G	FL4/29	8.5	FL3/14	AM1/35G
10	9.6	9.8	9.25	FL4/48A	FL4/23	9.5	FL3/8	AM1/35A
11	10.6	10.8	10.25	FL4/48B	FL4/24	10.5	FL3/9	AM1/35B
12	11.6	11.8	11.25	FL4/48C	FL4/25	11.5	FL3/10	AM1/35C
13	12.6	12.8	12.25	FL4/48D	FL4/26	12.5	FL3/11	AM1/35D
15	14.6	14.8	14.25	FL4/48E	FL4/27	14.5	FL3/12	AM1/35E

\*An FL4/48 reference programme filter is only fitted when required and versions A ('Send' or 'Receive'), B, C or D of the FL4/23 to 29 filters are fitted in the sending and receiving end monitors as necessary.

been designed for use in this position at the sending end of the monitoring systems. The A version, providing greater attenuation at the tone frequencies, is normally used, and is now known as the A 'Send' version to distinguish it from a slightly modified A version (known as A 'Receive') used with three-winding repeating-coils at receiving ends.

#### Coupling to Line

It has become common practice to use a three-winding repeating-coil, usually an LL/216, to couple the sending-end and receiving-end equipment to the monitored line or link, which is assumed in these instances to be 150 ohms. At the sending end a 600-ohm winding on the repeating-coil takes the sent programme signal from the lowpass filter FL4/23-29, while the reference programme tones are fed via resistors to the low-impedance tertiary winding.

If a two-winding repeating-coil is used at the sending end, the tones are added to the sent programme before the repeating-coil primary by means of a T network of resistors which are introduced by

simple modifications in the monitor. (See Fig. 4.)

With a three-winding repeating-coil in use at the receiving end, the line is connected to the 150-ohm winding, a lowpass filter is connected to the 600-ohm winding to accept the programme signal, and a high-pass filter is connected to the tertiary winding to accept the reference programme tones. When a two-winding repeating-coil is fitted at the receiving end, the lowpass and highpass filters have their inputs connected in parallel to the secondary winding. The type of repeating-coil used, as well as the line bandwidth, determines the version of lowpass filter in the FL4/23-29 series that is used to pass the programme signal.

#### Receiving-end Programme Filtering

If a three-winding repeating-coil is used to couple the monitored line or link to the receiving-end monitor MN2M/4A, the lowpass filter that accepts the programme signal from the 600-ohm winding is a modified A version, known as an A 'Receive' version, of whichever filter in the FL4/23-29 series is suitable



for the line bandwidth. This filter prevents the reference tones reaching the programme equipment beyond the monitor.

If a two-winding repeating-coil is used, a B or D version of the lowpass filter in the FL4/23-29 series must be employed. Either of these forms a complementary pair with the corresponding highpass filter in the FL3/8-14 series (used to accept the reference tones) when their inputs are connected in parallel.

See Table 2 and the Instructions on filters FL4/23-29 and FL3/8-14.

#### *Reference Programme Tone Decoding*

In the MN2M/4A, the reference programme tones are passed by the highpass filter in the FL3/8-14 series to a tone amplifier AM1/35. One of the versions A to G of this amplifier is fitted according to the tone frequencies to be received. The AM1/35 permits a wide range of level adjustment common to both tones and separates them with some discrimination into two outputs which can be adjusted a moderate amount in relative level. With these facilities, the A and B tone signals are each set at  $-30$  dB before application to the decoders DM1/1A and DM1/1B.

There is provision, as in earlier monitors, for fitting a pad, AT1, before the tone amplifier as part of the level adjustment, but the performance of the AM1/35 has tended to make this unnecessary and AT1 has been omitted from many MN2M/4A monitors.

The DM1/1A and DM1/1B are tuned respectively to the lower and upper monitoring code tones. The appropriate input frequency to the decoder causes the transistor switch in its output circuit to operate, providing the reference input to the comparator UN20/2.

#### *Compared Programme Processing*

The programme signal obtained from the lowpass filter in the MN2M/4A is fed out of the monitor, usually to an equaliser and a distribution amplifier. It is returned to the monitor as the compared programme signal, either directly, or via a further path and equipment, which is therefore included in the scope of the monitoring process.

The compared programme signal is applied to the receiving-end monitor at zero level and is fed in parallel to the inputs of AM1M/16A and AM1M/16C processing amplifiers. The four outputs provided by these two units switch their d.c. state at different levels of compared programme ( $-38$ ,  $-32$ ,  $-12$  and  $-6$  dB).

#### *Comparator Unit UN20/2*

The AM1M/16A and AM1M/16C amplifiers and the DM1/1A and DM1/1B decoders in the MN2M/4A are connected to the comparator UN20/2. The state of the transistor switches in the outputs of the amplifiers together with the states of those in the

decoders govern the operation of the gate circuits of the comparator.

Lamp displays on the comparator UN20/2 indicate the instantaneous programme levels at the sending and receiving ends of the system and three coloured lamps indicate the state of the monitor at any instant. Under normal conditions the green lamp should be lit; when a programme fault is detected by the comparator the green lamp is extinguished and a yellow lamp lights, while failure of the incoming tone signal causes a red lamp to light.

#### *Error Signal Unit UN1/99*

The signals from the UN20/2 are fed into the error signal unit UN1/99. This is arranged to alarm after a series of momentary discrepancies in a short time, or after a sustained discrepancy lasting for about 1.5 seconds.

