PROJECTS BOOK 19

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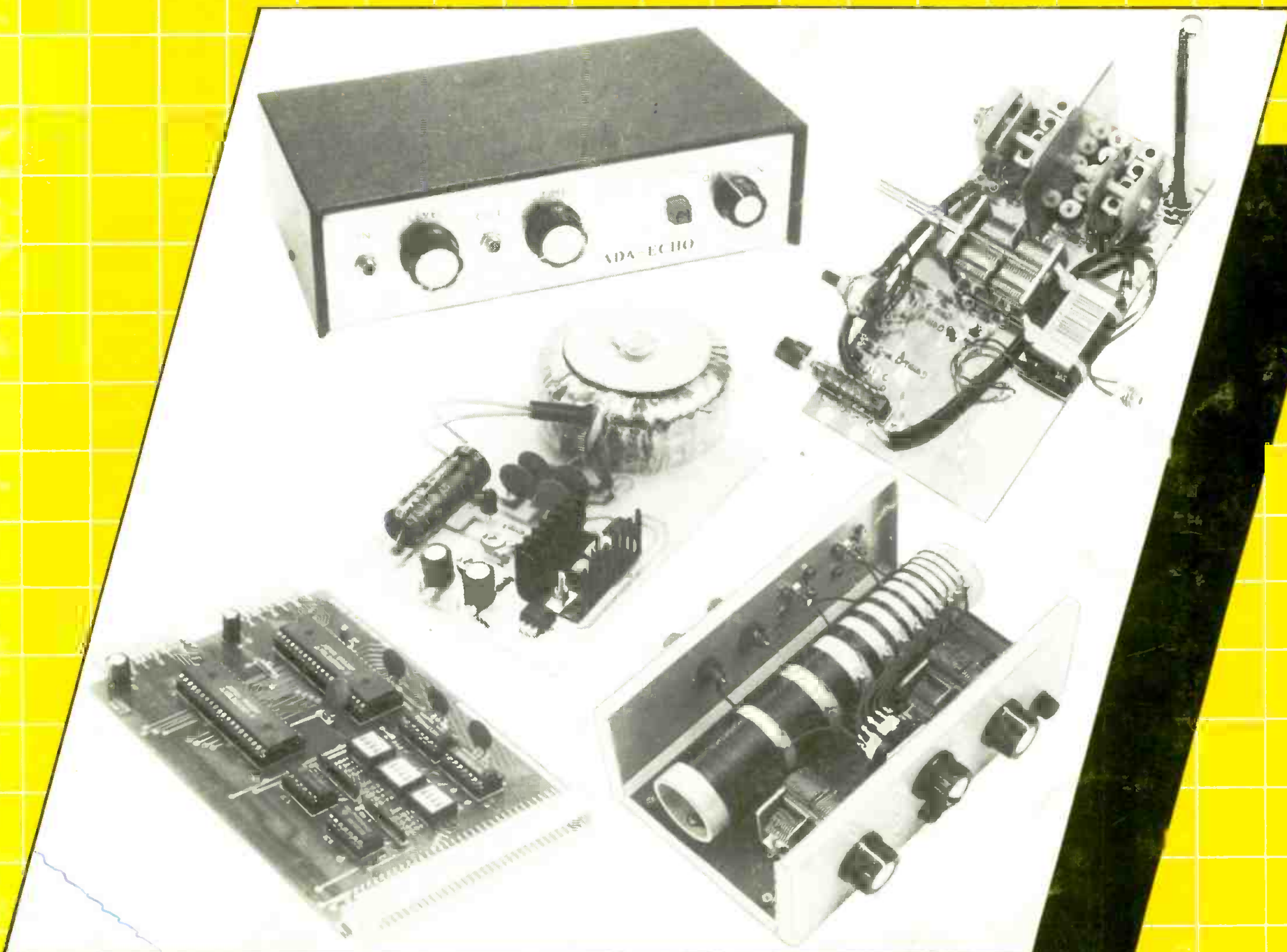

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Electronics
THE MAPLIN MAGAZINE

PROJECT BOOK NINETEEN

This Project Book replaces issue 19 of 'Electronics' which is now out of print. 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 price list, order as XF08J, available free of charge.

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AERIAL AND TUNING UNIT

Two Devices

In the following article, two add-on devices for your receiver are described in detail for you to construct. They are designed to increase the strength of the radio signal being received over a wide range of frequencies. For broadcast and shortwave listeners using a general coverage receiver both devices will offer an improvement in reception even when used in conjunction with a small aerial system.

The first device is a simple, passive Aerial Tuning Unit. The second is the Active Aerial which incorporates a dual-gate Mosfet amplifier. The best results are achieved when both are used together with an outdoor aerial system. However, worthwhile improvements in radio reception are possible when using only one device or the other. In deciding whether to use just one or perhaps both of the units, with your particular receiving station, it is recommended that you read through each part of this article and also determine if the deficiency is due to aerial impedance mismatch or lack of receiver sensitivity.

Aerial Tuning Unit

One of the most common types of simple receiving aerials is the end-fed, long wire, its length being governed by the amount of space available within the boundaries of your property. An average length for such an aerial is between 20 and 50 metres. Its height above the ground is not critical at MW/SW frequencies, but it is far more convenient to get it up in the air out of the way, usually at around 5 to 10 metres. The main disadvantage of this system is that its impedance presented to the aerial input of a communications receiver will vary depending upon the frequency. The range of impedance values may swing from a few ohms to several thousand ohms. When looking at the frequency/impedance characteristics of your aerial system you will need to know its wavelength relationships.

The mathematical calculation is quite simple. The velocity of a radio wave, whilst travelling through free space, is constant at 186,000 miles or 300,000,000 metres per second. In the following formula, V = Velocity, and F = Frequency in Hertz (cycles). The result is the full wavelength in metres.

$$\frac{V}{F} = \frac{300{,}000{,}000}{1{,}875{,}000\text{Hz}} = \frac{300}{1.875\text{MHz}} = 160$$

The relationship between the impedance and the wavelength of the aerial will vary; at a full or half wave length it will appear to the receiver as a relatively high impedance, while at quarter-wave, or at an odd multiple of quarter-waves, it is considerably lower.

The aerial input impedance of most communications receivers is 50Ω. Unless the impedance of the aerial matches that of the input of your receiver, you will not transfer all the RF energy from the aerial to the receiver input circuit. The more extreme the mismatch the weaker the received signal will appear, and under adverse conditions it could vanish into the background noise. The answer to this problem would be an impedance matching

by C.S. Barlow & Ms M.A. McCarthy

AERIAL TUNING UNIT

SPECIFICATION OF PROTOTYPE

Frequency Range	= 600kHz to 30MHz
Input Impedance, Aerial	= Variable
Output Impedance, Receiver	= 50Ω
Transmitter Power Capability	= 10 watts

transformer which will accept a wide range of input impedances and convert them down to the 50Ω level required by the receiver. At the frequencies where the aerial impedance is close to that of the input of the receiver no amount of matching will improve the signal. Under these conditions more gain in the aerial system or in the receiver would be necessary.

Circuit Description

The circuit shown in Figure 1 consists of two variable capacitors and a tapped inductor forming a 'T' configuration. The origin of this

- ★ **Boost Radio Reception with these Super Projects**
- ★ **Both Units can be used with a Wide Range of Radios**
- ★ **Tuner is Simple to Construct, DC Power not Required**
- ★ **No Coil Winding on Aerial Project**
- ★ **Includes High Quality Telescopic Aerial**

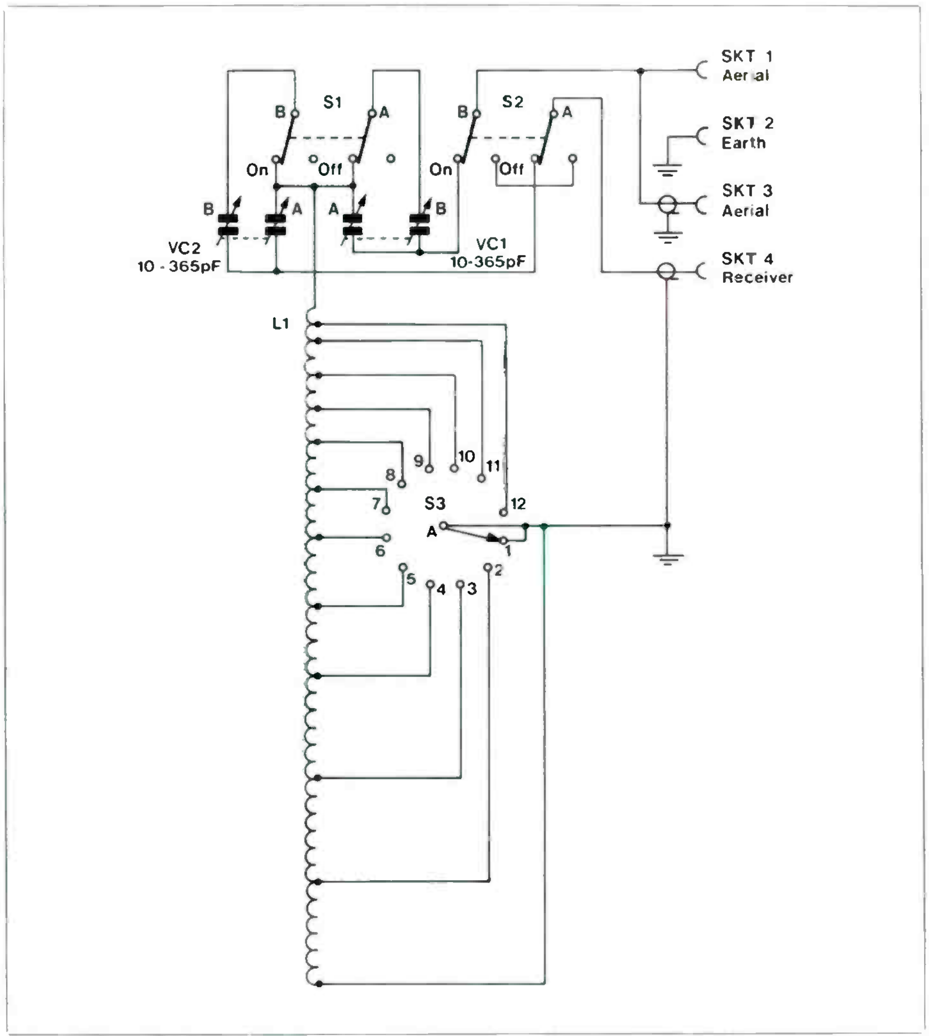


Figure 1. Tuner Circuit

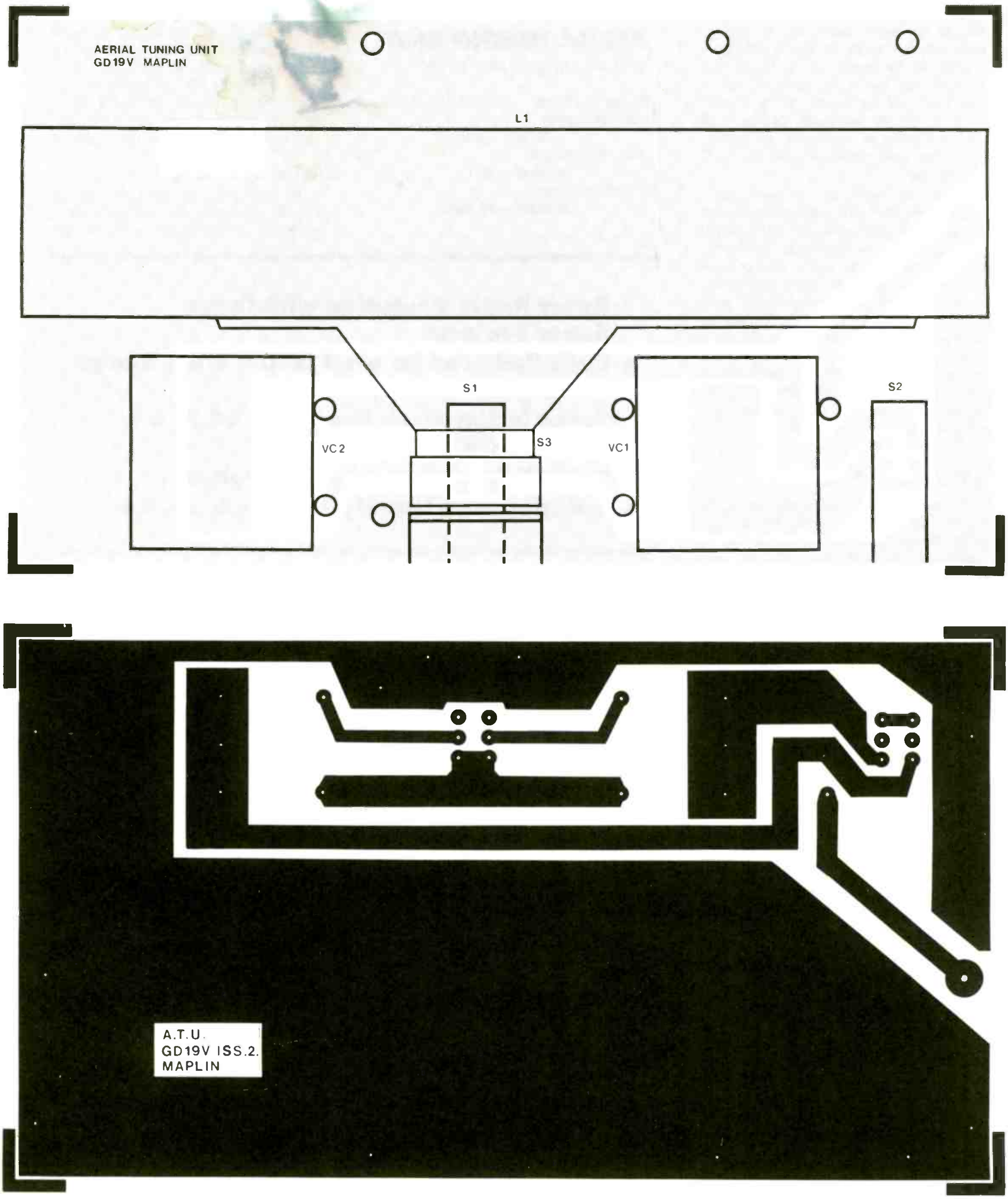


Figure 2. Tuner PCB

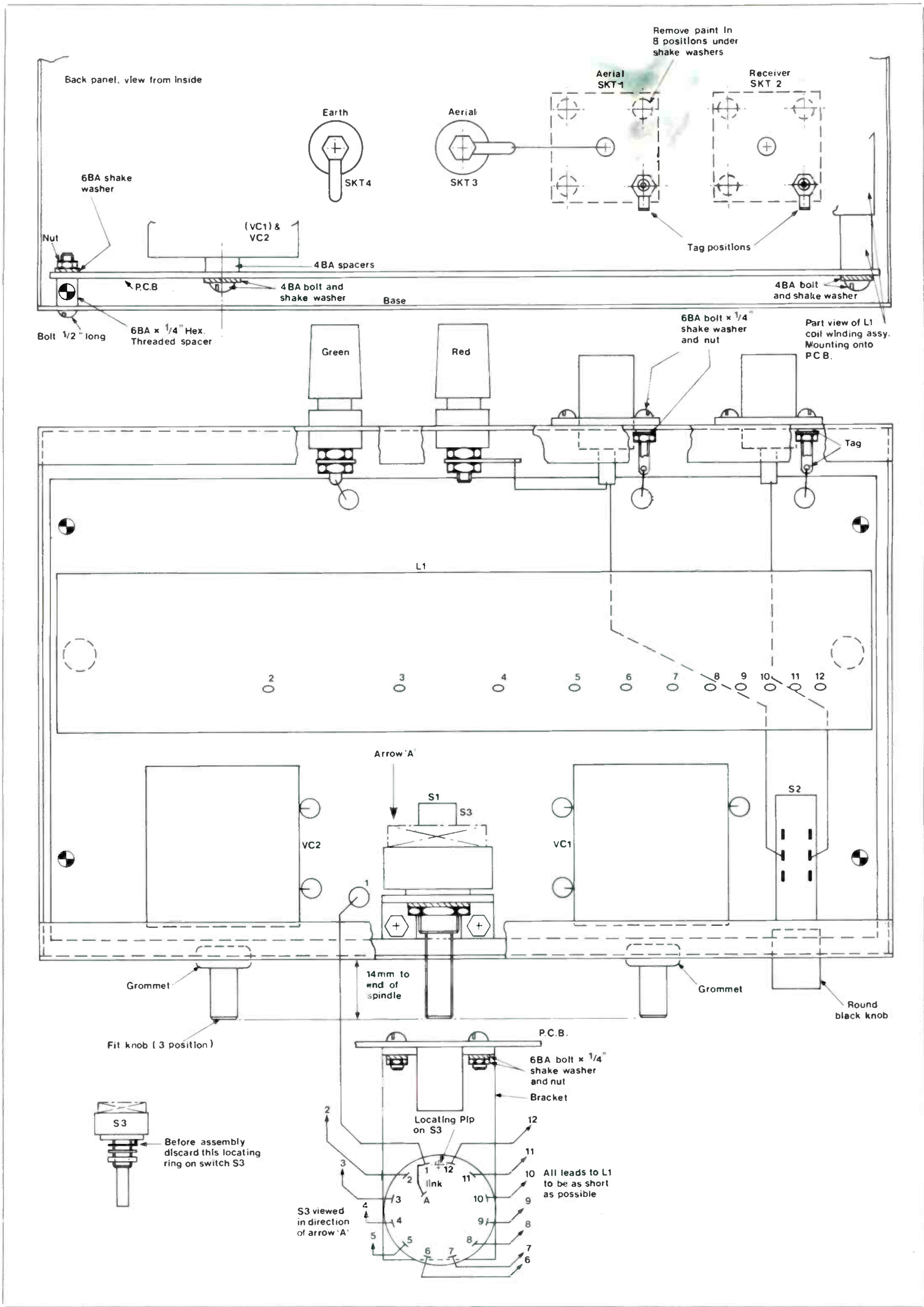


Figure 3. Wiring the Tuner

type of circuit is not clear, but it has been attributed to an American designer and is sometimes referred to as a Transmatch. The frequencies covered by the device will be determined by the values of VC1, VC2 and L1.

The prototype performed well over a range of frequencies from 600kHz to 30MHz, however this may vary fractionally depending upon the type of aerial and receiver in use. To achieve this wide range, both VC1 and VC2 are arranged so that single or dual sections (gangs) can be switched in by S1 (the 'C x 2' switch), and L1 has multiple taps switched in by S3 (the 'L' switch). The remaining switch S2 is the signal bypass, mainly used for comparing the direct signal to the improved, matched one.

VC1, the aerial capacitor, matches the aerial load impedance to the tuned circuit formed by VC2 and L1. The resonant impedance of this tuned circuit is dependant upon the combined L/C ratio of VC2, L1 and the load impedance transferred by VC1. VC2, on the receiver side, subsequently matches the output of the circuit to the 50Ω aerial input of the receiver.

Construction

The pcb has a printed legend to assist in the positioning of each component, see Figure 2. The sequence in which these components are fitted is not vitally important; however, the following instructions will aid in the easy assembly of this project.

Install the veropins at the positions indicated by the white circles on the pcb. Next insert the push switches S1 and S2, making certain that they are pushed firmly down on to the surface of the board.

When handling the variable capacitors VC1 and VC2 *always* keep the vanes fully enmeshed (fully retracted) to avoid damaging them; clearance between the vanes are very small and they can easily be bent accidentally causing a short-circuit. When mounting these capacitors use the 4BA quarter-inch bolts and spacers. Line up the capacitor so that it is square to the legend, and the side tags are in line with the holes in the pcb. Make sure that the bolts are secure, as they are the principle means of connecting the frame side of the capacitor to the rest of the circuit!

Fit the switch bracket using the 6BA hardware as shown in Figure 9. Before fitting the rotary switch S3, remove the nut and shake-proof washer to reveal the moving contacts' stop-ring, which can be positioned to select a maximum number of ways from 2 to 12. Since all 12 positions are to be used here, you can remove and discard this ring. Cut the plastic shaft of the switch to a length of 29mm from the *mounting face*, that is, the boss at the base of the threaded bush (see Figure 3). Refit the large lockwasher to S3, then attach S3 to the bracket as shown in Figure 9.

The Coil Assembly

The coil assembly L1 must be prepared before fitting it to the rest of the circuit. The former supplied in the kit has already been cut to the length required and drilled. However, if you are not constructing from a kit, then

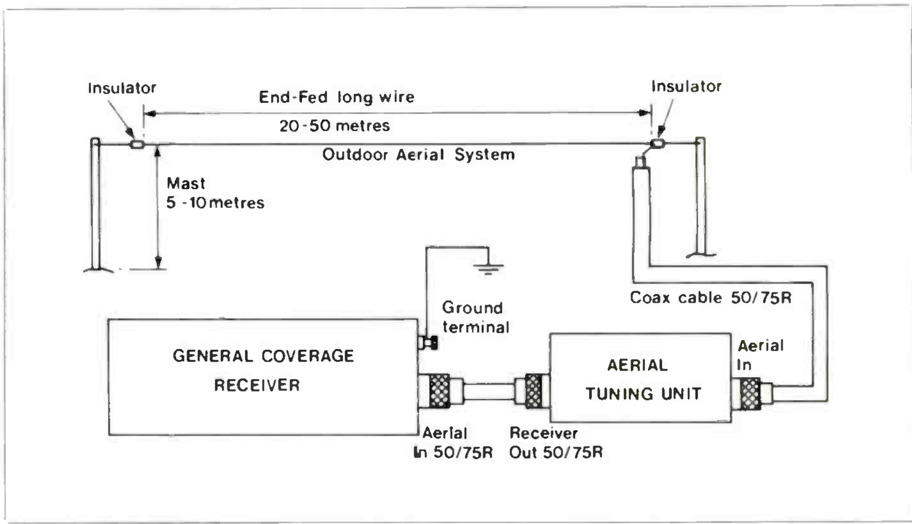


Figure 4. System Set-up

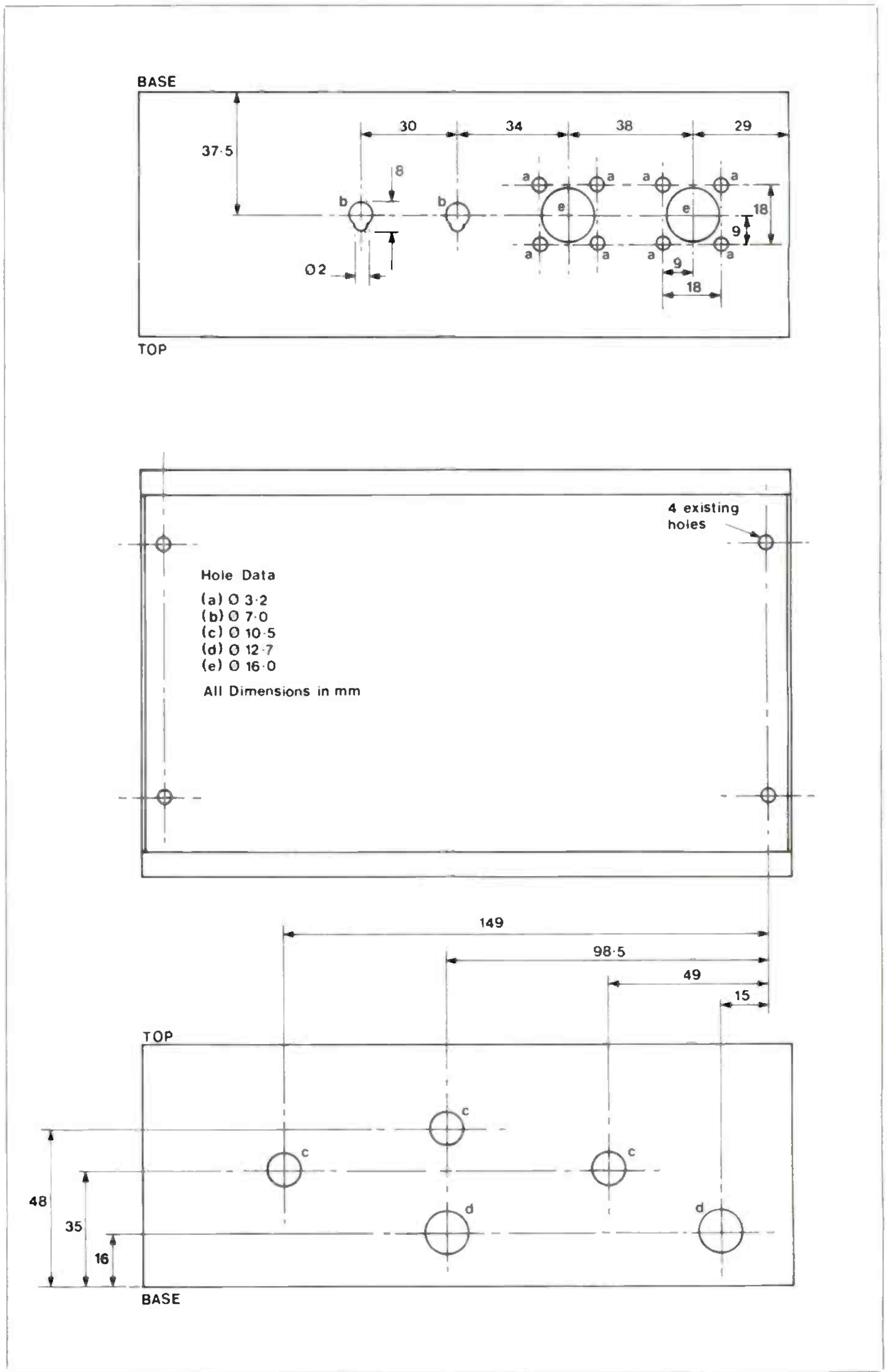


Figure 5. Tuner Case Drilling

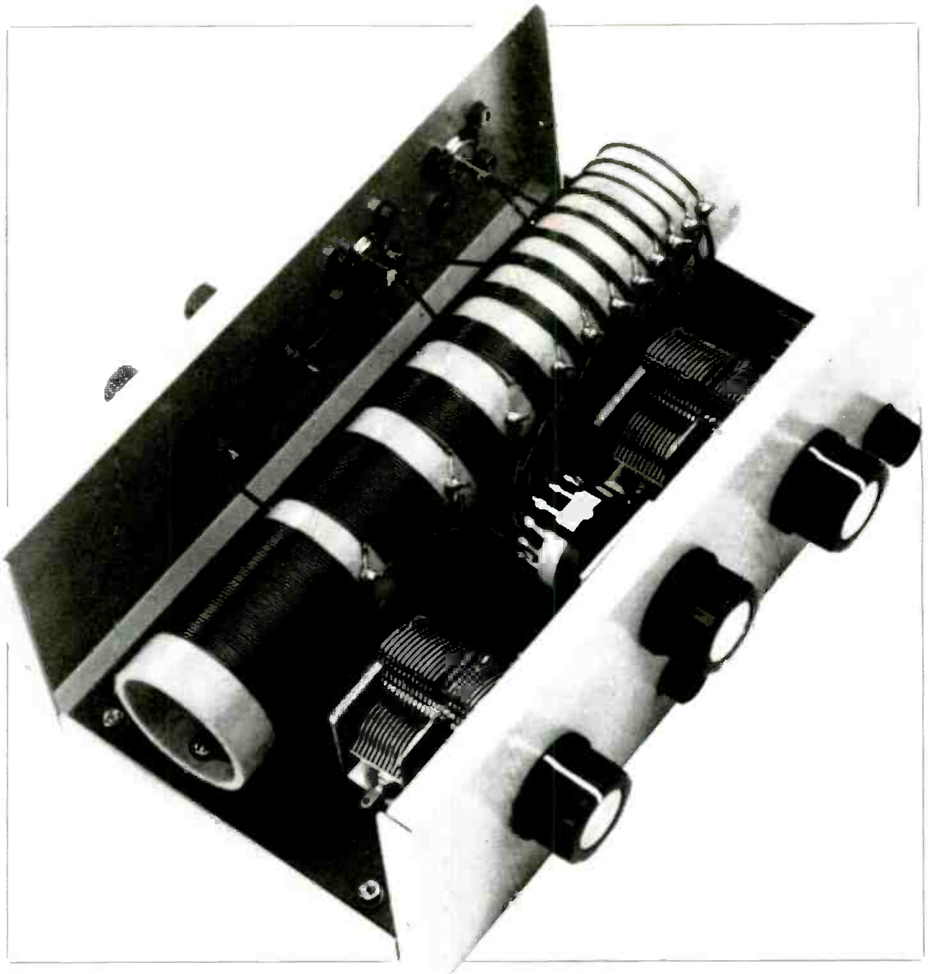
drilling and cutting information is provided in Figure 7. The small holes running along the tube are for the double-ended veropins, which form the tapping points for the finished coil, and you must use a drill bit of the correct size if you are doing this yourself.

The pins must be a tight fit so that a soldering iron can be used to insert these pins as the heat softens the material of the former, making the installation easier, and the pin solid on cooling.

