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# RADFORD

## HIGH SENSITIVITY AUDIO VOLTMETERS AND NOISEMETERS

HSV1. High Sensitivity Audio Voltmeter. Average reading
HSV2. High Sensitivity Audio Voltmeter. True r.m.s. reading
ANM1. High Sensitivity Audio Noisemeter. Average reading
ANM2. High Sensitivity Audio Noisemeter. True r.m.s. reading

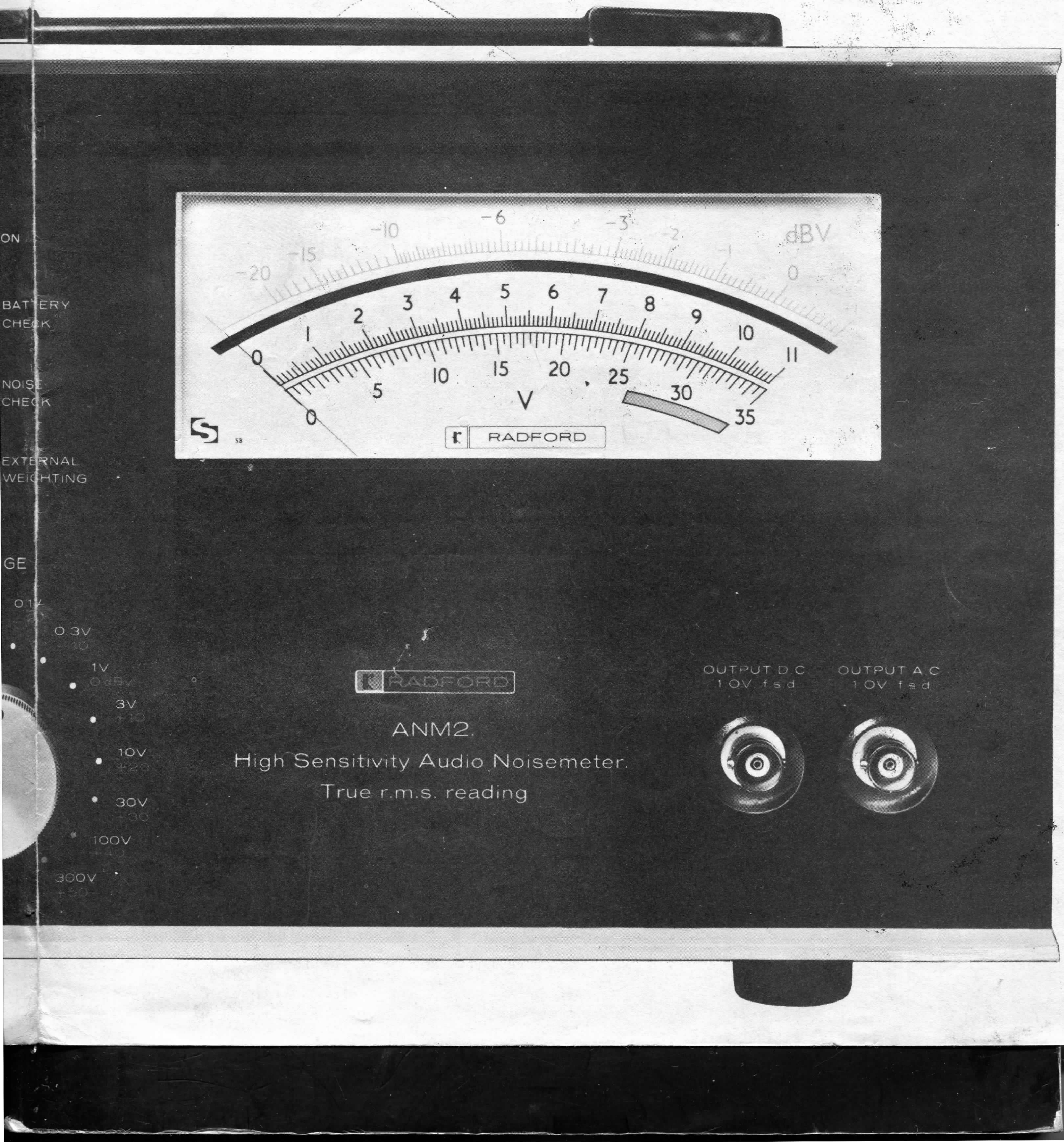

Fig. 8 Weighting networks, frequency response curves.

