A.C. TEST METERS ATM/1 & ATM/1P

Introduction

A.C. Test Meter ATM/1 was designed to replace Amplifier Detector AD/4 and Test Programme Meter Amplifier TPM/3 and to perform the functions of both these units. Basically, therefore, it is a valve voltmeter which is calibrated to read a.c. voltage levels on a bridge-rectifier meter, and programme volume and noise levels on a peak programme meter.

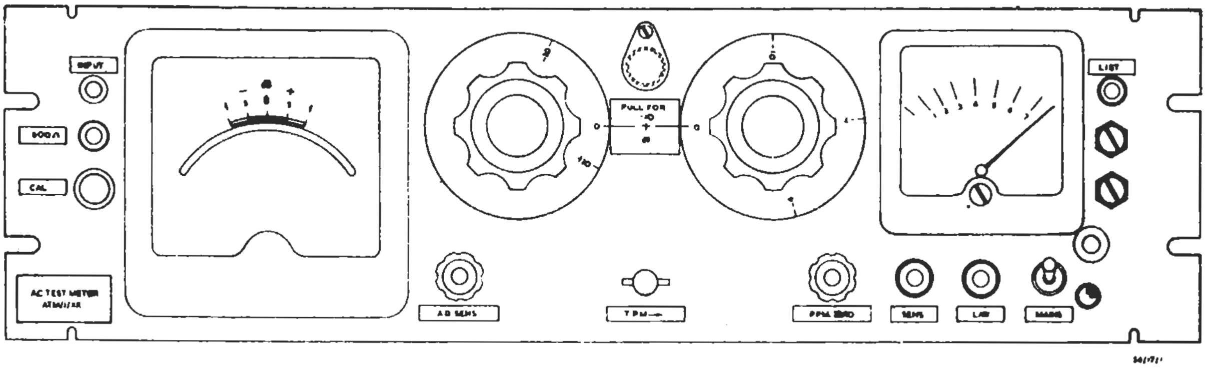

Fig. 1 ATM/1: Face Panel

The following facilities which are not available in the AD/4 and TPM/3 have been embodied:—

(1) Sensitivity range extended to + 20 dB to — 70 dB for both functions.

(2) Built-in power supply unit, making the unit readily adaptable for portable use.

(3) Provision of aural monitoring for noise measurements (TPM condition only).

(4) Inclusion of bandpass filtering 10 c/s to 20 kc/s in TPM condition.

(5) Internal approximate calibration signal source (50 c/s) for check on operation in the field.

(6) Lengthened scale in AD condition making the effective scale length about twice that in the AD/4.

The unit is built on a 19 in. × 5¼ in. panel for bay mounting and weighs 19 lb. It forms part of the equipment on A.C. Test Bay AC/55. For portable use it is fitted in a standard carrying case, CS2/2B, and is then coded ATM/1P. The layout of the front panel is shown in Fig. 1.

Circuit Description (Fig. 3)

Block Schematic (*Fig.* 2)

The unit consists basically of two amplifiers in cascade stabilised by negative feedback, each being preceded by a calibrated attenuator. The second amplifier can be switched to either the bridge-rectifier meter or the peak programme meter rectifying circuits and meter, depending on the function required. In the TPM condition the function switch also introduces a low-pass filter between the two amplifiers, and a variable 20-dB gain control in the feedback path of the first amplifier.

Input Circuit

A balanced input is provided by the input transformer LG/47SA which is loaded on its secondary side by the first calibrated attenuator AT1 in parallel with R54

The attenuator is a stud-type potentiometer PN/10A1 feeding the first amplifier and gives 70 dB attenuation in 10-dB steps, the actual calibration markings being "+ 20" to "— 50". Its resistance is 40 kΩ and the 24 kΩ resistor R54 is connected in parallel with it to reduce the effective resistance to 15 kΩ. This reduction in impedance level allows a simplification in the design of the input transformer which has a turns ratio of 1·88 : 1 to give an input impedance of approximately 50 kΩ.

