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BEST OF MAPLIN PROJECTS BOOK THREE

EDITORIAL

'Best of Maplin Projects Book Three', is a compilation of the most popular projects from 'Maplin Projects Books Nine to Twelve', which are now out of print. Other issues of 'Maplin Projects Books' will be replaced by 'Best of' projects books as they go out of print. Back issues of 'Electronics – The Maplin Magazine' are available until they, too, go out of print and will then be replaced by projects books. For kit prices, please consult the latest Maplin catalogue and free price change leaflet, order as CA99H.

R.T. Smith

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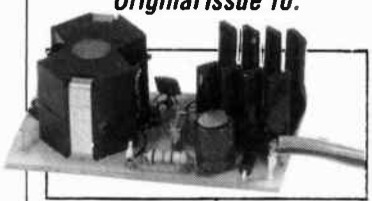
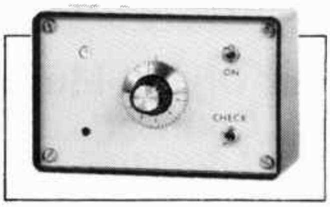
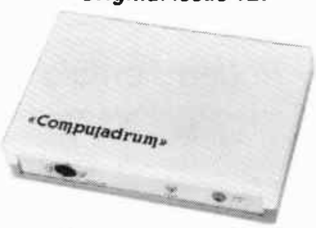
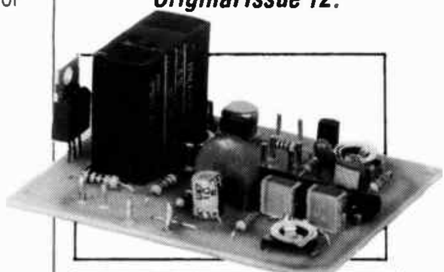
PROJECTS

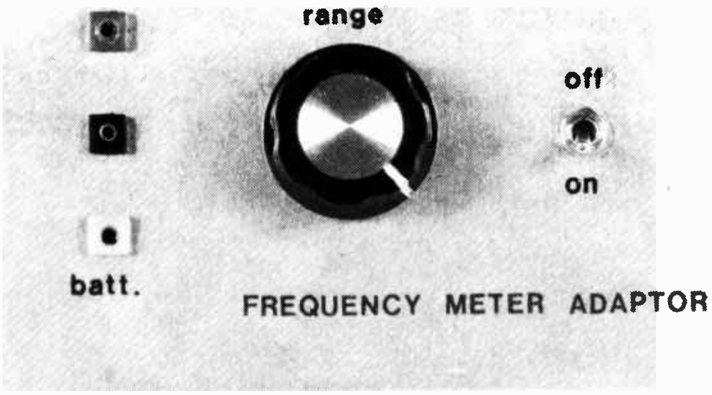








Frequency Meter Adaptor



★ **Turns Your Digital Multimeter into an Accurate Frequency Counter**
★ **Ideal For Measuring Audio Frequencies and Beyond**
★ **Battery Operated ★ Easy To Use**

by Robert Penfold

A sophisticated frequency meter capable of highly accurate measurements at frequencies into the VHF range is extremely useful for anyone who is involved in radio communications, or certain specialised fields of audio frequency electronics. However, for most audio frequency work a relatively simple frequency meter is adequate, and costs substantially less than a high specification DFM.

This simple and inexpensive project is a frequency to voltage converter, which can be used with a digital multimeter switched to the 0 to 1.999 volts range to give a four range frequency meter having full scale values of 199.9Hz, 1.999kHz, 19.99kHz, and 199.9kHz. The unit will also operate with an analogue multimeter having a suitably low D.C. voltage range, but if the full scale voltage is less than 1.999 volts the full scale value of each frequency range will be reduced accordingly. The accuracy of the unit is largely dependent on the quality of the multimeter with which it is employed, and the accuracy with which the unit is calibrated, but results should be more than adequate for most audio frequency testing.

LM2917N

The LM2917N is a frequency to voltage converter IC which has a dual purpose comparator/amplifier output stage which enables the device to activate a relay or similar load if the input frequency exceeds or falls below a certain level, or to act as a straightforward converter. In this application it is just a simple frequency to voltage conversion that is required. Figure 1 gives pinout details of the LM2917N and shows the internal stages of the device.

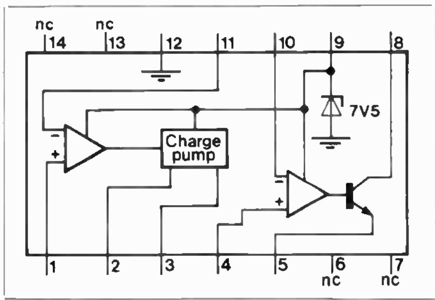
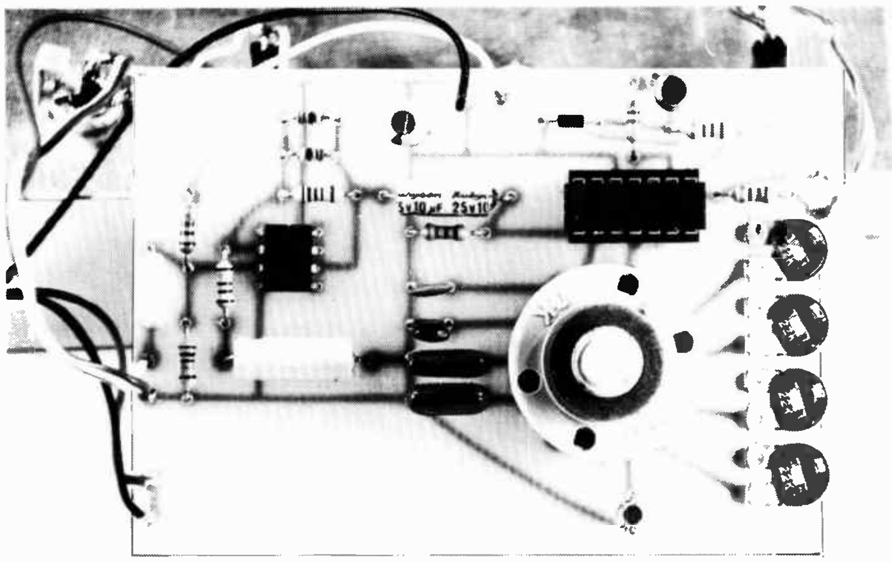


Figure 1. The LM2917 pinouts and internal circuit blocks.

An operational amplifier is used at the input, and this stage has built-in hysteresis which gives the circuit excellent immunity to noise on the input signal. The frequency to voltage conversion is carried out by a charge pump circuit which requires only three discrete components. This stage offers frequency doubling which enables a fast response time and a low ripple output to be obtained. The output operational amplifier has both inputs accessible and drives an npn transistor which can be used in either the common collector or emitter follower mode. A 7.5 volt zener diode enables the supply to be stabilised in critical applications.



The Circuit

Figure 2 shows the circuit diagram of the adaptor. IC1 is used as a simple non-inverting amplifier which boosts the sensitivity of the circuit by a factor of 11 times, and enables the unit to operate with an input as low as 2 millivolts RMS. This stage also gives the unit a reasonably high input impedance of about 500kΩ. D1 and D2 clip the output signal of IC1 to prevent an excessive input signal being applied to IC2.

R5 is used to bias the input of IC2 to the negative supply rail. Four switched timing capacitors (C4 to C7) give the unit its four measuring ranges, and a separate calibration preset for each range (RV1 to RV4) ensures good accuracy on all ranges. The third discrete component in the charge pump circuit is filter capacitor C8, and the value of this component is chosen to give a suitable compromise between response time and output ripple. 100pF is the lowest acceptable value for the timing capacitor, and 10kΩ is about the lowest usable value for the filter (calibration) resistor, and this limits the maximum operating frequency of the unit to about 200kHz. If the input signal level is inadequate to operate the input stage and charge pump circuit properly the latter fails to give an output voltage. This makes it obvious that an inadequate input level is present and prevents misleading readings from being obtained.

The output from the charge pump circuit is connected to the non-inverting input of the operational amplifier at the output of IC2, and this is used as a buffer amplifier having the npn transistor as an emitter follower output stage. At SK2 and SK3 this gives a low impedance output voltage which is proportional to the input frequency.

In this application a well regulated supply voltage is essential if accurate and consistent results are to be obtained. A single 9 volt battery is inadequate to give such a supply since the internal zener diode of IC2 is a 7.5 volt type, and for this to operate efficiently the supply input potential must always be at least one volt or so higher than this zener voltage. The circuit is therefore powered from two 9 volt batteries in series giving a nominal 18 volt supply, but this is fed to IC2 via a simple series regulator which is comprised of TR1, R8 and D3. The use of this regulator plus the internal zener diode of IC2 gives excellent stability with no discernable change in frequency reading if the supply is varied from 14 to 20 volts. SK4 enables the total battery voltage to be checked easily by providing an external test point. The current consumption of the circuit is about 12 milliamps.

Construction

Most of the components, including S1, are mounted on the printed circuit board, as illustrated in Figure 3. Assuming S2 is an ordinary rotary switch having tags rather than the printed circuit pins, the ends of the tags must be trimmed off using a pair of side cutters to leave what are effectively printed circuit pins that will fit into the board without too much difficulty. However, be careful to leave these pins as long as possible by trimming away no more than is absolutely necessary. In other respects construction of the board is quite normal.

An aluminium box measuring about 133 by 70 by 38mm makes a neat but inexpensive housing for the unit. The front panel layout can be seen by referring to the photographs, but from the electrical point of view the layout is not critical. However, it is advisable not to radically depart from this layout unless you

Continued on page 7

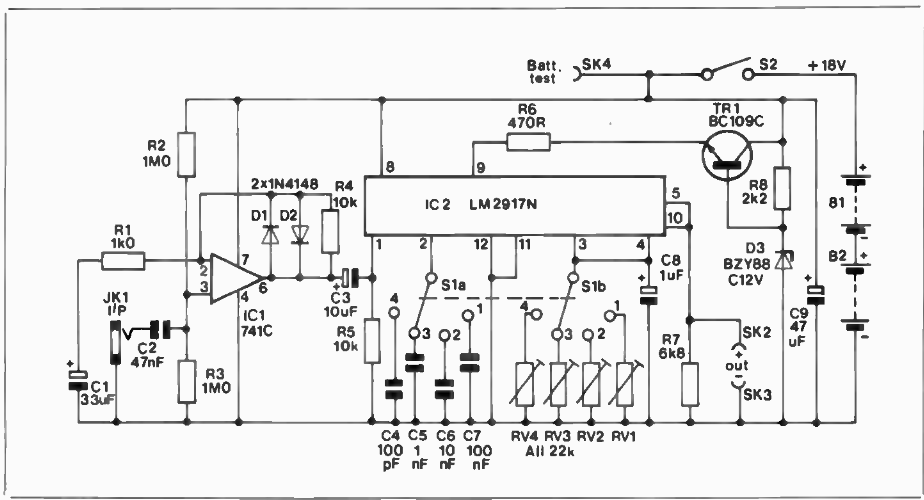


Figure 2. The circuit diagram.

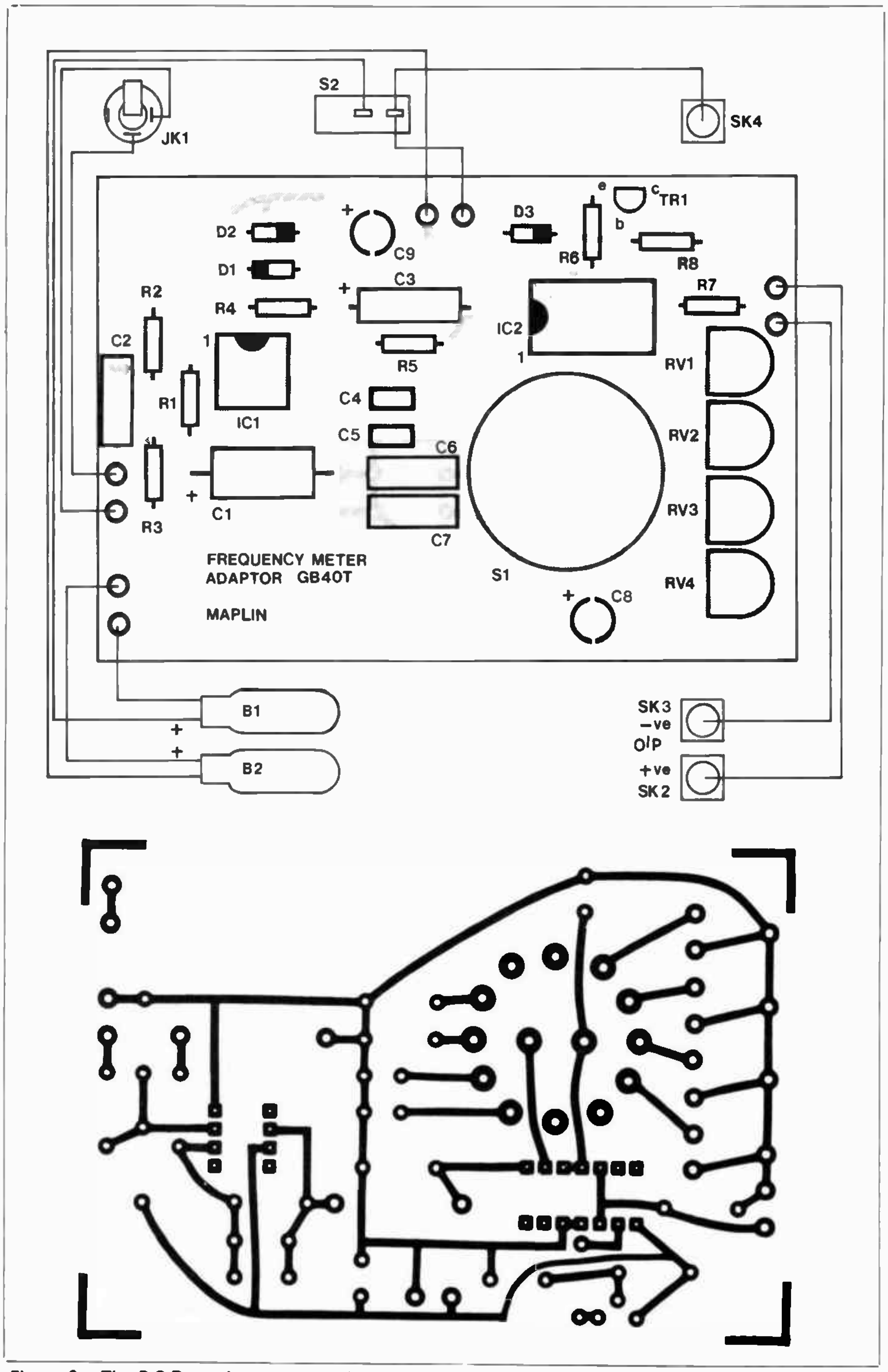


Figure 3. The P.C.B. track, component layout and wiring diagram.

Personal Stereo D·N·L

★ SMALL AND PORTABLE
★ IMPROVES SOUND QUALITY
★ EASY TO BUILD

by Robert Penfold

Most personal stereo cassette players are capable of a creditable level of performance, but a weakness of all but a few of the more recent and expensive machines is a lack of any proper form of noise reduction circuit. Most units simply have a high/low tone switch which gives a certain amount of treble cut in the "low" position and helps to keep down the amount of tape noise.

This add-on noise reduction unit simply plugs between the personal stereo unit and the headphones. It is a dynamic noise limiter, which is merely a form of lowpass filter. However, the cut-off frequency of the filter is not fixed, and it varies in sympathy with the dynamic level of the input signal. With little or no input to the unit the cut-off frequency would be quite low at about 4 or 5kHz, but at higher input levels the cut-off frequency would be forced upwards, reaching perhaps 15 or 20kHz, with the input at its maximum level.

This gives a large amount of noise reduction at low volume levels, but at high volume levels the amount of noise reduction is negligible. In practice the ineffectiveness of the system at high dynamic levels does not matter since the noise will be masked by the main signal and will not be noticeable anyway. In fact the lack of filtering is an advantage since it avoids an unnecessary reduction in the high frequency performance of the system. The weakness of a single-ended noise reduction system of this type is that it does reduce the treble response at low dynamic levels, and to a lesser extent at medium signal levels, but it is nevertheless a great improvement in comparison to a simple top-cut filter.

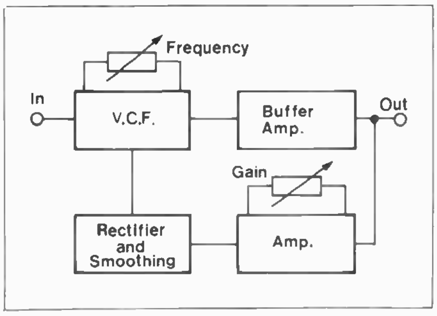
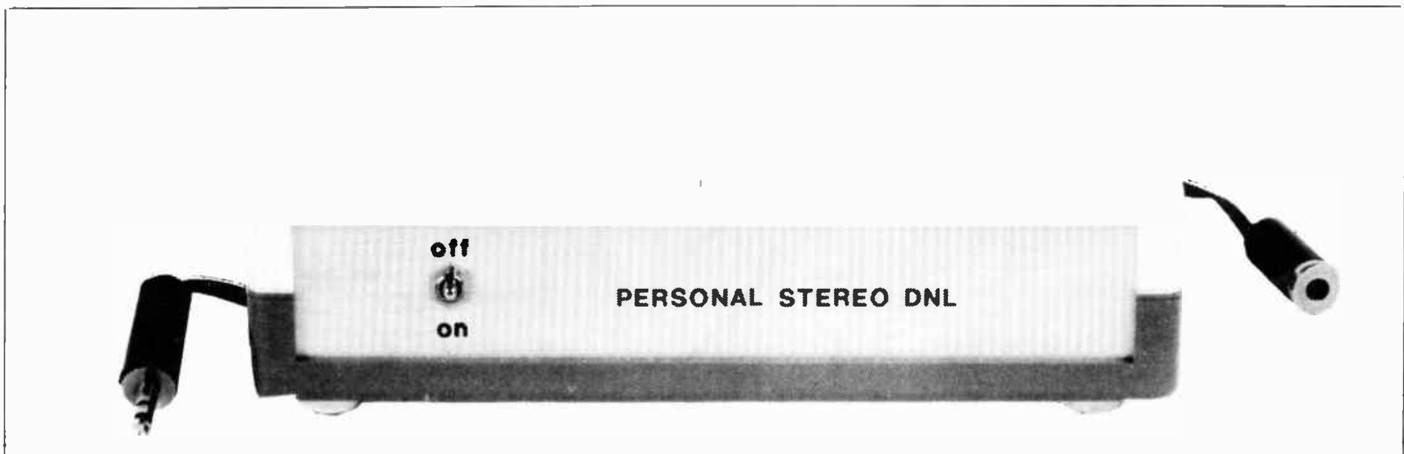


Figure 1. Block diagram.

Circuit Operation

The arrangement used in the DNL unit is outlined in the block diagram of Figure 1. This is for one channel only, but with units of this type the two stereo channels are processed by separate but identical circuits.

The lowpass filter is a voltage controlled type, and a preset control enables the cut-off frequency (under quiescent conditions) to be set at a suitable figure. The filter cannot directly drive the headphones which typically require a maximum input voltage of about 1 volt RMS into an impedance of only about 35 ohms. A



buffer amplifier which provides a suitably low output impedance and drive current capability is therefore used at the output of the filter.

Some of the output of the unit is coupled to an amplifier. The amplified signal is rectified and smoothed to produce a control voltage for the VCF. With low level input signals the control voltage is too small to have any significant effect on the VCF, but at higher input levels there is a roughly proportional increase in the control voltage, and the cut-off frequency of the filter is moved higher, giving the desired effect. The gain of the amplifier has been made variable so that the unit can be adjusted to only fully remove the treble cut when the input signal reaches its maximum level.

Figure 2 shows the circuit diagram for one channel of the unit. Most of the components are duplicated in the other channel. As is standard practice, these components have the same identification numbers in the components list and printed circuit overlay, but with one hundred added (e.g. what is R8 in one channel is R108 in the other). Note that IC1 is a dual device which has one section used in each channel of the unit (the pin numbers in brackets are those for the second channel). The battery, on/off switch S1, and supply decoupling capacitor C8 are common to both channels.

IC1 is a transconductance operational amplifier which is used as the basis of the VCF. This is a straightforward 6dB per octave circuit with the values of bias and feedback resistors R3 to R6 chosen to give approximately unity voltage gain. However, the circuit will have less than unity gain if the bias current fed to the amplifier bias input (pin 1) is inadequate in relation to the load impedance from the output of the amplifier to the earth rail. This impedance is largely formed by C3, and as the impedance of a capacitor decreases as signal frequency is increased, at some point the impedance of C3 must become so low that the gain of the circuit is rolled-off. RV1 and R7 supply a quiescent bias current to the filter, which, strictly speaking, is a current rather than a voltage controlled type. By means of RV1 the cut-off frequency of the filter can be set at the desired figure. Of course, by applying an increased bias current the cut-off frequency can be raised, and with a high enough current it will be taken beyond the upper limit of the audio spectrum so that the treble cut is effectively eliminated.

The signal across C3 is coupled to the output amplifier via an internal buffer amplifier of IC1. The output amplifier consists of an operational amplifier (IC2) plus a discrete complimentary emitter follower output stage to boost the output current capability of the circuit to an acceptable level of high frequency distortion. D1 and R9 were therefore added to give a small quiescent bias voltage across the bases of the output transistors, and this leaves no significant crossover distortion.

TR3 is used as a simple common emitter amplifier which amplifies the output signal prior to rectification and smoothing by D2, D3 and C7. RV2 gives a controlled amount of negative feedback to the amplifier and enables the voltage gain to be varied between about 14 and 40dB. The bias voltage developed across C7 is fed to the amplifier bias input of IC1 via R12, and the current that flows through R12 in the presence of a strong bias voltage gives the required modification of the filter's cut-off frequency. The value of C7 and other components in the control voltage circuit produce rapid attack and decay times, and this is essential if the unit is to operate efficiently, and the changes in frequency response are not to be apparent to the user. As the circuit only processes high frequency signals it is possible to have attack and decay times of only a few milliseconds without introducing significant distortion.

Coupling capacitor C5 has been given quite a low value so that bass and lower middle frequencies are not efficiently coupled to TR3. This avoids having strong low frequency signals, which would not mask the noise, from operating the VCF and lifting the treble cut.

The current consumption of the circuit is only about 9 milliamps under quiescent conditions, and does not increase dramatically at high volume levels. A PP3 size battery is therefore adequate as the power source, although a higher capacity battery such as six HP7 (AA) size cells would probably be a better choice if the unit is likely to receive a great deal of use.

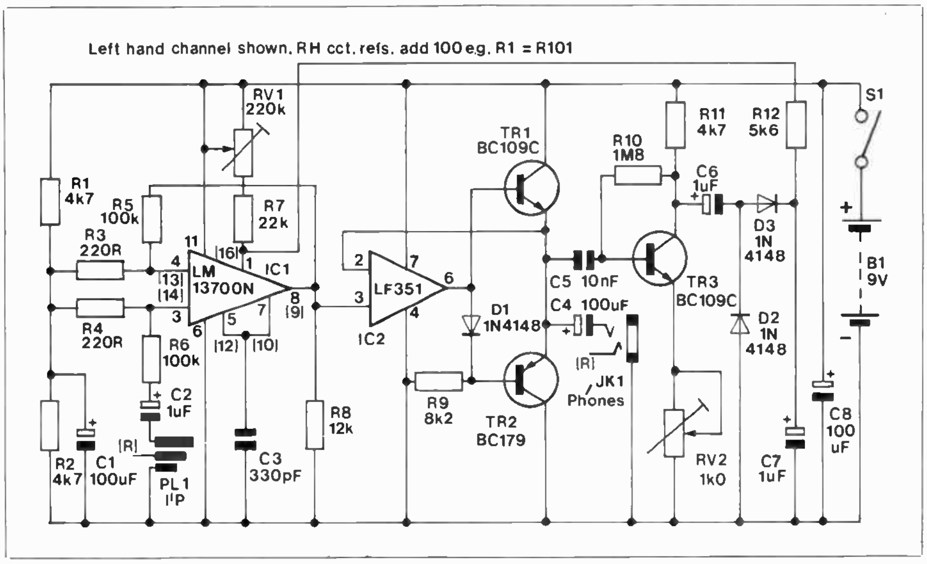


Figure 2. Circuit diagram.

Construction

Refer to Figure 3 for details of the printed circuit board. Construction of the board should not be difficult provided the resistors and diodes are fitted first, followed by the capacitors, presets, Veropins, and remaining semiconductors. Do not overlook the single link wire. Also, note that IC2 has the opposite orientation to the other two ICs.