The alarm is indicated by the lighting of a red lamp. There is provision in the form of a relay with externally accessible changeover contacts for an external alarm circuit to be operated.

The UN1/99 embodies a restoration delay unit UN14/7. This is used when the external alarm circuit is required to initiate executive action such as a changeover to spare equipment, or where a succession of alarms is not desired. The alarm circuit then remains operated until 15 minutes after receipt of the last error signal from the comparator UN20/2, unless this delay is cancelled by pressing a reset button on the front of the panel. On first switching on, the UN1/99 is prepared for operation in about two minutes by the action of a relay circuit.

When the 15-minute delay is not required, the restoration delay unit may be made inoperative by strapping pins 10 and 14 on the UN1/99 panel socket.

#### **MN2M/3A and MN2M/4A: Adjustment and Testing**

##### *Power Supplies*

MN2M/3A (including FL4/48):  
24 volts,  $240 \pm 25$  mA d.c.

MN2M/4A:  
24 volts,  $420 \pm 30$  mA d.c.  
6 volts,  $350 \pm 50$  mA d.c.

##### *Apparatus Required*

Frequency counter (preferably at sending end),  
with an amplifier if necessary to obtain sufficient operating input  
Oscilloscope (at receiving end)  
Avometer Model 8 (at receiving end)  
A.C. test meter ATM/1 (at both ends)  
Tone source TS/10 (at both ends)  
600-ohm variable attenuator AT/30 or PAT/3  
(at both ends)

*Sending-end Adjustments*

1. Commence with no signal at the programme input to the sending-end equipment. In this condition, the sending-end monitor should produce a tone B output. Check with a frequency counter that the tone B frequency is correct within  $\pm 10$  Hz. The counter may be connected to a listen jack at the tone output or to a U-link socket normally joining the sending-end equipment to line. Alternatively, the tone signal may be sent by line to a counter available at a remote point.
2. Disconnect the sending-end equipment from the line (by removing the U-link which is usually fitted) and terminate the sending equipment at this point with the input of an amplifier-detector (e.g. the ATM/1 in the amplifier-detector condition) arranged internally or externally to present 600 ohms impedance. Add 240 ohms in parallel with the amplifier-detector so that the combination approximates a 150-ohm load. The tone-B level into this load, shown by the amplifier-detector, should normally be  $-40 \pm 2$  dB. (This assumes that there is a three-winding repeating-coil at the output of the sending-end equipment. Where a two-winding repeating-coil is used, the load should be 600 ohms and the level  $-34 \pm 2$  dB.) To adjust the tone-B level, mount the GE1/3 on a chassis extender and reset RV2 in this unit.
3. Connect a tone source to a 0.5-dB step attenuator. Bridge the output of the variable attenuator with an amplifier-detector arranged internally or externally to load the attenuator with 600 ohms. From this combination feed a 1-kHz signal at  $-45$  dB to the reference-programme input of the sending-end monitor (i.e. to the input of the processing amplifiers, via the optional FL4/48 lowpass filter if fitted).
4. Increase the 1-kHz input and find the level at which the tone from the sending-end monitor changes from tone B to tone A. The change may be heard on headphones connected to the tone output of the monitor or at the programme output where it is fed to the line-sending repeating-coil, but with the highest-frequency tones, good headphones are necessary and the ear may not discern the change. Alternatively, the change may be detected by observing tone level and noting the small alteration which usually occurs, or can be made to occur by resetting the tone-A output on RV1 in the GE1/3. If the point of change is first found roughly, reduce the 1-kHz input to restore tone B and then increase it again carefully. The change should occur when the 1-kHz level reaches  $-35 \pm 0.5$  dB. A small error may be corrected by mounting the AM1M/16B on a

chassis extender and adjusting RV1 on the AM1/14B board on the left of the unit. See the Instruction on AM1/14, 16 for full adjustment and test information.

5. Set the 1-kHz input so that tone A is obtained and check with a counter that the tone-A frequency is correct within  $\pm 10$  Hz.
6. Check the level of the tone A output from the line winding of the repeating-coil, as tone-B level was checked in step 2. The tone-A level should be the same as that required for tone B. To adjust the level of tone A, reset RV1 in the GE1/3.
7. Raise the 1-kHz input level and check that when it reaches  $-9 \pm 0.5$  dB the tone output changes from tone A alone to tones A and B together. A small error in the point at which the change occurs may be corrected by mounting the AM1M/16B on a chassis extender and adjusting RV1 on the AM1/14E board on the right of the unit. See the Instruction on AM1/14, 16 for full adjustment and test information.

*Local Receiving-end Adjustments*

1. Connect a tone source to a 0.5-dB step attenuator. Bridge the output of the step attenuator with an amplifier-detector (e.g. an ATM/1 in the amp-det condition) arranged internally or externally to load the attenuator with 600 ohms. From this combination apply a 1-kHz signal at  $-50$  dB to the compared-programme input feeding the AM1M/16 amplifiers in the receiving-end monitor (i.e. monitor input terminals 7 and 8). Disconnect, by use of a break jack or other means, the normal compared-programme path to this input, which is commonly from the line receiving amplifier.
2. Increase the 1-kHz input and find the level at which the  $-38$  dB lamp on the monitor (on the UN20/2) switches on. If the level is first found roughly, drop the level to extinguish the  $-38$  dB lamp and then increase the level again carefully until the lamp lights. The  $-38$  dB lamp should light at a 1-kHz input level of  $-38 \pm 0.5$  dB. A small error in the operating level may be corrected by mounting the AM1M/16A on a chassis extender and adjusting RV1 on the AM1/14A board on the left of the unit. See the Instruction on AM1/14, 16 for full adjustment and test information.
3. Similarly find the levels of an increasing 1-kHz input at which the  $-32$ ,  $-12$  and  $-6$  dB lamps are switched on. The operating levels should be within  $\pm 0.5$  dB of the values indicated by the lamps. Small errors in the operating levels can be corrected by adjusting RV1 on, respectively, the AM1/14C board on the left of the

AM1M/16C unit, the AM1/14D board on the right of the AM1M/16A unit, and the AM1/14F board on the right of the AM1M/16C unit.