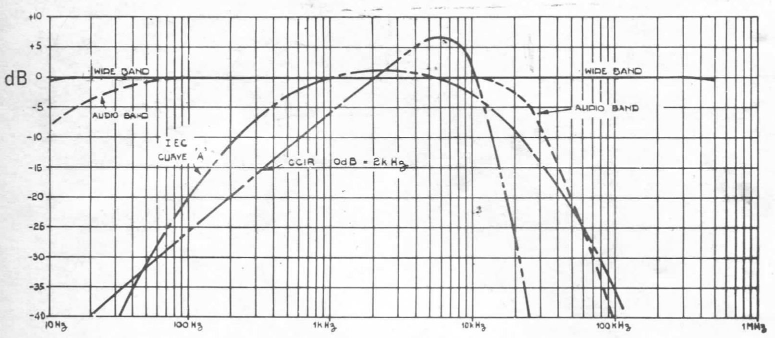


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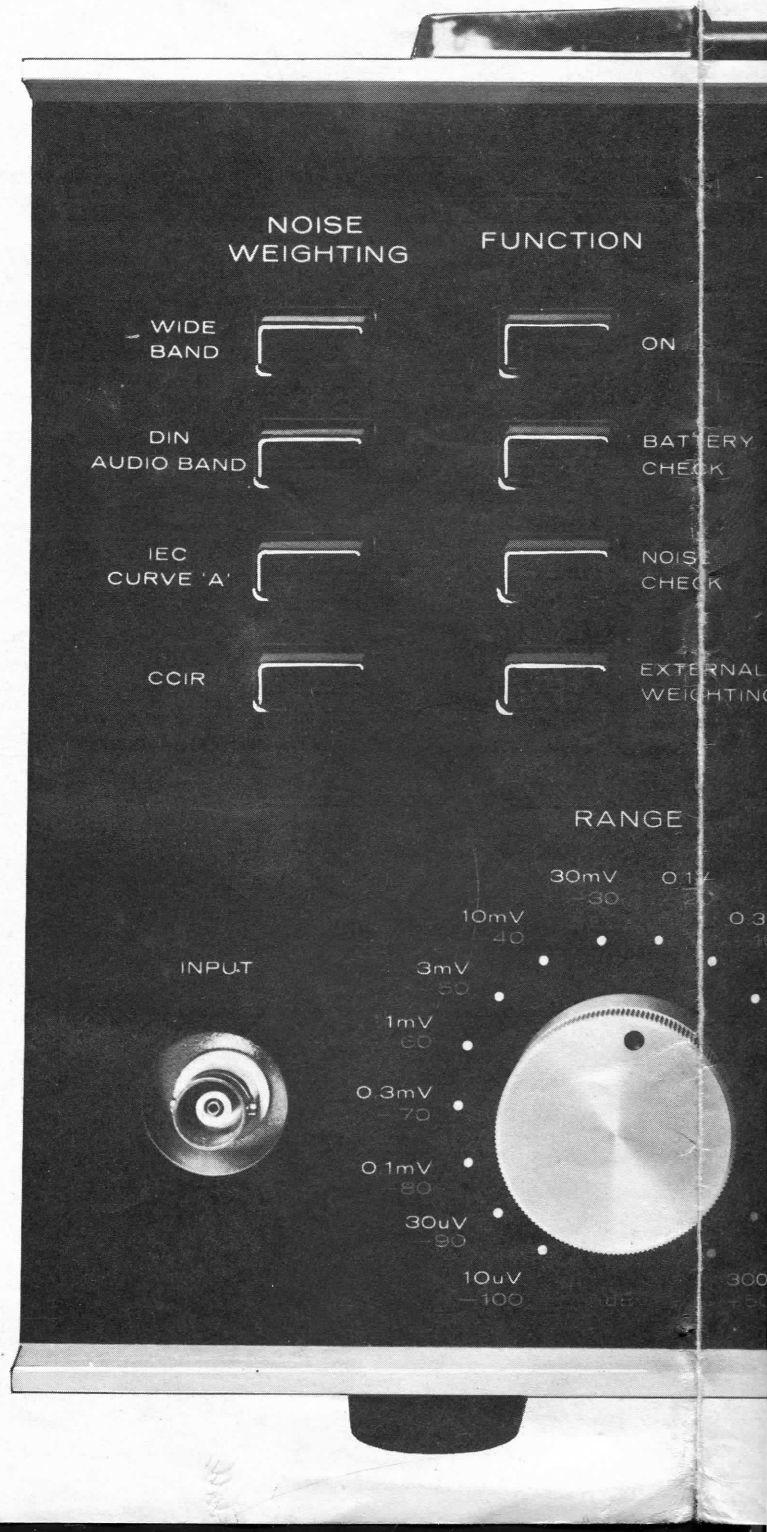
Fig. 8 Weighting networks, frequency response curves.