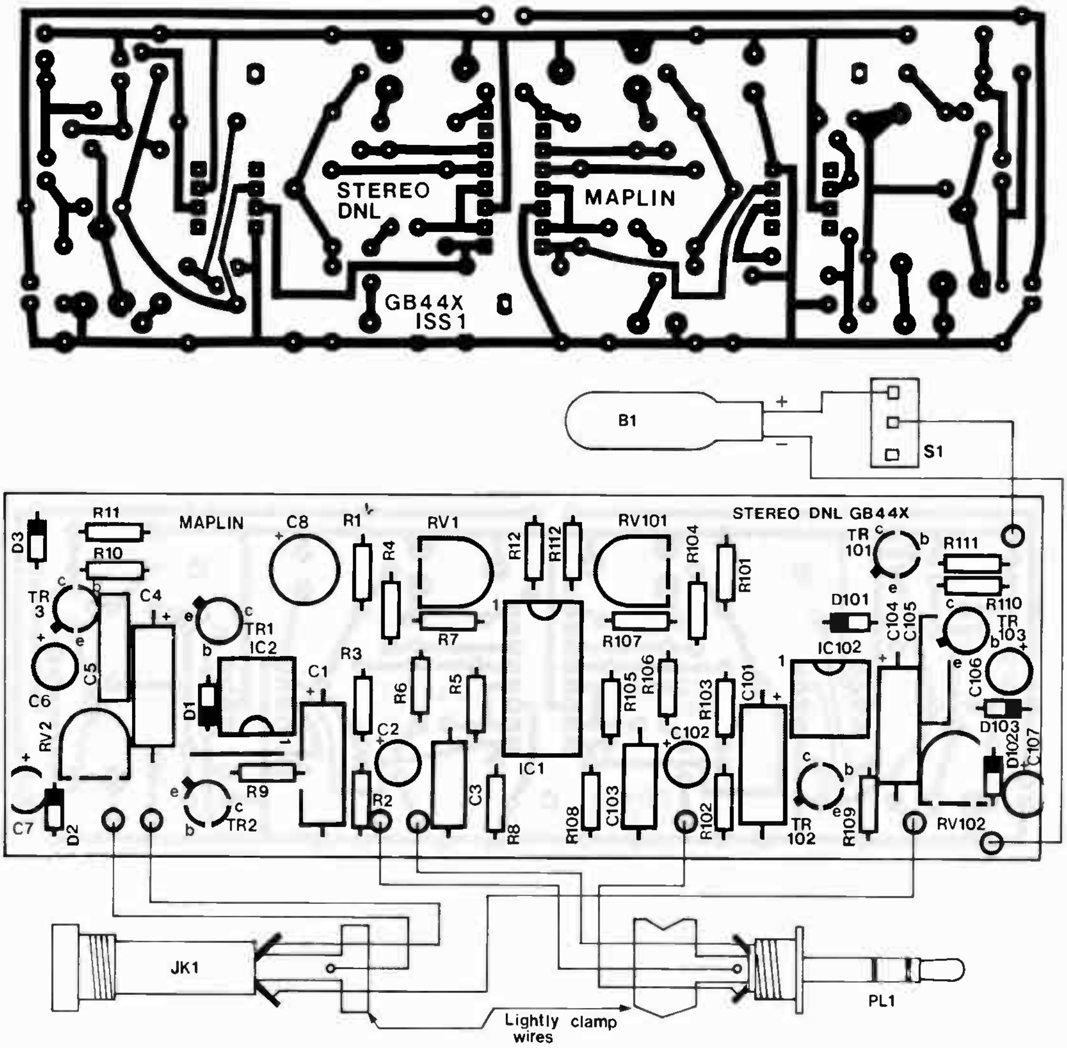


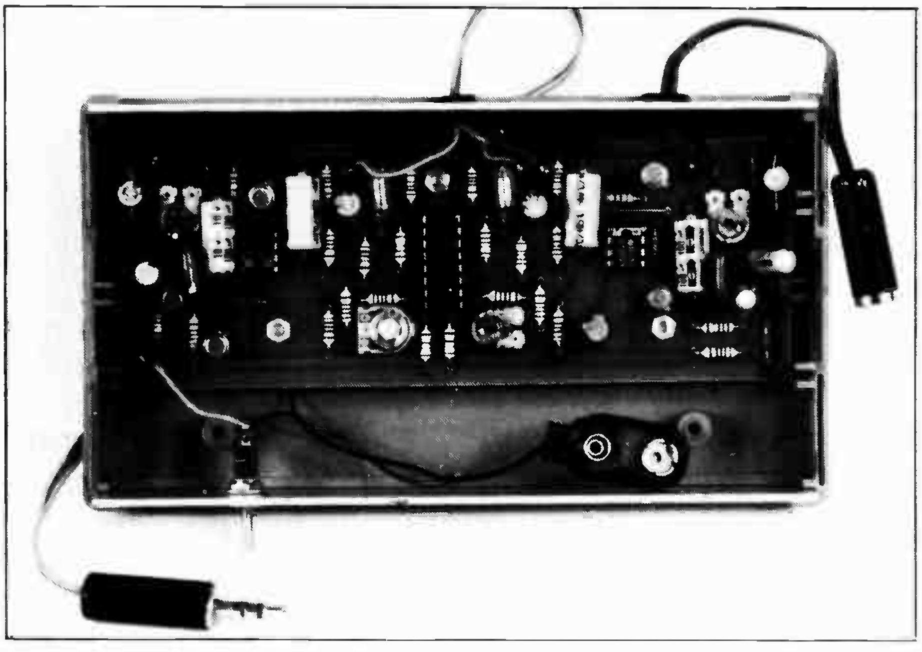
Figure 3. PCB artwork.

A verocase having approximate outside dimensions of 153 by 84 by 39.5mm makes a neat and practical housing for the unit, but it should be possible to utilise any plastic or metal box of around the same size. The printed circuit board is mounted on the base panel of the case using 6BA fixings. S1 is mounted towards the left hand end of the front panel, and holes for the input and output leads are drilled at the centre and right hand end of the rear panel. Connecting wire is taken from the ribbon cable supplied in the kit. The connection to the headphones is by way of a 3.5mm stereo chassis socket, or instead a line socket, e.g. RK51F, can be used on the end of an 'extension lead' if you want your headphones to have a freer rein. The connection to the personal stereo unit is via a 3 way lead about half a metre or so in length, and terminated in a 3.5mm stereo jack plug. As these leads carry high level, low impedance signals it is not essential to use screened types.

Setting Up

If suitable test gear is to hand, RV1 and RV101 can be adjusted to give a -6dB point a suitable frequency. With this type of equipment a cut-off frequency of somewhere between 4 and 10kHz is normally used, depending on the degree of noise reduction that is required, and 6kHz should be a suitable figure. However, either one leadout wire of D3 and D103 should be temporarily disconnected, or a temporary shorting link should be wired across D2 and D102 so that the test signal does not alter the cut-off frequency of the filter.

Again, if suitable test gear is available RV2 and RV102 can be adjusted to give the desired frequency response with an input signal level that roughly corresponds with maximum volume (about 1 volt RMS). Use a test



signal at a frequency of a few kilohertz.

It is not essential to have any test equipment in order to set up the unit satisfactorily, and RV1/101 can simply be adjusted to give the desired amount of noise reduction, being careful to keep the two stereo channels well balanced in this respect. Do not be tempted to set these controls for a very high level of noise reduction as this would give a very poor frequency response at low signal levels, and the changes in frequency response would be so large that they would probably be clearly audible to the user.

RV2 and RV102 can simply be set by trial and error. If these are set at or near minimum resistance the filtering will be lifted even at quite low dynamic levels, and this will be heard as a rise and fall in the noise level as the input signal rises and falls in amplitude. RV2 and RV102 should be advanced to the point where this effect is no longer apparent on their respective channels, but not significantly further than this.

The setting of the volume control on the personal stereo unit obviously has an effect on the way in which the DNL performs. When setting up the unit the volume control should be at a fairly high setting. The DNL will then function properly when the system is used at fairly high volume levels, but will function more or less as a straight forward top cut filter if the system is used at low volume settings. In practice tape noise is generally only objectionable when listening at high volume levels, and it would not be worthwhile using the unit at low volume settings anyway. The DNL has nominally unity voltage gain, and there should not be any appreciable change in volume when it is used.

The unit will work with the tone switch on the personal stereo unit in either the "high" setting or the "low" one, but results will probably be best with this control in the "high" position. If this gives excessive treble at high signal levels backing off RV2 and RV102 slightly should clear the problem.

PERSONAL STEREO DNL PARTS LIST

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

R1,2,11,101,102,111	4k7	6	(M4K7)
R3,4,103,104	220Ω	4	(M220R)
R5,6,105,106	100k	4	(M100K)
R7,107	22k	2	(M22K)
R8,108	12k	2	(M12K)
R9,109	8k2	2	(M8K2)
R10,110	1M8	2	(M1M8)
R12,112	5k6	2	(M5K6)
RV1,101	Hor Encl Preset 220k	2	(UH07H)
RV2,102	Hor Encl Preset 1k	2	(UH00A)
CAPACITORS			
C1,4,101,104	Axial 100μF 10V	4	(FB48C)
C2,6,7,102,106,107	PC Elect 1μF 100V	6	(FF01B)
C3,103	Polystyrene 330	2	(BX31J)
C5,105	Polyester 0.01μF	2	(BX70M)
C8	PC Elect 100μF 10V	1	(FF10L)
SEMICONDUCTORS			
IC1	LM13700N	1	(YH94C)
IC2,102	LF351	2	(WQ30H)
TR1,3,101,103	BC109C	4	(QB33L)
TR2,102	BC179	2	(QB54J)
D1-3,101-103	1N4148	6	(QL80B)
MISCELLANEOUS			
S1	SPST Ultra Min Tggle	1	(FH97F)
PL1	Stereo Plas 3.5 Plug	1	(HF98G)
JK1	Ster 3.5mm Ch Skt	1	(FK03D)
	Stereo DNL PCB	1	(GB44X)
	DIL Socket 8-pin	2	(BL17T)
	DIL Socket 16-pin	1	(BL19V)
	Pin 2145	1 Pkt	(FL24B)
	Ribbon Cable 10-Way	1 Mtr	(XR06G)
	PP3 Clip	1	(HF28F)
	Constructors' Guide	1	(XH79L)
	Stereo DNL Ins	1	(XK64U)
OPTIONAL			
	Verobox 211	1	(LL08J)
	Battery K9VHZ	1	(FK62S)

A complete kit of all parts, excluding optional items, is available:
Order As LK27E (Personal Stereo DNL Kit)

Frequency Meter Adaptor *Continued from page 3*

are quite sure that everything will physically fit into place properly. The board is fixed in place inside the case when S1 is fitted onto the front panel, and no additional mounting is required, but wire the board to the rest of the unit before finally fitting it in place. There is sufficient room for the two batteries to fit in the space beneath the board, and a piece of foam material can be used to hold them in position.

Calibration

Ideally the unit should be calibrated with the aid of a crystal calibrator having output frequencies of 100Hz, 1kHz, 10kHz and 100kHz so that RV1 to RV4 can be adjusted to give the correct readings from the multimeter which is fed from SK2 and SK3. This is not essential though, and any signal source which provides known frequencies can be used as a calibration source. For optimum accuracy the calibration frequencies should represent about 50% or more of the full scale reading of the range concerned. A good quality A.F. signal generator should have adequate scale accuracy, or an alternative is to use a synthesiser or other musical instrument as the signal source. For example, the 'A' above middle C is at a frequency of 440Hz, with every octave increase in pitch giving a doubling of frequency, and each fall of one octave giving a halving of frequency.

Readings obtained using the unit are not significantly affected by the input waveform, and accurate results should be obtained with both symmetrical and pulse signals. The circuit is also largely unaffected by the amplitude of the input signal with the output falling to zero in the unlikely event of an inadequate input signal level, but signals of more than about 10 volts peak to peak will overload the unit and could give erroneous results. It would therefore be advisable to use an attenuator probe when measuring very high level signals.

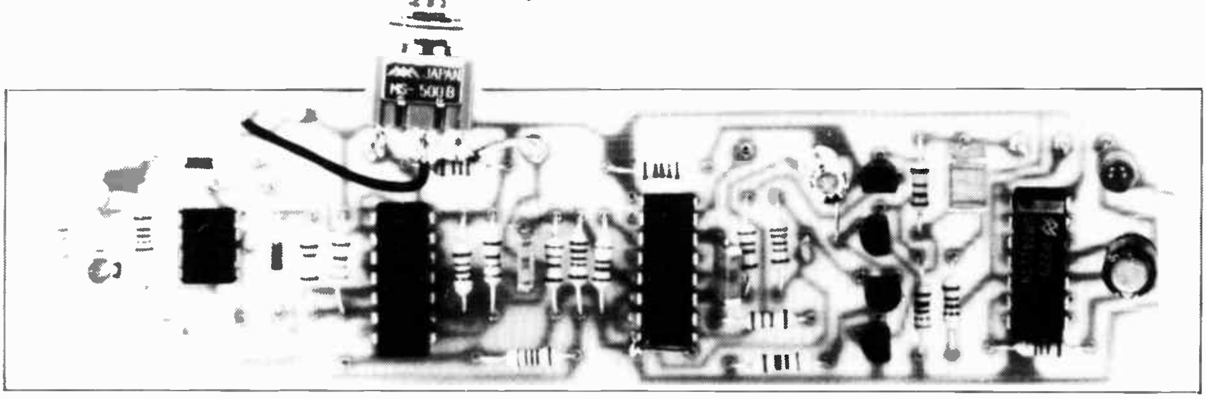
FREQUENCY METER ADAPTOR PARTS LIST

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

R1	1k	1	(M1K)
R2,3	1M	2	(M1M)
R4,5	10k	2	(M10K)
R6	470Ω	1	(M470R)
R7	6k8	1	(M6K8)
R8	2k2	1	(M2K2)
RV1-4	Hor Encl Preset 22k	4	(UH04E)
CAPACITORS			
C1	Axial 33μF 25V	1	(FB35Q)
C2	Polyester 0.047μF	1	(BX74R)
C3	Axial 10μF 25V	1	(FB22Y)
C4	Ceramic 100	1	(WX56L)
C5	Poly Layer 0.001	1	(WW22Y)
C6	Poly Layer 0.01	1	(WW29G)
C7	Poly Layer 0.1	1	(WW41U)
C8	PC Elect 1μF 100V	1	(FF01B)
C9	PC Elect 47μF 25V	1	(FF08J)
SEMICONDUCTORS			
D1,2	1N4148	2	(QL80B)
D3	BZY88C12/BZX55C12	1	(QH16S)
TR1	BC109C	1	(QB33L)
IC1	μA741C 8-pin DIL	1	(QL22Y)
IC2	LM2917	1	(WQ38R)
MISCELLANEOUS			
S1	Rotary SW6	1	(FH43W)
S2	SPST Ultra Min Tggle	1	(FH97F)
JK1	Jack Socket 3.5	1	(HF82D)
SK2	2mm Socket Red	1	(HF47B)
SK3,4	2mm Socket Black	2	(HF44X)
	Frqncy Mtr Adptr PCB	1	(GB40T)
	DIL Socket 8-pin	1	(BL17T)
	DIL Socket 14-pin	1	(BL18U)
	PP3 Clip	2	(HF28F)
	Knob K7B	1	(YX02C)
	7/0.2 Wire 10M Blk	1 Pkt	(BL00A)
	Pin 2145	1 Pkt	(FL24B)
	Constructors' Guide	1	(XH79L)
	Freq Meter Adaptor Ins	1	(XK63T)
OPTIONAL			
	Box AB7	1	(LF08J)
	Battery K9VHZ	2	(FK62S)

A complete kit of all the above parts, but excluding optional items, is available:
Order As LK20W (Freqncy Mtr Adptr Kit)

by Chris Bearman



LOGIC PULSER

★ Makes checking IC functions much simpler
★ Inexpensive addition to your test gear ★ Easy-to-use

For anyone who builds or services circuitry incorporating TTL logic, a pulser is an invaluable piece of test equipment. This device enables the user to stimulate logic gate inputs when they are already connected into a circuit. This way it is often possible to test an I.C. which otherwise would have had to be removed with the associated trouble and possibility of damage. A logic pulser is usually used in conjunction with a logic probe which will locate and display the signal produced. The TTL pulser has the advantage of already having a pulse detector circuit built into it, thus making it versatile and easy to use.

The pulser supplies a very short, but powerful, pulse each time the switch is depressed, the current of which will exceed half an Amp. This current is more than enough to overcome any TTL output, but could normally damage the I.C. being overridden, and therefore the pulse width is deliberately limited to a very short period. When the switch is depressed, the output will firstly fall to a logic low, and will then rise to give a logic high, so as to toggle the gate input regardless of the state it was previously being held at. When the pulse is completed the pulser's output will return to its former high impedance state. By holding down the switch, a stream of pulses will be clocked out at around fifty hertz, which can be very useful when checking counting circuits, etc.

Circuit Description

A total of four I.C.'s and four transistors are used in the circuit, which is built on an etched printed circuit board. Around twenty-five milliamps at five volts is required from the host equipment's power supply for operation.

The first half of the 7400 is used to de-bounce the biased toggle switch. Output pin 11 applies a negative edge to pin 5 of the 4049 via C1. The signal now travels in two different paths. Firstly, inverter output pin 6 switches on the transistors TR2 and TR4, so pulling down the output to logic '0'. The same signal from inverter output pin 4 eventually switches on transistors TR1 and TR3 as well, but this is delayed by the extra inverter, (pins 9 and 10) and capacitor C5. By the time that these two transistors conduct to take the output high, the output low condition has terminated. On completion of the high going pulse, the second pair of transistors are turned off, therefore allowing the output to return to its high impedance state.

If the switch is held down for more than half a second, the clock generator IC3 will come into operation. Firstly C2 is allowed to charge up via resistor R9 until the 555 triggers. When this happens, its output (pin 3) will go low, so changing the state of output pin 6 of the R.S. flip-flop. This will now allow the 555 to oscillate in the astable mode, acting on inverter pin 5 via 1K ohm resistor R5. It will be noticed that two of the inverters in the 4049 package are not used but their inputs must be tied down to prevent any damage to the I.C. due to static build up.

The pulse detector part of the circuit is designed around a 74121 I.C. This I.C. is a monostable multivibrator which is used to extend the pulse detected to a length which may be observed on an LED. Each time a pulse is detected the LED will flash on.

Construction

The components for the pulser are all mounted onto the single-sided etched printed circuit board with the exception of the LED and the toggle switch which should be fitted into the housing. The resistors should be soldered in first, followed by the capacitors. Ensure that the correct polarity is observed when fitting the tantalum and electrolytic types. Solder in the four links on the board with pieces of tinned copper wire or resistor lead off-cuts. Fit the pins to the board and connect up the LED and the switch. The cathode of the LED will be found to be adjacent to the flat on the body. The normally closed connection to the switch is that which is furthest from the toggle when in the biased position, the common connection is that in the centre. Putting aside the I.C.'s, solder in the rest of the semiconductors and the I.C. sockets ensuring that the notches correspond to the pin 1 markers on the legend. Then carefully insert I.C.1, I.C.3 and I.C.4 into their sockets with the end notch or pin 1 marker on each aligning with the notch on the socket and '1' marker on the legend. Careless handling of CMOS devices can cause internal damage due to static build-up, so care should be taken when I.C.2 is fitted. Try to handle the I.C. as little as possible without touching the pins once it has been removed from its protective packaging.

Testing

Before applying power, check the circuit carefully for possible mistakes which could have been made in the assembly. Check in particular that the I.C.'s and the transistors are the right way round. If all appears well, connect a five-volt supply to the pulser with a milli-ammeter in series, observing that the current consumption should be in the order of 25-30mA. If it is very much higher than this, remove the power and look for any errors. Assuming that the consumption is correct, switch off, remove the meter and temporarily connect a wire from the pulse 'in' pin to the pulse 'out' pin. Reconnect the

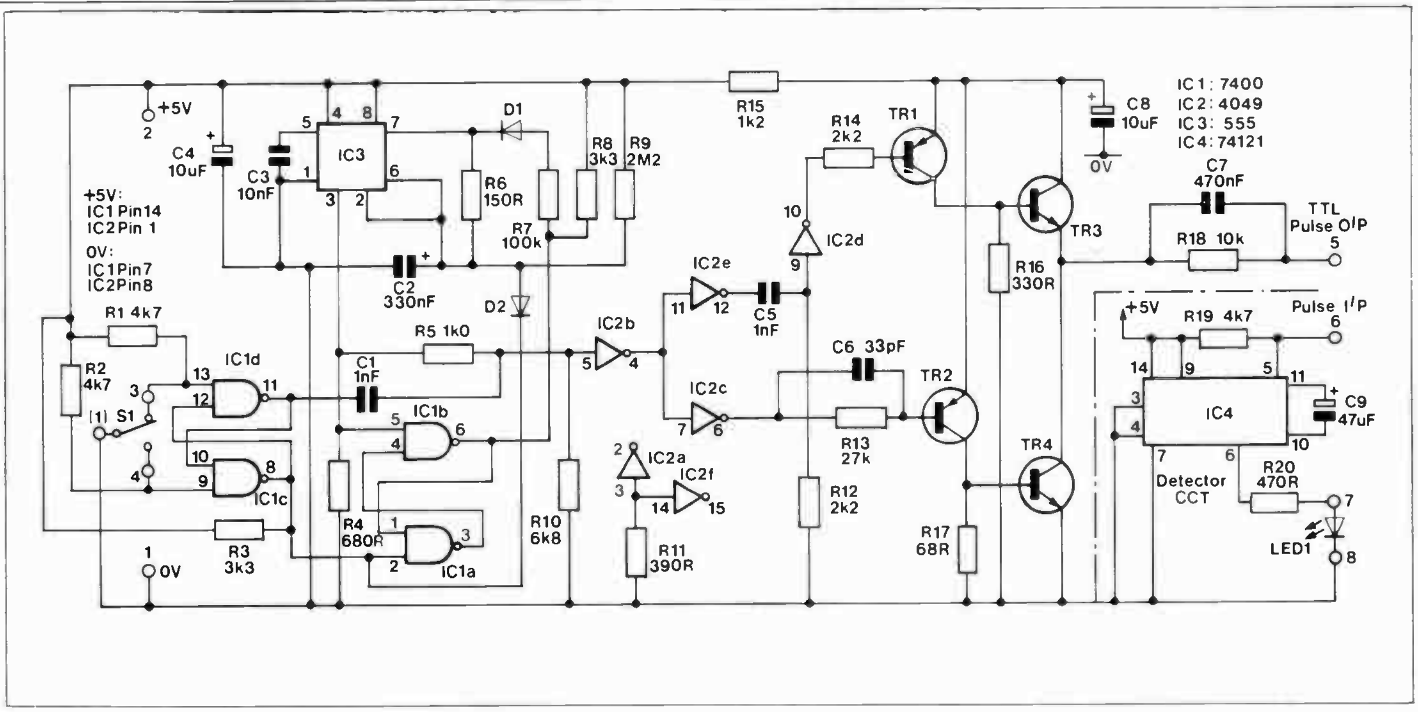


Figure 1. Circuit diagram

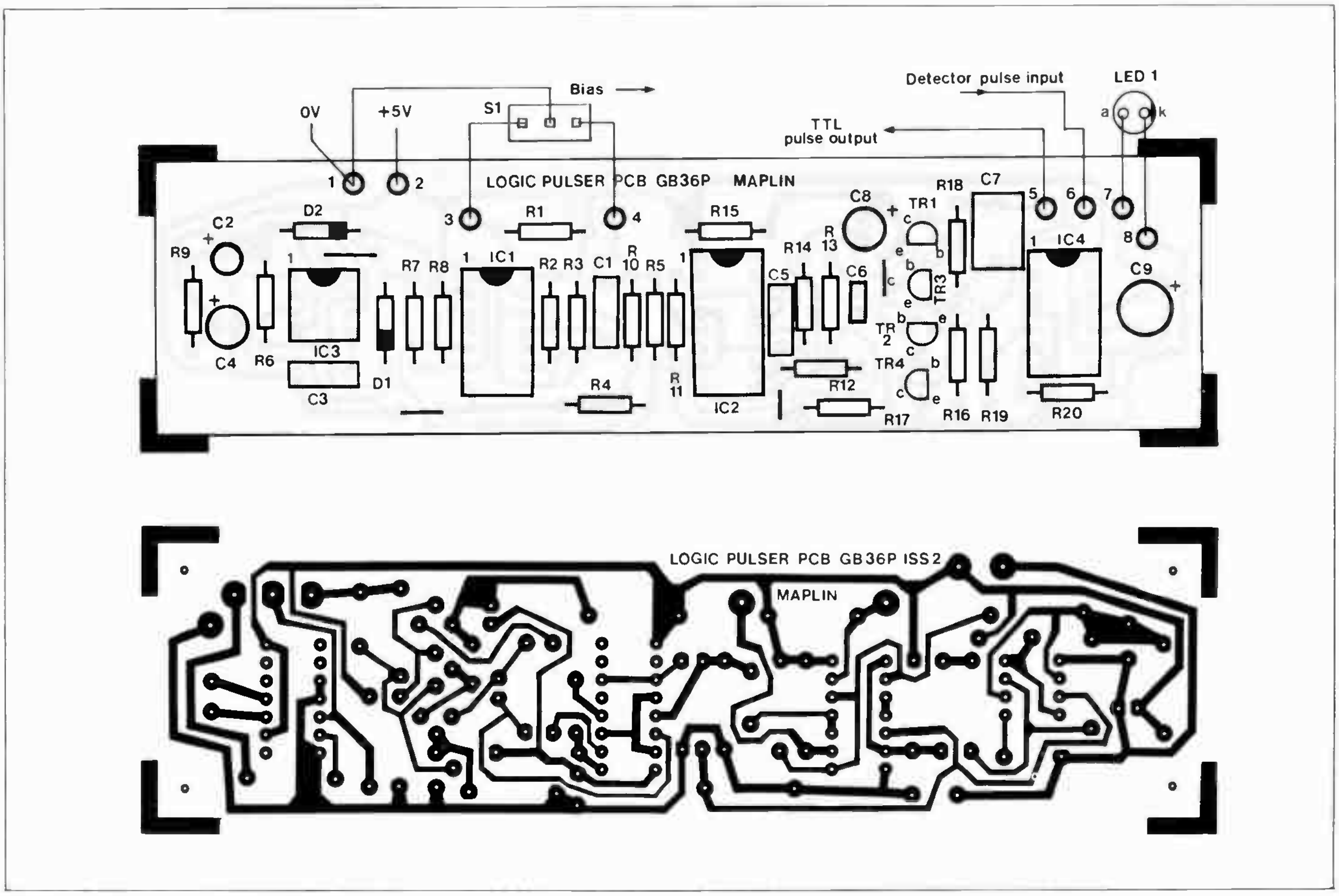


Figure 2. PCB layout and wiring diagram

supply and toggle the switch once. The LED should flash on once and go out. Now hold the switch in the 'on' position. The LED should flash once, then after half a second delay a stream of continuous pulses should be seen. Now temporarily connect the 10 ohm resistor supplied between the output of the pulser and ground first, and then between the output and the +5V rail. Toggling the switch with the resistor in both of these positions should give the same results as found without it connected. This test shows the ability of the pulser to force both logic states sinking a current of over half an Amp. Now remove the 10 ohm resistor and the wire between the pulse in and out. The pulser is now ready for use.