When handling the 22 s.w.g. enamelled copper wire, be careful not to accidentally kink it as this will make the close winding of the coils difficult. Commence winding the coil as shown in Figure 8. Make sure that the ends of the e.c.w. to be soldered have all enamel completely removed, by scraping all around with a small knife. On reaching a veropin tapping point or a solder tag, it will be necessary to remove the enamel from the copper wire without cutting it, by scraping the area adjacent to the pin for a length of ¼ inch, or just enough to allow the wire to be soldered to the pin. Make sure that you tin the wire with a small amount of solder first to ensure a good connection. When winding the wire on the former you may discover that it has a mind of its own and will attempt to unwind itself if you relax the tension before fixing it to an anchoring point. As a means of preventing this occurence temporarily wrap insulation tape around each section of the coil before soldering. This becomes less of a problem as the number of turns required in each section decreases.

Each end of the coil has a 4BA solder tag attached to it and is secured to the threaded spacer by a bolt, as shown in Figure 3. Install the coil assembly to the pcb, using the 4BA hardware provided. Ensure all the bolts are secured firmly as they are the means of connecting the coil to the rest of the circuit.

The wiring to the coil is made by using various lengths of the solid core wire as provided in the kit. A guide showing the runs of wire from each tapping of the coil to the numbered tags on S3 is shown in Figure 3.



Typical record

RECEIVER	AERIAL	FREQUENCY	INDUCTANCE L	RECEIVER C	AERIAL C	C × 2
TRIO - TS940S	Long wire	14·2 MHz	9	4	7	Out
YAESU - FRG 8800	Dipole	3·7 MHz	3	8	4	Out
ICOM - R71	Long wire	700 kHz	1	6	10	In

Figure 6. Typical Record Chart

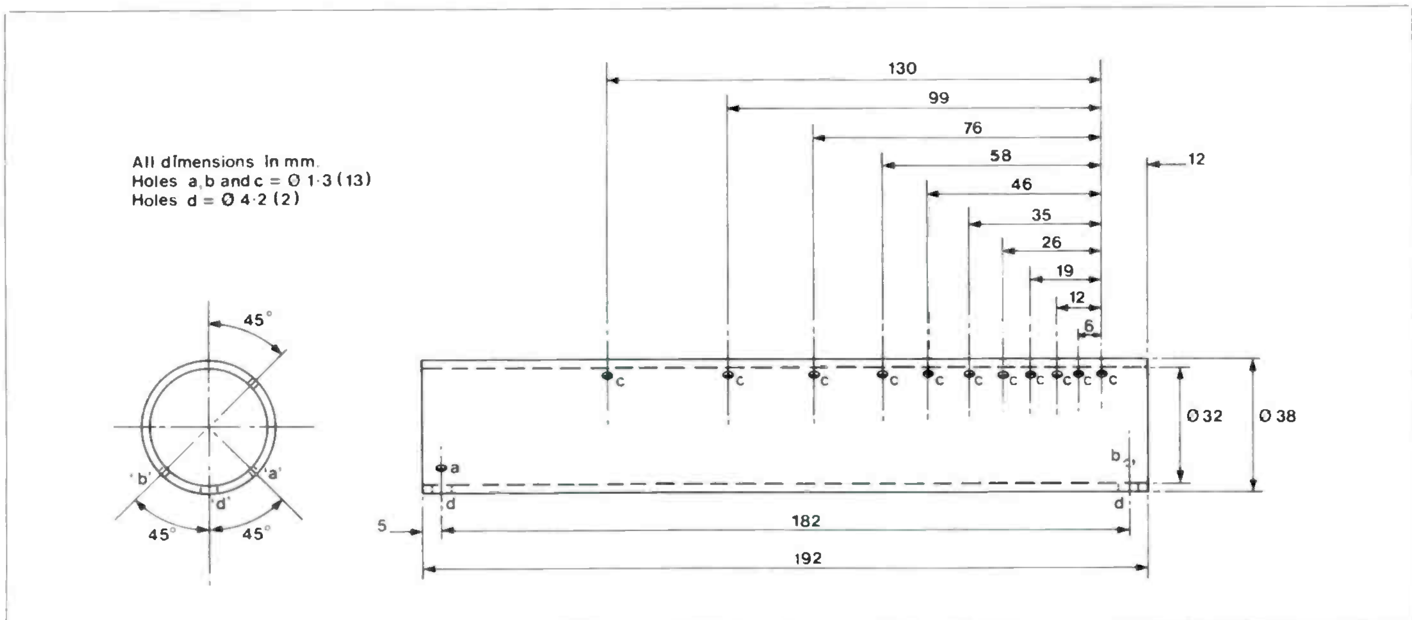


Figure 7. Coil Tube Drilling

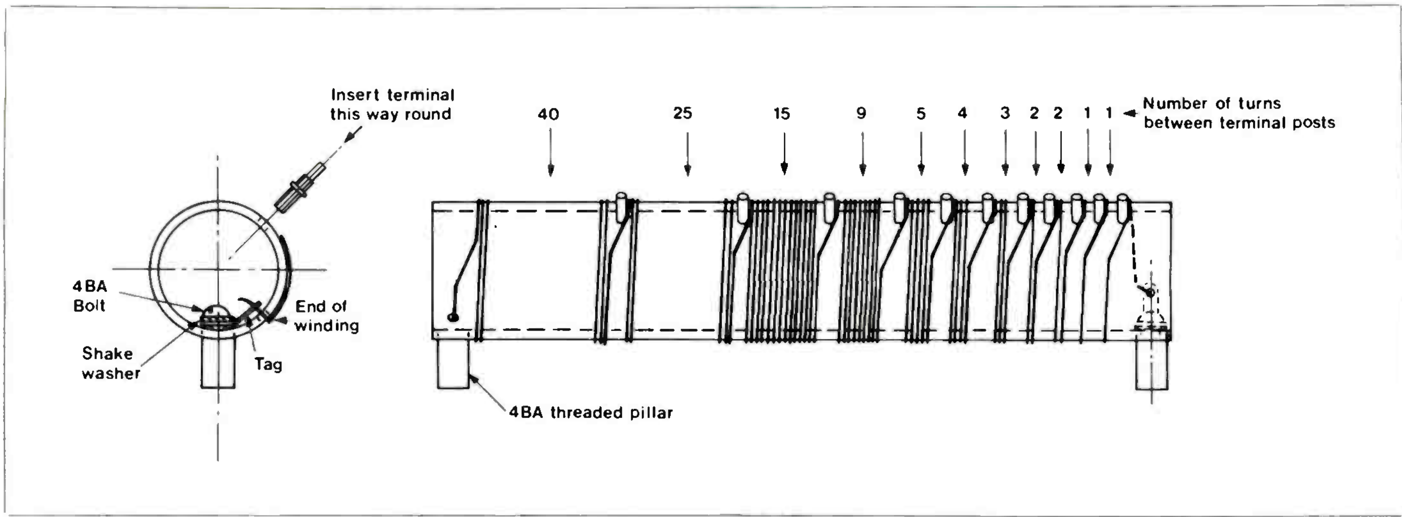


Figure 8. Coil Winding

Do make sure that the correct switch tag goes to each tapping to avoid confusion and future problems.

The cabinet for which the ATU pcb was designed is the 'Blue Case Type 222' (XY45Y) and it is painted on all its surfaces. When drilling the holes for sockets SK3 and SK4, ensure that the paint is removed from the inside of the cabinet at the positions where the 6BA solder tags will be fixed, see Figure 3. This will provide a good earth connection to the chassis, which is vital at radio frequencies. Use the drilling information shown in Figure 5 to position the holes in the front of the chassis using the self-adhesive front panel to check that the placement is correct before doing any drilling.

Having drilled the holes, at the same time clearing them of any swarf, clean the front of the case of all dirt and grease and remove the protective backing from the front panel. Carefully position and then firmly push down using a dry, clean cloth until it is securely in place. Before installing the pcb assembly, fit the grommets into the front panel at the positions shown in Figure 3. These grommets are necessary as the metal shafts of the capacitors are above ground potential and therefore if they touch the chassis they will short out the signal to earth. For this self-same reason the control knobs are made of a non-conductive material, thus preventing any unusual effects when handled by the operator.

The pcb itself is held in place by four 6BA, half-inch bolts and spacers underneath, plus four 6BA shake-proof washers and nuts on the top. The spacers are necessary to prevent the circuit from shorting out to the bottom of the metal cabinet. Now fit SK1 to SK4 on the back of the cabinet and wire them in to the circuit using the solid core wire, as shown in Figure 3.

Testing

The best way of testing the unit is to connect your aerial to the input of the ATU and your receiver to the output, as shown in Figure 4. Most communications receivers have some sort of signal strength meter, usually referred to as an 'S meter', and this is the only indication needed when tuning the ATU for a peak. If your receiver has no meter then it must be done by ear. Under these conditions, if your receiver has the facility of switching out the AGC, then the peak in signal will be more audible.

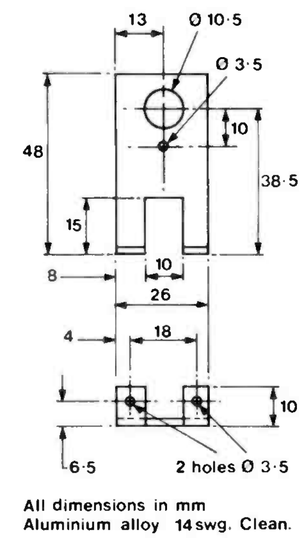


Figure 9. Tuner Bracket

When starting from a new frequency, set both variable capacitors to their halfway positions, that is at position '5' on the front panel scales. The 'C x 2' switch should be out, and the inductance switch 'L' at position one.

Push the bypass switch in. You may note, at this stage, a reduction in signal strength. Rotate 'L' until the signal peaks, then adjust the settings of the aerial and receiver controls simultaneously until no further improvement can be made. If either of the 'C' controls are at position '10' extra capacitance can be brought in by pressing in the 'C x 2' switch, and re-adjusting the controls. Sometimes the 'L' switch also requires slight modification. In general, the lower the frequency being used then the more inductance required. This corresponds to a low setting of the 'L' switch, for example '1' or '2' at MW frequencies, and '11' or '12' at 10 metres. If no improvement can be made to the signal being received, it is probably because the aerial system is presenting the correct impedance match at that particular frequency. Therefore no amount of tuning can enhance the signal.

To assist you in keeping a record of the various settings of the ATU for a given frequency and aerial system, a suggested chart for entering your observations is shown, see Figure 6.

The ATU was not designed for transmitter use, since higher voltage capacitors would have been essential and therefore much more expensive than those used here. Heavier duty switches would also have been necessary, making the entire assembly much bulkier. Therefore, this unit is definitely *not* designed for transmitters with more than 10 watts output!

Active Aerial

Aerial theory is a very complicated subject. Needless to say, to expect a good performance from 150kHz to 30MHz from just one aerial would be expecting a lot. The ideal would be a number of separate aerials each resonant to a smaller part of the frequency spectrum. However, not everyone has the space available for so many aerials, and so one must suffice for the whole of the range. This means, depending on the length of the aerial system, the performance will vary over the radio frequency spectrum. It is possible to make some improvement with the addition of an Aerial Tuning Unit. This device attempts to match the aerial impedance to the receiver; however, it is only a passive device consisting usually of a set of variable inductors and variable capacitors.

ACTIVE AERIAL

SPECIFICATION OF PROTOTYPE

Tuned Input/Output Frequency Range	= 150kHz to 30MHz
Variable Gain	= 0dB to +20dB
Input Impedance, High (Integral Telescopic Aerial)	= 50kΩ
Input Impedance, Low (External Aerial)	= 50Ω
Output Impedance	= 50Ω
Power Supply, Internal PP3 Battery or External DC	= +7 to +15 Volts
Low Voltage Indicator Threshold	< +7 Volts

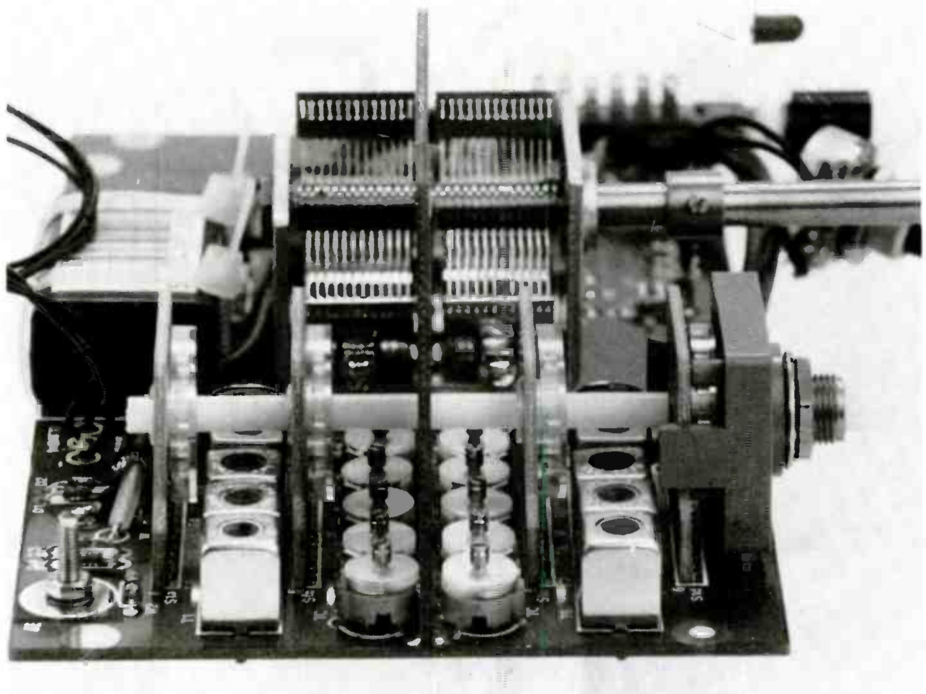
In some cases, it is not possible to have an outdoor aerial, and yards of wire trailing about the house are definitely not desirable, especially by the wife! So a small telescopic aerial is integrated into the design.

But a telescopic whip aerial at short wave frequencies, even with an aerial tuning unit, will have a very poor performance over the entire range of frequencies previously mentioned. A further complication when using an aerial that is not resonant at the frequency you wish to receive, is the possibility of a stronger signal swamping the desired signal, because of the aerial being more resonant at that frequency. This can be a minor or a major problem, depending upon the quality of the receiver.

The greater the number of tuned RF stages, and the narrower the passband, then the better the performance will be under these adverse conditions. A solution to both these problems is to use an active Tuned Aerial Amplifier. When used with an outdoor aerial system, it will offer an improvement over the entire frequency range.

The unit has its own telescopic aerial for use where a proper outdoor aerial is not practical or possible. Also it can be employed as a deliberate 'low sensitivity' option, to reduce gain as, sometimes, too much signal is as bad as too little. This again depends upon the quality of the receiver being used.

The tuning of the amplifier is very similar to that of a radio, with a band switch and tuning control. To obtain the best results, simply tune the amplifier to the same frequency as the radio for a peak in signal strength. If an aerial tuning unit is to be used in conjunction with this amplifier, then it must be connected between the input of the amplifier and the aerial. The two devices will then optimise your aerial system.



The power source for the active aerial is an internal PP3 battery or, an external DC power supply of between +7 volts and +15 volts can be used. This means the active aerial can be used virtually anywhere, i.e. at home, in the car or on a boat.

An LED indicator has been provided to give warning of low battery voltage. In this event the indicator will not light, but the active aerial will still work with reduced performance. The power drain of the unit is minimal, so the internal battery will last for quite a time when in general use. The LED operates as a 'power on' indicator while the battery is healthy, or where an external power source is used.

Circuit Description

The circuit shown in Figure 10 is a simple, single transistor RF amplifier with a tuned input and output. This is done to keep the passband to a minimum. It is not possible to tune through the entire range of frequencies with only one coil, so switched coils are used to cover the RF spectrum from 150kHz to 30MHz. These are manufactured with a low impedance winding for aerial/receiver input matching. They each have an adjustable ferrite core to permit alignment, and are encased in a metal can for screening purposes. To obtain the frequency coverage required, five switched coils are used on the

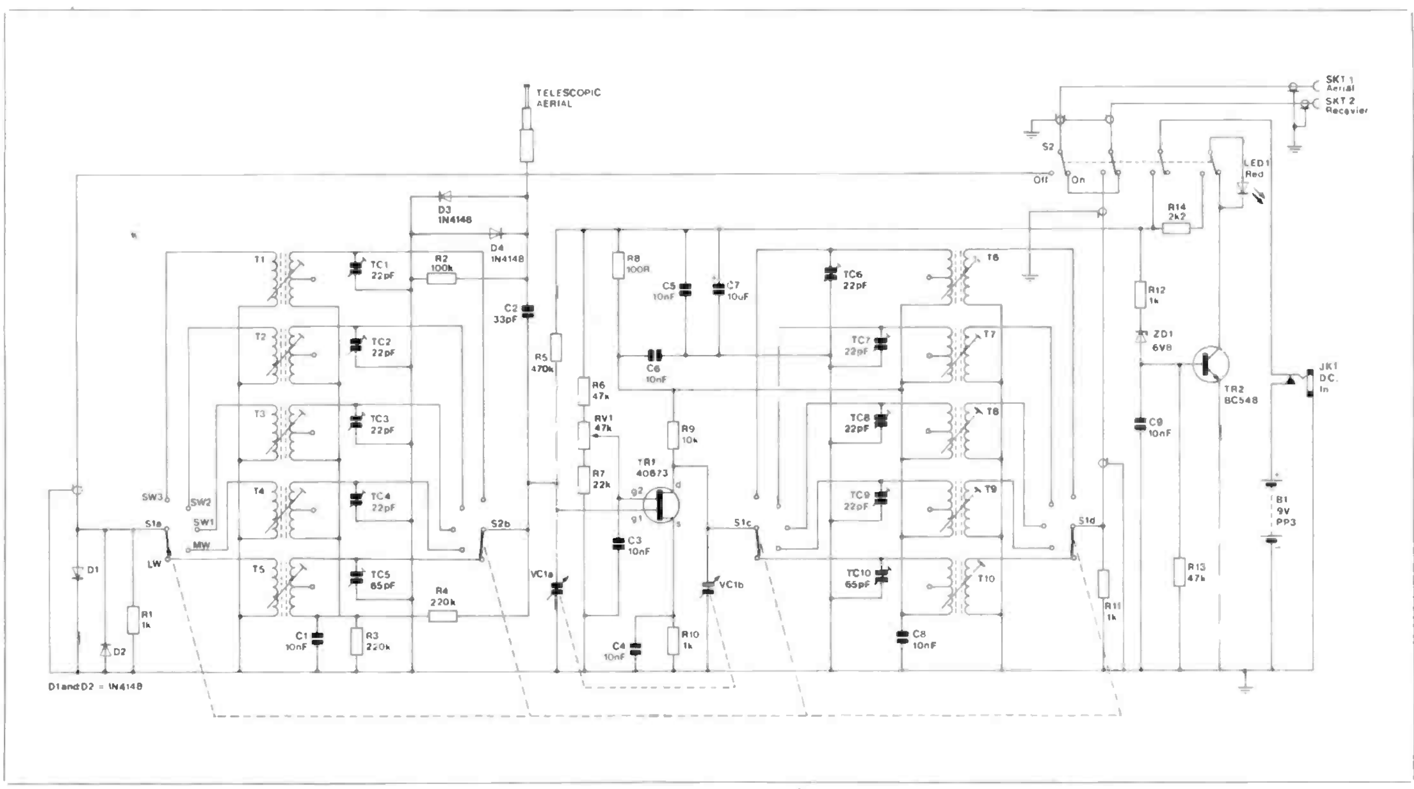
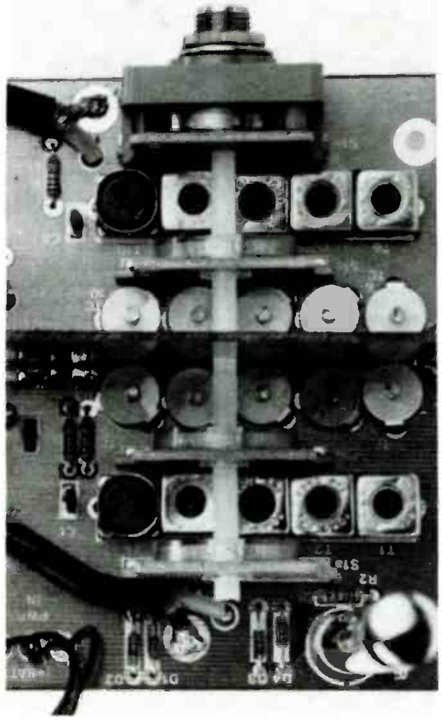


Figure 10. Aerial Circuit



input to the amplifier and a further five on the output. The bands are as follows: LW, MW, SW1, SW2, and SW3. As can be seen from the circuit diagram, the input and output of each coil must be switched. This is achieved by the multi-segment rotary switch S1. S1a connects the external aerial to the low impedance input of the desired coil; S1b switches the output of the coil to G1 (the signal input gate of TR1). G1 is at a much higher impedance than the external aerial input, and it is at this point, via ceramic capacitor C4, that the telescopic whip aerial is introduced when used. The tuning of these input stages is provided by the variable capacitor VC1a, and the DC biasing for G1 is provided by resistors R3, R5.

The required output coil is switched into the drain circuit of TR1 by S1c, and is tuned by VC1b. The low impedance output of each coil is selected by S1d and fed to the receiver via the 'ON/OFF' switch S2.

The gain of the amplifier is set by rotary potentiometer RV1, which varies the DC bias on G2 of TR1. Its limits are fixed by R6, R7.

There are several ceramic capacitors in the circuit to provide de-coupling for the prevention of instability at RF frequencies. These are C6, C8, C9, C10 and C11.

The low voltage indicator is a simple transistor switch operating a high-efficiency, red light-emitting diode (LED) to keep the power drain to a minimum. TR2 will be turned on and the LED will light as long as there are more than +7 volts applied to the cathode of ZD1. As soon as the voltage drops below +7 volts TR2 turns off and the LED will go out.

S2, the ON/OFF switch, has two functions – it applies the voltage to the circuit and switches the RF input/output, so when the active aerial is switched off, the external aerial is connected directly to the receiver.

JK1 is the external power input socket. When in use, it disconnects the internal PP3 battery from the rest of the circuit. The positive supply should be wired to the tip connection of the external power plug, and the negative supply to the body or 'ring' of the plug. See Figure 14.

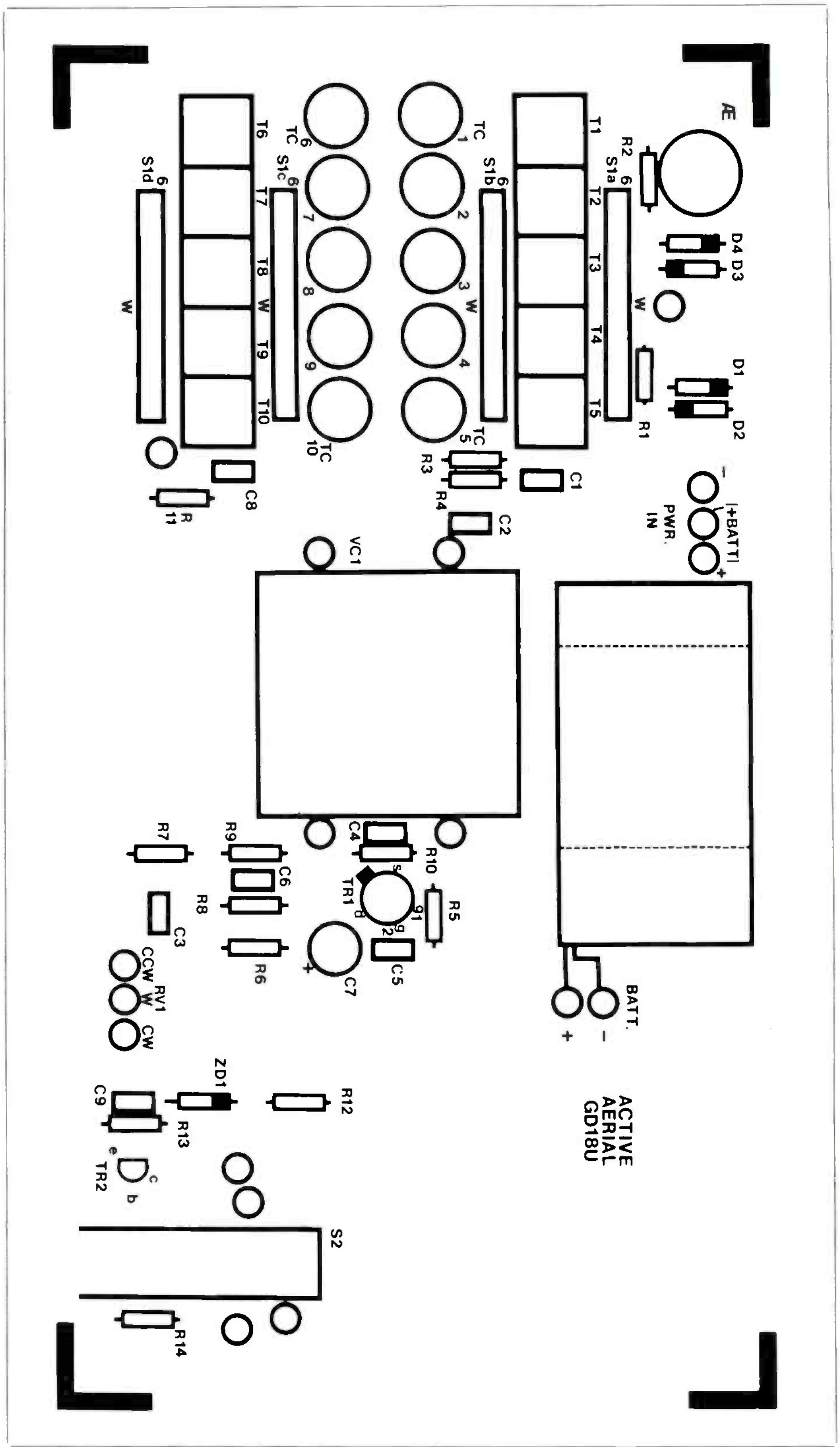


Figure 11. Aerial PCB Overlay

A list of voltage readings is shown in Figure 15. These were taken from the prototype, using a high input impedance Digital Multimeter. No aerial or receiver was connected, and the telescopic aerial was fully retracted. The band switch was set to LW and the tuning control to 150kHz. The power supply was as close as possible to +9 volts and all voltage readings were positive, relative to the chassis/ground.

Construction

When dealing with RF amplification the layout of the components is critical. This is because any stray capacitive or inductive coupling between the input and output will cause oscillations and instability in the circuit. All the components are mounted in such a way as to keep their leads as short as possible for this very reason. The Printed Circuit Board has most of its top surface covered in copper to increase the stability of the circuit at RF frequencies. To further increase the stability, wherever possible, pcb mounted components have been used, for

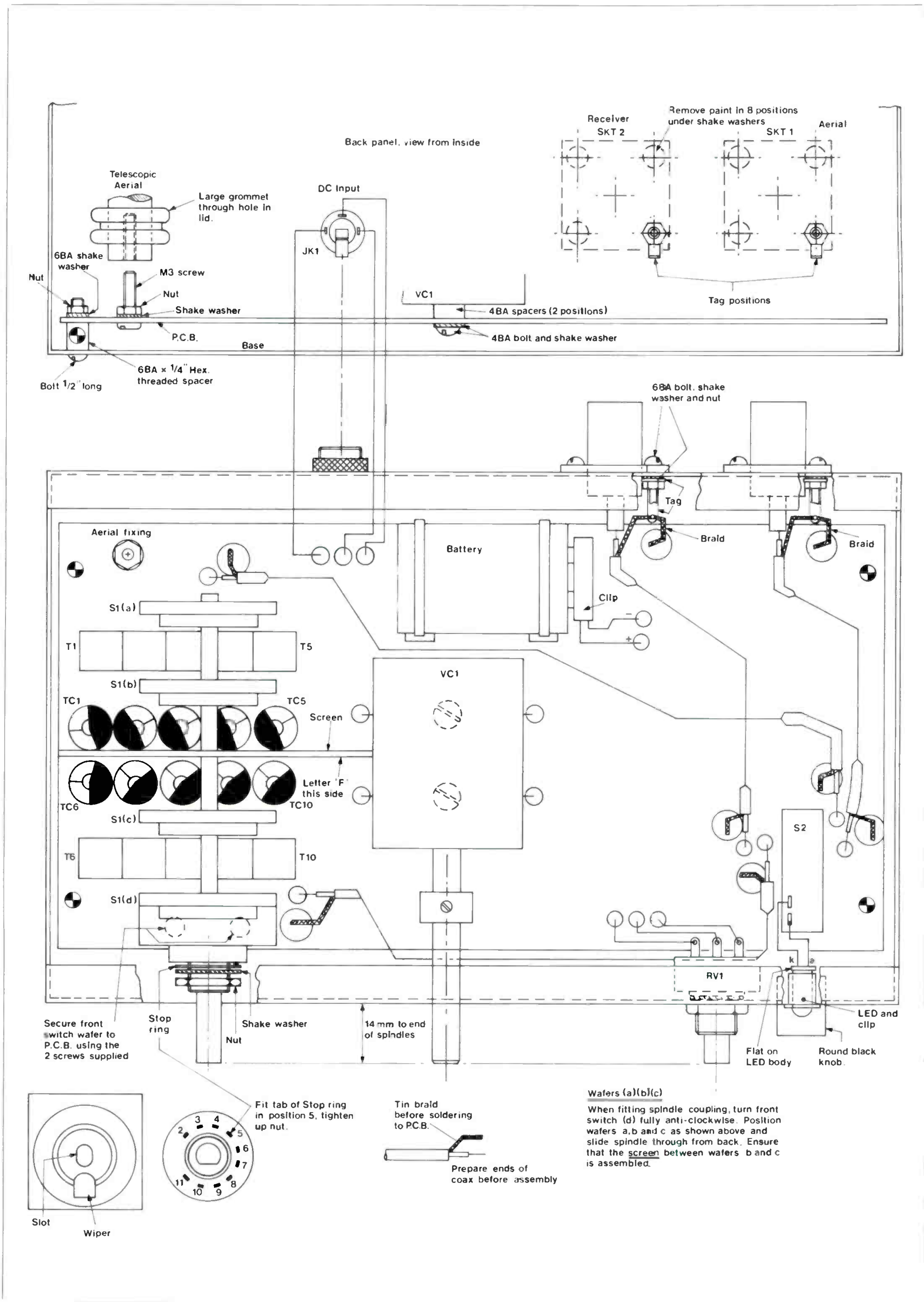


Figure 12. Aerial Wiring

example, S1a, b, c, d, and T1 to T10. S2 is mounted as close to the surface of the pcb as possible, but its position is not as critical, because it only switches DC voltage to the amplifier circuit. The wiring to and from this switch is screened 50Ω coaxial cable. This type of cable is used to prevent any stray pick-up of RF signals, and is the only way to efficiently carry such signals any distance. The voltage indicator circuit layout does not require the same amount of precision however, as it is only a simple DC transistor switch, therefore no instability problems are expected.