#### *Overall System: Receiving-end Adjustments*

These receiving end adjustments require operation of the overall system and it is assumed that:

- (a) The sending-end monitor and the compared-programme circuits of the receiving-end monitor have been adjusted as previously described.
  - (b) The line, or link, and the sending-end and receiving-end equipment have been set up so that the receiving-end programme output to be monitored is equal in volume to the sending-end input when satisfactory operating conditions exist.
  - (c) The noise introduced in the line, or link, is known to be acceptable and has negligible effect on the receiving-end monitor when satisfactory operating conditions exist.
1. Ensure that there is no signal applied to the sending-end programme input. This will result in tone B from the sending-end monitor. Measure the level at the tone-B jack on the receiving-end AM1/35 unit using the high-impedance input of an amplifier-detector, and adjust the level to roughly  $-35$  dB by means of the AM1/35 Gain controls. Note the level obtained.
  2. Apply  $-20$  dB at 1 kHz to the sending-end programme input. This will result in tone A from the sending-end monitor. Measure the level at the tone-A jack on the AM1/35.
  3. Note the difference between the tone A level obtained and the tone-B level set previously. By means of the Adj. Diff. control on the AM1/35, alter the tone-A level so that it half approaches the tone-B level previously set. Obtain a tone-B signal from the sending end and check that the level at the tone-B jack on the AM1/35 has approached the level set at the tone-A jack. Alternate between tones A and B from the sending end and trim the Adj. Diff. control until the two tone levels at the jacks are equal within  $\pm 1$  dB. Readjust the AM1/35 gain controls so that the tones are each at a level of  $-30 \pm 1$  dB.
  4. At the receiving end, mount the DM1/1A on a chassis extender and remove the DM1/1B. Obtain a tone-A signal (alone) from the sending end. Connect an Avometer Model 8 on its 2.5-volt range to the test point on the front of the AM1/35 and if necessary adjust RV2 on the DM1/1A to obtain a reading of about  $-1$  volt.
  5. Remove the DM1/1A and mount the DM1/1B on a chassis extender (at the position normally occupied by the DM1/1B). Obtain a tone-B signal (alone) from the sending end. With the Avometer still connected to the AM1/35, if necessary adjust RV2 on the DM1/1B to obtain a reading of about  $-1$  volt.
  6. Insert the DM1/1A and readjust RV2 in the DM1/1B to obtain a reading of exactly  $-1$  volt on the Avometer. Apply the Avometer, on its 25-volt range, to the slider of RV1 on the DM1/1B and if necessary adjust RV1 to obtain  $-4.5 \pm 0.1$  volts at this point.
  7. Mount the DM1/1A on a chassis extender and repeat step 4, but with the DM1/1B in its normal operating position. Readjust RV2 so that exactly  $-1$  volt is obtained at the AM1/35 test point. Transfer the Avometer, set to its 25-volt range, to the slider of RV1 on the DM1/1A and if necessary adjust RV1 to obtain  $-4.5 \pm 0.1$  volts at this point. Remove the chassis extender and restore the DM1/1A to its normal position.
  8. At the receiving end, mount the UN20/2 on a chassis extender. With the overall system operating on a programme input consisting of speech, connect an oscilloscope to observe the waveform at terminal 2 of delay circuit V on the right-hand board in the UN20/2. Adjust RV1 in circuit V so that it is set just off the range where pulses are seen on the oscilloscope. (This is intended to eliminate spurious error pulses under normal conditions, which would be integrated and might operate the UN1/99, yet leave circuit V in the UN20/2 set to pass signals when true fault conditions occur.) Adjust RV1 in delay circuit W in the UN20/2 so that the green lamp on this unit does not flicker. Delay circuit U does not require adjustment.

#### *Overall System Tests*

These tests should be made to confirm correct performance following adjustment of the monitoring system and may be made subsequently as a check on the operation of the system.

1. At the sending end, connect a tone source to a 0.5-dB step attenuator and bridge the output of the attenuator with an amplifier-detector arranged internally or externally to load the attenuator with 600 ohms. From this combination apply a 1-kHz signal at  $-50$  dB to the programme input of the sending-end equipment. Using an Avometer Model 8, check that  $-1.00 \pm 0.05$  volt is obtained at the test point on the AM1/35 unit on the receiving-end monitor. Check that this voltage is also obtained if the 1-kHz input signal is raised to  $-20$  dB.
2. Restore the 1-kHz sending-end input to  $-50$  dB. The two bottom, unlabelled, level-indicating

white lamps on the receiving-end UN20/2 unit should light. Increase the 1-kHz sending-end level and check that, when the -35 dB and -9 dB lamps on the UN20/2 go on, the sending-end levels are within  $\pm 0.5$  dB of -35 and -9 dB respectively. If either sending-end level is out of tolerance, reset the appropriate AM1/14 amplifier in the sending-end monitor to function correctly as described under Sending End Adjustments. When it is known that the sending-end monitor is satisfactory, increase the sending-end level from -50 dB and note the levels at the receiving-end monitor input terminals 7 and 8 when the -35 dB and -9 dB lamps go on. These receiving-end levels should also be within  $\pm 0.5$  dB of -35 and -9 dB. If necessary, adjust the gain of the monitored link to obtain these results.