ILLUSTRATED (Actual size)
ANM2. Audio Noisemeter.




## 7. Specification

| | | |
|---|---|---|
| Voltage measurement range | : | 10µV to 300V, (–100dBv to +50dBv) 16 ranges in 10dBv steps. |
| Frequency response characteristic when used as voltmeter. | | Flat over bandwith with 0.5dB edge limits of: |
| Voltage ranges 100µV to 300V | : | 4Hz and 500kHz |
| Voltage range 30µV | : | 6Hz and 150kHz |
| Voltage range 10µV | : | 16Hz and 70kHz |
| Frequency response characteristic of Noisemeter weighting networks. | | |
| DIN 'Audio band' | : | Sensibly flat over audio band with 3dB points at 22Hz and 22kHz. Rolls off 6dB/oct. 22Hz, 18dB/oct. 22kHz. |
| IEC/DIN 'Curve A' | : | ±0.5dB IEC recommendation |
| CCIR | : | ±0.5dB CCIR recommendation |
| Input impedance. | | |
| Voltage ranges 10Mv to 300V | : | 1M ohm shunted by <30pF. |
| Voltage ranges 30µV to 3mV | : | 820k ohm shunted by <75pF. |
| Voltage range 10µV | : | 600k ohm shunted by <75pF. |
| Accuracy. | | |
| Attenuator resistors | : | 0.25% |
| Meter scale linearity | : | Better than 1% for 20%-100% f.s.d. (typically better than 0.5%). |
| Range-to-range correlation | : | Better than 1%. |
| Calibration | : | 0.25% f.s.d. 1.00V range. |
| Waveform error (true r.m.s. reading instruments only) | | |
| For crest factor up to 10 | : | ±1%. |
| Inherent noise, input short circuited. | | |
| Wide band | : | Less than 1.2µV (–118dBv). |
| DIN 'Audio band' | : | Less than 0.4µV (–128dBv). |
| IEC/DIN 'Curve A' | : | Less than 0.3µV (–130dBv). |
| CCIR | : | Less than 0.3µV (–130dBv). |
| Output A.C. | : | 1.0V ±2% corresponding to 1.0V nominal f.s.d. |
| Output D.C. (on true r.m.s. instruments only) | : | 1.0V ±0.5% corresponding to 1.0V nominal f.s.d. |
| Power supply | : | 2 x PP9 batteries, included. |
| Size | : | 11¼" x 7" x 8½" deep overall. |
| Weight | : | 12 lb. Packed weight 17 lb. |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# HIGH SENSITIVITY AUDIO VOLTMETERS AND NOISEMETERS

HSV1. Audio Voltmeter. Average reading
HSV2. Audio Voltmeter. True r.m.s. reading
ANM1. Audio Noisemeter. Average reading
ANM2. Audio Noisemeter. True r.m.s. reading



## 1. Introduction

Four instruments are described which are derived from a basic battery operated voltmeter design having 16 measurement ranges from 10µV for full scale meter deflection to 300V f.s.d. The Voltmeter has a high input impedance and low inherent noise. It is fitted with a high grade meter having a 5" mirror scale of excellent linearity, calibrated in volts and dBv.

