POWER AMPLIFIER AM1/37

Introduction

The AM1/37 is intended for use, in conjunction with a separate input oscillator, to drive a low-power shaded-pole induction motor over a frequency range of 15 to 90 Hz via a suitable output transformer. It has a frequency response flat to within $\pm 0{\cdot}5$ dB over the working range, it has a gain of 30 ± 1 dB and it is capable of delivering 50 watts into a 7·5-ohm resistive load. There are no variable controls except for a preset setting-up control.

The amplifier was designed to receive its input signal from a variable-frequency oscillator OS3/5. Both the AM1/37 and the OS3/5 are subunits of power supplier PS1/27, which

(a) provides a 50-Hz supply of 4 amps at 52 volts centre-tapped for the amplifier, and

(b) contains an output transformer and switching circuit via which the amplifier may feed a motor, the alternative condition of the switching system giving the motor a 50-Hz mains supply.

The amplifier itself has also a 40-mA d.c. output at -36 volts intended to supply the OS3/5.

The PS1/27 and its subunits were designed to provide a disk reproducer RP2/6 with a variable-frequency drive supply.

References

Variable-frequency Oscillator OS3/5.
Variable-frequency Power Supplier PS1/27.
Disk Reproducer RP2/6*.

General Description

The working unit can be divided into three parts, as shown in Fig. 1. These parts are (1) a printed wiring board, (2) a surrounding metal frame and (3) components on power supplier PS1/27.

The printed wiring board, of standard ISEP size (7 by 4·4 in), carries the components enclosed in the chain-line block on the left of the diagram. This board is fitted to a surrounding metal frame which carries the heat sink for the output transistors, their associated components and those of the bridge rectifier. The side panels of the metal frame together with the wiring board fit into runners of a standard ISEP nest, and the board and frame circuit is terminated on a 25-way plug with coding pins 3, 11 and 17.

The PS1/27 comprises a metal tray on which are mounted an ISEP nest and the components of the power supplier circuit. The nest is intended to carry the AM1/37 board and frame, and also the OS3/5 board. The power supplier circuit components are indicated within the block on the right of Fig. 1, and include a mains transformer T1, the amplifier output transformer T2 with changeover switch for fixed or variable motor speed, interference suppression components and neon indicator lamps. On the front panel of the PS1/27 tray are fixed the changeover switch (marked *Fixed* and *Variable*) with associated neons and a control for varying the oscillator frequency.

Component Mounting

Amplifier Board

TR1 and TR2 are mounted in a twin heat sink to ensure thermal tracking; the heat sink is held off the board by 6BA nuts. TR3 is also mounted in a heat sink held off the board by 6BA nuts; the screw which retains this transistor in the heat sink is of metal because a plastic screw tends to creep and cause destruction of the transistor. The 100-kilohm linear *Offset* control R5 must be a 2-watt type to provide adequate current carrying capacity. Access to this control is obtained via a hole in the right-hand side plate (viewed from the heat sink end). The 2,000-μF capacitors C5A and C5B are mounted in capacitor clips. Resistors R13 and R14 get very hot and should not be touched.

Amplifier Frame

The insulating washers used for mounting TR6 and TR7 to their heat sink must be hard anodised or solid aluminium oxide; mica must not be used. If these transistors have to be replaced, any burrs on them must be removed to avoid puncturing the washers; before the transistors are fitted to the heat sink all mating surfaces should be coated with a layer of Midland Silicones Limited EP2623 compound. The twin heat sink carrying TR4 and TR5 must be held with nylon screws.

The mounting stud of the full-wave rectifier D1 is at $+35$ volts with respect to the metalwork and is protected with a rubber grommet. Test

* Designs Department Technical Memorandum No. 1.51(70).

resistors R24 and R25 are mounted on the left-hand plate of the metal frame on stand-off insulators.

Circuit Description (Fig. 1)

Main considerations in the design of this 50-watt amplifier are stability when driving a mainly reactive load and the provision of a low-loss power supply. The power supply circuit comprises a mains transformer (on the PS1/27 tray) and a simple full-wave rectifier D1 with two large reservoir capacitors C13 and C14 giving a ±36-volt balanced system with the centre point earthed. This eliminates the complexity of a regulated system with its inherent power losses. The use of a balanced power supply also makes possible a more efficient utilisation of the direct voltage available and the cancellation of ripple voltage in the amplifier load.

