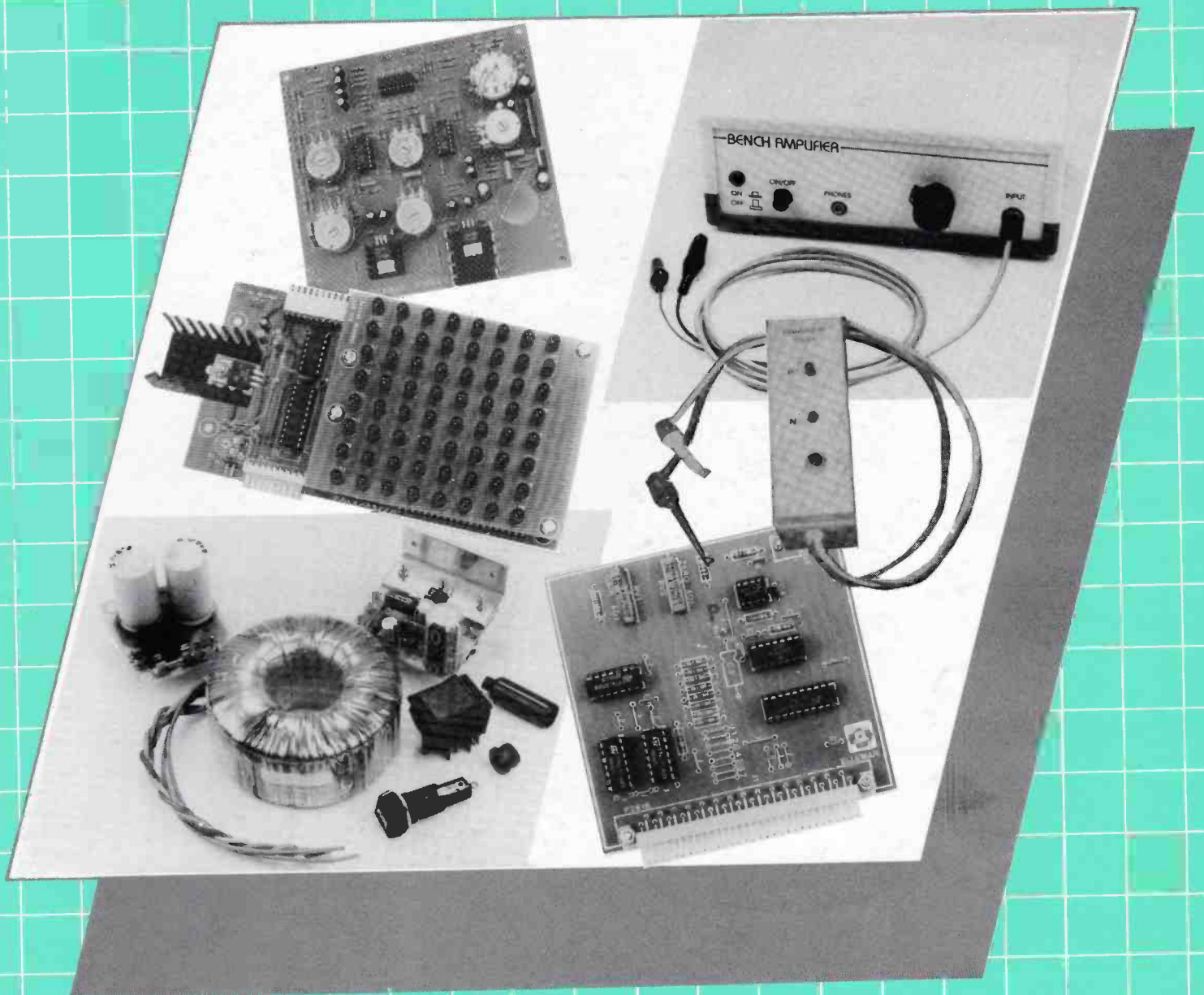


PROJECTS BOOK 64

/// Maplin /// Maplin /// Maplin



LOW-COST BENCH AMPLIFIER
15W AMPLIFIER &
POWER SUPPLY

IN-CIRCUIT TRANSISTOR TESTER
LED MOVING MESSAGE DISPLAY
PARTS 3 AND 4

MODULAR HEADPHONE MODULE
DIGITAL-TO-ANALOGUE
CONVERTER CARD

CONTENTS

MAPLIN PROJECTS BOOK SIXTY FOUR

EDITORIAL

■ This Project Book replaces Issue 64 of *Electronics*, which is now out of print, and contains a compilation of projects from this magazine. Other issues of *Electronics* will also be replaced by Project Books once they are out of print. For current prices of kits please consult the latest Maplin Catalogue or the free price change leaflet, order as CA99H.



■ Editor Robert Ball.
■ Compiled by Mike Holmes.
■ Contributing Authors Alan Williamson, Dennis Butcher, Terry Pinnell, John Koushappas, Martin Pipe, Nigel Skeels.
■ Technical Authors Robln Hall, Mike Holmes.
■ Technical Illustrators Ross Nisbet, Paul Evans, Nicola Hull, Kevin Kirwan.
■ Production Scheduler Steve Drake.
■ Print Co-ordinators John Craddock, Len Carpenter.
■ Publications Manager Roy Smith.
■ Development Manager Tony Bricknell.
■ Drawing Office Manager John Dudley.
■ Art Director Peter Blackmore.
■ Designer Jim Bowler.
■ Published by Maplin Electronics plc.
■ Mail Order P.O. Box 3, Rayleigh, Essex SS6 8LR.
■ Telephone Retail Sales: (01702) 554161.
■ Retail Enquiries: (01702) 552911.
■ Trade Sales: (01702) 554171.
■ CashTel: (01702) 552941.
■ General: (01702) 554155.
■ Fax: (01702) 553935. ■ Telex: 995695.

Visit a Maplin Shop for Personal Service.

You'll find Maplin Service in:
Belfast, 357-359 Lisburn Road. Telephone: (01232) 683929.
Birmingham, Sutton New Road, Erdington. Telephone: (0121) 384 8411.
Brighton, 65 London Road. Telephone: (01273) 620930.
Bristol, 302 Gloucester Road, Horfield. Telephone: (01179) 232014.
Cardiff, 29-31 City Road. Telephone: (01222) 464554.
Chatham, 2 Luton Road. Telephone: (01634) 818588.
Coventry, 12 Bishop Street. Telephone: (01203) 550504.
Dudley, Unit 7, Sterling Park. Telephone: (01384) 485051.
Edinburgh, 126 Dalry Road. Telephone: (0131) 313 5551.
Glasgow, 264-266 Great Western Road. Telephone: (0141) 353 3323.
Ilford, 302-304 Green Lane. Telephone: (0181) 599 0100.
Leeds, Carpet World Building, 3 Regent Street. Telephone: (01132) 449200.
Leicester, Office World Building, Burton Street. Telephone: (01162) 623288.
Liverpool, Edge Lane, Fairfield. Telephone: (0151) 230 0366.
London, 146-148 Burnt Oak Broadway, Edgware. Telephone: (0181) 951 0969.
107-113 Stanstead Road, Forest Hill. Telephone: (0181) 291 9192.
120-122 King Street, Hammersmith. Telephone: (0181) 748 0926.
Manchester, 169 Cheetham Hill Road, Cheetham Hill. Telephone: (0161) 832 2550.
8 Oxford Road. Telephone: (0161) 236 0281.
Middlesbrough, Unit 1, The Forbes Building, 309-321 Linthorpe Road. Telephone: (01642) 242900.
Milton Keynes, Snowdon Drive (next to Office World), Winterhill. Telephone: (01908) 692720.
Newcastle-upon-Tyne, Unit 4, Allison Court (beside The Metro Centre), Gateshead. Telephone: (0191) 488 9555.
Northampton, 139 St James Road. Telephone: (01604) 756726.
Nottingham, 86-88 Lower Parliament Street. Telephone: (01159) 410242.
Portsmouth, 98-100 Kingston Road. Telephone: (01705) 654411.
Preston, Unit 1, Corporation Street. Telephone: (01772) 258484.
Reading, 129-131 Oxford Road. Telephone: (01734) 566638.
Sheffield, 413 Langsett Road, Hillsborough. Telephone: (01142) 855492.
Slough, 216-218 Farnham Road. Telephone: (01753) 551419.
Southampton, 46-48 Bevois Valley Road. Telephone: (01703) 225831.
Southend-on-Sea, 282-284 London Road, Westcliff-on-Sea. Telephone: (01702) 392000.
Stockport, 259-261 Wellington Road South. Telephone: (0161) 480 4900.
Stoke-on-Trent, 39-45 London Road. Telephone: (01782) 749947.

All our shops are open from 9.00am to 5.30pm Monday to Saturday (9.30am Friday). Shops that are open on Sundays are: Brighton (if local conditions permit), Edinburgh 10.00am to 4.30pm; Glasgow 9.00am to 5.30pm; Manchester Oxford Road and Cheetham Hill, if local conditions permit; Newcastle 10.00am to 4.30pm. All shops are closed for Public Holidays. Shops do not close for lunch.

PROJECTS

2 LOW-COST BENCH AMPLIFIER

■ A general-purpose bench amplifier ideal for fault-finding and audio work.



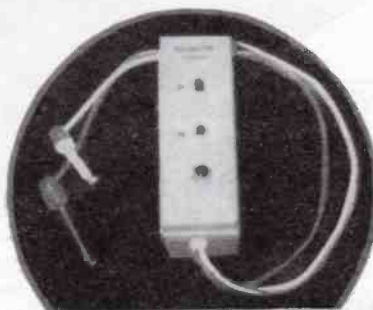
8 15W AMPLIFIER & POWER SUPPLY

■ A versatile audio amplifier for numerous applications.



15 IN-CIRCUIT TRANSISTOR TESTER

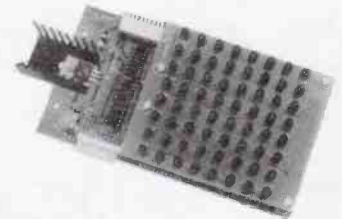
■ Find faulty transistors easily with this simple project.



FOR MAIL ORDER ENQUIRIES, PLEASE DO NOT CALL OUR SHOPS AS THEY WILL BE UNABLE TO HELP YOU.
Send all mail to: P.O. Box 3, Rayleigh, Essex SS6 8LR.

18 LED MOVING MESSAGE DISPLAY SYSTEM

■ Part 3 describes the construction of a suitable power supply.

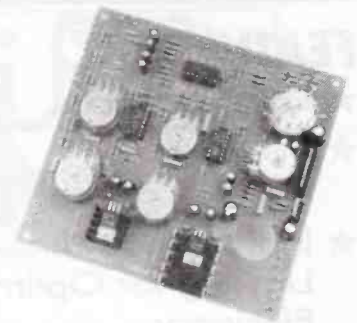


24 LED MOVING MESSAGE DISPLAY SYSTEM

■ Part 4 describes the PC software and usage.

30 HEADPHONE MODULE FOR MODULAR MIXING SYSTEM

■ Part of a high quality Modular Mixing System.



35 DIGITAL-TO-ANALOGUE CONVERTER CARD

■ Part of the Intelligent Motherboard expansion system.

Copyright. All material is subject to worldwide copyright protection, and reproduction or imitation in whole or part is expressly forbidden. All reasonable care is taken to ensure accuracy in preparation of the magazine, but Maplin Electronics plc cannot be held legally responsible for its contents. Where errors occur corrections will be published as soon as possible afterwards. Permission to reproduce printed circuit board layouts commercially, or marketing of kits, must be sought from the publisher.
©Copyright 1994 Maplin Electronics plc.



BENCH AMPLIFIER

Design by Alan Williamson
Text by Martin Pipe



FEATURES

- ★ Excellent Value
- ★ 500mW Output Power
- ★ Input Bandwidth Limiting for Optimum Efficiency
- ★ High Input Impedance
- ★ Protected against DC Offsets and Reverse-Polarity Power Connection

APPLICATIONS

- ★ Signal Tracing during Servicing
- ★ Monitoring Audio Signals

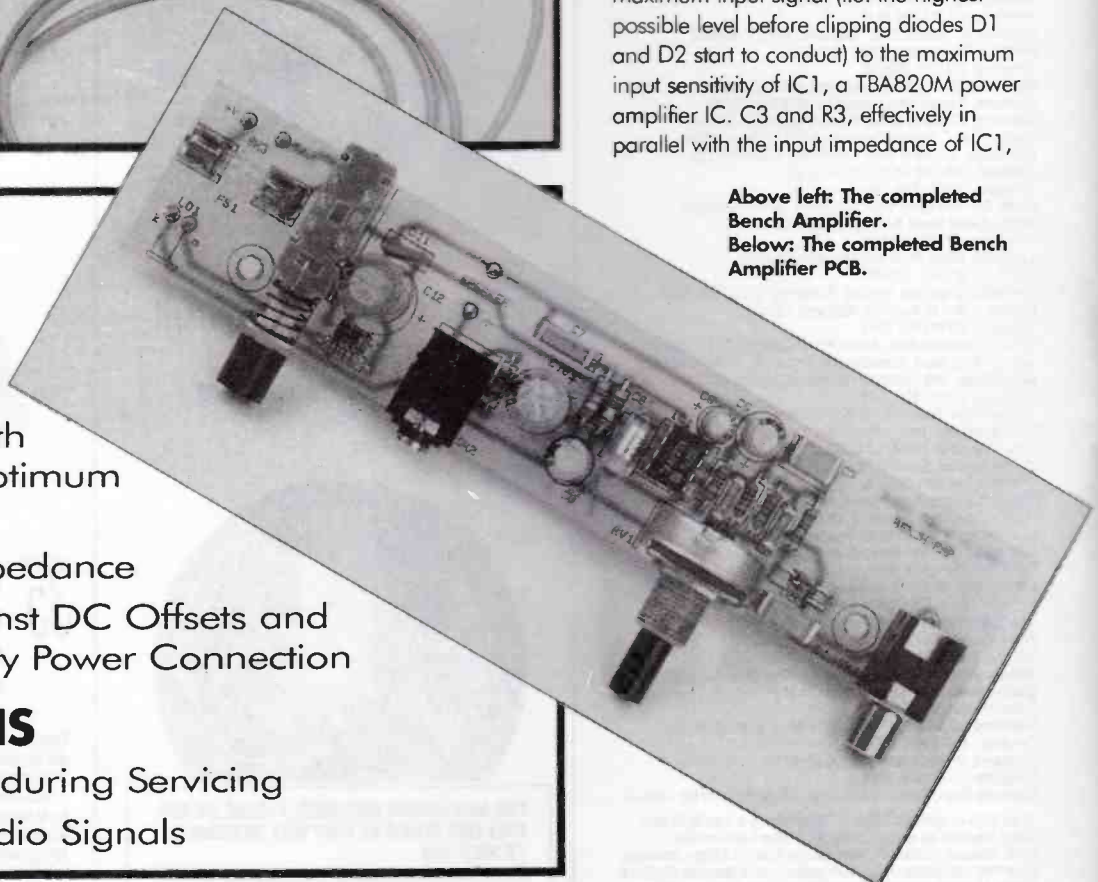
The Bench Amplifier, a very useful piece of equipment for the home laboratory, is another project in the Low-Cost Test Equipment series, which includes the AF Signal Generator and the Minilab Power Supply (the latter will shortly be featured in 'Electronics'). The full output power of the Bench Amp is a little over half a watt before distortion starts to become objectionable. 500mW is, however, quite adequate for test-bench signal tracing and monitoring applications. The input impedance of the amplifier is approximately 400k Ω , which will prevent the circuit under test from being significantly loaded. Loading can often change a circuit's behaviour – not exactly desirable during servicing work! There is a second-order filter on the input of the amplifier that limits its bandwidth to 50Hz to 15kHz (-6 dB). This means that all of the amplifier power is used at frequencies that the speaker can comfortably reproduce.

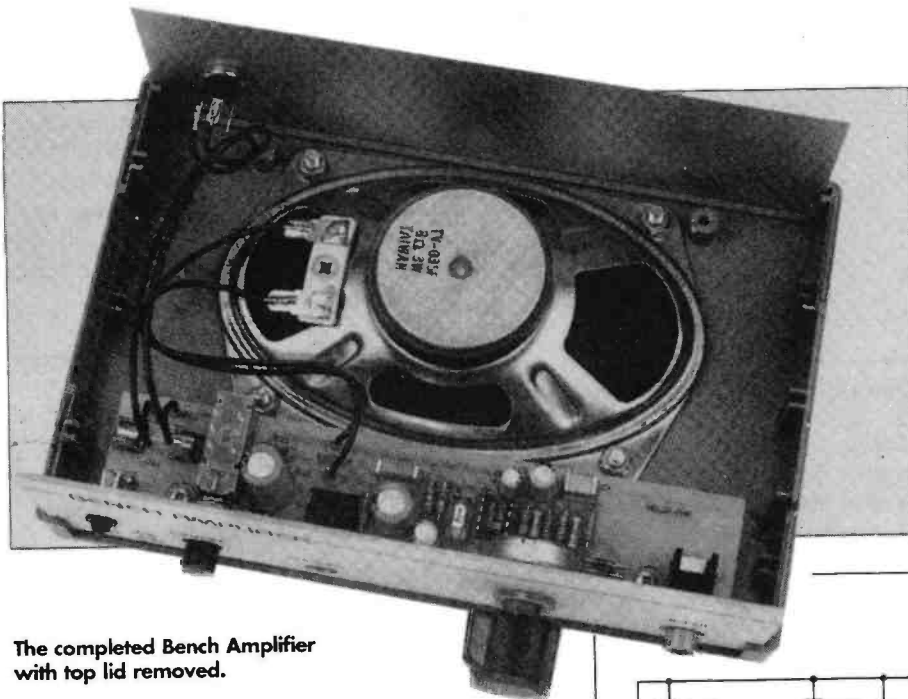
In conjunction with the low-distortion AF Signal Generator, the Bench Amplifier is very useful for servicing audio equipment. For example, if a multi-stage amplifier is faulty, each stage can be checked in turn.

Circuit Description

As can be seen from the circuit diagram of Figure 1, the input to the bench amplifier is AC-coupled by C1 so that any DC offsets present with the monitored signal will not damage the IC. RV1 is the input attenuator; in conjunction with C1, it also forms the first high-pass filter. Diodes D1 and D2 are present to limit excessive input signals. R1 and C2 form the first low-pass filter; R1, together with R2, also attenuates the maximum input signal (i.e. the highest possible level before clipping diodes D1 and D2 start to conduct) to the maximum input sensitivity of IC1, a TBA820M power amplifier IC. C3 and R3, effectively in parallel with the input impedance of IC1,

Above left: The completed Bench Amplifier.
Below: The completed Bench Amplifier PCB.





The completed Bench Amplifier with top lid removed.

form the second high-pass filter. C4 and R3, also in parallel with the input impedance of IC1, form the second low-pass filter. The gain of IC1 is set by R4 and C5, while C6 is incorporated in the circuit to increase the chip's supply ripple rejection; note that IC1 has been designed to operate over a wide range of single rail supply voltages. The remaining components associated with IC1 are: C8, which is used for frequency compensation; C9 and R5, which are the bootstrapping components present to increase the input impedance of IC1; R6 and C7, which form the Zobel network (a filter that removes RF frequencies from

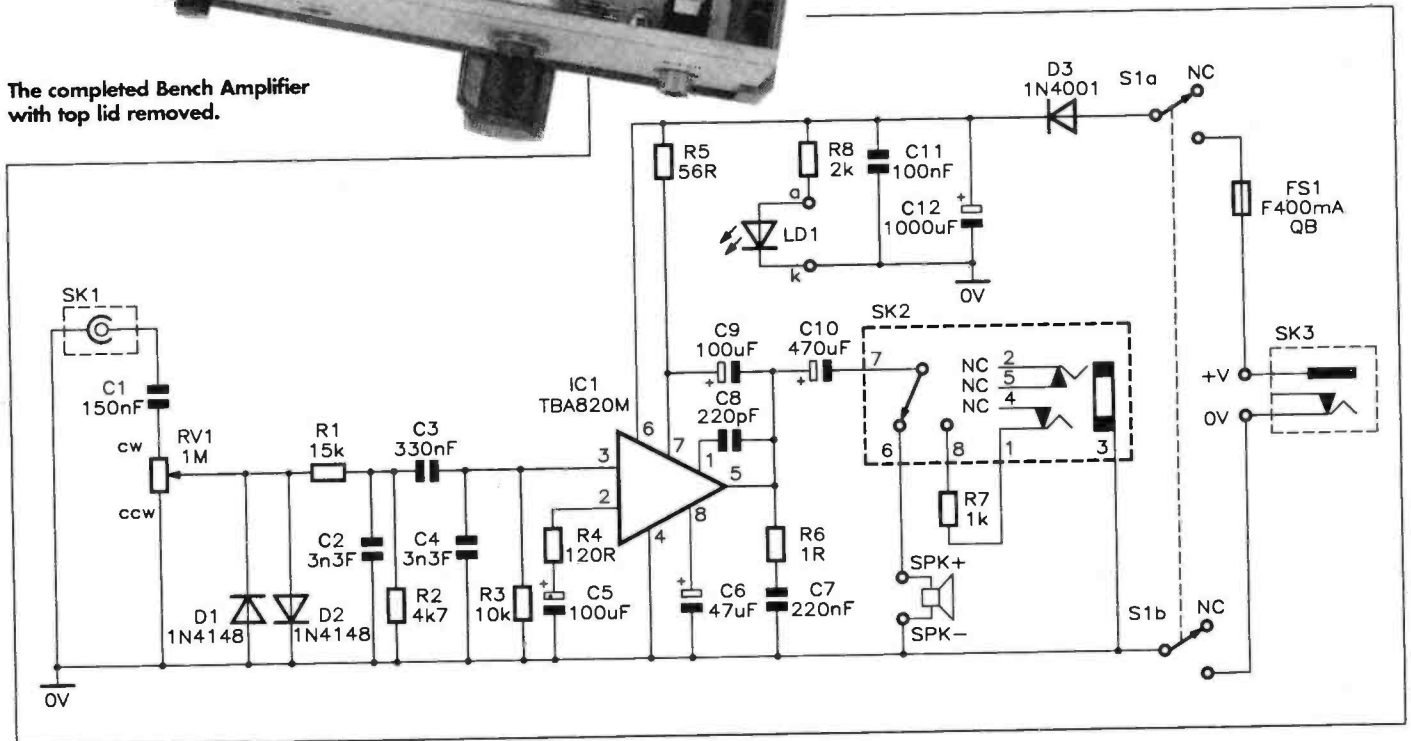


Figure 1. Bench Amplifier circuit diagram.

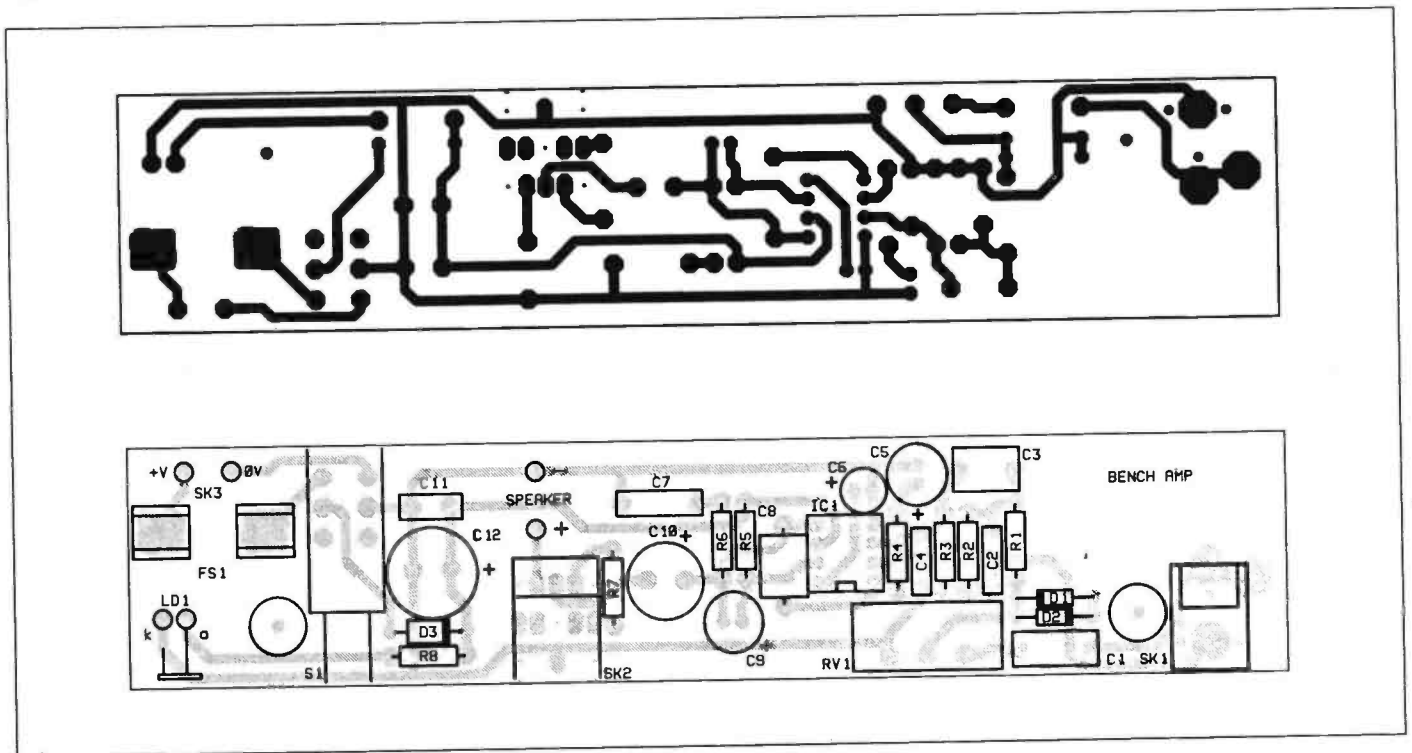


Figure 2. Bench Amplifier PCB legend and track.

the output); and C10, which AC-couples the output of IC1 to the speaker. Inserting a 3.5mm jack plug into the headphone socket, SK2, disconnects the speaker and switches R7 into the circuit; this resistor is present to limit the output volume and protect your ears! Power-on indicator LD1 is a low current LED; R8 is its series current limiting resistor. The remaining power supply components are decoupling capacitors C11 and C12; and D3, which has been incorporated to prevent damage to the circuit caused by accidentally reversing the connections to power socket SK3.

PCB Assembly

Before starting construction, read through the Constructors' Guide for good practical advice on kit-building, particularly if you are relatively new to the hobby. Begin PCB assembly by fitting the resistors, followed by the diodes; refer to the PCB legend in Figure 2. Ensure that the band on each

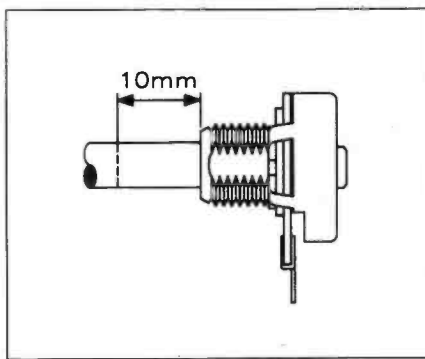


Figure 3. Trimming potentiometer shaft.

diode corresponds to that shown on the legend. The same precaution should be applied when fitting the capacitors; C5, 6, 9, 10 and 12 are electrolytic devices, and must be correctly orientated. Fit the fuse into the fuse clips, insert the whole assembly into the PCB, and then solder the clips whilst holding the assembly flush to the PCB from the other side. Trim the shaft of RV1 to

the length shown in Figure 3, and then fit it to the PCB. Install the switch (SW1) and the sockets (SK1,2). Note that these items must be pushed, as far as possible, against the PCB, otherwise the forces exerted on them may eventually cause their connecting tracks to lift from the board, causing intermittent operation. Fit the PCB pins from the component side, followed by the button for SW1.

Finally, check the PCB for solder bridges, whiskers, dry joints and misplaced components.