The Audio Voltmeter (HSV1) becomes an Audio Noisemeter (ANM1) by the inclusion of frequency contouring networks having characteristics recommended by international organisations concerned with specifications and measurement standards, as being suitable for the quantitative measurement of the subjective effect of noise in audio systems.

The HSV1 and ANM1, in common with most alternating current measurement instruments, respond to the average or mean value of the waveform being measured and are calibrated in r.m.s. values on a sine wave.

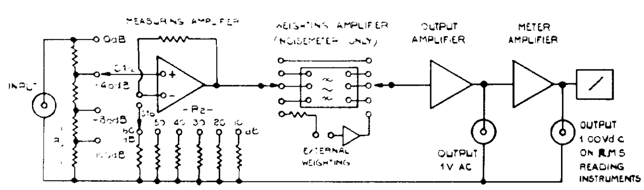
In the HSV2 and ANM2 instruments an r.m.s. to d.c. convertor module is incorporated which provides a true r.m.s. reading on waveforms with a crest factor in excess of 10. These instruments are also provided with an additional output socket giving 1.00V d.c. output corresponding to 1.00V at nominal full scale meter deflection to operate a chart recorder or d.c. digital voltmeter.

All the instruments are fitted with a socket to enable an external network of any weighting characteristic to be introduced in the measuring circuit. This extends the use of the instruments to vibration and acoustical measurement as well as to the measurement of gramophone turntable rumble, f.m. receiver noise, etc.

## 2. Audio Voltmeter – design details

The Voltmeter comprises an input attenuator combined with amplifier, an output amplifier, and a meter amplifier driving a taut band meter movement as illustrated in Fig. 1.

Fig. 1 Voltmeter/Noisemeter. Schematic diagram



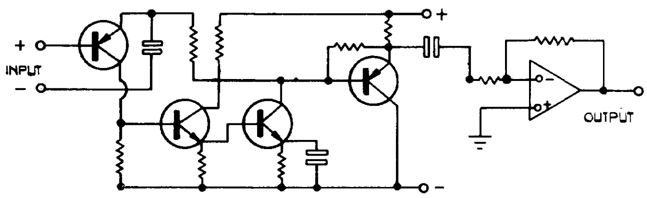

2.1 *Input attenuator and measuring amplifier*

In order to accommodate a wide range of input voltage, a combination of a passive input resistor chain and a variable gain amplifier is used to provide the correct signal level to the output amplifier. The passive attenuator $R_1$ has four positions at 0dB, –40dB, –80dB and –100dB. The measuring amplifier gain is adjusted in 10dB steps up to 60dB by $R_2$ to provide an input measurement voltage range from –100dBv (10µV f.s.d.) to +50dBv (300V f.s.d.) with a 16 position switch.

The measuring amplifier has a low inherent noise, (< 0.4µV with short circuit input, audio bandwidth) which means a measuring error of less than 3% on a signal of 2µV from a low source resistance.

The attenuator is frequency compensated to provide a linear frequency response of ±0.5dB – from 4Hz-500kHz on input ranges 100µV-300V; 6Hz-150kHz on the 30µV range; and 16Hz-70kHz on the 10µV range. A simplified circuit of the measuring amplifier is shown in Fig. 2.

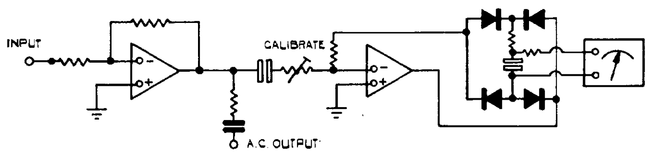
Fig. 2 Measuring amplifier, simplified circuit




2.2 *Output and meter drive amplifiers. Average reading meter*

The output and meter drive amplifier is constructed on a separate circuit board module from the measuring amplifier. The average sensing board contains three operational amplifiers. The a.c. output is taken from the junction of the input amplifier and the meter drive amplifier as shown in Fig. 3. The other operational amplifier buffers the external weighting circuit.

Fig. 3 Output and meter amplifiers, average reading, simplified circuit




2.3 *Output and meter drive amplifiers. True r.m.s. reading meter*

The r.m.s. reading amplifier circuit board is similar to the average reading circuit board except that the meter drive circuit components are replaced by a hybrid true r.m.s. to d.c. converter module. The simplified circuit is shown in Fig. 4.