The input pair TR1 and TR2 provides an input impedance of about 200 kilohms; the circuit also provides d.c. stabilisation and permits the setting up of d.c. conditions by the *Offset* control R5. TR1 and TR2 drive TR3 which in turn drives TR4 and TR5. TR3 uses a familiar circuit with the bootstrap capacitor C8 connection but omits quiescent current stabilising components between the bases of TR4 and TR5 as cross-over distortion can be disregarded. TR4 and TR5 drive the output transistors TR6 and TR7, which are two silicon npn power transistors, used in a series-connected push-pull class-B configuration, TR6 is driven in a Darlington circuit by the npn transistor TR5 and TR7 is driven in a Darlington circuit by the pnp transistor TR4 which is complementary to TR5 and hence makes possible a common drive from the collector of TR3.

The centre point of the output pair TR6 and TR7 provides the output directly to T2 (on the PS1/27 tray). It also provides a.c. and d.c. feedback, the former via R15, R10, C5 and the latter via R15 and TR2. This centre point is set up by the *Offset* control R5 to be at half the h.t. potential so that there is zero voltage across the primary of the output transformer.

Fuses FS1 and FS2 protect the output transistors from the effects of overload. R24 and R25 (with their links) are used to give further protection to the output transistors when the operating conditions of the amplifier are being adjusted.

R11 and R12 also give overload protection, C9 attenuates high frequencies and the combination R26, C15 limits the load at high frequencies so as to prevent parasitic oscillations.

Maintenance

General

It is essential that this amplifier be set up correctly and carefully if damage is to be avoided. When components are being replaced it is important to conform to the requirements mentioned under the heading *Component Mounting*. Note the following:

1. The heat sink of TR3 must have a metal clamp screw.
2. The collector connections of TR6 and TR7 must be sound and their resistance to the heat sink must be greater than 10 megohms when checked with a 250-volt megger.
3. The screw connections of C13 and C14 must be tight.

D.C. Tests

1. For the initial set-up remove the links from R24 and R25 and connect an Avometer (on 100-volt d.c. range) across the total h.t. supply (lower potential end of R24 and R25).
2. Feed the primary of mains transformer T1 (on the PS1/27) from a Variac and slowly increase the voltage until the Avometer reads 40 volts.
3. Check that the output (PLA 14, 15, 16, 17) potential is about half this (i.e., 20 volts); if this potential is wildly out there is a serious fault which must be found before proceeding any further.
4. Increase the output from the Variac to the full primary voltage of T1; the total h.t. supply as measured in accordance with 1 and 2 should be about 60 volts.
5. Now connect the Avometer (100-volt range) between the output (PLA 14, 15, 16, 17) and ground (PLA 10, 11, 12, 13) with the Avometer positive lead on the output tag, and slowly adjust *Offset* control R5 for 0 volts d.c.
6. Repeat this test with the links across R24 and R25 replaced, using progressively lower ranges of the Avometer to indicate 0 volts as R5 is adjusted.
7. Connect the mains transformer T1 to the mains, using the correct transformer tap setting to suit the measured mains voltage.
8. Measure the emitter, base and collector voltages of each transistor with respect to ground. These voltages should lie between the maxima and minima shown in Table 1 on page 5