Fitting the Bench Amplifier into the Optional Case

If you plan to build your Bench Amp into the recommended box, holes first need to be drilled as shown in Figures 4 (front panel), 5 (rear panel) and 6 (base). Stick the self-adhesive panel (reproduced in

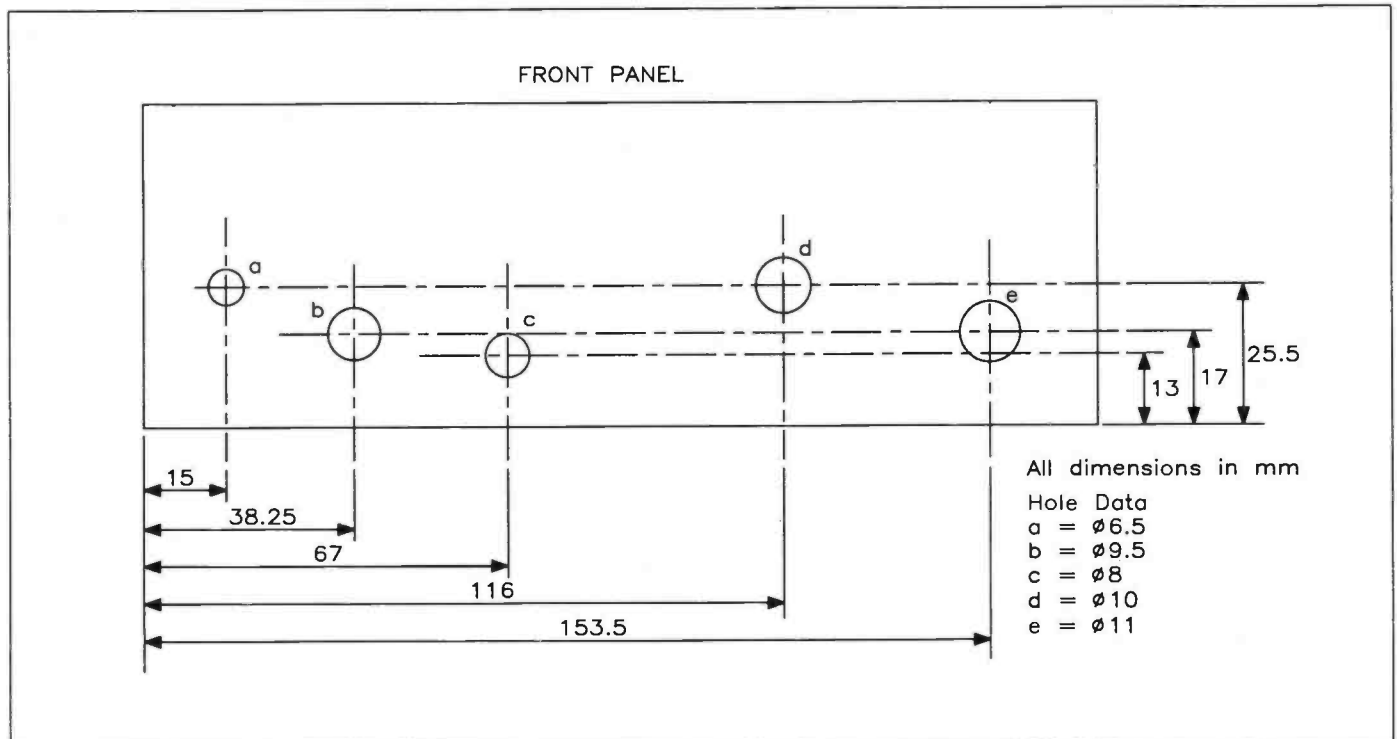


Figure 4. Front panel drilling details.

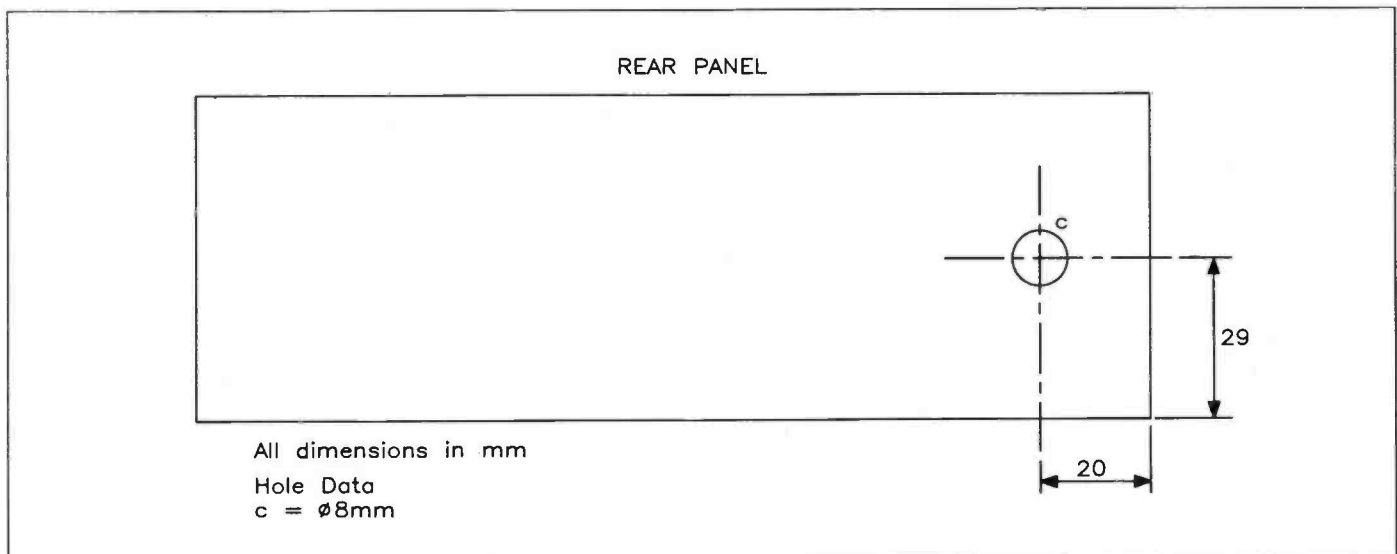


Figure 5. Rear panel drilling details.

All dimensions in mm

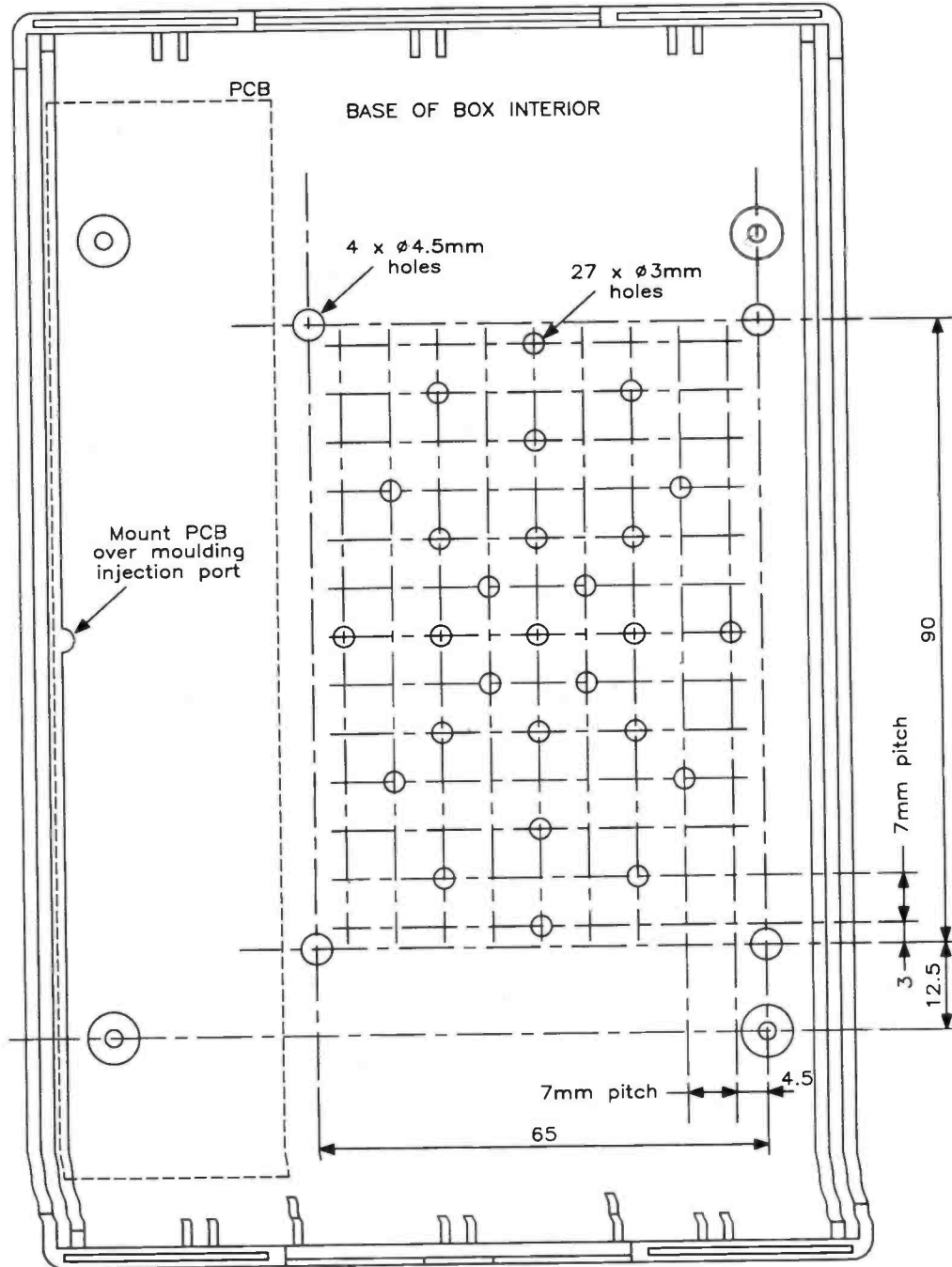


Figure 6. Base drilling details.

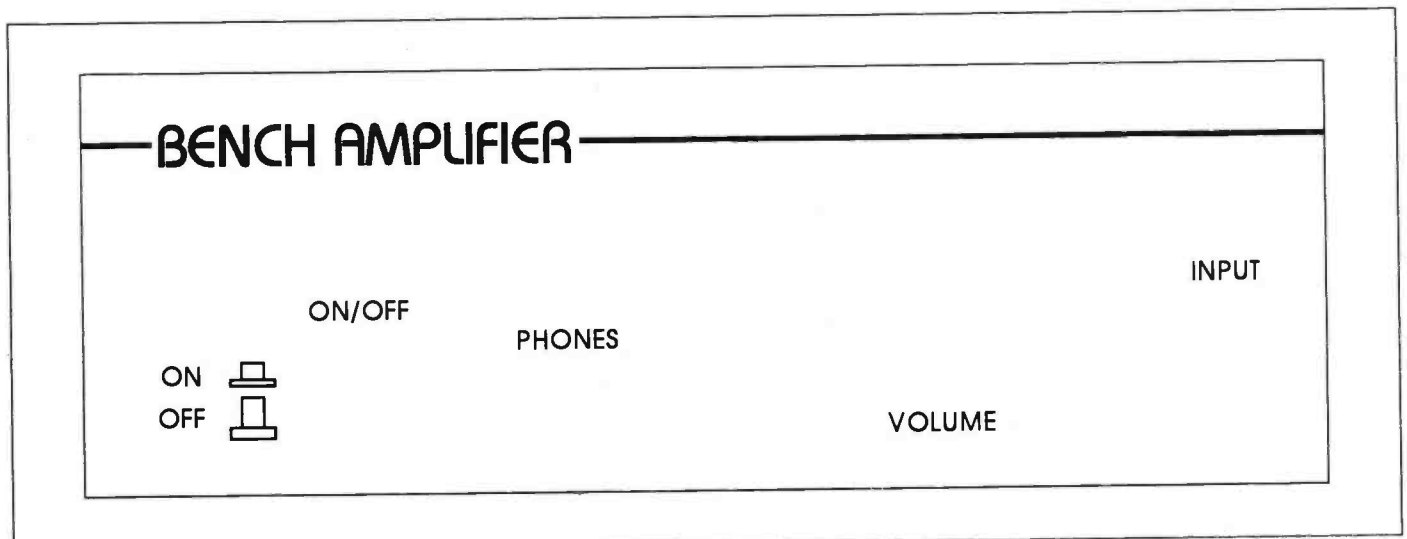


Figure 7. Front panel legend.

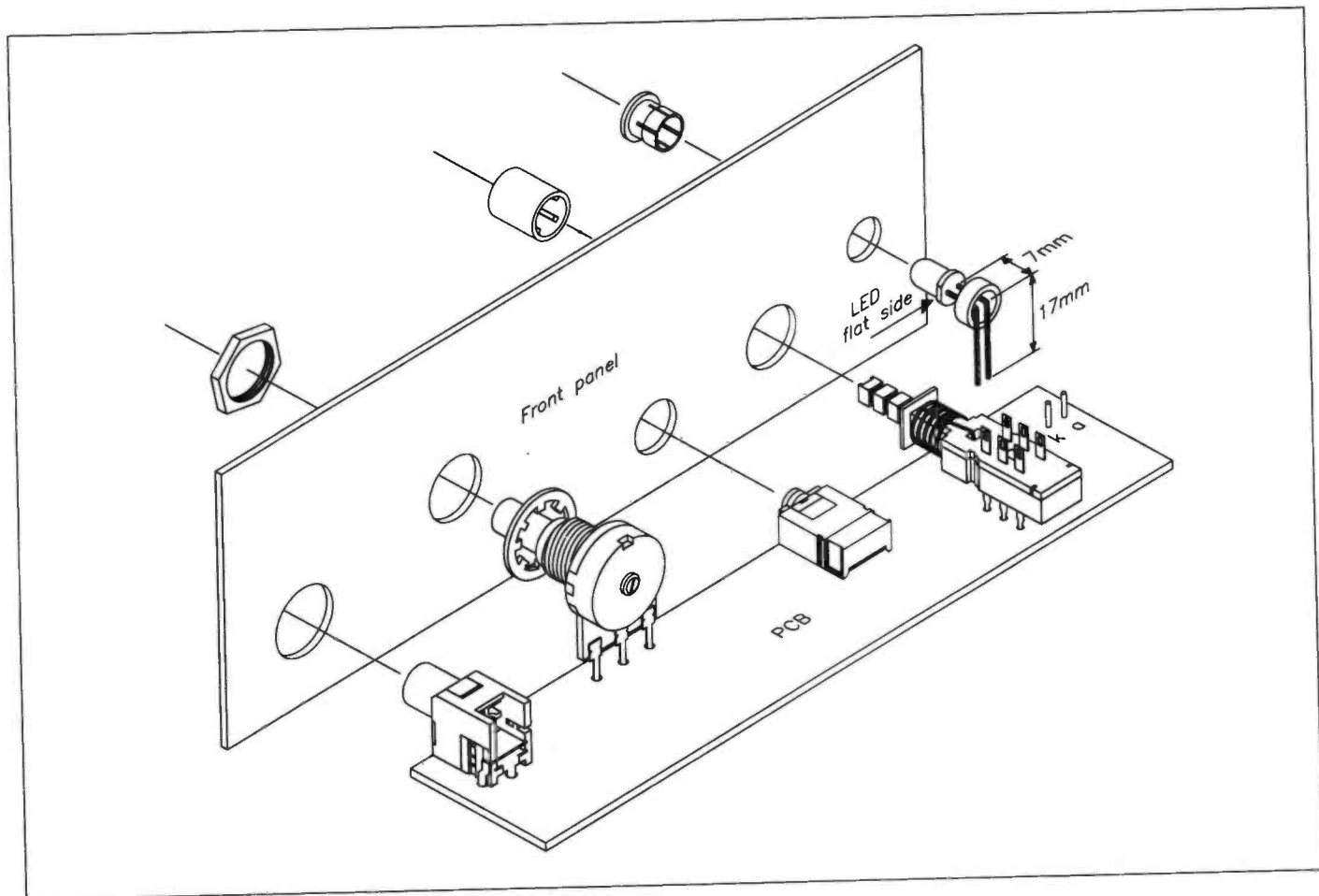


Figure 8. Exploded assembly diagram.

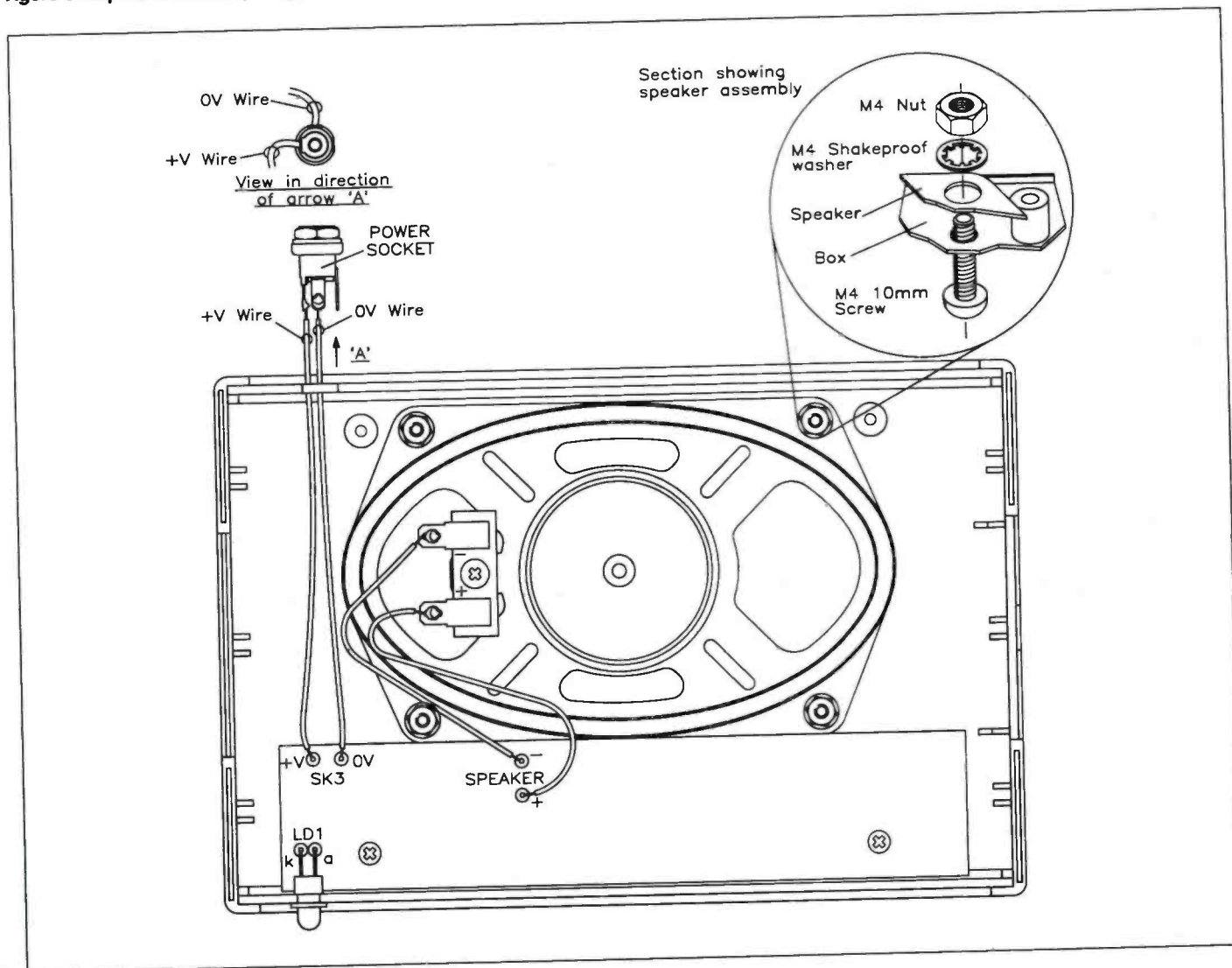


Figure 9. Wiring and speaker installation.

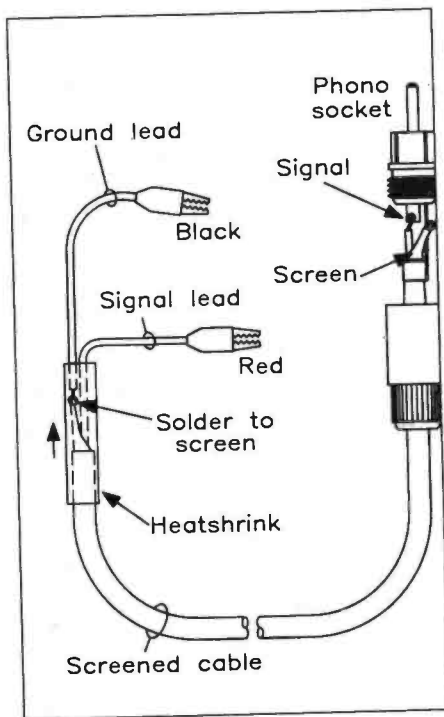


Figure 10. Making the test lead.

Figure 7) legend to the (now drilled) front panel, and then cut out the holes using a sharp craft-knife or scalpel. Insert LD1's bezel into the panel, after trimming and bending the leads of the LED as shown in Figure 8. Insert the LED into the bezel, and lock it in position with the retaining ring.

Loosely assemble the PCB to the front panel as shown in Figure 8, holding it in place with RV1's securing nut. Note that the pot washer is fitted between the panel and the potentiometer.

Fit the whole assembly into the box, screw the PCB into position and tighten RV1's securing nut. Install the speaker into the box, as shown in Figure 9, and fix in place with the supplied M4 screws, nuts and washers.

Install the power socket into the rear panel, then slide the panel into the box. Solder the LED leads to the PCB pins marked 'a' and 'k' (refer once again to Figure 8). Wire up the power socket and speaker

as shown in Figure 9. Finally, clip the two

halves of the box together, and attach the rubber feet to the bottom of the box.

After making the test lead, as shown in Figure 10, the Bench Amplifier is complete and ready for testing.

Testing

Connect a 9V DC power source (e.g., XX09K battery eliminator) to the power socket (the centre pin is positive), plug the test lead into the phono socket, and turn the volume control anti-clockwise. Pushing the switch SW1 to its inner 'on' position, the LED should illuminate; if not, check the polarity of the supply. Connect a signal source (e.g., oscillator, radio, cassette player) to the test lead. As the volume control is turned up, the test signal should be heard from the speaker. When an earpiece or headphones is plugged into SK2, the speaker will be muted, but the sound source should still be heard, from the earpiece (or right headphone only in the case of stereo headphones).

Your Bench Amp is now ready for use!

BENCH AMPLIFIER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film (Unless specified)

R1	15k	1	(M15K)
R2	4k7	1	(M4K7)
R3	10k	1	(M10K)
R4	120Ω	1	(M120R)
R5	56Ω	1	(M56R)
R6	1Ω	1	(M1R)
R7	1k	1	(M1K)
R8	2k	1	(M2K)
RV1	1M Pot Log	1	(FW28F)

CAPACITORS

C1	150nF Poly Layer	1	(WW43W)
C2,4	3n3F Poly Layer	2	(WW25C)
C3	330nF Poly Layer	1	(WW47B)
C5,9	100μF 25V PC Elect	2	(FF11M)
C6	47μF 25V PC Elect	1	(FF08J)
C7	220nF Poly Layer	1	(WW45Y)
C8	220pF Polystyrene	1	(BX30H)
C10	470μF 16V PC Elect	1	(FF15R)
C11	100nF 16V Minidisc	1	(YR75S)
C12	1000μF 16V PC Elect	1	(FF17T)

SEMICONDUCTORS

IC1	TBA820M	1	(WQ63T)
D1,2	1N4148	2	(QL80B)
D3	1N4001	1	(QL73Q)
LD1	LED 5mm 2mA Red	1	(UK48C)

MISCELLANEOUS

FS1	Fuse 20mm 400mA	1	(UJ77J)
S1	Latchswitch 2-pole	1	(FH67X)
SK1	PCB Phono Skt	1	(HF99H)
SK2	PCB 3.5 Stereo Switched Skt	1	(JM20W)
SK3	Panel Mount Power Skt 2.5	1	(JK10L)
	Elliptical Speaker 3W	1	(GL16S)

LED Clip 5mm	1	(YY40T)
Knob RN18 Red	1	(FD67X)
Latchswitch Button Black	1	(KU75S)
Fuse Clip 20mm Type 1	2	(WH49D)
Pin 2145	6	(FL24B)*
Wire 7/0-2 10m Black	50cm	(BL00A)*
Cable Single Black	1m	(XR12N)*
Screw-Cap Phono Black	1	(HQ54J)
Croc Clip Red	1	(FS48C)
Croc Clip Black	1	(FS49D)
Steel Screw M4 x 10mm	4	(JY14Q)*
Shake Proof Washer M4	4	(BF43W)*
Steel Nut M4	4	(JD60Q)*
Heat Shrink CP 48	3cm	(BF89W)*
PCB	1	(GH36P)
Front Panel	1	(DH84F)
Instruction Leaflet	1	(XU15R)
Constructors' Guide	1	(XH79L)

Optional (Not in Kit)

Verobox 215	1	(LQ08J)
AC Adaptor Unreg. 300mA	1	(XX09K)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as a kit.

Order As LT30H (Low-Cost Bench Amplifier)

Please Note: Items in the Parts List marked with a * are supplied in 'package' quantities (e.g., packet, strip, reel, etc.), see current Maplin Catalogue for full ordering information.

The following new items (which are included in the kit) are also available separately.

Low-Cost Bench Amp PCB **Order As GH36P**
Low-Cost Bench Amp Panel **Order As DH84F**



15W POWER AMPLIFIER MODULE

Design
revised by
Dennis Butcher
Text by
Martin Pipe and
Dennis Butcher

FEATURES

- ★ 15W RMS Output Power (into 4Ω load)
- ★ Short-Circuit Protected
- ★ Low Distortion
- ★ Amplifier and Power Supply Kits Available
- ★ Low Cost

APPLICATIONS

- ★ Superior Replacement Amplifier Module for Most Music Centres
- ★ Monitor Amplifier
- ★ Bench Amplifier



This article describes a 15W Hi-Fi amplifier module based around the TDA2030A IC; this design is an improvement on the existing tried and tested 15W TDA2030 amplifier that has given consistently high performance for over 12 years. By a careful redesign of the original PCB layout, and a few judicious component changes, the performance has been considerably improved over the original. As you can see from the specifications (refer to Table 1), the total harmonic distortion (THD) has been reduced to less than 0.1% across the board (it was originally as high as 5%), with a useful increase in the output power. All of this adds up to an extremely versatile little (literally – it only measures 63 x 60mm!) amplifier with a very useable output power rating. The output, incidentally, is completely short-circuit proof and, although the over-stressing of any electronic device is not recommended, the built-in thermal protection means that the IC is capable of surviving most fault conditions. Construction is quite easy, as the component count is low, and no elaborate test equipment is required for setting up the completed amplifier. It is worth noting that all the test figures quoted are 'worst case'; they were achieved using the uncased prototypes in an electrically 'noisy' environment (laboratory bench-top), and all connections

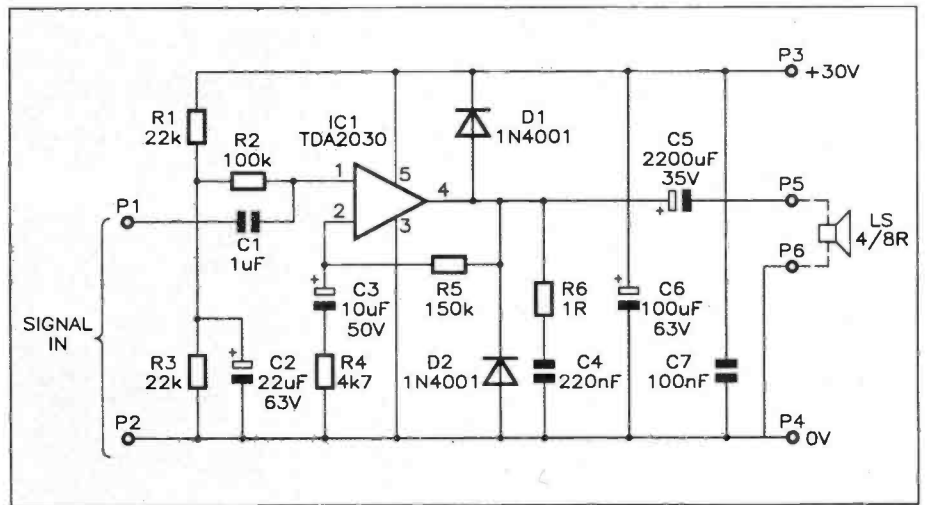
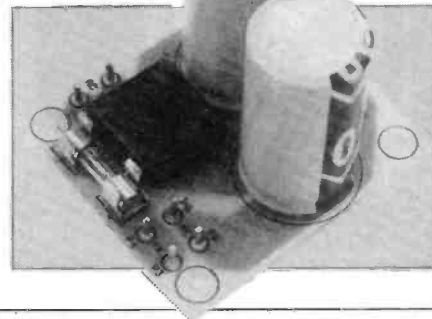


Figure 1. 15W Amplifier Module circuit diagram.