3. Set the sending-end input in turn to 100 Hz and 6 kHz, and at each frequency raise the input level from -50 dB and note the levels at the receiving-end monitor input terminals 7 and 8 when the -35 dB and -9 dB lamps go on. These receiving-end levels should be within  $\pm 4$  dB of -31.0 dB and -10.5 dB at 100 Hz, and within  $\pm 4$  dB of -33.5 dB and -9.5 dB at 6 kHz. (The tolerance of  $\pm 4$  dB consists of  $\pm 1$  tolerance for the action of the sending-end AM1/14 processing amplifiers at 100 Hz and 6 kHz, and an assumed tolerance of  $\pm 3$  dB for the gain and frequency response of the transmission link.)
4. Set the sending-end input in turn to 1 kHz, 100 Hz and 6 kHz, and at each frequency raise the input level from -50 dB and note the receiving-end level at which each of the level-indicating lamps on the UN20/2 switches on. The -38 dB and -32 dB lamps should light at receiving-end levels differing by at least 3 dB (but not more than 6 dB) from the receiving-end level when the -35 dB lamp goes on. The -12 dB and -6 dB lamps should light at receiving-end levels differing by at least 3 dB (but not more than 6 dB) from the receiving-end level when the -9 dB lamp goes on. If necessary

to obtain these results, adjust the appropriate AM1/14 amplifiers in the receiving-end monitor as described under Local Receiving End Adjustments. If an adjustment is made at one frequency, repeat the tests at the other two frequencies until satisfactory results are obtained at all three frequencies without adjustment. (Include similar tests at any frequency at which satisfactory operation of the monitoring system needs to be confirmed.)

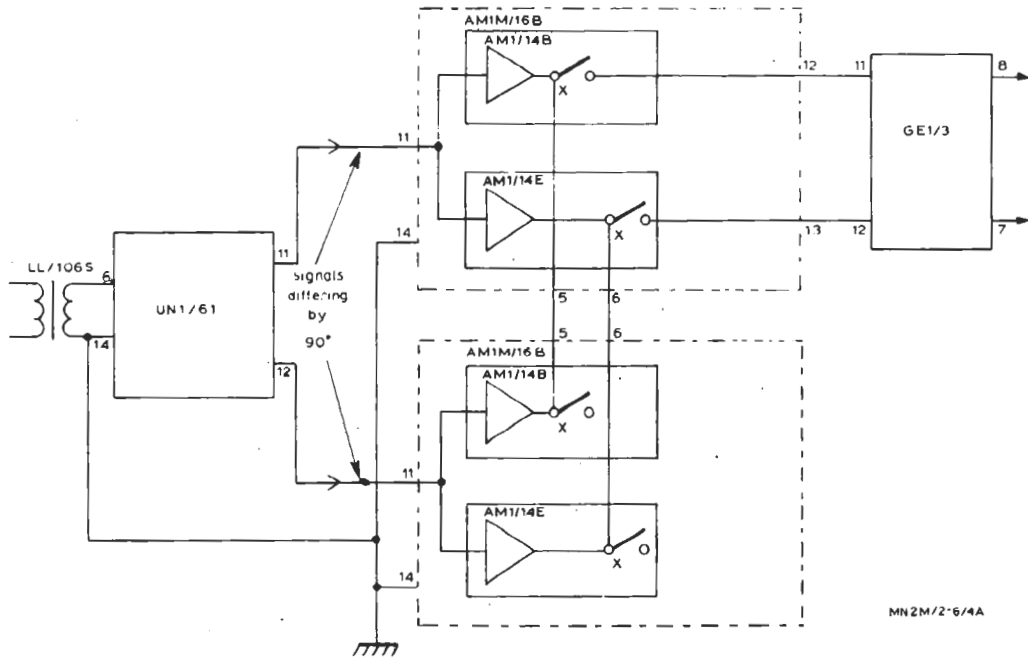
5. Increase the sending-end input from -50 dB to 0 dB at 1 kHz and note the sending or receiving-end levels at which the UN20/2 lamps go on. Reduce the sending-end level again to -50 dB and check that each level-indicating lamp goes out at a level  $3.5 \pm 1$  dB below the level of increasing tone which brings it on.
6. Apply a 1-kHz signal at 0 dB level to the programme input at the sending end. At the receiving end, if the lamp in the pushbutton on the UN1/99 unit is lit, clear this alarm indication by pressing the button. Break the compared-programme signal path in the receiving-end equipment (by opening a break jack at the monitor input or removing the lowpass filter in the compared-programme chain). The green lamp on the UN20/2 should go out and the amber lamp should light. The alarm lamp in the UN1/99 pushbutton should light about 1.5 seconds after the break in the compared-programme path.
7. Repeat step 6, but break the reference programme tone input to the receiving-end monitor (by opening a break jack or removing the highpass filter through which the tones are fed). The green lamp on the UN20/2 should go out and the amber and red lamps on this unit should light. The alarm lamp in the UN1/99 pushbutton should light about 1.5 seconds after the tone break.
8. Briefly switch on the 1-kHz 0-dB sending-end input signal a number of times with intervening breaks of 2 seconds or more. The green lamp on the UN20/2 should remain lit and no alarm indication should develop on the UN1/99.