The gain control, RV1, supplies a variable DC reference voltage to Gate 2 of TR1. This Gate is de-coupled to RF by C7, so the positioning of RV1 can be remote from the circuit board. The finished unit is housed in a metal case for screening purposes and protection of components on the pcb.

PCB Assembly

The pcb is a double-sided, plated-through hole type. This was used for maximum reliability and stability. However, removal of a misplaced component is quite difficult with this kind of board so do double check each component type, value and its placement on the circuit board. The pcb has a printed legend to assist in the correct positioning of each item, see Figure 11. The sequence in which the components are fitted is not important, however the following instructions will be of use in making the task as straightforward as possible.

It is best to start with the smaller components first. Begin with the resistors plus the ceramic and tantalum cpacitors. Save some of the offcuts from the resistor leads as these will be used later. The diodes D1 to D4 and ZD1 have a band at one end which should be lined up with the markings on the pcb. Do not fit TR1, the dual-gate Mosfet yet, but go on to fit TR2.

Install S2, making certain that it is pushed down firmly on to the surface of the pcb. When handling the variable capacitor VC1 always keep the vanes fully meshed to avoid damaging them as this could produce a short circuit. To mount the variable capacitor use the 4BA, quarter-inch bolts and spacers. Line it up square to the legend, and with the side tags in line with the four holes in the pcb. Make sure the bolts are secure, since they are the means of connecting one side of the variable capacitor to the rest of the circuit. If you have a powerful soldering iron, for example 25 watts, you can solder the tags on the bottom of the capacitor to the pcb through the hole provided between the two 4BA fixing bolts.

The screening plate, which is formed from a prepared piece of double-sided copper-clad board, is soldered to the top of the pcb at the position shown on the legend. This is the long, bare strip of tinned copper to the left of VC1. Use the central vertical plate of VC1 as a guide to positioning. The front of the screen is denoted by the letter 'F' (and its stock code) and this must face forwards. Make sure it is upright and correctly orientated to allow the switch shaft of S1a, b, c, d to pass through it. It may be helpful to temporarily 'tie-down' the screen to the pcb with masking tape or similar, from edge to edge of the pcb and over the top of the screen to pull it into contact with the board. Then the correct position can be easily adjusted and the screen will be supported in this position for soldering. Ensure that it butts against the centre plate of VC1 and is dead centre of the strip.

Commence soldering by making small joints at each end first. Then recheck the position to make sure the screen hasn't moved. If it has, remelt the joints and reposition. Once you are satisfied that the screen is central to the pcb strip, that it butts against VC1 and the hole for the shaft of S1 is in the right place, and that it is properly vertical, then you can complete the solder joints all along both sides of the pcb. There is a lot of copper here so allow time for the iron to heat the joint. Travel along the joint a step at a time, whilst feeding copious lengths of solder into the joint. You must ensure that the area is heated enough to form the joint properly.

Repeat the procedure for the other side. When you have finished, the work can be inspected and any suspect spots touched up, and the tape, if used, removed. If any pcb

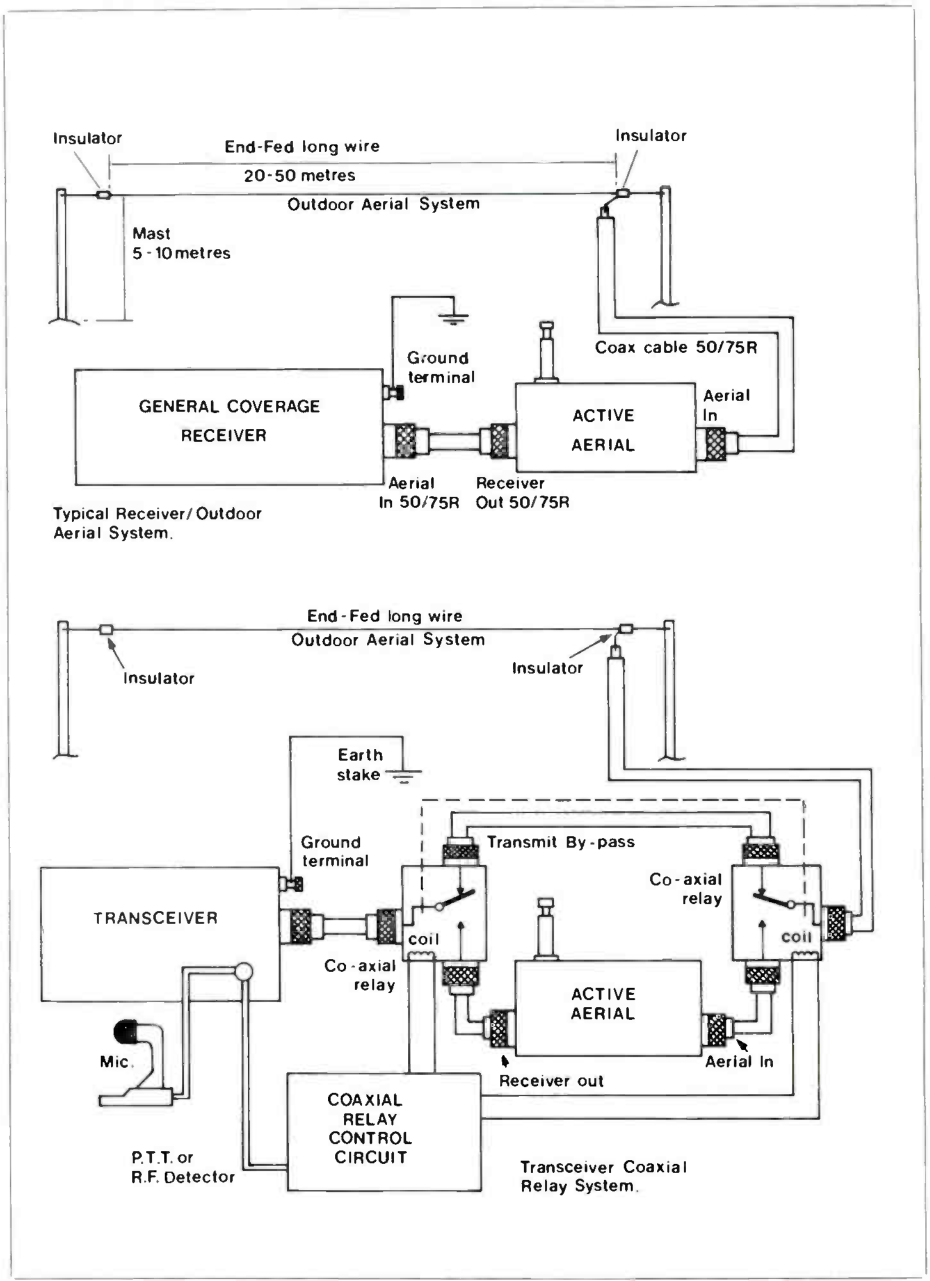


Figure 13. System Set-ups

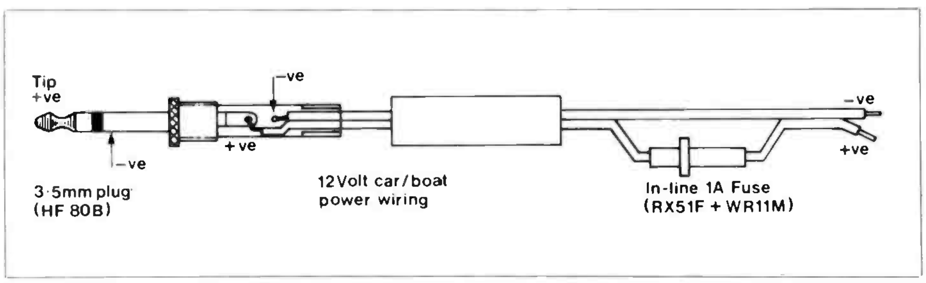


Figure 14. Power Plug

holes in the immediate vicinity have become filled in the process, then you will have to clear these using a pcb drill of the correct size. As a guide, the seventh hole of each position for the four elements of S1 can be used as a centre line corresponding to the position of the coupling shaft.

The trimmer capacitors TC1 to TC10 and the coils T1 to T10 are now installed. The trimmers are colour coded as Green = 22pF, and Yellow = 65pF.

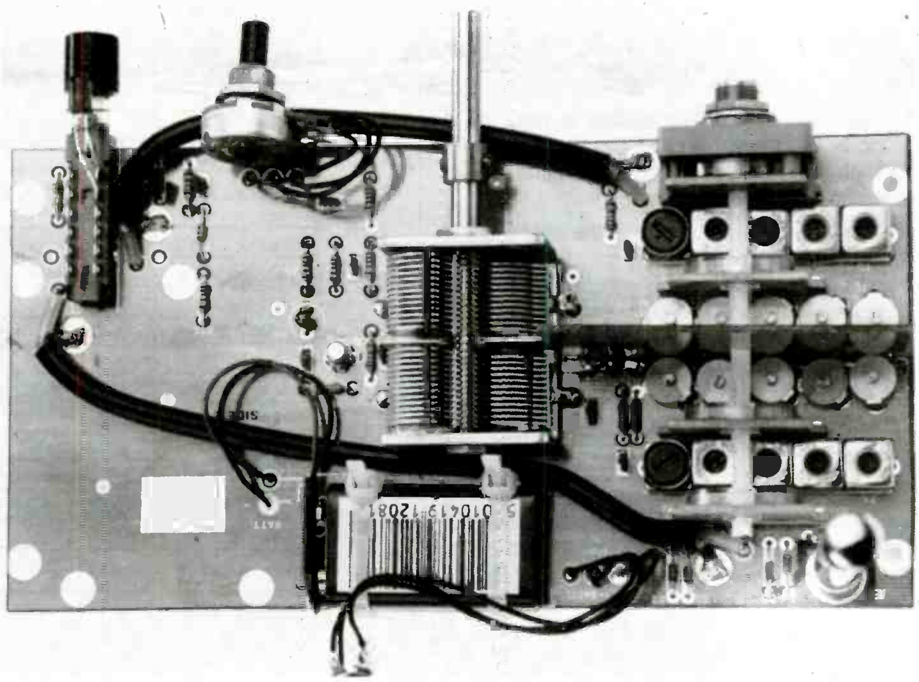
When fitting the coils T1 to T5 and T6 to T10, note that they are all tightly packed together in two rows on the pcb. When installing these be very careful not to stress the terminal pins; the internal wire ends of the windings are extremely fine and are easily broken if the pins are twisted for example. It may be a good idea to insert T1 to T5, and T6 to T10 one at a time consecutively, and to only solder the screening can pcb tab on the *opposite* side to that against which the next coil will be inserted. Only this one solder joint at this stage allows some sideways flexibility until all coils in the row have been installed. The next coil to be inserted is likely to be a tight fit against the previous, so press the coil down to the pcb while soldering. This joint will include the screening can tabs of this *and* the previous coil. The last two coils are likely to be the tightest fit and may have to be supported in position while soldering.

Complete soldering the screening can tabs, and then go on to solder all the pins of all the coils. Repeat the procedure for the row comprising T6 to T10.

The band switch, S1a, b, c, d is installed by first fitting the main switch unit at the position shown, using the bolts and spacers provided. The switch has a nut and shake-proof washer on it. If these are removed, a metal ring which governs the number of positions in which the switch can be set (the stop-ring), is revealed. This ring must be set to allow the switch a maximum of five positions. First remove the stop-ring, which will usually fall out easily, and then count four rectangular holes in a clockwise direction from the start (The first position is always for two-way operation). Replace the stop-ring with its tab in the fourth hole position. Hold it in place and check that the switch does actually rotate to only five positions, then put the washer and nut back on to prevent the ring from moving, then rotate the switch fully anti-clockwise to the first position (LW).

When installing the remaining three switch segments, make sure they are in the position shown in Figure 12, and that the transparent plastic part is facing the main switch assembly previously installed. It is also important that the segments are upright and pushed fully into the holes in the pcb to ensure the plastic coupling shaft passes through each switch segment without jamming. Upon inserting the shaft, ensure that the wiper of each segment is at the bottom and that the main switch assembly is at position 1. Then gently feed the plastic coupling shaft through all the segments, keeping them upright and turning as necessary to allow the coupling to enter each segment, until it is pressed home into the main switch assembly.

Use the off-cuts of wire from the resistor leads for wiring in the four tags on the variable capacitor to the corresponding holes in the pcb.



TR 1	GAIN MINIMUM	GAIN MAXIMUM
G1	+2·8V	+2·8V
G2	+1·7V	+5·2V
D	+8·6V	+8·3V
S	+1·6V	+2·9V
CURRENT DRAIN	8·3mA	11mA

Figure 15. Voltage Chart

The telescopic aerial is held in position by the metric nut and bolt size M3, as shown in Figure 12. Do not fit the telescopic aerial at this stage, as it makes the pcb difficult to handle.

The final position of the red LED indicator will depend upon its location in the front panel of the finished boxed unit, so leave the leads of the LED at their full length when soldering them to the tags on the top of S2, as seen in Figure 12. Fit TR1 on to the pcb at the position shown ensuring that the metal tag matches the legend. The reason for leaving TR1 until the last possible moment is simply because it is a MOS device and can be sensitive to stray static charges. These may damage the device but, once in the completed circuit, its gate inputs are at a much lower impedance, so the possibility of damage is greatly reduced. This leaves the fitting of the coaxial cable. Care should be taken when preparing the ends of the cable and a guide is given in Figure 12. Four pieces are required in the following lengths:-

One at 6in. (150mm); One at 7in. (180mm); Two at 4in. (100mm).

The two 4in. pieces of cable connect S2 to the input and output sockets SK1 and SK2. Extra braiding is required at the socket end of the cable for connecting the solder tags to the top of the pcb, at the position shown on the legend. The 7in. length connects the input of the amplifier to S2, and the remaining 6in. piece connects the output to S2.

The case which the unit is designed to fit is the 'Blue Case Type 222' (XY45Y), and is painted on all its surfaces. When drilling the holes for sockets SK1 and SK2, ensure that the paint is removed from the inside of the case at the positions where the 6BA solder tags are fitted, see Figure 17. This will ensure a good earth connection to the chassis, which is very important at radio frequencies. Follow the drilling instructions in Figure 17 when preparing the front of the case. The self-adhesive front panel can be used as a guide for checking the positioning of the holes. Having drilled the holes at the same time clearing them of any swarf, clean the front of the case and remove the protective backing from the self-adhesive front panel. Carefully position and firmly push down using a dry, clean cloth until it is securely in place.

Before installing the pcb assembly, fit the brass tuning shaft through the front of the case, as shown in Figure 12. Please note that the afore-mentioned shaft is cut to 36mm in length *overall*. The pcb assembly is held in place with four 6BA, half-inch bolts and spacers underneath, plus four 6BA shake-proof washers and nuts on the top surface of the assembly. The spacers are necessary to prevent the circuit from shorting out on the bottom of the metal case.

Before fitting the gain control, RV1, cut the shaft to a length of 17mm from the mounting face. Mount RV1 on to the front of the case using the nut and shake-proof washer provided. Wire into the circuit as shown in Figure 12.

Fit the LED clip to the front panel and position the LED, previously installed, so it rests inside the clip. Next install the two coaxial sockets, SK1 and SK2 using the 6BA hardware shown in Figure 12. The remaining socket is the external DC input, JK1, which is mounted in the position shown in Figure 12.

The three sockets are then wired into circuit. The coaxial cable from S2 going to

SK1 and SK2. The external DC socket is connected to the main pcb via three short pieces of wire. Install the PP3 battery clip at the position shown. The battery is held in place by two re-usable cable ties which pass through the holes in the pcb and around the battery to secure it in place.

Finally, fit the knobs on to the shafts of the controls and check that they all move freely, not scraping the front panel. This completes the construction of the unit. After carefully checking to ensure that there are no errors, you are now ready to move on to DC testing and RF alignment procedures.

DC Testing

The circuit can be treated as two separate parts, TR1 and RF amplifier, and TR2 the low voltage indicator. VC1a and b should be fully meshed, that is, set to 150kHz LW. Set the band switch to LW and the gain control to maximum. Connect a multimeter, selected to show current, in series with the positive supply of the 9 volt battery. Turn the power switch to on. If all is well then you should observe a reading of approximately 12mA and the LED indicator should be lit. If you reduce the gain control of the amplifier then you should notice a reduction in supply current to approximately 8mA. Remove the meter from the positive battery supply and reconnect the battery to make the voltage tests. A chart showing all the voltage and current readings expected from the tests is shown in Figure 15.

If your circuit readings are close to those given in the chart then you can begin the RF alignment procedure. However, if there are any major discrepancies it is likely that you have a fault in the circuit. In this instance check all your soldering and component orientation. If everything checks out then start a more detailed series of tests to establish whether there is a faulty component in the circuit. If you are lacking the necessary test gear to determine the nature of the fault, then Maplin can offer a repair service, the terms of which have been published in the magazine on numerous occasions. It is hoped however, that this will be a final resort and that most problems will be minor and therefore easily corrected with the basic equipment usually found in most amateur electronics enthusiasts homes.

RF Alignment

After the DC testing procedure it will be necessary to adjust the input/output coils T1 to T10, for their correct frequency tuning points. Each coil contains a ferrite tuning slug. Adjusting its position in the coil will increase or decrease the inductance and so affect the tuning point. Ferrite is a very brittle material and should be handled with great care as, if broken, it may jam up inside the coil, rendering any further adjustments impossible. For this reason a proper trimming tool is recommended, *not* a screwdriver! The one most suited to this task in the Maplin range of trimming tools, is the pot-core type BR51F. This tool has two blades, one at either end. The wider blade being suitable for adjusting the LW and MW coils T4, T5, T9 and T10, the

STEP	BAND SWITCH	ACTIVE AERIAL AND RADIO TUNING	ADJUST FOR PEAK SIGNAL READING	
			INPUT	OUTPUT
1	LW	150kHz	T5	T10
2	LW	500kHz	TC5	TC10
REPEAT	STEPS	1 and 2		
3	MW	500kHz	T4	T9
4	MW	1·5MHz	TC4	TC9
REPEAT	STEPS	3 and 4		
5	SW 1	1·5MHz	T3	T8
6	SW 1	4 MHz	TC3	TC8
REPEAT	STEPS	5 and 6		
7	SW 2	4 MHz	T2	T7
8	SW 2	10 MHz	TC2	TC7
REPEAT	STEPS	7 and 8		
9	SW 3	10 MHz	T1	T6
10	SW 3	30 MHz	TC1	TC6
REPEAT	STEPS	9 and 10		
END				

Figure 16. Alignment Chart

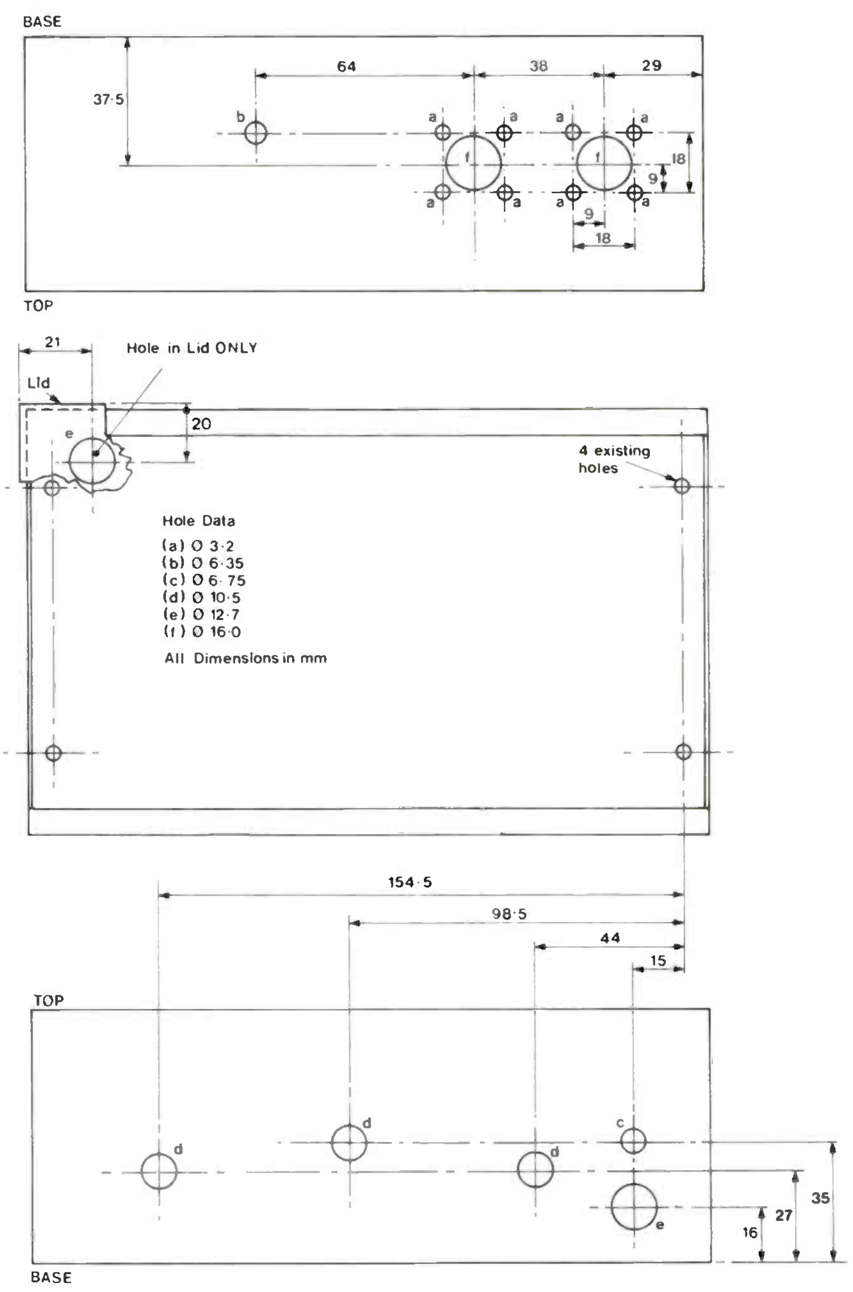


Figure 17. Aerial Case Drilling

ACTIVE AERIAL PARTS LIST

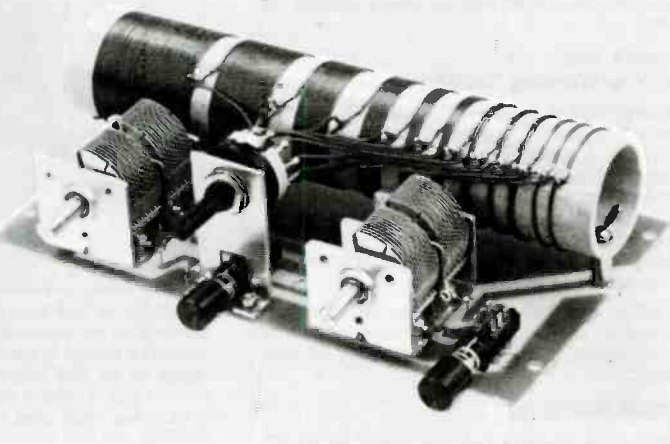
RESISTORS: All 0.6W 1% Metal Film			
R1,10,11,12	1k	4	(M1K)
R2	100k	1	(M100K)
R3,4	220k	2	(M220K)
R5	470k	1	(M470K)
R6,13	47k	2	(M47K)
R7	22k	1	(M22K)
R8	100Ω	1	(M100R)
R9	10k	1	(M10K)
R14	2k2	1	(M2K2)
RV1	47k Potentiometer Linear	1	(FW04E)
CAPACITORS			
C1,3,4,5,6,8,9	10nF Ceramic	7	(WX77J)
C2	33pF Ceramic	1	(WX50E)
C7	10µF 16V Tantalum	1	(WW68Y)
VC1	10-365pF Variable	1	(FF40T)
TC1,2,3,4,6,7,8,9	Trimmer 22pF	8	(WL70M)
TC5,10	Trimmer 65pF	2	(WL72P)
SEMICONDUCTORS			
D1,2,3,4	1N4148	4	(QL80B)
ZD1	BZY88C6V8	1	(QH10L)
TR1	40673	1	(QX34M)
TR2	BC548	1	(QB73Q)
LED1	High Bright Red LED	1	(WL84F)
MISCELLANEOUS			
SKT1,2	Socket SO239	2	(BW85G)
JK1	Jack Socket 3.5mm	1	(HF82D)
	PP3 Clip	1	(HF28F)
	Telescopic Aerial	1	(LB10L)
S1a,b,c	Wafer 1-pole 12-way	3	(FA97F)
S1d	PCB Rotary 1-pole 12-way	1	(FT56L)
S2	Latchswitch 4-pole	1	(FH68Y)
T1,6	KANK3335R TOKO Coil	2	(FD04E)
T2,7	KANK3334R TOKO Coil	2	(FD03D)
T3,8	KANK3333R TOKO Coil	2	(FD02C)
T4,9	RWR331208 TOKO Coil	2	(FD01B)
T5,10	CAN1A350EK TOKO Coil	2	(FD00A)
	Knob K7B	3	(YX02C)
	Extension Spindle	1	(RX30H)
	Round Button Black	1	(FL31L)
	Grommet Large	1	(FW60Q)
	LED Clip	1	(YY40T)
	ISO Bolt M3 x 12mm	1 Pkt	(BF52G)
	ISO Nut M3	1 Pkt	(BF58N)
	Active Aerial PCB	1	(GD18U)
	Coax Cable Low C	1 metre	(XR19V)
	Bolt 6BA x ½ inch	1 Pkt	(BF06G)
	Nut 6BA	2 Pkts	(BF18U)
	Washer Shake Proof 6BA	2 Pkts	(BF26D)
	Solder tags 6BA	1 Pkt	(BF29G)
	Bolt 4BA x ¼ inch	1 Pkt	(BF02C)
	Spacer 4BA x ⅛ inch	1 Pkt	(FW30H)
	Hook-up Wire 7/.02mm	1 Pack	(BL00A)
	Plastic Wafer Shaft	1	(FA98G)
	Screen Plate	1	(GD26D)
	Bolt 6BA x ¼ inch	1 Pkt	(BF05F)
	Washer 4BA Shakeproof	1 Pkt	(BF25C)
	Tapped Spacer 6BA x ¼ inch	1 Pkt	(FD10L)
OPTIONAL			
	Case Blue 222	1	(XY45Y)
	Front Panel	1	(FA99H)
	PP3 Silver Seal Battery	1	(FK62S)
	AC Adaptor Regulated	1	(YB23A)
	Re-usable Cable Tie	2	(RK59P)

A complete kit of all parts, but excluding optional items, is available:
Order As LM05F (Active Aerial Kit)
The following are also available separately, but are not shown in the 1986 catalogue:
Active Aerial PCB **Order As GD18U**
Aerial Screen Plate **Order As GD26D**
Toko Coil CAN1A350EK **Order As FD00A**
Toko Coil RWR331208 **Order As FD01B**
Toko Coil KANK3333R **Order As FD02C**
Toko Coil KANK3334R **Order As FD03D**
Toko Coil KANK3335R **Order As FD04E**
Plastic Shaft **Order As FA98G**
1 Pole 12-Way Wafer **Order As FA97F**
Aerial Front Panel **Order As FA99H**
6BA Tapped Spacer x ¼in. (Pack of 10)
Order As FD10L

AERIAL TUNING UNIT PARTS LIST

CAPACITORS			
VC1	10-365pF Variable	2	(FF40T)
MISCELLANEOUS			
S1,2	Latchswitch 2-pole	2	(FH67X)
S3	Rotary SW12B	1	(FF73Q)
SK1	Terminal Post Red	1	(HF07H)
SKT2	Terminal Post Green	1	(HF05F)
SKT3,4	Socket SO239	2	(BW85G)
	Round Button Black	2	(FL31J)
	Knob K7B	3	(YX02C)
	Aerial Tuner PCB	1	(GD19V)
	Plate (Rotary Switch Mtg)	1	(FD07H)
	Veropin 2140	1 Pkt	(FL20W)
	Bolt 6BA x ¼ inch	1 Pkt	(BF05F)
	Bolt 6BA x ½ inch	1 Pkt	(BF06G)
	Nut 6BA	2 Pkts	(BF18U)
	Washer Shakeproof 6BA	2 Pkts	(BF26D)
	Solder Tag 6BA	1 Pkt	(BF29G)
	Solder Tag 4BA	1 Pkt	(BF28F)
	Washer Shake 4BA	1 Pkt	(BF25C)
	Bolt 4BA x ¼ inch	1 Pkt	(BF02C)
	Spacer 4BA x ⅛ inch	1 Pkt	(FW30H)
	Spacer 4BA x ½ inch	1 Pkt	(LR71N)
	Tapped Spacer 6BA x ¼ inch	1 Pkt	(FD10L)
	Grommet Small	2	(FW59P)
	Bell Wire White	1 Pack	(BL94C)
	Wire EC 22 swg	2 Rolls	(BL27E)
	Tube drilled	1	(YM61R)
OPTIONAL			
	Case Blue 222	1	(XY45Y)
	Front Panel	1	(FD11M)

A complete kit of all parts, excluding optional items, is available:
Order As LM06G (Aerial Tuner Kit)
The following are also available separately but are not shown in the 1986 catalogue:
Aerial Tuner PCB **Order As GD19V**
Aerial Tuner Plate **Order As FD07H**
Tuner Front Panel **Order As FD11M**
Pre-drilled Tube **Order As YM61R**
6BA Tapped Spacer x ¼in. (Pack of 10)
Order As FD10L



narrower blade for S1, 2, and 3, coils T1, T2, T3 and T6, T7, T8.