Using The Pulser

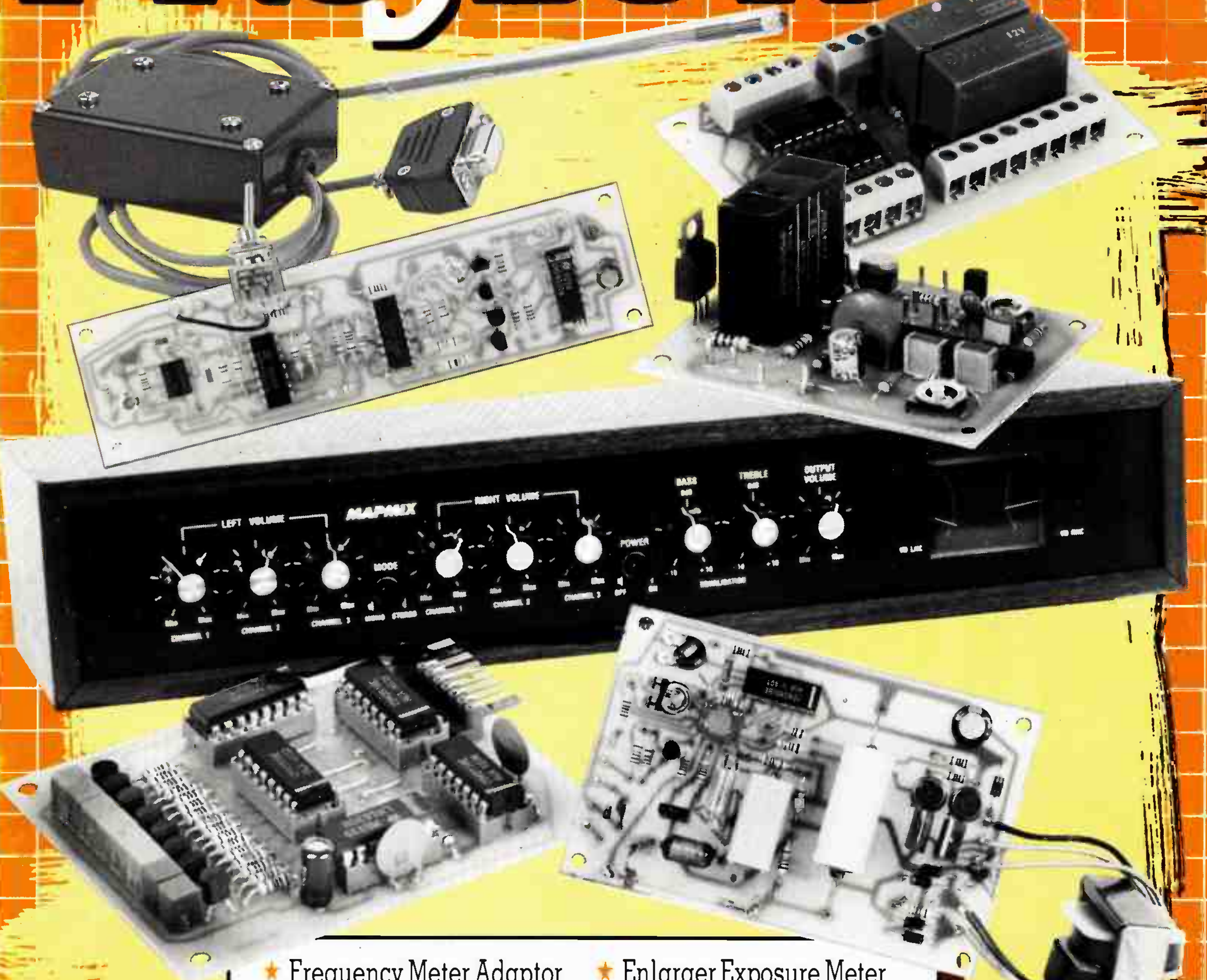
Connect the supply from the circuit under test to the pulser. Now connect the pulse 'in' to the output of the gate to be tested and the pulse 'out' to the gate input. If the gate is working correctly, the LED will flash as the switch is toggled. To test a counter, connect the pulse 'in' to one of the counter outputs and the pulse 'out' to the counter input. When the switch is held down, the stream of pulses will keep clocking the counter enabling the pulse 'in' to be moved to the other outputs to check that they are all active. Alternatively each state of the counter may be checked by stepping through at the rate of one pulse at a time.

Continued on page 11.

Best of Maplin PROJECTS

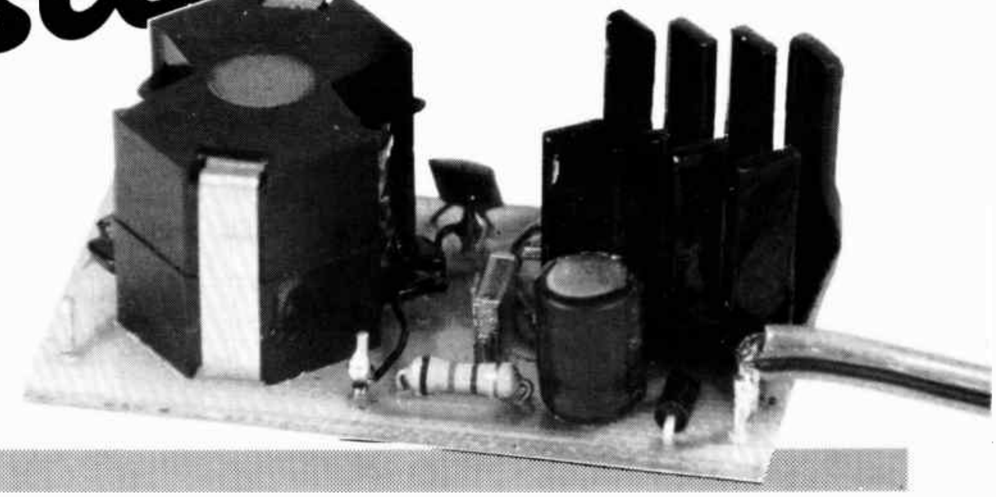
BOOK 3

XC03D



- Frequency Meter Adaptor
- Personal Stereo DNL
- Logic Pulser
- Fluorescent Tube Driver
- Auto-Waa Effects Unit
- Mapmix 6-Channel Mixer
- Xenon Tube Driver
- Enlarger Exposure Meter
- 8-Channel Fluid Detector and Mains Controller
- TU1000 RTTY Terminal
- Computadrum
- Light Pen
- PWM Motor Driver

8 Watt 12 Volts Fluorescent Tube Driver



By Dave Goodman

★ Ideal for Camping, Caravans and Boats
★ Runs from 12V Battery Supply
★ High Efficiency Light Output

Fluorescent lights have many advantages over incandescent lamps when used out of doors especially when limited power resources are available. Heat output is very low, reducing the risk of fire especially in tents and an average family car battery could supply sufficient power for up to 15 hours continuous use. Light output radiates from the length of the tube, not from one focused point making diffusers and reflectors unnecessary, and being much kinder on the eyes. Unfortunately there is one problem with fluorescent tubes: high voltages are required to 'strike' and run them, so a method of driving many hundreds of volts from a 12 volt source must be employed. Our fluorescent tube driver meets the requirements and provides a system at much lower cost than commercially available units.

Circuit Description

When power is applied, TR1 is turned on hard via R1 and L2. L1 is energised and passes a high current which induces a pulse in L2 and turns TR1 off for the duration of the pulse. No current flows through L1 at this time and L2 offers a low impedance path from R1 to TR1 base thus turning it on again. Due to this alternating field a large voltage is developed across L1 – around 100 volts – and step-up winding L3 generates several hundred volts, enough to strike the fluorescent tube. The load now remains constant across L3 and the oscillation frequency is maintained by time constant R1 and C2.

Under normal load running conditions a 50kHz square wave at 250 volts should be present across pins 5 and 6. In case of reversed battery connections, D1 prevents damage to both TR1 and battery from occurring, and it will not pass current under these conditions. C1 decouples the supply rails and prevents RF transmission from long battery-lead cables (see circuit diagram, Figure 1).

Transformer Construction

Three separate windings are required, see Figure 2, these being:

Secondary L3: 200 turns of 34swg (0.3mm) E/C wire
Secondary L2: 15 turns of 34swg (0.3mm) E/C wire
Primary L1: 30 turns of 24swg (0.6mm) E/C wire

Wind L3 first on the bobbin (Figure 2a) by tinning the E/C wire and soldering it to the L3 start terminal. Wrap each turn close to the previous one and build up in layers. Approximately 30 to 32 turns can be made across the former, so six layers should be built up as neatly as possible. Terminate L3 at the finish terminal and insulate the windings with a single layer of PVC insulating tape wrapped tightly around the coil. Next wind L2 (Figure 2b) starting and terminating on the opposite two bobbin pins (3rd one not used). Again, spread all 15 turns tightly across the previous coil L3 – eight turns across and 7 turns back. Finally, wind L1 straight on top of L2 (Figure 2c). Wind two layers, 15 across and 15 back again leaving two inches of spare wire at each end. Wrap three turns

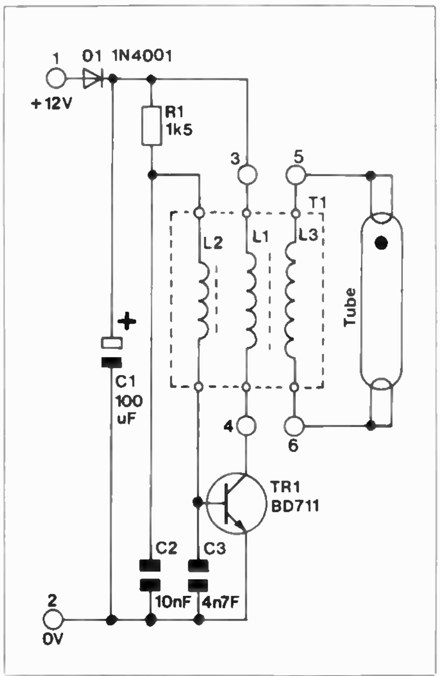


Figure 1. Circuit diagram

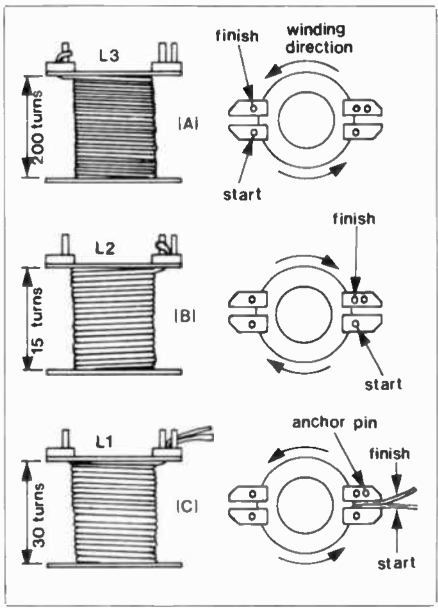


Figure 2. Construction of T1

of PVC tape tightly around L1 to prevent it from unwinding and drop into one section of T1. Fit the remaining section over the bobbin and secure both halves with metal clips clamped over each end. Before fitting onto the PCB make sure the windings of L2 and L3 have been soldered correctly to their bobbin pins and remove any excess solder which may prevent insertion into the board.

PCB Construction

Refer to the parts list and Figure 3. Mount the capacitors C2,3 and resistor R1. Insert diode D1 correctly to the legend on the PCB to ensure correct polarity. Next insert Veropins 1 to 6. Position the vaned heatsink and mount TR1 (Figure 4) making sure that the leads of TR1 go through the board and tighten the nut and bolt. Insert C1, which is polarised, and finally fit T1. L1 is soldered to pins 3 and 4 and the two wire ends should be scraped to remove the enamel before tinning. Solder components and cut off all excess leads.

Using the Module

Connect an ammeter in series with pin number 1 and +12 volt supply; supply common or −ve goes to pin 2. Set the ammeter scale to allow a reading of 1 amp or more and apply power. A high pitch whistling may be heard, with a current reading of 0.4 to 0.5A. If the reading is 1A or more, switch off and reverse L1 connections to pins 3 and 4 and check again. Remove power and connect an 8W 12 inch fluorescent tube across pins 5 and 6. The tube will probably have two starter terminals at each end (four altogether). Join each pair together before connection to the pcb. Keep all connections short and insulate bare terminals to prevent the risk of shock. Remember high voltages are present here and could be dangerous, even with limited current availability!

Apply power again and the tube should glow dimly, then after a second or two light up completely. Check current reading is approximately 0.5A. No whistling should be audible and the tube should not flicker, but if this is not so, try reversing L1 connections to pins 3 and 4 or reverse tube connections to pins 5 and 6.

The inverter can drive two tubes in series (not parallel), at slightly reduced light output levels and the supply current will rise by 100mA or so when doing this. Resistor R1 can be increased up to 2k to reduce light output (and supply current) or taken down to 470Ω for increased light output, with supply current up to 1A. With the specified value for R1, tube life expectancy should be high and the prototype has been running for a great many hours without problem.

For housing the tube, clear plastic piping as used on water tank overflows etc. can be utilised and fitted to a small plastic box containing the inverter. The module could then be potted for safety and a cork fitted into the open end of the pipe.

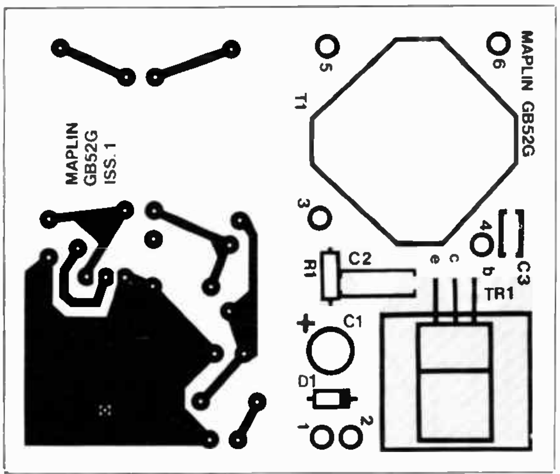


Figure 3. PCB legend

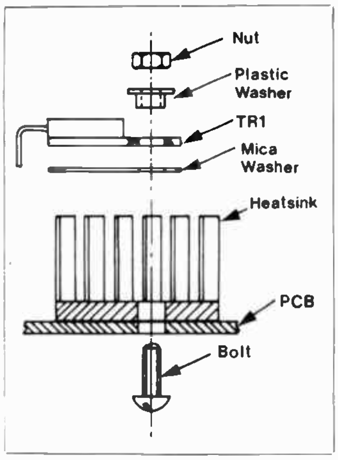


Figure 4. Mounting the transformer and heatsink

FLUORESCENT TUBE DRIVER PARTS LIST

RESISTORS: 0.6W 1% Metal Film			
R1	1k5	1	(M1K5)
CAPACITORS			
C1	PC Elect 100μF 25V	1	(FF11M)
C2	Poly Layer 0.01	1	(WW29G)
C3	Ceramic 4700	1	(WX76H)
SEMICONDUCTORS			
D1	1N4001	1	(QL73Q)
TR1	BD711	1	(WH15R)
MISCELLANEOUS			
L1	30 Turns 24 swg E.C.W.		
L2	15 Turns 34 swg E.C.W.		
L3	200 Turns 34 swg E.C.W.		
T1	Type 3 Core	1	(HX09K)
	Type 3 Bobbin	1	(HX10L)
	Type 3 Clips	2	(HX11M)
	Kit (P) Plas	1	(WR23A)
	Vaned Htsnk Plas Pwr	1	(FL58N)
	Pin 2145	1 Pkt	(FL24B)
	Tube Driver PCB	1	(GB52G)
	Bolt 6BA ½in.	1 Pkt	(BF06G)
	Nut 6BA	1 Pkt	(BF18U)
	EC Wire 0.56mm 24 swg	1 Rl	(BL28F)
	EC Wire 0.236mm 34swg	1 Rl	(BL42V)
	12V Tube	1	(LQ11M)
	Constructors' Guide	1	(XH79L)
	Fluor Tube Driver Ins	1	(XK66W)

A complete kit of all parts for this project is available:
Order As LK35Q (Fluor Tube Drvr Kit)

LOGIC PULSER *Continued from page 9.*

LOGIC PULSER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1,2,19	4k7	3	(M4K7)
R3,8	3k3	2	(M3K3)
R4	680Ω	1	(M680R)
R5	1k	1	(M1K)
R6	150Ω	1	(M150R)
R7	100k	1	(M100K)
R9	2M2	1	(M2M2)
R10	6k8	1	(M6K8)
R11	390Ω	1	(M390R)
R12,14	2k2	2	(M2K2)
R13	27k	1	(M27K)
R15	1k2	1	(M1K5)
R16	330Ω	1	(M330R)
R17	68Ω	1	(M68R)
R18	10k	1	(M10K)
R20	470Ω	1	(M470R)
	10Ω (see text)	1	(M10R)
CAPACITORS			
C1,5	Poly Layer 0.001	2	(WW22Y)
C2	Tant 0.33μF 35V	1	(WW57M)
C3	Poly Layer 0.01	1	(WW29G)
C4,8	PC Elect 10μF 50V	2	(FF04E)
C6	Ceramic 33	1	(WX50E)
C7	Poly Layer 0.47	1	(WW49D)
C9	PC Elect 47μF 25V	1	(FF08J)
SEMICONDUCTORS			
D1,2	1N4148	2	(QL80B)
TR1,2	2N3703	2	(QR27E)
TR3,4	2N3704	2	(QR28F)
IC1	7400	1	(QX37S)
IC2	4049UBE	1	(QX21X)
IC3	NE555	1	(QH66W)
IC4	74121	1	(QX73Q)
MISCELLANEOUS			
	Pulser PCB	1	(GB36P)
	DIL Socket 8-pin	1	(BL17T)
	DIL Socket 14-pin	2	(BL18U)
	DIL Socket 16-pin	1	(BL19V)
	Pin 2141	1 Pkt	(FL21X)
S1	Sub-Min Toggle J	1	(FF70M)
LD1	LED Red	1	(WL27E)
	LED Clip 5mm	1	(YY40T)
	Constructors' Guide	1	(XH79L)
	Logic Pulser Ins	1	(XK56V)

A complete kit of all parts for this project is available:
Order As LK19V (Logic Pulser Kit)

AUTO~WAA
·EFFECTS UNIT·

by Robert Penfold

★

Automatic — no foot pedal needed

★

Very low power consumption

★

Wide range of musical effects

There are several ways of producing the well-known and much used waa-waa effect, but in each case the basic effect is generated using some form of bandpass filter which is swept up and down over all or part of the audio band. This boosts a fairly narrow and continuously changing band of frequencies, and it is mainly the consequent variations in the relative strengths of harmonics in the processed signal that give the effect.

The difference between the various types of waa-waa effects units is the way in which the filter frequency is varied, and there are three main types. The most simple of these is where the filter is controlled manually using a foot-pedal. The other two types operate the filter automatically, one using an oscillator to sweep the filter in a cyclic manner, and the other using a sort of envelope generator to move the filter frequency in sympathy with the strength of the processed signal.

This auto-waa unit is of the third type, and this form of waa unit has the advantage of being very easy to use while giving an excellent range of effects. With this design it is possible to adjust the minimum filter frequency to practically any audio frequency, and a sweep depth control is also included. Another useful feature of the unit is a resonance control which enables the bandwidth of the filter to be adjusted. The filter is actually a 12dB per octave lowpass type, but positive feedback is used to give a peak in the response just above the cut-off frequency, and this type of filter probably gives the best waa effect. With the resonance control fully backed-off the filter operates as a straightforward 12dB per octave lowpass type, and the unit then gives a more subtle but useful effect.

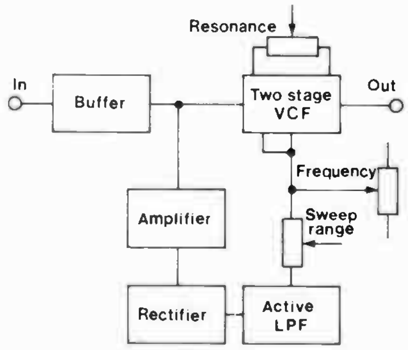


Figure 1. Block diagram.

Block Diagram

The block diagram of Figure 1, helps to explain the general way in which the circuit functions.

A buffer stage at the input gives the circuit a reasonably high input impedance and provides a suitably low drive impedance for the subsequent stage. Some of the output from the buffer stage is fed through a two stage voltage controlled filter (VCF) and then to the output. The rest of the output from the buffer stage is fed to an amplifier, and the amplified signal is then rectified to produce a DC control voltage for the filter. The operating frequency of the filter is roughly proportional to the control voltage, and the DC output from the rectifier is roughly proportional to the amplitude of the input signal. As the amplitude of the input signal rises and falls the operating frequency of the filter is therefore moved up and down in the required manner. The sweep range control is included between the rectifier and the VCF, and the base frequency control is also in this part of the unit.

For this system to work properly it is essential for the control voltage to be an accurate reflection of the input level, and it must have fast attack and decay times so that it accurately tracks the input signal. On the other hand, the output from the rectifier must be well smoothed to prevent audio signals being fed to the control input of the filter and producing distortion products. In this design the use of a three stage active filter instead of a single smoothing capacitor gives fast attack and decay times with no significant breakthrough at audio frequencies.

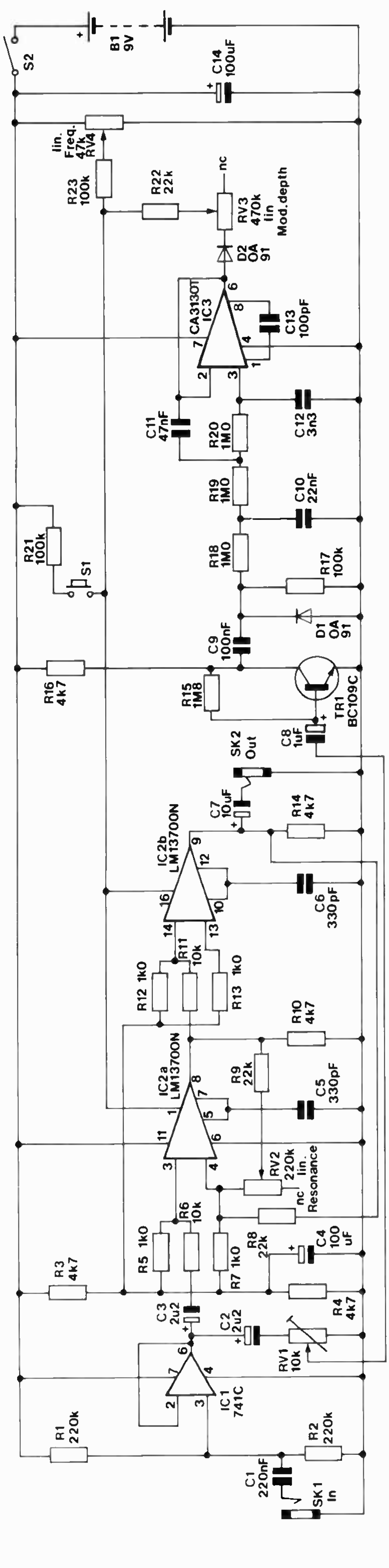
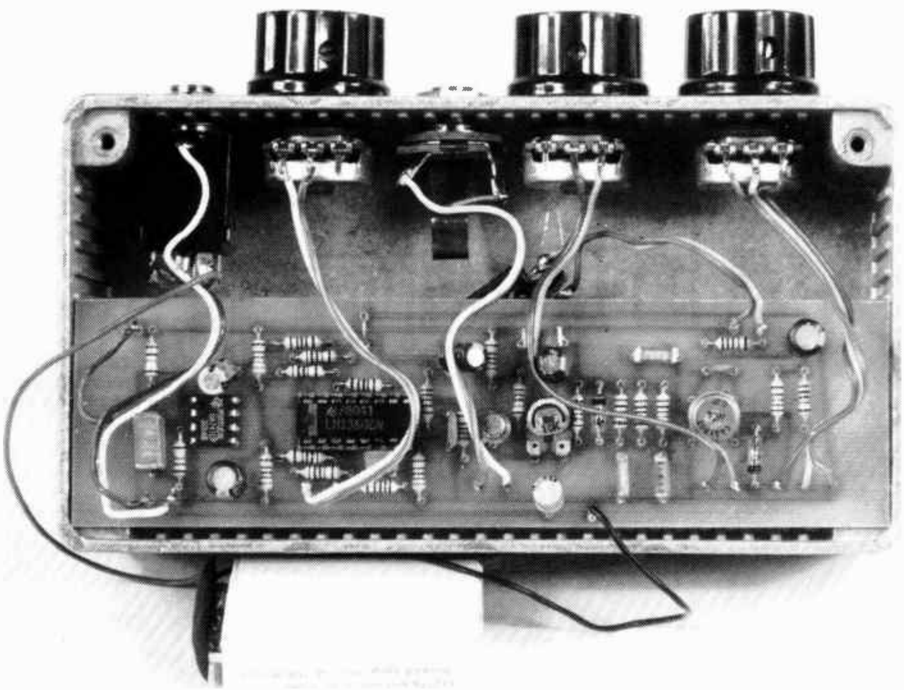


Figure 2. Circuit diagram.



The Circuit

The circuit is based on an LM13700N dual transconductance amplifier, as can be seen by referring to Figure 2.

ICI is used as the buffer amplifier at the input of this unit, and this provides the circuit with an input impedance of over 100 kilohms. C3 couples some of ICI's output to the VCF which uses transconductance amplifiers and buffer amplifiers of the LM13700N, IC2.

With RV2 set at minimum resistance the circuit operates as a straightforward 12dB per octave lowpass filter with R8 and R9 setting the nominal voltage gain of the circuit at unity at pass frequencies. The frequency at which the roll-off commences is determined by the values of filter capacitors C5 and C6, and the gain of the amplifiers (which is in turn dependent on the bias current fed to pins 1 and 16). The cut-off frequency can therefore be varied by means of a control current, or a control voltage if a resistor is added in series with the control inputs so that the current flow is roughly proportional to the input voltage. The filter's cut-off frequency can be varied manually using RV4 which supplies a variable control voltage – R23 is the series resistor. The cut-off frequency can be set anywhere within the audio range. If S1 is closed, a strong bias current is fed to the filter regardless of the setting of RV4 so that the cut-off frequency is set above the upper limit of the audio band and the filtering is effectively removed. In practice S1 is a foot operated switch and it enables the waa effect to be easily switched in and out.

The filter is actually a state-variable type with bandpass filtering available at the output of IC2a, but this output is unused in this application. Instead, a form of bandpass filtering is obtained at the output of IC2b by adjusting RV2 for increased resistance so that the feedback over IC2a is decreased. This gives a boost in gain, but only over a narrow band of frequencies immediately below the cut-off frequency. This form of filtering gives the required boost over a narrow band of frequencies, but it gives normal (unity) voltage gain at frequencies below this band. As a result of this there is no attenuation of the fundamental frequencies in the processed signal, and it is for this reason that this type of filtering gives what is generally accepted as a better waa effect than conventional bandpass filtering.