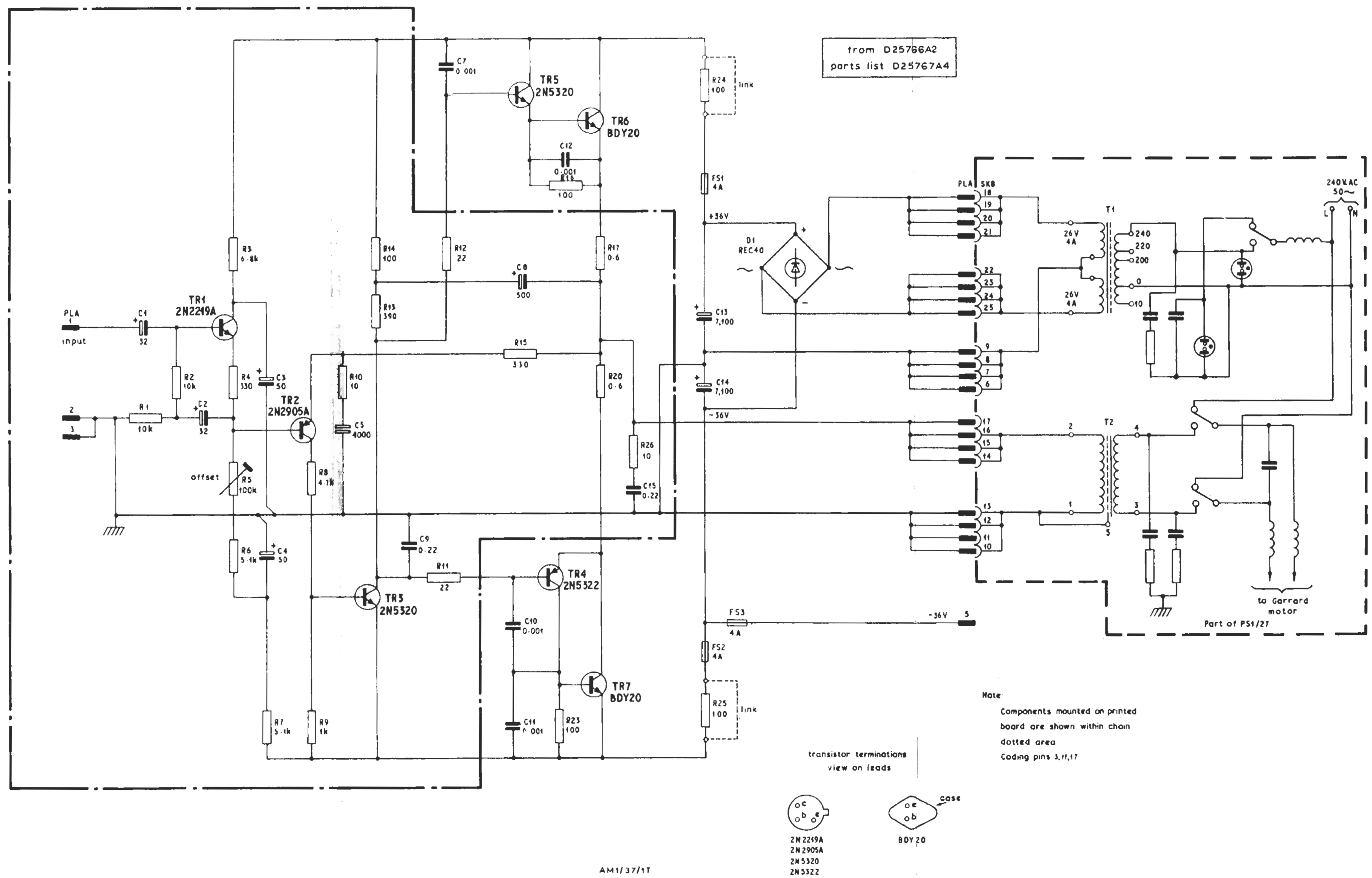

Fig. 1. Circuit of AM1/37

TABLE 1

TR No.	Emitter		Base		Collector	
	Min.	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*
TR1	−0·5	−2·0	0	−1	+6·7	+37
TR2	−0·2	−1·25	−0·5	−3	−12	−36
TR3	−31·5	−38·5	−30·8	−38	+1	+1·4
TR4	0	0	+1·0	+1·4	−31·5	−38·5
TR5	+0·5	+0·7	+1·0	+1·4	+31·5	+38·5
TR6	0	0	+0·5	+0·7	+31·5	+38·4
TR7	−31·5	−38·5	−31·5	−38·5	0	0

NOTE: The above readings were taken with an Avometer Model 9 Mark 2.

TABLE 2

Input (dB)	*Output*			*H.T.*		*T1 In (mA)*
	dB	*V*	*W*	*mA*	*V*	
Short cct	—	—	—	86·5	80	67
−20	+10	2·45	0·8	247	79	107
−2	+28	19·36	50	1400	72	410

A.C. Test Data

Input impedance at 50 Hz	about 200 kilohms
Source impedance	not more than 10 kilohms
Output impedance at 50 Hz	about 0·1 ohm
Load impedance	7·5 ohms nominal
Gain at 50 Hz	30 ±1 dB
Frequency response from 10 to 100 Hz	±0·5 dB

Typical measurements made at 50 Hz are shown in Table 2.

With a cathode ray oscilloscope across the output, distortion is negligible (not more than 0·2 per cent) with an input of −2 dB. Clipping starts at an input of − 1 dB.

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