As well as a high-impedance input jack, a 600Ω input jack is provided, wired via the inners of the high-impedance jack. Both jacks are partially screened from the adjacent AD meter, which is at a relatively high a.c. potential, to prevent a low-amplitude high-frequency oscillation (about 150 kc/s) which occurred in the experimental model under certain high-sensitive conditions.

maintain approximately the same source impedance, with the attenuator pad either in or out of circuit, for the calibrated attenuator AT2 which feeds the second amplifier. This is necessary to ensure negligible change in the sensitivity-frequency characteristic when the " — 10 dB " switch is operated. R20 has been kept as low as possible to avoid unnecessary loss of sensitivity.

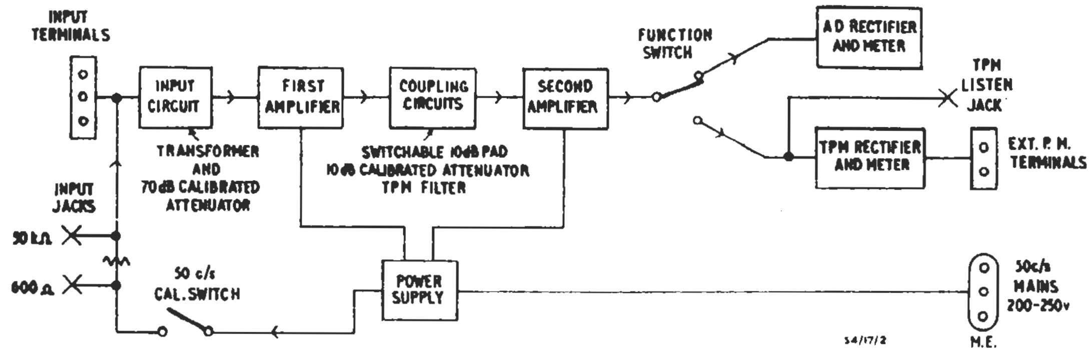

Fig. 2 ATM/1: Block Schematic

First Amplifier

Two EF86 valves are used in the first amplifier. In the AD condition of operation the gain is fixed, and 20 dB negative feedback is taken from the second anode to the first cathode circuit.

In the TPM condition 20 dB variation in gain is provided by the variable resistance R49 in the feedback path. The corresponding change in the amount of feedback is only 3·5 dB because the V2 anode circuit impedance increases as the resistance is increased, thus increasing the gain without feedback.

Coupling Circuits between First and Second Amplifiers

In both AD and TPM conditions the first amplifier is followed by a 10-dB attenuator pad R21, R22. This pad is normally in circuit but may be switched out by a push-button. It is primarily intended to give an extra 10-dB gain for measuring noise in the TPM condition. If it is switched out in the AD condition small fluctuations in the meter reading may be noticeable when transients occur in the mains supply. These fluctuations are due to low-frequency components and are prevented in the TPM condition by the inclusion of a high-pass filter with a cut-off frequency of 10 c/s in the input circuit of the programme meter rectifier.

Between the first amplifier and the 10-dB fixed attenuator pad the resistor R20 is included to

The calibrated attenuator AT2 is a stud-type potentiometer PN/11A1 with a total resistance of 100 kΩ giving 10-dB attenuation in 0·5-dB steps. It is calibrated to read " 0 " to "— 10 dB".

In the TPM condition a low-pass filter is connected between the first amplifier and the 10-dB fixed pad, and the complete response of the TPM circuit gives an equivalent noise bandwidth of 22·6 kc/s (see later). (In the TPM/3 the response extends to 100 kc/s with a 10-dB peak around 60 kc/s.)

Second Amplifier

A CV 455 (6060) valve is used as a two-stage amplifier with negative feedback from the second anode to the first cathode circuit. In the AD condition the bridge-rectifier meter circuit is in a negative current feedback path via C14 which includes the AD sensitivity control R50. The latter gives a variation in negative feedback of ± 2 dB and has a carbon track to give smooth control.