A certain amount of the output from IC1 is taken via preset attenuator RV1, and then amplified by TR1 which is used as a straightforward high gain common emitter amplifier. The amplified signal is rectified by D1 and then applied to the input of the active filter which is based on IC3. This is a conventional three stage circuit apart from the fact that R17 biases the input of the filter to earth and the filter only handles positive half cycles. A CA3130 is used in the IC3 position because this has a CMOS output stage which enables its output to go within a few millivolts of the negative supply rail. Most operational amplifiers, such as the standard 741C device, have a minimum output voltage of about 2 or 3 volts which is far too high to give acceptable results in this circuit. Another advantage of the CA3130 is that it has an extremely high input impedance, and due to the high value of filter resistors R18 to R20 this is essential. The filter resistors have been given such a high value in order to enable the low cut-off frequency of about 10 Hertz to be achieved using reasonably low filter capacitor values. This cut-off frequency gives more than adequate attack and decay times but ensures that there is no significant ripple on the DC output signal.

The output of IC3 is coupled to the control input of the VCF by way of D2, R22, and RV3. The latter acts as the modulation depth control. D2 is needed to prevent any interaction between the depth and frequency controls.

As the circuit has a current consumption of only about 4.5 milliamps a small (PP3 size) 9 volt battery can be used as the power source.

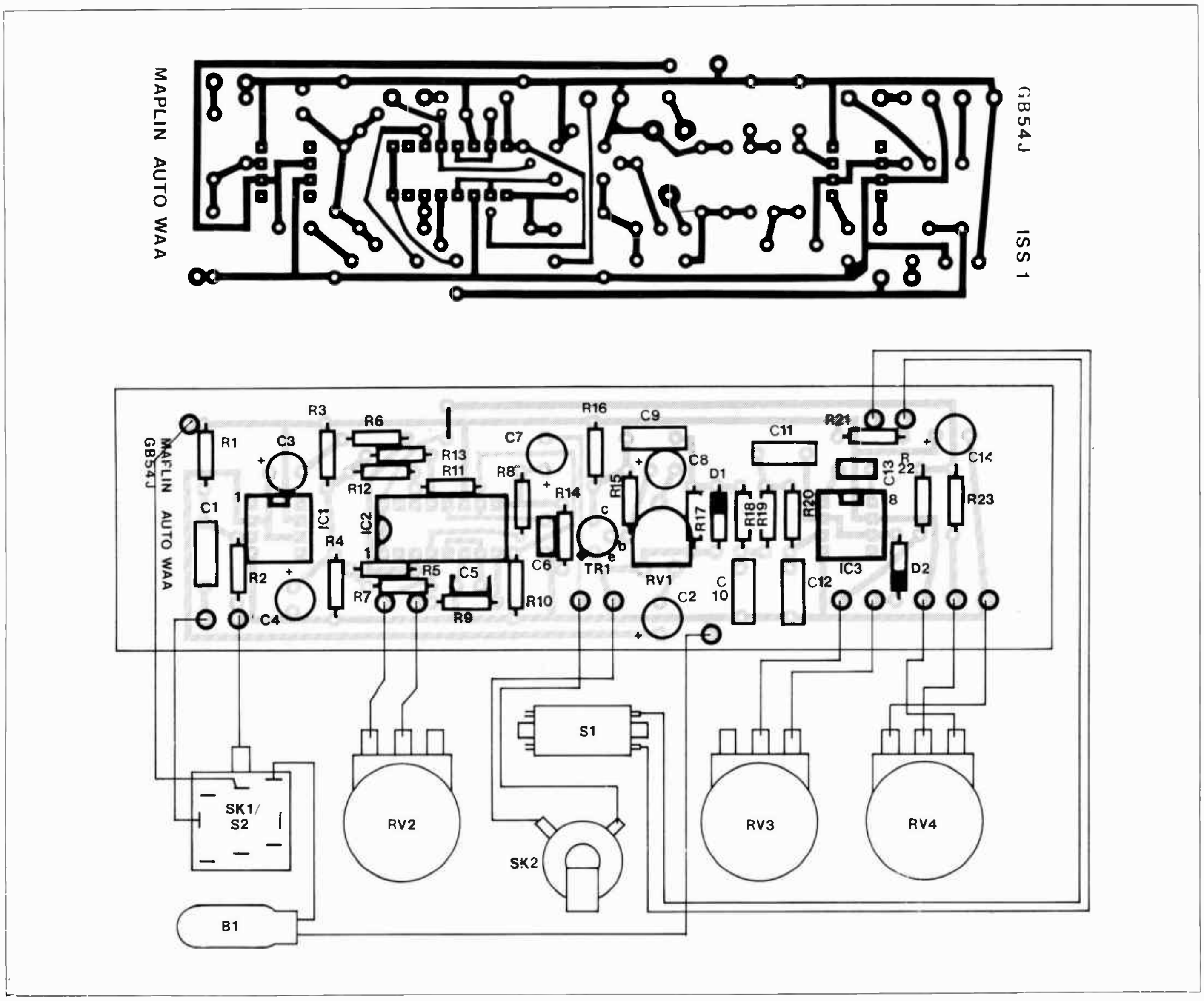


Figure 3. Legend, artwork and wiring diagram.

Construction

Full details of the printed circuit board are provided in Figure 3. The resistors, capacitors, and single link wire are soldered in place first, followed by the semiconductor devices, IC3 has a MOS input stage and should therefore be fitted in place of all, while taking the usual MOS handling precautions. D1 and D2 are germanium diodes which are more susceptible to damage by heat than silicon devices. Appropriate care not to overheat these components should be taken when they are being soldered to the board. It is helpful to fit Veropins at places where connections to off-board components will eventually be made.

For this type of project a very tough case is required, and one which screens the circuit from electrical noise is also an asset. A diecast aluminium box is ideal, and the printed circuit board has been designed to fit a 150 by 80 by 50mm case of this type. The two sockets and three potentiometers are mounted on the front panel (which is one of the 150 by 50mm sides of the case), and S1 is mounted centrally on the top panel. S2 is a pair of make contacts on SK1 and the unit is therefore automatically switched on and off when a jack plug is plugged into and removed from SK1. An ordinary on/off switch could be used if preferred, but it would be difficult to accommodate this on the rather crowded front panel, and the suggested method is probably the most practical solution. Incidentally, this method of on/off switching is often used for musical effects units.

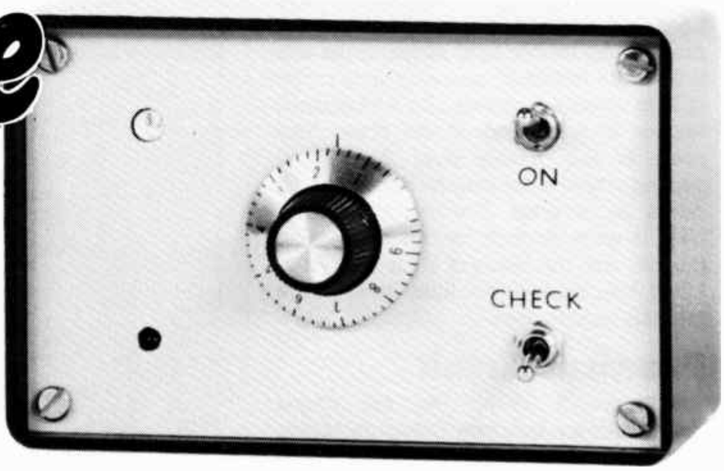
Next the hard-wiring is added, as shown in the wiring diagram of Figure 3. This is all quite straightforward and should not give any problems. Finally, the printed circuit board is fitted into the set of guide rails nearest the rear of the unit with the component side facing forwards. There is plenty of space for the battery to the rear of SK1, and a piece of foam material can be used to keep the battery in place.

Adjustment

The only preset control is RV1 which must be adjusted to suit the input signal level. If it is set too far in a clockwise direction the filter frequency will tend to go to its highest level even when the input signal has fallen well below its peak level. If it is set too far in the opposite direction the filter frequency will be virtually static at the level set using RV4. A suitable setting for RV1 is found by empirical means, and is any setting that produces a good waa effect with the filter frequency sweeping up and down in sympathy with volume of the processed signal. The unit can handle a low level signal from (say) a low output guitar pick-up, or a high level signal from a high output pick-up, keyboard instrument, or any similar signal source. However a very low level signal, such as the output from a microphone, would require a certain amount of preamplification.

Results are likely to be best with RV2 well backed off, RV4 set for a base frequency around the middle of the audio band, and RV3 set for a medium to high modulation depth. However, a little experimentation will soon show what settings give the best effects. Setting RV4 for a low base frequency could result in fundamental frequencies in the processed signal being substantially boosted as the filter sweeps through them, and with a high level input overloading with attendant distortion could result. There is also a danger of overloading the equipment fed from the output of the unit, and the best effect tends to be obtained with the filter sweeping over medium and high frequencies anyway. *Continued on page 17*

Enlarger Exposure Meter



★ **Over Six Stops Range**
★ **Simple & Inexpensive Design**
★ **Battery Operated** ★ **Low Consumption**

by Robert Penfold

A common way of determining the optimum exposure when making enlargements is to make a test strip, but it is quicker and more convenient to use an enlarger exposure meter. With the aid of an exposure meter of this type only one test strip needs to be produced for each box of paper. The correct exposure for each negative is then quickly and simply obtained using the meter to indicate the correct aperture.

A unit of this type can be very simple and inexpensive, and the enlarger exposure meter featured in this article certainly falls into this category. It is perhaps a little misleading to refer to it as a 'meter' since it does not actually incorporate a meter movement of any kind. Instead, the unit has a calibrated potentiometer and a LED indicator. A reading is obtained by adjusting the potentiometer to the point where the LED switches on and off, and then taking the reading from the potentiometer's scale. This scale is only in arbitrary units from 0 to 10, but it is perfectly adequate for this application.

The meter has a usable range of six stops or more. It is completely self contained with power being obtained from an internal 9 volt (PP3 size) battery which has a long operating life. A simple battery check facility is included so that misleading results due to an inadequate supply voltage can be avoided.

Operating Principle

The circuit is based on an operational amplifier which is used as a voltage comparator. Figure 1 shows the basic circuit of the unit.

An operational amplifier amplifies the voltage difference across its two inputs, and at DC it has an extremely high voltage gain of typically about 200,000 times. Therefore, only a very small voltage difference at the inputs is needed in order to send the outputs of the device

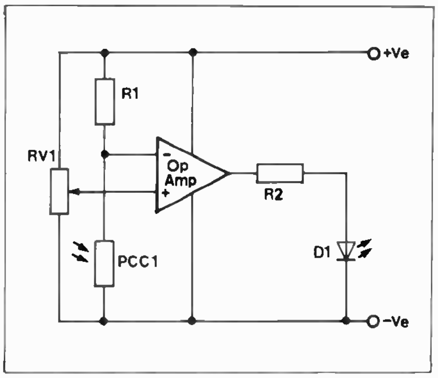


Figure 1. Voltage Comparator

fully positive or negative. The output goes positive if the non-inverting (+) input is the one at the higher potential, or negative if the inverting (−) input is at the higher voltage.

A reference for the non-inverting input is provided by RV1, which is the calibrated potentiometer. The voltage at the inverting input is produced by the potential divider which comprises load resistor R1 and photocell PCC1. The resistance of PCC1 varies in sympathy with the light level to which it is subjected. The higher the light level the lower the resistance of PCC1, and the lower the voltage fed to the inverting input of the operational amplifier. If RV1 is adjusted for maximum slider potential, and then gradually backed off, the output of the operational amplifier will initially be high, but will switch to the low state as the slider voltage falls below the potential produced by the photocell circuit. In other words, by adjusting RV1 to this switch-over point its scale reading will reflect (in arbitrary units) the voltage produced by the photocell circuit, and therefore the light level received by the photocell. Due to the high gain of the operational amplifier a high degree of precision can be obtained with this system, and the accuracy is limited largely by the degree of precision with which the potentiometer's position can be read, rather than by any electrical limitations. In fact, in practice the output of the operational amplifier will only be high or low, and it will not be possible to adjust RV1 for an intermediate level.

LED indicator LD1 is used to show the output state of the operational amplifier,

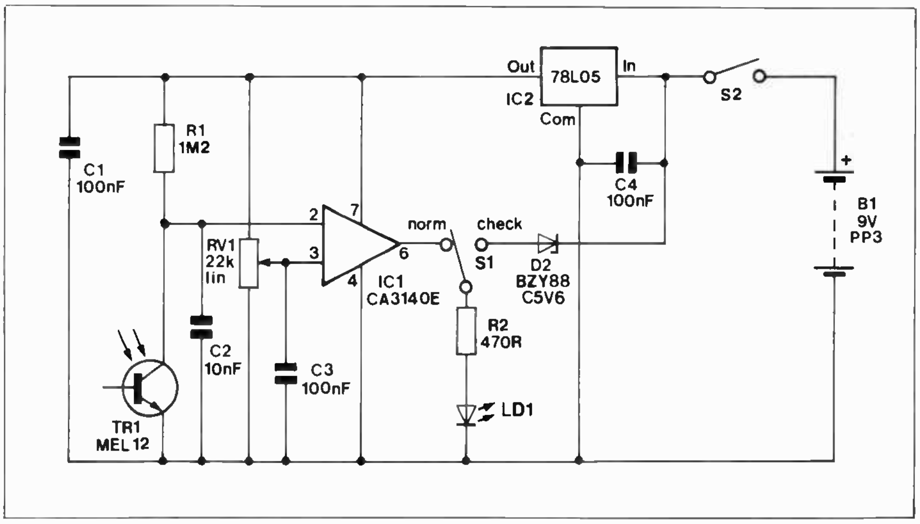


Figure 2. Practical Circuit

and this switches on when the output is high. In theory the unit covers an extremely wide light level range, since RV1 can be adjusted to match any voltage produced by the photocell circuit. In practice the usable light range of the unit is far more restricted as a very wide range of light levels are covered by a very small section at each end of the scale. The scale is only usable over the central section where a comparatively small light range is covered. The range covered here is wide enough for this application though, and the value of R1 is chosen to bring the appropriate light level range into this usable area.

Practical Circuit

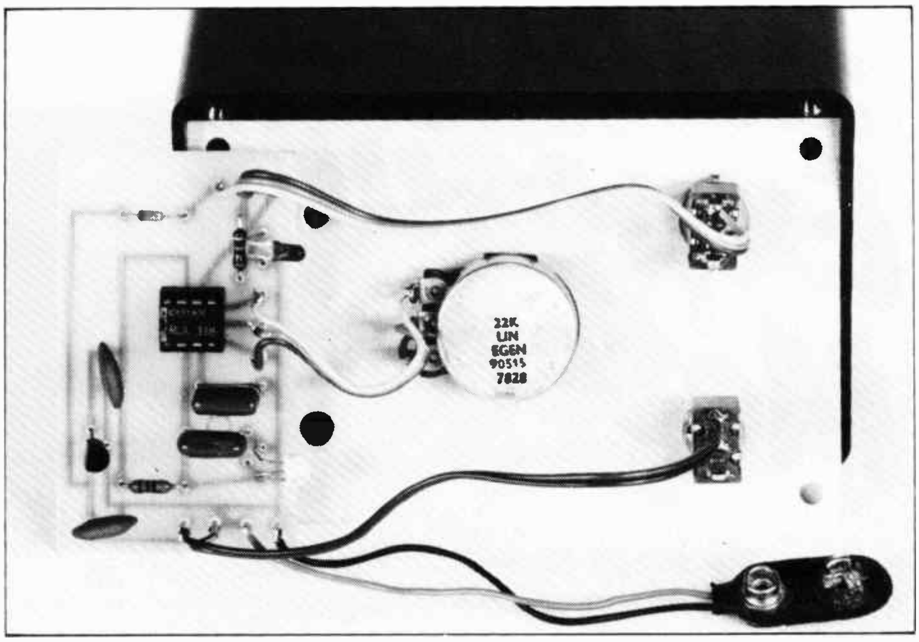
Figure 2 shows the full circuit diagram of the Enlarger Exposure Meter, and this has obvious similarities with the basic circuit. However, there are a few important differences.

One of these is the use of a photodarlington transistor as the photocell, rather than a photoresistor. A photodarlington device has the advantage of a relatively fast response at low light levels and it is also inexpensive. A disadvantage is that is does not provide a true resistance, and changes in the supply voltage may not cause a proportional change in the output voltage of the photocell circuit, This results in changes in supply voltage slightly changing the reading produced by a given light level; a stabilised supply therefore has to be used. IC2 is a small monolithic voltage regulator which gives a well stabilised 5 volt supply that ensures good accuracy and consistent results. The circuit has to operate at very low light levels (far lower than an ordinary exposure meter), and this is reflected in the high value of load resistor R1. IC1 is a MOS operational amplifier which has an extremely high input resistance and operates well at a supply potential of just 5 volts. Most other operational amplifiers will not work in the circuit.

The circuit is very sensitive to stray mains 'hum' pick-up and other electrical noise, due to the use of the operational amplifier with its full voltage gain. C2 and C3 help to minimise this unwanted pick-up which could otherwise prevent a well defined switch over point from being obtained, and could seriously impair the accuracy of the unit.

A simple battery check circuit is included, and the only additional components used in this are S1 and D2. With S1 in the 'normal' position the LED indicator LD1 and its current limiting resistor R2 are connected across the output of IC1 so that the unit functions normally. In the 'check' position the LED indicator circuit is connected across the non-stabilised 9 volt battery supply via zener diode D2. With about 5.6 volts dropped across D2 and just under 2 volts needed across D1 before it will switch on, around 7.5 volts is needed across the battery check circuit before LD1 will pass any current at all, and about 8 volts is needed before it will light up reasonably brightly. Therefore, if LD1 lights up brightly when S1 is set to the 'check' position the battery voltage is satisfactory. If LD1 lights up only dimly the battery is nearly exhausted, and if it fails to light the battery should be replaced immediately. Incidentally, the battery check facility only functions when the unit is switched on.

The current consumption of the circuit is only about 5 or 10 milliamps (depending on whether D1 is switched on or off) and a small (PP3 size) 9 volt battery is quite adequate to power the unit.



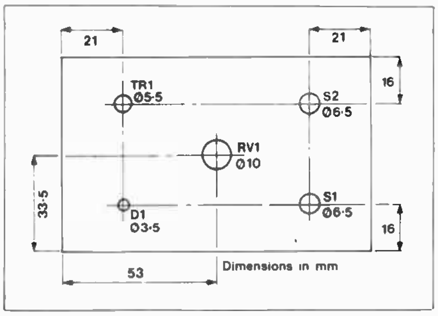


Figure 3. Front Panel Drilling

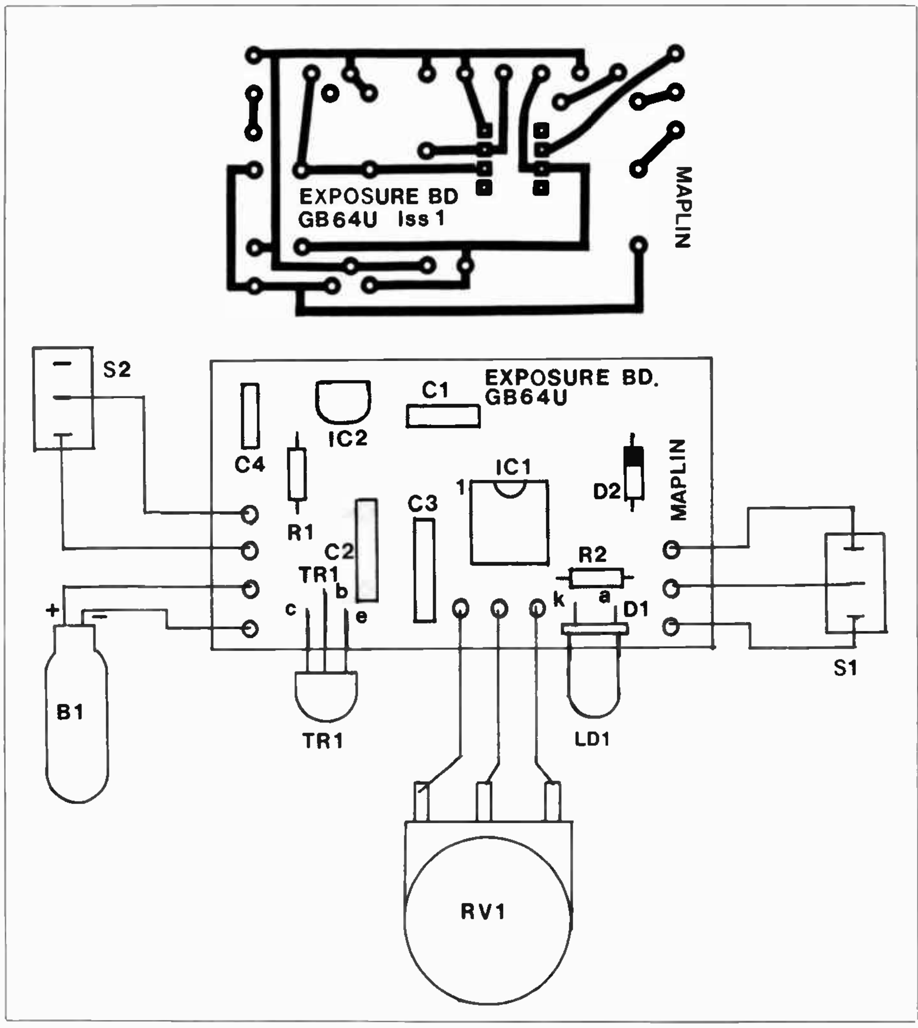


Figure 4. PCB Layout and Wiring

Construction

The recommended case for this project is a plastic type having an aluminium front panel and approximate outside dimensions of 111 by 71 by 48 millimetres. As the printed circuit board has been specifically designed to fit this case it is strongly recommended that this particular type should be used. If all the components are to fit into place properly, especially TR1 and LD1, it is essential that the mounting holes in the front panel are drilled in the correct positions. Figure 3 gives drilling details for the front panel, and once again, it is strongly recommended that this layout should be used.

Details of the printed circuit board and wiring are provided in Figure 4. IC1 is a MOS input device and it should therefore be mounted in an 8 pin DIL socket. Do not fit IC1 onto the board until all the other components have been mounted, and leave it in the antistatic packaging until then. Handle IC1 as little as possible. LD1 and TR1 are mounted at right angles to the board, and are made to protrude slightly over the edge of the board. When the completed board has been wired up to the rest of the unit it is slotted into the vertical set of guide rails on the extreme left hand end of the case, with the component side of the board facing inwards. With LD1 and TR1 suitably positioned they will fit into their mounting holes in the front panel when this is pushed into place.

Either RV1 must be fitted with a calibrated control knob, or it must be fitted with a pointer knob and a scale must then be marked around this. The former is by far the easier option, and is the one adopted for the prototype. An indicator line must be marked on the front panel next to RV1.

In Use

In use the unit is simply placed on its back on the enlarger baseboard with the photocell facing upwards towards the enlarging lens. In order to find the correct scale setting for a particular box of paper it is necessary to first determine the optimum aperture and exposure times for an average negative. This is done in the usual way by producing a test strip. With the negative and the diffuser in place and the enlarger adjusted for the appropriate aperture, position the exposure meter on the baseboard and adjust RV1 to the switch-over point. Make a note of the scale reading and the exposure time on the box of paper.

The procedure for finding the correct exposure for a new negative is then quite straightforward. Place the exposure meter on the baseboard and set it at the reading marked on the box. With the negative and diffuser in position the aperture of the lens is adjusted to bring the meter to the switch-over point. This then gives the correct aperture for the exposure time marked on the paper's box. The same exposure time is always used for a given box of paper, and only the aperture is varied to suit each negative.

As the photocell has only a very small sensitive area it is possible to use the unit as a spot meter, reading either a highlight or a shadow tone as desired, or it can be utilised as an integrating meter if a diffuser is fitted under the enlarging lens while metering (as described above). An important point to keep in mind is that a different scale reading for a given box of paper will be obtained for each of these three methods, and if using more than one of these you must note the correct readings for each method on the box (and then be careful to use the right one each time).

The unit should give satisfactory results without any modifications being made, but it is just possible that the range of light intensities that you will use may tend to be in a cramped position at one end of the scale or the other. If necessary R1 can be raised in value to broaden out the low light level end of the scale, or it can be reduced in value to broaden out the opposite end of the scale.