The assembled Power Supply.



were made with unscreened cable; provided that reasonable care is taken in construction and installation, the results obtained in normal use should actually be far better!

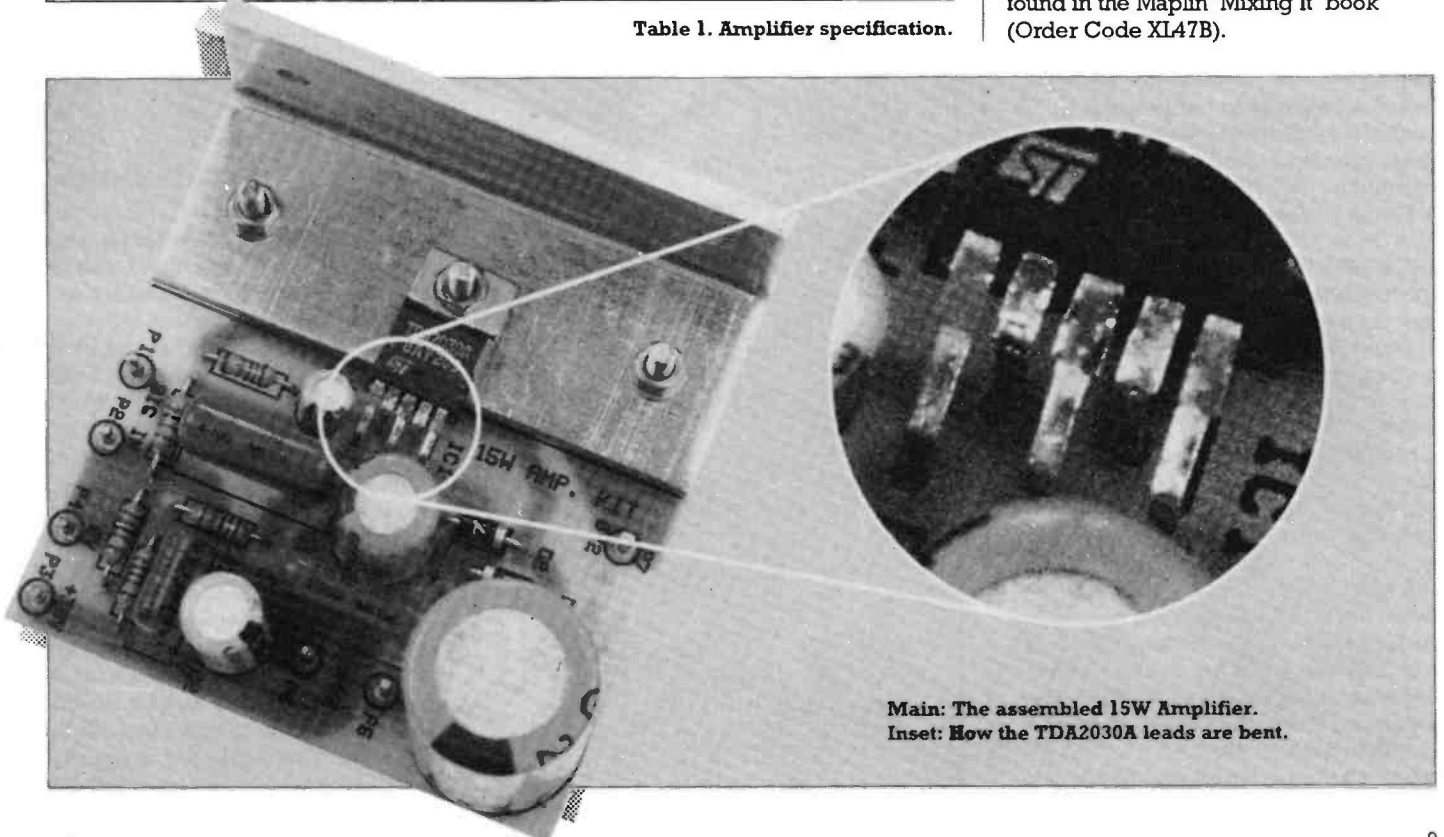
Circuit Description

Referring to the amplifier's circuit diagram of Figure 1, it can be seen that most of the circuitry is contained in the TDA2030A (IC1), the pinout of which is shown in Figure 2. C3, R4 and R5 are the components that control the closed-loop gain of the amplifier; to experiment with the gain of the amplifier, any or all of these three components may be altered in value – within certain constraints of course! Note that the manufacturer recommends that the closed-loop gain should always be higher than 24dB; any lower, and the amplifier will become unstable.

The input is ac-coupled by C1, and should therefore be easy to interface to a preamp or line-level source such as the output of a cassette deck or microphone preamp. Some useful ideas may be found in the Maplin 'Mixing It' book (Order Code XL47B).

Maximum Supply Voltage:	40V DC
Output Short Circuit Protection:	Continuous
Input Sensitivity for maximum output (4Ω speaker load):	244mV RMS (-10.03dBu)
Input Sensitivity for maximum output (8Ω speaker load):	288mV RMS (-8.59dBu)
Total Harmonic Distortion * (mono into 4Ω):	0.05% (15W RMS)
Total Harmonic Distortion (mono into 8Ω):	0.05% (11W RMS)
Total Harmonic Distortion (stereo into 4Ω):	0.1% (15W RMS)
Total Harmonic Distortion (stereo into 8Ω):	0.1% (11W RMS)
Bandwidth:	20Hz to 100kHz (4Ω)
Bandwidth:	10Hz to 100kHz (8Ω)
* Using LT24B PSU module(s) and YK86T transformer.	

Table 1. Amplifier specification.



Main: The assembled 15W Amplifier. Inset: How the TDA2030A leads are bent.

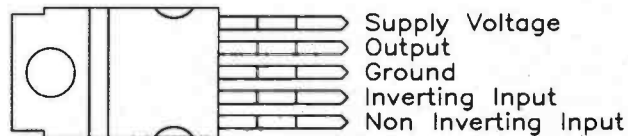


Figure 2. TDA2030A (IC1) pin-out.

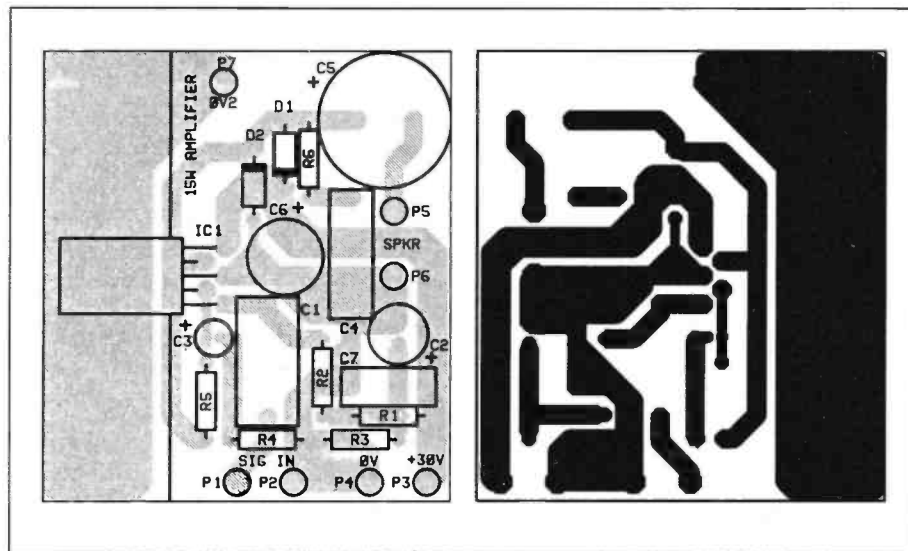


Figure 3. Amplifier Module PCB legend and track.

D1 and D2 protect IC1 from any induced emf generated by the inductance of the speaker coil; if these components were not present, the amplifier IC could be damaged. C5, meanwhile, protects the speaker from the dc offset on the output of the IC. R1 and R3 hold the input at half the supply voltage so that the output waveform will be symmetrical; R2 is present to keep the input impedance high. R6 and C4 form a Zobel network, which helps to remove any stray RF frequencies from the output. Finally, C6 and C7 decouple the power supply rail.

Amplifier Construction

Before embarking on construction, a read of the Constructors' Guide may prove beneficial, particularly to novice kit builders. Referring to the PCB legend of Figure 3, insert and solder the PCB pins (P1 to P7), all resistors, capacitors and diodes. Ensure that all the electrolytic capacitors and diodes are fitted with the correct polarity.

Carefully straighten the leads of IC1 by clamping lightly in a vice or a pair of large pliers, before reforming them as shown in Figure 4. This rearrangement is necessary because the IC's leads were originally designed for vertical, rather than horizontal, mounting. Referring to Figure 5's oblique view of the PCB, fix the bracket to the PCB using two of the 6BA bolts, nuts and washers. Carefully mount the IC onto the bracket (locating the leads in the PCB at the same time) using the remaining 6BA hardware, after smearing a small amount of heat transfer compound (not supplied) onto the mating surfaces, if required. It is important to understand that the tab of the IC is connected internally to pin 3,

and is therefore at 0V potential; this pin must always be connected to the most negative part of the amplifier circuit and as such it may be desirable to isolate the tab from the heatsink by using an insulating bush and greaseless washer as shown in Figure 6, and leaving pin 7 (0V2 - discussed later) unconnected. After finishing construction, check your work for misplaced components, dry joints, solder bridges and the like.

Power Supply Arrangements

The following details are for a 30V DC unregulated power supply suitable for powering the 15W amplifier module. Note that one such supply module is required for each amplifier (i.e. two are needed if you are building a stereo amplifier). Only one transformer is used, however; the YK86T transformer is rated at 120VA, which can supply ample current for two amplifier modules). For mono applications, the two secondaries are wired in parallel; for stereo applications, however, each secondary feeds a separate amplifier module (see Table 2). A PCB is available for this project, and all of the components (except for the transformer itself) are available as a kit of parts. Transformer apart, the supply itself consists of a bridge rectifier, fuseholder and a total of 4,400 μ F of reservoir capacitance, which are shown in the circuit diagram, Figure 7.

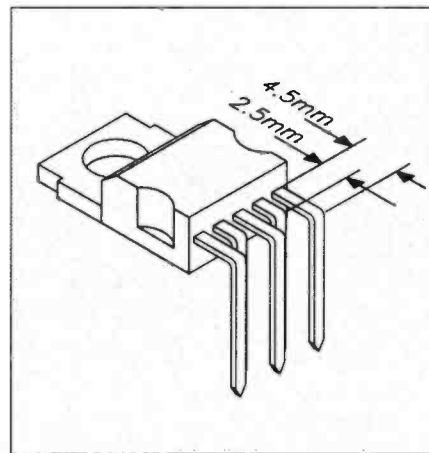


Figure 4. Reforming the leads of IC1.

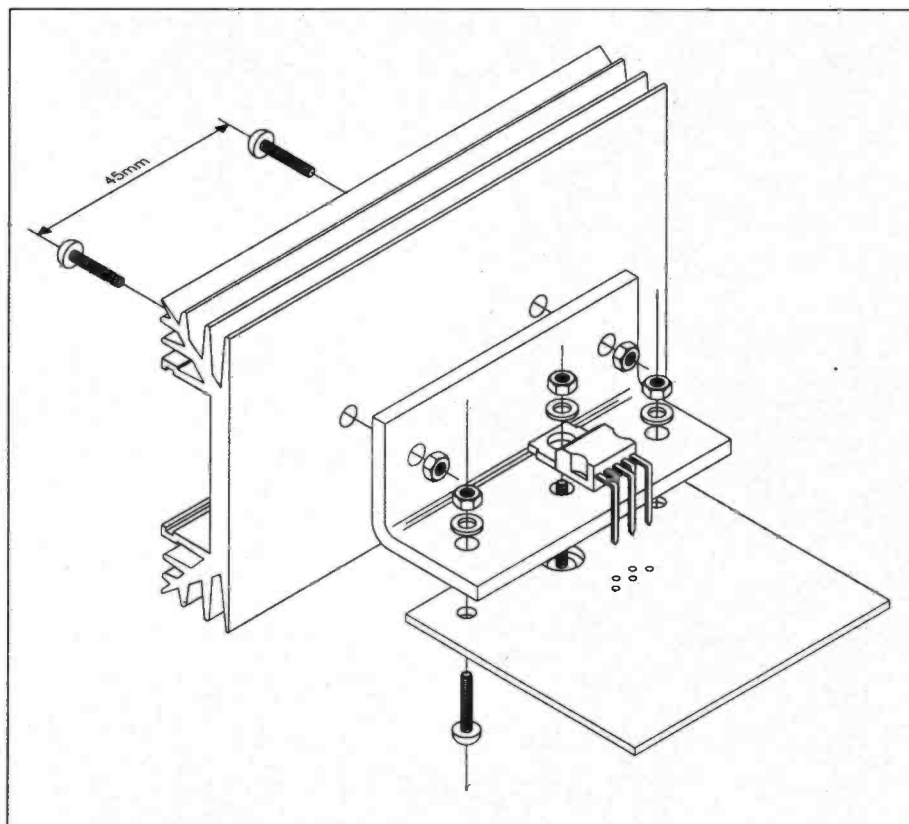


Figure 5. Mechanical assembly of Amplifier Module (non-isolated heatsink).

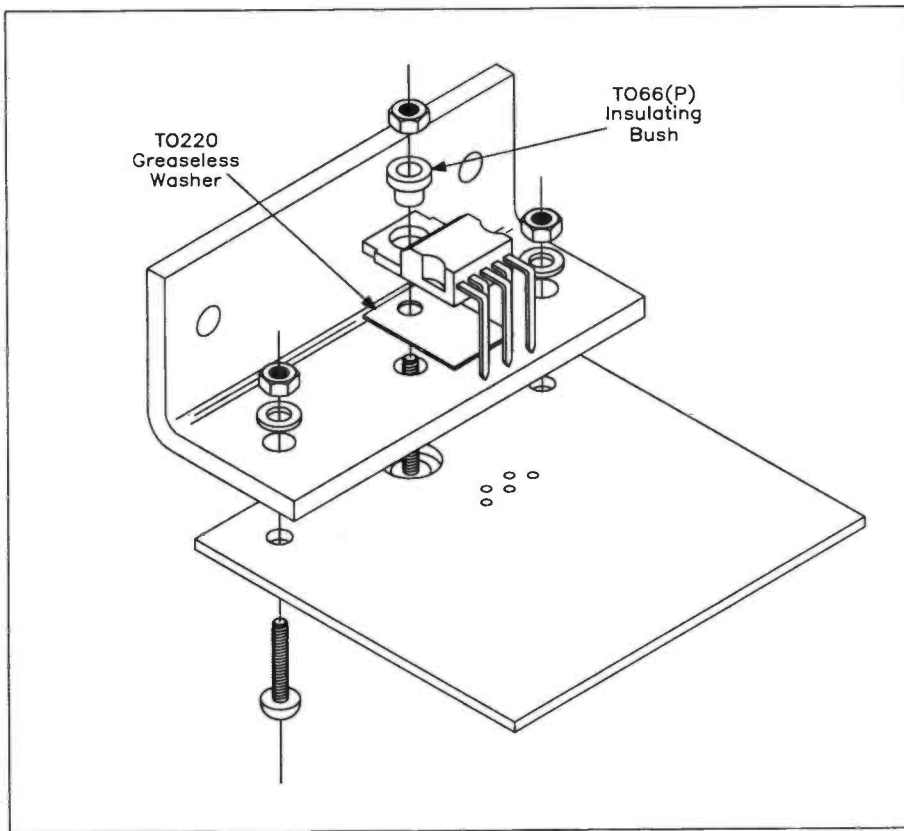


Figure 6. Mechanical assembly of Amplifier Module (isolated heatsink).

	PSU 1/Pin 1	PSU 1/Pin 2	PSU 2/Pin 1	PSU 2/Pin 2
Mono PSU	Red/Blue	Yellow/Grey	—	—
Stereo PSU	Red	Yellow	Blue	Grey

Table 2. Transformer secondary wiring.

Constructing the Power Supply PCB

Referring to the PCB legend of Figure 8, solder all components and PCB pins into place. It is important to ensure that the two reservoir capacitors, C1 and C2, are inserted the correct way round. Note that the two fuse clips should be pushed down as close as possible to the PCB, before soldering them in place. After finishing construction, check your work – particularly the polarity of the capacitors!

Installation

The amplifier(s) may be fitted into any case of a suitable size. Although it is feasible to install the completed modules into a plastic box, we would recommend the use of a metal case, which will provide good electrical screening of the amplifier and wiring. In addition, it will provide some degree of heat dissipation – but this cannot be a proper substitute for a suitable heatsink! Note that a metal case must be properly earthed, if it is also going to accommodate the mains supply. If you are not building the LT24B power supply as described in this article, the one used must be capable of supplying between +25V and +40V at 1.2A per amplifier. This applies in situations where a suitable supply rail is already present in existing equipment.

The amplifiers are best mounted as far away as possible from the power transformer, to avoid the possibility of hum being induced into the amplifier

circuitry; a possible layout is shown in Figure 9. This, of course, will vary depending on the size of the case, and other requirements specific to your chosen application.

Once a suitable layout has been decided, the transformer and modules can be fitted. Using the mounting hardware supplied, fit the transformer onto the chassis or case; the round metal plate and one rubber washer go over the top of the transformer, while the other rubber washer goes under the transformer; fit the 2BA solder tag on the screw before fitting the nut. Spacers should be used to hold the amplifier and PSU modules above the bottom of the case; this is particularly important if a metal case is used! Solder the secondary connections to Pin 1 and Pin 2 of each power supply module, as determined from Table 2.

Note that the mains earth should be soldered to the solder tag associated with the transformer mounting screw, but not to 0V on the PSU, otherwise an earth loop – a major cause of hum – may be introduced. Figure 10 shows how to fit the fuseholder, and a mains switch should one be required. It is important to insulate all connections at mains potential with heat-shrink sleeving. Alternatively, purpose-designed insulating boots are available for panel-mounting fuseholders (FT35Q) and switch terminal blades (FE65V). If an insulating boot is to be used with the chosen fuseholder, it should be held in place with a cable tie, as shown in Figure 10.

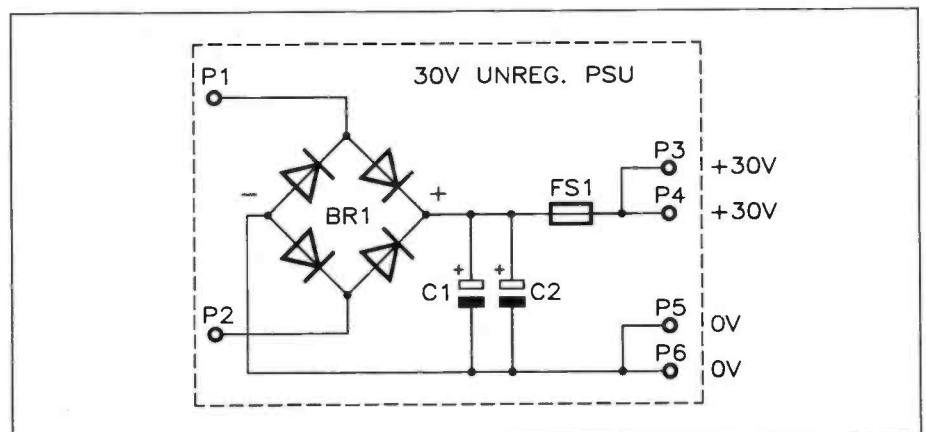


Figure 7. Power Supply Module circuit diagram.

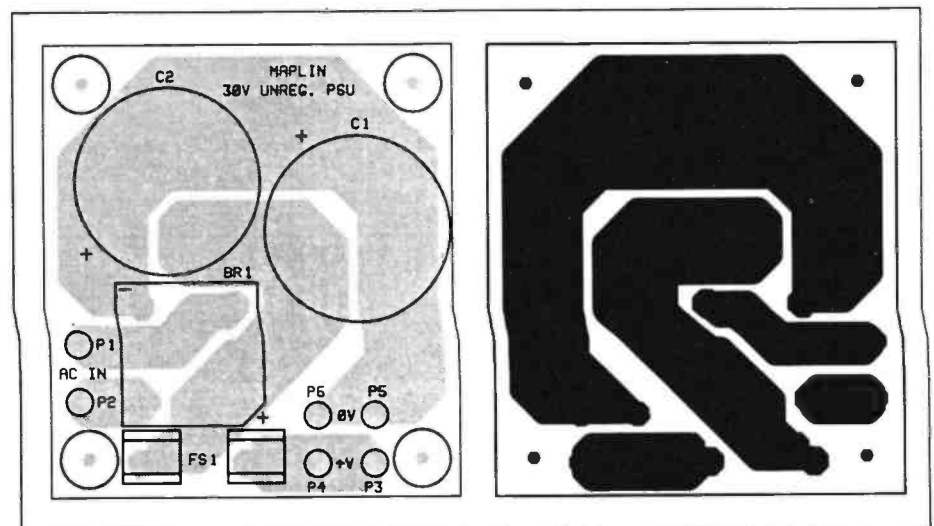


Figure 8. Power Supply PCB legend and track.

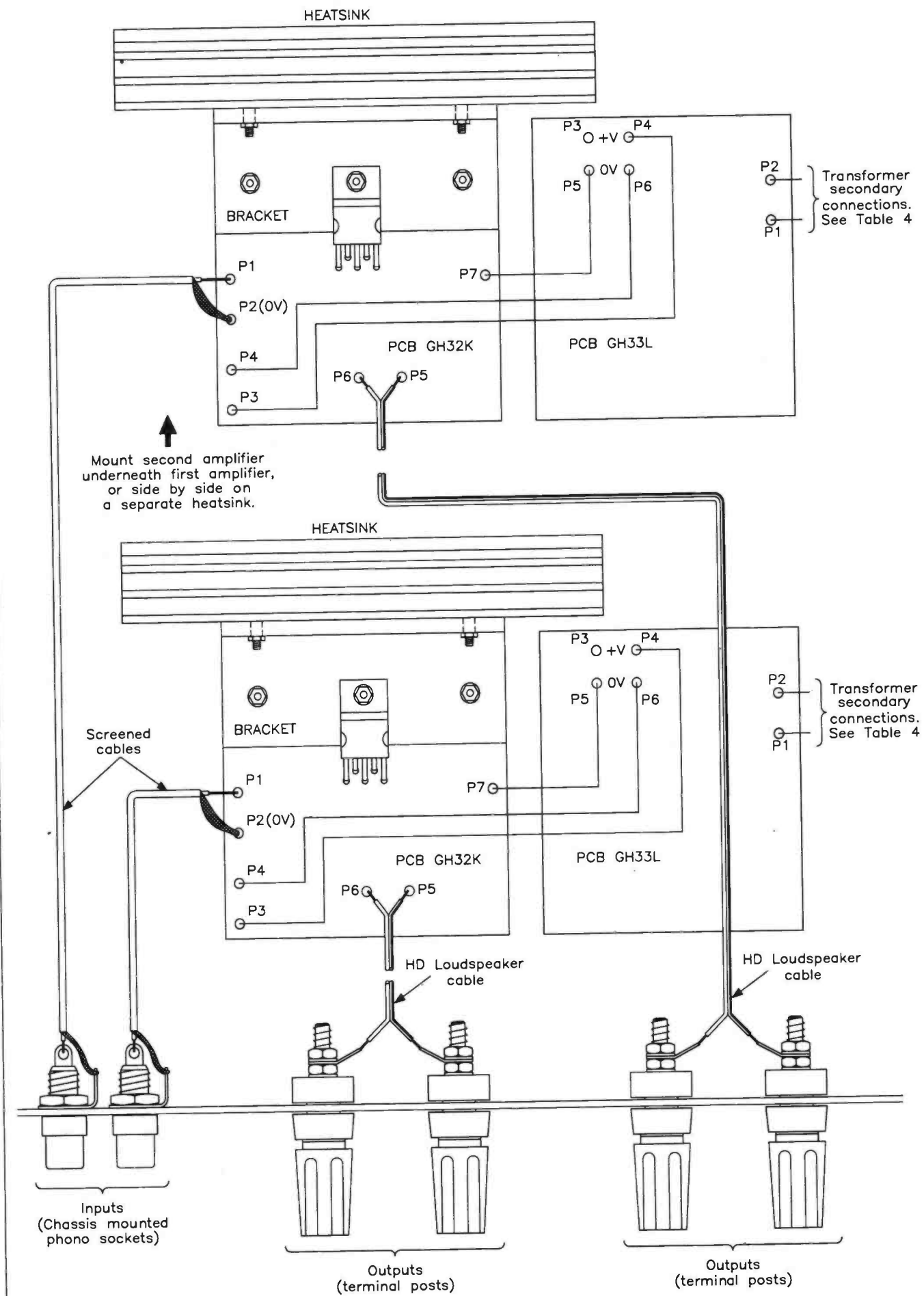


Figure 9. Suggested layout for stereo amplifier system.

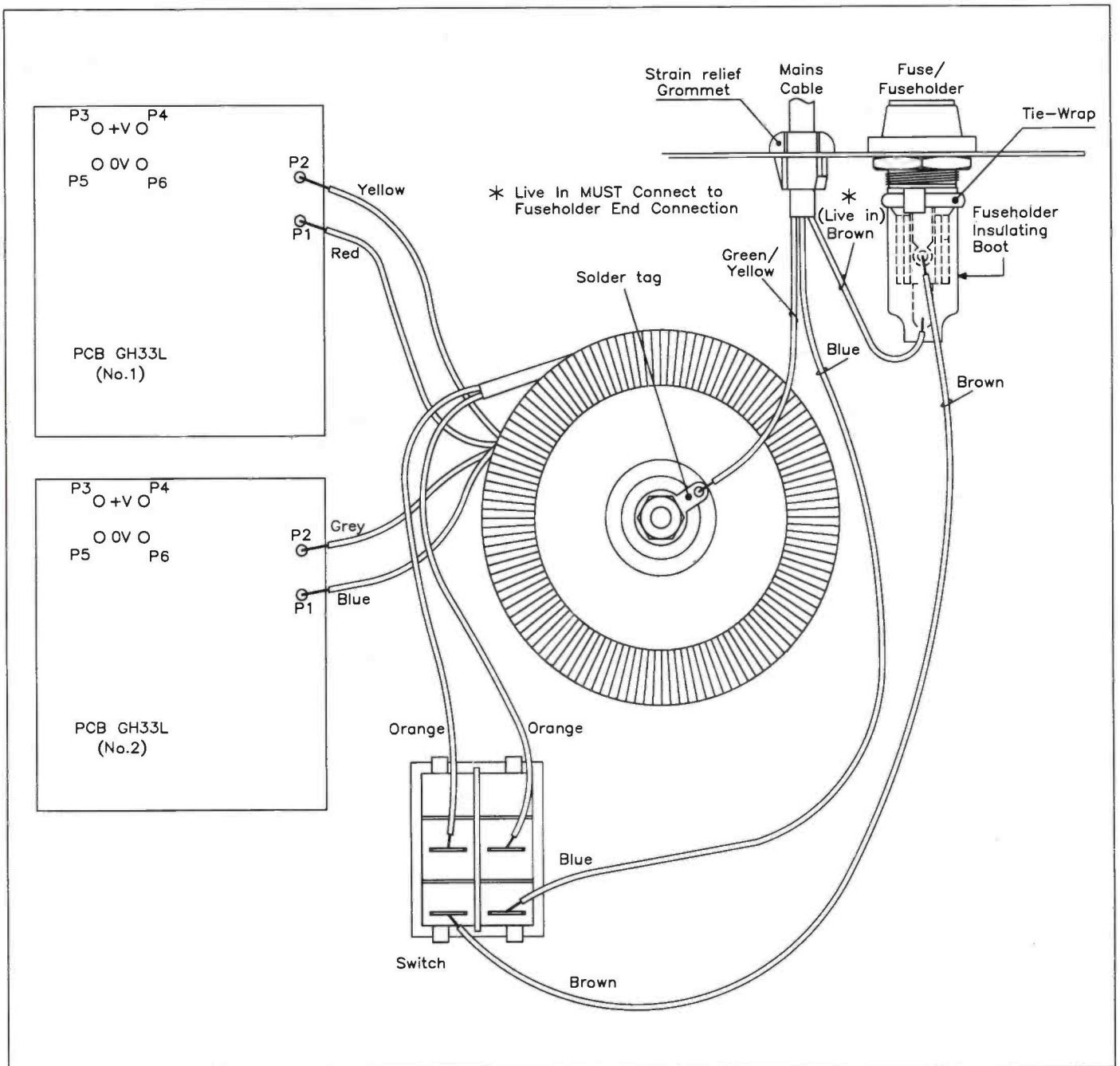


Figure 10. Transformer and mains wiring (stereo system shown).