## 3. Audio Noisemeter – design details

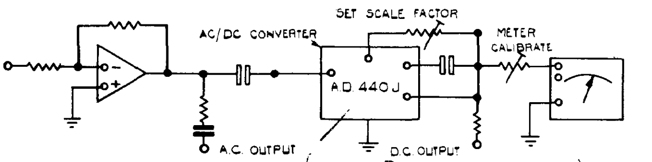
The High Sensitivity Voltmeter (HSV1 and HSV2) becomes an Audio Noisemeter (ANM1 and ANM2) by the addition of a circuit board module which incorporates the weighting networks, and a panel mounted switch for selecting the desired weighting characteristic.

3.1 *Noise measurement considerations*

The measured figure of noise only in an audio system has no value in itself. It is the ratio of *signal/noise* which is significant. Noise, which can be defined as the total output of the circuit when the wanted signal is removed, is a function of the circuit frequency bandwith. To ensure that quantitative measured results bear a relationship to practical use it is common practice to restrict the bandwith of noise measurement within the limits of the system of which the equipment forms a part. The audio frequency band is accepted as being from 20Hz-20kHz. Measurements made through a band pass filter rejecting frequencies outside these limits must therefore produce a more practical noise figure, making it possible to compare the noise performance of one system with another.

Noise may contain more energy at some frequencies than others within the measurement band. Due to the characteristic of the ear, noise measurement using a flat response over the pass band may not correlate with the audible sensation. For this reason authoritative international organisations have recommended the use of special filters to contour the noise frequency spectrum before measurement to approximate the aural effect in a given application. A measurement using a frequency/amplitude contoured filter is said to be 'weighted'.

Fig. 4 Output and meter amplifiers. True r.m.s. reading, simplified circuit.




The Audio Noisemeter is provided with four measurement frequency characteristics as described below which cover almost all requirements of noise measurement for so called consumer, high fidelity and professional audio equipment.

Information on noise measurement, including recommendations for a measurement standard for consumer equipment using an average responding meter with the CCIR weighting network, are given in Dolby Laboratories Inc. Engineering Field Bulletin No. 19/2 – 'Noise Measurements on Consumer Equipment'.

3.2 *Wide band – flat frequency response characteristic*

In this position the weighting network module is not in circuit and the response is flat from 4Hz-0.5MHz.

3.3 *DIN 'Audio band' weighting characteristic*

This is based on DIN specification 45.500 April 1975 – 'High Fidelity Standard'. It is a maximally flat band pass filter for the audio band with an effective noise bandwith of 23kHz. The 3dB points are at 22Hz and 22kHz. DIN 45.500 specifies rolloffs of 36dB/octave outside the band but this is considered impracticable. The instrument included filter rolls off at 6dB/octave at 22Hz, and 18dB/octave at 22kHz. In normal circumstances with equipment found in practice, the difference in noise readings is negligible. (See Fig. 5 simplified circuit and Fig. 8 response curve.)

3.4 *IEC 'Curve A' weighting characteristic*

This curve is also specified in DIN 45.500 – April 75 'High Fidelity Standard'. The network is made up from simple series connected low pass and high pass sections as shown in the simplified circuit Fig. 6 to provide the specified frequency characteristic shown in Fig. 8.

3.5 *CCIR weighting characteristic*

(Green Book Vol. V part 7, Recommendation 468.) This network is a series connection of two 3rd order filters. The second of these uses an operational amplifier as the gain element. The 0dB point of the characteristic is set at an arbitrary 2kHz by adjusting the amplifier gain (see Figs. 7 and 8).

## 4. Functions, facilities and controls

The following functions are performed from a vertical bank of four push button switches: On/Off, Battery Check, Noise Check and External Weighting.

4.1 *Noise Check*

This switch connects the voltmeter input to chassis ground so that the inherent noise of the instrument only is read. It is useful also as a check for spurious readings from induction or injection.