EXPOSURE METER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film (Unless stated)			
R1	1M2	1	(M1M2)
R2	470Ω	1	(M470R)
RV1	Pot Lin 22k	1	(FW03D)
CAPACITORS			
C1,4	Disc 0.1μF 50V	2	(BX03D)
C2	Polyester 0.01μF	1	(BX70M)
C3	Polyester 0.1μF	1	(BX76H)
SEMICONDUCTORS			
LD1	Mini LED Red	1	(WL32K)
D2	BZY88C5V6/BZX55C5V6	1	(QH08J)
TR1	MEL 12	1	(HQ61R)
IC1	CA3130E	1	(QH28F)
IC2	μA78L05AWC	1	(QL26D)
MISCELLANEOUS			
S1,2	Sub-Min Toggle A	2	(FH00A)
	Enlarger Exp Mtr PCB	1	(GB64U)
	Metal Panel Bx M4004	1	(WY01B)
	Knob F10	1	(RW78K)
	DIL Socket 8-pin	1	(BL17T)
	7/0.2 Wire 10M Blk	1 Pkt	(BL00A)
	Pin 2145	1 Pkt	(FL24B)
	PP3 Clip	1	(HF28F)
	Constructors' Guide	1	(XH79L)
	Exp Meter Ins	1	(XK68Y)

A complete kit of all parts for this project is available: **Order As LK44X (Enlarger Exposure Kit)**

AUTO-WAA *Continued from page 14*

AUTO-WAA PARTS LIST

RESISTORS: All 0.6W 1% Metal Film (Unless stated)			
R1,2	220k	2	(M220K)
R3,4,10,14,16	4k7	5	(M4K7)
R5,7,12,13	1k	4	(M1K)
R6,11	10k	2	(M10K)
R8,9,22	22k	3	(M22K)
R15	1M8	1	(M1M8)
R17,21,23	100k	3	(M100K)
R18,19,20	1M	3	(M1M)
RV1	Hor Encl Preset 10k	1	(UH03D)
RV2	Pot Lin 220k	1	(FW06G)
RV3	Pot Lin 470k	1	(FW07H)
RV4	Pot Lin 47k	1	(FW04E)
CAPACITORS			
C1	Poly Layer 0.22	1	(WW45Y)
C2,3	PC Elect 2.2μF 100V	2	(FF02C)
C4,14	PC Elect 100μF 10V	2	(FF10L)
C5,6	Ceramic 330	2	(WX62S)
C7	PC Elect 10μF 50V	1	(FF04E)
C8	PC Elect 1μF 100V	1	(FF01B)
C9	Poly Layer 0.1	1	(WW41U)
C10	Poly Layer 0.022	1	(WW33L)
C11	Poly Layer 0.047	1	(WW37S)
C12	Poly Layer 0.0033	1	(WW25C)
C13	Ceramic 100	1	(WX56L)
SEMICONDUCTORS			
D1,2	OA91	2	(QH72P)
TR1	BC109C	1	(QB33L)
IC1	μA741C 8-pin DIL	1	(QL22Y)
IC2	LM13700N	1	(YH64U)
IC3	CA3130E	1	(QH28F)
MISCELLANEOUS			
SK1	DPDT Jack Socket	1	(BW80B)
SK2	Jack Skt Open	1	(HF91Y)
S1	Press Toe SPDT	1	(FH92A)
	Auto-Waa PCB	1	(GB54J)
	DIL Socket 8-pin	2	(BL17T)
	DIL Socket 16-pin	1	(BL19V)
	Knob K7B	3	(YX02C)
	7/0.2 Wire 10M Blk	1 Pkt	(BL00A)
	PP3 Clip	1	(HF28F)
	Pin 2145	1 Pkt	(FL24B)
	Constructors' Guide	1	(XH79L)
	Auto Waa Ins	1	(XK67X)
OPTIONAL			
	Nicad PP3	1	(HW31J)
	Box DCM5005	1	(LH73Q)
	Feet Cab	1 Pkt	(FW19V)
	Bolt 4BA ¼in.	1 Pkt	(BF02C)
	Nut 4BA	1 Pkt	(BF17T)

A complete kit of parts for this project, excluding optional items, is available:
Order As LK36P (Auto-Waa Kit)

Mapmix - Six Channel Audio Mixer

by
Dave Goodman

★ **Twin VU Meters**
★ **Battery Operation**
★ **Master Volume Control**
★ **Switched Mono/Stereo Modes**
★ **Bass and Treble Equalisation**
★ **Six Microphone or Instrument Inputs**

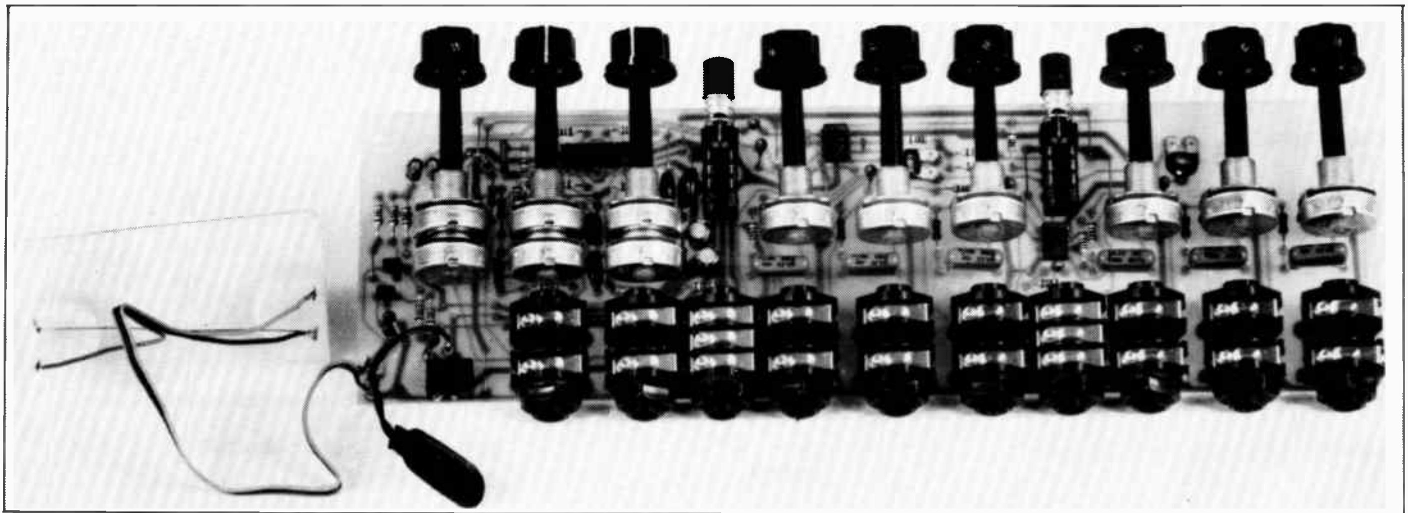
Introduction

The Mapmix is a versatile six input mixer, in the stereo mode it has three inputs connected to the left channel and three inputs connected to the right channel. For mono use all six inputs are connected to both output jacks via the mode select switch. Both left and right channels have separate post-mix send/receive facilities, for connecting external effects units. Tonal balance can be modified with Bass and Treble controls. The twin VU meter gives an indication of final output levels although it is unaffected by the master volume control, which is connected to the output. All input and output connections are made with standard ¼ inch mono jack sockets, while send and receive connections utilise ¼ inch stereo jack sockets. The unit is powered by a 9V battery – so current consumption has been kept at a very low level, to prolong battery life. However, external DC power supplies can be connected using the 2.1mm power socket.

Circuit Description

Low power IC's are used to keep power requirements to a minimum – approximately 1.75mA quiescent current at 9V. IC1a and b are configured as virtual earth mixers with inverted outputs and can be referred to as 'adders'. For the left channel, input signals are applied to IC1b via SK1 to 3 with signal attenuation, or volume control, being performed by RV1 to 3. Resistors R1 to 3 and R7 have the same value, a signal applied to SK1 only, will appear at C7 +V in inverted form, but at the same amplitude as the input. Thus the mixer exhibits a unity gain characteristic under this condition. If signals are now applied to all three inputs, the total current flowing in R7 will be equal to the sum of the input currents and the output voltage at C7 will be equal to the sum of the input voltages. For instance, a 100mV signal applied to all three inputs, with RV1 to RV3 set to maximum will produce the sum product of 300mV at C7; the signals being effectively 'added' together. Blocking capacitors C1 to C3 isolate IC1b from possible DC level changes present at the input jacks; the input impedance of each channel is set by the volume control resistance at 100k ohms. R11 carries the mixer output to the send terminal, this being the 'tip' connection of a stereo jack plug. Without a plug inserted into SK4, the switched connections direct the signal path to S1 and IC2a, another inter-stage unity gain mixer, which re-inverts the input signal and provides a low impedance drive to the tone control stages which follow. S1 is shown operated, which is the mono mode, thus IC2b receives the same input signal as IC2a.

When an external device is inserted into SK4, both 'tip' and 'ring' are disconnected by the internal switching and receive inputs are connected to IC2a via level preset RV10. Effects units such as echo, phase, reverb or perhaps another mixer can be inserted here and mixed into the rest of the system. IC1a and IC2b



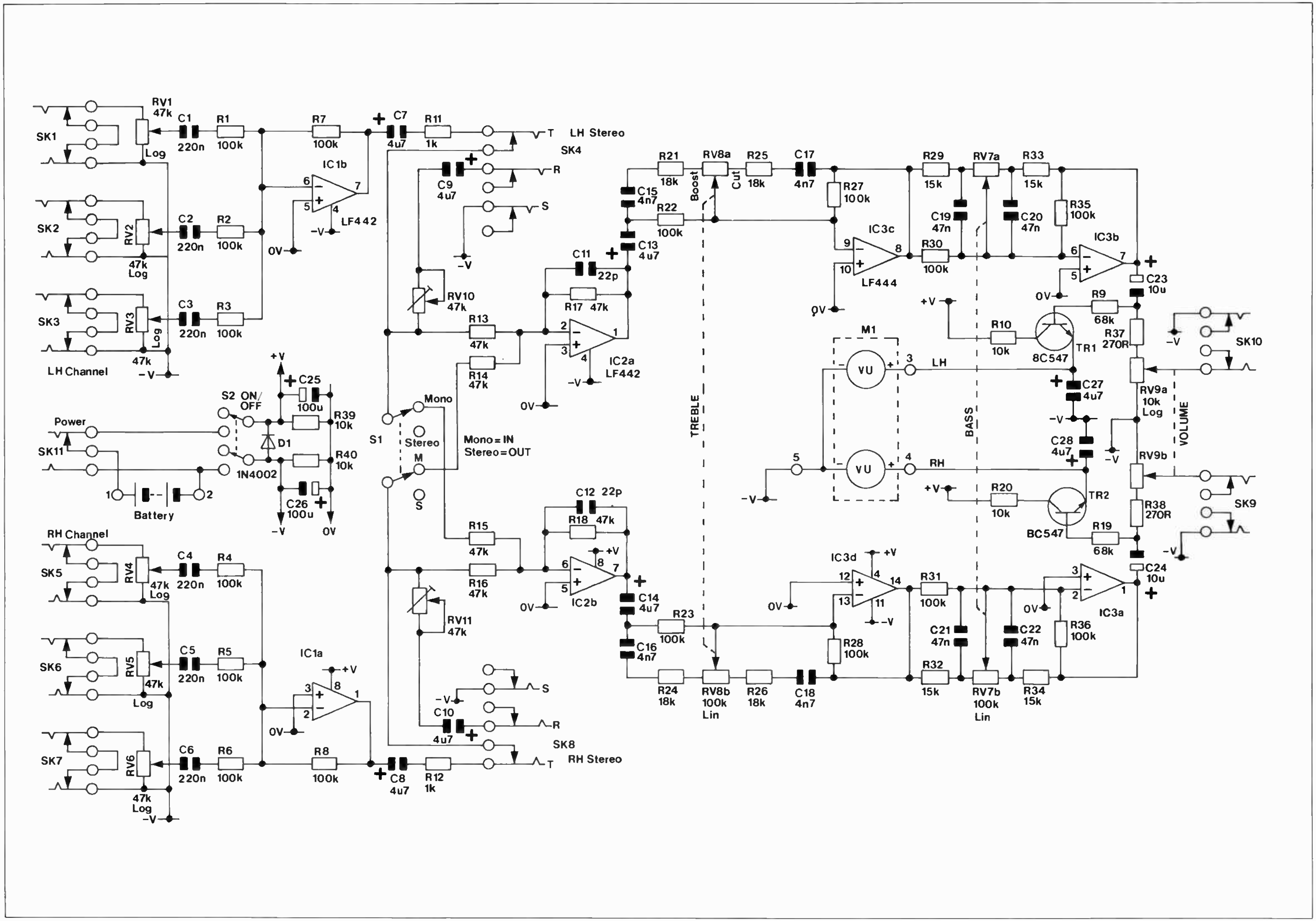


Figure 1 Circuit Diagram

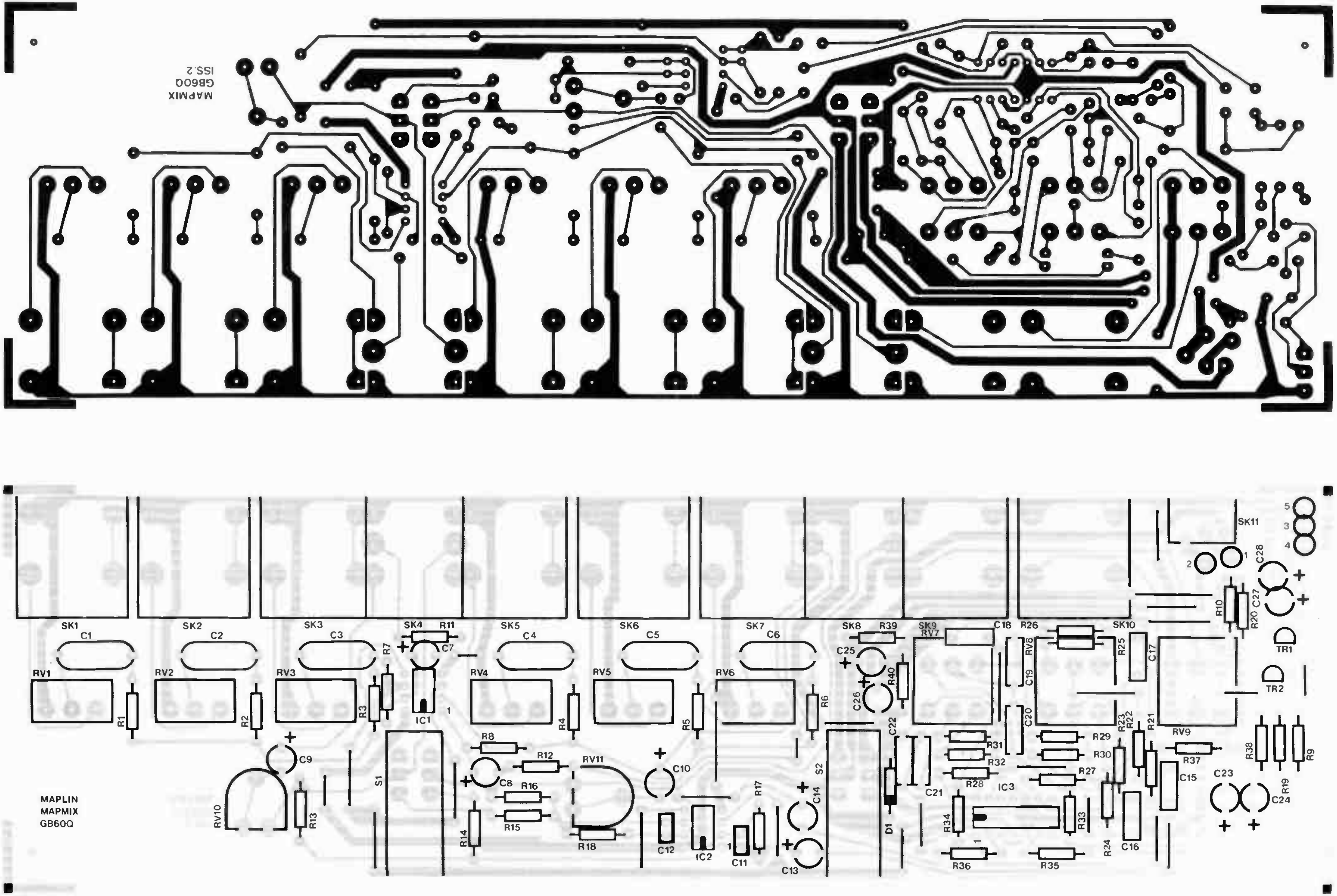


Figure 2 Artwork & Legend

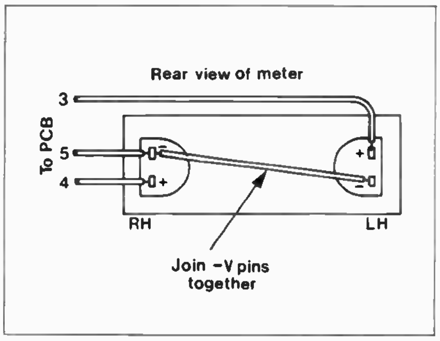


Figure 3 Meter Wiring

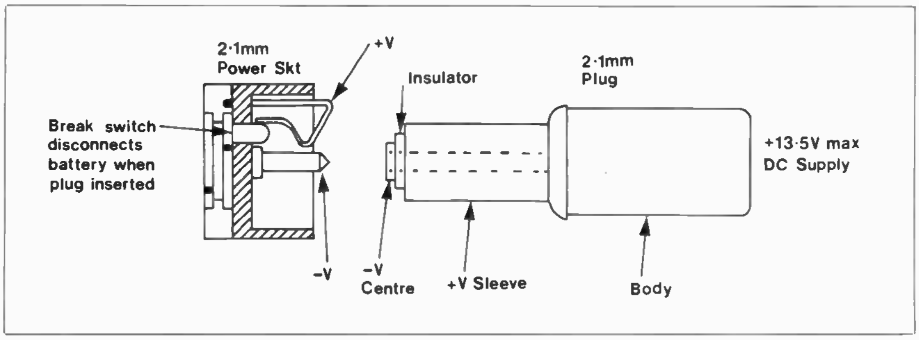


Figure 4 Power Plug & Socket

function in exactly the same way as previously described for the left channel. Switching S1 out of circuit establishes the stereo mode, where left and right channels become independent of each other.

IC3c and d form the active section of the treble control RV8, which is a dual potentiometer. Both channels, although electrically independent, can be set for flat response by keeping the wipers central. A boost of up to 10dB at 10kHz can be applied by turning the wiper of RV8 clockwise and a cut of 10dB by turning anti-clockwise. Similarly IC3b and IC3a form the active section of bass control RV7, another dual potentiometer. This control gives up to 10dB boost or cut at 40Hz when rotated clockwise or anti-clockwise respectively. Separate active filters are used to keep interaction to a minimum, for improved performance and to lessen the effects of distortion – which can be noticeable in multi-feedback type systems. R37 (38) is located in the output stage to prevent IC3b from drawing excessive supply current if the output connecting cable is shorted out, whilst RV9 (master volume control) is set at maximum. This raises the output impedance slightly, to about 1k ohm, or 10k ohm at low output volume settings – this is, however, adequate for most audio amplifier input stages.

Emitter follower TR1 (TR2) charges capacitor C27 (C28) to produce a mean DC average from the outgoing AC signal, this capacitor also dampens the meter response – otherwise it would be unreadable, with the needle bouncing around on its mountings! Switched potential dividing stages have not been incorporated with the meter, so low level input signals applied to the mixer will not be registered on the scale. Zero on the scale corresponds to approximately 0dB (+or− 1dB) or 775mV at 1kHz applied to one input, maximum volume, mono mode and tone controls set flat. The maximum scale reading corresponds to an output level of 1.6V RMS (4V peak to peak), which is some 2dB down on the absolute signal handling capability of the mixer. Because the input levels can be continuously variable it is possible that signals of a few millivolts to a few dozen volts can be connected to the system. The maximum signal that any one channel can handle is 500mV – with the volume set to maximum and sufficient margin allowed for bass and treble boost. Of course higher input signal levels simply require the volume control to be turned down.

Prototype Specifications:–

Power Requirement:	1.75mA with 9V battery (eg PP3). Or fully regulated external PSU – max 13.5V DC.
Frequency Response:	25Hz – 30kHz ±1dB
Bass Control:	±10dB at 40Hz
Treble Control:	±10dB at 10kHz
Meter Response:	50Hz ±1dB
LHC/RHC Tracking:	±1dB
Signal To Noise:	Better than 65dB
Distortion:	<0.05% at 1kHz – flat
Input Impedance:	100k ohm each channel
Output Impedance:	1k ohm at max. setting

PCB Assembly

Refer to the parts list for component values and Figure 2 (legend/overlay) for designations. Begin construction by inserting each of the 25 links, using 24swg B.T.C. Next insert the 40 resistors into their respective positions, the PCB hole spacing is set at 13mm and each resistor lead must be bent to fit and then pushed firmly onto the board. Mount both 47k presets, RV10 and RV11, and diode D1 making sure of correct polarisation. Now fit the sockets for ICs 1 to 3, these must be fitted correctly – align the notch in one end of the socket with the legend.

Solder the part assembled board at this stage and remove all excess wire ends. Next the capacitors can be fitted. C1 to C6 are polyester types and mount in-line across the centre of the board. C7 to 10 and C13,14,27,28 are polarised types with long +V leads and short −V leads, ensure they are mounted correctly to the PCB legend. C23 to 26 are PCB mounting electrolytics, which are of course polarised, only the −V lead is identified so care must be taken to fit these components correctly. Now fit TR1 and TR2 and power socket (SK11) along with the five pins which are inserted from the track side of the PCB, finally solder these components. The ten PC mounting jack

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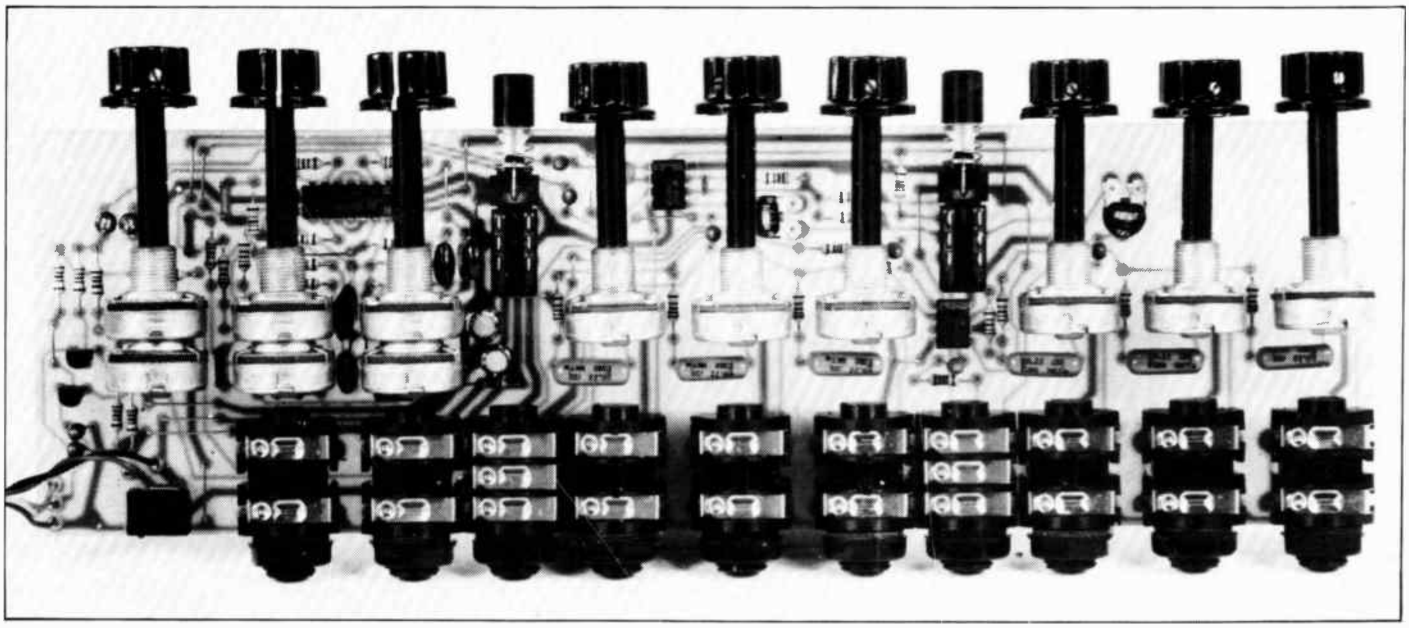
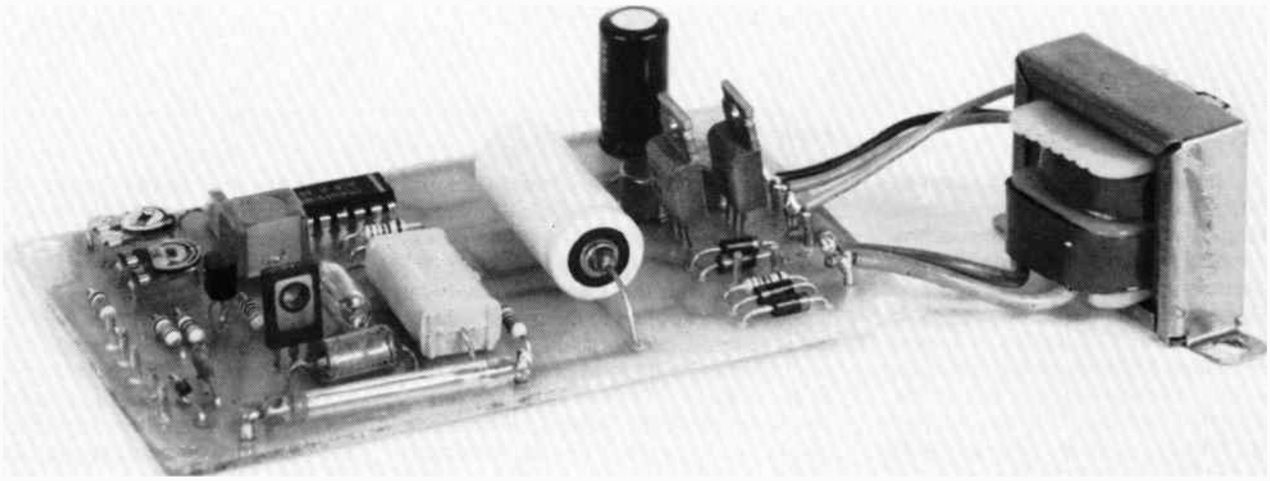


Xenon Tube Driver



★ **Driver Module for Xenon Tube**
★ **Complete with Trigger Transformer**
★ **External Triggering or**
★ **Internal Strobe Oscillator**

by Dave Goodman

Introduction

The Xenon Tube, along with the Trigger Transformer required to operate it, are regular subjects of enquiry by many of our readers, therefore to put the books straight, a tube driver module with external triggering and 'on board' strobe oscillator is offered. The module can be used for photography, roadside hazard indication, navigation, distress beacons or perhaps underwater communications, and is ideal for further experimentation. Xenon tubes are glass envelopes filled with a gas which emits blue/white high intensity light when energised. A high voltage potential of 210 to 400V must be applied across both anodes, A1 and A2, (see Figure 4g) which will allow the gas to 'strike' when a 3 to 5kV pulse is applied to the trigger electrode strip, located along one side of the tube. To generate the EHT triggering voltage, a pulse transformer is used which is similar in action to the well known car ignition coil (see Figure 4f), stepping up the primary (B,C) voltage to the required secondary (B,A) voltage.