It must be understood that the heatsink bracket is not adequate for normal use, and should be bolted to the case and/or heatsink, such as Heatsink 4Y (FL41U). Thermal compound should be smeared at the contact point between the mating surfaces.

Testing the Power Supply

Remove FS1 (if fitted). Connect a multimeter, set to a suitable DC voltage range, between Pin 5 (0V) and the positive side of C1. Apply power to the circuit and check that the off-load voltage is about 36V ($\pm 1V$). Disconnect the power, remove the multimeter and fit FS1. Repeat the tests for the second power supply, if used.

Final Construction

Connect each PSU to pins 4 (0V) and 3 (+30V) of the corresponding amplifier

using heavy-gauge insulated wire. Lengths of wire (XR32K, black; XR36P, red) are supplied with the kit for this purpose; keep the connections as short as possible.

Connect pins 5 and 6 of each amplifier to a suitable speaker with good quality speaker cable (e.g., XR60Q). When selecting speakers for use with the amplifier modules, bear in mind that although this amplifier is rated at 15W RMS, it is capable of delivering up to 30W on transient peaks. Speaker sockets can be used, particularly if the amplifiers are being built into a case; chassis-mounting 2-pin DIN sockets (HH31) or terminal posts (e.g., HF02C, black; HF07H, red) can be used, depending on your personal taste and the amplifier's intended application. An audio source, at a level of around 250mV RMS, should then be connected to the amplifier's input pins, 1 and 2 (note that Pin 2 is 0V). Alternatively, an input socket could be used - a chassis-mounting phono socket

(e.g., YW06G) is ideal. If you require a socket that is isolated from the case, (JZ05F, black; JZ06G, red) could be used. A further connection may be made from the PSU 0V to Pin 7 (0V2) on the amplifier; this is not essential but provides a good ground connection to the heatsink bracket and the corresponding copper track on the underside of the PCB, and can help to reduce noise. As mentioned earlier, this pin should be left unconnected if you wish to isolate the circuit from the case.

Testing the Amplifier(s)

First ensure that the audio input is set to minimum, switch the power supply on; gradually increase the audio input level and check that the output shows no audible distortion throughout the full power range. If you are using a second amplifier for stereo applications, connect this in the same manner and repeat the tests.

15W AMPLIFIER MODULE PARTS LIST

RESISTORS: All 1% Metal Film

R1,3	22k	2	(M22K)
R2	100k	1	(M100K)
R4	4k7	1	(M4K7)
R5	150k	1	(M150K)
R6	1Ω	1	(M1R)

CAPACITORS

C1	1μF Polyester	1	(BX32D)
C2	22μF 63VPC Elect	1	(FF07H)
C3	10μF 50V PC Elect	1	(FF04E)
C4	220nF Polyester	1	(BX78K)
C5	2200μF 35V PC Elect	1	(IL28F)
C6	100μF 63V PC Elect	1	(FF12N)
C7	100nF Polyester	1	(BX76H)

SEMICONDUCTORS

D1,2	1N4001	2	(QL73Q)
IC1	TDA2030	1	(WQ67X)

MISCELLANEOUS

15W Amp Bracket	1	(YQ36P)
Pin 2141	1 Pkt	(FL21X)
PCB	1	(GH32K)
Bolt 8BA x 1/2in.	1 Pkt	(BF06G)
Washer 6BA	1 Pkt	(BF22Y)
Nut 6BA	1 Pkt	(BF18U)
Heavy Duty Speaker Cable	1m	(XR60Q)
Instruction Leaflet	1	(XU07M)
Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

Heatsink 4Y	1	(FL41U)
TO66(P)	1	(WR23A)
Heat Transfer Compound	1 Tube	(HQ00A)
Heavy Duty Speaker Cable	As req.	(XR60Q)

30V UNREGULATED POWER SUPPLY MODULE PARTS LIST

CAPACITORS

C1,2	2200μF 63V PC Elect	2	(JL29G)
------	---------------------	---	---------

SEMICONDUCTORS

BR1	PW01	1	(WQ57M)
-----	------	---	---------

MISCELLANEOUS

FS1	Fuse 2A A/S	1	(WR20W)
	Fuse 20mm Clip Type 1	2	(WH49D)
	Pin 2141	1 Pkt	(FL21X)
	PCB	1	(GH33L)
	Wire 3202 Black	1m	(XR32K)
	Wire 3202 Red	1m	(XR36P)
	Instruction Leaflet	1	(XU07H)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

S1	Neon Switch Red	1	(YR70M)
FS3	Fuse 1 1/2in. 1A	1	(WR11M)
TR1	Toroidal Transformer		
	120VA 24V	1	(YK86T)
	Fuseholder	1	(FA39N)
	Fuseholder Boot	1	(FT35Q)
	Tie Wrap 102	1	(BF91Y)
	Miniature Mains Cable	As req.	(XRO1B)
	Strain Relief Grommet 5R2	1	(LR48C)
	Push-on Receptacles	1 Pkt	(HF10L)
	Push-on Receptacle Covers	1 Pkt	(FE85V)
	Tag 2BA Solder	1 Pkt	(BF27E)
	Chassis Mounting Phono Skt.	2	(YW06G)
	Chassis Mount 2 pin DIN Skt.	2	(HH31J)

The Maplin 'Get-You-Working' Service is available for these projects, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as kits, which offer a saving over buying the parts separately.

Order As LT23A (15W Amplifier Module)

Order As LT24B (Unregulated 30V PSU)

Please Note: Where 'package' quantities are stated in the Parts Lists (e.g. packet, strip, reel, etc.), the exact quantity required to build the projects will be supplied in the kits.

The following new items (which are included in the kits) are also available separately,

but are not shown in the 1993 Maplin Catalogue.

15W Amplifier Module PCB **Order As GH32K**

Unregulated 30V PSU PCB **Order As GH33L**



IN-SITU TRANSISTOR TESTER

by Terry Pinnell

FEATURES

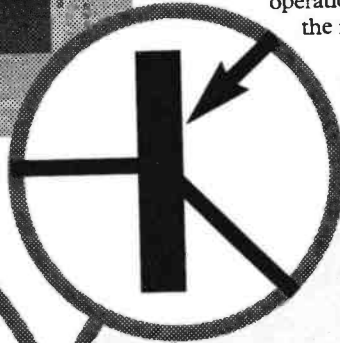
- ★ Tests NPN and PNP Transistors
– In or Out of Circuit
- ★ Easy to Use – 2-LED Indication
of Transistor Condition
- ★ Low Power Consumption
- ★ Easy to Build
- ★ Low Cost

I made this little device about ten years ago, and it has proved to be one of the most useful items of test gear on my workbench. Transistor testers of more conventional design have been published regularly in the electronics hobbyist magazines, and many digital multimeters now also include facilities for testing transistor gains. But all of these assume the transistor is in splendid isolation, with its leads neatly available and disconnected from other circuitry. In unique contrast, the unit described here can also test a transistor which is still permanently connected in its circuit.

If your projects always work first time – and never go wrong – then you probably won't need this gadget. But I suspect most hobbyists have similar problems to mine. Once a project has been assembled, Sod's Law dictates that it will exasperatingly refuse to do what it should. Or it will fail months (or even years) later, when all memory of its design and peculiarities have long since faded away, and you must fall back on any records you made, or on the original published article (if any).

Of course, there are many possible reasons for a project failing to work – like poor soldering, careless wiring, polarity-reversed capacitors or diodes, and even (admit it!) an overlooked run-down battery or blown fuse. But experience indicates that faulty transistors take a high place in this league-table. Their failure can be attributed to a variety of causes. It could be because they had been connected wrongly, or that too much heat was applied when soldering. Perhaps current flow was excessive, because of incorrect resistor values, eventually burning out the transistor. If the usual protective surge diode associated with the switching of inductive loads (such as relays) is of inadequate rating, then the transistor might survive a hundred operations and give up the ghost on the next.

However, whatever the cause, it usually becomes blindingly obvious only after you've discovered it!



APPLICATIONS

- ★ Testing Ex-Equipment Transistors
- ★ Servicing

Until then it can be an infuriating mystery. When the circuit dies on you and you've checked all the obvious things, shaken it around a bit, applied a soldering iron hopefully to a few random joints and changed the odd IC, then sooner or later you'll want to check out the transistors. In some cases, if you have a clear idea of the circuit's principles and are comfortable with a bit of basic electronics theory, then you can methodically perform tests with your multimeter and logically draw conclusions about each transistor's status. But if you are not such a masochist, then you need the In-Situ Transistor Tester. It avoids any unsoldering, can be used even in a crowded circuit, and reliably gives a clear indication of the component's condition, for both NPN and PNP types.

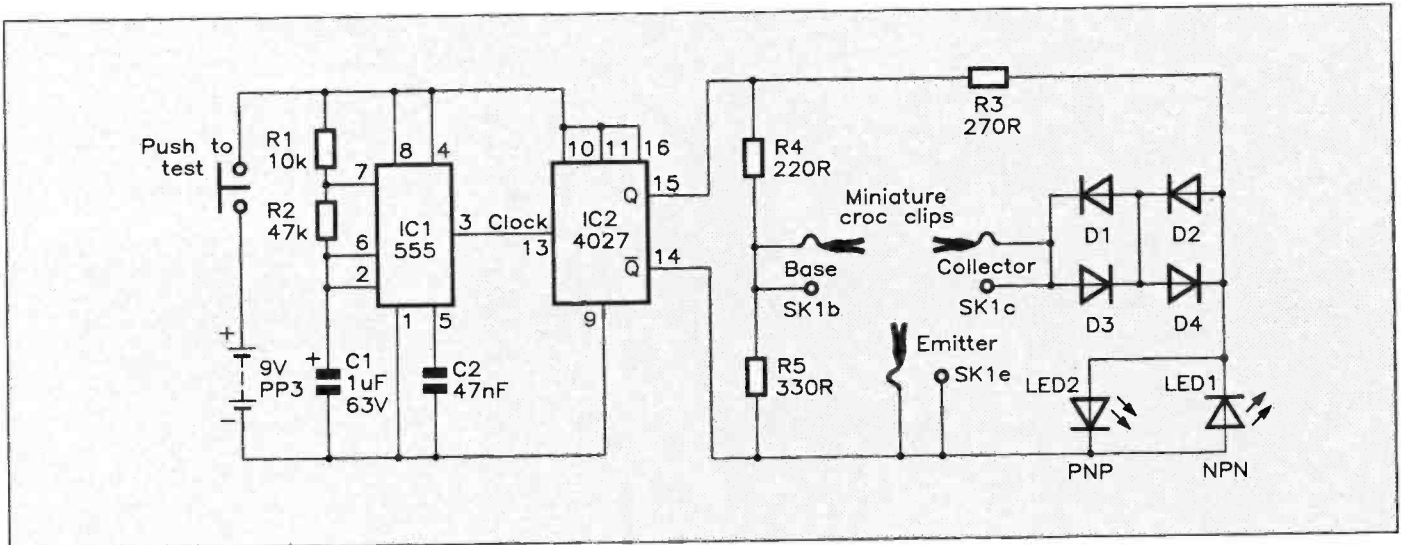


Figure 1. In-Situ Transistor Tester circuit diagram.

Circuit Description

The full circuit diagram is shown in Figure 1. When power is applied via the push-button, a conventional 555 astable multivibrator produces square pulses at a frequency of about 10Hz. These clock the 4027 CMOS J-K flip-flop, IC2. Note that IC2 is actually a dual device, but only one of the two flip-flops is used here. With both inputs taken to +V, each positive-going edge of the clock input (pin 13) causes the output (pin 15) to go high and low alternately – the flip-flop effectively divides the signal frequency by two. Note that when pin 15 is high, the complementary output Q (pin 14) is low, and vice versa.

These outputs are at a low-ish impedance and can provide quite a large maximum cur-

rent (around 10mA) at the 9V supply level used here, which is more than enough to drive the bases of most transistors, including power types.

To understand how the transistor section of the circuit works, let us take an NPN type as an example, and consider each half of the astable cycle in turn. Figure 2 shows the situation when Q is high and Q-bar is low – the transistor is switched on, via current limiting resistor R4. This means that the two LEDs are effectively shorted out, because the voltage drop across D1 and D2 is about 1.2V – significantly less than the 1.8V or so needed by the LED. As a result, neither LED is lit during this period.

When the flip-flop outputs change polarity during the second half of the cycle, with Q now low, the status is as in Figure 3. The

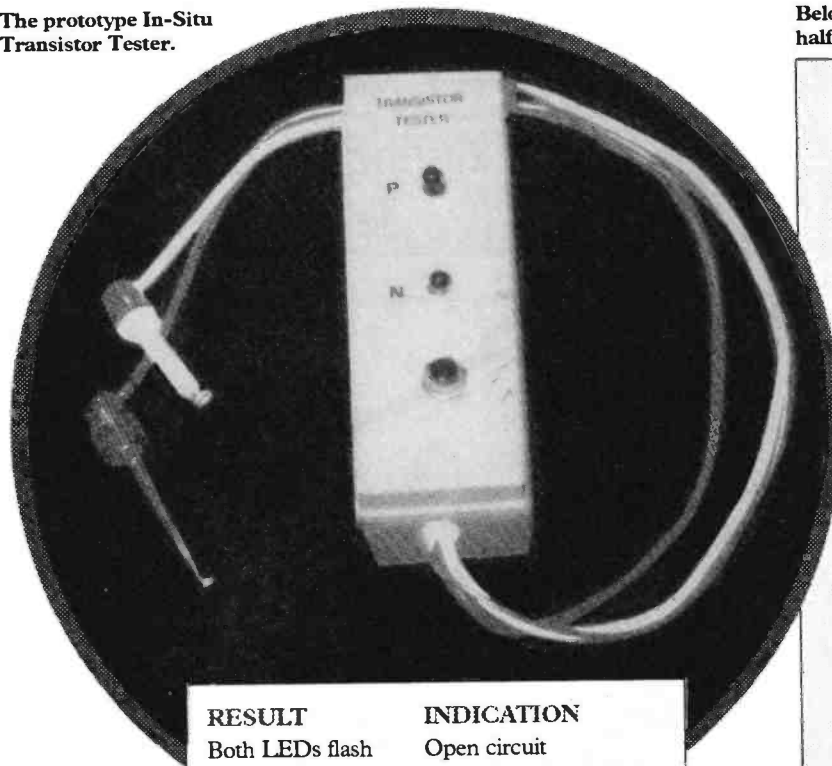
transistor is now reverse-biased, so it is switched off and all current flows through LD1, via limiting resistor R3. LD1 therefore flashes on and off, correctly indicating a properly functioning NPN transistor under test.

A similar analysis will show that LD2 flashes for a good PNP type.

An open-circuit transistor (perhaps burnt out) will pass current on neither half-cycle, so both LEDs will flash on and off alternately. However, if the transistor is shorted out between collector and emitter it will always conduct, and therefore neither LED will be lit at any time.

The four diodes (D1, D2, D3 and D4) are present to allow for situations where the transistor has a base-collector or base-emitter short. Here, the other (working) junction

The prototype In-Situ Transistor Tester.



RESULT	INDICATION
Both LEDs flash	Open circuit
or	Base-Emitter short
or	Base-Collector short
LED1 flashes	NPN OK
LED2 flashes	PNP OK
Neither flash	Collector-Emitter short

Table 1. Possible transistor test results.

Below: Figure 2. Effective circuit for NPN transistor during half-cycle when Q is high.

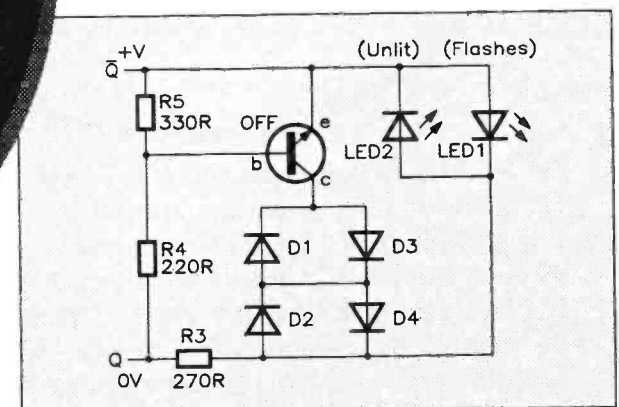
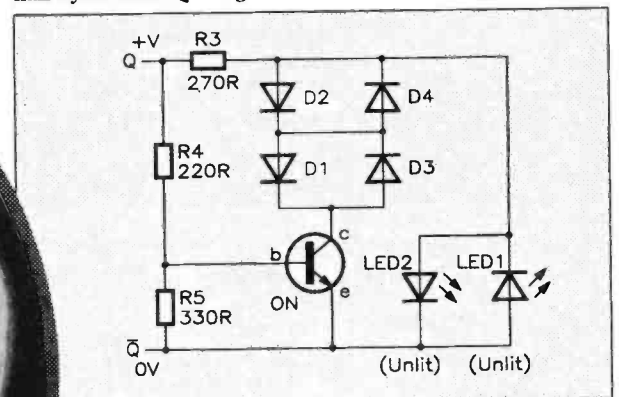


Figure 3. Effective circuit for NPN transistor during half-cycle when Q is low.

would act as a diode, conducting on half-cycles – misleadingly indicating a good component. If D1 and D2 (or D3 and D4) conduct, the voltage dropped across them is about 1.2V. If the transistor was functional, only about 0.1V would be dropped across it – so in total, the voltage across the diodes and transistor would be about 1.3V, insufficient for the LEDs to be activated on those half-cycles when the transistor is on. On the other hand, if the transistor has a base-collector or base-emitter short, then the voltage drop across it will be about 0.6V, giving a total of approximately 1.8V – enough to light up the appropriate LED. As a result, both LEDs will flash, as they would for the quite different fault of an open-circuit transistor. All these possible results are summarised in Table 1.

Power consumption is low; in fact the prototype's original 9V PP3 battery lasted until quite recently – not bad Ever Ready!

Construction

The method of construction is not critical – you can use stripboard or even etch your own PCB, if you like. I built the original In-Situ Transistor Tester circuit on a small piece

of Veroboard. As you can see from the photograph, I used an empty photographic slide container to house this project, and it still looks OK after ten years. A small project box from the current Maplin range would be more suitable, though!

In addition to the three miniature crocodile clips, a transistor socket could be mounted onto the case for the convenient testing of new or unsoldered components.

Due to its simplicity, this circuit should be easy to assemble. The standard rules of electronic construction, as outlined in the Constructors' Guide, apply here – in particular, make sure that polarised components (D1 to D4, C1, IC1, IC2) are wired up correctly. Once your circuit has been built up, it is always good practice to check it for solder bridges, misplaced components, dry joints and so on – mistakes spotted now save frustration and expense later.

Use

For virtually all the tests I've ever made, the unit has worked perfectly. There are conceivable situations, however, when it is theoretically possible for the tester to give a

misleading result. For example, transistors that have particularly low value resistors across their base-collector or base-emitter junctions may prove problematic. R4 should prevent this from happening, unless such resistors have a value of 47Ω or less. In practice, though, even power transistors can usually be satisfactorily tested in-circuit.

The In-Situ Transistor Tester is also useful if, like me, you tend to hoard old transistors. Sometimes you may even be unsure whether they are NPN or PNP, much less whether they work or not! Using this unit, you can quickly answer both questions.

In summary, short of unsoldering the faulty component and replacing it, this handy little gadget just about does it all!

Note

The circuit and information presented here must be considered as a basis for your own experimentation. No warranty is given for suitability in particular applications – Maplin cannot support this information in any way. However, where possible, we endeavour to check that information presented is correct, and that circuits will function as stated.

IN-SITU TRANSISTOR TESTER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1	10k	1	(M10K)
R2	47k	1	(M47K)
R3	270Ω	1	(M270R)
R4	220Ω	1	(M220R)
R5	330Ω	1	(M330R)

CAPACITORS

C1	1μF 63V Minelect	1	(YY31J)
C2	47nF 16V Ceramic	1	(YR74R)

SEMICONDUCTORS

IC1	NE555	1	(QH66W)
IC2	4027BE	1	(QX16S)
D1 – D4	IN4148	4	(QL80B)
LD1, 2	LED 5mm Red	2	(WL27E)

MISCELLANEOUS

8-pin DIL Socket	1	(BL17T)
16-pin DIL Socket	1	(BL19V)

PP3 Battery Clip	1	(HF28F)
Alkaline PP3 Battery	1	(FK67X)
Wire 7/0.2 Red	1 Pkt	(BL07H)
Wire 7/0.2 Black	1 Pkt	(BL00A)
Wire 7/0.2 White	1 Pkt	(BL09K)
Stripboard	1	(JP46A)
Miniature Crocodile Clip Red	1	(FM37S)
Miniature Crocodile Clip Black	1	(FK34M)
Miniature Crocodile Clip White	1	(FK37S)
TO18 Transistor Socket	1	(WR29G)
and/or		
TO5 Transistor Socket	1	(WR31J)
Push-to-Make Switch	1	(FH59P)
Housing e.g.: Hand-held Case with Battery Compartment	1	(ZB17T)
Constructors' Guide (if required)	1	(XH79L)

The Maplin 'Get-you-Working' Service is not available for this project.

The above items are not available as a kit.

MOVING MESSAGE
DISPLAY SYSTEM

DISPLAY SYSTEM



PART THREE

Text by John Koushappas
and Martin Pipe

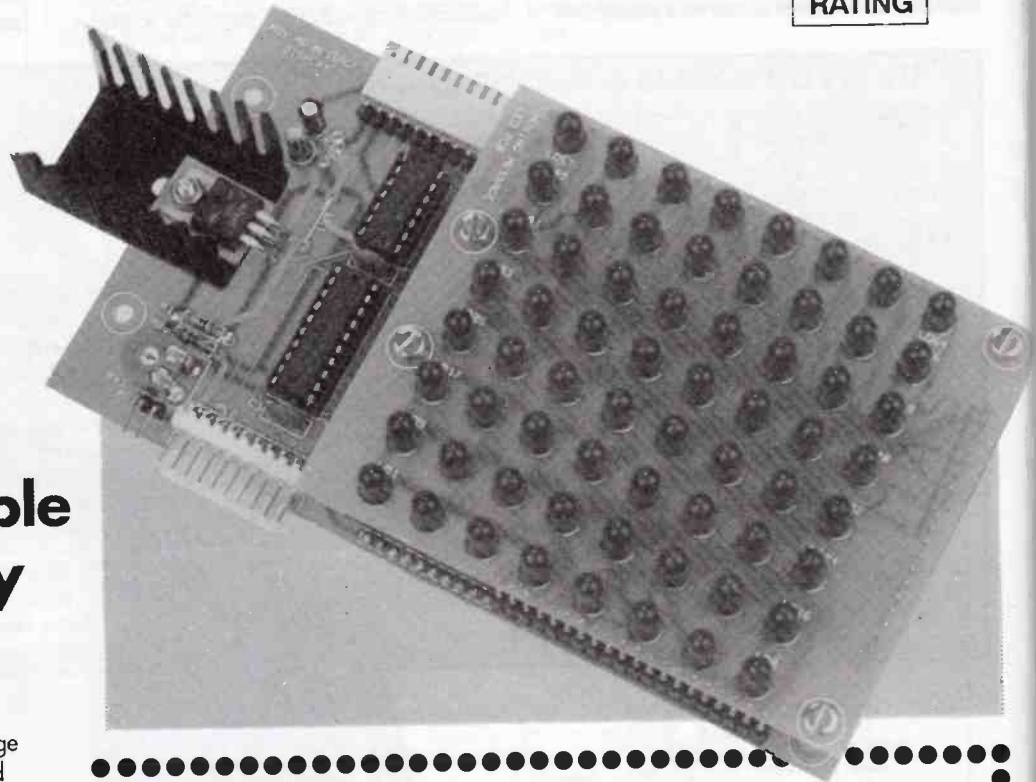
Design by John Koushappas

Development by
Tony Bricknell

Constructing the Expandable Power Supply

Unregulated Power Supply

All of the modules in the Moving Message Display require an external mains-based power supply. This power supply needs to be capable of supplying an unregulated (but well smoothed) DC voltage of between 7 and 9V at a minimum current of 1A for each display module, and between 80 and 120mA for each controller module. With the appropriate components, the design to be described will provide sufficient power, at a voltage of 9V, for up to six Moving Message Display Modules, and the three associated Controller Modules. As the required voltage regulator circuitry is present on the display modules themselves, the power supply is of simple design. The PCB used, incidentally, is that of the 15W Amplifier PSU described elsewhere in this issue. Different sets of components are used, however – we use the plural form intentionally as the number of modules to be powered influences the specifications and ratings of the components required in each set. If you do have one of

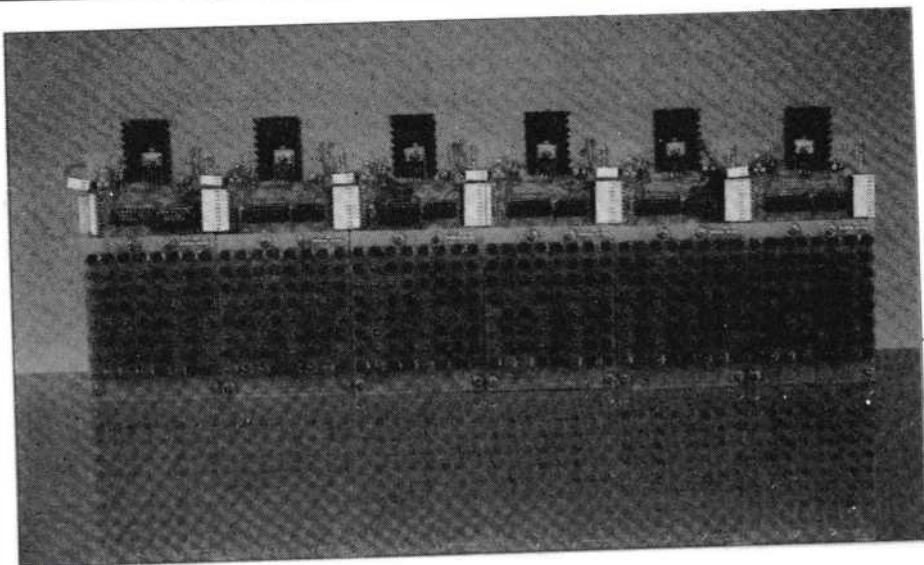


FEATURES

- ★ Designed for use with any computer equipped with three 8-bit I/O ports – e.g., an IBM PC or compatible equipped with the Maplin 24-line PI/O card
- ★ Easily programmable from BASIC
- ★ Expandable to 32 boards by 'daisy-chaining' modules together
- ★ Large viewing area makes display highly readable in all lighting conditions
- ★ Programmable scrolling in all directions
- ★ Facilities for fade up/down
- ★ Programmable 'fizzle' effects
- ★ Direct pixel addressing for Speed (Animations, etc.)
- ★ Easy to Build

APPLICATIONS

- ★ Shop Displays
- ★ Announcements in Public Areas
- ★ Attention Grabbing!
- ★ Special Effects



A bank of display modules.

positions - C1 and C2 - available on the PCB). In addition, the transformer and fuse ratings are increased to allow for the extra demands made by a larger system.

The Display Controller boards derive their power supply from connector PL1 (pins 1 and 2) on each odd-numbered Display Module (refer to Part 2). The current drawn should not exceed 120mA for a fully populated Master; the others should draw somewhat less. The Moving Message Display Module's voltage regulator has 300mA of specified headroom to cover this requirement.

Because you are expanding the system - possibly continuously - you must remember to upgrade the unregulated power supply each time. If you intend to build an expandable system larger than a Base System, you should use the larger (50VA) toroidal transformer.