*Continued overleaf*

**Monitors MN2M/5A and MN2M/6A: Description**

The MN2M/5A and 6A are used for monitoring lines or links, in general over 200 miles long, where the delay in the transmission path is likely to cause unsatisfactory performance with the MN2M/3A and 4A.

similarly to the MN2M/3A, as described previously, except that the reference programme signal fed to the monitor via a repeating-coil is reproduced by a UN1/61 in the form of two signals with a 90-degree phase difference, and these are separately applied to two AM1M/16B processing amplifiers instead of one.



*Fig. 5. Quadrature System in the MN2M/5A, Showing Interconnections between AM1/14 Amplifiers.*

**Summary of Equipment**

The MN2M/5A consists of all the units in an MN2M/3A with the addition of a quadrature unit UN1/61 and a second processing amplifier AM1M/16B.

The MN2M/6A consists of all the units in an MN2M/4A with the addition of a UN1/61, a second AM1M/16A and a second AM1M/16C.

The particular versions of some units used, and the frequency settings of others, depend on the upper frequency of the line or link to be monitored, as described for the MN2M/3A and 4A and shown in Table 2.

**Function of Units**

At the sending end the MN2M/5A functions

The input repeating-coil may be preceded by a version of the lowpass filter FL4/48, depending on the same considerations as apply to the MN2M/3A.

Each AM1M/16B contains two amplifiers, an AM1/14B and an AM1/14E, having their inputs connected together. (See Fig. 5.) The two signals differing in phase by 90 degrees are recombined as shown at the appropriate points (X) by paralleling the detected outputs of the two AM1/14B amplifiers and the detected outputs of the two AM1/14E amplifiers. The mean voltages at these points are used to control the switch circuit in one AM1/14B and one AM1/14E. The state of the switch circuits in these amplifiers decides the frequencies, representing reference programme levels, sent to line by the tone generator GE1/3.

*Continued overleaf*

At the receiving end, the MN2M/6A differs from the MN2M/4A in that the compared programme signal is initially converted by a UN1/61 quadrature unit into two signals with 90 degrees separation. Each of these signals is applied to both an AM1M/16A and an AM1M/16C as shown in Fig. 6. Between the two AM1M/16A units and the two AM1M/16C units, the pairs of AM1/14A, D, C and F amplifiers have their detector outputs strapped (as between the processing amplifiers in the MN2M/5A described previously and shown in Fig. 5) and the switch circuit of only one AM1/14 in each pair has its d.c. signal fed to the UN20/2 comparator.

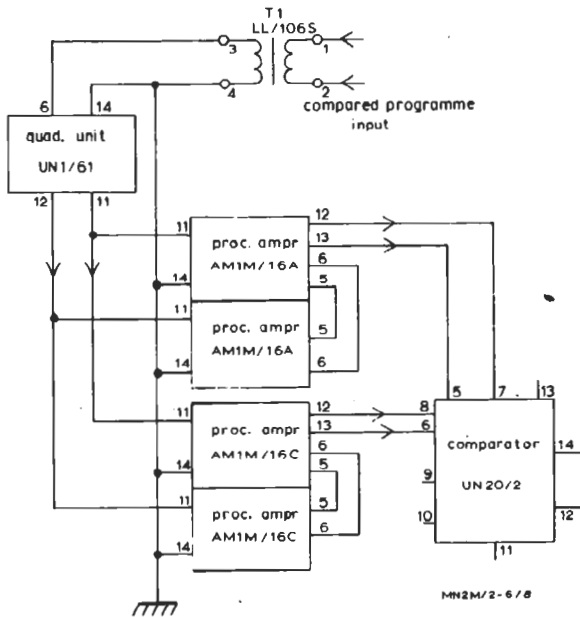


Fig. 6. Quadrature System in the MN2M/6A

**MN2M/5A and MN2M/6A: Adjustment and Testing Power Supplies**

MN2M/5A (including FL4/48):  
24 volts, 415 ±25 mA d.c.

MN2M/6A:  
24 volts, 700 ±50 mA  
6 volts, 350 ±50 mA

**Adjustment and Test Procedures**

These are the same as for the MN2M/3A and 4A except when it is necessary as part of the local sending-end and receiving-end adjustments to reset the operating level in any of the AM1M/16A, B and C processing amplifiers, which are in pairs in the MN2M/5A and 6A. In these monitors, the right-hand AM1M/16A, B or C unit of a pair should be completely removed while the left-hand unit is adjusted (on a chassis extender) to function at the required level. Then the left-hand unit which has been set should be fully inserted while the right-hand unit

is adjusted (on a chassis extender) to obtain action again at the same level.

**MN2M/3A, 4A, 5A and 6A: Operation**

*Notes on Use*

Since the sending-end equipment introduces signalling tones into the programme chain, the sending-end should not be introduced into a circuit carrying programme without ensuring that the receiving end equipment is already in circuit, nor should the receiving end be removed before the sending end is removed.