Additional negative feedback, giving a total of 18 dB, is provided by a separate d.c. path through R46. If this negative feedback were taken via C14 the latter would have to be inconveniently large to prevent a peak in the response at a very low frequency.

In the TPM condition the feedback has a fixed value of 17 dB.

AD Meter Circuit

The AD meter is fed from four crystal diodes (CV 425) in a bridge connection. These have been found to be more efficient and less affected by temperature changes in this application than selenium and copper oxide rectifiers. They have extremely low self-capacitance which is of value in preventing the large stray capacitance of the meter itself and associated wiring from being coupled into the feedback circuit.

The meter used is a shaped-pole type with 0·1-dB scale markings from − 0·5 dB to + 0·5 dB and with further markings at − 1 dB and + 1 dB. A current of 500 μA corresponds to 0 dB on the scale. The shaped pole-pieces are designed to expand the scale near the middle of the range, and give a scale which is effectively about twice as long as that of the AD/4 meter.

The capacitor C16 shunting the meter terminals prevents a visible vibration of the meter pointer when the apparatus is used for low-frequency measurements, and it also serves to limit surges through the meter when the apparatus is switched on.

The AD meter has a dead-beat response, and *stiction*, measured as the change in input level required to give a visible change in the meter reading at mid-scale, is less than 0·02 dB.

PPM Circuit

In the TPM condition the output of the second amplifier is connected to the transformer T2 (AGG/11SH). The capacitor C12 is connected in series with the primary of this transformer to form a high-pass filter with a cut-off frequency at about 10 c/s to reduce interference from transients in the mains supply as already mentioned.

The rest of the PPM circuit, which includes the full-wave rectifier V4 and the variable-mu pentode valve V5 for obtaining the logarithmic law required, is almost identical with that used in Monitoring Amplifier MNA/3.

A peak programme meter with the standard movement and scale is included in the unit and there is provision for connecting an external PPM in series with it.

Apparatus Function Switch

The changeover from AD to TPM condition is accomplished by operation of the switch SWA, a 3-pole, 2-way lever type, which has one pole at the anode of V3(b) for switching to the appropriate meter circuit and two in the circuit between the two amplifiers for switching the TPM low-pass filter and the PPM sensitivity control. The metal backing ring of the switch rotor is earthed to prevent capacitive coupling which would give undesired negative feedback and affect the gain at the higher frequencies.

TPM Aural Monitoring

An unbalanced monitoring output is provided in the TPM condition by the inclusion of a 680Ω resistor (R48) in the PPM rectifier input circuit. The signal developed across it is brought to a listen jack on the front panel. Short-circuiting R48 has a negligible effect on the PPM reading. The monitoring circuit is primarily intended for headphone checking of the character of the signal being measured. It does not provide high-quality monitoring because of the varying shunting effects of the diodes (V4). Distortion on steady tone is of the order of 0·5 per cent.

Calibrating Voltage Circuit

When no accurately-known calibrating voltage is available a rough check on the sensitivity of the ATM/1 is provided by switching a zero level 50 c/s signal (derived from a potentiometer across the 6·3-volt winding of the mains transformer) on to the input terminals of the unit. The connection is made via the inner contacts of the input jack JKA. The 600-Ω input impedance and resistor R43 form the potentiometer.

Power Supply

A contact-cooled type bridge rectifier MR1 provides the h.t. supply. This component is considerably underrun, the current delivered being 22 mA whereas the manufacturer's rating is 40 mA.

Controls

The following controls are provided:—

1. *+ 20 dB to − 50 dB* in 10-dB steps—calibrated variable attenuator AT1.
2. *0 to − 10 dB* in 0·5 dB steps—calibrated variable attenuator AT2.
3. *− 10 dB* push-button to give 10 dB increase in gain.
4. *CAL* push-button to inject 50 c/s at zero level approx.
5. *TPM LAW* preset screwdriver-operated potentiometer.