Set each coil so that its ferrite tuning slug is approximately halfway through its range of movement within its screening can. This will provide a good starting point for the alignment of each coil. There are small trimming capacitors installed to compensate for any tracking errors in the main tuning control. When starting the alignment procedure set all these trimmers TC1 to 10 to their halfway position. The same trimming tool used to set the coils will fit the slots in the tops of the trimmers.

The easiest method of alignment is to use a radio receiver which has a signal strength meter, sometimes referred to as an 'S meter'. However, if you possess more sophisticated test gear, by all means use it! The first method will be quite sufficient to produce good results from the unit but may take longer to achieve, as you may have to wait for favourable band conditions to find a stable signal to align with. You can use the inbuilt telescopic aerial or an external one when aligning the unit. When using an external aerial or setting up with test gear it is better to have the telescopic aerial folded down to its shortest length.

The connection to the receiver or test gear should be made with a short length of good quality, 50 or 75Ω coaxial cable, such as XR19V or low loss coax XR29G. Also use a good quality PL259 plug, with reducer if necessary, to ensure good connections throughout the system.

The alignment procedure is the same for each band and is in two main stages. First the low frequency end of the band with VC1a, b almost fully meshed, where you adjust the input/output coils for a peak in signal reading. The second stage at the high frequency end of the band with VC1a, b virtually fully open, where you adjust the input/output trimmer capacitors for a further peak in signal strength. This procedure is then repeated until no further improvement can be achieved on that band. The next band is then given the same treatment and so on, until all the bands have been aligned. A chart showing the frequency points plus the coil and trimmer references is shown in Figure 16.

Until the unit is properly aligned on each band you can not expect it to perform at its optimum and therefore, under adverse conditions, it may give an unstable result. If instability occurs during alignment it can usually be rectified by reducing the gain of the unit until the problem clears and alignment can be resumed. If the alignment has been carried out correctly no instability should occur, even with the gain control set at maximum.

In Use

The active aerial must never be directly connected to a transmitter or transceiver as any RF power transmitted through the unit will result in damage to the amplifier circuit and possible damage to the external equipment. If the unit is to be used in conjunction with such a device, an automatic bypass circuit would have to be added, as shown in Figure 13. The change-over action of the coaxial relays is controlled by the push-to-talk (PTT) line or by detecting some of the transmitted RF output.

With general use and a good quality PP3 battery a long period of service can be expected. Once the battery is exhausted it must be removed as soon as possible as even the modern types of battery will sometimes leak corrosive chemicals which will damage the circuit board and components. A battery which is left unused over a long period of time will decay to its discharged state; therefore if the unit is not to be used, or stored over a long period of time, it is good practice to remove it.

When using an external power source make sure the polarity is correct! Most small battery eliminators will be adequate but it is advisable to use one which has a regulated voltage output. The reason for this is the low current consumption of the unit which on an unregulated supply will allow the voltage to go much higher than its stated output.

If using the unit from the +12 volt supply of a car or boat make sure that you have a small fuse, for example 100mA, in line with the power supply cable and make the connection to the unit via the 3.5mm jack plug before connecting the +12 volt supply.

When no external aerial is available, the telescopic whip of the active aerial, fully extended, will give reasonable results over the whole of the tuning range. However, if there is an external aerial connected the whip is still active and can be more effective on certain frequencies. This, of course, depends on the type of external aerial in use and also whether or not an aerial tuning unit is being used. There are various types of external aerial to choose from, so for more detailed information refer to an aerial construction handbook. Maplin supply a number of these handbooks which cover the LW through to 10 metres SW. Normally when using an external aerial system, the telescopic whip should be folded down thus enabling you to assess the improvement of the signal when the unit is switched in and out.

The tuning of the active aerial is quite simple. First set the band switch so that the tuning control covers the same frequency range as that of the receiver. The incoming radio signal will peak in strength when the tuning of the unit matches the frequency of the receiver. You will soon obtain a good working knowledge of the tuning and gain settings suitable for your receiver and aerial system.

In Conclusion

Having matched the aerial impedance with the aid of the ATU and amplified the signal using the active aerial, you can do no more to improve the performance of your particular aerial/receiver system at the RF level. Improving the aerial system significantly could be difficult depending upon your location and the amount of space available to you. Improving your receiver would mean either extensively modifying the circuit of your current model or replacing it with a far more expensive alternative. However, at the audio level, sharp filtering can give further improvements in station readability by removing those annoying whistles and noises that come in with weak or low-powered stations. Such a device is currently being developed and will appear in a later issue of this magazine. The combination of all three devices should be quite spectacular and stations that were previously unintelligible will be dragged out of the background noise or QRM!

MAPLIN SERVICE

With most electronic projects, performance will depend on the conditions of use. Recommendations and suggestions made in the articles in this Projects Book are for guidance only, since conditions of use are beyond our control.

Repairs and Get-You-Working Service

Our 'Get-You-Working Service' is available for any of the projects published in this Projects Book, *provided* they are constructed on our ready-etched printed circuit boards, and that they use a majority of components supplied by us. We regret we *cannot* extend this service to the 'interest' circuits, for which we do not provide ready-made boards, or supply as projects or kits; nor for projects or kits that have been *customised or modified by the constructor.*

We cannot enter into correspondence with regards to fault-finding, and recommend you return the unit to us for servicing if you are unable to rectify the fault yourself.

Project Servicing

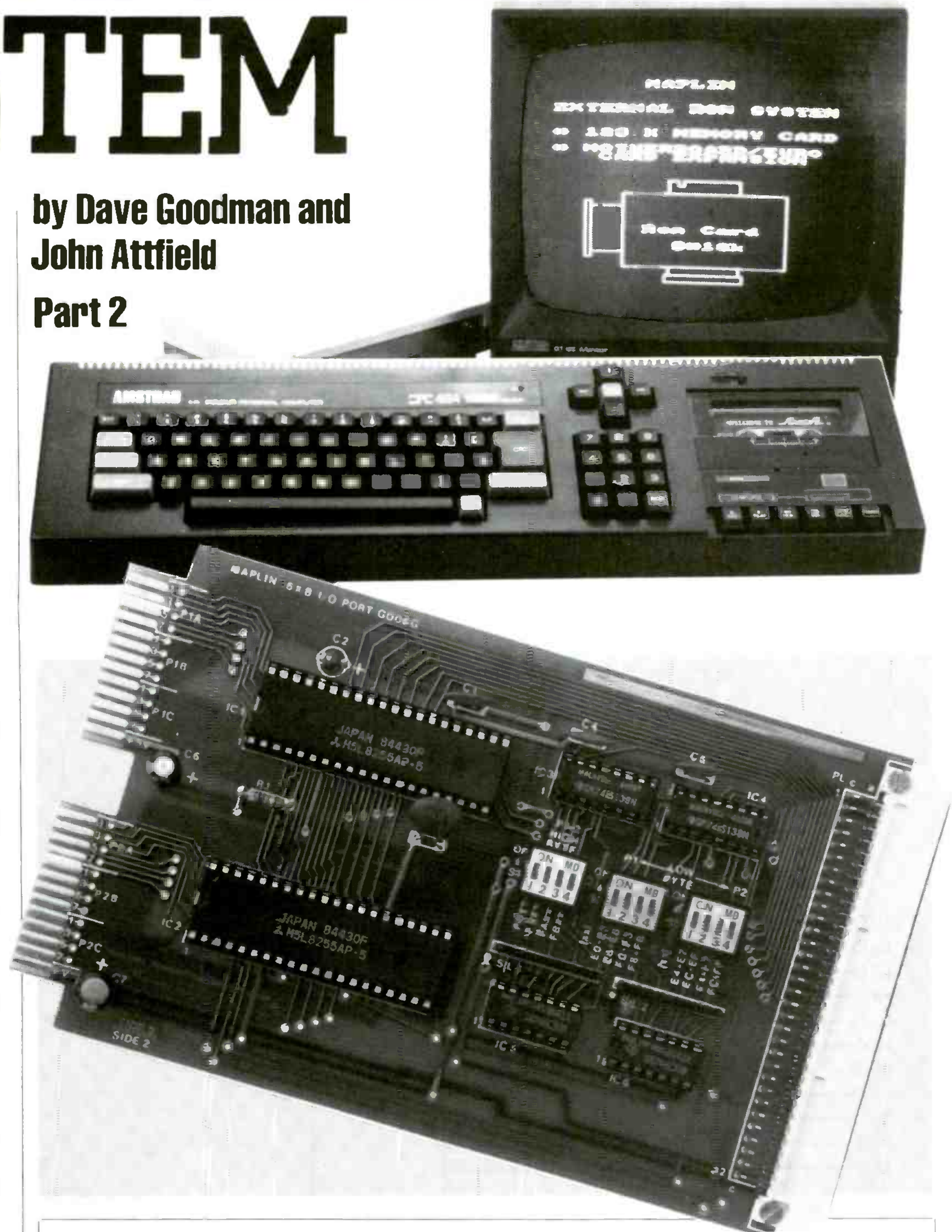
If the problem has been caused by a faulty component supplied by us, then there will be no charge for the work performed or the components used. If the fault has been caused by error(s) in construction, then there will be a charge for the work performed at a rate of £12.50 per hour, or part of an hour plus the cost of any damaged components which need to be replaced. If *no fault* is found on the unit, then there will still be a charge of £12.50 per hour or part of an hour *for the time involved in establishing this fact.*

Projects returned for repair should be addressed to:–
Service Department
Maplin Electronic Supplies Ltd
P.O. Box 3, Rayleigh, Essex SS6 8LR

AMSTRAD EXPANSION SYSTEM

by Dave Goodman and John Attfield

Part 2



6 x 8 bit I/O Port

Part 1 of this series featured an External ROM Card and Motherboard system. The ROM Card can hold up to 8 ROMs with each ranging in size from 2K to 16K. A Motherboard module connects to the ROM Card, and can take up to six plug-in eurocard projects.

One such project is a 48-bit Input/Output Port card, another is a power supply module which drives the ROM Card buffer components and Motherboard cards, and it is these that we shall deal with in this issue.

Circuit Description

Figure 1 shows two 8255A (P.P.I.) devices, IC1 and IC2. Both devices are fully programmable for a variety of I/O functions, and contain four main registers each. In each case address lines A0 and A1 determine which 8255 register is accessed, with the RD and WR lines controlling data flow into or out of the register via data bus D0 to D7. IC3 and IC4 decode address blocks allocated by the Amstrad, and enable IC1 and IC2 at the correct time. IOSEL, A8 and A9, are decoded by IC3 to produce upper byte values (Hex) F8, F9, FA and FB. Any combination of values can be selected by switch S1, to produce a negative or active low ($\overline{E}$) pulse from IC5 to IC4 pin 4. Similarly, IC4 decodes lower byte values from A2, A3 and A4, being selected by switch S2 and switch S3. Again, any combination of 1 to 4 switches can be selected to produce a negative ($\overline{CS}$) select pulse from IC6 to IC1 and IC2. R1 and C2 produce a short positive pulse when the supply is first connected. This pulse RESETs both PPI's by clearing their control registers, thus setting all ports to the input

★ **Six 8-bit Input/Output Ports**
★ **Address Select Facilities**
★ **Plugs directly into Maplin Motherboard**
★ **Power Supply Card available**

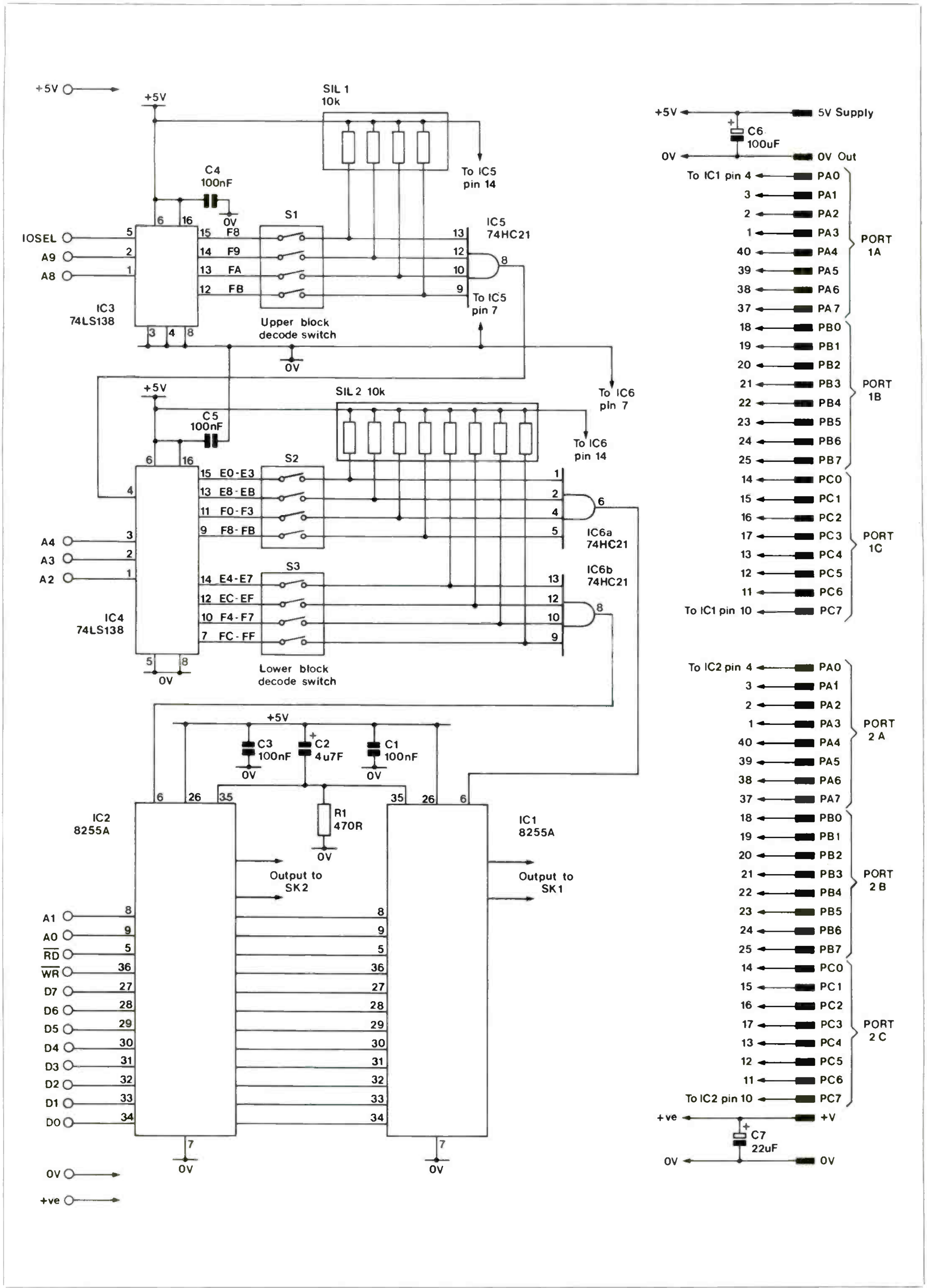


Figure 1. 6 x 8-bit Port Circuit

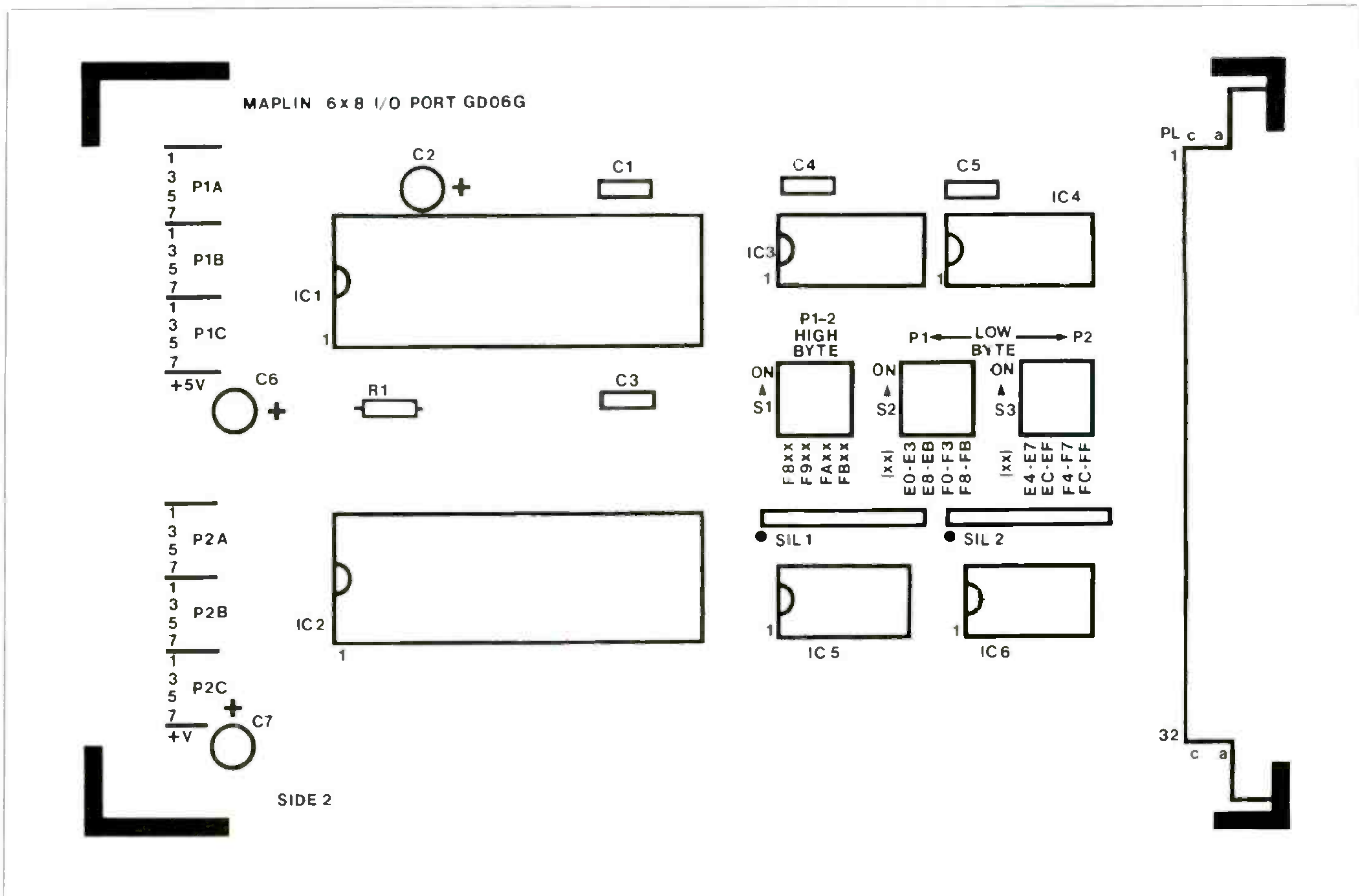


Figure 2. 6 x 8-bit Port PCB Overlay

mode. IC1 ports have been designated as P1A, P1B and P1C and IC2 ports are P2A, P2B and P2C. Each port has its own 8-bit bus, giving a total of 6 ports x 8 bits or 48 bits. Bits can be set to output data or input data in different configurations or modes, as will be explained later.

This project is designed to be plugged into our motherboard, and must not be connected to the Amstrad Expansion socket. For further details, please refer to Part 1 of this series.

Construction

Commence construction on the 6x8 port pcb (GD06G), where side 2 is the component side. With reference to the parts list and Figure 2, begin construction by inserting the IC sockets. Those for IC1 and 2 are 40-pin sockets, IC3 and 4 are 16-pin sockets and IC5 and 6 are 14-pin types.

Press them down onto the board, with the end notch or indent in-line with the white marker block on the legend. Bend a few of the legs on each socket to help keep them in position and solder in place. Do not fit any ICs until preliminary tests have been completed.

Fit the 4-way DIL switches S1, S2 and S3 in like manner and solder them in place. The two SIL resistor packs can now be inserted with the white dot, at one end of the body, matched with the white dot on the pcb legend. It is important to fit these two components correctly, as a SIL pack contains eight resistors, all commoned together at one end; this common pin is marked with the small white dot.

Fit electrolytic capacitors C6 and C7, taking note of lead polarity, and also the tantalum capacitor C2. This capacitor has its +V lead marked on the body. Insert the four remaining disk capacitors C1, C3 to C5 and also resistor R1.

Carefully solder all components in place on side 1 of the pcb, and remove excess leads and wire ends using side cutters. The 2 x 32-way right-angled plug is inserted in position PL1, from side 2, making sure that all 64 terminal pins pass through the board before soldering, see Figure 3. It might be advisable to secure this to the pcb using ½in. x 6BA screws and nuts first. Do ensure all components are fitted correctly before soldering, as the pcb track pads are plated-through the board from side 1 to side 2, thus making component removal difficult if necessary at a later date.

Testing

Plug the I/O card into any socket position on the Motherboard. If you do not have 64-way receptacles fitted onto the mother-

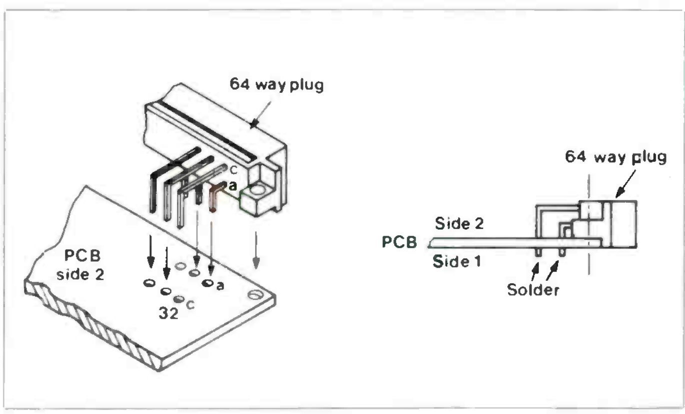


Figure 3. Fitting the 64-pin plug

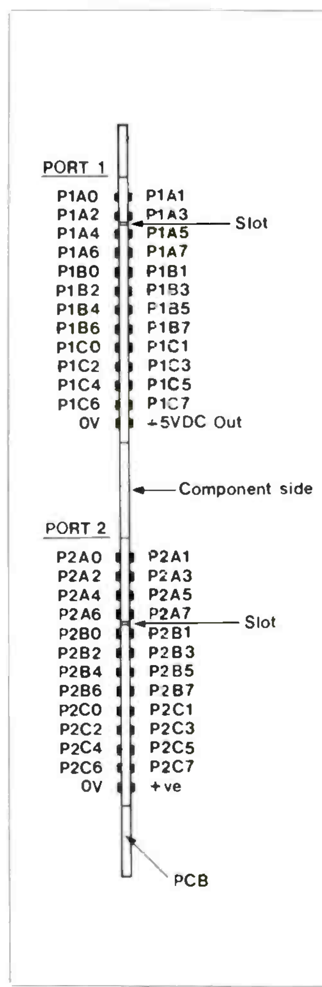
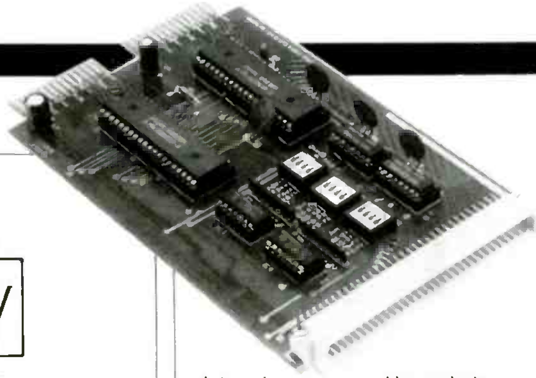


Figure 4. Edge Connections



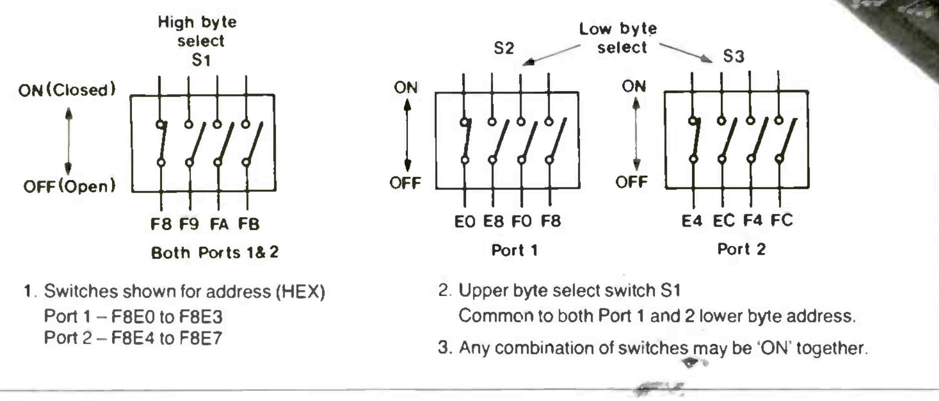


Figure 5. Address selecting

board, then these will have to be purchased and mounted first (see the Amstrad ROM Card leaflet).

Check the ROM Card extension IDC cable is fitted correctly onto the Motherboard, and that the ROM Card buffer components have been inserted and tested. The Amstrad PSU is not capable of supplying the plug-in cards, so a separate PSU is required. A suitable PSU project is available and details follow later in this article.

If you have a +5V DC regulated supply already, connect it to the Motherboard +5V and 0V terminal pins. The ROM Card buffer components also receive their supply from the Motherboard PSU. With I/O Card, Motherboard, PSU and ROM Card connected to the Amstrad, turn on both PSU and computer power. Refer to Figure 4 and measure the voltage across 0V and +5V terminals on Port 1 card edge-connector with a meter. If wrong, then recheck PSU wiring. Remove the I/O Card from the Motherboard and insert the six IC's.

Address Selection

There are 128 possible I/O addresses available on the Amstrad. Unfortunately, these addresses are not consecutive, as certain combinations of bits serve different functions. Addresses available are as follows:

HEX

F8E0 to F8FF
F9E0 to F9FF
FAE0 to FAFF
FBE0 to FBFF

The lower byte in each case (E0–FF) is common to all, but the upper or higher byte changes in blocks, see Table 1.

I/O addresses for external use require A10 low only. A11 to A15 must be high as other devices use these bits. This also applies to A5, A6 and A7, which are low for disk and communication channels only. As a point of interest:

A15 low selects the video gate array.
A14 low selects the CRT controller.
A13 low selects expansion ROMs.
A12 low selects printer port.
A11 low selects the PPI-8255 I/O chip.

Note that only one of bits A10 to A15 should be used at any time, so for I/O use, A10 is always low. Seven of the bits referenced as 'X' determine upper and lower byte values. A0 to A7 is the lower address byte and A8 to A15 the upper address byte. Any 'X' bit can be set high or low for a total of 128 addresses (7 bits) where A8 and A9 determine upper byte addresses F8, F9, FA, FB (Hex) and A0 to A4 determine lower byte addresses from E0 to FF (Hex). Hence the non-consecutive address range in use on this card.

To increase flexibility in use, address blocks can be selected on the card as required, shown in Figure 5. The 4-way switch bank S1 allows for selection of the upper byte address, which is common to all ports, and S2 selects the lower byte addresses in 4 byte blocks from E0 to FF, for Port 1 only.

Similarly, switch bank S3 selects 4 byte block addresses for Port 2. If this addressing method seems strange then it must be understood that Port 1 and Port 2 PPI chips have four internal registers selected by address lines A0 and A1. These register addresses are sequential, so for Port 1, address E0, E1, E2 and E3 can be selected (switch 1 on S2), and Port 2 address E4, E5, E6 and E7 selected by switch 1 on S3. If so desired, all twelve switches can be set 'ON' so that any of the 128 addresses will access the Ports, but doing so will cause problems if more than one I/O card is fitted on the Motherboard!