If it is necessary to use a replacement line for a period that does not amount to months, it is normal practice to employ a programme failure monitor (e.g. MN1/1A) on the replacement line while retaining the MN2M/3A and 4A, or 5A and 6A, on the original line, which may be under investigation.

*Diagnosis of Fault Indications*

Fig. 7 illustrates the combinations of lamps which, when alight on the UN20/2 comparator unit in a receiving-end monitor, show that the monitored conditions are satisfactory. Some examples of lamps indicating unsatisfactory conditions are also given.

Chart 1 shows in simplified form the sequence of considerations and actions that can be followed to ascertain the cause when the UN1/99 error signal unit in a receiving-end monitor goes into the alarm condition.

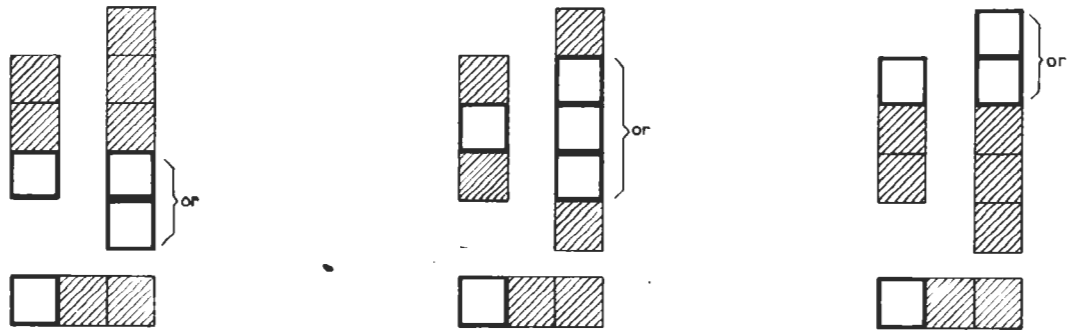
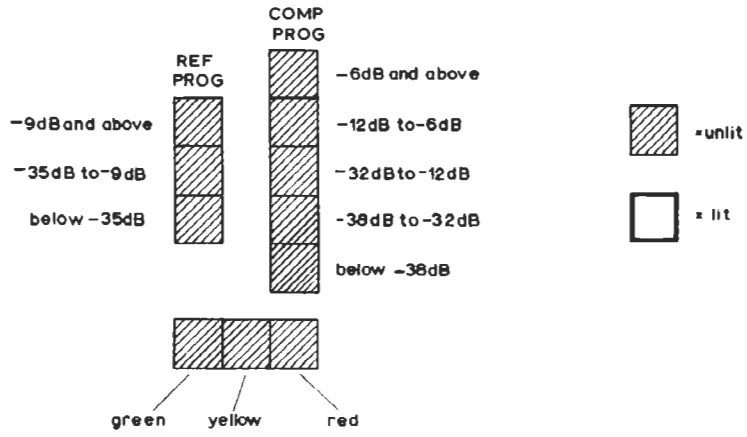
As shown by the chart, when the receiving-end monitor indicates (and conveys to other equipment in some instances) that there is an alarm:

1. Make an immediate listening check on the received signal to establish whether a gross degradation of quality exists, or if there is a complete loss of received programme. The latter will be confirmed and distinguished from an unusually long break in programme material if the red lamp is alight on the UN20/2 comparator, since this lamp indicates a loss of the monitoring tones which share the line or link with the programme signal.
2. If a listening check does not reveal an obvious fault, make a more detailed check by observing the lamps on the UN20/2. Note the state of the coloured lamps and also study the white level-indicating lamps. The significance of these lamps and the manner in which they function is detailed in the following paragraphs.

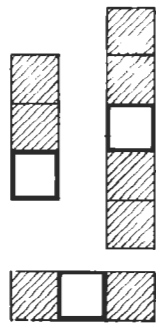
*(a) Red Lamp Continuously On*

This indicates that neither of the two monitoring tones is being received. The cause may be that the link or link is cut. This is likely to be the fault when it has already been found that there is no received programme signal in the listening test.

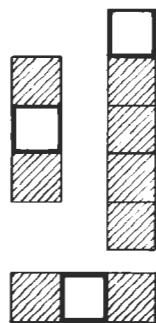
UN20/2 panel lamps



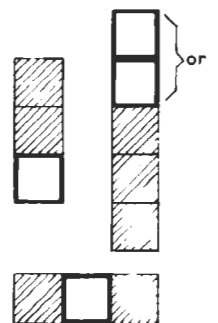
three combinations of lighted lamps indicating satisfactory conditions



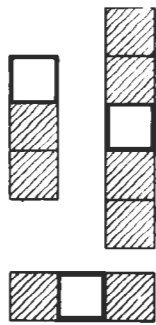
transmission gain high or excessive noise



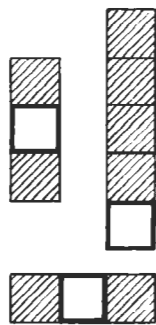
transmission gain high or severe noise on received programme