6. *TPM SENS* preset screwdriver-operated potentiometer.
7. *TPM ZERO* potentiometer with knob.
8. *AD-TPM* changeover lever-type switch.
9. *AD SENS* potentiometer with knob.
10. *MAINS* 2-pole, 2-throw toggle switch.

Performance

Power Supplies

Mains Supply: 200 V-250 V 50 c/s
Consumption: 23 VA

Sensitivity

(a) AD CONDITION

Input levels for " zero " reading on meter:

Minimum: -60 dB (normal)
-70 dB (with " -10 dB " button pulled-out)

Maximum: $+20$ dB

Range of *AD SENS* control: From $+2{\cdot}0$ to $-2{\cdot}0$ dB.

Note 1: The extra 10 dB sensitivity with the " -10 dB " button pulled out is primarily intended for noise measurements in the TPM condition. If it is used in the AD condition small fluctuations in meter readings caused by transients in the mains supply may be noticeable.

Note 2: A change in mains supply voltage of $\pm$ 5 per cent. causes $\pm$ 0·1 dB change in sensitivity, and one of $\pm$ 10 per cent. causes $\pm$ 0·2 dB change in sensitivity.

(b) TPM CONDITION

Minimum and maximum input levels for a reading of " 4 " on the meter are -70 dB and $+20$ dB respectively.

Range of *SENS* control: From $+10$ dB to -10 dB.

Sensitivity-Frequency Characteristic

With test tone from 600-Ω impedance source.

(a) AD CONDITION

For any setting of the controls, the sensitivity does not change with frequency in the range 20 c/s to 20 kc/s by more than $\pm$ 0·05 dB relative to its value at 1 kc/s.

(b) TPM CONDITION

The frequency response is such that the equivalent noise bandwidth is 22·6 kc/s. (See later.)

For any setting of the controls, the sensitivity does not change by more than $\pm$ 0·3 dB from its value at 1 kc/s, as the frequency is varied between 30 c/s and 15 kc/s.

Input Impedance

At 30 c/s: 34 kΩ
,, 50 c/s: 39 kΩ
,, 1 kc/s: 46 kΩ
,, 10 kc/s: 48 kΩ

TPM Response Time, Recovery Time and Law

These are similar to the TPM/3 and MNA/3 and the same tests apply.

Valve Data

	Valve	Anode Current	Screen Current	Cathode Voltage
V1	(EF86)	0·7 mA	0·14 mA	1·3 V
V2	(EF86)	1·3 mA	0·25 mA	1·5 V
V3A	(½6060)	1·5 mA	—	1·1 V
V3B	(½6060)	5·0 mA	—	1·4 V
V4	(CV140)	—	—	—
V5	(CV454)	5·5 mA	2·2 mA	1·5 V
V6	(CV449)	5·0 mA	—	—

Equivalent Noise Bandwidth

The measurement of noise requires that the sensitivity/frequency characteristic of the measuring apparatus be accurately known. For noise having equal energy per octave (" white " noise) the measured noise is proportional to an integral $\int_0^\infty g^2\,df$ where g is the sensitivity of the measuring system at a particular frequency f.

For the ATM/1 in the TPM condition the value of this integral is best found by constructing a graph of *relative sensitivity*^{2} against *frequency* from the known relative sensitivity/frequency characteristic, and taking the area under the curve by counting squares. Dividing this by the mid-band value of *relative sensitivity*^{2}, which could be made unity, gives a quotient which is the bandwidth of the hypothetical system having a rectangular-shaped gain/frequency characteristic and which would have an equivalent response to noise. This is termed the " Equivalent Noise Band-width " of the system and should not be confused with the " Bandwidth."