BINARY

A 15				A 11	A 10	A 9	A 8	A 7		A 5	A 4				A 0
1	1	1	1	1	0	X	X	1	1	1	X	X	X	X	X

Table 1

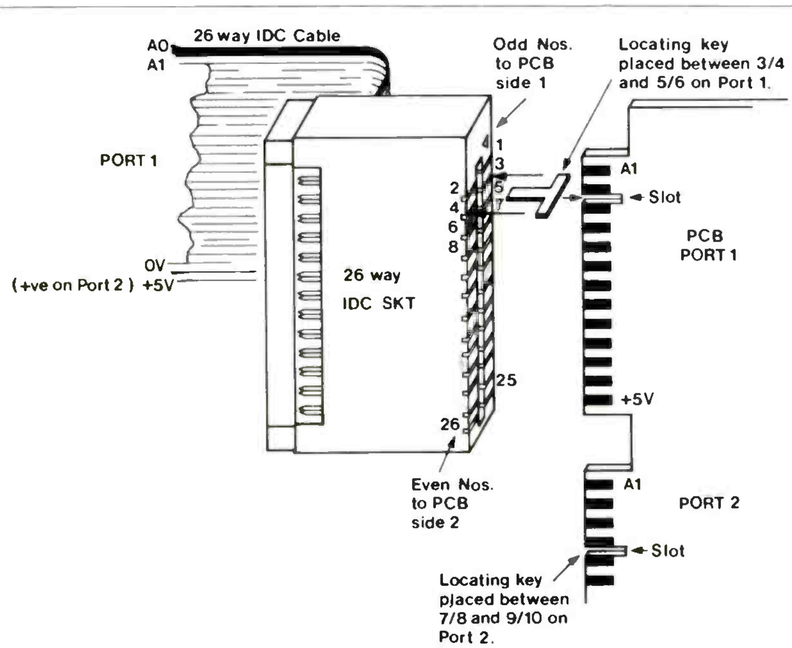


Figure 6. Connection to the 6 x 8-bit PCB

Test Routines

Set all twelve (S1 to S3) switches down to 'OFF', and select F8 (S1), E0–E3 (S2) and E4–E7 (S3) switches to 'ON' only. The remaining nine switches should not be in the 'ON' position!

Port 1 enable addresses are now F8E0 to F8E3, and Port 2 addresses are F8E4 to F8E7. Plug the I/O card into the Motherboard, and turn on the PSU and the Amstrad. Type in and RUN program 1.

Lines 20 and 40 ask for Port address and data to be sent using the BASIC OUT (port), data command.

P.P.I. Programming

The Programmable Peripheral Interface IC has four internal registers as shown in Table 2.

The Control Register has data written to it to determine various functions of Ports A, B and C, see Table 3.

For example, to set I/O Registers A, B, C on Port 1, to output mode: OUT (F8E3), 80. Another example is to set I/O Register A to output, B to input, C (upper) to output and C (lower) on to input on Port 2: OUT (F8E7), 83.

Note that register C of both Ports can be 'split' into two half bytes or nibbles. The lower half bus (C0 to C3) and upper half bus (C4 to C7) can be set to *different* I/O modes, as shown in Table 3. Mode 0 operation is the most commonly used method of passing data to and from the Ports, although there are a further two operating modes for the 8255A PPI. Further information is available on data sheets (see Parts List).

To continue with the testing using program 1, enter F8E3 in response to 'address =', and 80 after 'data ='. Both address and data values will be printed, and Control Register 1 (Port 1) will be programmed for Ports 1A, 1B and 1C to assume mode 0 output mode.

Refer to Figure 4 for the I/O edge connections, and connect a voltmeter to 0V and P1 A0 (the top connector). The reading should be 0V or very close.

Now enter address F8E0 and data 01, and the reading on Port 1A, bit 0 should be high (+4 to +5V). Using the same address (F8E0), enter data values 02, 04, 08, 10, 20, 40 and 80 (Hex), and check that all outputs P1 A0 to A7 each go high in turn.

Repeat this test on Port 1 B0 to B7, using address F8E1, and Port 1 C0 to C7, using address F8E2. Any bits that do not change indicate a fault and should be investigated. Data codes written out to all ports are 'latched' permanently within the IC until 'Reset' or overwritten by new data codes.

At any time, the Control Register can be accessed to change the status of Ports A, B and C. Please note that this particular register can be *written to only*, and status codes cannot be read from it.

Port 2 registers can be checked in the same way by entering data code 80 at address F8E7 to set P2 A, B and C registers to output mode. F8E4 will be Port 2A, F8E5 is Port 2B and F8E6 is Port 2C. Write data codes 00 to FF to each of these ports and check for appropriate bit conditions as before.

In Program 2, Ports 1A to 1C are set for output and Ports 2A to 2C are set for input modes. If Port 1 A0 to A7 is connected to Port 2 A0 to A7, Port 1 B0–B7 to Port 2 B0–B7, and Port 1 C0–C7 to Port 2 C0–C7, then the program will test each one of 48 bits and display errors, if any, as they are found.

I/O Connector

The 2 x 13-way card edge connections may be terminated with a 26-way IDC edge connector and cable (see Parts List). Polarising keys for these connectors can also be fitted, and the card slots are in different positions. Figure 6 shows these particular IDC sockets and terminal/cable connections.

When using the card, note that Port I/O signals should be at TTL levels of 0V to +5V. Current sourcing is low and relays, etc., cannot be driven directly. 0V,

```
10 CLS
20 INPUT"ADDRESS = ",a$
30 a=VAL("&"+a$)
40 INPUT"DATA = ",d$
50 d=VAL("&"+d$)
60 OUT(a),d
70 CLS
80 PRINT "ADDRESS = ";a$,"DATA = ";d$
90 GOTO 20
```

Program 1

REGISTER TYPE	A1	A0	PORT 1	PORT 2
CONTROL REGISTER	1	1	E3, EB, F3, FB	E7, EF, F7, FF
I/O REGISTER PORT C	1	0	E2, EA, F2, FA	E6, EE, F6, FE
I/O REGISTER PORT B	0	1	E1, E9, F1, F9	E5, ED, F5, FD
I/O REGISTER PORT A	0	0	E0, E8, F0, F8	E4, EC, F4, FC

Table 2

Mode 0 Port Definitions

DATA (HEX)	PORT A	PORT B	PORT C (UPPER)	PORT C (LOWER)
80	OP	OP	OP	OP
81	OP	OP	OP	IP
82	OP	IP	OP	OP
83	OP	IP	OP	IP
88	OP	OP	IP	OP
89	OP	OP	IP	IP
8A	OP	IP	IP	OP
8B	OP	IP	IP	IP
90	IP	OP	OP	OP
91	IP	OP	OP	IP
92	IP	IP	OP	OP
93	IP	IP	OP	IP
98	IP	OP	IP	OP
99	IP	OP	IP	IP
9A	IP	IP	IP	OP
9B	IP	IP	IP	IP

Table 3

```
10 MODE 2
20 CTREG1=&F8E3 : CTREG2=&F8E7
30 PORT1A=&F8E0 : PORT2A=&F8E4
40 PORT1B=&F8E1 : PORT2B=&F8E5
50 PORT1C=&F8E2 : PORT2C=&F8E6
60 OUT(CTREG1),&80 : OUT(CTREG2),&9B
70 PORT1=PORT1A : PORT2=PORT2A
80 FOR i%=0 TO 255
90 OUT(PORT1),i% : in%=INP(PORT2)
100 LOCATE 1,1
110 PRINT"PORT 1=";HEX$(PORT1);",";HEX$(i%,2),
130 PRINT"PORT 2=";HEX$(PORT2);",";HEX$(in%,2)
150 IF in%<>i% THEN GOSUB 1000:IF INKEY$="" THEN 150
170 NEXT
180 PORT1=PORT1+1:PORT2=PORT2+1
190 IF PORT1<>CTREG1 THEN 80
200 PRINT : PRINT"TEST COMPLETE"
999 END
1000 LOCATE 17,3
1005 PRINT"ERROR!"
1010 PRINT HEX$(PORT1,4);"=";HEX$(i%,2),,
1020 PRINT HEX$(PORT2,4);"=";HEX$(in%,2)
1030 RETURN
```

Program 2

+5V and +V PSU rails are extended out to the edge connector, and these terminals may need decoupling if currents greater than 500mA are envisaged.

PSU Module

Figures 7 and 8 show the circuit diagram and overlay of a small PSU module for driving the Motherboard buffer circuitry (ROM Card) and plug-in cards. A regulated +5V and unregulated +V are available for wiring to the associated Motherboard terminals, and maximum current is 1 Amp @ 5V DC, depending on the transformer used.

For general low current, low voltage use, a mains adaptor (see Parts List) can be fitted to the module. The particular adaptor specified requires a socket to be fitted (SK1) on the pcb for connecting one of the 4, 2.5mm plugs moulded onto the adaptor cable.

Alternatively, a mains transformer can be wired directly to the AC inputs on the PSU module. A transformer is necessary when fitting the EPROM Programmer module on to the '6 x 8 I/O CARD' as voltages of +21V to +25V are required for programming EPROMs (Note: maximum unregulated DC voltage must be less than +27V).

The PSU module comprises a simple bridge/smoothing circuit, 5V regulator, decoupling capacitor and indicator LED. REG1 is fitted onto a vaned heatsink before mounting on the pcb (see Figure 9) using ¼in. x 6BA bolt and nut and washer as shown. The BR1 rectifier package *must* be inserted correctly, with the + symbol on the package adjacent to the + on the legend. There may also be two ~ symbols on the package which denote the input AC terminals.

C1 must be fitted correctly. Note that it is the −V lead that is

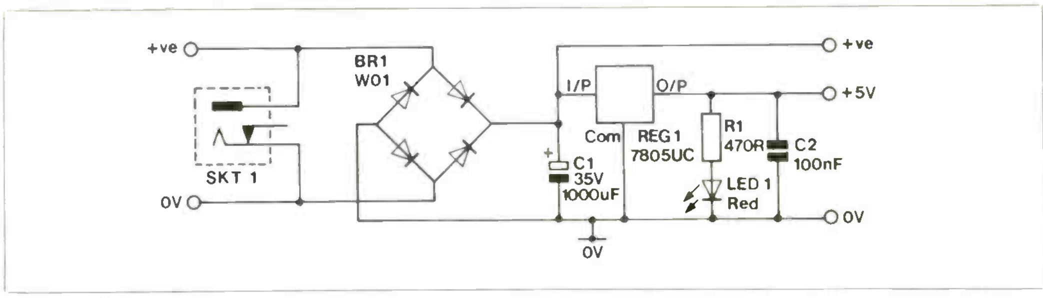


Figure 7. PSU Circuit

marked on the body, and *not* the +V lead. Insert the +V lead into the hole marked '+' on the legend.

When mounting LED1, note that the cathode lead (k) is the shortest of the pair, and is also the lead directly beneath a flat edge on the package skirt. Carefully solder all components, but note that it might be a good idea to install the regulator IC1 complete with heatsink and bolted in position on the pcb, thus ensuring correct location before soldering – bend the 3 leads to 90° according to the pattern of the pcb holes, and insert these whilst laying the IC flat onto the heatsink.

Insert three vero-pins in the +5V, +V and 0V positions from the *track side* of the pcb. Push each pin onto its pad with a hot iron and apply solder.

Using the PSU Module

Insert SK1 and solder to the board if you intend using the mains adaptor supply. One of the adaptor's four multiplugs fits the socket correctly. If using a transformer, such as a torroidal, then bare and tin the RED and GREY secondary wires, and insert into the two holes marked 'AC' on the pcb. Solder these in place of SK1.

The remaining two second-

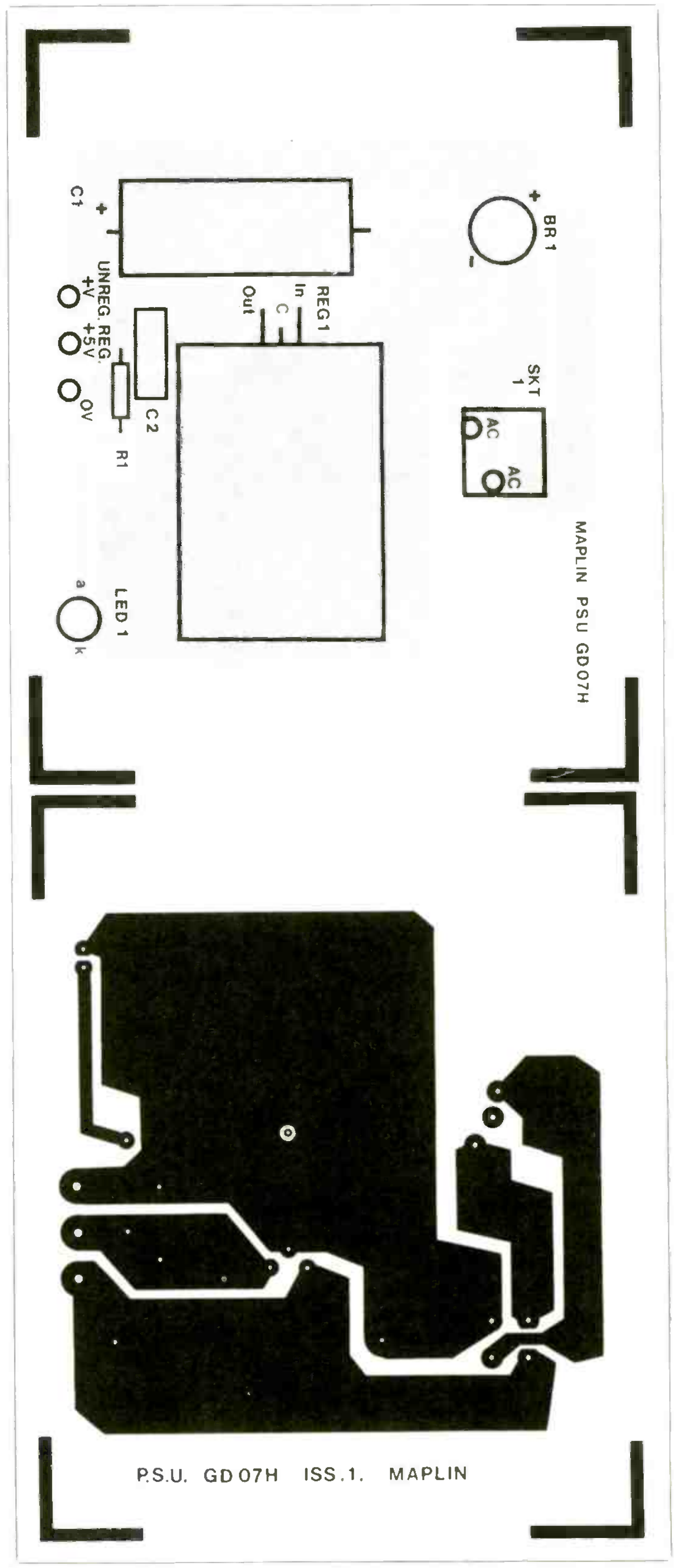
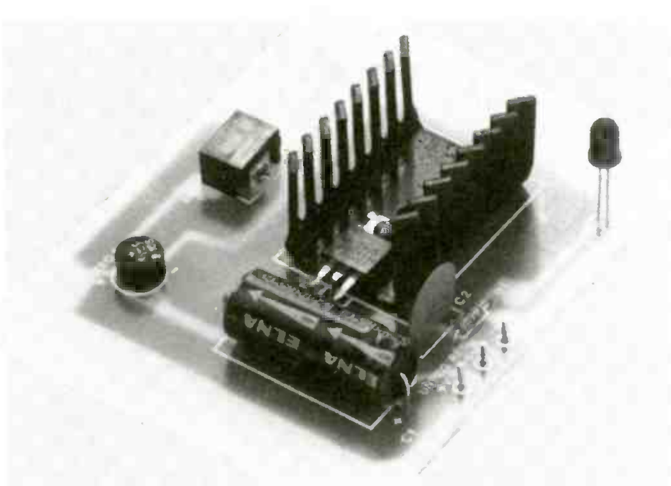


Figure 8. PSU PCB Track and Legend



aries, BLUE and YELLOW, are joined together by twisting the prepared ends and soldering. Insulate this termination with sleeving and/or insulation tape to prevent short circuit problems (see Figure 10).

Apply mains power to the supply source and check with a voltmeter connected between the 0V pin and +5V pin for 4.8 to 5.1V DC. The 0V to +V pin will be +15 to 18V with the adaptor connected (selector switch set to 12V). Check that LED1 glows brightly with the power supply on. This LED may also glow dimly once connected to the Motherboard and ROM Card, with the Amstrad supply on only.

Wire all three PSU module terminals to each corresponding terminal on the Motherboard. ROM Card buffer circuitry tests are covered in the booklet supplied with that module, so they will not be repeated here.

Standard 'Euro-Card' sizes have been adopted for the Motherboard system which allows PSU, I/O card and Motherboard to be fitted to Euro-Card rack frames. The PSU circuit board has been enlarged for this reason, and will fit vertically in rack guide rails if required.

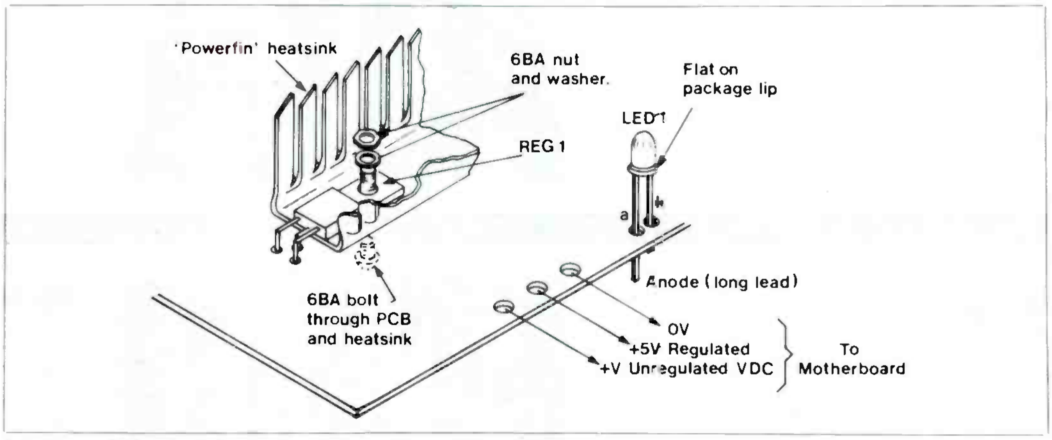


Figure 9. Fitting LED1 and REG1

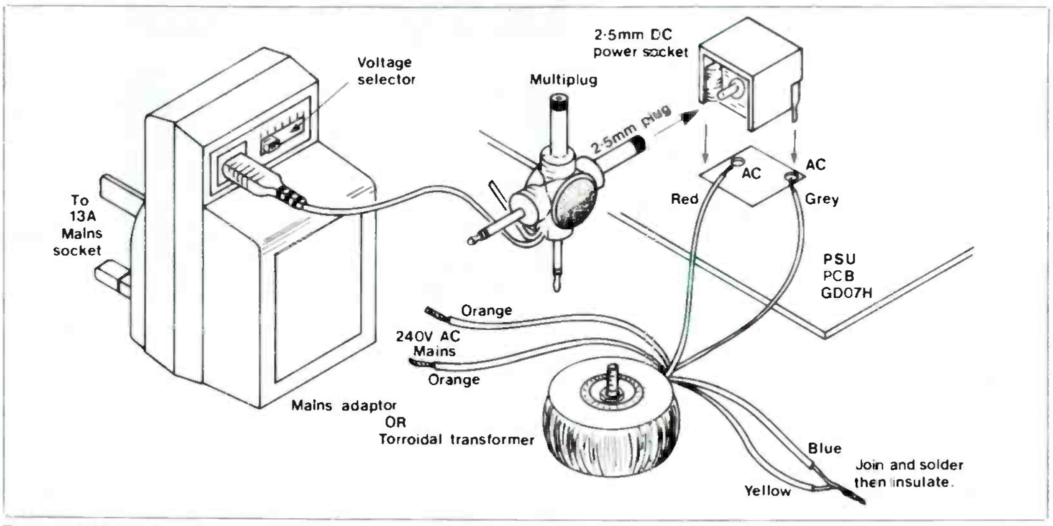


Figure 10. Mains Supply

EXPANSION SYSTEM PSU PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1	470R	1	(M470R)
CAPACITORS			
C1	1000µF 35V Axial Electrolytic	1	(FB83E)
C2	100nF Disc ceramic	1	(BX03D)
SEMICONDUCTORS			
BR1	W01	1	(QL38R)
REG1	µA7805UC	1	(QL31J)
LED1	LED Red	1	(WL27E)
MISCELLANEOUS			
SK1	PCB 2.5mm DC Pwr Skt	1	(FK06G)
	Expansion PSU PCB	1	(GD07H)
	Powerfin plastic Heatsink	1	(FG55K)
	Bolt 6BA x ¼in.	1 Pkt	(BF05F)
	Nut 6BA	1 Pkt	(BF18U)
	Veropin 2145	1 Pkt	(FL24B)
OPTIONAL			
	AC adaptor Unregulated	1	(XX09K)

A complete kit of all parts, excluding optional items, is available for this project:
Order As LM03D (Expansion PSU Kit)
The following item included in the above kit list is also available separately, but is not shown in the 1986 catalogue:
Expansion PSU PCB. **Order As GD07H**

6 x 8 BIT PORT PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1	470R	1	(M470R)
SIL 1,2	10k SIL Resistor	2	(RA30H)
CAPACITORS			
C1,3,4,5	100nF Minidisc	4	(YR75S)
C2	4µ7F 16V Tantalum	1	(WW64U)
C6	100µF 10V PC Electrolytic	1	(FF10L)
C7	22µF 63V PC Electrolytic	1	(FF07H)
SEMICONDUCTORS			
IC1,2	8255A	2	(YH50E)
IC3,4	74LS138	2	(YF53H)
IC5,6	74HC21	2	(UB12N)
MISCELLANEOUS			
	6 x 8 Bit Port PCB	1	(GD06G)
S1,2,3	DIL Switch SPST Quad	3	(FV43W)
	DIL Socket 14-pin	2	(BL18U)
	DIL Socket 16-pin	2	(BL19V)
	DIL Socket 40-pin	2	(HQ38R)
	PCB Plug Gold 64-way	1	(FJ51F)
OPTIONAL			
	26W IDC Edge Connector	2	(FT88V)
	Polarising Key IDC	2	(QY73Q)
	Flat IDC Cable 26-way	As req	(XR75S)
	PCB Receptacle Gold 64-way	1	(FJ47B)
	Colour coded IDC Cable 26-way	As req	(XR82D)
	8255A PPI Data Sheet		

A complete kit of all parts, excluding optional items, is available for this project:
Order As LM02C (6 x 8 bit Port Kit)
The following item included in the above kit list is also available separately, but is not shown in the 1986 catalogue:
6 x 8 bit Port PCB. **Order As GD06G**

ADA ECHO ECHO ECHO

by Robert Penfold

Until quite recently digital delay lines were extremely expensive pieces of equipment which relatively few people could afford. Analogue delay lines of the charge coupled type offer an inexpensive alternative, but where long delays are required (a few hundred milliseconds or more) these are not very practical since a number of devices connected in series are required, and performance is compromised. The massive drop in the prices of memory chips over the last year or so has changed the situation dramatically, with some of the higher capacity types falling to only about one tenth of their previous cost.

Practical Digital Delay

This digital echo unit was designed to take advantage of these recent price reductions, and the unit is based on the 6264-3 memory chip. the 6264-3 is a CMOS static RAM having a capacity of 64k (organised as 8k of 8 bit bytes). Obviously, 8k is not a massive amount of memory, but it enables reasonable delay/bandwidth combinations to be provided. In analogue delay line terms it is equal to a 16384 stage device, bearing in mind that the 'bucket brigade' system used in such delay lines requires two stages per stored sample, whereas a digital type requires just one byte of memory per stored sample. It would, therefore, require thirty two of the popular TDA1022 512 stage delay lines to give a comparable level of performance to this unit!

The echo time is continuously variable from approximately 75ms to 450 milliseconds, giving a range of effects which vary from a short reverberation type sound to a medium-long echo. A feedback control enables the echo level and the echo decay time to be adjusted over a broad range. The unit is intended to operate with an input level of several hundred millivolts r.m.s, and it can therefore be driven directly from synthesisers and most guitar pick-ups. With low level sources, such as microphones and low output guitar pick-ups, a suitable preamplifier must be added at the input to the unit.

★ Based on the 6264-3 CMOS Static RAM
★ Echo Variable from 75 to 450 Milliseconds
★ Can be Driven Directly from a Synthesiser

Operating Principle

It is a common misconception that digital delay lines, like analogue types, operate on the 'bucket brigade' principle. This is not the case however, rather it can be best described as a simple form of recording and playback, where the 'recording medium' comprises the RAM chip, an operation quite different to the passing of sample voltages along a line of charge storage circuits. The method of operation is in many ways closer to that of a tape loop echo unit than a 'bucket brigade' type. The block diagram of Figure 1 helps to explain the way in which the unit functions.

Circuit Description

The input stage is a mixer, and its purpose is merely to combine the input signal with the delayed signal. Some of the mixer's output signal is used to drive the input of the delay circuit, and the first stage here is an active lowpass filter. With any form of sampling system, it is important that the sampling rate is at least twice the maximum

input frequency. In this case the minimum sampling frequency is at about 18kHz and the audio bandwidth accordingly has to be restricted to around 9kHz or less. Allowing strong signals at more than about 9kHz into the system would generate severe 'aliasing distortion,' and would give a very poor quality audio output. (See 'A/D/A Conversion Techniques', Maplin Magazine Vol. 5 Issue 18.) In this design the lowpass filter restricts the bandwidth of the delay line to about 8kHz. This is obviously far less than the full audio bandwidth, but it is still more than adequate for good results in this application. Note also that it is only the bandwidth of the *delayed* signal that is restricted; the straight-through signal is not subjected to any filtering.

The next stage is a compressor, and this is followed by the eight bit analogue to digital converter. An eight bit system has the advantage of enabling relatively inexpensive and easy to obtain components to be used in the design, but it has the disadvantage of not achieving much more than a rather low, innate level of performance. The signal to noise ratio is typically only about 46dB, and the total harmonic distortion is around 0.5% just below the clipping level. Performance is much worse than this would suggest though, as each time the input level is reduced by 6dB the distortion level doubles. This represents about 50% distortion at the −40dB level, which is an unacceptable level of performance.

The use of the compressor alleviates this to a large extent. The compressor has a 2 to 1 ratio characteristic, and when the input signal level is at −40dB, the signal fed to the analogue to digital converter is only at −20dB. This gives a much improved performance, with a distortion level of only about 5% with the input signal at −40dB. This is still far less than hi-fi standard, but it is quite acceptable for electronic music applications. Of course, severe compression of the signal is undesirable in the final output, and so it is corrected by a 1 to 2 expander at the output of the delay line. Overall, therefore, the delay line leaves the dynamic levels of the processed signal unaltered.

A useful by-product of the compression/expansion process is an effective doubling of the signal to noise ratio to about 90dB, and the compressor/expander circuit is in fact a standard compander type noise reduction system. However, in this application, it is the reduction in distortion rather than the reduction in noise which is of prime importance.

System Timing

A clock oscillator governs the sampling rate, and it is by varying the clock frequency that the delay time is varied. A timing control circuit ensures that the memory chip, the analogue to digital converter, and the digital to analogue converter are all synchronised together and operate in unison. The basic sequence of events is as follows. Firstly, the analogue to digital converter is presented with a 'start conversion' signal pulse. Then the memory chip is set to the read mode, and the output digital to analogue converter is activated. This latter converter has a built-in eight bit latch at the input, and it therefore holds its current output level until it is fed with a new sample.