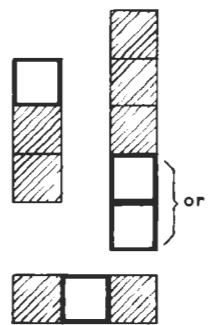
transmission gain very high or severe noise



transmission gain low or overload



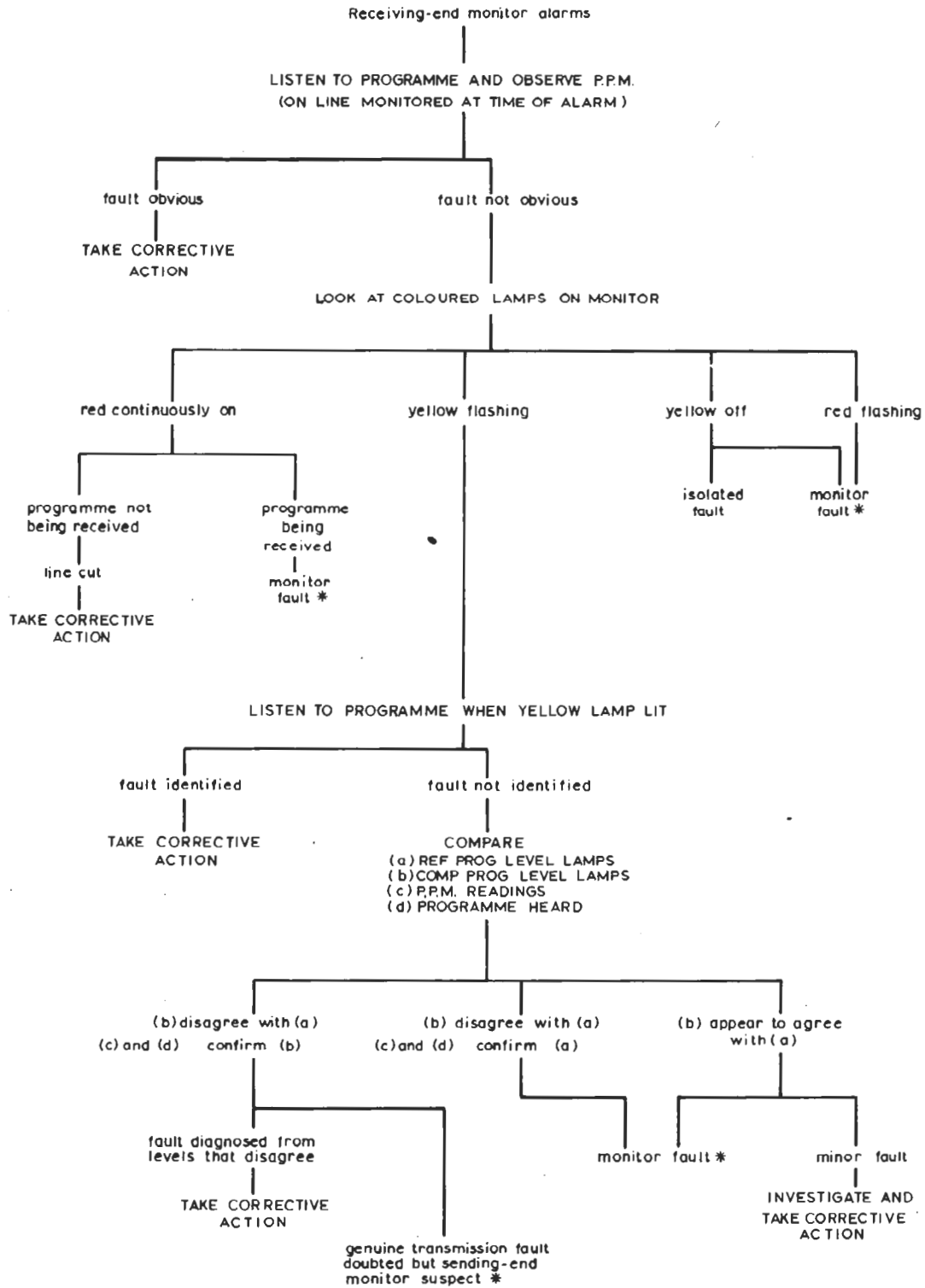
transmission gain low



transmission gain very low

MN2M/2-6/7

Fig. 7. Some Conditions Indicated by Combinations of Lighted Lamps on the Comparator Unit



\* See text for monitor faults. In the case of a monitor fault, it may be possible to mute the error signal unit and restore pre-alarm conditions.

MN2M/2-6/9

Chart 1. Simple Fault Diagnosis at Receiving End



It is possible to lose both tones due to a monitor failure, which can be at the sending or receiving end. Then the lowest reference level lamp remains alight while the compared programme lamps show the varying programme level and the yellow lamp also lights when the compared programme is above  $-32$  dB. Listening checks (by means of a monitoring loudspeaker or ATM/1 with good headphones) at the receiving-end repeating-coil and the AM1/35 tone amplifier jacks will reveal whether there are incoming tones.

*(b) Red Lamp Flashing*

This indicates the loss of one of the reference signal tones due to a fault in the sending or receiving-end monitor. The red light comes on because, as the programme varies, there are periods when there is no tone. If the red light operates when the programme is between  $-35$  and  $-9$  dB, it is tone A that is lost, or if the red light operates when the programme is below  $-35$  dB, tone B is lost. The missing tone may be identified by observing the compared programme level lamps as the red lamp comes on.

Because the loss of one tone causes the receiving-end monitor to sense incorrectly at times the band of levels in which the reference signal lies, there are occasions when the yellow lamp indicates a level discrepancy as well as the red lamp flashing on. One instance of this arises because, in the absence of both tones, the receiving-end monitor registers a reference level of less than  $-35$  dB (as it does correctly for tone B). Therefore, if tone A (alone) is not obtained, as it should be, when the reference level is between  $-35$  and  $-9$  dB, then the yellow lamp indicates a level discrepancy while the compared programme is actually in agreement between  $-32$  and  $-12$  dB.