Circuit Description

To generate the xenon strike voltage a simple inverter system is employed. Each half of transformer T1 secondary is connected to a power transistor (TR3 and TR4) and the common centre tap is connected to +V supply. By alternately switching each transistor on and off, one half of T1 is grounded at a time, and maximum current flows through each winding in turn. By inductive effect a 50V peak pulse develops between TR3 and TR4 collectors (across T1 secondary)

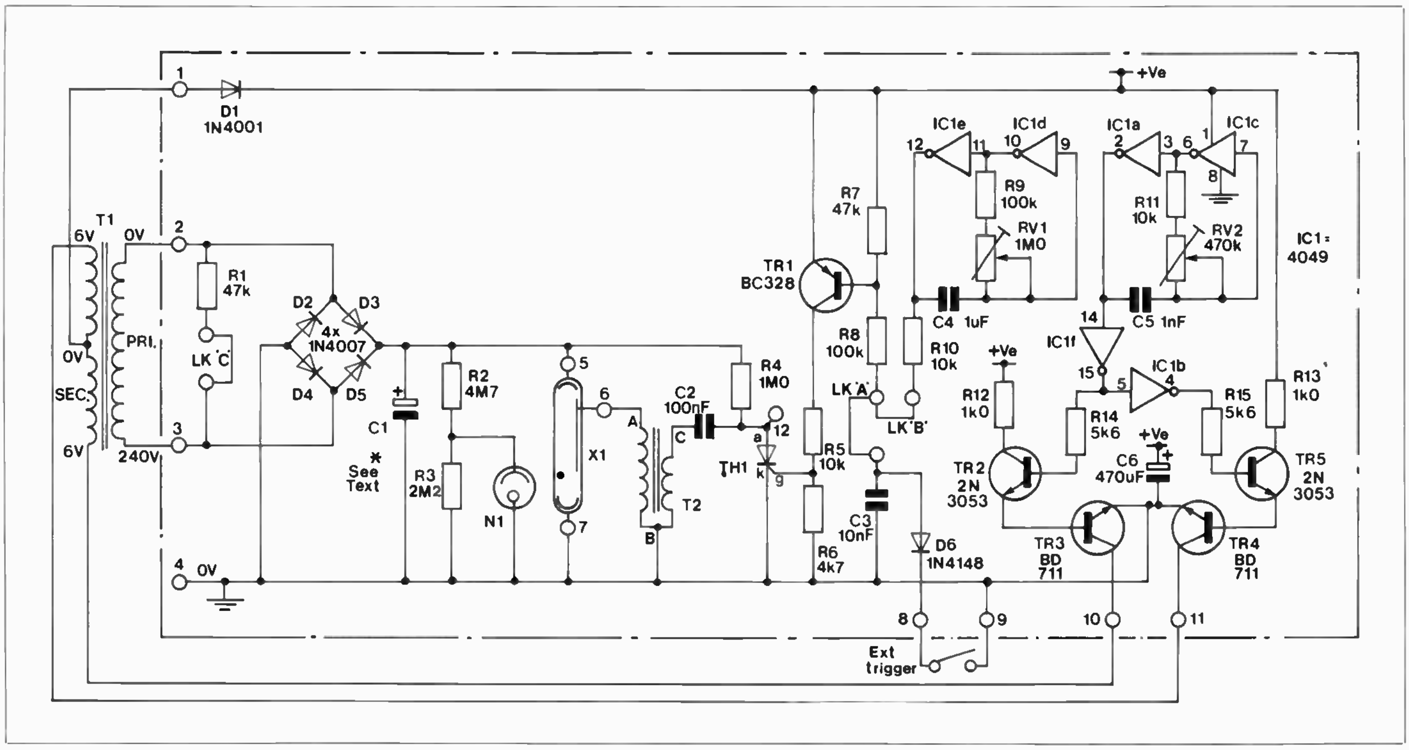
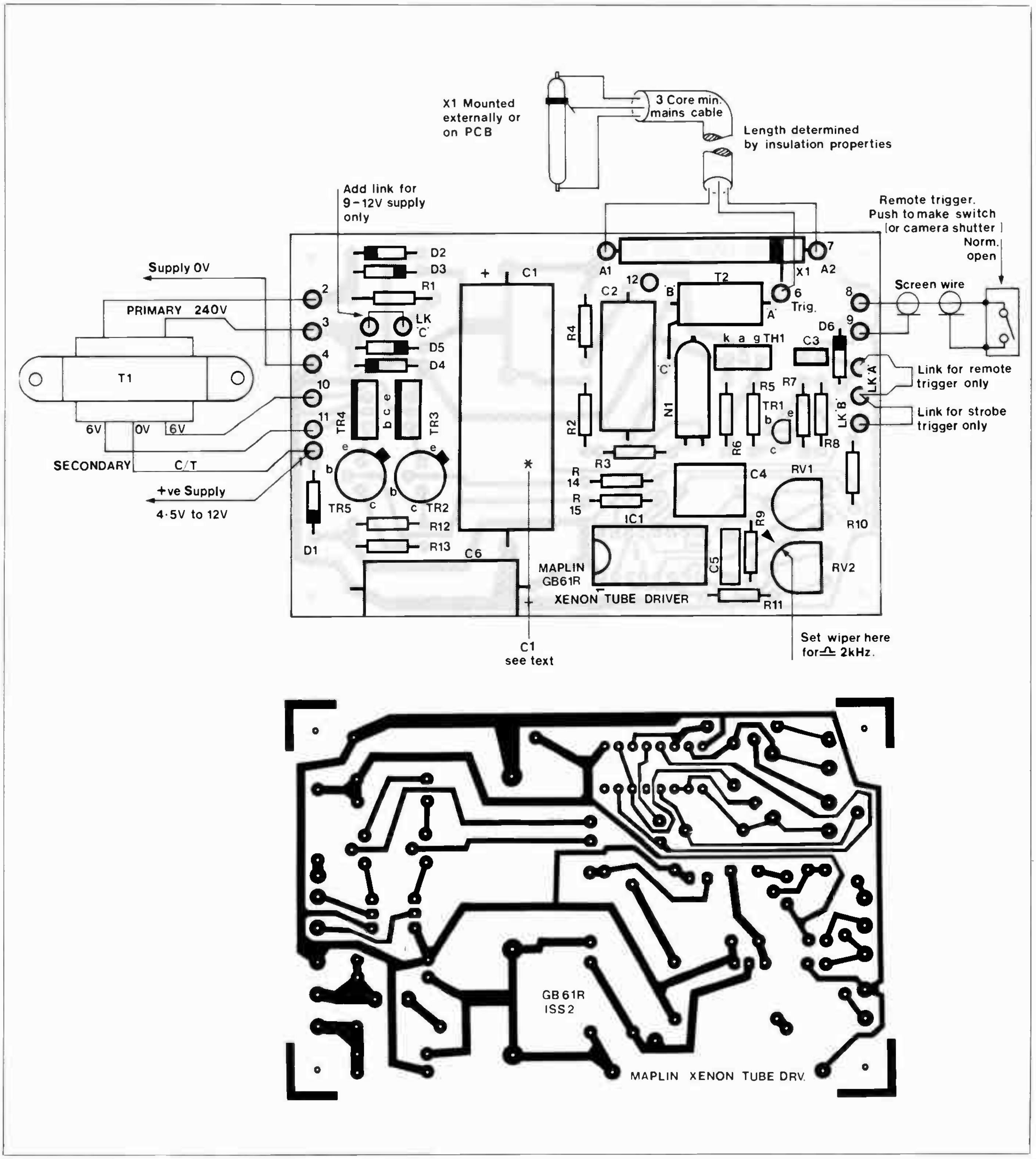


Figure 1. Circuit Diagram



Figures 2 and 3. PCB Track Legend and Wiring Diagram

which is stepped up by the primary winding approximately 20 times to produce a 1kV peak signal at pins 2 and 3. T1 is in fact a normal 240 to 12V mains transformer connected the reverse way round; instead of applying 240VAC for stepping down to 12VAC, we apply 12VAC and step it up to 240VAC, or in this case 1kVAC.

The alternating signal for switching TR3 and TR4 comes from a CMOS inverter/oscillator IC1a,c and f. IC1c has a variable resistance RV2, and R11 connected across it, which maintain the input voltage level close to the output level on pin 6. If IC1a output, pin 2, is assumed to be low (0V) capacitor C5 will start to charge via RV2 and IC1c pin 7 input will be momentarily pulled low. By inverter action IC1c pin 6 will go high (+V) maintaining IC1a pin 2 in the low state. As C5 charges, the voltage across it increases until a point is reached when IC1c input pin 7 is potentially high enough to flip the output pin 6 low, IC1a pin 2 will then change state from low to high. At this stage the voltage across C5 is reversed and a discharge path via RV2 and R11 gradually drops the potential at IC1c input until the switching level is reached and the oscillation cycle repeats. RV2 determines both charge and discharge times which can be varied from 25μs to 650μs, or between frequencies of 40kHz and 1.5kHz.

IC1f buffers the oscillator and drives the emitter follower driver transistor TR2. With output high, TR3 is turned on, IC1b goes low and TR4 is turned off. When IC1f output goes low TR3 is turned off, IC1b output switches high and TR4 turns on. C6 decouples the +VE rail and D1 helps prevent component damage in the case of supply reversals.

Once oscillation is established, D2 to D5 form a full wave bridge rectifier for charging C1. This capacitor must be of a high voltage rating, in this case 450V working, and to keep the voltage within limits, R1 can be connected across T1 primary by inserting link 'C' if necessary (see Testing).

Neon lamp N1 indicates when the C1 charge voltage is high enough to strike the xenon tube, but as neons normally conduct at around 90V, a high impedance potential divider (R2, R3) is required to set this threshold. Resistor R4 charges a high voltage capacitor, C2 via the pulse transformer primary winding (T2, c and b). By discharging C4 to ground a fast rise-time spike of several hundred volts is generated in the primary of T2 which is stepped up to some 5kV in the secondary winding thus triggering the tube. C1 discharges a high current pulse through the tube to ground and is then re-charged by the inverter.

Connecting link 'A' allows an external make switch to momentarily connect D6 to ground, TR1 base potential is lowered via R7 and R8, TR1 conducts so that a positive gating voltage appears at R5, R6. Thyristor TH1, which can be viewed as a switched diode, conducts and C2 is discharged to ground from the anode to the cathode. Immediately after discharging, C2 re-charges via R4 so that the anode voltage rises positively, under this condition TH1 would remain in a permanently conducting state, even without further control gate signals! This is obviously not what is required and somehow the thyristor must be reset to a non-conducting high impedance state. Fortunately the effect of expanding T2 primary, by discharging C2 through it, results in the coil contracting back again, thus producing a high, negative voltage, spike in the reverse direction. This is applied via C2 to TH1 – making the anode more negative than its cathode. The conducting state is thus prevented by reverse biasing the anode/cathode junction and TH1 resets to the high impedance state, under gate control.

A second CMOS oscillator runs at a lower frequency than the inverter clock and with link 'B' inserted can be used to strobe the xenon tube from approximately 0.5Hz to 6Hz. If required links A and B can both be fitted for repeat and manual triggering.

Construction

Refer to the parts list and begin by bending the resistor leads for fitting into the PCB. Do the same with diodes D1 to D6 referring to Figure 4a for orientation. Mount both presets (RV1 and RV2), IC1, TR1 and C1 to C5. Figure 4c, d and e shows lead connections for TR2 and 5, TR3 and 4, also TH1 which must be fitted correctly to the legend. Next fit pulse transformer T2 with the primary lead C exiting on the left towards C2. Now fit vero-pins P1 to 11 from the track side of the PCB and push home with a soldering iron. All components may now be soldered and excess wire ends cut off. Clean the tracks with solvent and a brush, then inspect for solder splashes, dry joints, short circuits etc. Neon N1 can be fitted either way round, but X1 must be

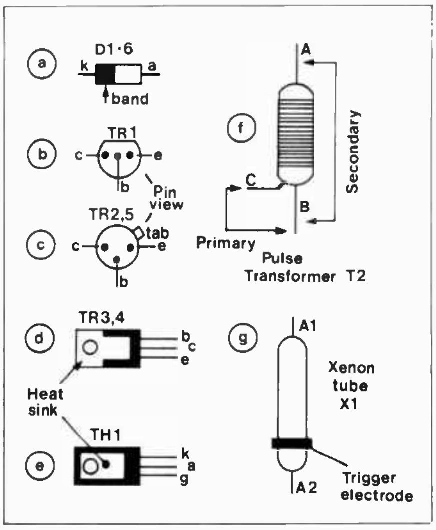


Figure 4. Component Reference

fitted with the double wire end to the right of the board. For test purposes carefully solder the anodes A1 and A2 to pins 5 and 7 respectively, and the trigger electrode directly to the component side of the PCB (Figure 3). Mount the min. mains transformer T1 with the primary (thick wires) to pins 2 and 3 and the secondary (three thin wires) to pins 10 and 11. The centre tap (middle wire) connects to pin 1 (+V). Finally re-check the construction and when completely satisfied, proceed with testing.

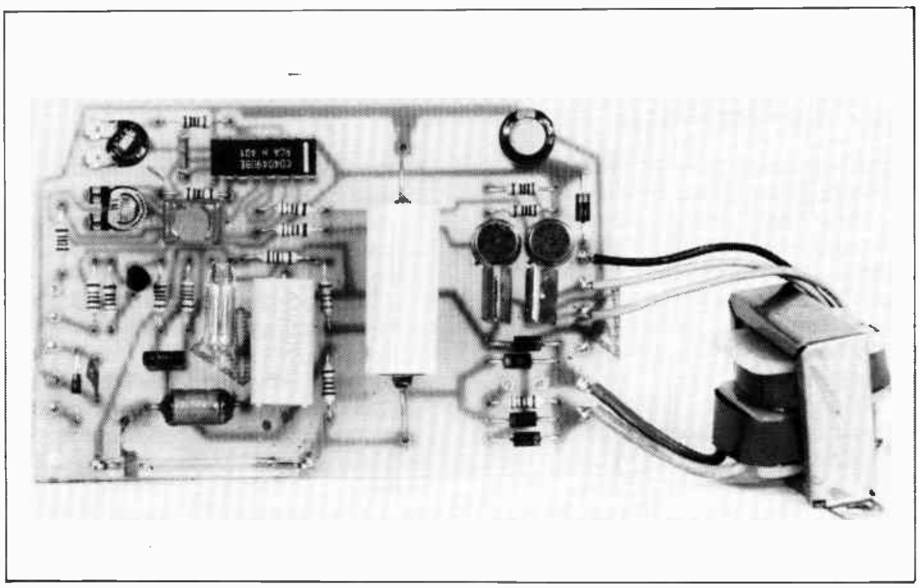
Testing

Connect a suitable power supply of from 4.5V to 12V with +V to pin 1 and 0V (−V) to pin 4. Adjust RV1 wiper to about half-travel and RV2 wiper to the arrow on the legend. Turn on the power whereupon a slight buzzing sound should be heard, after a few seconds the neon should start to glow. Now take a length of insulated wire, connect one end to 0V and momentarily touch the other end onto pin 12. The xenon tube should flash and a loud crack may be heard as the air around the tube expands; N1 will go out. If using a 9 to 12V power supply connect link 'C' to prevent excess charge across C1 and connect link 'A'. Re-apply power, wait for the neon to glow, then touch pins 8 and 9 together, once again the tube will flash. Switch off the power, discharge the system by grounding pin 12, remove link 'A' and connect link 'B'. Re-apply power, the tube should flash at approximately 1 second intervals. Adjusting RV1 will vary the flash rate slightly, but not a lot. Switch off the power, discharge pin 12 to ground and remove the +V PSU lead, leave T1 centre tap in place. Now connect an ammeter between the +V supply lead and pin 1 on the PCB, set the range to 0.5 or 1A and switch on. The final current reading will be dependent on the supply voltage, on average it should be around 80mA for a 6 volt supply. Slowly adjust RV2 clockwise or anti-clockwise until the lowest reading is found, link 'B' may have to be removed before doing this check. If a frequency counter or 'scope is available, monitor the inverter clock on IC1 pin 15, it should be close to 2kHz at minimum current setting. Also an oscilloscope connected across C1 with a 10M ohm probe should read below 450V DC with a 12V supply and link 'C' inserted. Note that link 'C' will not be necessary when using a power supply of 4.5 to 9 volts.

Strobe Rate Adjustment

Capacitor C1 is supplied as 47μF but may be reduced in value providing its working voltage is kept at 450V or more. Because the inverter source is high impedance, the charge rate for C1 is slower for larger capacitance values and faster for smaller values. The final value chosen will depend upon the use to which the module is to be put. Thus faster strobe oscillator times will require C1 being lower in value, say 10μF or less, to increase the oscillator frequency still further, C5 can be reduced in value.

One major effect of reducing C1 in value is a reduction in discharge current through the tube, hence a reduction in light output, so this must be borne in mind when selecting C1. If it is required to use the 47μF value for C1, but light intensity needs to be variable, link 'C' can be inserted and the value of R1 decreased to suit.



XENON TUBE DRIVER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film Unless Specified

R2	4M7	1	(M4M7)
R3	2M2	1	(M2M2)
R4	1M	1	(M1M)
R5,10,11	10k	3	(M10K)
R6	4k7	1	(M4K7)
R1,7	47k	2	(M47K)
R8,9	100k	2	(M100K)
R12,13	1k	2	(M1K)
R14,15	5k6	2	(M5K6)
RV1	Hor Encl Preset 1M	1	(UH09K)
RV2	Hor Encl Preset 470k	1	(UH08J)

CAPACITORS

C1	Axial 47μF 450V	1	(FB43W)
C2	IS Cap 0.1μF	1	(FF56L)
C3	Disc 0.01μF 50V	1	(BX00A)
C4	Poly Layer 1	1	(WW53H)
C5	Poly Layer 0.001	1	(WW22Y)
C6	Axial 470μF 16V	1	(FB72P)

SEMICONDUCTORS

D1	1N4001	1	(QL73Q)
D2-5	1N4007	4	(QL79L)
D6	1N4148	1	(QL80B)
TR1	BC328	1	(QB67X)
TR2,5	2N3053	2	(QR23A)
TR3,4	BD711	2	(WH15R)
TH1	C106D	1	(QH30H)
IC1	4049UBE	1	(QX21X)

MISCELLANEOUS

T1	Sub-Min Tr 6V	1	(WB00A)
T2	4kV Trigger Transfmr	1	(YQ63T)
N1	Wire Neon	1	(RX70M)
X1	Xnn Tube High Energy	1	(YQ62S)
	Pin 2141	1 Pkt	(FL21X)
	Xenon Tube Dr PCB	1	(GB61R)
	DIL Socket 16-pin	1	(BL19V)
	Constructors' Guide	1	(XH79L)

A complete kit of parts is available for this project:
Order As LK46A (Xenon Tube Driver Kit)

MAPMIX *Continued from page 21*

sockets can now be inserted and soldered in position, noting that SK4 and SK8 are stereo jacks with six terminals. Fit both latch switches with the sprung ends protruding over the PCB edge and solder in place. Now fit the single potentiometers RV1 to RV6 with the spindles protruding over the same edge of the PCB and solder in place; finally do likewise with the three dual potentiometers RV7 to RV9.

Closely inspect all solder joints, for excess solder, shorts, dry joints etc, and clean the PCB track with a suitable solvent. Re-check all components, values etc and when satisfied insert ICs 1-3 into their respective sockets. Then connect the PP3 type battery clip with the red (+V) to pin 1 and the black (−V) to pin 2.

If the dual VU meter is being used then it must be wired to the PCB pins 3,4 and 5 (see Figure 3) using hook-up wire.

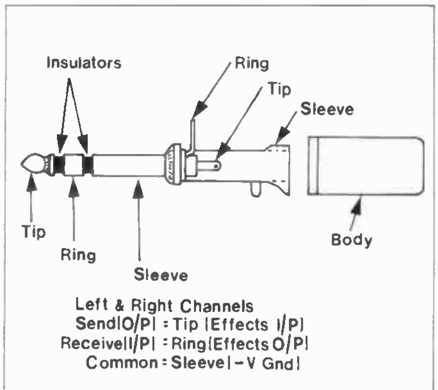


Figure 5 Stereo Jack Connections

Both −V terminals on the meter movements should be joined together and connected to −V supply pin 5, as shown.

Using the Mixer

Details of connection to an external power supply are shown in Figure 4.

The inner terminal of SK11 is connected to −V and the outer spring contact to +V. Do not exceed 13.5V as some component working voltages may be exceeded; note that when a plug is inserted into SK11 the battery is disconnected.

The connections to the send and receive jacks are shown in Figure 5, send outputs (tip) carry the signal from the mixer to external equipment and receive inputs (ring) carry processed signals from the equipment to the mixer. The sleeve terminal is for screen connection or earth return.

It should be borne in mind when using the mixer that amplification is low, the unit does not act as a pre-amplifier. Thus when mixing microphone, musical instrument or line output levels, as recommended, an amplifier with integral pre-amp or a power amp and suitable pre-amp should be used.

MAPMIX PARTS LIST

RESISTORS: All 0.6W 1% Metal Film Unless Specified

R1-8,22,23,27,28, 30,31,35,36	100k	16	(M100K)
R9,19	68k	2	(M68K)
R10,20,39,40	10k	4	(M10K)
R11,12	1k	2	(M1K)
R13-18	47k	6	(M47K)
R21,24,25,26	18k	4	(M18K)
R29,32,33,34	15k	4	(M15K)
R37,38	270Ω	2	(M270R)
RV1-6	Pot Log 47k	6	(FW24B)
RV7,8	Dual Pot Lin 100k	2	(FW88V)
RV9	Dual Pot Log 10k	1	(FX09K)
RV10,11	Hor Encl Preset 47k	2	(UH05F)

CAPACITORS

C1-6	Polyester 0.22μF	6	(BX78K)
C7-10,13,14,27,28	Tant 4.7μF 16V	8	(WW64U)
C11,12	Ceramic 22	2	(WX48C)
C15-18	Poly Layer 0.0047	4	(WW26D)
C19-22	Mylar 0.047	4	(WW20W)
C23,24	Minelect 10μF 16V	2	(YY34M)
C25,26	PC Elect 100μF 10V	2	(FF10L)

SEMICONDUCTORS

D1	1N4002	1	(QL74R)
IC1,2	LF442CN	2	(QY30H)
IC3	LF444CN	1	(QY31J)
TR1,2	BC547	2	(QQ14Q)

MISCELLANEOUS

SK1-3,5-7,9,10	Mono PCB 1/4" J/Skt	8	(FJ00A)
SK4,8	Stereo PCB 1/4" J/Sk	2	(FJ05F)
SK11	PC Mtg Power Socket	1	(RK37S)
S1,2	Latchswitch 2-pole	2	(FH67X)
M1	Dual VU Meter	1	(YQ47B)
	Sm Latchbutton Black	2	(BW13P)
	Knob K7A	9	(YX01B)
	Pin 2141	1 Pkt	(FL21X)
	PP3 Clip	1	(HF28F)
	Mapmix PCB	1	(GB60Q)
	DIL Socket 8-pin	2	(BL17T)
	DIL Socket 14-pin	1	(BL18U)
	Constructors' Guide	1	(XH79L)

OPTIONAL

	Mapmix Case	1	(XG38R)
	Mapmix Front Panel	1	(FJ36P)

A complete kit of parts, excluding optional items, is available for this project: **Order As LK49D (Mapmix Kit)**

EIGHT-CHANNEL FLUID DETECTOR

by Nigel Fawcett

Introduction

This project, as the title suggests, is a variation of the very popular fluid detector circuit, only here it has been taken a stage further, and has thereby increased the range of applications for such a device. The project came about as the result of building a darkroom and workshop into a garage which required a sink with hot and cold running water. Getting the water in was no problem, but getting it out again was a different matter. The garage was considerably lower than the house, and did not have immediate access to any main drainage point.

The only solution was to pump the water back up to house level, and thereby into the normal domestic waste system. The waste from the garage sink emptied into an expansion tank of the kind used in central heating systems, and was pumped out again with a self-priming pump purloined from a redundant washing machine. It was here that the need for a fluid detector lay. A means of determining the presence of water was required to switch on the pump. However, it was foreseen that a greater inflow of water than the pump could reasonably handle might occur. To overcome this problem, eight separate channels were incorporated to detect the increasing level of water in the tank, and so indicate the effectiveness of the pump.

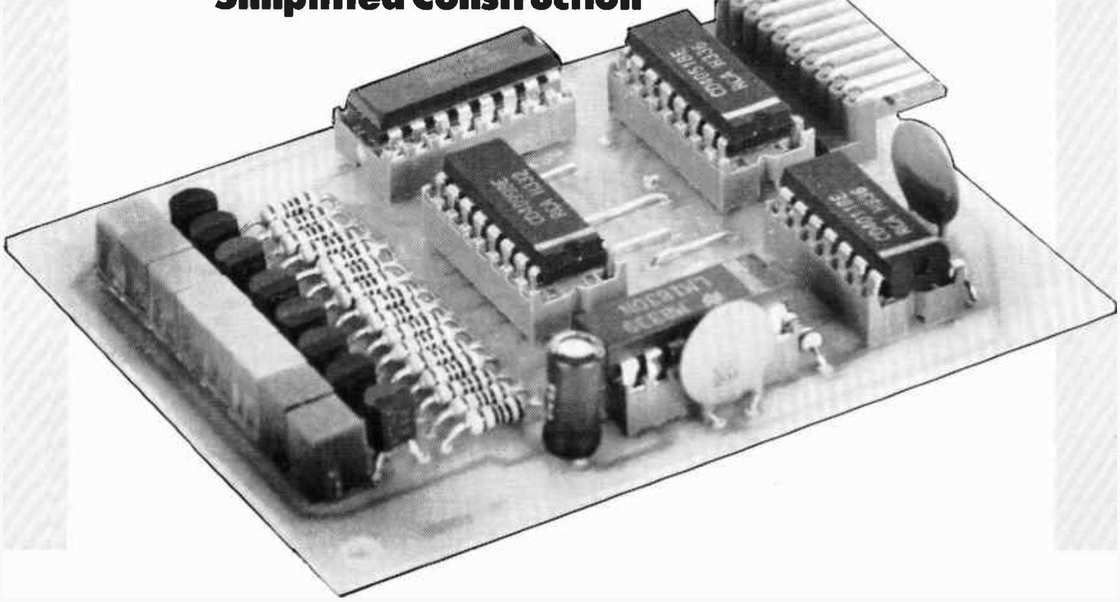
Circuit Description

At the heart of the circuit (see Figure 1) is the LM1830 fluid detector chip IC2. This is the type of IC commonly found in drinks vending machines, washing machines, and a whole host of other domestic and industrial appliances. It is a well designed IC which includes an A.C. current to the probes to alleviate the problem of plating. The output is also pulsed, and can be used to drive a speaker or LED directly, but in this instance an 'on' or an 'off' condition was required to interface with the CMOS digital part of the design. This is achieved by the reservoir capacitor C4, which smooths the oscillator output, and the pull-up resistor R2.

The IC detects the presence of water by comparing the resistance across the probes with an internal resistor. One probe is connected to ground, whilst the other is connected to pin 10 of the IC. In this particular design, eight independent probes are connected to the single 8-channel analogue multiplexer/demultiplexer IC1. Each of the channels is scanned approximately once a second, and during the scan time IC2 checks for the presence of water (conductive fluid). If water is detected than the output of IC2 goes high and is written into the latch corresponding to the input channel of the 8-bit addressable latch IC3.