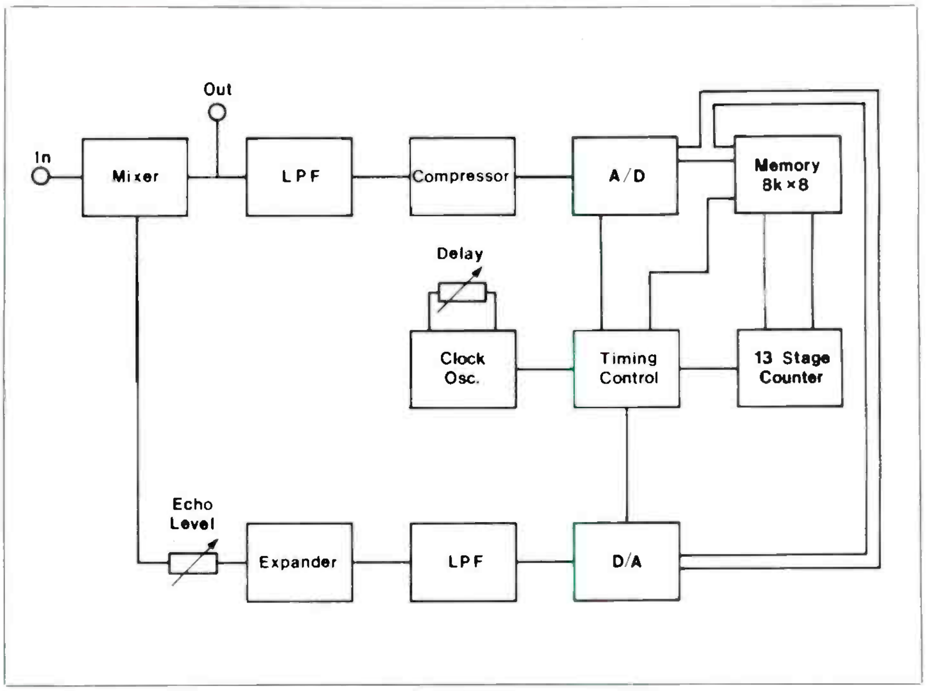


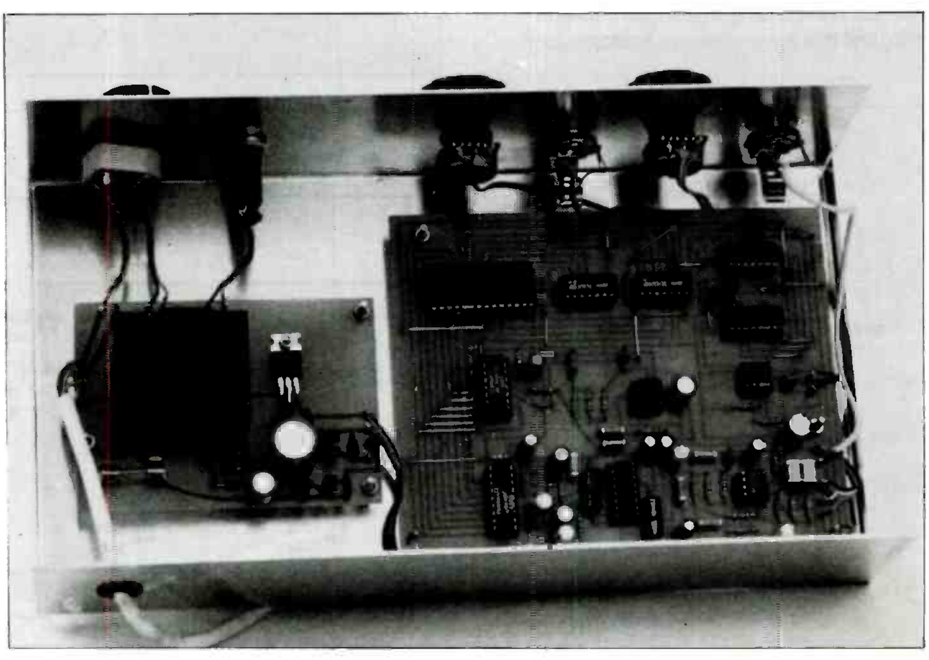
Figure 1. Digital Echo Block Schematic

The next step is for the memory chip to be set to the write mode, and for the input sample taken by the analogue to digital converter to be delivered to the current address, overwriting the existing sample value stored there. Then the 13-stage binary counter is fed with an input pulse, and as it is this counter which controls the sequencing of memory addresses, the memory circuit is moved on to the next address.

The whole process then repeats itself, with the old sample at the current memory address being delivered to the output digital to analogue converter, and then over-written by a new sample value, and the memory incremented. This process continues indefinitely, with the memory being continuously cycled through all 8192 addresses. The important point to note here is that each new sample does not reach the digital to analogue converter until the memory chip has been cycled through all 8192 addresses and back again to the address where the new value was stored. This gives the required delay, and the delay time is equal to 8192 divided by the clock frequency.

Recycling the Output

The output from the digital to analogue converter is a stepped waveform, by virtue of the conversion process, but a lowpass filter at its output smooths out the steps to some extent, giving an output waveform which closely resembles the input waveform. A controlled amount of the delayed signal is then mixed with the input signal. This results in the signal circulating around the system until it gradually dies away, giving a multiple echo effect.



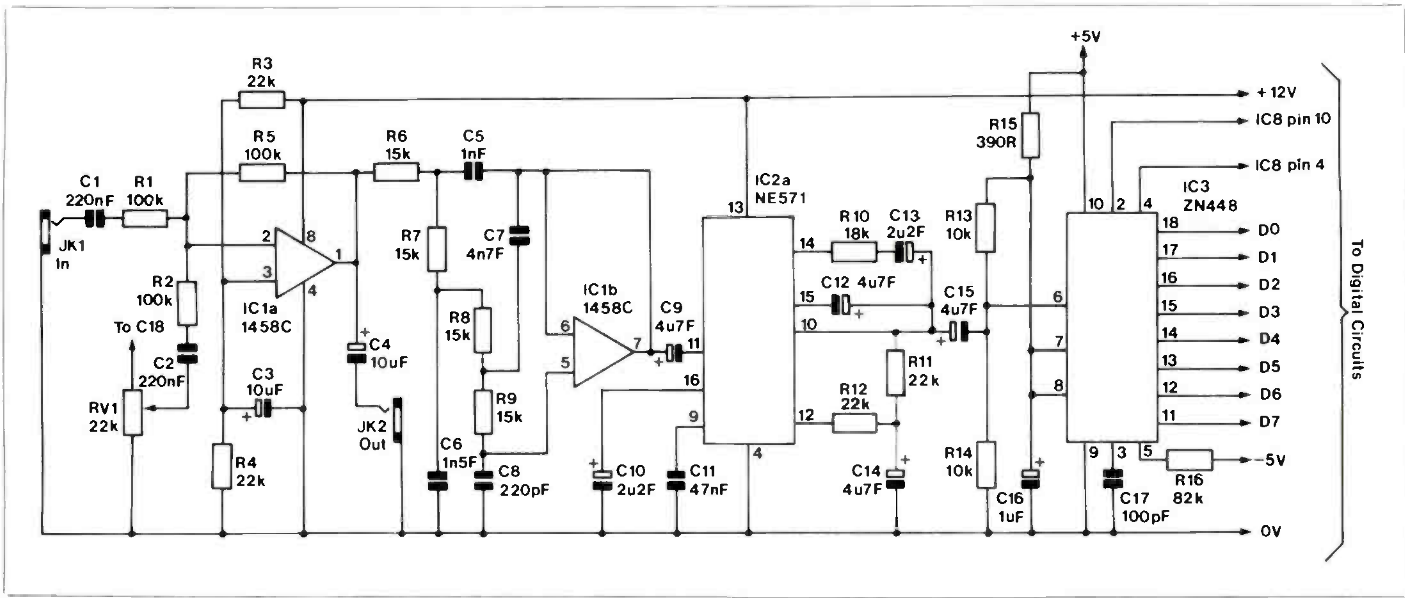


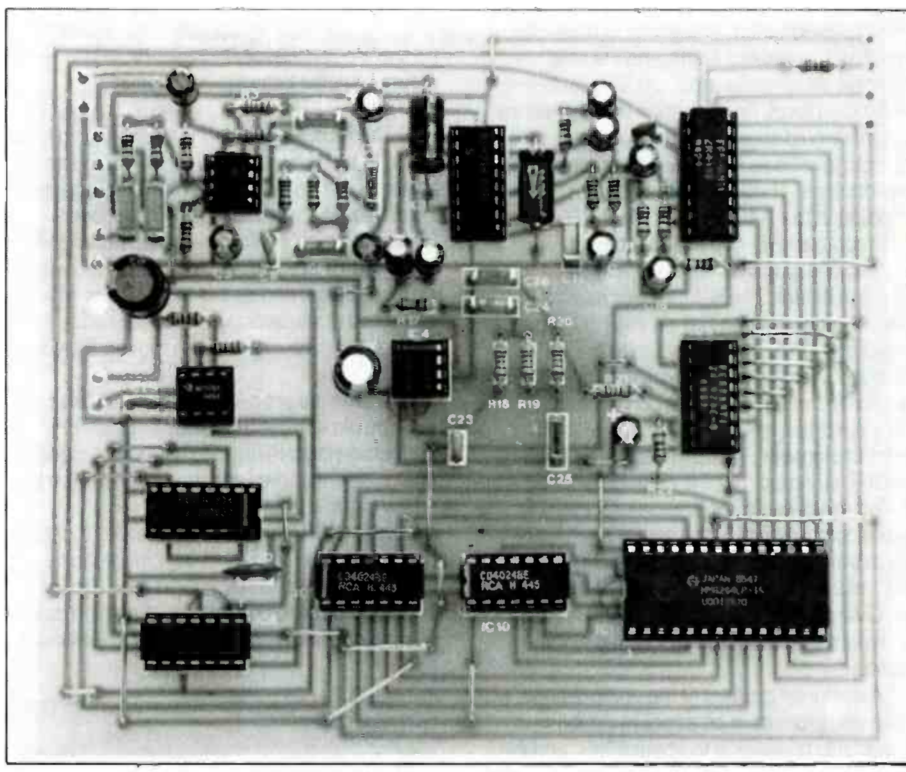
Figure 2. Analogue to Digital Converter Stage Circuit

With a low echo level the signal quickly decays to an insignificant level, but with a high level it can be made to take several seconds to die away to zero. In practice the amount of echo signal that can be used is limited by the noise and distortion that is added to the signal on each pass through the delay line. The maximum usable decay time is proportional to the delay time, since a short delay time results in the signal being circulated more frequently, and the noise and distortion therefore build up that much more rapidly.

Record Circuit

Figure 2 shows the circuit diagram of the input and analogue to digital converter stages. IC1a operates as the mixer stage, and this is a straightforward summing mode circuit. RV1 is the feedback level control. The lowpass filter is based on IC1b, and this is a conventional fourth order (24dB per octave) type having a cut-off frequency of just under 8kHz. The compressor uses one section of an NE571 (IC2a) which is specifically designed for use as a 2 to 1 compander.

IC3 is the analogue to digital converter chip, and this is a successive approximation



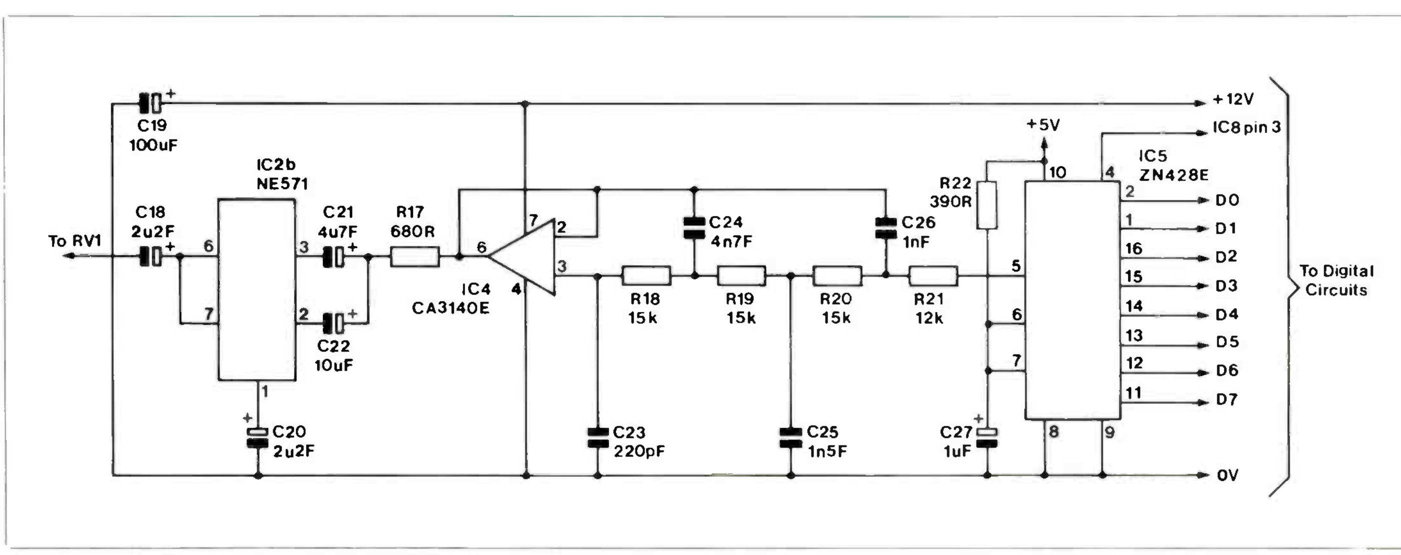


Figure 3. Digital to Analogue Converter Stage Circuit

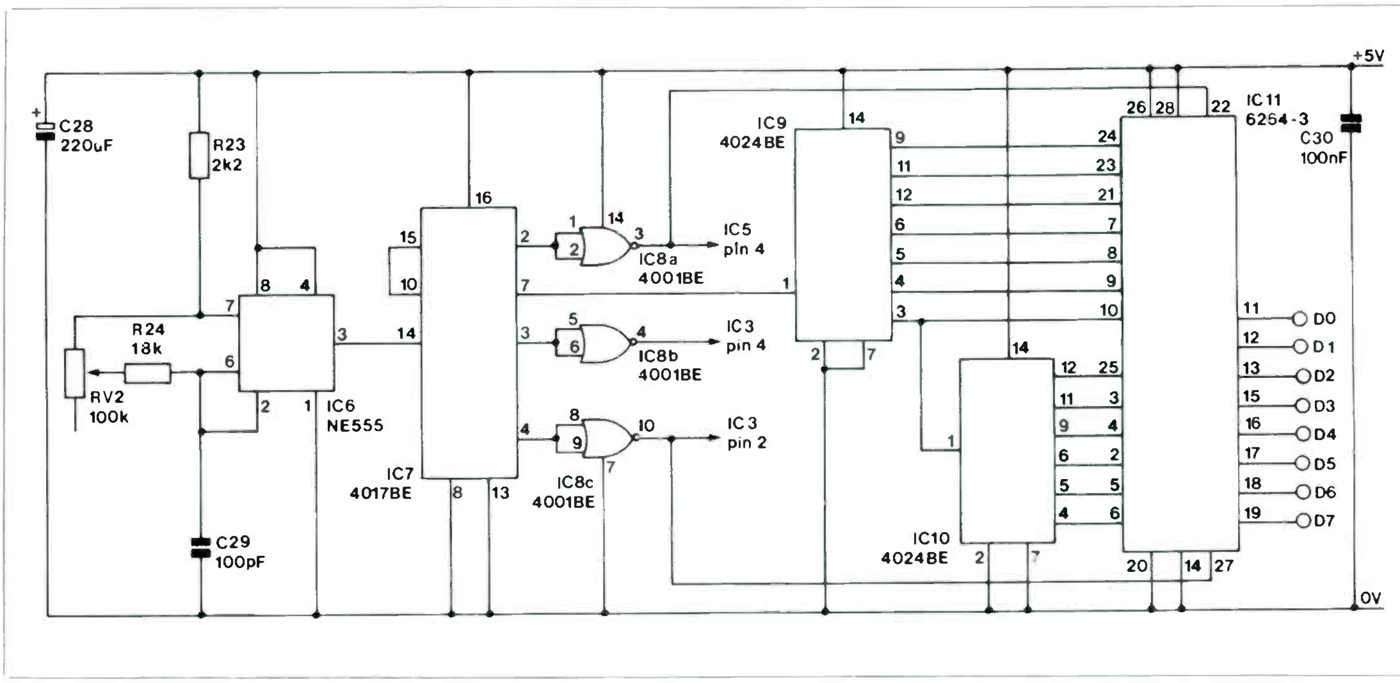


Figure 4. Clock, Control and Memory Stage Circuit

type. It has a built-in clock oscillator which has C17 as one of the timing components. The specified value for C17 sets the clock frequency at about 1MHz, which is the maximum figure at which the ZN448E is guaranteed to function properly. Nine clock cycles are required in order to complete each conversion, which corresponds to about 110,000 conversions per second at the maximum clock rate. This limits the minimum delay time to about 75ms, although shorter times could be obtained by using less than the full 8k of memory. However, for the present application, the 75 to 450ms delay range is perfectly adequate.

IC3 has an integral 2.55 volt precision reference source for its digital to analogue converter stage, and this has the discrete load resistor R15 and decoupling capacitor C16. The analogue input is biased from the reference source by R13 and R14. R16 is the 'tail' resistor for the high speed comparator stage at the input of IC3, and this must be fed from a −5 volt supply. Note that the analogue circuits are powered from a +12 volt supply, while the digital circuits operate from a +5 volt line. The circuit therefore requires three supply potentials.

Playback Circuit

The circuit diagram for the digital to analogue converter stages appears in Figure 3. The converter device is a ZN428E (IC5). Like the ZN448E, this has a built-in 2.55 volt reference source, and it is an ideal complementary converter for the ZN448E. The ZN428E is a conventional digital to analogue converter based on a precision voltage source driving an R–2R resistor network via eight electronic switches.

IC4 acts as the buffer stage in the lowpass filter, which is essentially the same as the one used in the record circuit. The filter is direct coupled to the output of IC5, and IC4 must be of a type which is capable of supplying output voltages right down to the 0 volt rail. Operational amplifiers such as the 741C and LF351 will not function properly in the place of IC4 in this circuit.

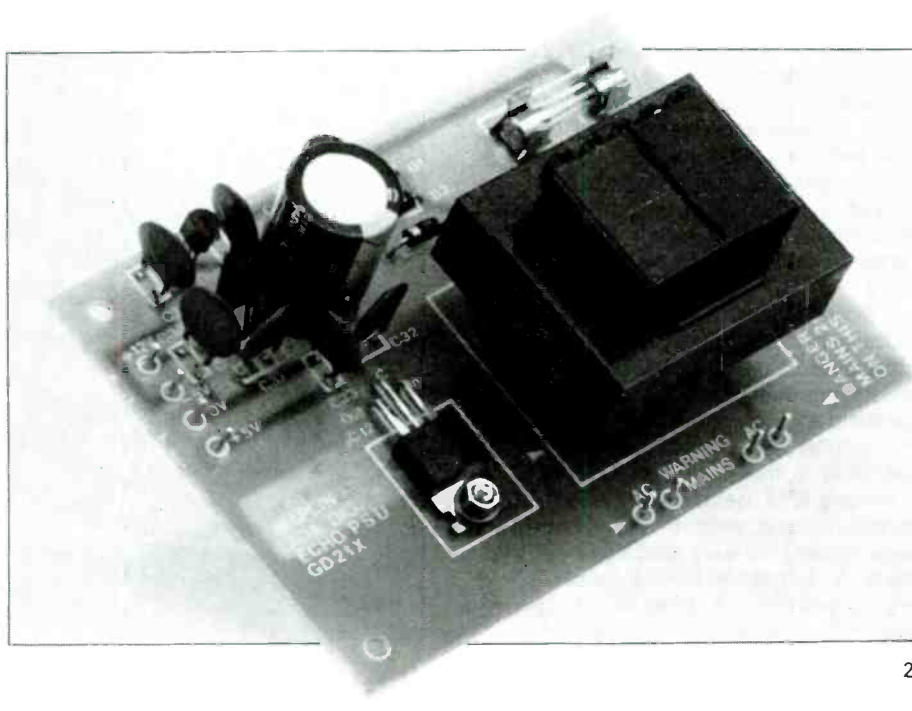
IC2b is the expander circuit, and it utilises the second section of the NE571. The two sections of the device are identical incidentally, and it is the discrete components which determine whether the device operates as a compressor or expander. This helps to give good complementary characteristics which ensure that there are no significant distortions to the dynamic levels overall.

Memory Circuit

The clock, control and memory circuit is shown in Figure 4. IC6 is a 555 timer device connected in the standard astable mode, and this acts as the clock oscillator. RV2 is the delay time control. IC6 has a higher operating frequency range than one might expect since the control circuit provides only one record/playback cycle per four clock cycles.

Control of the converters and memory chip is provided by IC7, which is a CMOS one of ten decoder. Outputs '0' to '9' of IC7 normally go high in sequence on successive clock pulses, and then the device cycles back to '0' on the next clock pulse, and this process repeats itself indefinitely. In this case though, output '4' is connected to the reset input and the count is consequently cut short with the device immediately resetting to '0' when output '4' goes high. Outputs '0' to '3' are used to control the four phases of each record/playback cycle.

Output '0' drives the 'start conversion' input of IC3, but as this input is active low, the output of IC7 has to be inverted. Next, output '1' activates the 'write' input of memory chip IC11 and the latches at the input of IC5, and again the positive pulse must be inverted as both inputs are active low types. On the third phase, output '2' goes high, but this signal is also inverted, giving a negative pulse to set IC11 to the read mode and activating the tri-



state buffers at the output of IC3. On the fourth phase, a clock pulse is supplied to the 13-stage binary counter which generates the address bus. The counter is comprised of two 7 stage devices connected in series (IC9 and IC10), with the final stage of IC10 being left unused.

Power Supply

The power supply circuit is shown in Figure 5, and this uses a 12 volt mains transformer and a push-pull rectifier to give an unstabilised supply of about +17 volts. IC12 and IC14 are monolithic voltage regulators which provide well smoothed and regulated outputs of +5V and +12V respectively from the unregulated supply. D1 provides a halfwave rectified negative supply, and IC13 then produces a stabilised −5 volt output from this.

Construction

Nearly all of the components are accomodated on two printed circuit boards. There is one board for the main ADA Echo circuitry, and a separate p.c.b. for the power supply components only. Commence construction of the power supply board first. FS1 is mounted in a pair of printed circuit mounting clips, and mains transformer T1 is also a printed circuit mounting component. Make sure that these components are fully pushed down onto the board before soldering them in place, and use plenty of solder so that they are firmly held in position. Find and identify the six ceramic disc capacitors C32, C33, C35 to C38 with reference to the p.c.b. overlay and the parts list. Insert these into the postions as shown on the overlay, and bend over the leads underneath to retain them whilst soldering. After soldering, trim off all excess wires with side cutters.

Find and identify the 3 rectifiers D1–3. Insert these into position as shown on the legend after bending the leads first, but carefully so as not to break the plastic body. The stripe around one end of the package marks the cathode, and this *must* align with the white bar on the legend or serious damage could result. Solder and trim excess wire as above.

Insert the two PC electrolytics C31 and C34, observing correct polarity. These capacitors are usually marked with a black stripe and '–' sign adjacent to the negative lead, the other being the positive lead. Identify which lead is which and match these to the holes marked '+' on the legend. Fit eight veropins at the points circled on the legend where connections to off-board components will be made.

Insert IC13 and IC14 into the positions indicated by matching them to the 'D' shapes of the legend. Note the centre lead of each is offset to one side. Bend the leads over under the board and solder carefully, whilst checking by touch that these components do not get too hot. If they do, then allow to cool before continuing. IC12 does not have to dissipate very much power, and so it does not require a large heatsink, but is is a good idea to bolt it to the board. Do this now after bending the 3 leads as required so that they are correctly positioned in the solder pads and the screw

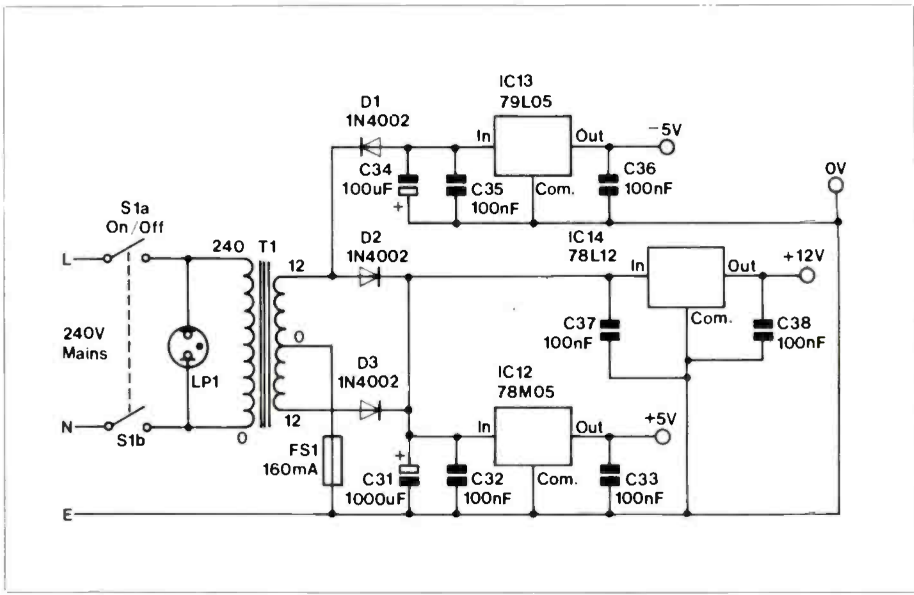


Figure 5. Power Supply Circuit

holes line up, and then attach with the screw and nut supplied. Then solder the 3 leads now that IC12 is secure. Put the PSU board to one side.

Assembling the Main PCB

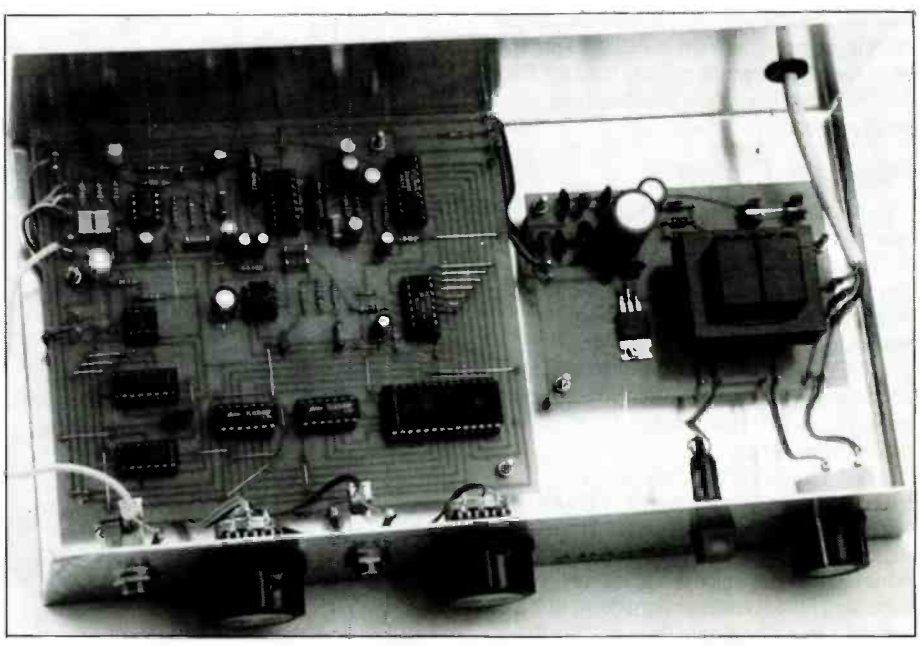
Find and identify all resistors with reference to the parts list and p.c.b. overlay. Make sure that the correct values are recognised with the aid of a resistor colour code chart if necessary. Commence installing all the resistors by inserting into the position indicated on the legend, bending the wires to right angles to facilitate insertion and then folding them over underneath prior to soldering. Trim off excess wire using side cutters.

Be careful not to omit any of the wire links shown as solid lines on the p.c.b. legend. These can be made from 22swg tinned copper wire, or the waste leads trimmed from resistors and capacitors should suffice if a reel of suitable wire is not to hand. Fit 13 veropins at the points circled on the legend, where connections to off-board components will be made.

Identify, mount and solder all non-electrolytic capacitors with reference to the parts list and the p.c.b. legend. Install them one at a time, double checking for the correct value. Next insert and solder all the PC electrolytics observing correct polarity as previously described.

Most of the integrated circuits on the main board are either CMOS types, fairly expensive, or both. It is therefore advisable to use the DIL integrated circuit holders, or sockets, provided in the kit for all eleven devices.