Fig. 5 DIN 'Audio band' weighting network, simplified circuit

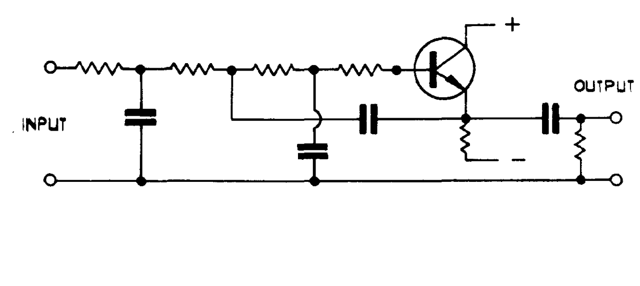
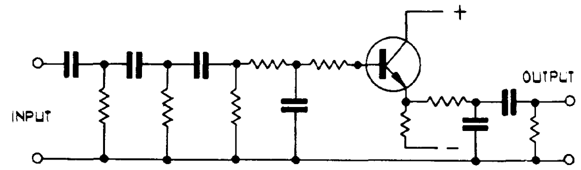



Fig. 6 IEC 'Curve A'. Weighting network, simplified circuit




4.2 *External Weighting*

A 5-way socket is fitted to the rear panel of the instrument and is introduced into the circuit by the push button panel switch. A + and –9V supply is wired to the socket in addition to the filter send and receive connections and chassis earth. The filter send circuit connection is driven by an operational amplifier with an output source resistance of 1k ohm ±2% at an output level of 100mV. The input resistance at the filter receive circuit is 1Mohm.

4.3 *Noise meter weighting selection*

A second vertical push button switchbank adjacent to the function switch bank is fitted to the Noisemeter for selection of the included weighting filters.

4.4 *Voltage measurement range selection*

The 16-way rotary range switch is controlled by a $1\frac{1}{4}$" knob. The ranges are engraved on the panel around the knob in µV/mV/V and dBv.

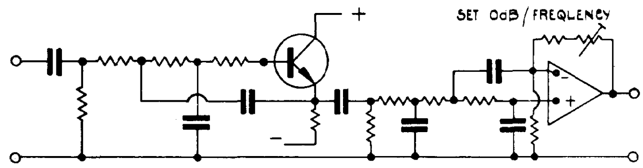
4.5 *Terminations*

BNC sockets are fitted as input and output terminations. The output socket is provided for visual inspection of the measured waveform and to enable the instrument to be used as a calibrated variable gain amplifier. An additional BNC socket is fitted adjacent to the amplifier output socket on the true r.m.s. instruments which provides 1.00V d.c. when the measured signal reads 1.00V r.m.s.

4.6 *Meter scales*

The meter has three printed scales: 0 to –20dBv, printed red, (nominal 0dBv and +1dBv over-range), voltage scale 0-11 (nominal 10 f.s.d. + over-range) and voltage scale 0-35. In the Noisemeter the dBv scale is dominant above the mirror, and the voltage scales are dominant in the Voltmeter.

Fig. 7 CCIR. Weighting network, simplified circuit




## 5. Construction

The High Sensitivity Audio Voltmeters and Noisemeters are constructed on an open chassis assembly comprising the basic chassis and front and rear panels which are secured together by spacer bars. The front facia is an anodised aluminium extrusion to which is fitted a trim panel. The trim panel is of aluminium with a blue/black anodised finish. It is chemically engraved, highlighting the characters in natural aluminium against the contrasting background. The dBv characters are filled in red corresponding with the red printing on the meter scale. The chassis assembly is enclosed by a baseplate and a wrap around cover with carrying handle. It is constructed from 18swg. mild steel sheet and finished bright zinc. The cover is made from aluminium, coated with a blue texture finish plastic. The knob is machined from solid aluminium bar and clear anodised, fitted with a skirt engraved with a dot for alignment with the dot on the facia engraving.

The electronic circuits are constructed on glass epoxy printed wiring boards, screen printed with component identification and connecting wire numbers and colour. Connections to the board are made with 'Amp' type connectors for easy service. All components are of the highest quality obtainable.

## 6. Guarantee

The instrument is guaranteed in the United Kingdom for a period of one year from the date of purchase. It covers the free replacement or repair of any defective component or part of the equipment during this period. It also covers the cost of labour in executing the repair or replacement if the instrument is returned to the factory service department, carriage paid, within the guarantee period.