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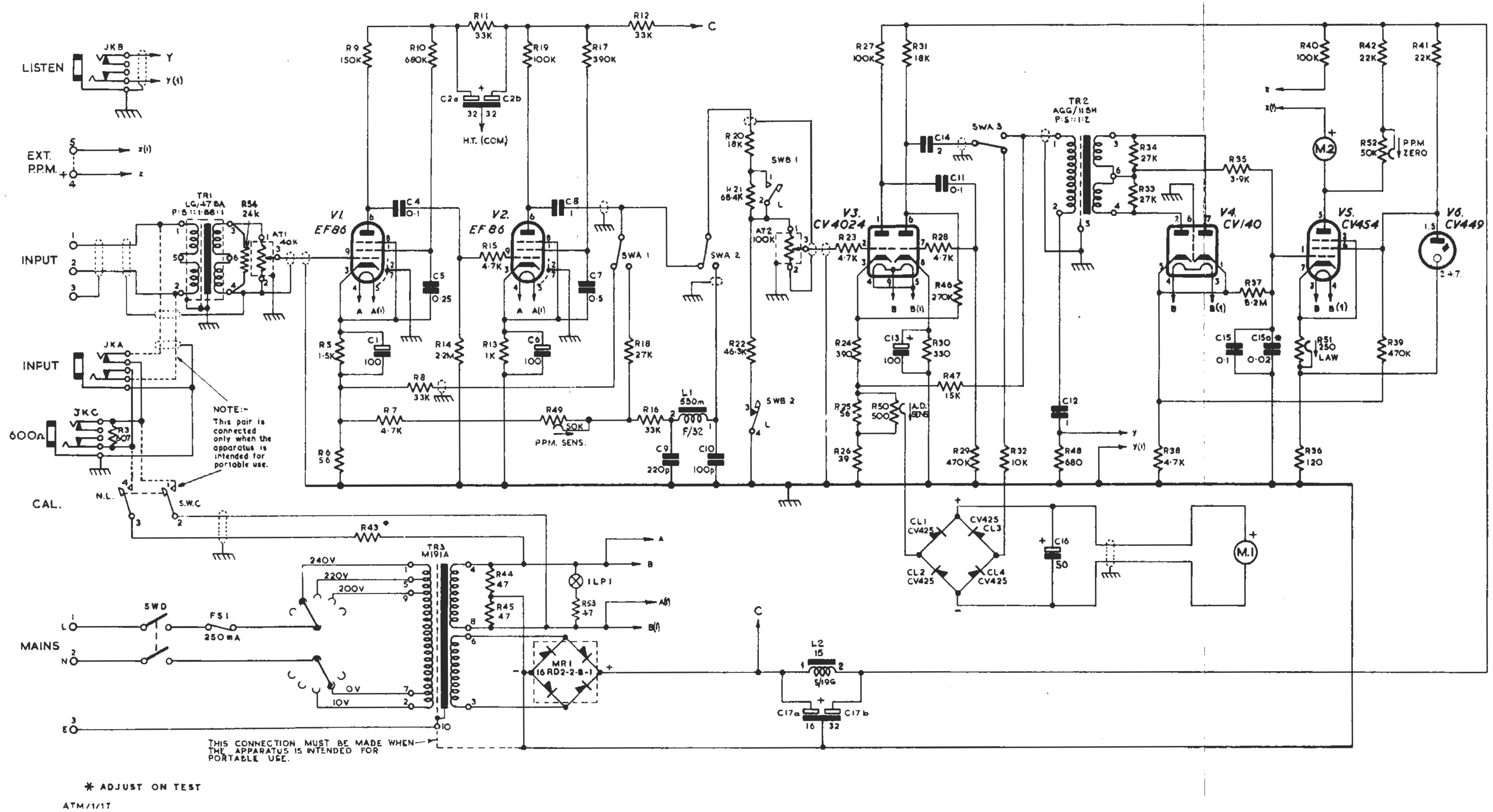

Fig.1 Circuit of the AC Test Meter ATM/I