Additionally, IC4, IC7, IC8, IC9, IC10, and IC11 are the CMOS types and require the usual handling precautions; you must avoid a heavy build-up of static electric charge between yourself and the device or the work area. Work on a metal tray or aluminium foil, to thoroughly ensure that any static potentials around the work area are equalised. Hold the IC with thumb and forefinger at the ends, and touch the lead-out pins as little as possible. However, you may need to squeeze the pins slightly to ensure that the IC will push easily into its socket. In each case, identify pin 1 by



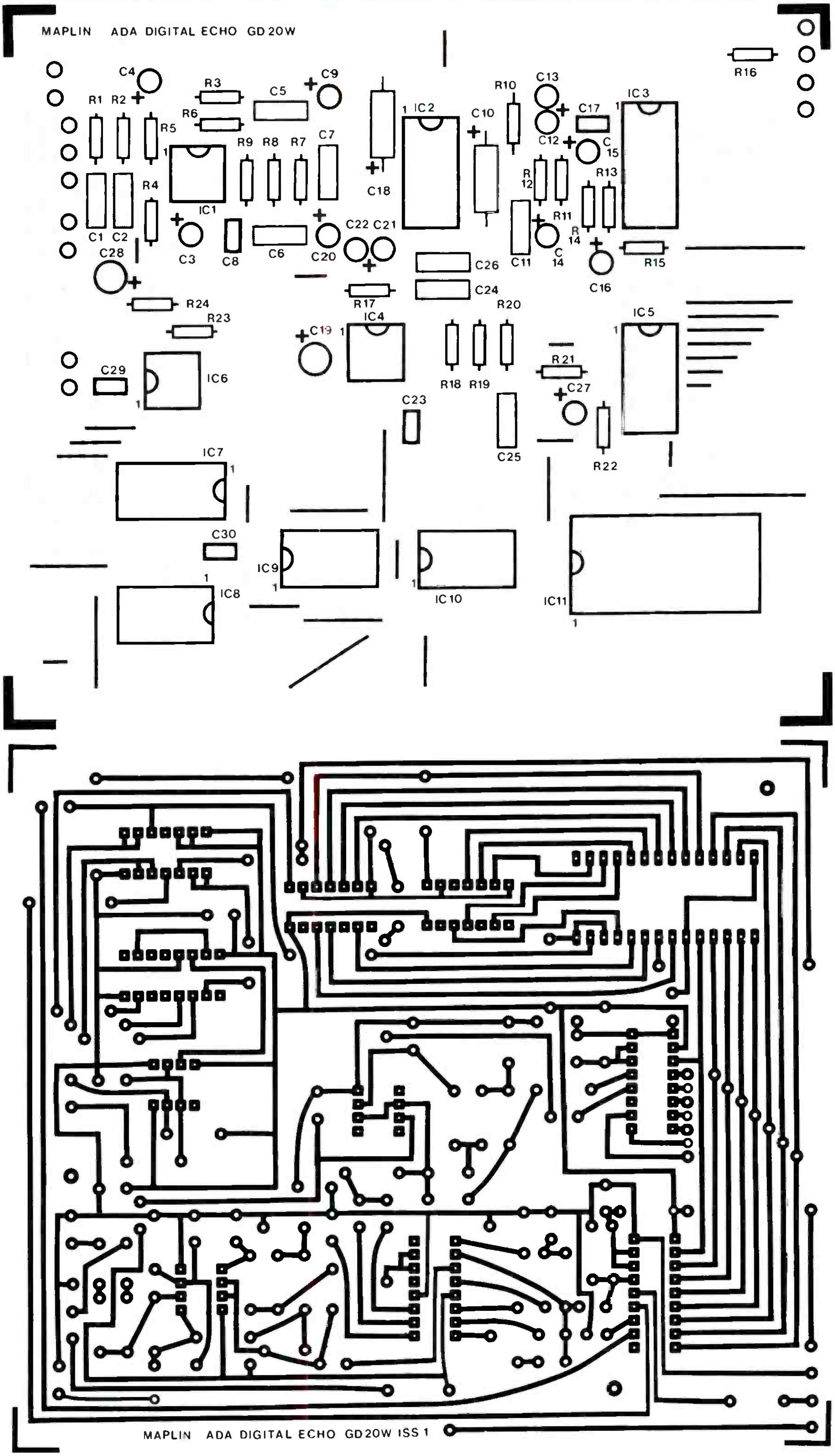


Figure 6. Main PCB Track and Overlay

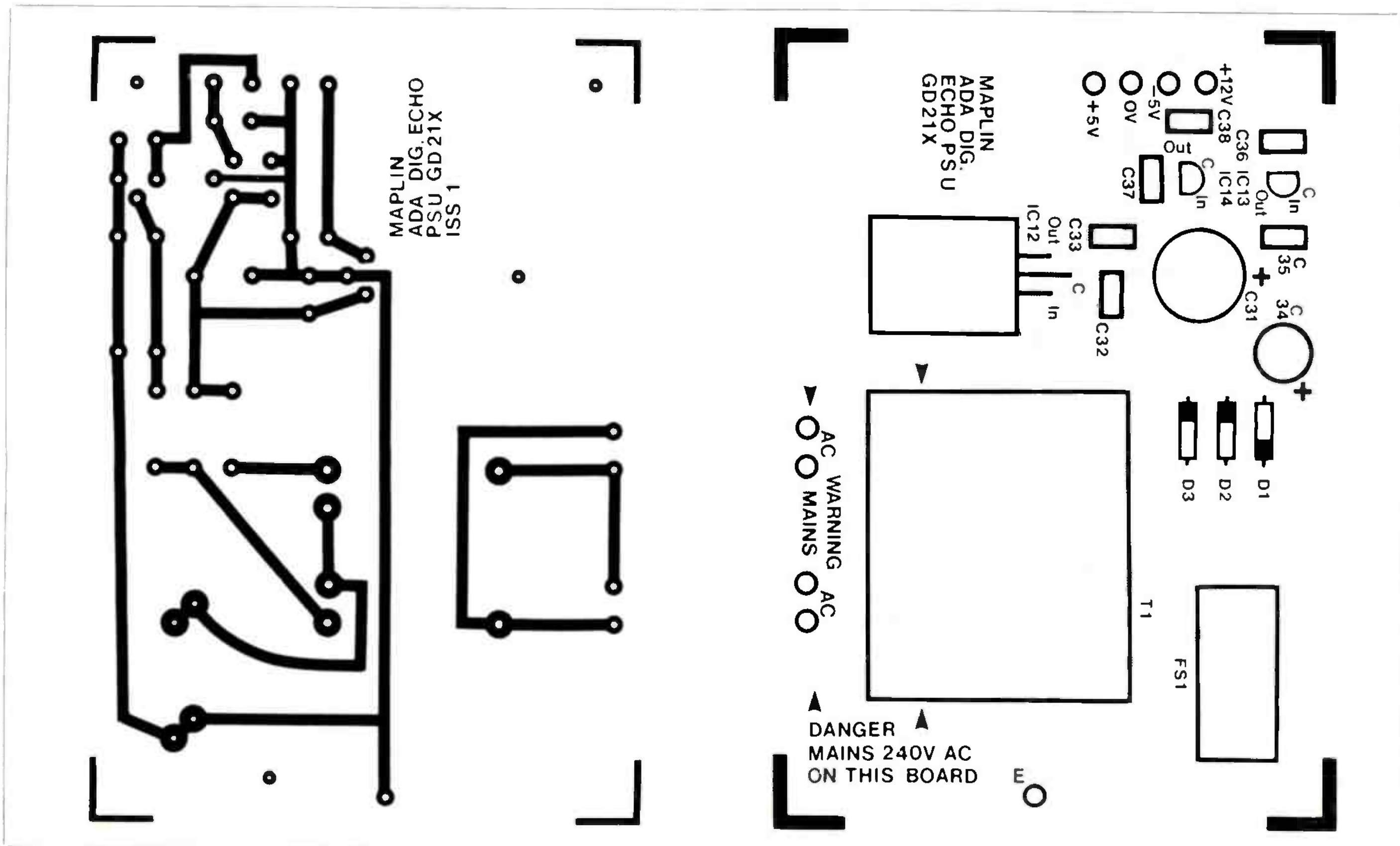


Figure 7. PSU PCB Track and Overlay

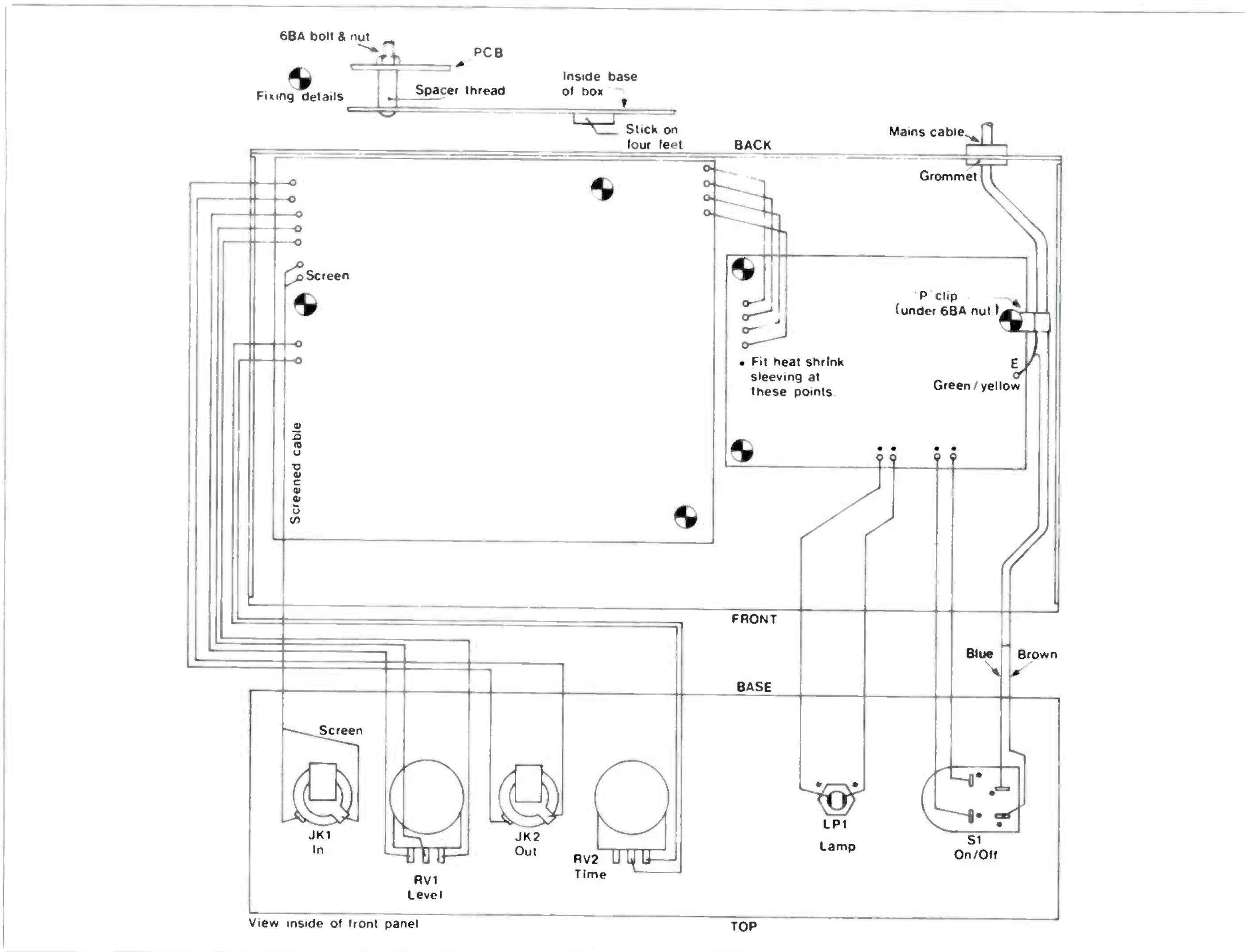


Figure 8. Wiring up the Project

the recessed dot or the notch at one end of the package. This must align with the white marker block shown on the legend, otherwise the device will be connected wrongly into the circuit and almost certainly destroyed, so be sure to fit them the right way around, and double check their orientation against Figure 6 when the board has been completed.

Installation

A metal instrument case having approximate outside dimensions of 279 x 159 x 76mm makes an inexpensive but practical and attractive housing for this project. Any similar case should be suitable, but the case should not be significantly smaller than the size specified above. The two printed circuit boards are bolted to the base panel of the case using 6BA fixings, including ½in. (12.7mm) threaded spacers to ensure that the connections on the undersides of the boards are kept well clear of the metal casing. The main board is positioned well towards the left hand side of the unit, and as far towards the rear as possible. This leaves plenty of space for the power supply board towards the right hand side of the unit.

Complete the unit by adding the small amount of point-to-point wiring, being especially careful to avoid errors when dealing with the power supply wiring. It is advisable to insulate all the connections that are at mains potential so that there is no risk of electric shocks being sustained due to accidental contact with these connections. Always use a ¼in. bore chassis grommet where the mains cable exits through the rear panel. Finish by wiring a mains plug to the mains lead.

Testing and Use

It is a good idea to wire up the power supply first and make sure that this is operating properly before wiring its outputs to the main Echo p.c.b. Do take care with mains wiring and ensure that no errors whatsoever exist, before even contemplating plugging in and switching on. The mains panel neon should light and then you can use a voltmeter to check for the three voltage outputs of +5V, −5V and +12V DC respectively. Also, chassis must be connected to mains earth – you can test for this by unplugging the unit and testing for continuity from the mains plug earth pin to chassis, using the lowest ohms range on the multimeter. If all is well, complete wiring to the main board.

Make quite sure that the outputs connect through to the main board correctly (the two boards have been designed so that no crossed wires are required here).

With RV1 and RV2 both set at a roughly middle setting, a short burst of noise will be produced from the output when the unit is first switched on, which should be followed by a very low background noise level. The burst of noise is simpy due to the random values present in the RAM at switch-on being outputed before they are over-written by the recording circuit.

The echo effect should be readily apparent on practically any type of input signal, and using RV2 it should be possible to vary the delay time over the approximate limits mentioned previously. With RV1 well backed

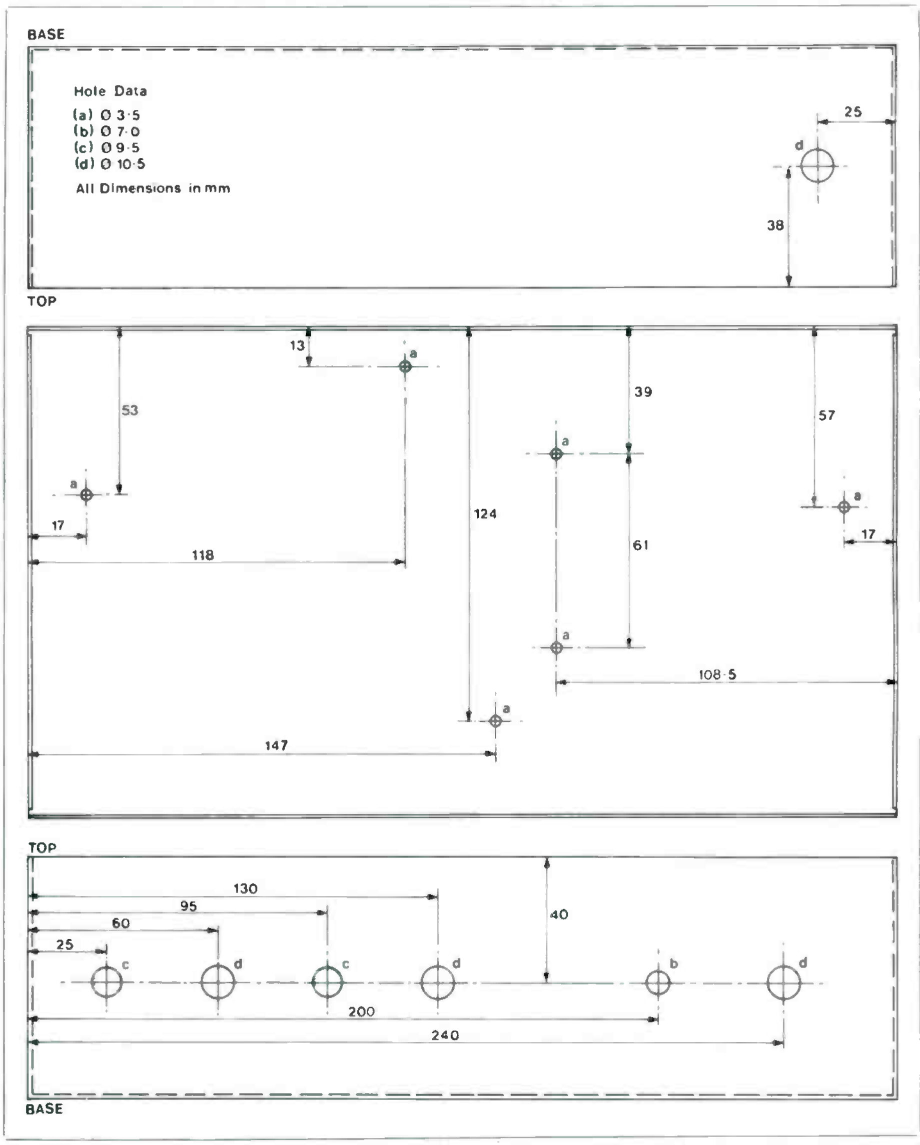


Figure 9. Box Drilling

off, the echo level should be quite low, and the echoes should rapidly fade away to an inaudible level. By advancing RV1 the echo level should be boosted, and the decay time should be substantially prolonged. If RV1 is advanced too far the echo signal will be maintained indefinitely, or it will actually increase in strength on each pass through the delay line. The unit is not normally used with such a high level of feedback, as it results in the signal building up to the point where overloading occurs and the output signal becomes just a mass of noise. However, there is an interesting technique whereby a short burst of input signal at a farily low level is supplied to the unit. Initially a high level of feedback is used in order to gradually build up the signal to a crescendo, after which the feedback level is decreased in order to make the signal die away again. This tehcnique works best with fairly long echo times.

The unit can take input levels of up to 2.55 volts peak to peak before the onset of clipping and serious distortion, and for optimum results the input signal should be at something approaching this level.

Continued on page 36.

'MIXING IT'

by Dave Goodman

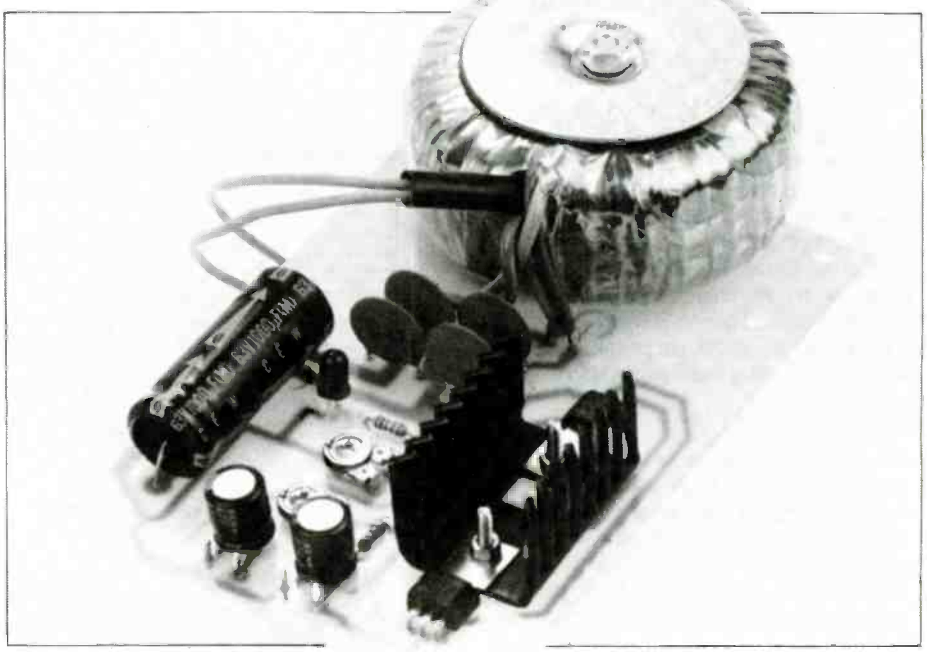
Part 3

Using Maplin High Quality Mixer Modules

The Maplin range of HQ mixer pre-amplifier modules serve as useful building blocks in audio circuits requiring high quality signal processing. In Parts 1 and 2 of this series, several modules were detailed, along with general specifications and use. To recap on this, here is a list of available modules:

In Part 1 (Vol.5, No.17).

1. General Purpose Input Module Mono.
2. General Purpose Input Module Stereo. For use with either pre-amplified signal sources or musical instruments such as guitars, organs and synthesisers. Supply requirements: 30V DC @ 25mA.
3. Tone Control Module Mono.
4. Tone Control Module Stereo. Active bass and treble controls. Supply requirements: 30V DC @ 1mA(M), 2mA(S).



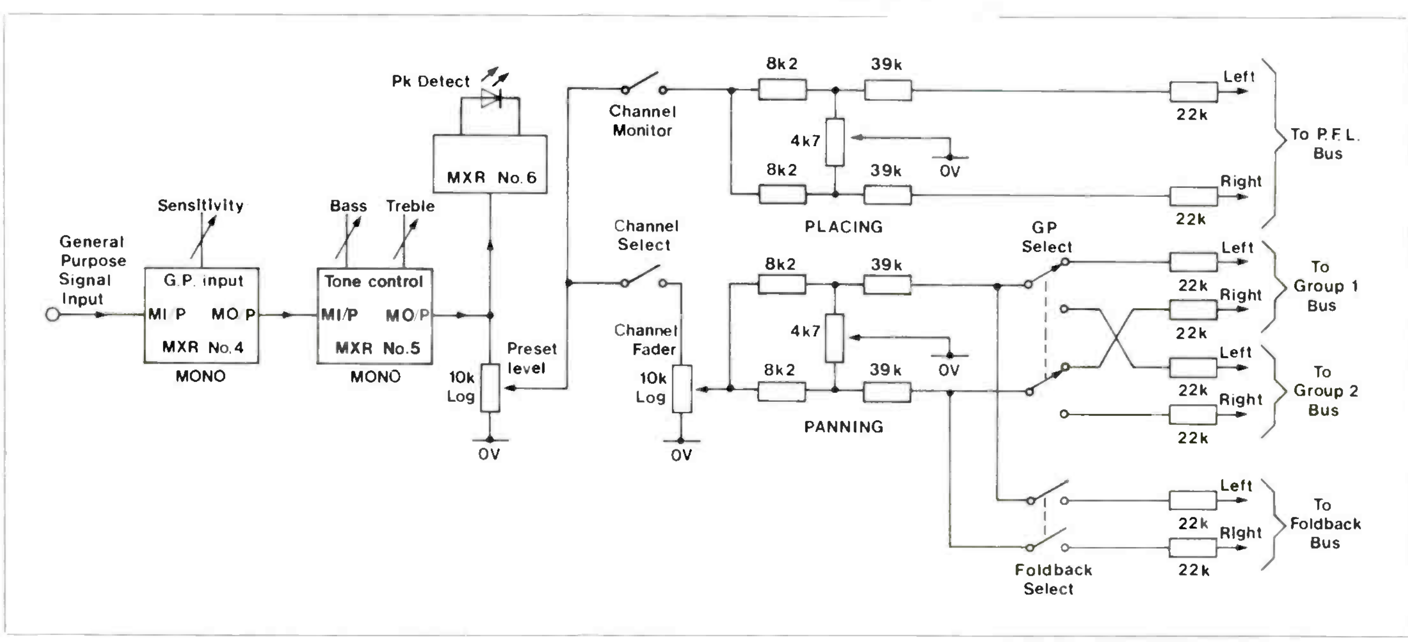


Figure 36. Typical Mono System

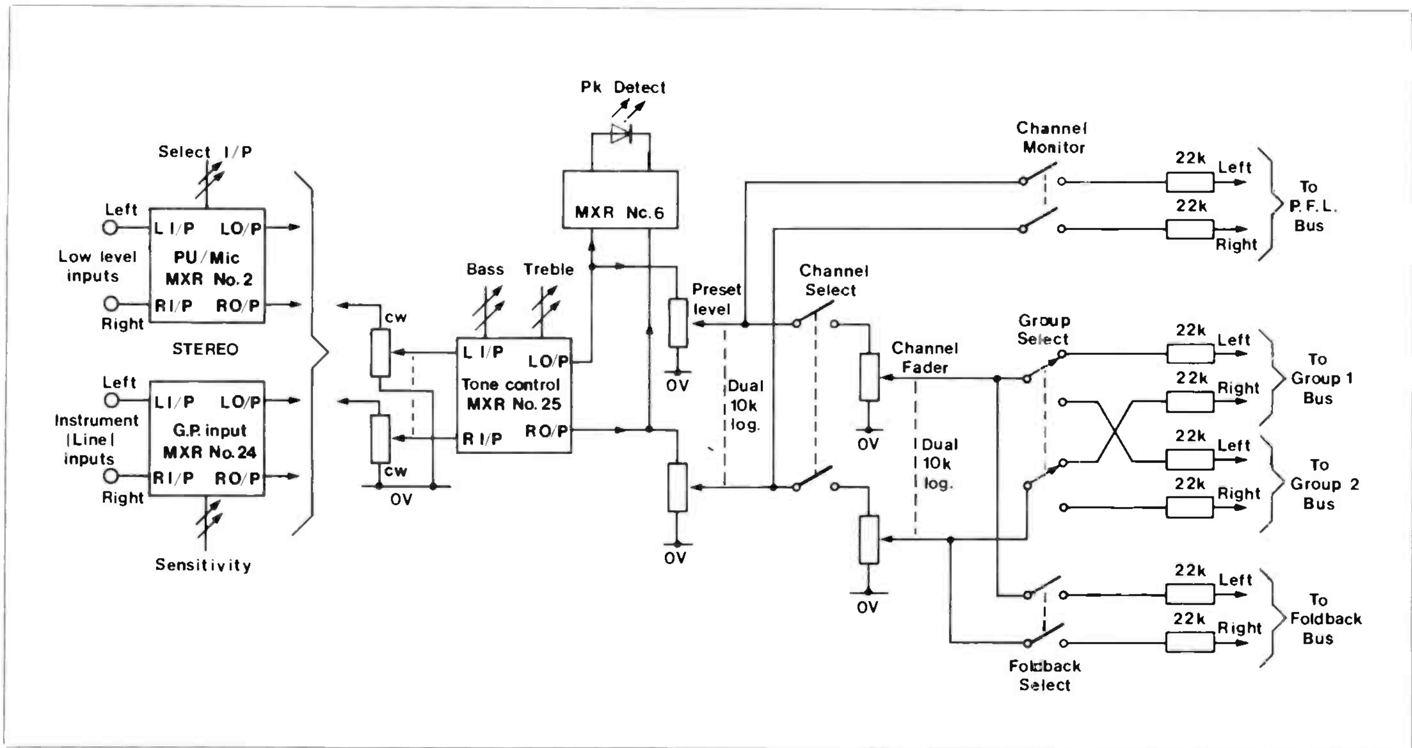


Figure 37. Typical Stereo System

5. Peak Overload Detector Module. Mono/stereo input LED driver. Supply requirements: 30V DC @ 12mA (Inc. LED).
6. Filter Module (Mono Only). Switchable low pass filter with variable slope control. Supply requirements: 30V DC @ 5mA.

In Part 2 (Vol.5, No.18).

7. PU or MIC Input Module Mono.
8. PU or MIC Input Module Stereo. For use with magnetic cartridges, High-Z microphones and ceramic cartridges. Supply requirements: 30V DC @ 6mA(M), 12mA(S).
9. Mixer Amp Module Stereo. For combining several different signal sources together. Supply requirements: 30V DC @ 14mA.
10. Line Amp Module (Mono Only). High level buffer stage driver. Supply requirements: 30V DC @ 14mA.
11. VU/Monitor Amp Stereo. For driving headphones or twin VU meter movements. Available in two different versions. Supply requirements: 30V DC @ 40mA max.

When deciding on power supplies, determine the total current requirement from all modules to be used. A twin PSU module is available with two separate regulated supply rails. Each rail is rated up to 0.3A and variable from 1.5V to 30V DC.

Interconnection

There are countless ways in which any combination of these modules are likely to be used in practice, dependant upon individual requirements and specifications. To help the constructor get a general idea of mixer arrangements, Figures 36 to 38 show the different modules in a theoretical large scale mixing system. The diagrams are *not* complete projects and are shown as examples only. Figure 36 could be a typical 'Mono' channel for pre-amplified or instrument inputs, with tone controls and preset volume control. The channel can be monitored over the Pre-Fade Level bus, and a 'Placing' control determines left or right channel levels.

The main group busses are really sub-mixing channels allowing multi-channel mixing and selection as in Figure 38. The foldback bus is used for monitoring input channels and would then drive Stage or Local amplifiers and speakers for monitoring purposes. Figure 37 shows a typical 'Stereo' channel with Pick-Up, Microphone or General Purpose inputs. Again, the PFL, Group and Foldback busses are selectable and any number of such channels could be connected to the various busses using 22k resistors.

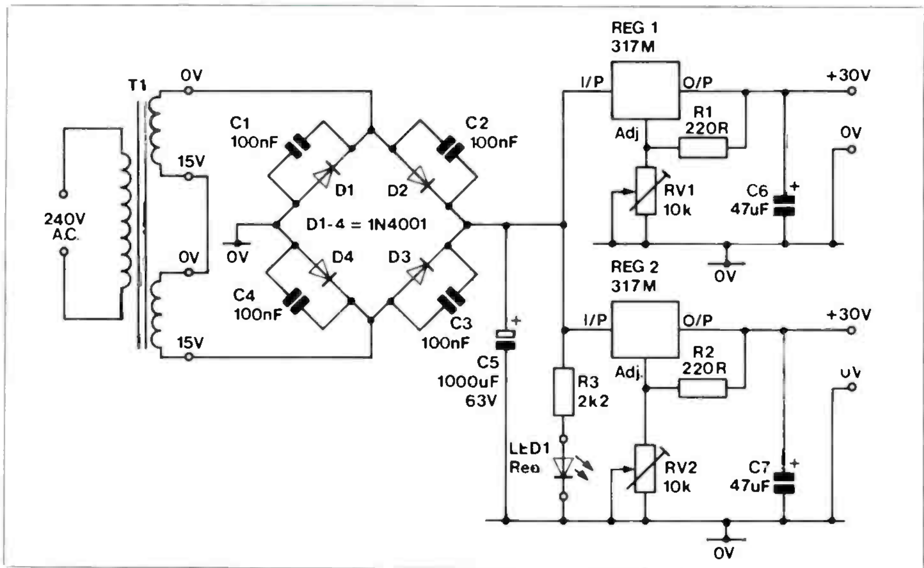


Figure 39. PSU Circuit

Mixer PSU Module

Figure 39 shows a twin, variable power supply capable of providing up to 300mA from each of the two outputs or up to 500mA from one output only. Both regulator outputs can be varied for 1.5V to 30V DC.

Construction and Use

Locate and fit bridge diodes D1 to D4, and ceramics C1 to C4. Insert the 220Ω resistors R1 and R2 and LED supply resistor R3. Mount presets RV1, RV2 and fit LED 1 with the longer lead (Anode) in hole a, and short lead (Cathode) in k. The cathode may also be identified by a flat on the skirt around the LED body.