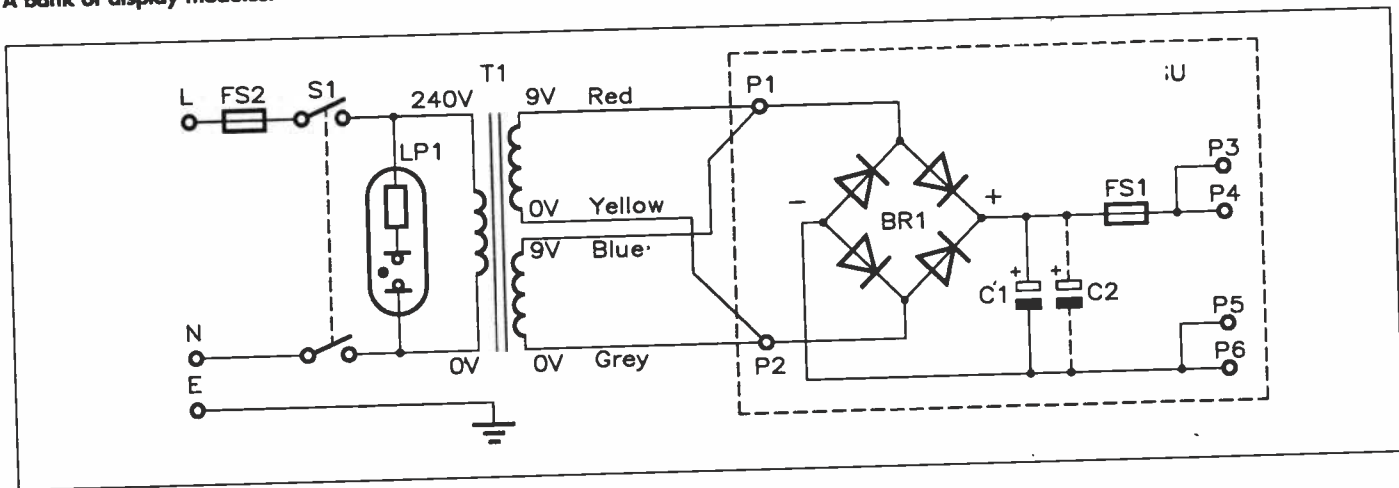


Figure 1. Unregulated Power Supply Module circuit diagram.

the 15W Amplifier PSUs, do not attempt to use it with the Moving Message Display - around 30V DC is produced with the amplifier transformer; the display system requires only 9V!

Power Supply Variations

The Unregulated Power Supply designed for use with the Moving Message Display Module is based around the 15W Amplifier PSU PCB. It accommodates a bridge rectifier, fuse and reservoir capacitor(s). The required mains transformer is too large to be mounted on the PCB and so is separate, being wired to the PCB by means of PCB pins. The overall circuit diagram is shown in Figure 1.

The bridge rectifier converts the AC output from the transformer into a full-wave rectified AC voltage, which is then smoothed by a reservoir capacitor, C1 (and C2 where fitted). The smoothed DC voltage is then output via a fuse, FS2, which protects the power supply against an overload which may, for example, be caused by a short circuit.

As mentioned earlier, the actual component types used depend on the number of display modules to be powered. The variations are summarised in Table 1. Note that the increased reservoir capacitance required for larger loads can be obtained by increasing the value of the capacitor, or by fitting a second (there are two suitable

Number of Modules	Transformer, T1	Bridge Rectifier, BR1	C1	C2	FS1
1	0 to 9V, 0 to 9V 1.66A, 1.66A	PW01 WQ57M	4700µF FM83E	—	1.25A A/S UJ96E
	Order Code YK09K				
2	0 to 9V, 0 to 9V 1.66A, 1.66A	PW01 WQ57M	4700µF FM83E	—	2.5A A/S UJ97F
	Order Code YK09K				
3	0 to 9V, 0 to 9V 1.66A, 1.66A	PW01 WQ57M	10,000µF JL31J	—	3.15A A/S RA11M
	Order Code YK09K				
4	0 to 9V, 0 to 9V 2.77A, 2.77A	PW01 WQ57M	10,000µF JL31J	—	5A A/S RA12N
	Order Code YK14Q				
5	0 to 9V, 0 to 9V 2.77A, 2.77A	PW01 WQ57M	10,000µF JL31J	4700µF FM83E	5A A/S RA12N
	Order Code YK14Q				
6	0 to 9V, 0 to 9V 2.77A, 2.77A	PW01 WQ57M	10,000µF JL31J	10,000µF JL31J	6.3A A/S RA13P
	Order Code YK14Q				

Table 1. Power Supply Options.

Unregulated Power Supply PCB Assembly

Construction of the Power Supply PCB is perfectly straightforward. Orientation of the reservoir capacitor(s), C1 and C2 (where fitted) is critical – the minus symbol embossed on the capacitor(s) must point away from the '+' symbols printed on the PCB legend, which is reproduced in Figure 2. Failure to observe correct polarity may cause the capacitors to act as very effective mortars! Of equal importance is the correct fitting of the bridge rectifier, BR1. The positive symbol moulded into its casing must line up with that of the PCB legend – a dot or 'missing corner' may also indicate the bridge rectifier's positive terminal.

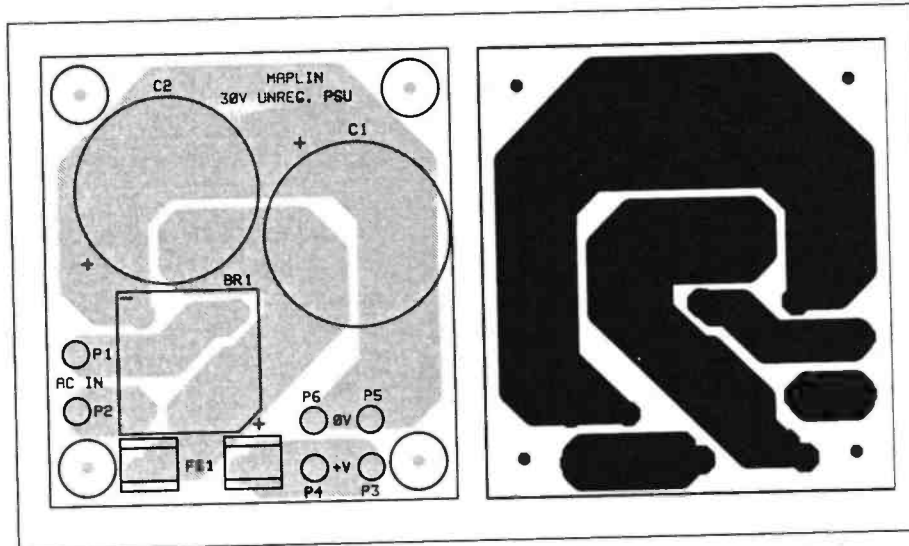


Figure 2. Unregulated Power Supply PCB legend and track.

The PCB pins are fitted from the track side of the board – these should be pressed in with a hot soldering iron. Additional information on soldering and general assembly, should you require it, can be found in the Constructors' Guide (XH79L).

When wiring up the transformer, it is important that it is wired up correctly – otherwise the fuse may blow and/or the transformer will burn out. The correct wiring details are shown in Figure 1. In short, the 'start' ends of each secondary winding (red and blue) are both connected to P1, while the 'finish' ends of each secondary winding (yellow and grey) are both connected to pin 2. Note that this colour code applies to both transformer types used with the Moving Message Display system.

Expansion of the PCB for use with a greater number of modules is easy. Moving up from a Base System, for example, simply involves desoldering the old components and replacing them with those capable of coping with the extra load – as outlined in Table 1.

Wiring up the Power Supply to the Moving Message Display

Each moving message display module must have its own power supply wires coming from the power supply source – an example of a 'fully loaded' power supply with 6 display modules is shown in Figure 3. It is critically important to ensure correct polarity – pins P5 and P6 are the power supply

ground, while the positive supply rail is present on pins P3 and P4. Failure to observe correct polarity may cause severe damage to each Moving Message Display Module and Controller Module – so please check that all connections are correct. In addition, do not daisy-chain the power supply, as this can cause several problems and could even be dangerous. Make sure that you use cable of a suitable rating, as each display module requires 1A of current.

When your system goes beyond a six display board system, it is necessary for you to build a second unregulated power supply which can then take your display system's expansion up to 12 display modules (and 6 controllers). When doing this, be sure to link the 0V supply rails together at the sources of

power supply capable of providing 3.9V at the large currents required (approximately 35A for a fully expanded system). Under such circumstances, the regulator components (IC1, RV1, R1, R2) would be omitted from each Display Module. Note that a separate 3.9V feed (connected to PL1) is required for each Module – the arrangement would be similar to that of Figure 3, except that the Unregulated Power Supply Module shown in the drawing would, of course, be a high-power (e.g., switch-mode) regulated one.

Safety Ground Links On Display/Controller Modules

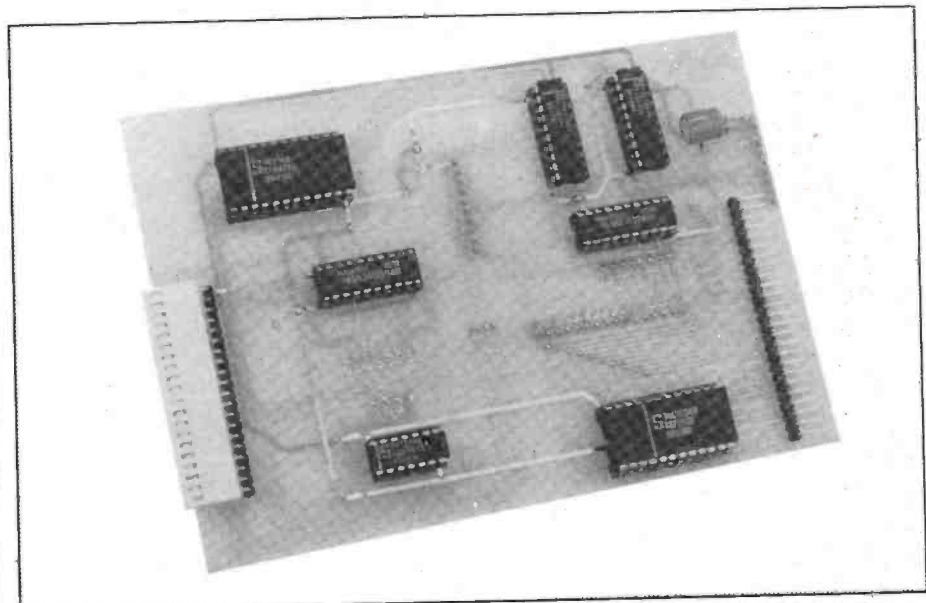
The safety ground links provided on the Moving Message Display Module (LK2) and the Controller Module ('SAFETY GROUND') are there for two reasons. Firstly, they provide a safety net for inter-board grounding. This is important if a ground does not make properly, from one display board to the next, via the power supply ground return wire – something that may be particularly relevant after the Moving Message Display System has been in use for a long period of time. Secondly, making this link can secure the common ground between one board and the next, and the power supply common, thus preventing a potential difference building up between one board's common line and the next, thus preventing TTL logic level problems occurring along a long daisy-chain.

In most circumstances, these connections are unlikely to be required. If the power supply connections have been made consistently, no problems should occur and the first problem will be avoided. The second problem is more difficult to predict. However, no problems have been encountered with the prototypes and these links were left unmade. If problems are encountered (differing brightnesses of the LEDs, incorrect data being displayed, etc.), experimentation with the safety grounds is encouraged when everything else has been checked.

their outputs. Incidentally, a 12-board system would contain 96 LEDs across and so would be as large as most commercial display panels. Furthermore, because of the larger pitch used in our display, it would be some 30% longer as well.

Regulator Bypass Link on Display Module

The regulator bypass link, LK1, is intended for use in situations where you may have a



Controller board, component-side.

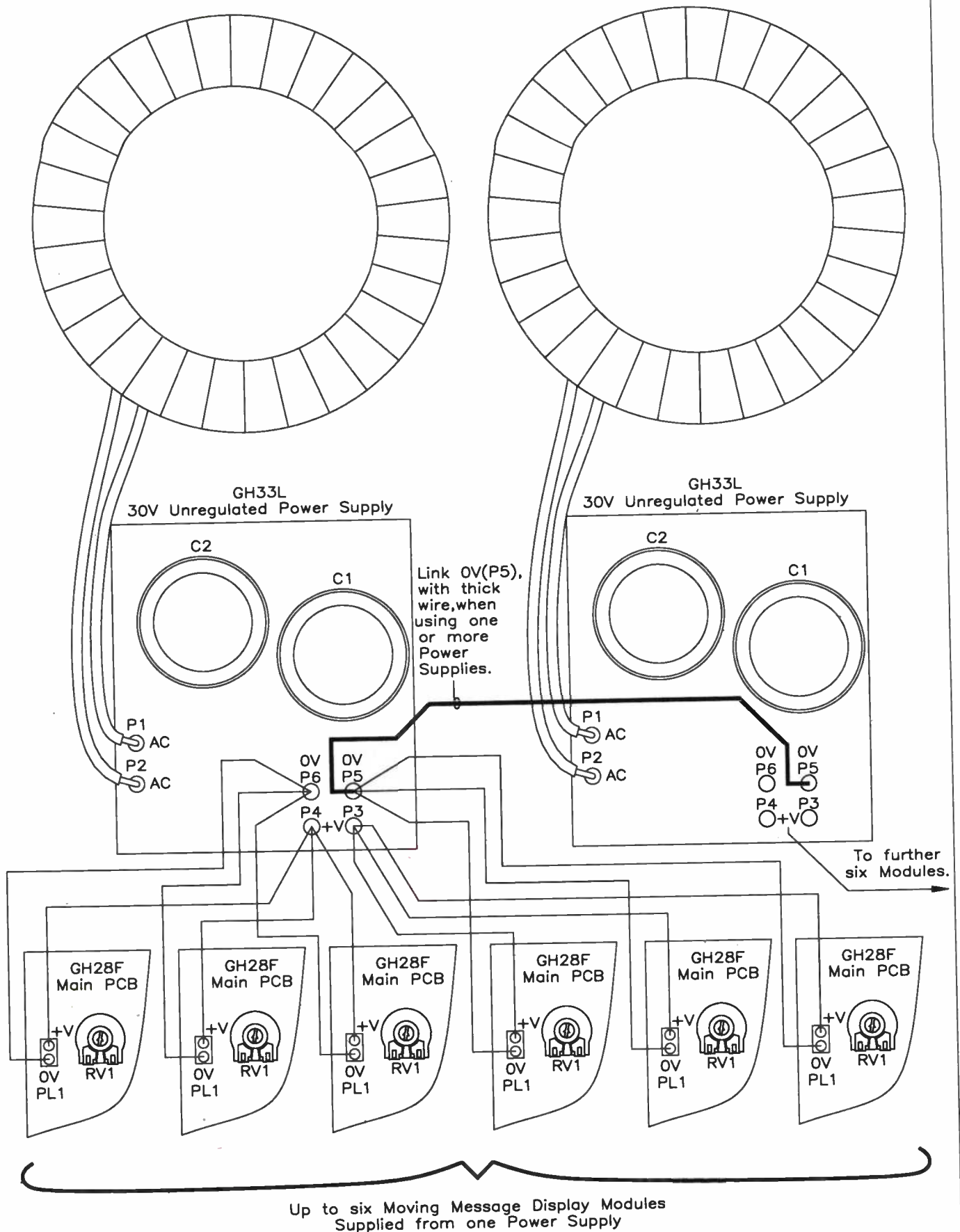


Figure 3. Wiring the PSU Module to (up to 6) Display Modules.

```

1000 KEY OFF
1010 COLOR 15,1
1020 CLS
1030 PRINT:PRINT:PRINT
1040 PRINT:PRINT:PRINT
1050 PRINT"
1060 PRINT
1070 PRINT"
1080 PRINT
1090 PRINT"
1100 PRINT
1110 PRINT"
1120 PRINT
1130 PRINT"
1140 LET NOUGHT%=0
1150 MODULES%=2
1160 ACROSS%=8*MODULES%-1
1170 LET BASEADD%=&H300
1180 LET DATAPORT%=BASEADD%
1190 LET CONTROLPORT%=BASEADD%+1
1200 LET OE%=BASEADD%+2
1210 LET CR%=BASEADD%+3
1220 OUT CR%,128
1230 OUT OE%,1
1240 DIM ARRAY%(90)
1250 DATA 0,0,0,0,0,0,0,0,0
1260 DATA 0,0,0,0,0,0,0,0,0
1270 DATA 0,0,0,0,0,0,0,0,0
1280 DATA 0,0,0,0,0,0,0,0,0
1290 DATA 255,2,4,2,255,0
1300 DATA 252,10,9,10,252,0
1310 DATA 255,9,9,6,0
1320 DATA 255,128,128,128,0
1330 DATA 129,255,129,0
1340 DATA 255,4,8,16,255,0
1350 DATA 0,0,0,0,0,0,0,0,0,0
1360 DATA 0,0,0,0,0,0,0,0,0,0
1370 DATA 0,0,0,0,0,0,0,0,0,0
1380 DATA 0,0,0,0,0,0,0,0,0,0
1390 FOR B%=0 TO 90
1400 READ ARRAY%(B%)
1410 NEXT B%
1420 FOR B%=1 TO 10
1430 FOR FRAME%=0 TO 80
1440 FOR DISWINDOW%=0 TO ACROSS%
1450 OUT CONTROLPORT%,DISWINDOW%
1460 OUT DATAPORT%,ARRAY%(FRAME%+DISWINDOW%)
1470 OUT OE%,3
1480 OUT OE%,1
1490 OUT OE%,3
1500 NEXT DISWINDOW%
1510 NEXT FRAME%
1520 NEXT B%
1530 SCREEN 0
1540 KEY ON
1550 CLS
1560 END

```

Moving Message Display "

Moving Message Demo"

John Koushappas"

(C) Copyright 1992 Maplin Electronics Plc."

V1.0"

```

: ' Number Of Modules In System
: ' i.e. 8 LEDs Per Module
: ' Base Address pointer - set to suit
: ' Port A = Data Port
: ' Port B = Control Port
: ' Port C = Display Output Enable
: ' Control Register for initialising 8255
: ' Initialise ports A, B, C as output ports
: ' Switch display on
: ' Create an array for the image
: ' blank screen to start with
: ' blank screen to start with
: ' blank screen to start with
: ' blank screen to start with
: ' M
: ' A
: ' P
: ' L
: ' I
: ' N
: ' blank screen to end
: ' blank screen to end
: ' blank screen to end
: ' blank screen to end
: ' Loop length of message data
: ' Load array with message data

```

: ' Phew!

MAPLIN.BAS Program.

Testing and Interfacing Modifying the Lead

In Part 2 of this series, we gave wiring details for a lead that interfaced the Moving Message Display Module to the P/O Card. This enabled the single Moving Message Display Module to be fully tested. However, this lead will only work with a single display module - to work with a Base System (i.e. two Display Modules and a Controller Module) upwards, the lead requires modification. This is because the connections are different for the control bus, and there is an additional line to wire in - refer to Figure 4.

Test Program

Listing 1 is a full listing of the MAPLIN.BAS program shown last month, with all the modifications needed to run on a Base System. It will also work on a system of up to 4 display modules with a changing of one variable, Modules%, from 2 to 4. Type this program in and save it as "MAPLIN2.BAS".

Modifying The MMDM Diagnostics Program for use with the Base System

Listing 2 is a 'typeover' for DIAGNOSE.BAS, which was originally published in Part 2 - just load in DIAGNOSE.BAS and type over the lines shown. This program will now allow you to carry out, on the Base System, most of the tests that you carried out on the single module. Save the program under a different name, for example, "BASETEST.BAS". One important aspect to notice in the program is the way data is now clocked into each column.

Testing the Base System

Power up the Base System, and run the BASETEST.BAS test program diagnostic. Run through each test and observe the display.

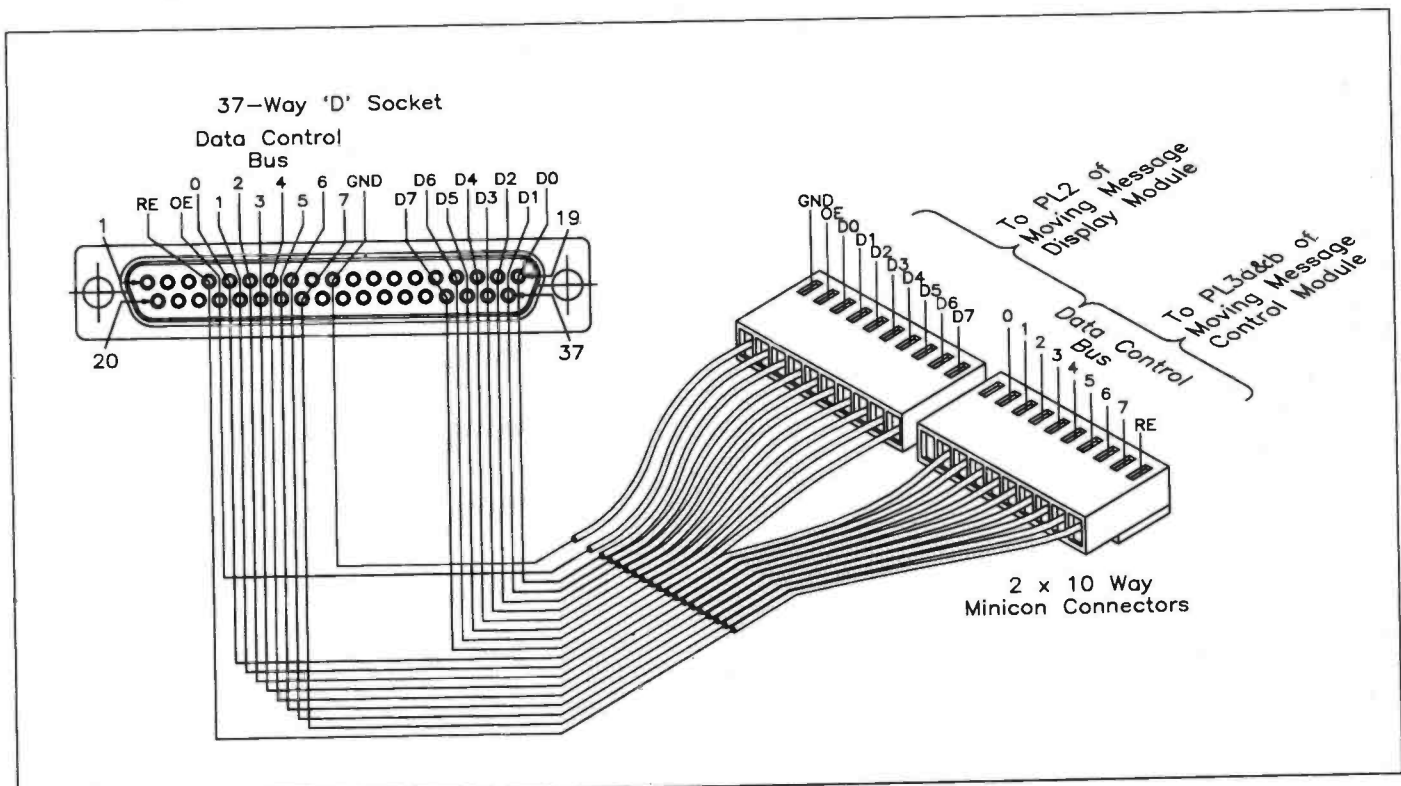


Figure 4. PC I/O Card to Base System interface lead details.

```

1120 PRINT"
1530 LET ACROSS%=15
1710 PRINT"
1860 FOR I%=0 TO ACROSS%
1870 OUT CONTROLPORT%,I%
1882 GOSUB 3000
1902 GOSUB 3000
2000 PRINT"
2180 FOR I%=0 TO ACROSS%
2190 OUT CONTROLPORT%,I%
2202 GOSUB 3000
2222 GOSUB 3000
2320 FOR I%=0 TO ACROSS%
2330 OUT CONTROLPORT%,I%
2352 GOSUB 3000
2372 GOSUB 3000
2550 OUT CONTROLPORT%,I%
2562 GOSUB 3000
2582 GOSUB 3000
2800 FOR I%=0 TO ACROSS%
2810 OUT CONTROLPORT%,I%
2822 GOSUB 3000
3000 ' Subroutine to toggle data in
3010 '
3020 OUT OE%,3
3030 OUT OE%,1
3040 OUT OE%,3
3050 RETURN

```

```

" Base System Pattern Tests"
" Number Of Bits Across The Display
" Base System Pattern Tests"
" Loop Length Of Display
" Control Port Number
" Clock the data in
" Clock the data in
" This routine not available for Base System ":RETURN
" Loop length of display
" Open weighted control line
" Clock the data in
" Clock the data in
" Loop length of display
" Select control line
" Clock the data in
" Clock the data in
" Clock the data in
" Clock the data in
" Loop length of display
" Control port number
" Clock the data in

```

You should know what to expect on the display because all the tests are the same as those you carried out on the single module. If you encounter any faults, you'll have to get the logic probe out again! If nothing appears at all, on any of the tests, check the control line from port C, bit 1. This is the WRITE line, an active low line that toggles in every bit of data. Check that it actually reaches IC4 pin 19. Check also the data port, the control port and the OUTPUT ENABLE line to the display modules, as any of these could also cause a blank display if you cannot see them pulsing or active during a program run.

When all is well, testing of the Base System is complete!

Next Month

In the fourth and final part of this series, we will look at the final testing and use of the complete Moving Message Display System.

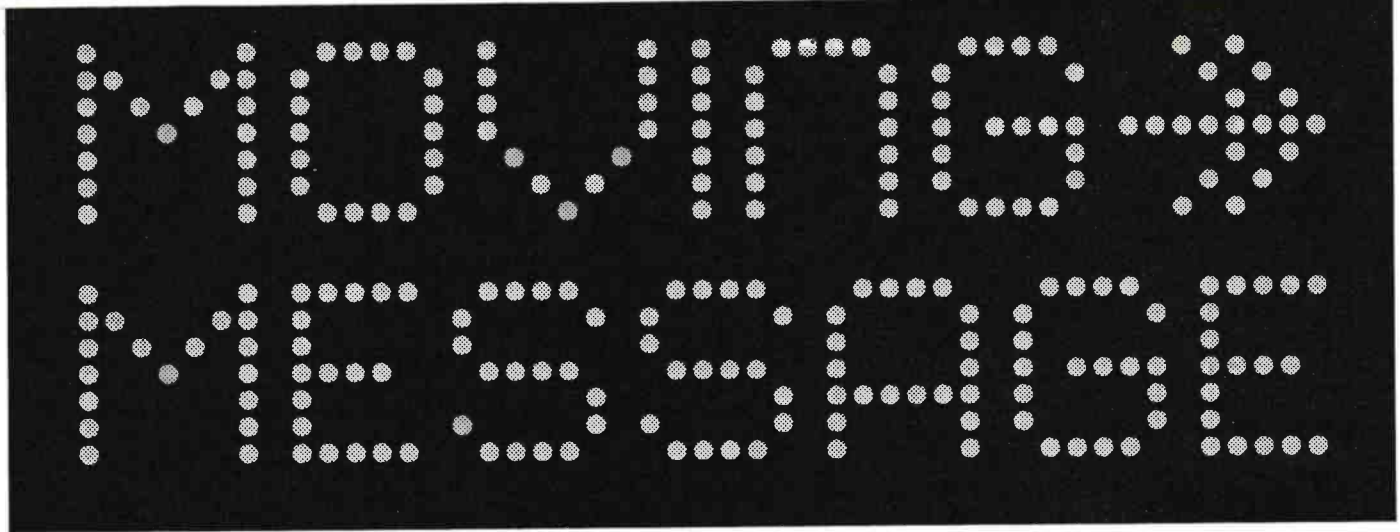
Typeover lines for DIAGNOSE.BAS Program.

UNREGULATED POWER SUPPLY PARTS LIST

CAPACITORS (Refer to Table 1)			
C1	4700µF 16V PC Elect	1	(FM83E)
	or 10,000µF 16V PC Elect	1	(JL31J)
C2	4700µF 16V PC Elect	1	(FM83E)
	or 10,000µF 16V PC Elect	1	(JL31J)
SEMICONDUCTORS			
BR1	PW01 Bridge Rectifier	1	(WQ57M)
MISCELLANEOUS (Refer to Table 1)			
T1	30VA 9V Toroidal	1	(YK09K)
	or 50VA 9V Toroidal	1	(YK14Q)
FS1	Fuse 20mm A/S 1.25A	1	(UJ96E)

or Fuse 20mm A/S 2.5A	1	(UJ97F)
or Fuse 20mm A/S 3.15A	1	(RA11M)
or Fuse 20mm A/S 5A	1	(RA12N)
or Fuse 20mm A/S 6.3A	1	(RA13P)
PCB	1	(GH33L)
Fuse Clip 20mm Type 1	2	(WH49D)
PCB Pin 2141	1 Pkt	(FL21X)
Instruction Leaflet	1	(XU06G)
Constructors' Guide	1	(XH79L)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.
The above items are not available as a kit.