Similarly, because both tones are required to represent a reference programme signal above  $-9$  dB, if one tone is lost, the yellow lamp will indicate a level discrepancy when the monitor fails to register a reference level above  $-9$  dB at the same time as it senses a compared programme signal above  $-6$  dB.

By listening (using a monitoring loudspeaker or ATM/1 with good headphones) at the incoming line repeating-coil and the AM1/35 jacks, it is possible to establish if the undetected tone is being received but failing to operate the detector. These checks can quickly determine whether the fault is likely to be at the sending end or receiving end, and its possible location.

*(c) Yellow Lamp Continuously On*

This can only occur if the reference and compared signals remain in complete disagreement. Such conditions are unlikely, but can occur when there is excessive noise on a line while there is a prolonged absence of programme material.

*(d) Yellow Lamp Flashing*

The yellow lamp comes on while there is a disagreement between the reference and compared programme signals. The extent of disagreement can be judged by the length of the periods that the lamp is on relative to off. By listening closely to the received programme signal at times when the yellow lamp is lit, the cause of the disagreement may be identified.

The yellow lamp is particularly likely to come on as the programme signal varies, because at these times a transmission fault can easily cause the reference and compared programme levels to lie briefly in bands that do not agree in the comparator unit. However, programme material can often remain for periods well inside one band of levels only, and if the transmission fault is small the yellow lamp remains out during these times. For example, a pause in speech may be followed by a passage maintaining levels above  $-9$  dB.

Note also that a minor fault may cause the yellow lamp to flash on as the programme signal rises in level but not as it drops, or vice versa.

A study of the white level-indicating lamps should assist in finding the nature of the fault indicated by the yellow lamp. If the yellow lamp lights when the reference signal is in a particular band, the compared signal lamps should be noted at these times. A fault may be indicated when the reference signal is in the band below  $-35$  dB due to excessive noise combining with the compared programme signal, or a fault may be indicated when the reference signal is in the band above  $-9$  dB due to overloading in the compared programme path.

If the flashing of the yellow lamp cannot be associated with a particular band of reference signal levels, the lamps for each of the reference signal bands should be watched in turn and a comparison made with the compared programme lamps. Frequently it may appear that the compared programme signal is moving up or down in level ahead of or behind the reference signal. This indicates too much or too little gain in the monitored transmission path, which may be due to the development of a fault or the result of a line-up error.

To compare the level-indicating lamps, it may be found best to stand to one side of the comparator unit so as to narrow the angle of view and effectively eliminate the space between the lamps.

If an occasional level disagreement lights the yellow lamp, but this does not occur every time the signal level varies, listening to the programme material while observing the lamps can be helpful. For example, if the yellow lamp flashes when a particular type of sound occurs, this may give a clue to a frequency response defect.

It is important to carry out an initial diagnosis of a fault indication immediately it occurs and not to delay until maintenance and testing are possible,

when the fault indication may have ceased and the cause may remain in doubt (with the performance of the monitor suspect). If the probable cause of the fault indication can be established, subsequent tests are more likely to be successful in locating the trouble.

#### **Obsolete Monitors MN2M/3, 4, 5 and 6**

The majority of these monitors have been converted to Types MN2M/3A to 6A, and it is intended that the remainder shall be converted or withdrawn.

The MN2M/3 and 5, although largely similar to the MN2M/3A and 5A, were not fitted with the optional FL4/48 high input-impedance lowpass filter, to make the reference programme input similar in bandwidth to the received compared programme signal. Nor were these early monitors immediately suitable for connection to line via a three-winding repeating-coil.

The receiving-end monitors MN2M/4 and 6 differed from the MN2M/4A and 6A in that they were not suitable for connection to line by means of a three-winding repeating-coil, and they were fitted with an AM7/4 amplifier in the position occupied in the later monitors by the specially designed tone amplifier AM1/35.

Intended only for connection to a two-winding repeating-coil, the MN2M/4 and 6 were fitted with a B or D version (usually the former) of the appropriate lowpass filter in the FL4/23 to FL4/29 series. These

versions are suitable for connection to a repeating-coil secondary in parallel with the corresponding highpass filters FL3/8 to FL3/14.

Unlike the AM1/35 used in later monitors to amplify the received reference signal tone, the AM7/4 does not have such a wide range of gain adjustment, nor does it provide separate outputs of the two tones with some discrimination and differential gain adjustment. While there was no facility for making the two tones equal, it was usual to precede the AM7/4 with a pad (AT1) to obtain the correct general tone level from the amplifier, and one separate jack was fitted for checking the tone output of the AM7/4 (whereas the AM1/35 has two such jacks on its panel). The AM7/4 consumes more current than an AM1/35, making the 24-volt supply drain of the earlier receiving-end monitors some 30 mA greater.

#### **References**

1. Designs Department Specification 5.113(66), Sound Automatic Monitor Minor MN2M/2.
2. Designs Department Specification 5.112(66), Sound Automatic Monitor Major MN2M/3 + MN2M/4, and MN2M/5 + MN2M/6 (with Quadrature).
3. Designs Department Technical Memorandum 11.63(71), Sound Automatic Monitors MN2M/3A to 6A.
4. Automatic Monitoring, BBC Engineering Monograph No. 62, April 1966.

DPEB 12/72