Insert PC electrolytics C6, C7 and axial C5 noting lead polarity. The negative lead is marked with a minus (−) sign on the body. Insert two 6BA x ¼in. bolts through the pcb from the track

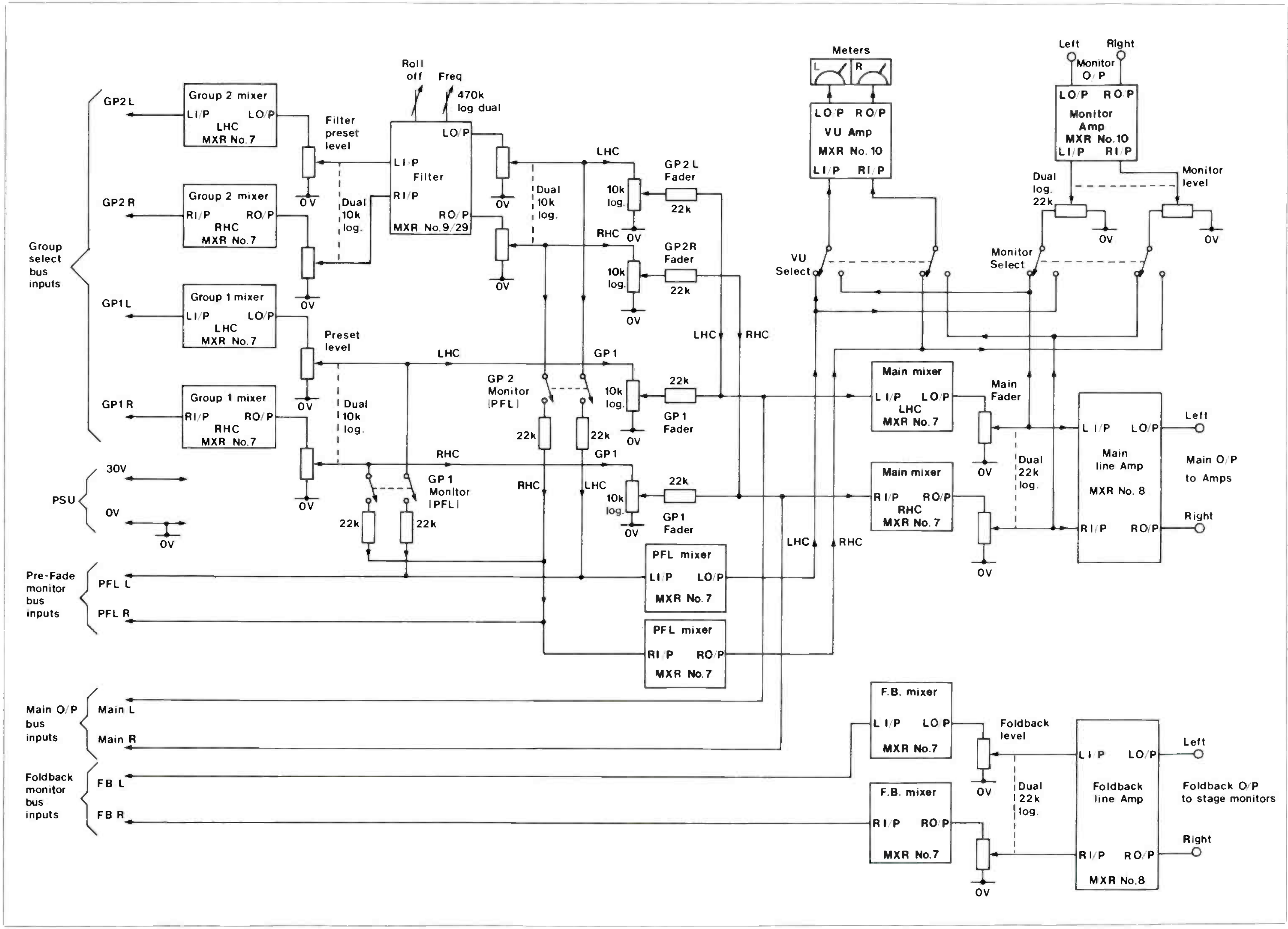


Figure 38. Multi-channel Mixing

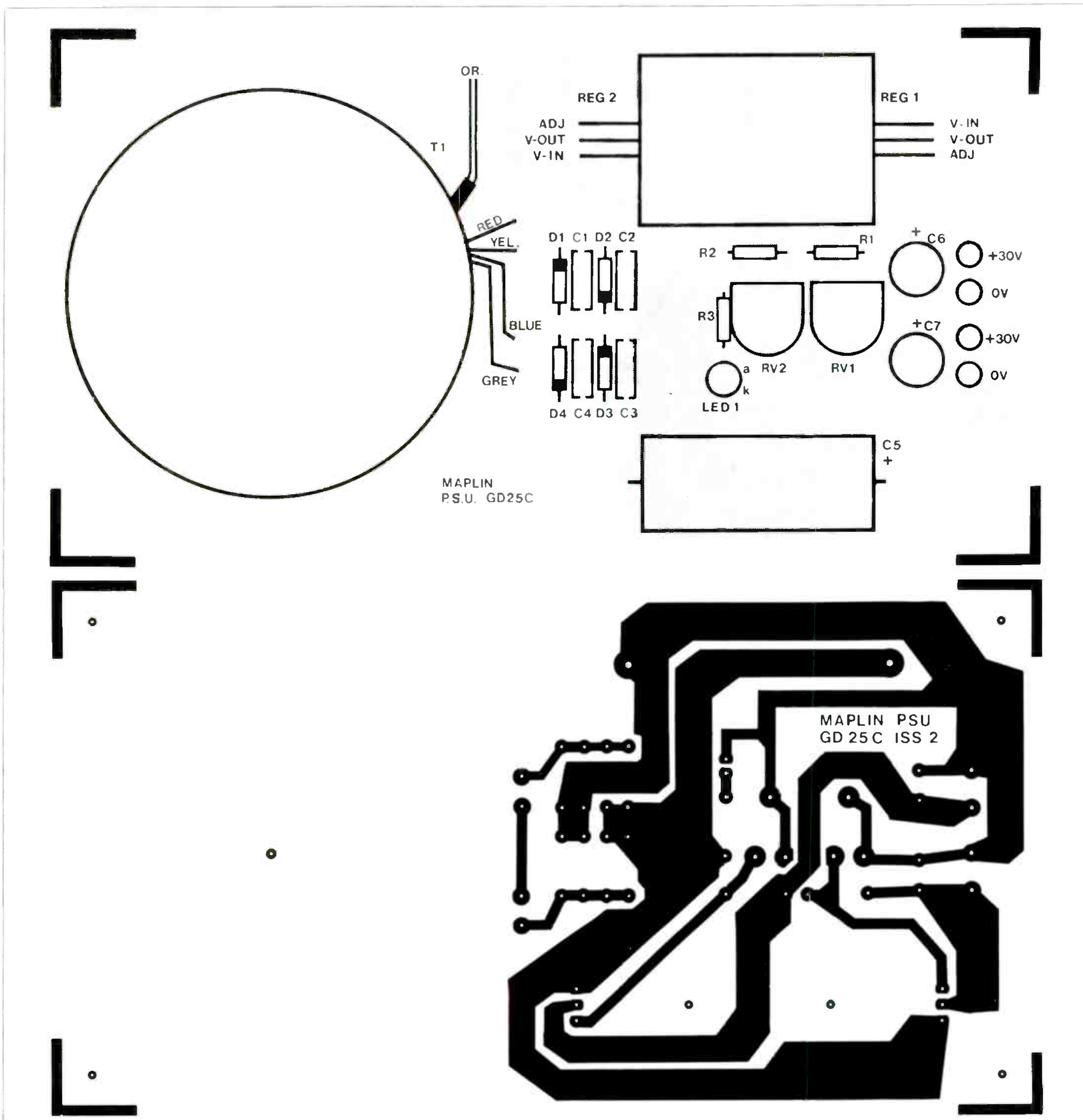


Figure 40. PSU Layout and Legend

side, and place two heatsinks over them. Next fit REG1 and REG2 mounting tabs over both bolts and heatsinks, with the body identification markings (LM317) facing upwards, away from the pcb.

Insert the three regulator terminal leads into their respective holes, after bending to 90° to the same pattern, and bolt in place with 6BA washers and nuts. Only after doing this should you solder the six leads on the track side of the pcb.

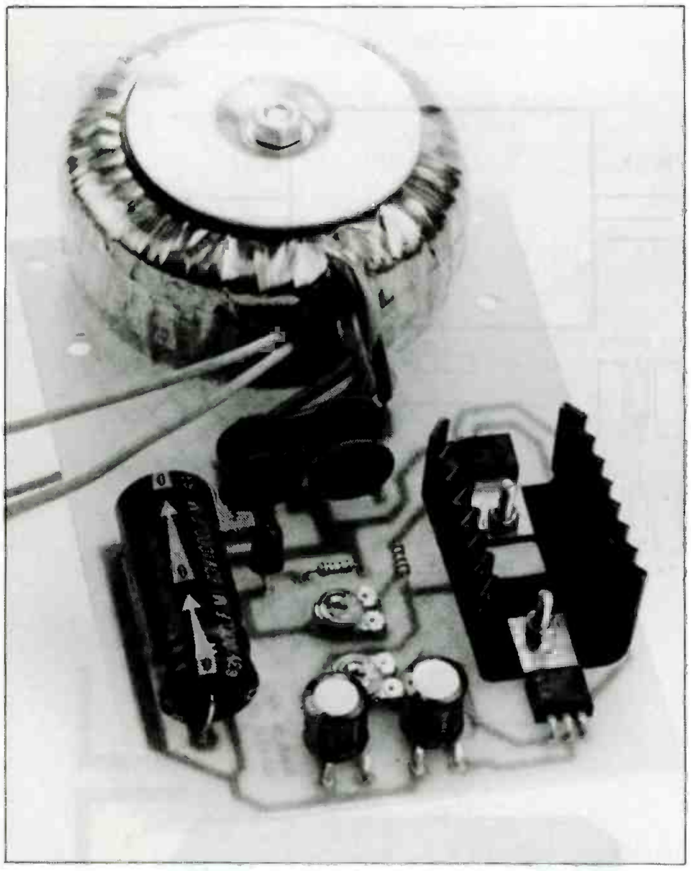
Insert a 4mm toroidal mounting bolt through the pcb from the track side. Slide a 50mm rubber pad over this bolt, on the component side and position the toroidal transformer over both bolt and pad. Fit a second rubber pad on top of T1 and also the recessed, metal washer. Finally, tighten the whole assembly in place with the small washer and nut supplied. Do not overtighten as the pcb will distort and may crack tracks and components. All four colour coded secondary wires from T1 should be inserted into the board, following the legend. Any deviation from the legend colour coding could well result in a damaged transformer! The final pair of orange primary leads are for connecting to 240V AC mains only. Solder all components and leads carefully, and cut off all excess wire ends. Insert four vero pins in each supply output, 0V and +V positions, and solder them to the track. Figure 40 shows the PSU pcb layout and legend.

Testing

Connect a voltmeter to the +V pin nearest to REG1 and any 0V pin. Apply 240V mains to T1 primary (orange) leads and adjust RV1 to read +30V DC on the meter. The wiper positioning should be approximately half way on the preset.

Remove the voltmeter and re-connect to the second supply pins 0V and +V. Adjust RV2 for +30V DC as before.

With the PSU module in use, ensure adequate air flow around the REG1/2 heatsink bracket to prevent overheating problems. The bracket runs quite hot under full load conditions so keep it away from any object liable to melt or burn, especially mains cables!



MIXER PSU PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1,2	220Ω	2	(M220R)
R3	2k2	1	(M2K2)
RV1,2	10k Hor Sub-min Preset	2	(WR58N)

CAPACITORS

C1-4	100nF Disk Ceramic	4	(BX03D)
C5	1000μF 63V Axial Electrolytic	1	(FB84F)
C6,7	47μF 63V PC Electrolytic	2	(FF09K)

SEMICONDUCTORS

D1-4	1N4001	4	(QL73Q)
LED1	LED Red	1	(WL27E)
REG1,2	LM317M	2	(RA86T)

MISCELLANEOUS

T1	Toroidal Transformer 30VA 15V	1	(YK11M)
	Mixer PSU PCB	1	(GD25C)
	Heatsink	2	(FL58N)
	Bolt 6BA x ¼in.	1 Pkt	(BF05F)
	Nut 6BA	1 Pkt	(BF18U)
	Washer 6BA	1 Pkt	(BF22Y)
	Veropin 2145	1 Pkt	(FL24B)

A complete kit of all parts is available for this project:
Order As LK90X (Mixer PSU Kit)
The following item in the above kit is also
available separately but is not shown in the 1986 catalogue:
Mixer PSU PCB **Order As GD25C**
A ready-built Module is also available:
Order As YM24B (Mixer PSU Assembled)

ADA ECHO *Continued from page 31.*

ADA-ECHO PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1,2,5	100k	3	(M100K)
R3,4,11,12	22k	4	(M22K)
R6-9,18-20	15k	7	(M15K)
R10,24	18k	2	(M18K)
R13,14	10k	2	(M10K)
R15,22	390Ω	2	(M390R)
R16	82k	1	(M82K)
R17	680Ω	1	(M680R)
R21	12k	1	(M12K)
R23	2k2	1	(M2K2)
RV1	22k Pot log	1	(FW23A)
RV2	100k Pot lin	1	(FW05F)

CAPACITORS

C1,2	220nF Poly layer	2	(WW45Y)
C3,4,22	10μF 50V PC Electrolytic	3	(FF04E)
C5,26	1nF Poly layer	2	(WW22Y)
C6,25	1n5F Poly layer	2	(WW23A)
C7,24	4n7F Poly layer	2	(WW26D)
C8,23	220pF ceramic	2	(WX60Q)
C9,12,14,15,21	4μ7F 63V PC Electrolytic	5	(FF03D)
C10,18	2μ2F 100V Axial Electrolytic	2	(FB15R)
C11	47nF Poly layer	1	(WW37S)
C13,20	2μ2F 100V PC Electrolytic	2	(FF02C)
C16,27	1μF 100V PC Electrolytic	2	(FF01B)
C17,29	100pF ceramic	2	(WX56L)
C19,34	100μF 25V PC Electrolytic	2	(FF11M)
C28	220μF 16V PC Electrolytic	1	(FF13P)
C30,32,33,35-38	100nF Minidisc	7	(YR75S)
C31	1000μF 35V PC Electrolytic	1	(FF18U)

SEMICONDUCTORS

D1-3	1N4002	3	(QL74R)
IC1	1458C	1	(QH46A)
IC2	NE571	1	(YY87U)
IC3	ZN448E	1	(UF43W)
IC4	CA3140E	1	(QH29G)
IC5	ZN428E	1	(UF41U)
IC6	NE555	1	(QH66W)
IC7	4017BE	1	(QX09K)
IC8	4001BE	1	(QX01B)
IC9,10	4024BE	2	(QX13P)
IC11	6264-3	1	(UF34M)
IC12	μA78M05UC	1	(QL28F)
IC13	μA79L05AWC	1	(WQ85G)
IC14	μA78L12AWC	1	(WQ77J)

MISCELLANEOUS

S1	Rotary mains switch	1	(FH57M)
JK1,2	Jack skt open	2	(HF91Y)
T1	PCB Transformer Tr0-12x2 0.25A	1	(YJ54J)
LP1	Min. neon red	1	(BK52G)
FS1	Fuse A/S 160mA 20mm	1	(RA05F)
	Fuse clips	2	(WH49D)
	A/D/A Digital Echo PCB	1	(GD20W)
	A/D/A Dig. Echo PSU	1	(GD21X)
	Veropin 2145	1 Pkt	(FL24B)
	DIL socket 8-pin	3	(BL17T)
	DIL socket 14-pin	3	(BL18U)
	DIL socket 16-pin	3	(BL19V)
	DIL socket 18-pin	1	(HQ76H)
	DIL socket 28-pin	1	(BL21X)
	Cable 'P' clip 3/16in.	1	(LR44X)
	Sleeving H/Shrink CP24	1 mtre	(BF87U)
	Screened cable single white	1 mtre	(XR14Q)
	Cable Min. mains white	1 mtre	(XR02C)
	Ribbon cable 10-way	1 mtre	(XR06G)
	Knob K7B	1	(YX02C)
	Knob K7C	2	(YX03D)
	Grommet small	1	(FW59P)
	Bolt 6BA x 1in.	1 Pkt	(BF07H)
	Nut 6BA	1 Pkt	(BF18U)
	Threaded spacer 6BA	1 Pkt	(LR72P)
	Case WB5 vinyl	1	(LH40T)
	Cabinet feet	1 Pkt	(FW19V)

A complete kit of all parts is available for this project:
Order As LM04E (A/D/A Digital Delay Kit)
The following items in the above kit list are also
available separately, but are not shown in the 1986 catalogue:
A/D/A Digital Echo PCB **Order As GD20W**
A/D/A Dig. Echo PSU PCB **Order As GD21X**

DID YOU MISS THESE ISSUES!

Project Book 1 Universal Timer. Programmable mains controller. **Combo-Amplifier**. 120W MOSFET power amp. **Temperature Gauge**. 10°C - 100°C, LED readout. **Pass The Bomb!** Pass-The-Parcel with a difference. **Six easy-to-build Projects on Veroboard**. Car batt. monitor; Colour snap game; CMOS Logic Probe; Peak Level meter; Games timer; Multi-colour pendant.
Order As XA01B (Maplin Project Book No. 1) Price 85p *NV*.

Project Book 2 Digital Multi-Train Controller. Controls up to 14 model trains. **Home Security System**. Six independant channels. **Digital MPG Meter**. With large LED display, a must for more economical motoring.
Order As XA02C (Maplin Project Book No. 2) Price 85p *NV*.

Project Book 3 ZX81 Keyboard. 43 keys, plugs directly into ZX81 with no soldering. **Stereo 25W MOSFET Amp**. 25W r.m.s per channel; Disc, Tape, Tuner & Aux. **Radar Intruder detector**. 20 metres range, may be used with our security system. **Remote Control for Train Controller**. Remote control by infra-red, radio or wire.
Order As XA03D (Maplin Project Book No. 3) Price 85p *NV*.

Project Book 4 Telephone Exchange. Up to 32 extensions on 2-wire lines. **Remote Control for Amplifier**. Volume, balance and tone controlled via infra-red link. **Frequency Counter**. 8 digit DFM, 10Hz - 600MHz range. **Ultrasonic Intruder Detector**. Areas up to 400 square feet can be covered.
Order As XA04E (Maplin Project Book No. 4) Price 85p *NV*.

Project Book 5 Modem. 300 baud transmission speed over normal telephone lines. **Inverter**. 240V AC 60W from 12V car battery. **ZX81 Sound Generator**. 3 tone generators fully controlled from BASIC. **Central Heating Controller**. Optimised performance with this advanced system. **External Horn Timer**. Exterior intruder alarm. **Panic Button**. Add on to our Home Security System. **Model Train Projects**. Add on to our Multi-Train Controller. **Interfacing Micro processors**. How to use parallel I/O ports, with circuits.
Order As XA05F (Maplin Project Book No. 5) Price 85p *NV*.

Project Book 6 VIC20 & ZX81 Talkbacks. Speech synthesis projects. **Scratch Filter**. Tunable active circuit 'reclaims' scratched records. **Bridging Module**. Converts two 75W MOSFET amps to one 400W full bridge amplifier. **Moisture Meter**. Finds damp in walls and floors. **ZX81 TV Sound and Normal/Inverse Video**. TV sound and inverse video direct. **Four Simple Veroboard Projects**. Portable Stereo Amp; Sine Generator; Headphone Enhancer and Stylus Organ.
Order As XA06G (Maplin Project Book No. 6) Price 85p *NV*.

Project Book 7 CMOS Crystal Calibrator. For amateur radio receiver calibration. **DX'er's Audio Processor**. Improved sound from Communications Receivers. **Enlarger Timer**. An accurate timer for the darkroom. **Sweep Oscillator**. Displays AF frequency response on an oscilloscope screen. **VIC20 and ZX81 Interfaces**. RS232 compatable.
Order As XA07H (Maplin Project Book No. 7) Price 85p *NV*.

Project Book 8 Spectrum Modem/RS232 Interface. 2400 baud self contained operating system. **Synchime**. Simulates bells, gongs and other chiming sounds. **Dragon 32 RS232/Modem Interface**. Plugs into ROM expansion port. **Codelock**. Programmable electronic lock. **CMOS Logic Probe**. Digital display shows logic states. **Minilab Power Supply**. Versatile unit for the test bench. **Dragon 32 I/O Ports**. Two 8-bit ports. **Doorbell for The Deaf**. Flashing lamp attracts attention.
Order As XA08J (Maplin Project Book No. 8) Price 85p *NV*.

Project Book 9 Spectrum Keyboard. 47 full travel keys. **VIC Extendiboard**. Three expansion ports, one switchable. **Oric Talkback**. Speech synthesiser for the Oric 1. **TDA7000 FM Radio**. Complete FM receiver on a chip. **ZX81 High Resolution Graphics**. 256 x 192 fine pixel display. **Nine Projects!** Personal Stereo Dynamic Noise Limiter; Logic Pulser; TTL RS232 Converter; Pseudo Stereo AM Radio; and more.
Order As XA09K (Maplin Project Book No. 9) Price 85p *NV*.

Project Book 10 Spectrum Easyload. Helps cassette loading with the Spectrum. **80m Receiver**. Simple SSB direct conversion receiver. **Fluorescent Tube Driver**. 8W 12V for camping and caravanning. **Auto-Waa**. Automatic waa-waa effects unit. **Digi-Tel Expansion**. Expands Maplin Telephone Exchange to 32 extensions. **Oric 1 Modem Interface**. Adapts the Oric 1 to the Maplin Modem. **Dragon 32 Extendiport**. Makes the Dragon's cartridge socket more accessible.
Order As XA10L (Maplin Project Book No. 10) Price 85p *NV*.

Project Book 11 Mapmix. Six channel audio mixer. **Xenon Tube Driver**. Xenon flash tube module with strobe. **Enlarger Exposure Meter**. Simple inexpensive tool for the darkroom. **8 Channel Fluid Detector**. Check control fluid level in up to 8 containers. **Servo & Driver Module**. Servo mechanism with driver module kit. **Mk II Noise Reduction Unit**. Improves signal/noise ratio of tape recordings. **Cautious Ni-Cad Charger**. Controlled charging of ni-cad cells. **Motherboard for The BBC Micro**. Gives easy access to ports.
Order As XA11M (Maplin Project Book No. 11) Price 85p *NV*.

Project Book 12 RTTY Unit. The TU1000 receives/transmits Radio Teletype; connects to computer via RS232. **Computadrum**. Use your computer as a drum synthesiser. **Light Pen**. Draw onto the TV screen or select menu options. **PWM Motor Drive**. Reversible model motor driver for 6V and 12V.
Order As XA12N (Maplin Project Book No. 12) Price 85p *NV*.

Project Book 13 Explosive Gas Alarm. Flammable gas detector. **Flash Meter**. Get your exposure right when using your flash gun. **Musical Announcer**. A doorbell with a difference. **Mains Controller**. An add-on for the 8-Channel Fluid detector.
Order As XA13P (Maplin Project Book No. 13) Price 85p *NV*.

Project Book 14 Live Wire Detector. Invaluable aid for the handyman. **Trundle**. The line follower robot as featured on Channel 4. **4-Channel PWM Controller**. Digital control of motors and servos. **Display Driver Module**. How to use our LED bargraph display ICs. **Control-A-Train**. Full inertia control of model trains. **Spectrum I/O Controller**. Buffered 2-way 8-bit data bus and 8 control lines.
Order As XA14Q (Maplin Project Book No. 14) Price 85p *NV*.

Project Book 15 Z80 CPU Module. Expandable CPU based controller. **Sharp MZ-80K Serial Interface**. Get into communications with this project. **Ultrasonic Car Alarm**. Stop car thieves. **Active Crossover**. Includes matched output power amplifiers. **Guitar Equaliser**. Specifically for six string electric guitatrs. **Fabulous Five**. A selection of interesting circuits.
Order As XA15R (Maplin Project Book No. 15) Price 85p *NV*.

Project Book 16 Floodlight Controller. Both power supply and mains switching unit for the Infra-red Intruder Detector Kit. **Spectrum Parallel/Serial Interface**. Provides 8-bit I/P and O/P parallel or serial transfer with programmable UART. **Mains Tx/Rx Data Communications System**. Sends or receives data via the mains wiring. **16-Channel Logic IC Tester**. Simultaneously displays logic states for any logic IC of up to 16 pin-outs on your oscilloscope.
Order As XA16S (Maplin Project Book No. 16) Price 85p *NV*.

Project Book 17 Video Digitiser. Interface a TV camera to your computer. **Mixing It**. A comprehensive range of audio amplifier modules. **Hobbyist's Temperature Controller**. General purpose electronic mains power thermostat. **ASCII Keyboard**. Professional computer keyboard with standard ASCII output. **Play Along Mixer**. Play along to your favourite records and tapes on your own instrument.
Order As XA17T (Maplin Project Book 17) Price 85p *NV*.

Project Book 18 Weather Satellite Receiver. Display regional weather systems on your TV or monitor. **Mixing It Part 2**. Mono/stereo Hi–Z mic input, mixer and line amplifiers; VU/headphone driver. **Stepper Motor Driver**. How to build and start using the Stepper Motor Kit featured in the Catalogue. **Amstrad Expansion System**. The Maplin Amstrad External ROM Card System for the CPC 464, CPC 664 and 6128. **Sealed Lead Acid Battery Charger**. Special high stability output with automatic trickle charge mode for sealed lead acid batteries. **Fantastic Five**. Veroboard projects comprising HF tremelo unit, crystal checker, clap switch, low–Z ohmmeter, snooze timer.
Order As XA18U (Maplin Project Book 18) Price 85p *NV*.

Project Book 20 Weather Satellite Decoder. Displays output from Satellite Receiver on TV or monitor. **Infra Red Proximity Detector**. Short range heat or movement detector. **Fibre-Optic Link**. Sends AF signals over up to 20m of fibre-optic cable. **Low-Z Microphone Pre-amp**. For 200-600Ω mics plus gain adjustment.
Order As XA20W (Maplin Project Book 20) Price 85p *NV*.

Electronics Issue 21 6 Channel Burglar Alarm. Develop a complete security system. **Six Circuits**. Bass Fuzz, Voice-Over Unit, Noise Gate, Envelope Tremolo, RTTY Decoder and Scratch & Rumble Filter on veroboard. **Notch Filter**. AF processor for communications receivers. **12V Public Address System**. 10W per channel from car battery. **Tungsten Lamp Controller**. AC phase control for mains lamps.
Order As XA21X (Maplin Magazine Volume 6 Issue 21) Price 85p *NV*.

Electronics Issue 22 MIDI Interfacing Techniques. Connect MIDI instruments to the VIC20 or CBM64. **Hi-Fi Speakers & Enclosures**. Two high quality loudspeaker cabinet designs. **Keypad for Z80 CPU**. At last a keypad I/F & ROM for the Z80 CPU kit. **4½ Digit Counter**. Versatile basic counter module to 4½ digits. **Weather Satellite Down Converter Part 1**. Aerial & freq. converter for MAPSAT Receiver to tune into the Meteosat satellite. **Mini Circuits**. Veroboard Audio Level Tester, Sound Triggered Flash, In-Circuit Resistance Meter, I/R Audio Isolator.
Order As XA22Y (Maplin Magazine Volume 6 Issue 22) Price 85p *NV*.

Electronics Issue 23 MAPSAT Frame Store #1. Z80B CPU controller. **Servo Tester**. Proportional servo tester. **Weather Satellite Down Converter Part 2**. Channel Switching Unit. **Capacitance Tester**. 5 ranges, 3 digit display. **More Mini Circuits**. Movement alarm, Stepper Motor Driver, Pink Noise Generator, Optical Port Data Link, 'Metal Pedal'.
Order As XA23A (Maplin Magazine Volume 6 Issue 23) Price 85p *NV*.

Electronics Issue 24 Nuclear Radiation Monitor. Alpha, Beta, Gamma & X-ray gieger counter. **VHF Pre-Amp Module**. MAPSAT VHF pre-amp. **External Horn Programmable Timer Update**. Modifying the module for use with other than the Maplin Home Security System. **MAPSAT Frame Store #2**. The Video Graphics Card. **VHS Video Alarm**. Battery powered portable movement alarm built into a VHS Video Cassette.
Order As XA24B (Maplin Magazine Volume 6 Issue 24) Price 85p *NV*.

Electronics Issue 25 Track side Rapid Charger. Model radio control car ni-cad battery pack charger using 12V car battery as power source. **Slow Charger**. Mains powered trickle charger for model cars. **Temperature Module Expansion**. Relay switch board and serial to parallel converter add-ons. **Disco Partylite**. High quality, 3 channel party lights. **Mini Metal Detector**. Detects ferrous and some non-ferrous metals such as iron wall board nails or brass screws. **Tester for Electrical Domestic Appliances**. Check the safety of any new appliance before you plug it into the mains. **Bob's Mini Circuits**. A pulsed speed controller, a train controller & an electronic lock.
Order As XA25C (Maplin Magazine Volume 7 Issue 25) Price 85p *NV*.

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