DISPLAY SYSTEM



PART FOUR

Software Development

Text by John Koushappas and Mike Holmes

Design by John Koushappas

Development by Tony Bricknell

In Parts 1 to 3 of the Moving Message Display project we looked at the design and construction of a high specification, expandable, moving message display system. Test and demonstration programs, shown in Parts 2 and 3, have illustrated the use of the display system at various stages of completion, for both single and multi-character displays. This, the final part, covers the full software development for all levels of the system. The programs have been written to run under GW-BASIC on a PC or compatible computer having hard and/or floppy disk drive(s), and with the Maplin PIO card (Order Codes: kit, LP12N; ready-built, AM11M) installed in an available extension slot.

This software was originally developed on a Computers Lynx 128K, which was a Z80

based home computer, circa 1983, but more recently re-designed to take advantage of the increased facilities that a PC or compatible machine and GW-BASIC provide. (NOTE: GW-BASIC has been given away free with MS-DOS 4, and now an introductory variation of Quick-Basic comes with MS-DOS 5.)

The software development consists of a suite of Basic programs which allow text input, bit pattern generation, file handling, run-time parameters, and the displaying of messages within an effective MMD environment. This includes 'auto-booting' MS-DOS batch files (operating at DOS level), which pass control to either the main MMD management menu or to the display program. The basic 'flow diagram' of how this works is shown in Figure 1 (further explanation follows later).

Through data generation and file handling, this suite of programs will allow any number of messages, each of which can be any size up to 1,000 characters, to be made and sequentially output to the display in any selected display mode. A hard disk is particularly useful, because not only can you easily boot the PC's operating system from it, but you can also use its high speed access to provide almost continuous message data flow, in other words transition from one stored message to the next would appear to be transparent to the viewer.

The programming has, as much as possible, been done in a top down fashion, thus there are several discrete modules all of which are 'interlinked' via a main menu program.

The programs presented here are still only the minimum 'bare bones'; there are no fancy windows to look into and very few frills. It is entirely up to you whether you want to add pretty 'front-ends' of your own, but

FEATURES

- ★ Designed for use with any computer equipped with three 8-bit I/O ports – e.g., an IBM PC or compatible equipped with the Maplin 24-line PI/O card
- ★ Easily programmable from BASIC
- ★ Expandable to 32 boards by 'daisy-chaining' modules together
- ★ Large viewing area makes display highly readable in all lighting conditions
- ★ Programmable scrolling in all directions
- ★ Facilities for fade up/down
- ★ Programmable 'fizzle' effects
- ★ Direct pixel addressing for Speed (Animations, etc.)
- ★ Easy to Build

APPLICATIONS

- ★ Shop Displays
- ★ Announcements in Public Areas
- ★ Attention Grabbing!
- ★ Special Effects

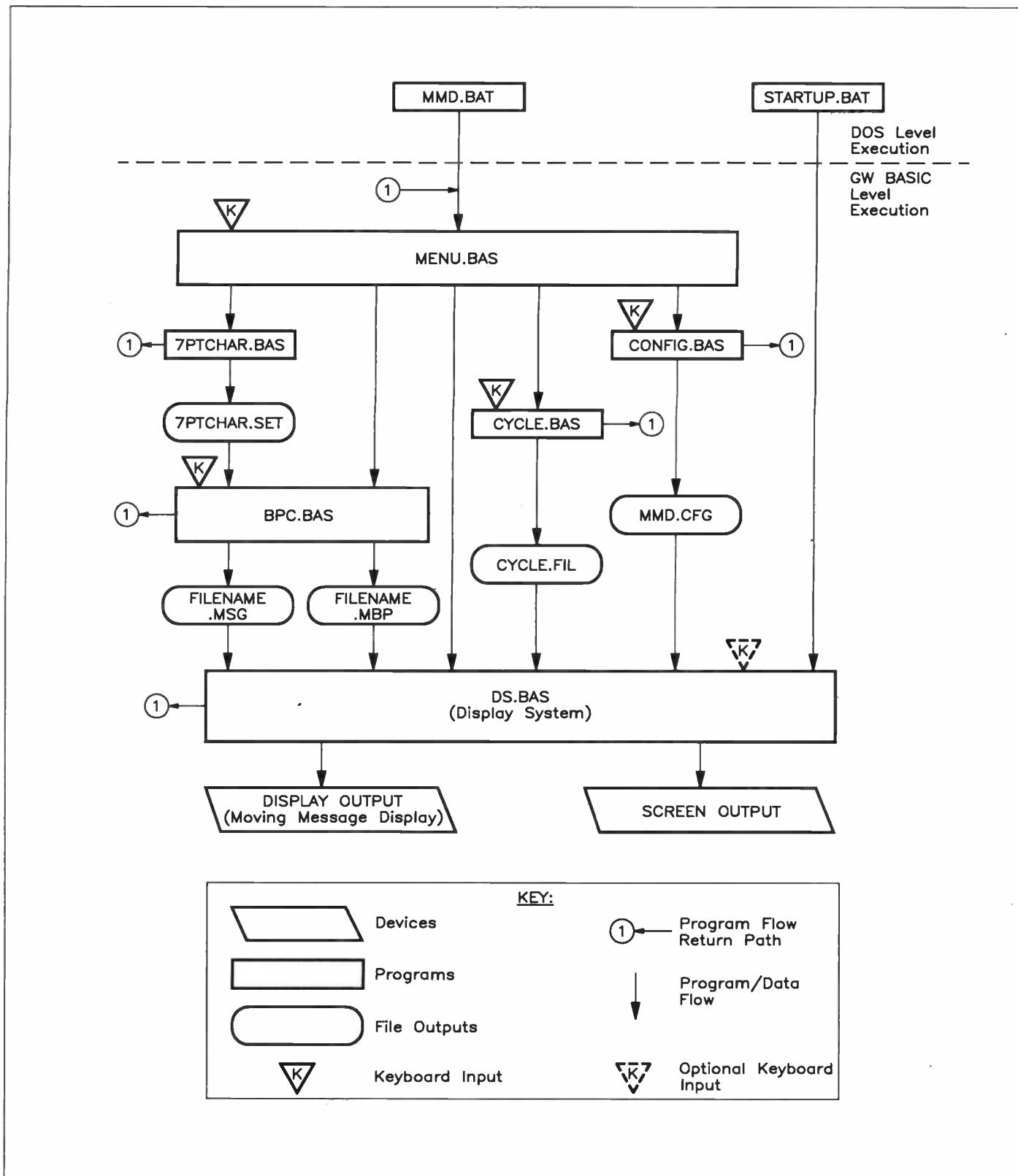


Figure 1. Flow chart of program execution of the system as a whole, showing the sequence of the individual programs and their data files.

you should not alter the core of each program if it can be avoided, as this is likely to introduce errors!

I must stress at this point that professional programming is all about writing programs that are idiot-proof. Unfortunately, I am not a professional programmer and these programs are not necessarily idiot-proof. If the conditions for correct input are not adhered to, these programs may stop with error messages. You will then have to restart the program you are in with a RUN statement (or, if an '.EXE' file, reload and rerun it at the DOS prompt by retyping its name -

more about these '.EXE' versions later) and try to identify the cause of the problem that occurred or avoid entering the bad data.

Moving Message Types - An Attribute Classification

Before the actual programs are discussed in any detail, I will describe the three message types, as I have classified them, which are available in the Moving Message Display System. The three message types are: Type 1 = static, Type 2 = dynamic, and Type 3 = attribute functions. Type 2 is also subdivided

into two further parts: horizontal or truly dynamic, and vertically recalculated.

Static Message Classification (Type 1)

This class of message is one which does not move across the board. In this case each column has its own memory which is the 74LS373 octal data latch (ICs 4 to 11 in Figure 5, Part 1, 'Electronics' Issue 62), and thus this is the standard mode of operation for this system. It provides the unique feature that you can load the screen up with a message, and then leave it there while you

do something else with the computer. The octal latches, acting as static memory, do not need to be refreshed or scanned and so will display the output indefinitely. Once the message is in the display memory, you are then free with your processor time to execute other functions. These include fade up, fade down and flash. These functions are carried out with the use of the display output enable hardware line.

Dynamic Message Classification (Type 2)

Horizontally, or Truly Dynamic

A horizontally scrolling message works by pointing, with an address pointer, to the start address of the memory containing the message. You then display the next 8 columns, followed by those for each of the remaining number of modules, on the screen. Because this does not involve any calculation, merely the incrementing of the message address pointer, and because the length of the message is independent of the length of the display, this type of scrolling is truly dynamic. By the same token, scrolling from left to right, i.e. backwards, is also truly dynamic. Another point to note is that, in the execution of the scroll, the actual message is not manipulated or interfered with in any way.

Vertically, Recalculated

Messages which scroll in the Y-direction, i.e. up and down, are not truly dynamic scrolls. This is because the original data in the vertical scroll position is continuously read, and then a calculation is carried out for each

vertical scroll increment. This means the original data is no longer being displayed, but rather a remaining part of it is. This can be a little risky if not programmed accurately. It also takes up a fair amount of execution time.

Attribute Functions (Type 3)

Attribute functions are not display scrolling routines, rather they are support functions for the correct logical operation of the display system. A complete summary of the message types and attribute classification is shown in Table 1 below.

The Programs

There are six major programs which make up the latest Moving Message Display System software suite (this group does not

include the test programs featured in Parts 2 and 3). In addition to these there are two accompanying batch files, which allow immediate launch from power-up or from the DOS prompt.

We have made all the programs, including the test programs of Parts 2 and 3, available on a 360K 5 $\frac{1}{4}$ in. floppy disk, rather than you being faced with the (extremely) tedious task of copy-typing all the listings! In addition it has given us the opportunity to provide '.EXE' compiled versions of the main system suite which can be invoked like transient DOS commands, for those of you without a BASIC interpreter. Of the '.BAS' listings, the original GW-BASIC listings are provided, plus slightly varied versions which run in DOS 5's QBASIC environment. There is also an additional batch file provided at the root directory of the master disk which will 'install' the system for you, i.e. transfer the disk's

Program Name	File Name	Function
1. Installation	INSTALL.BAT	Make working copies on destination.
2. Configuration	CONFIG.EXE	Hardware configuration declarations.
3. Character Set	7PTCHRGN.EXE	7-point character set generator.
4. Cycle and Sequence	CYCLE.EXE	Orders display of messages.
5. Bit Pattern Compiler	BPC.EXE	Text input / generate bit pattern.
6. Display System	DSS/E.EXE	Displays the messages (2 versions).
7. Menu	MENU.EXE	Main menu program.
8. Display Auto-Start	STARTUP.BAT	Loads and runs DSS/E.EXE.
9. MMD	MMD.BAT	Loads and runs MENU.EXE.

Type	Attribute Number	Function	
Static	3	Clear Screen Display - output message of blank.	
	4	Output a Static Message the length of the display - loads the octal data latches which make up the screen memory.	
	6	Slow Flash 10 Times - relies on 4 - toggling OE line slowly.	
	7	Basic Fade Up - relies on 4 - toggling OE line quickly.	
	8	Basic Fade Down - relies on 4 - toggling OE line quickly.	
	9	Basic Fade Up, Delay, then Fade Down - relies on 4.	
Dynamic	10	Clear Screen Line by Line - relies on 4 - clearing of each latch by a full load, followed by emptying of the latch.	
	Horizontal True	10	Scroll Message Left - pointer to start of message. Increment pointer.
		11	Scroll Message Right - pointer to end of message. Decrement pointer.
	Vertical Recalculated	12	Scroll Static Message Up 1 - MODulus 256.
		13	Scroll Static Message Up 2 - Remainder of integer division.
14		Scroll Static Message Down 1 - MODulus 256.	
15		Scroll Static Message Down 2 - Remainder of integer division.	
Attribute Functions	1	Turn off Screen Display - OE line = 0.	
	2	Turn on Screen Display - OE line = 1.	
	5	One Second Delay - Delay loop.	

Table 1. Message types / attribute classification.

contents to whichever other disk or drive you want the working version to run on. (The system cannot be run on the master itself.)

The names, functions and Input/Output of all these are as described below. The MMD programs should all be saved under a sub-directory called 'MMD', whether stored on a hard disk or floppy disk (this is automatically taken care of by the installation batch file).

Program Names and Specifications

In the table above, the programs are referred to as '.EXE' versions for convenience, as these can be run immediately from the DOS environment. The equivalent source listings of these are found under the directories 'QB-PROGS' of the installed system, while the GW-BASIC listings are under the 'GW-PROGS' subdirectories. As space here is limited, the following is taken from the more comprehensive instructions supplied on the master disk.

Program Inputs and Outputs

Look again at Figure 1 to see how the individual programs work together to produce a complete operational system of control. Notice that programs further 'down stream' need data, stored in files, that has been generated by programs 'up stream'. Such a module, for example 'DS', will be

entirely unable to run properly without these data files present and accessible. Example files are available from the master floppy disk by way of illustration of what these data files should be like.

1. INSTALL.BAT Input: user's choice of destination drive for working version, and MMD system level.

Action: transfer complete directory structure as working version to destination drive, generates 'MMD.BAT' and 'STARTUP.BAT', optionally re-configures 'AUTOEXEC.BAT' if present to run 'DSS/E' immediately on power-up.

2. CONFIG.EXE Input: user input hardware configuration type, number of modules in system, I/O ports' base address (PIO card).

Output: file MMD.CFG

3/1. 7PTCHRGN.BAS ONLY:

Input: user modifies program for first ASCII character number, last ASCII character number, number of bytes per character, add to 7 point character set data if expanded character set required.

3/2. 7PTCHRGN.EXE No inputs possible. Only outputs character patterns for ASCII values 32 to 90, or ' ' (space) to 'Z' inclusive.

Output: file 7PTCHAR.SET

4. CYCLE.EXE Input: user input file names, order of files to cycle through, cycle mode, editing/re-editing facility.

Output: file CYCLE.FIL

5. BPC.EXE Input: read file 7PTCHAR.SET; user input filename to save under, message text, message editor, message attributes script.

Outputs: files filename.MSG, filename.MBP

6/1. DSE.EXE Input: read files MMD.CFG, Message Cycle Filename (usually 'CYCLE.FIL'), and, as listed in the Message Cycle File (usually 'CYCLE.FIL'), both 'filename.MSG' and 'filename.MBP'; optional user input, name of alternative Message Cycle File.

Output: Moving Message Display on an expanded system of multiple modules with controller only.

6/2. DSS.EXE Alternative to above, required to output display to a single module without a controller.

7. MENU.EXE Input: Menu choice of program to execute.

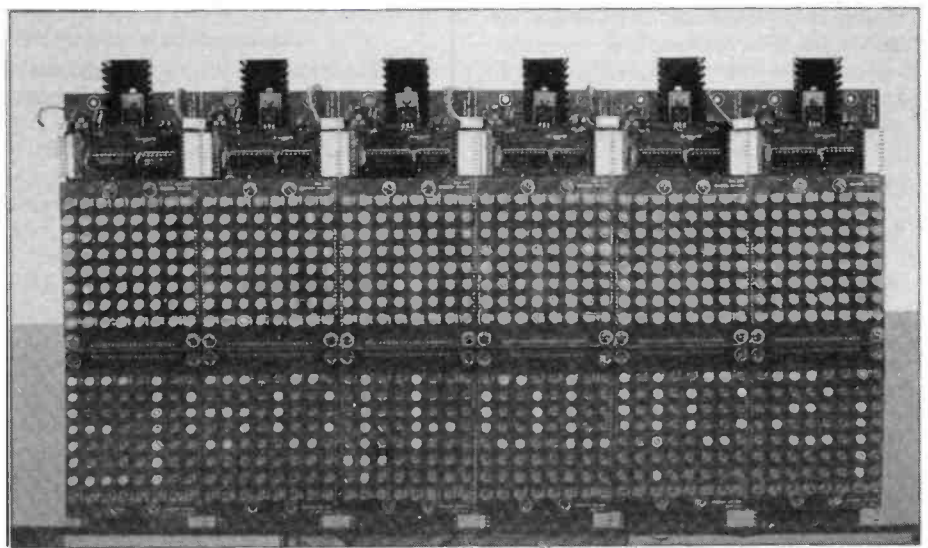
Action: executes the selected program. Note that all selected programs will reload and rerun (or attempt to) the menu when they terminate.

Programming Details

For the following, the GW-BASIC listings are referenced. The Q-BASIC versions are virtually identical, having only minor modifications, necessary for the somewhat different Quick Basic environment. Compiled .EXE versions are indicated between brackets.

MENU.BAS (MENU.EXE)

This is a simple menu program which allows selection of all the programs in the software development to be accessed quickly and easily. All the programs accessible from the menu options return to this menu upon completion, thus making the system cyclic. (The compiled .EXE versions look to see whether MENU.EXE exists in the current directory before attempting to boot it.)



A bank of display modules.

CONFIG.BAS (CONFIG.EXE)

This is a simple program which asks for your hardware details. It asks for your display's type (single module or expanded), and the level of construction in terms of the number of display modules you have if expanded, and for the 8255 PIO card's I/O port base address. This address is determined by which expansion slot the Maplin PIO card is plugged into. The program saves these parameters in a small file called 'MMD.CFG'. You only have to declare these parameters once, and if you change your hardware specification, you only need rerun this program and enter the new parameters once more. So long as 'MMD.CFG' exists and is accessible, 'DS' will be able to extract these details.

7PTCHRGN.BAS (7PTCHRGN.EXE)

In Part 1 of this project, a brief description was given of how the patterns for moving messages are made. The messages are made up from sets of bit patterns, each of which corresponds to a letter or alphanumeric (or graphic) character. The bit patterns for all the characters are held in a look-up table which is accessed by the Bit Pattern Compiler (BPC), which uses the table to generate the bit pattern for each character in the message text. (When created, the message text is merely typed at the keyboard as ordinary words.) Part 1 also stated that this look-up table could be embedded in the computer program itself (meaning the Bit Pattern Compiler), or it may be loaded by the (Bit Pattern Compiler) program as a data file.

Our system here uses the latter method, in the interests of flexibility. '7PTCHRGN' is the generator program that makes a 7-point character set, and saves it as a data file for use later by the Bit Pattern Compiler (BPC). The program need only be run once, and it generates a file called '7PTCHAR.SET'. The main reason for having a program generate the look-up table this way is that, eventually, it will allow for different character sets to be designed, selected, and expanded.

The program also saves three important parameters in the first three entries of the file which are the first ASCII character in the set, the last ASCII character, and the number of bytes per character. These parameters are needed by the Bit Pattern Compiler in order to derive the look-up table formula required for this character set.

One last point about the character set. You will notice that I have only included the characters up to ASCII value 90 (character capital 'Z'). If you want to include the rest of the set (e.g., 91 to 126), just continue the data statements in the same style as shown in the listing and save the program. NOTE: you can only edit either of the BASIC listings, you cannot alter '7PTCHRGN.EXE'.

CYCLE.BAS - Cycle and Sequence (CYCLE.EXE)

This is where things start to get complicated. This program allows you to enter the names of the files containing the messages into a list, and arranged in the order that they will be displayed.

Firstly, you enter the number of names. Then you select whether you want the messages to cycle once or continuously. This is the cycle mode. Cycling once will mean that when the messages in the script generated by this program have been cycled through once by the display program, the display program will return to the main menu. If you select continuous cycle, the display program will run through the script of messages continuously until the program is escaped from or the computer is switched off. You then have the option of retrieving the existing 'CYCLE.FIL' file with the 'CYCLE' program, and adding to it or editing it. To create a new 'CYCLE.FIL', select 'N' for new.

Creating a new 'CYCLE.FIL' is easy. You type in the name of the file which will contain a message. Always use the extension '.MSG' for cycle file names. The next input is for the order number. The order number need not be the order in which you entered the message or the message file name. The order number tells the display program in which sequence to run through the script of messages. When all the file names have been input, a list showing what will be saved is displayed and a question asks for either 'E' for edit or 'S' for save. 'S' saves the data in 'CYCLE.FIL'.

Selecting 'E' for editing allows you to edit the message sequence you have just entered. If you no longer want the message to be displayed, you can enter a zero (0) for the order number, which will cause that message file name to be deleted from the messages script when the edited file is saved back to disk.

To edit the existing 'CYCLE.FIL' file, you

must first enter the number of file names, as before. This limits the number of names that will be read in from the original 'CYCLE.FIL', so you need to know how many names are already in there if you want to keep them. Entering a number greater than this implies you want to add entries to the existing 'CYCLE.FIL' list, and the program will create the extra entry spaces when you enter the editing screen. You will see these entries as blanks when you now enter edit mode. You must choose these edit line numbers, enter file names and order numbers. Upon completion the program returns control back to the main menu.

BPC.BAS - The Bit Pattern Compiler (BPC.EXE)

The Bit Pattern Compiler takes as a file input the 7-point character set, '7PTCHAR.SET', which is the look-up table, and the message(s) input by the user. The user must also input a script or list of 'attributes', which control the format of output from the display program. The program has limited line editing facilities for the message input. You can enter a message of up to 1,000 characters, but no more than 100 characters per edit line number. The program automatically inserts a single space between the end of the last word on one line and the first word on the next line. This allows messages to be butted together continuously.

After loading up the 7-point character set, a screen summary of instructions is displayed. First you must enter the file name to save the message under. You must NOT include an extension, because the program automatically adds '.MSG' to the message file name, and '.MBP' to the file which will contain the message's compiled bit pattern. You are then presented with the message input line editor.

Your message is typed in as required. As you type in each line, <RETURN> terminates the line. To terminate message input, you must key <RETURN> at the beginning of a new blank line. Your message is then displayed back to you with edit line numbers. If you want to re-edit a line or lines, you can do so now, by re-typing the line(s) in question. Clearing a line in the message can be done by choosing to edit that line and keying <RETURN> on a blank entry. This will not terminate the rest of the message following it. It and other blank lines in the message will be skipped at compilation time. An "end of input / edit session" message acknowledges completion of your message.

You are then taken to the 'Attributes Script Mode' for the message. You must enter a series of numbers which will define how the message you have just entered will be displayed on the Moving Message Display system. The script allows for 16 entries, which should be more than enough for most messages. Each attribute number is a declaration to the display program to run a specific subroutine which performs the action, and it is important to choose the correct sequence of subroutines in order to obtain the desired effects. Examples are shown in Table 2. If you use less than the full 16 attributes, you must terminate the attribute sequence with a zero (0) to end. (Keying a carriage return on a blank entry is incorrect, and will actually cause the program to leave a file open.)

Function	Attribute Sequence	Comments
Static Message Fade Up	1,3,4,7,0	Must clear screen of old message first. Must load screen with message before fade up. 0 to finish attribute input early.
Static Message Fade Up, Hold, Flash, and Fade Down	1,3,4,7,5,5,6,8,0	Switch off, clear screen, load screen memory, fade up, hold 1 second, hold 1 second, flash 10 times, fade down, end.
Scroll Long Message Left	1,3,2,10,0	Switch off screen, clear screen memory switch on screen, scroll left, end.
Scroll Message Right	1,3,2,11,0	Best for short messages or effects.
Scroll Static Message Up from bottom to top of screen, Flash, then Fade Down	1,3,2,12,6,8,0	There are many possible variations.
Scroll Static Message Down from top to bottom of screen, 5 second hold, then line Clear Screen	1,3,2,14,5,5,5,5,16,0	Five 5's because attribute 5 is a one second delay.
Fade Up Message and leave it there	1,3,4,7,0	Until next message in messages script.

Table 2. Display sequences using attributes.

The Order of Attributes

In order to get a sensible display output, the attributes you enter for your message must be entered in a logical order. If you imagine your moving message display screen as a window as shown in Figure 2, you will realize how messages must enter and leave the screen when scrolling. Providing you can make your attributes follow these conditions you should get good results. Table 2 shows a list of attribute sequences to perform various overall functions.

Upon completion of the input of your attribute sequence or script, you can sit back and watch the compiler do its work. A "Compilation completed successfully" message will indicate the bit pattern has been compiled correctly, and the bit pattern will be stored in the 'filename.MBP' file. The screen will be clear and the message itself along with the attributes script and some run time parameters will be saved into the 'filename.MSG' file.

The program then terminates and returns control back to the main menu (or, more accurately, reloads and runs it from start). To enter the next message, just select the Bit Pattern Compiler program from the menu again.

DS.BAS - The Display System Program (DSS.EXE, DSE.EXE)

The Display System Program is the main one in the suite of programs for the Moving Message Display system. It is also the most complex. It takes, as file inputs, configuration parameters from 'MMD.CFG', the file name and order script from 'CYCLE.FIL', and the messages files 'filename.MSG' and

'filename.MBP', with the display attributes, and their bit patterns generated by the Bit Pattern Compiler. The outputs are shown as text on the screen, and on the Moving Message Display system.

The program has two entry methods. It can either be invoked via the main menu, or by the batch file 'STARTUP.BAT', to which control can be passed from the PCs 'AUTOEXEC.BAT', so that the Moving Message Display is activated with the relevant input immediately upon power-up of the computer system. (This latter method is only applicable if 'INSTALL' found a copy of 'AUTOEXEC.BAT' at the root of the destination disk, and you answered 'yes' to the query 'modify AUTOEXEC.BAT? (y/n)' at installation time.)

The program opens by announcing itself, then loading the configuration parameters from 'MMD.CFG', then the I/O ports are initialised. There is then a conditional load of the script of file names, and their display order, from 'CYCLE.FIL'. This provides you the option of specifying an alternative file name if desired. A countdown to zero is displayed, allowing you to intercept the loading of the default 'CYCLE.FIL' within this time, and enter an alternative file name.

The alternative file can be another previously created with PBC as 'CYCLE.FIL', but subsequently renamed. If you do not intercept the countdown, 'CYCLE.FIL' is loaded and the file names are stored in one array, while their display order is stored in another array.

DSS.EXE and DSE.EXE are different in that the default file name needs to be

provided as a 'DOS command line parameter' before it can be used; if not provided, the program MUST stop and ask for a file name, whether intercepted or not. This means that any file other than 'CYCLE.FIL' can be specified for reading, and the Display System program will take this and start up the Moving Message Display without any human intervention. For example, at the DOS prompt: DSE CYCLE.FIL (default), DSE OTHER.FIL, DSS MESSAGE.DOC, etc. ('STARTUP.BAT' passes 'CYCLE.FIL' as the default.)

The program then enters its main loop. This sets up the conditions to cycle through the script of messages in the order determined by their order numbers. The message order is sorted on the message order number array to find each message file name order. That message is then loaded and displayed on the screen. Also included are parameters which indicate the size of the file, and the number of bytes per character, and the script of display attributes.

The message's bit pattern file is then loaded into a dynamic array. This is preceded with the loading of leading blanks, to the length of the display, followed by the loading of trailing blanks to the length of the display. These blanks are dynamically re-scaled whenever you change your hardware (in terms of the number of modules in your system), so that you do not have to retype all of your messages. The purpose of the leading and trailing blanks is to make sure that the screen is clear when a scroll left or scroll right operation is performed. You cannot rightly scroll left from an instantly displayed message, because you'll probably miss seeing the first few letters. The screen must be clear when a new message enters the display from the left or the right.

Having completed all the data file loads, the program now runs through the execution of the attributes script. Reading the attributes script numbers one by one, various subroutines are called as described on the menu screen for the attributes input of the Bit Pattern Compiler. Upon completion of the attributes script, the next message is loaded

and displayed as above. Upon completion of the displaying of all the messages in the messages script, a test is made to see if the cycle mode was for cycle once, or continuous cycle mode. If continuous cycle mode was selected, the main loop is continuously executed. If the mode was for one cycle, the program terminates and returns control back to the main menu.