Both IC1 and IC3 have a three bit address bus to select the desired

★ **8 LED's Indicate Fluid Level or Monitor up to 8 Separate Levels**
★ **Based on LM1830 IC – Simplified Construction**



channel, and the addressing for the chips is provided by half of the dual decade counter IC5. The clock for the counter is formed from two of the dual input NAND gates of IC4, R1 and C1. The other two gates of IC4 and the other counter of IC5 are used to produce a short pulse during each scan cycle, to ensure that data is only written into the output latches when IC2 has had time to sense the fluid and settle down. The outputs from the latch are then used to drive the eight LED's and their associated circuitry. In the application described in the introduction, the LED's for channels 1-6 were green and channels 7 and 8 were red. This provided visual stimulation when things were getting dodgy. In practice the colours chosen will depend on the application (see applications). It should be noted here that a remote lead was taken from channel one output to a separate board which was used to switch the pump on or off.

Construction Details

All the components are fitted on the printed circuit board (see Figure 2). Start by inserting, and soldering, the wire links and resistors, proceed with the IC sockets, capacitors, PL1, the transistors and LED's, and finally insert the integrated circuits into their respective sockets. Normal MOS handling precautions should be observed with the CMOS integrated circuits, with care to ensure correct orientation. PL1 is a ten pin connector, but only nine pins are required, and in fact there are only nine holes in the PCB, so pin one must be removed from the plug before it can be mounted on the board. This is easily achieved with a small pair of radio pliers.

A twelve volt power supply is required and, although no construction details are described here, a suitable

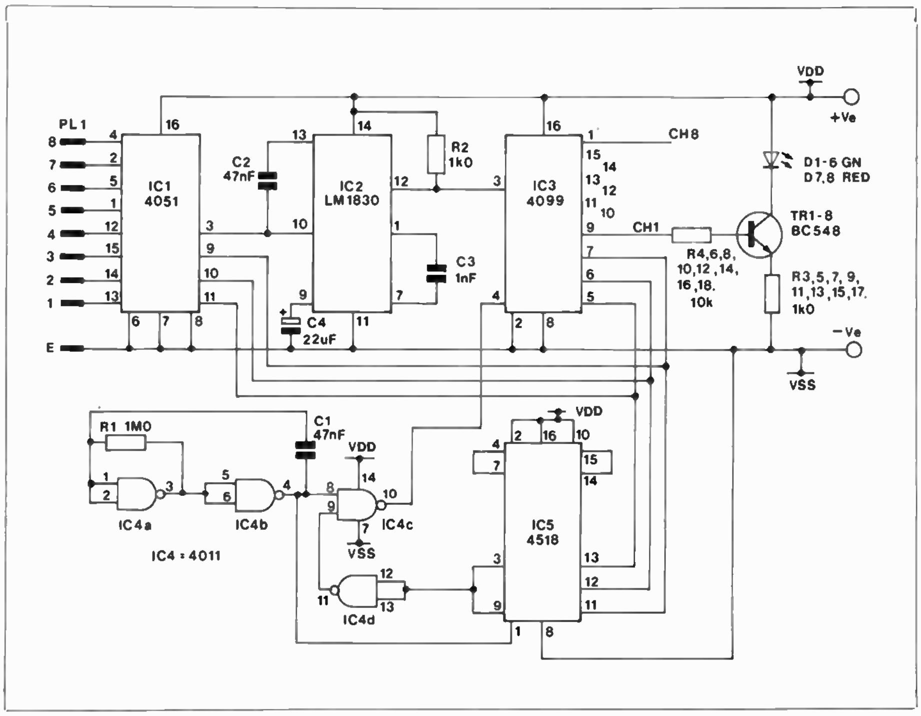


Figure 1. Circuit diagram

circuit can be found in the semiconductors section of the Maplin catalogue under regulators. As far as the construction of a probe is concerned, it would be beyond the realms of practicability to attempt the description of a suitable design, since it depends entirely on the application. The receptacle containing the fluid may be small or large, shallow or deep. There may be one individual container or up to eight separate ones. There may not even be a container at all (see applications). In many applications however, a simple narrow piece of copper strip Veroboard can be employed, using the strips horizontally, choosing appropriate strips for the particular levels, and connecting the ground terminal to the bottom strip.

Applications

Up to this point, most of the references to utilising this project have revolved around using all eight channels to monitor the fluid 'level' in a container. In the previous paragraph it was suggested that the various channels could in fact be used quite independently or in groups of any number. To explain this further, consider the following three applications for which the circuit has already been gainfully employed. Case one is for use in a car and is really rather a novel idea. The purpose here is to use the project to give a continuous visual indication of the amount of water in the windscreen washer bottle. When used in this way, the red LED's should be

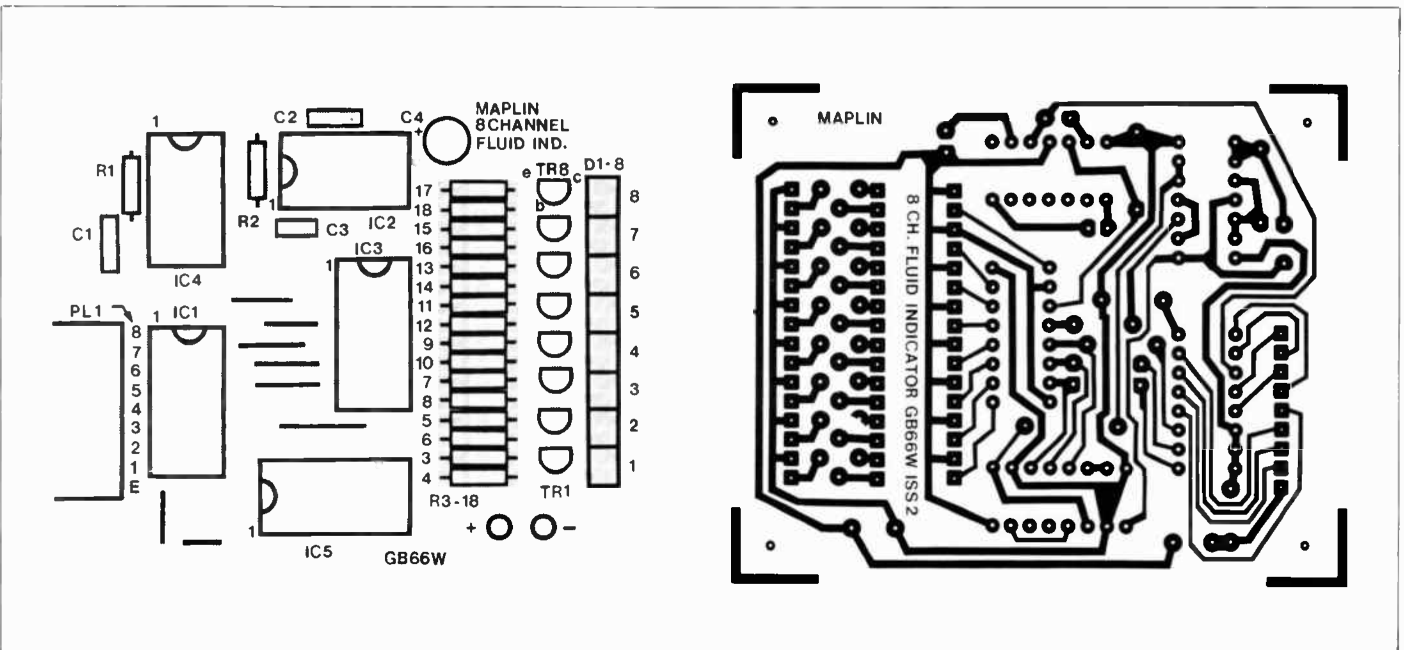
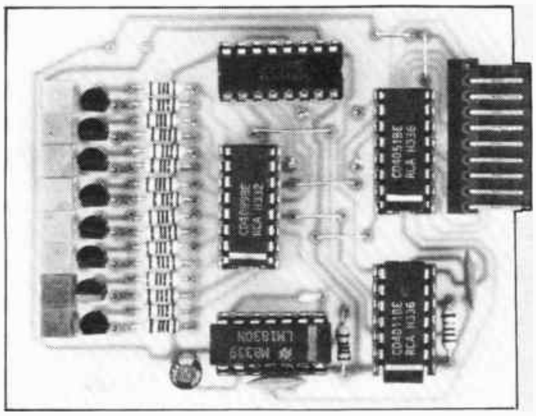


Figure 2. PCB track and layout

inserted in the positions for channels one and two, as a warning condition is now required when the water content is getting low. If you are using the idea in an estate car or any other car with a rear window washing facility then use two probes; channels 1-4 for one bottle and channels 5-8 for the other, and this time insert one red LED in channel one and the other in channel five. The strip of Veroboard was found to be ideal in this application.

Case two was for an installation which had a number of large tanks. These gradually drained over a period of time but when they got down to a predetermined level they were to be refilled by opening an electronically controlled valve. Here two channels were used for each tank, one channel opening the valve when fluid dropped below the minimum level, and the other closing the valve when the tank was full. Four tanks were able to be controlled by the one board.

Case three was for use in a nurseryman's greenhouses. The grower in question used mist sprayers in his houses which gave the plants a good spraying whenever the water had evaporated from the surface of the probes, which were placed at regular intervals between the plants. The mist was turned off again when enough water had fallen to bridge the gap on the probe and therefore detect the presence of water again. As he grew a large number of different plants at different temperatures and humidity, he was able to use each channel separately to give individual monitoring and control for all the environments he required.



There are obviously a great many more ways in which this circuit could be used, and these suggestions are only here to demonstrate the wide range of uses in which this project may be put to work.

8 CHANNEL FLUID DETECTOR PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1	1M	1	(M1M)
R2,3,5,7,9,11, 13,15,17	1k	9	(M1K)
R4,6,8,10,12, 14,16,18	10k	8	(M10K)
CAPACITORS			
C1,2	Minidisc 0.047μF 16V	2	(YR74R)
C3	Ceramic 1000	1	(WX68Y)
C4	PC Elect 22μF 25V	1	(FF06G)
D1-6	Shape LED R1 Green	6	(YY46A)
D7,8	Shape LED R1 Red	2	(YY45Y)
TR1-8	BC547	8	(QQ14Q)
IC1	4051BE	1	(QW34M)
IC2	LM1830	1	(YY99H)
IC3	4099BE	1	(QW57M)
IC4	4011BE	1	(QX05F)
IC5	4518BE	1	(QX32K)
SEMICONDUCTORS			
PL1	RA Lch PCB P1 10W	1	(RK68Y)
	DIL Socket 14-pin	2	(BL18U)
	DIL Socket 16-pin	3	(BL19V)
	8 Ch Fluid Dctr PCB	1	(GB66W)
	TC Wire 0.9mm 20swg	1 Rl	(BL13P)
	Constructors' Guide	1	(XH79L)
	8ch Fluid Detector Ins	1	(XK71N)

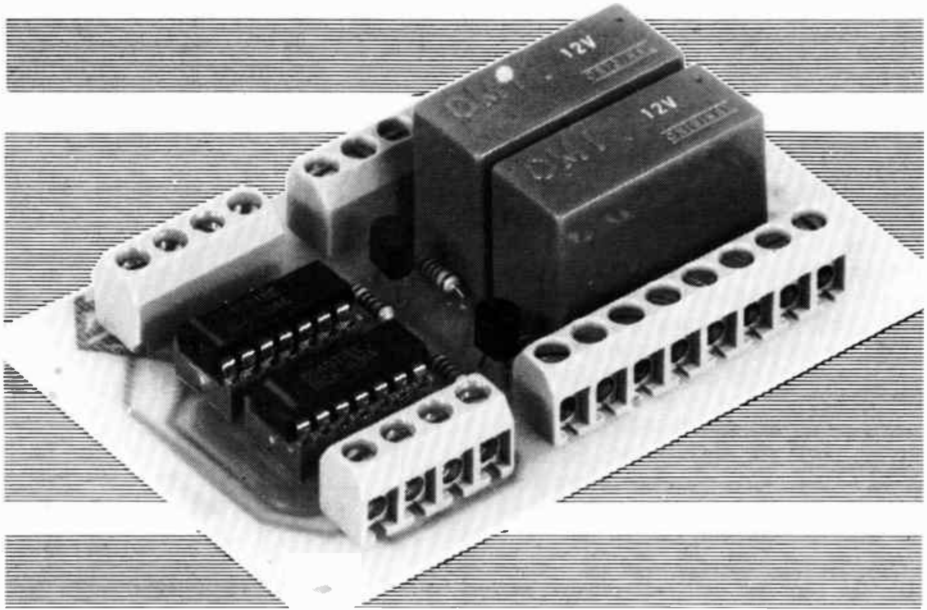
A complete kit of all parts is available for this project:
Order As LK48C (8 Ch Fluid Dtctr Kit)

MAINS CONTROLLER
FOR 8-CHANNEL FLUID DETECTOR

by Nigel Fawcett

To follow the previous 8-channel fluid detector project here is some more detailed information on how to use the digital outputs to control mains devices. The first, and simplest form, is to replace any of the LED's with the coil of a relay. This is achieved by removing the 1k load resistor (R3, 5, 7, 9, 11, 13, 15, 17 depending on which channel is being used), and replacing it with a 100 ohm resistor. The LED is also removed and this is replaced by the coil of the relay. The relay should have a coil resistance of approximately 300 ohms, and a nominal voltage of 12V DC. The modified output stage is shown in Figure 1.

If a channel is used to switch the mains and the LED is also required then the circuit shown in Figure 1 is needed in addition to the output stage on the Fluid Detector PCB. A flying lead from the IC side of the 10k resistor (IC3 and R4, 6, 10, 12, 14, 16, 18, depending on which channel is being used) must be taken to a separate board with the relay drive circuit on it. Refer to Figure 2. This modification satisfies the requirements of the nurseryman and his greenhouse mist sprayers, as described in the previous article.



The second and more complicated control circuit is used, for example, where a tank is gradually filling up with water, which must be pumped out to prevent the tank from overflowing. In addition, the water flowing into the tank can be turned off by mains controlled valves. It is decided that the pump should not start emptying the tank until it is half full, but should continue to pump out the contents until the tank is empty. If the inflow of liquid exceeds the outflow and the tank becomes full, then the inlet valves must be closed and remain closed until the tank is half empty. The requirements for the pump and the inlet valves

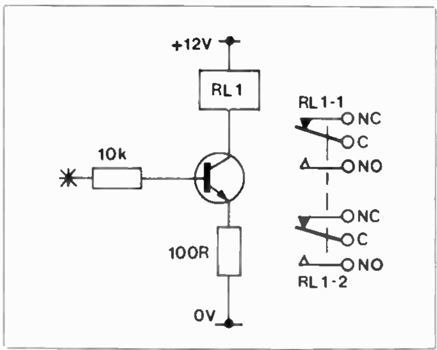


Figure 1. Relay driver

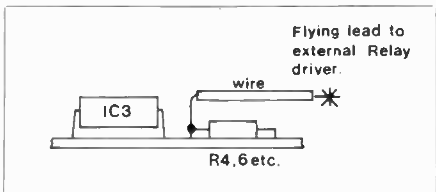


Figure 2.

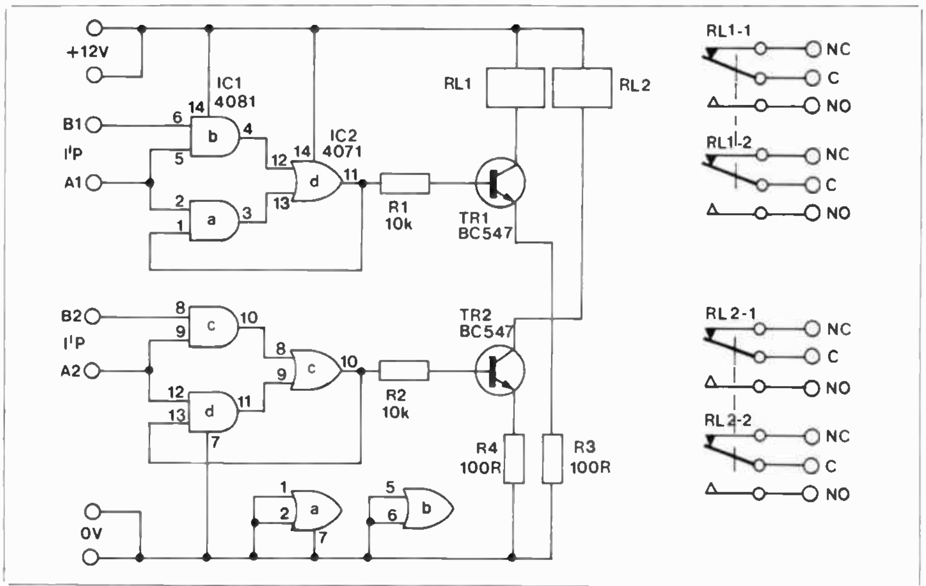


Figure 3. Circuit diagram

are actually the same, so two identical circuits are required. The logic for the circuit shown in Figure 3 is that the relay should be energised when two separate inputs are both 'high' and remain energised until both return to the 'low' state. In point of fact, only the 'A' input need go 'low' to release the relay, but the application hardware ensures that the 'B' input must already be logic 'low' before the 'A' input also becomes 'low'.

This second modification is the one that was used for the darkroom/workshop described previously, Figure 5 demonstrates this application in use.

Circuit Description

The circuit consists of two identical circuits, each of which comprise two AND gates, one OR gate, a relay driver and a relay. The 'A' input is used as the control input and is connected to both of the AND gates. The 'B' input is connected to one of the AND gates, and the outputs from the AND gates are in turn connected to the inputs of the OR gate. The output from the OR gate is used to control the relay, but is also fed back to the input of the other AND gate. When 'A' and 'B' are both low then the inputs to the OR gate are also low, holding the output low as well. When the 'A' input is taken high nothing changes, but when the 'B' input is also taken high the output from that AND gate goes high and in turn the OR gate output goes high, this switches the relay driver, but as the output is also fed back to the second AND gate, the output from the OR gate is latched high even when the 'B' input returns to the low state. The OR gate output will only return low when 'A' is also returned to the low state. In this way 'A' and 'B' can represent different fluid levels as output by the fluid detector board.

Construction

All components are fitted on the printed circuit board (see Figure 4). Start by inserting, and soldering the resistors, proceed with the IC sockets and PC terminals, followed by the transistors and the relays. Finally insert the IC's into their sockets. The 12V power supply is taken from the 8-channel fluid detector. Provision has been made on the PC terminals for the relays, for connecting earth wires, one of these should be taken to the earth point on the power supply.

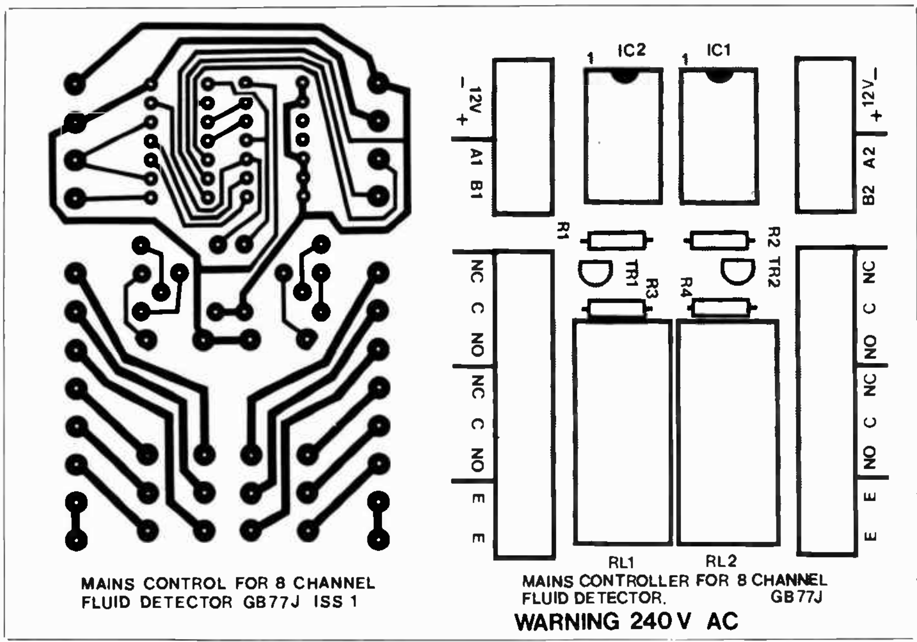


Figure 4. PCB track layout and overlay

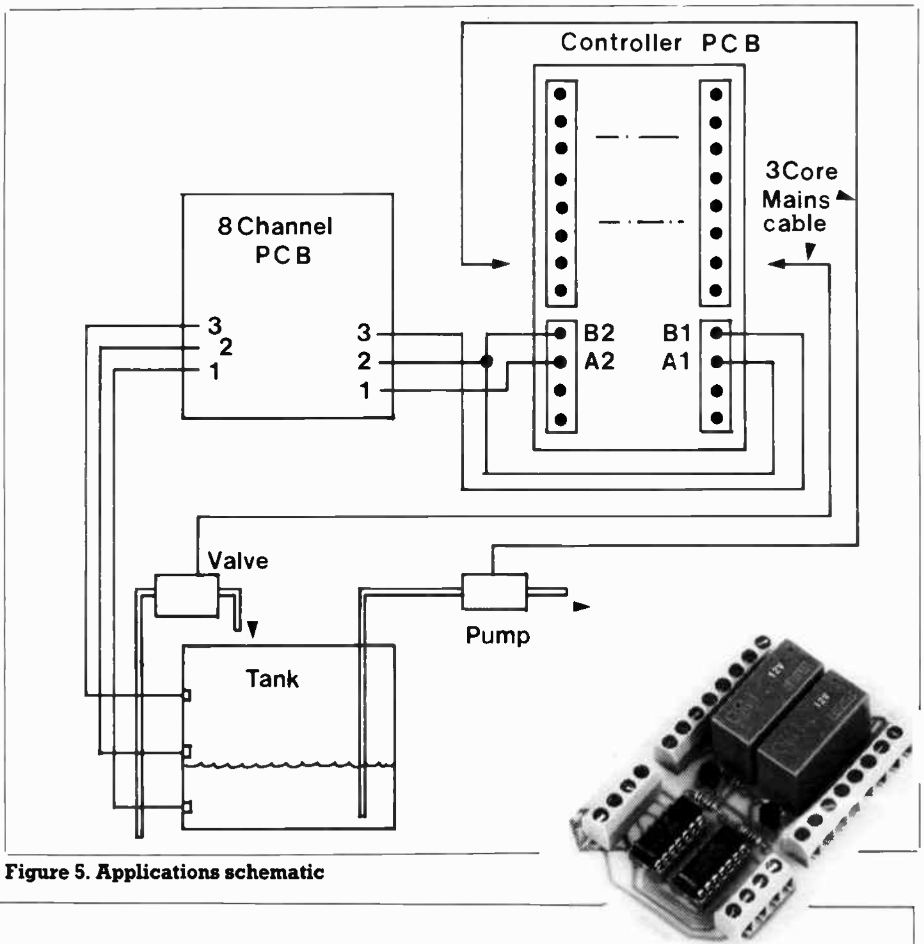


Figure 5. Applications schematic

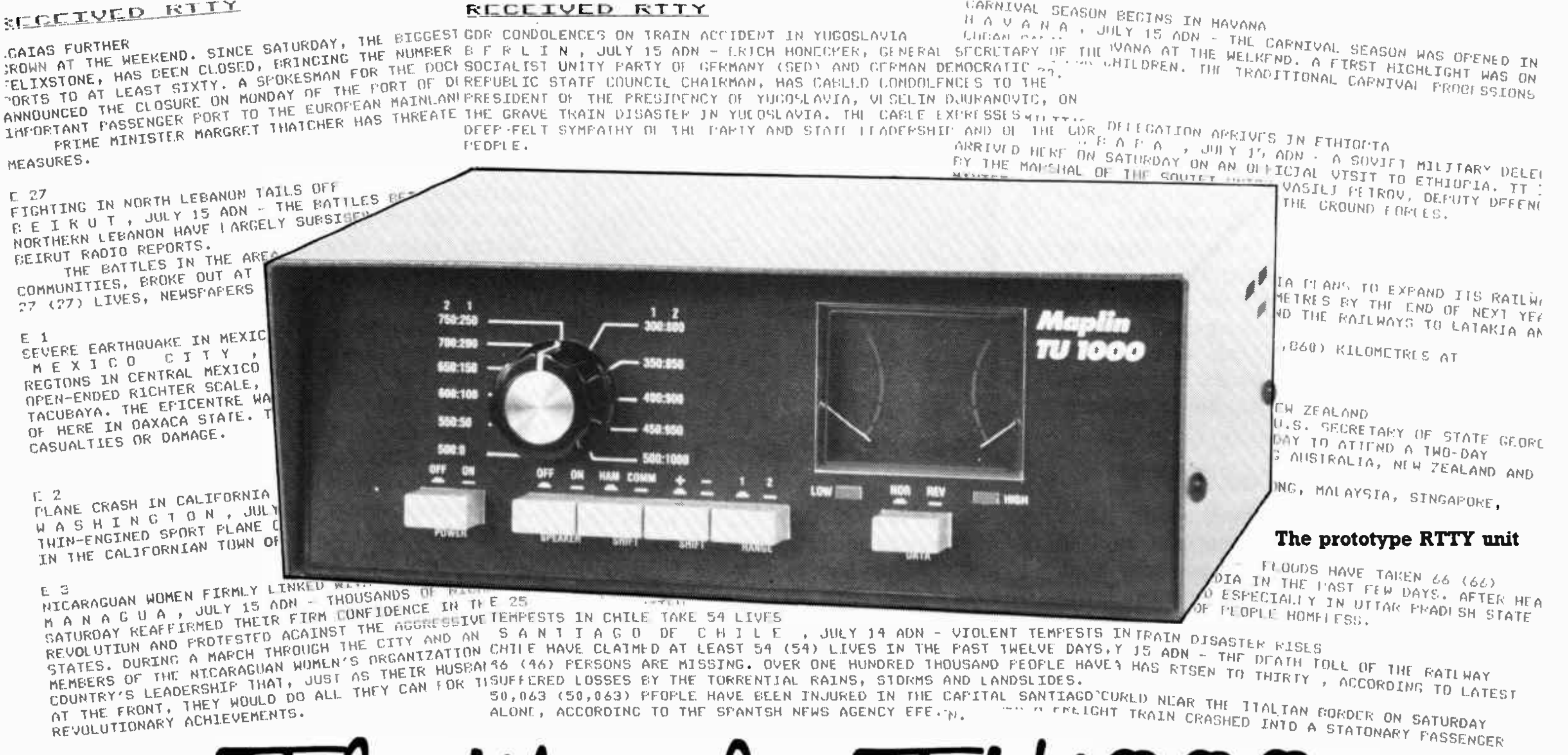
MAINS CONTROLLER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1,2	10k	2	(M10K)
R3,4	100Ω	2	(M100R)
SEMICONDUCTORS			
TR1,2	BC547	2	(QQ14Q)
IC1	4081BE	1	(QW48C)
IC2	4071BE	1	(QW43W)
MISCELLANEOUS			
RL1,2	5A Mains Relay	2	(YX98G)
	Mains Cntrllr PCB	1	(GB77J)
	4-way PC Terminal	2	(RK73Q)
	8-way PC Terminal	2	(RK38R)
	DIL Socket 14-pin	2	(BL18U)
	Constructors' Guide	1	(XH79L)
	8ch Mains Controller Ins	1	(XK72P)

A complete kit of all parts is available for this project:
Order As LK59P (Mains Controller Kit)

The Printed Circuit Board is also available separately:
Mains Cntrllr PCB **Order As GB77J**



The prototype RTTY unit

The Maplin TU1000 RTTY Terminal

Introduction

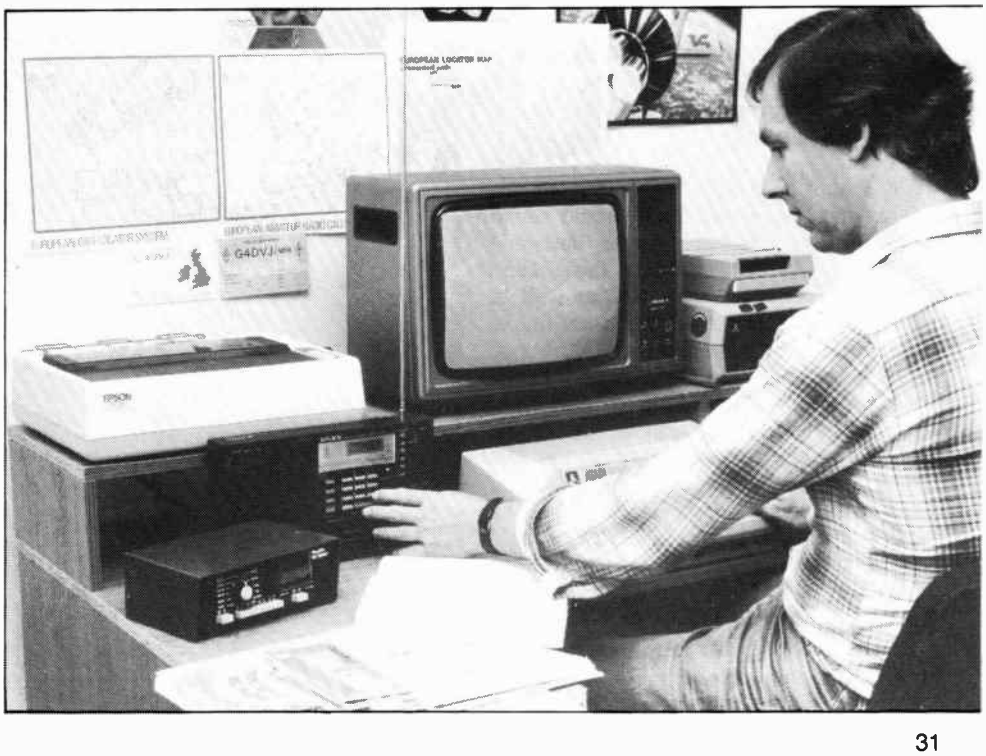
Home computers are mostly used for games and educational applications, but if you are looking for more than this, computer communications may be the answer. Many of you have probably heard of computers 'talking to each other', using a telephone modem. The major drawback to this system is the expense of running it. Telephone charges can run into pounds, for just a few minutes usage, though obviously this will depend on the distance and the time of the day. Transatlantic hook-ups are, therefore, prohibitively expensive and unless you are very wealthy, out of the question.