The shift left routine is virtually the same as the 'MAPLIN2.BAS' demo of Part 3. The shift right routine is the same as the shift left routine, except that the pointer to the bit pattern points to the end of the message (hence the need for the trailing blanks mentioned earlier), and counts backwards. The fade up and down routines work by changing the on to off time of the display by toggling bit 0 of port C, which is the display output enable line, at a high speed. This is called varying the mark to space ratio. The slow flash is a derivative of the fading routines, slowed down to provide perfect visible flashing (unlike commercial ones which occasionally cut and blink half way along the display).

The scroll up and scroll down routines are each divided into two parts. The first part moves a message from below the bottom of the display upwards onto the display. The message must stop so that it can be read, else there would be little point in having a scroll up routine. The second part scrolls the message upwards off the top of the display, until the screen is clear. The two scroll down routines are exactly the reverse of the scroll up routines.

The MMD Software Master Disk

There is a tutorial provided with the program suite when the system has been installed from the master disk, called 'MMDHELP.DOC'. The MMD software is installed by running 'INSTALL' on the master disk, giving it parameters specifying the destination drive where the system will be put, and whether the display driver to be used is for a single module or a base or

expanded system. This installation is unavoidable since, to make them all fit onto one 360K floppy disk, the files have been subjected to a storage compression technique, and have to be 'unpacked'.

Batch Files

STARTUP.BAT is used to load up and run DSS.EXE or DSE.EXE (depending on how it's been configured at installation time), the Display program, immediately from power-up, provided that the host PC's AUTOEXEC.BAT has also been altered to pass control to STARTUP.BAT. You need not touch anything. Because DSS/E will automatically load CYCLE.FIL, it will also load and display a complete pre-set series of messages, indefinitely, if continuous cycle is selected. This batch file is thus useful for unattended (e.g., timer started) 'boot-ups' of the display.

MMD.BAT is another simple batch file, providing a fast and easy method of getting to the Moving Message Display environment and running MENU.EXE at DOS level. Both these batch files also append the MMD directory path to the PC's existing DOS environment path declaration variable (first time only).

Differences Between DS.BAS required for a Minimum System and a Base/Expandable System

DS.BAS is designed for a Base System and above (if you intend to use it). Because of the slightly different way that a Minimum System clocks in its data (because the WR bar line is not implemented on the single module, and because you latch data by sending a logic low to the current latch control port), some lines need to be typed over DS.BAS. These lines are provided in TYPEOVER.BAS.

Possible Enhancements

There are many, many effects that could be programmed and added into this software. A walk past some commercial moving message displays should generate some new ideas. I have seen effects such as stretching, random fizzle (easy in BASIC), character flash, and of course, a digital clock. Message clearing effects include a hungry pacman, a car, and a rotating wheel. With regard to keyboard entry of the message, it may be advantageous to design import facilities from an ASCII editor into the bit pattern compiler. This would allow re-editing of a message and subsequent re-compilation of that message.

Acknowledgment

Thanks are due to Mr. Jason Morgan for highlighting fundamental programming concepts which would otherwise have not allowed these programs to be completed.

Software on Disk

A 5 1/4 in. disk with the MMD Software is available from Maplin - Order as Moving Message Display Software Disk (XL57M).

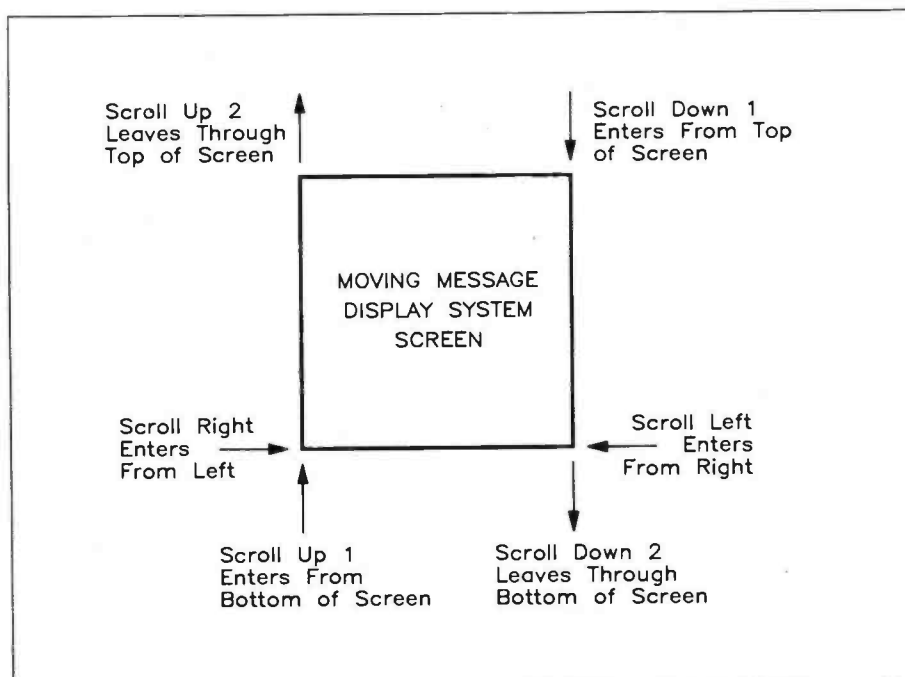


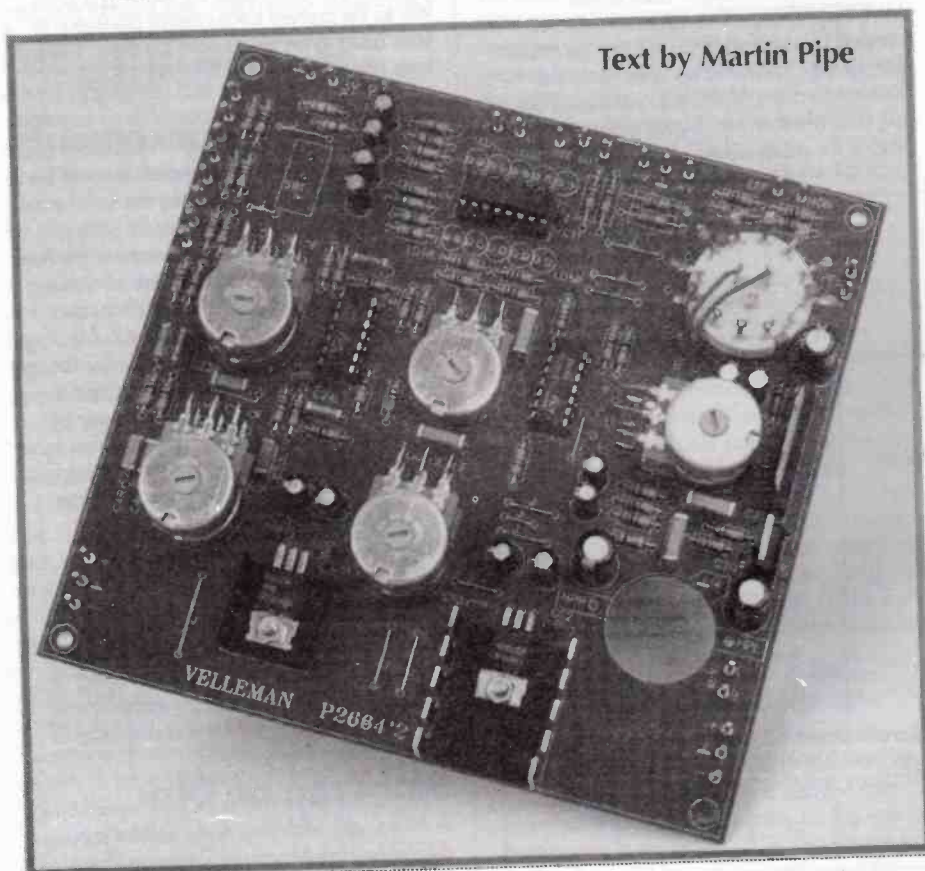
Figure 2. Representation of a single MMD display module as a window.



MODULAR MIXING SYSTEM

MASTER & HEADPHONE MODULE

The Master and Headphone Module is designed to be at the heart of a mixing system. It features a summing amplifier; each of the inputs can be fed in via a resistor, and there are no limits (save for practical ones!) with respect to the number of inputs that can be applied.



Text by Martin Pipe

The completed Master and Headphone Module (component-side).

There are three sets of stereo outputs – one set for a tape recorder, another for headphones, and the main (master) output. The master output features treble and bass tone controls, as well as a balance adjustment. The tape recorder output is exactly the same as the master output, except that the attenuator, mono/stereo switch, tone and balance controls have no effect on it. The headphone output can be used to monitor the pre-fade listen (PFL), effects send or monitor buses (if used), or the outputs – selection is by a 4-way rotary switch. Also included are two 5-LED VU meters, and split-rail voltage regulators for the module and other circuitry.

Circuit Description

1. Mixer/Tone Control

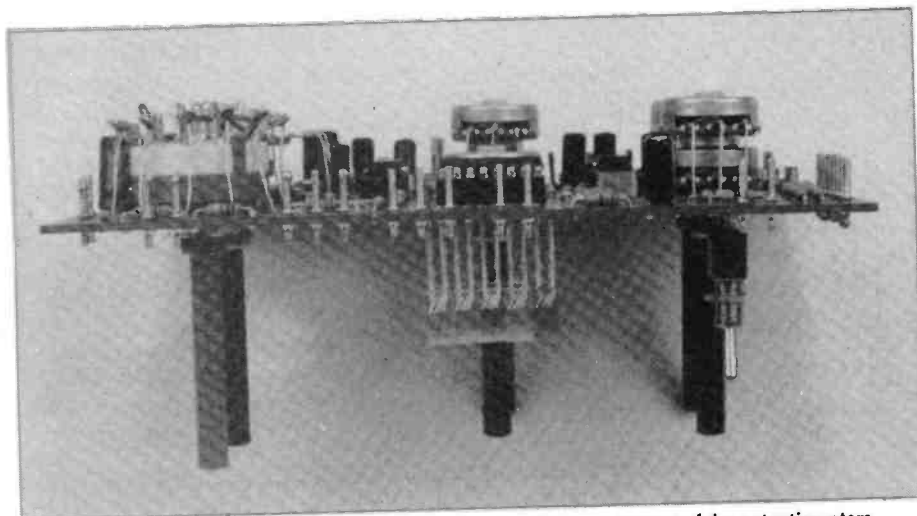
The circuit diagram of the Master and Headphone Module is shown in Figure 1. Amplifiers A1 and A2 are inverting input buffers, the output of which can be summed together (mixed to mono) by the stereo/mono switch SW1, and panned left to right (or vice versa) using the balance control RV1. If each signal to be mixed is fed into the input of A1 or A2, via a 10k resistor, the Op-Amp acts as a summing amplifier – the actual 'mixer' itself. Note that you will find these resistors on the mixer outputs of the other modules in the series; they have not been incorporated on the Master and Headphone Module since the exact number of channels will be dictated by the application in mind. If building a mixer around this module, the values of the Op-Amp gain-setting resistors (R1L and R1R respectively) depend on the number of channels – 8k2 for an 8-channel

FEATURES

- ★ Headphone amplifier with selector and volume control
- ★ Three fixed output levels 0.775 $\sqrt{2}$ dBu, 1.55 and 2.5V RMS
- ★ Tape recorder output
- ★ 2 x 5 LED VU meter
- ★ Bass and treble controls

APPLICATIONS

- ★ Mixers
- ★ Preamplifiers



Side-view of the Master and Headphone Module, showing the arrangement of the potentiometers and switches.

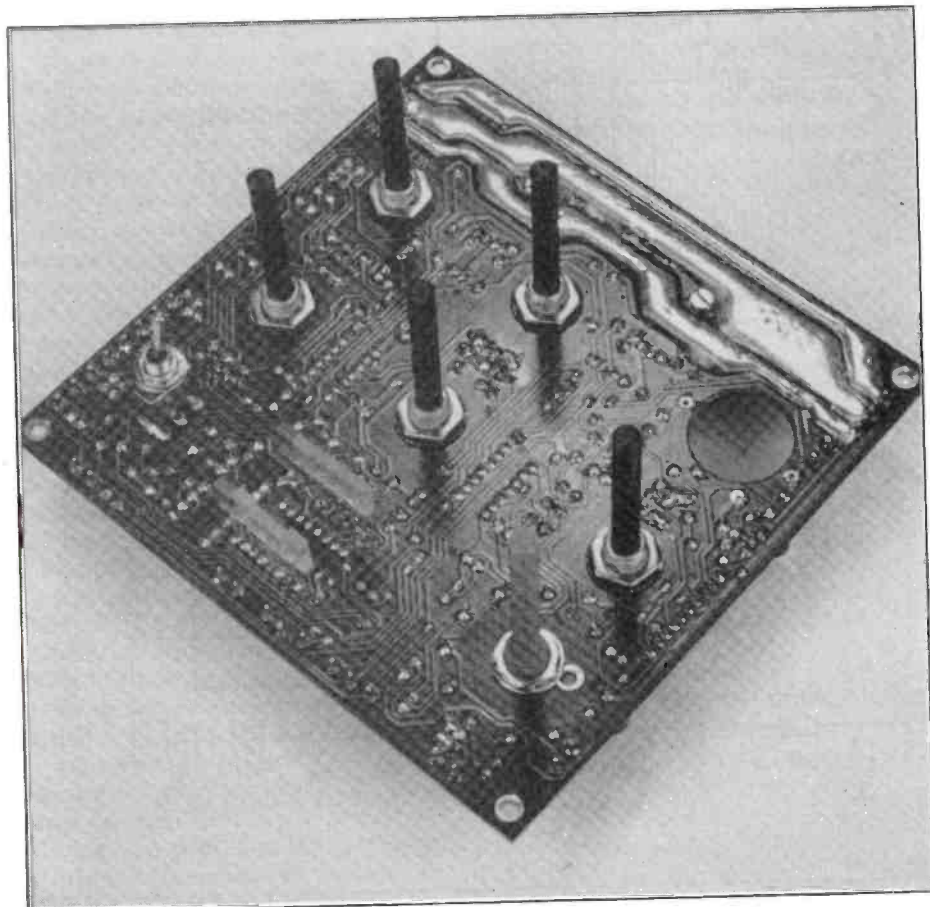
mixer, and 3k9 for a 12-channel mixer. Should you require a different number of channels, a suitable value of R1L/R can be found by dividing 50k by the number of channels; the nearest practical value should then be chosen. For example, 2k should be chosen if 24 channels are anticipated. If you are using this module in non-mixer applications (e.g., tone control, preamplifier), then input resistors (shown as Rx and Ry in Figure 1) must be added, so that the Op-Amps become inverting buffers. These resistors, and R1L/R, should be fixed at a value of 3k9.

After mixing (or buffering in the latter case), the two channels are then fed to a RV2L/R, a ganged attenuator ('volume control'). The output from each attenuator is fed to A5 (left channel) and A6 (right channel), each of which is a non-inverting

Op-Amp set up for a gain of 20dB (x10). Each channel is then passed through a Baxandall tone control circuit, which is formed by A7 (left channel) and A8 (right channel) – together with associated components. The tone controls are designed to have 15dB of cut and boost at 40Hz (bass) and 8.5kHz (treble). The signal(s) can then be tapped off at the high, medium or low outputs; each tap is derived from a potential divider formed by R10L/R to R13L/R. Note that the tone control circuit is inverting; this 'negates' the inverting action of A1L/R, and consequently each channel is phase correct.

2. Selector Switch and Headphone Amplifier

4-way switch SW2L/R selects between the master output (from the tone control), or



The completed Master and Headphone Module (track-side).

effects, monitor/return and PFL channels from other modules. In non-mixer applications this system could, no doubt, have other applications. Note that the PFL channel does not have an input resistor and that the effects send and return channels, being mono, are fed equally to both channels. The outputs from SW2L/R are then buffered by inverting Op-Amps A3 (left) and A4 (right). These Op-Amps have unity gain for the effects send and return channels, but the master channel is attenuated by a factor of 3. The outputs from A3 and A4 then feed IC4, via the headphone attenuator RV5L/R. Note that the VU meters can also be driven by A3 and A4. IC4 (LM2877) is the stereo integrated power amplifier used to drive the headphones. The output power from IC4 depends upon the impedance of the headphones used; 45mW will be delivered to a 400Ω pair (which will be more than loud enough!), 545mW into a 32Ω pair, and an ear-splitting 1.3W into an 8Ω pair – which is enough power to drive a pair of speakers to reasonable levels! Note that the outputs of IC4 are AC-coupled to prevent the headphones from being damaged by DC offsets.

3. VU Meter

IC3 (U2066B) is a purpose-designed dual 5-LED bargraph driver. Its associated components determine the attack and decay times, and the bandwidth over which indication will take place. Each of the two bargraph displays is made from three green, one orange and one red LED; the LEDs operate at approximately the following levels: red +3dB, orange 0dB, and green at -3, -6 & -12dB.

The input for the VU meter can be taken from the output of the tone control, or from the output of the select switch buffer. The latter option enables you to monitor all levels, and not just those of the master output. However, in those situations where the levels of the master output must be continually monitored (important recording sessions, radio stations) regardless of what's being heard 'through the cans', the former option may prove a better choice. Either option can be chosen when you build the unit.

4. Power Supply Provision

RG1 and RG2 are +15V and -15V voltage regulators respectively. Decoupled by C12 to C19, these two ICs supply all of the active components in the Master and Headphone Module, and any other circuits and modules – so long as the total load presented to each regulator does not exceed 1A. Of course, the unregulated supply rails feeding RG1 and RG2 must be capable of supplying such currents. Note that IC4, the headphone amplifier, has its own regulator (RG3).

Construction

If you are new to project building, refer to the Constructors' Guide (order separately as XH79L) for helpful practical advice on how

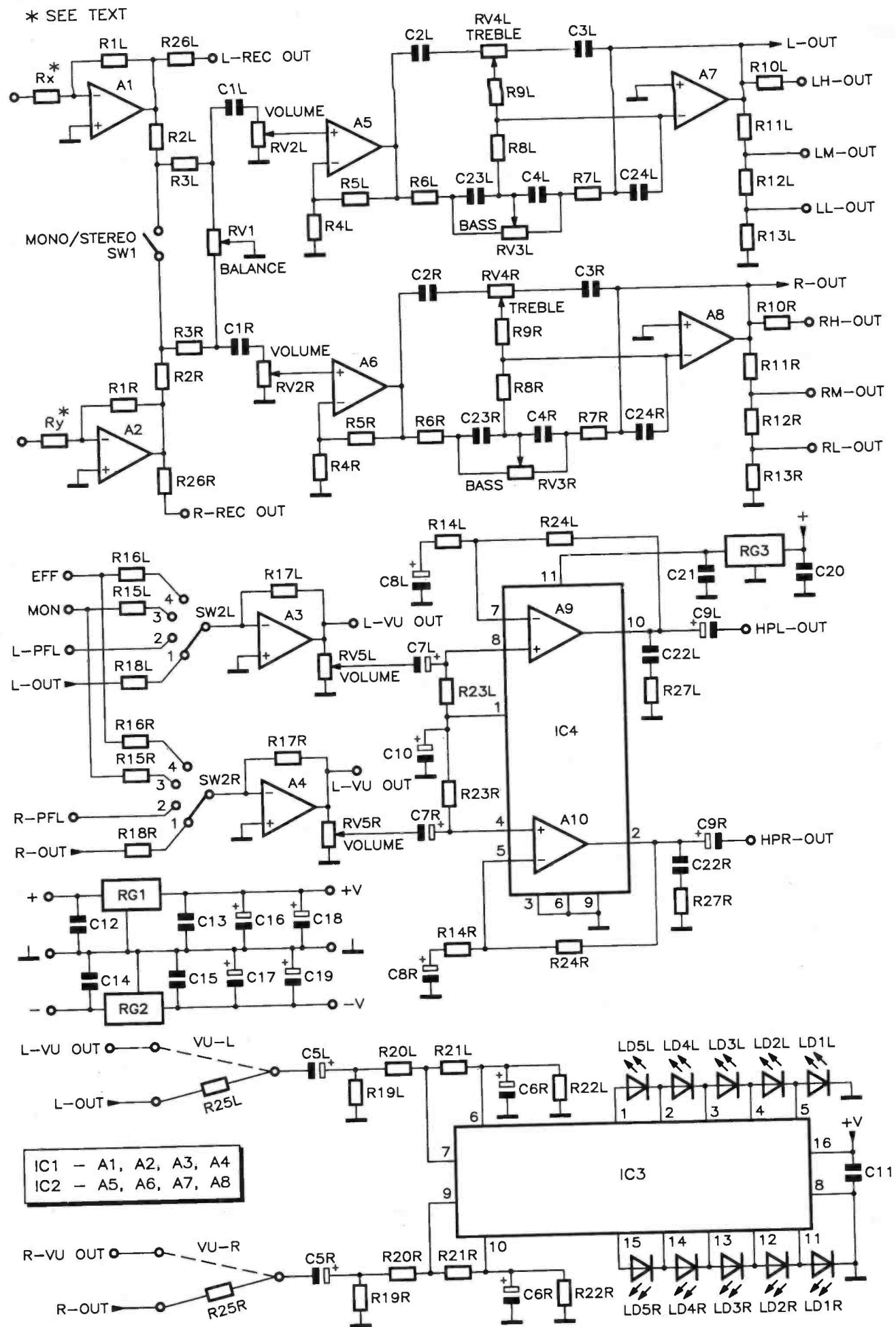


Figure 1. Master and Headphone Module circuit diagram.

Specification

Distortion:	0.05% (max.)
Signal-to-noise ratio:	>90dB
Bass control:	15dB boost and cut, centred at 40Hz
Treble control:	15dB boost and cut, centred at 8.5kHz
Output levels:	0.775V RMS (low); 1.55V RMS (medium); 2.5V RMS (high)
Headphone output:	45mW (400Ω load); 545mW (32Ω load); 1.3W (8Ω load)
VU meters:	green -12dB, -6dB, -3dB; orange (0dB); red (+3dB).
Current consumption (standby):	70mA
Current consumption (loaded):	500mA
Power supply voltage requirement:	±17.5V to 30V

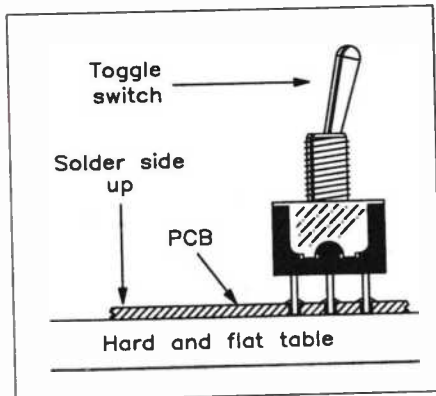


Figure 2. Fitting the mono/stereo switch SW1.

to solder, and identify components.

The first component fitted must be the toggle switch SW1. This is mounted on the solder side of the PCB. Place the PCB, solder side up, on a hard flat surface, as shown in Figure 2. Fit the switch squarely into position and solder the centre leg only. Viewing from the sides of the PCB, check that the switch is still 'nice and square' – if so, solder the other two legs into position. If not, melt the solder and try again.

The wire links marked 'J', and the PCB pins (inserted from the component side), are fitted next, followed by the resistors – except R25L/R. If you want the bargraph display to monitor the master output, fit R25L/R; if you wish to use the bargraph display to monitor the output from the select switch, however, fit the wire links in the positions marked with a dashed line, next to R25L/R. In addition, note that the value of R1L/R depends on the number of inputs – 8k2 for a 6-channel mixer, and 3k3 for a 12-channel mixer. If a different number of channels are required, the value for R1L/R as determined in the 'Circuit Description' section should be used. The capacitors can now be installed – watch out for the electrolytics (C5L/R to C9L/R, C10, C16 to C19), which are polarised devices and must be correctly orientated. Before fitting to the PCB, the leads of all electrolytic capacitors must be preformed. Fit the IC sockets next, aligning the notch on the socket with that printed on the legend.

Mount voltage regulators RG1 and RG2, together with their heatsinks (RG1 has the larger one) onto the PCB, using the 10mm M3 hardware supplied, as shown in Figure 3. In order to fit properly, the regulator leads should be bent through 90°, at a distance of 5mm from the package. The use

of thermally-conductive paste (not supplied), applied between the tab of each IC and its heatsink, may improve long-term reliability – particularly if the Master and Headphone Module's regulators are used to power ancillary items. Do not get the two regulators mixed up – the 7815 (+15V) is RG1, while the 7915 (-15V) is RG2. Once bolted down, they can be soldered in place. Note that the screws are fitted from the track side of the PCB. The final regulator, RG3 (7815), can be inserted along with the headphone amplifier, IC4 – the regulator tab faces inwards towards the rest of the PCB. When fitting IC4, the stripe (and cut corner on the heatsink tab) on IC4 corresponds to pin 1.

Install the potentiometers from the component side of the PCB, as shown in Figure 4. Make sure that each potentiometer goes in the correct position – in particular, do not confuse linear ('lin') and logarithmic ('log') potentiometers of the same value (for example RV3L/R and RV5L/R), as these have somewhat different characteristics! When you are satisfied that all of the potentiometers have been installed correctly, use the bandoliered wire links to connect their pins to the relevant positions on the PCB. The last component to be fitted is the switch SW2 – also fitted

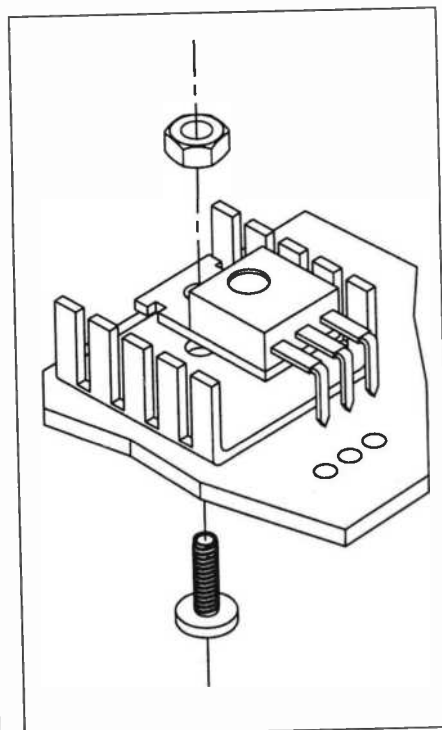


Figure 3. Fitting RG1/RG2.

from the component side.

If the effects send and return inputs are not required, the switch can be modified into a 2-way one. Turn the switch shaft fully anti-clockwise and remove the nut, spring washer and tab washer. Refit the tab washer in the hole identified on the body as '2'. After reassembling the control, fit it to the PCB and align it so that the numbers embossed on it line up with those printed on the PCB legend. Using some of the remaining bandoliered wire links (or component lead offcuts), wire up pins 1 to 8 of the switch to the relevant positions of the PCB. The final connections to SW2, pins 'A' and 'B', which are located in the centre of the switch, must be connected to the PCB using insulated wire (not supplied in the kit).

The LEDs are fitted from the track side of the PCB so that their tips are 23mm above the base of the PCB. The shorter (cathode) lead of each LED is aligned with the flat side of the LED shown on the board legend; note that LD1L/R are the red LEDs, LD2L/R are the orange and LD3 to 5L/R are the green. Solder only one lead from each LED; the second leg should not be soldered until all LEDs have been positioned at the correct height and are squarely aligned.

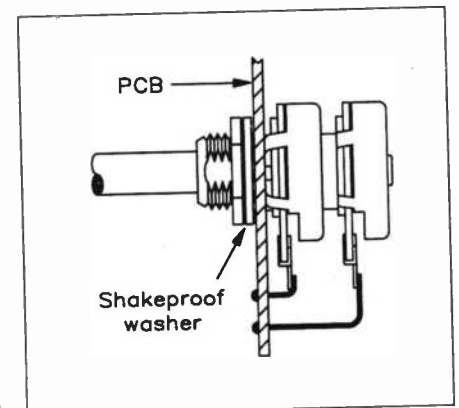


Figure 4. Installing the potentiometers.

Finally, coat the power supply tracks, which are the wide tracks free of solder resist, with more solder. After completing assembly, it is prudent to check your work – finding any incorrectly placed components could save considerable time and expense later on. Other gremlins to watch out for include solder bridges/whiskers and poor joints.

Testing and Installation

The best form of testing is to use the Master and Headphone Module in its intended application. Ensure that the power supply can provide the required currents. The module should be installed away from any strong mains fields (power transformers and the like), in a screened case. If the completed board is to form part of a modular mixing system, it should be built into a decent metal case anyway! Screened cable (such as XR15R) should be used for all audio connections, to reduce the possibility of hum pick-up. Once the installation has been inspected, the ICs can be inserted and the system powered up.

MASTER AND HEADPHONE MODULE PARTS LIST

RESISTORS

R1(L/R)	3k9 or 8k2 (see text)	2 of each
R2, 3, 4, 10, 26(L/R)	1k	10
R5 to 8, 14 to 17(L/R)	10k	16
R9(L/R)	3k3	2
R11, 19(L/R)	1k8	4
R12, 13(L/R)	1k5	4
R18(L/R)	33k	2
R20(L/R)	150k	2
R21(L/R)	120k	2
R22(L/R)	47k	2
R23, 24(L/R)	100k	4
R27(L/R)	2Ω7	2
R25(L/R)	3k9	2
(not necessarily fitted - see text)		
RV1	10k Lin	1
RV2, 5(L/R)	100k Dual Log	2
RV3, 4(L/R)	100k Dual Lin	2

CAPACITORS

C1, 22(L/R)	100nF Poly Layer	4
C2, 3(L/R)	4n7F Poly Layer	4
C4, 23(L/R)	47nF Poly Layer	4
C5, 6(L/R)	4μ7F 50V Electrolytic	4
C7, 8(L/R)	1μF 100V Electrolytic	4
C9(L/R), C10	220μF 35V Electrolytic	3
C11 to 15, 20, 21	100nF Resin-dipped Ceramic	5
C16 to 19	10μF 50V Electrolytic	4
C24(L/R)	15pF Ceramic	2

SEMICONDUCTORS

LD1(L/R)	Rectangular Red LED	2
LD2(L/R)	Rectangular Orange LED	2
LD3 to 5(L/R)	Rectangular Green LED	6
IC1, 2	TL074	2

IC3	U2066B	1
IC4	LM2877	1
RG1, 3	μA7815	2
RG2	μA7915	1

MISCELLANEOUS

SW1	SPDT Toggle Switch	1
SW2	3-pole 4-way Rotary switch	1
	14-Pin DIL Socket	2
	16-Pin DIL Socket	1
	Large Heatsink (for RG1)	
	Small Heatsink (for RG2)	
	PCB Pins	3 pks.
	PCB	1
	Screw M3 x 10mm	2
	Nut M3	2
	Bandoliered Wire Links	18
	Construction Leaflet	1

OPTIONAL (Not in Kit)

Alternative value of R1L/R - see text		
Constructor's Guide	1	(XH79L)
Screened Cable	As required	(XR15R)
Heat Transfer Compound	1 syringe	(HQ00A)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available in kit form only.

Order As VE33L (Master and Effects Module)

Please Note: Some parts, which are specific to this project (e.g., PCB, IC4) are not available separately.

The Digital to Analogue Converter Card is intended for use with the Intelligent Motherboard for the RS232 Serial Port Extension System, as described in Issue 59 of 'Electronics - The Maplin Magazine', and is an addition to the other plug-in cards in this range. The D-to-A (Digital to Analogue) Converter transforms a binary number, presented to it via the system data bus from the Intelligent Motherboard, into an analogue voltage output. The 8-bit binary input offers up to 256 possible steps, each step producing an analogue DC output of 4mV. With a binary input of 0000 0000 (decimal 0 or hex 00), the minimum output from the D-to-A converter is 0V, but with an input of 1111 1111 (decimal 255, hex FF) an output of 1.02V is obtained.

This output from the D-to-A Converter Card could then be used to control analogue equipment - for example the volume of an automated mixing desk or the control of lighting, even motors and actuators, etc. The possibilities are endless, and only limited by your imagination.

Circuit Description

As with all of the other plug-in cards for use with the extension system, a connection is made between the D-to-A Converter Card and the computer via the Intelligent Motherboard and its Extension Card, which buffers the data signals, generates the necessary auxiliary signals and provides the power supply for the interface plug-in cards.

The circuit of the card, which is shown in Figure 1, is quite simple and mainly consists of an octal latch presenting 8-bit data to the D-to-A converter, IC2. Since up to four cards can be installed in the motherboard extension card at the same time (and possibly more on further extension cards), each is required to be uniquely addressed to prevent addressing contention between the cards. This is achieved through the fitting of links at the positions 'A0' to 'A7' on the PCB. IC3 and IC4 between them provide eight 2-input, exclusive-OR gates, which together form an 8-bit logic comparator. An 8-bit address bus from the motherboard is presented to A0 to A7 in Figure 1 (J1-13 to J1-J25), while wire links may or may not be fitted between R1 to R8 and ground at 'A0' to 'A7'.

Each gate has an open-collector non-inverting output, and in each case, the exclusive-OR action requires that the two inputs must be at different logic levels to achieve an active high (output off) at the output. If both inputs are at the same level, either '0' or '1', the output is always '0' (output low, or on). Wherever a wire link is fitted at 'A0' to 'A7', there MUST be a logic '1' bit from the address bus corresponding to the same position, A0 to A7; similarly, where a link is omitted, the corresponding address bit must be '0'. Such a condition allows all the gates to release the common output line pulled up by R9, and thus this card is properly selected.

IC5 provides two inverters which also have open-collector outputs. Once

RS232

SERIAL PORT EXPANSION

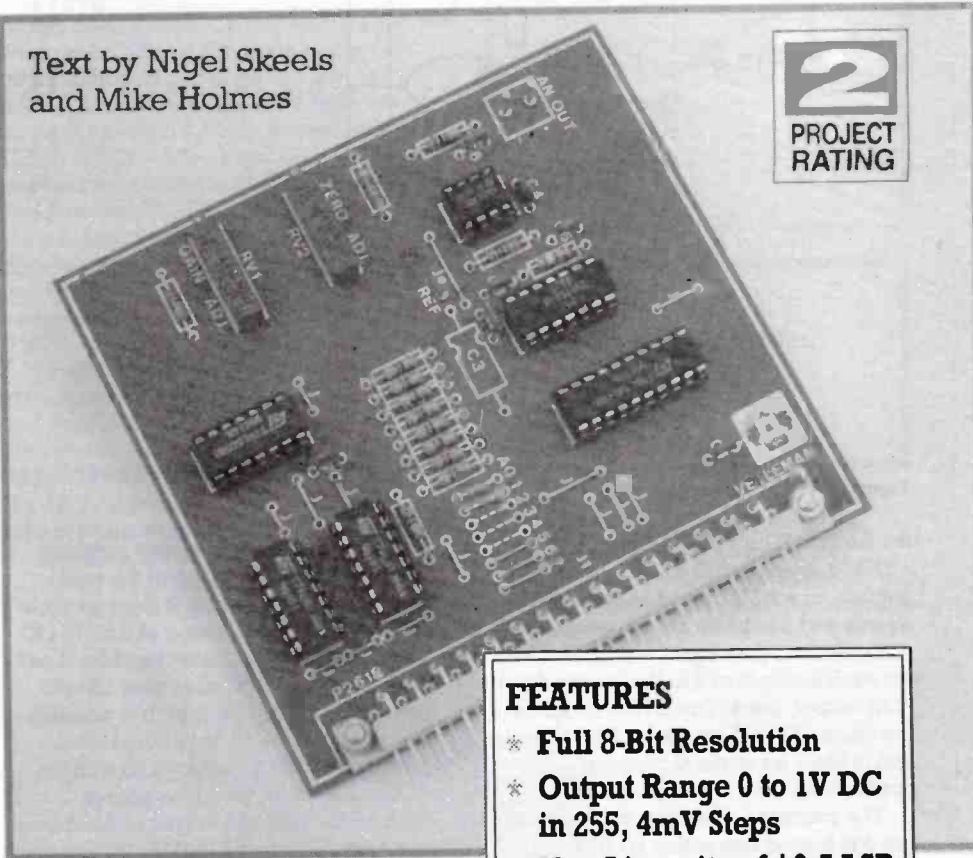
SYSTEM

PART SIX

Digital to Analogue Converter Card

Text by Nigel Skeels
and Mike Holmes

2
PROJECT
RATING



the eight exclusive-OR gates, properly addressed, are all off, it only remains for the I/O request control line \overline{IORQ} and the write enable line \overline{WR} to both go low to completely release the common output line, producing a positive going pulse at IC1 pin 11.

IC1 is an octal, D-type, positive edge triggered flip-flop, meaning that on each occurrence of the clock pulse input, pin 11, going high, the data bits on D0 to D7 are transferred to the outputs and latched by the flip-flops.

The OE (Output Enable) function of IC1 (it has tri-state outputs) is permanently enabled by pin 1 being tied to ground, so that the D-to-A converter, IC2, continuously receives

FEATURES

- * Full 8-Bit Resolution
- * Output Range 0 to 1V DC in 255, 4mV Steps
- * Non-Linearity of ± 0.5 LSB
- * Programmable from BASIC

APPLICATIONS

- * Analogue Control of Motor Speed, Attenuators, Frequency Generators, etc.
- * Automated Varying Voltage Generation
- * General Purpose Analogue Signal Generation

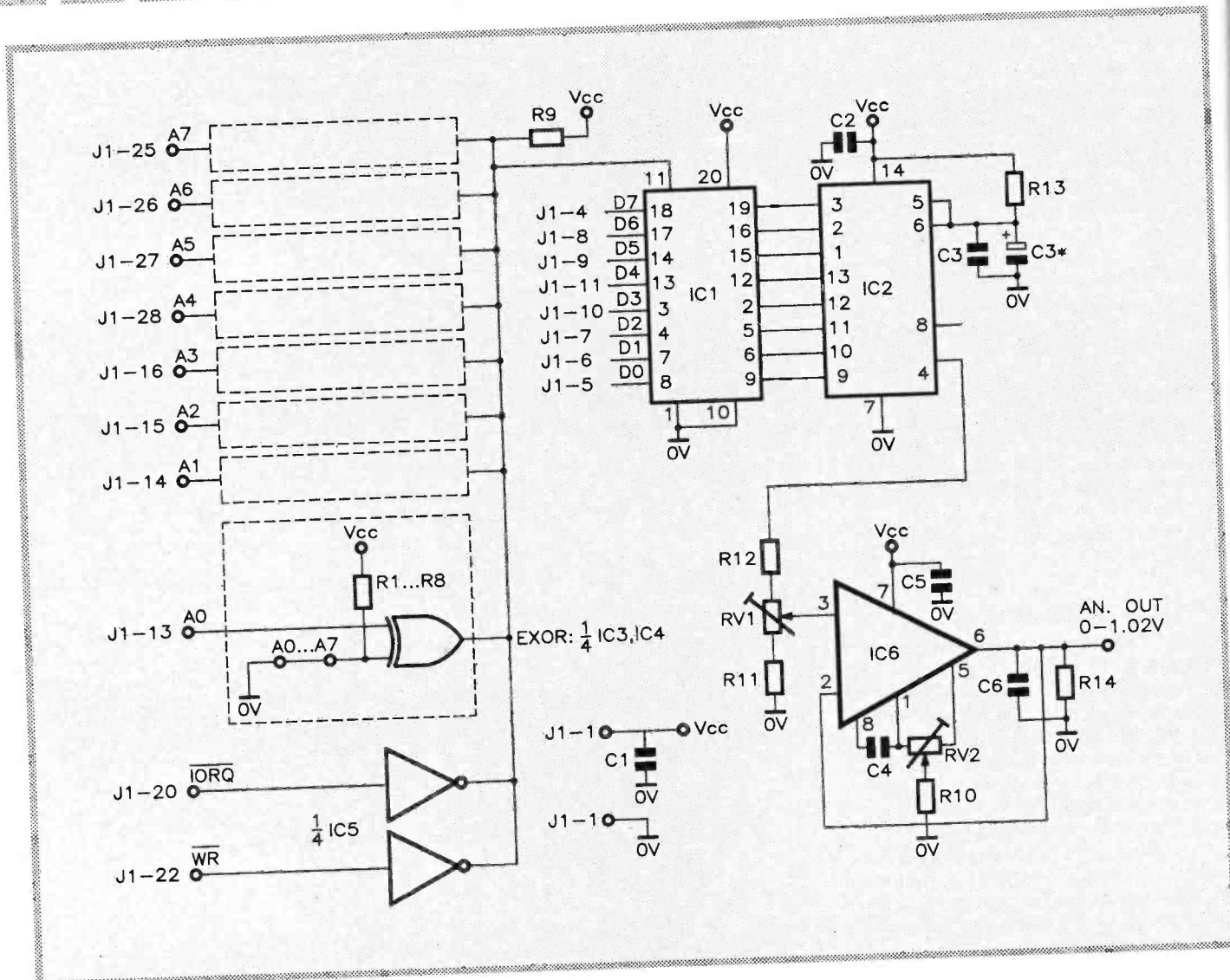


Figure 1. Circuit diagram.

the latched 8-bit data from IC1. IC2, a ZN426, is an 8-bit D-to-A converter containing a 2.5V precision reference source and produces binary weighted voltages (i.e., the output voltage doubles for each multiple of 2 in the binary data) at its output, pin 4. The ZN426 is one of the easiest D-to-A converter ICs to use and is ideal for general purpose applications, and is suitable here.

The precision reference voltage from pin 6 is biased into action by R13, and decoupled to ground via C3, before connecting to the reference input of IC2. It is possible that this reference source (output current 3mA) can be used to bias a further 1 or more ZN426 D-to-A chips on other cards, and this will enable all of them to 'track' together accurately with reference to the same source. It is only necessary if absolute accuracy between the different cards is essential; normally it is not important. However, should the precision reference be used in this way, a 2.2µF, 16V electrolytic should be added in parallel to C3 (marked as C3* in Figure 1), and space is provided on the PCB for it (but the component is not included in the kit).

The DC reference is necessary so that the D-to-A part of the ZN426 IC can relate

its DC output to some sort of constant, interpreted as the centre of the total range available. Hence, 2.5V equates to the centre of a total swing of 0 to 5V DC out at pin 4, but whatever its value it will also correspond to an input of 128 (80 hex, 1000 0000 in binary). It is possible for the reference to be at some other level (provided externally), to shift the centre point, but given the supply limitations the IC will run out of 'headroom' somewhere near the high or low extreme of the input binary value.

Moreover, the IC interprets values of 128 and above as 'negative' (where the Most Significant Bit is logic '1'). These upper values are stored in 'twos complement', i.e., as soon as the input rolls over from '0111 1111' (127) to '1000 0000' (128), it actually becomes '1111 1111' (-1). As long as the MSB is '1', the other bits will be inverted to produce the real value. The reason for this is that the supply current drawn depends, to a degree, on the various logic states in the internal gates, and if the value changes from '0111 1111' to '1000 0000' there may be sufficient disturbance in the supply current to affect the accuracy of the conversion. Using 'twos complement', the actual bit values stored will follow

a smooth transition from '0000 0000', through '1111 1111' to '1000 0000' over the whole range of inputs 0 to 255. This activity is, of course, entirely internal to the IC and is not something you need concern yourself with while actually using the card.

The final stage comprises IC6 by way of buffering, which is a CA3130 MOSFET input, CMOS output Op-amp, chosen for its ability to swing its output all the way to either supply rail level. The stage has unity gain, but is provided with adjustable input attenuator R12, RV1 and R11 to set the precise maximum output level. RV2 is used to cancel the ICs DC offset error. Both of these presets are multi-turn types.

Construction

Construction is quite straightforward and is dealt with in greater detail in the leaflet supplied with the kit. However, the following notes are also beneficial.

As a recommended sequence of events, firstly mount the wire links between the PCB holes marked 'j'. After fitting these the card's address must be chosen, and this is according to what other addresses you will be using for other cards, i.e. if this is the first card on the extension board then it can be given

the address '1', which would be set by installing wire links at 'A0', 'A5', 'A6' and 'A7' (see Part 1 in Issue 59 for a table showing the different addresses available, including special addresses for the multiplexer and an external real-time clock).

However, be warned that once the addressing links are fitted, the pattern may not be easily modified without risk of damage to the PCB. One recommendation is that, if you want to be able to alter the address settings at any time for greater flexibility and to better mix different plug-in cards, to be inserted at any position in the extension card, then you could use an octal SPST DIL switch (XX27E) at positions 'A0' to 'A7'. The hole spacing in this area is deliberately compatible with the standard DIL layout for this purpose. This will allow you to quickly and easily alter the card's address at any time.

Next fit the resistors, followed by the IC sockets, taking care to align the notch of each to the marker on the legend. Fit the capacitors C1 to C6 (there is no C3* provided, as explained earlier). Although most of the ICs are not CMOS types and should not be at risk from static damage, do not insert them into their sockets yet until all other work has been completed.

Fit the right-angled male PCB connector to the card by bolting in place using M3 hardware BEFORE soldering, as shown in Figure 2. Similarly fit the female connector to the motherboard, and solder. Then attach the upright PCB edge guides to the motherboard with the self-tapping screws as shown in Figure 3.

Insert the two PCB pins from the component side of the PCB at positions 'AN OUT', last of all, insert all the ICs, making sure to align the notch on each package with the notch on the sockets. Note that IC6 is a MOS device and, although it is a protected device, some care in handling is still advised.

Testing and Setting Up

The unit requires setting up before use. Firstly this involves setting the address, and secondly the calibration of the output stage by adjusting RV1 and RV2.

A unique address is required to be set by fitting wire links or a DIL switch bank on the PCB in the positions A0 to A7, as described above. This will enable the motherboard to recognise the board as an individual device, and data can then be transferred only to the card with the correct address.

Calibration of the unit should be completed using a multimeter (preferably a digital one for accuracy), with the range set to 2V DC and in conjunction with the following program :

```
001 EPEX XX XX XX
002 OPDA 3 001
```

Note the address has been set to card no. 3.

Connect the multimeter to the output of the card ('AN OUT'), and adjust the

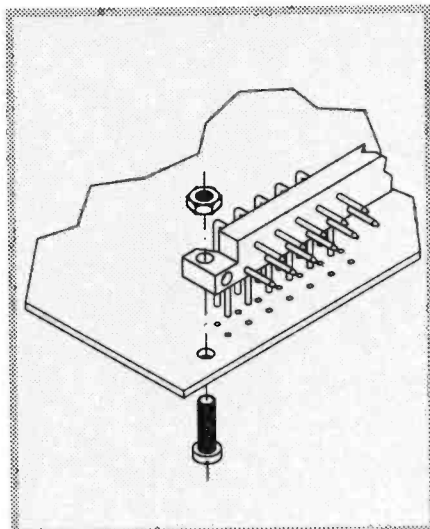


Figure 2. Mounting the card edge connector.

preset RV2 ('ZERO ADJ.') to obtain 4mV. Now type 'OPDA 3 250' (don't forget to hit the return key to enter the new line), and adjust RV1 until exactly 1.000V is shown on the multimeter. Because the 'ZERO ADJUST' affects the 'GAIN ADJUST' and visa versa, the procedure will need to be repeated several times until both the required readings are obtained. To double-check that the adjustments are correct, type 'OPDA 3 000', for a multimeter reading of 0.000V, then type 'OPDA 3 255' for a meter reading of 1.02V.

The following test program will begin by outputting 0V, then for each second that passes the output voltage increases, until on the 10th second the maximum output voltage of 1.02V will be achieved. On the 11th second the program will repeat again, outputting 0V.

```
001 EPEX XX XX XX
002 OPDA 3 000 XX XX X0
003 OPDA 3 005 XX XX X1
```

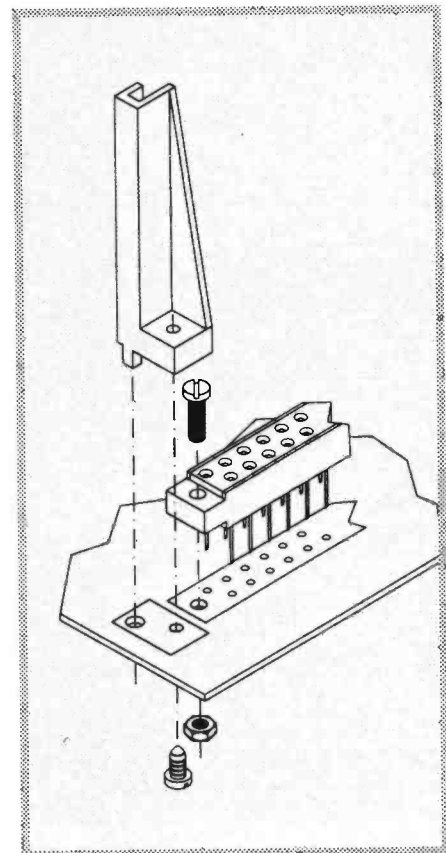
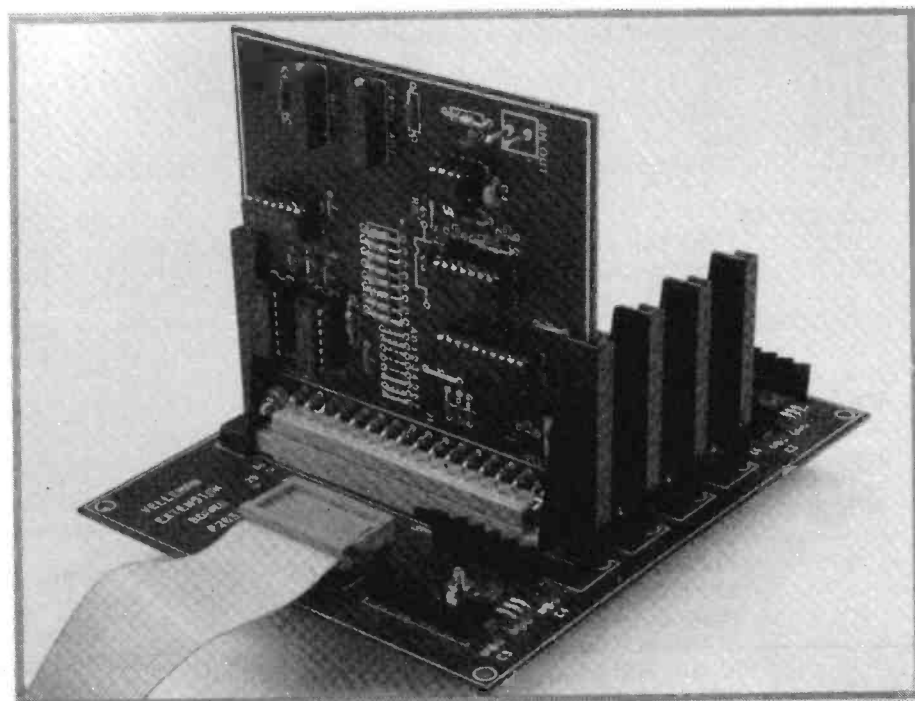


Figure 3. Mounting the motherboard PCB socket and card.

```
004 OPDA 3 010 XX XX X2
005 OPDA 3 020 XX XX X3
006 OPDA 3 040 XX XX X4
007 OPDA 3 070 XX XX X5
008 OPDA 3 100 XX XX X6
009 OPDA 3 180 XX XX X7
010 OPDA 3 200 XX XX X8
011 OPDA 3 255 XX XX X9
```

Note that program lines are only included for convenience and should not be included when entering the program.



The Opto-Coupler Input Card installed in the expansion unit.

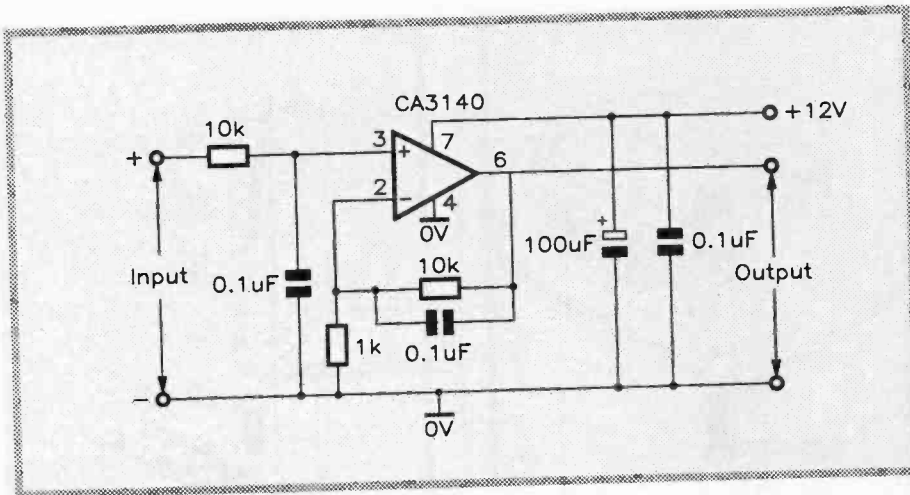


Figure 4. x 10 voltage amplifier circuit.

- * Heatsink Min 1°C/W for Max Dissipation of 45W & Max Temperature of 70°C
- ** Supply Reservoir Capacitor 10,000uF Min for 3A Output

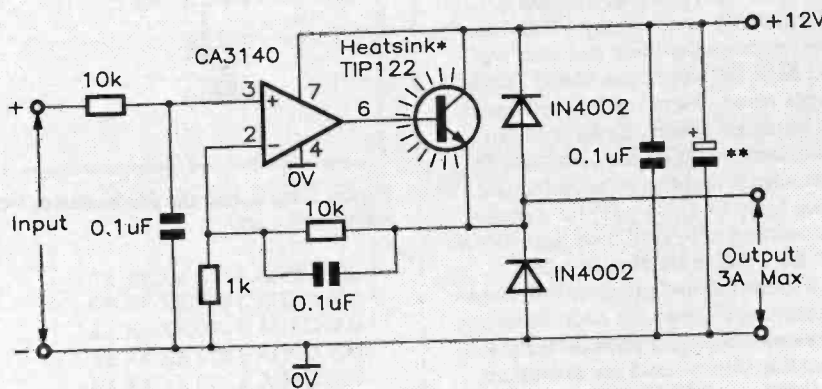


Figure 5. x 10 voltage amplifier with current buffer circuit.

In Use

When using the device it is obviously limited by the maximum voltage it can output (1.02V), but with the minimum of additional circuitry it is possible to amplify the output signal to a more acceptable level. The circuit shown in Figure 4 does just this using a CA3140 Op-amp. This circuit will amplify the voltage by a factor of 10, but is still not capable of supplying enough current for applications such as the control of lighting, motors, etc. For these, a current buffer is required; and this can be achieved by adding a TIP122 power transistor, with diode protection, to the circuit of Figure 4, as shown in Figure 5. PLEASE NOTE that the TIP122 will become hot in use and should be fitted to a heatsink that is appropriate for the amount of current being drawn.

The heatsink size can be calculated using the following formula. First calculate the power dissipation in the output transistor:

Maximum supply voltage - minimum output voltage x maximum output current = Watts

Secondly, to find the maximum permissible heatsink temperature:
 $\text{Max H/sink Temp} - \text{Room Temp} = \text{Max temp rise}$

Heatsink size = Max temp rise / Power dissipation = °C/W

Thermal resistance has not been taken into account, therefore you can multiply the answer by 0.9, this effectively increases the heatsink size by 10%. Also note that if you are driving a motor from the current buffer, then the motor must be fully suppressed.

D TO A CONVERTER CARD PARTS LIST

RESISTORS: All 5% Metal Film (Unless specified)

R1-10	4k7	10
R11,12	15k	2
R13	390Ω	1
R14	10k	1
RV1,2	10k Multi-Turn Preset	2

CAPACITORS

C1-3,5-7	100nF Monolithic Ceramic	6
C4	56pF Ceramic Disc	1

SEMICONDUCTORS

IC1	74LS374	1
IC2	ZN426	1
IC3,4	74LS136	1
IC5	74LS05	1
IC6	CA3130	1

MISCELLANEOUS

8-Pin DIL Socket	1
14-Pin DIL Socket	2
20-Pin DIL Socket	1
PCB Pins	2
31-Way PCB Plug	1
31-Way PCB Socket	1
PCB Guides	2

Screw M3 x 4mm	4
Nut M3	4
Self-Tapping Screw	2
Instruction Leaflet	1

OPTIONAL (Not in Kit)

C3*	2μ2F 100V Axial Electrolytic	1	(FB15R)
	10k Min Res	2	(M10K)
	1k Min Res	1	(M1K)
	100nF Monores	3	(RA49D)
	100μF 25V PC Elect	1	(FF11M)
	CA3140E	1	(QH29G)
	TIP122	1	(WQ73Q)
	1N4002	2	(QL74R)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available in kit form only.

Order As VE95D (D-to-A Converter Card)

Please Note: Some parts, which are specific to this project (e.g., PCB), are not available separately.

/// Maplin /// Maplin /// Maplin