An alternative is not to use the telephone network, but use radio communications instead. The advantages are that there are no charges for hooking-up and no distance limitations. There is one slight problem: to use the system for sending data, you must have a licence to use a radio transmitter. However, no licence is required to *receive* data! This in itself is an interesting and absorbing pastime.

With a modest communications receiver it is possible to receive data transmitted by radio amateurs from all over the world. The short wave bands also abound with commercial stations sending news, weather reports and many other services, 24 hours a day. This system of typed data by radio, referred to as 'radio teletype' or abbreviated to RTTY, has been in use for many years.

by Chris Barlow

- ★ **RS232 Compatible**
- ★ **Fixed or Variable Tone Shifts**
- ★ **Receive and Transmit**
- ★ **Visual Tuning Aid**
- ★ **VCO Controlled Filters**



The system uses two audio tones which represent the two logic conditions, high or low, to control a mechanical teleprinter, or an ever increasing number of computer-based VDU systems.

The TU1000 has been developed for the purpose of demodulating the received audio tones into RS232 logic signals that a home computer, with the necessary software, can display. The TU1000 also offers audio output tones controlled by your computer for transmitting RTTY data.

The History of RTTY

As previously mentioned, RTTY dates back to the beginning of the 20th century and the code used goes back even further. In 1874 a Frenchman, Emile Baudot, formulated a five-unit code to control an electro-mechanical system. In 1903, Donald Murray modified Baudot's code to run his time division multiplex system which was used by the British Post Office. This code, although modified slightly over the years, is still referred to as the Baudot Code under the auspices of the International Telecommunication Union.

The earliest recorded use of radio teletype was in 1904 during the Russo-Japanese war, for military and civilian purposes. The first use of encrypted radio teletype signals was in the two world wars for communicating secret messages between military positions. Encryption, or 'scrambling' of the message, is still in use today for confidential and restricted information by various factions world-wide, although the majority of stations send messages in plain language.

The Baudot Code

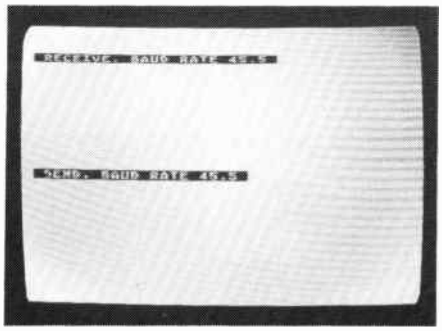
The code has five data bits, or elements, so there are only thirty-two possible characters to be interpreted. The alphabet takes twenty-six of the code values, which leaves six for control functions, null or no data, return, line-feed, space, letters and figures. The last two speak for themselves. 'Letters' puts the printer, or VDU into upper case A to Z and 'Figures' gives numbers 0 to 9, fifteen punctuation marks, and the 'bell' command.

If the 'bell' code were sent, on the receiving teleprinter a bell would sound to alert the operator to an incoming message. As you can see, the system does *not* support lower case as well as numbers and punctuation marks, unlike the majority of home computer displays.

A complete list of the Baudot Code, showing letters and figures, plus their decimal and hexadecimal values, is shown in Figure 1. Apart from the five data bits, the system uses 1 start bit and 1½ stop bits, although, in practice, you can set your RS232 port to 1 or 2 bits, if 1½ is not available.

The Two-Tone System

As stated in the introduction, RTTY uses two audio tones to represent the logic conditions high or low, commonly



referred to as mark and space tones. The mark produces the negative RS232 output and the standing tone when no data is being sent. The space tone gives the positive RS232 output and is generated when the RS232 input is taken positive.

The frequency difference of the tones can vary considerably but, in practice, three are used; 170Hz, 425Hz and 850Hz. The TU1000 has these three shifts, plus the ability to be tuned continuously up to a difference of 1000Hz between tones.

The space tone recognised by the TU1000 is 1275Hz. The mark is higher in frequency at 1445Hz for a 170Hz shift, 1700Hz for 425Hz, and 2125Hz for 850Hz shift.

The rate of change between the tones, or baud rate, has to be configured on your computer's RS232 port to resolve the incoming data correctly. Radio amateurs use baud rates of 45.45 or 50. Commercial stations tend to use 50, or 75 bauds, upwards.

LETTERS	FIGURES	DECIMAL	HEXA-DECIMAL
A	-	3	03
B	?	25	19
C	:	14	0E
D	$	9	09
E	3	1	01
F	! or %	13	0D
G	& or +	26	1A
H	£ or #	20	14
I	8	6	06
J	' or bell	11	0B
K	(	15	0F
L	)	18	12
M	.	28	1C
N	,	12	0C
O	9	24	18
P	0	22	16
Q	1	23	17
R	4	10	0A
S	bell or '	5	05
T	5	16	10
U	7	7	07
V	;	30	1E
W	2	19	13
X	/	29	1D
Y	6	21	15
Z	"	17	11
return	return	8	08
line feed	line feed	2	02
space	space	4	04
letters	letters	31	1F
figures	figures	27	1B
not used	not used	0	00

Figure 1. The Baudot Code

Circuit Description

The audio tones from the speaker or earphone socket are fed into the TU1000 via a two pin speaker DIN socket. The signal passes through choke CH1 and capacitor C1, to S1, the speaker on/off switch. The switch, when in the off position, connects the output of the receiver to a 10 ohm resistor to simulate a loudspeaker load. This facility is provided to mute the sound while maintaining the signal to the TU1000. When S1 is pressed in, the signal is fed, via CH2 and C2, to another two pin speaker DIN socket connecting your loudspeaker or earphone. The reason the incoming and outgoing signals go via the two chokes and capacitors, is to prevent any stray radio frequencies from entering the TU1000, if you use an amateur radio transmitter.

The audio signals passing through the system are tapped off S1 via the passive filter components R2, R3, C3 and C4 into IC1. IC1, with diodes D1 and D2, amplify the audio signal and limit the output to approximately 1 volt. This stage will provide limiting for an input as low as 10 millivolts. The limiting action is provided in order that the volume setting of the receiver and the fading radio signal are maintained to a constant level within the range of the circuit. At this stage, the frequencies are not separated for mark and space. The splitting of mark and space tones is achieved by feeding the output of the limiter to IC2 (MF10).

The MF10 is a dual switched capacitor filter. It offers two independent filter blocks controlled by a clock generator and, in the mode I have selected, the frequency passed by the filters is 100 times less than the clock frequency. That is, for a filter frequency of 1275Hz, the clock must run at 127.5kHz. The passband, or width of the filter, is very narrow because the difference between tones can be as little as 170Hz. There are two clock frequencies required to drive each filter. These clocks are generated by IC3 and IC4, which are voltage controlled oscillators. IC4's frequency is set by RV5, which is 127.5kHz. IC3 produces the clock frequencies for the mark filter, by switching in RV1 to RV4, setting the voltage controlled oscillator to 144.5kHz, 170kHz and 212.5kHz. These are the necessary shifts for 170Hz, 425Hz and 850Hz. RV1, 2 and 3 are preset potentiometers, while RV4 is a front panel potentiometer for the variable shift whose range is from almost 0 up to 1000Hz. IC's 3 and 4 also provide clock outputs which are required for generating the audio tones needed for transmitting data.

The mark and space tones leaving IC2, on pins 2 and 19, are buffered by IC5, a quad op-amp (3403). The remaining two stages of IC5 perform the task of driving the dual meter M1 that shows the mark and space tone levels. It is necessary to convert the mark and space tones to a DC voltage in order that the meters can display a *relative level*. This is achieved by D4 and D5 and the voltage produced here is fed to C13 and C14. The effect of

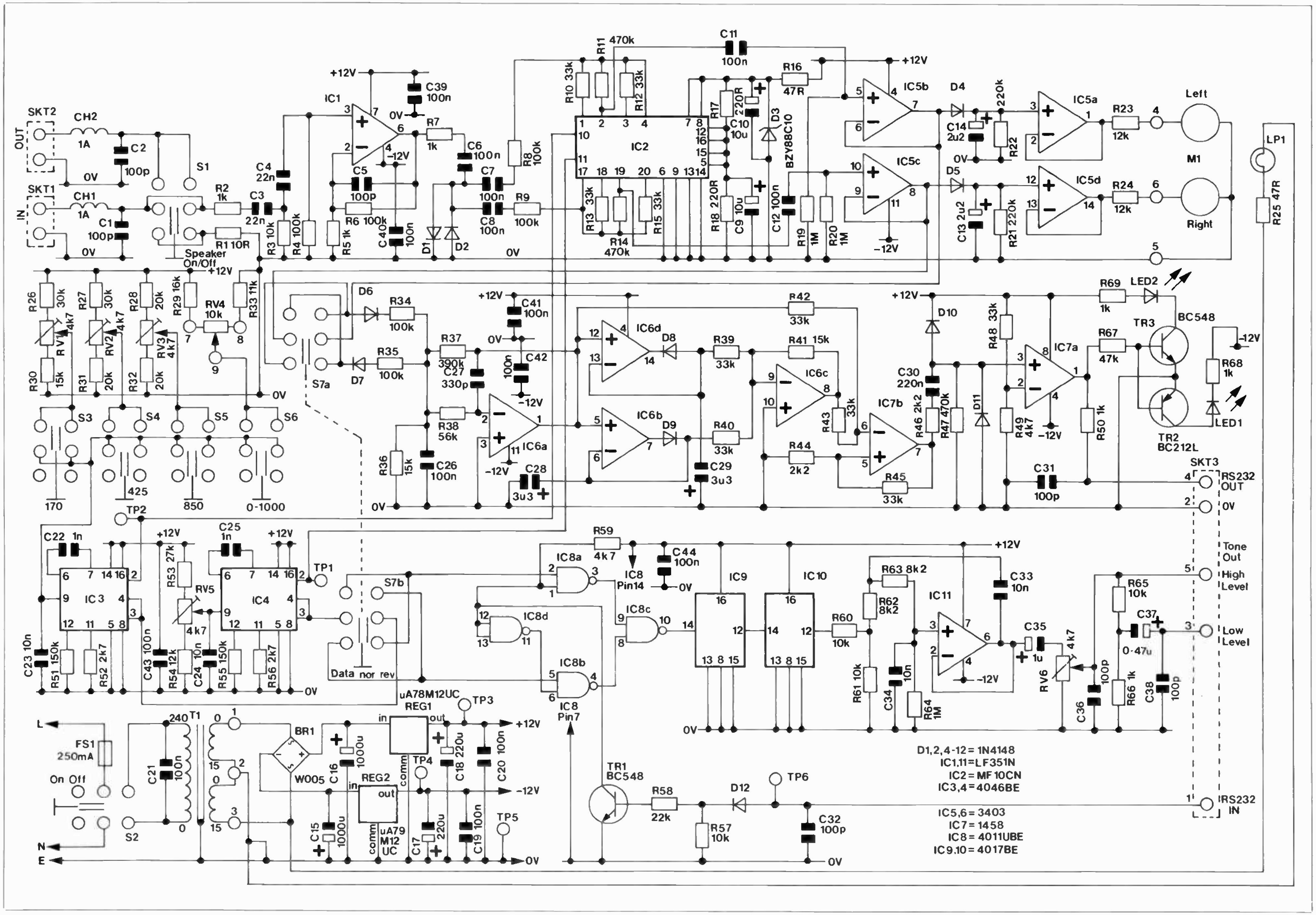
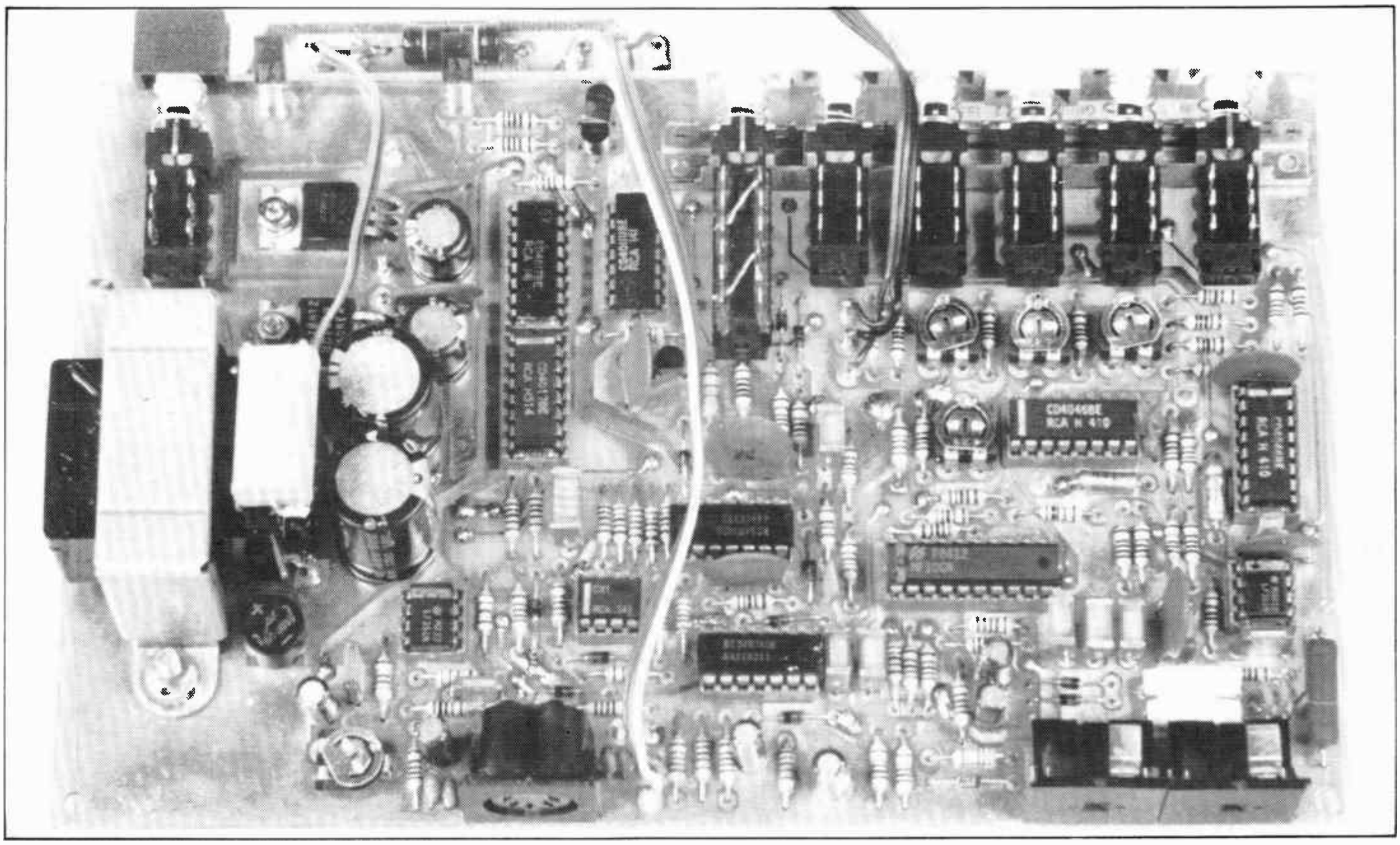


Figure 2. Circuit Diagram



this is to slow down the changes in level over a short period of time to maintain a more stable reading on the meters which are back-illuminated by LP1.

As previously mentioned, the mark and space tones are buffered by two sections of IC5, and are then fed, via S7 (section A), to the discriminator diodes D6 and D7. The function of S7 (A) is to accommodate normal or reversed tones. The discriminator circuit produces DC pulses, positive or negative, depending upon the dominant signal from either filter. The output from the discriminator is connected to IC6 (3403), which forms the active part of a low-pass filter. The signal is then fed to the remaining three sections of IC6, forming the signal balancing circuit. The output from this circuit provides a bias voltage which centres the output level of the low-pass filter to the input of the first part of IC7, a dual op-amp (1458). This section is referred to as the 'Slicer', the function of which is to allow only its output state to change when its input exceeds the pre-set threshold, set by the values of R44 and R45. This circuit prevents low level signals from producing spurious outputs.

The second half of IC7 forms the 'mark hold circuit' which returns the RS232's output negative if a space signal is longer than 150 milliseconds. Normally, this condition will not arise, because even at 45.45 bauds, the maximum space timing element is shorter in duration than 150 milliseconds, ensuring that if a prolonged tone is received, it will not hold the RS232 output high. The output from this stage is monitored by TR2 and TR3, which switch LED 1, or LED 2, on. These LED's indicate the logic state of the RS232 output. LED 1 indicates the mark, or negative output, while LED 2 indicates the space, or positive output. Before the RS232 output of IC7 is fed to pin 4 of the 5-pin DIN socket, it passes through R50 to limit the current should a short circuit accidentally appear on the RS232 line. Between pin 4 and ground, capacitor C31 has been placed to prevent any RF signals, that may be picked up on the leads connected to the 5-pin DIN socket, from entering the TU1000. This completes the description of the receiving part of the circuit and we now proceed to the audio tone generator used for transmitting.

If you recall, IC's 3 and 4 provide high frequency clock signal outputs which are now utilised in this part of the circuit to provide audio tones. S7, (section B), has the same function as section A, but allows normal or reversed tones to be transmitted. IC8 performs the function of selecting either the mark or the space high frequency clock when TR1 is turned on by the RS232 input on pin 1 of the 5-pin DIN socket. Normally, IC8 passes the mark clock frequency, however, when the RS232 input goes 'high', turning on TR1, IC8 gates the space clock frequency. The gated output of IC8 is fed to IC9 and IC10. These two IC's form a frequency 'divide by one hundred' stage which result in frequencies at the two audio tones required for transmitting. The audio tones will be directly related to the tones passed by IC2, the filter, because the same division ratio is used, which makes alignment of the transmit tones automatic, since they must be the same as the receive filter pass tones. In other words, once the receive tones are aligned, the transmit tones will *also* be aligned.

Before these tones can be fed to a transmitter, it is necessary to convert the square wave output of IC10 into a filtered signal, as a square wave is very rich in harmonics and can lead to a wide band transmitted signal. This is achieved by passing the square wave signal through a low pass filter, IC11. The cut-off frequency is set slightly higher than the maximum audio tone to be generated, and is set by the filter network, C33 and C34, R63 and R64. Although not a pure sine wave, the output is clean enough for

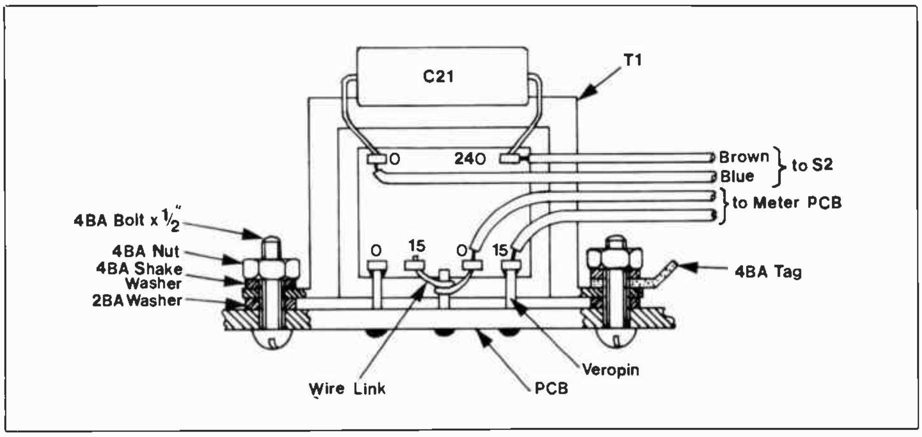


Figure 3. Transformer mounting

transmitting purposes. The level of signal is adjusted by RV6 from almost 0 to 2 volts peak to peak, available at pin 5 of the 5-pin DIN socket. A lower level signal is available at pin 3 which is again adjustable by RV6 from almost 0 to 200 millivolts peak to peak.

Finally, a brief description of the power supply. The transformer has a 15–0–15 volt AC secondary feeding BR1, a bridge rectifier which produces a DC positive and negative supply with respect to 0 volts. It is necessary to regulate *both* rails to + and −12 volts. This is carried out by regulators REG1 (μA78M12UC) and REG2 (μA79M12UC), and their associated decoupling capacitors C17 and C18. The only other power requirement in the circuit is for LP1, the lamp behind the meters. This supply is taken from one half of the 15 volt secondary of T1 (15 volts AC).

Construction

The components are mounted on a double-sided PCB and connections are made between the top and bottom tracks by through pins, the positions of which are indicated by the small circles on the board. You must insert the pins through the board, and solder them carefully on each side. It is important that these pins are installed *before* fitting any other components because some pins will be covered by certain IC sockets. The Veropins will be inserted next in the large circles marked on the board. These are pushed all the way into the board by applying the soldering iron to the head of the pin, and by pushing with a reasonable amount of pressure, the pin will go into the board. The IC sockets are fitted next, and care must be exercised in putting them in, matching the notch at the end of the socket with the printed mark on the legend. Starting with the 8-pin sockets at locations IC1, IC7, and IC11, then the three 14-pin sockets, followed by the four 16-pin sockets and finally the 20-pin socket. The IC's themselves are not inserted at this stage.

The 2-pin and 5-pin PCB mounted DIN sockets are installed next, making sure that the sockets are pushed tightly against the board. The next item to mount is the mains transformer. Take the solder tag included in the kit and fit the transformer using the 4BA hardware as shown in Figure 3. The secondary outputs from the transformer are then connected to the board in the following way: bend the two outer tags down carefully and solder them to the Veropins located beneath the tags. The two inner tags are connected to the remaining Veropin by using an off-cut from C21, the mains suppressor capacitor, as shown in the diagram. This capacitor is attached across the primary tags of the transformer. Finally, solder two insulated wires to the 0 and 15V tags using two wires from the 10-way ribbon cable.

The next components to be fitted are the voltage regulators, REG1 and REG2. These are installed using the 6BA nuts, bolts and shakeproof washers as per Figure 4. It is not necessary to use any silicone grease or mica washers for these devices.

The next item to be assembled is the 6-way switch-bank as shown in Figure 5. In the kit, you may receive a 6-way latchbracket and a 4-way latching bar. However, a 6-way latching bar may be supplied instead. If this is the case *carefully* cut off two tags to make a 4-way, and note that if the bar is bent in any way, it may cause the switch assembly to jam.

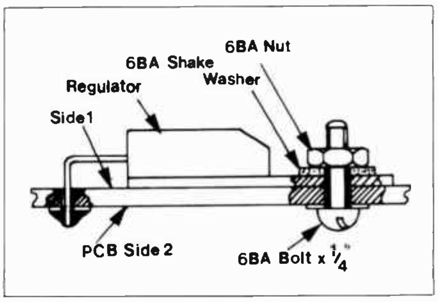
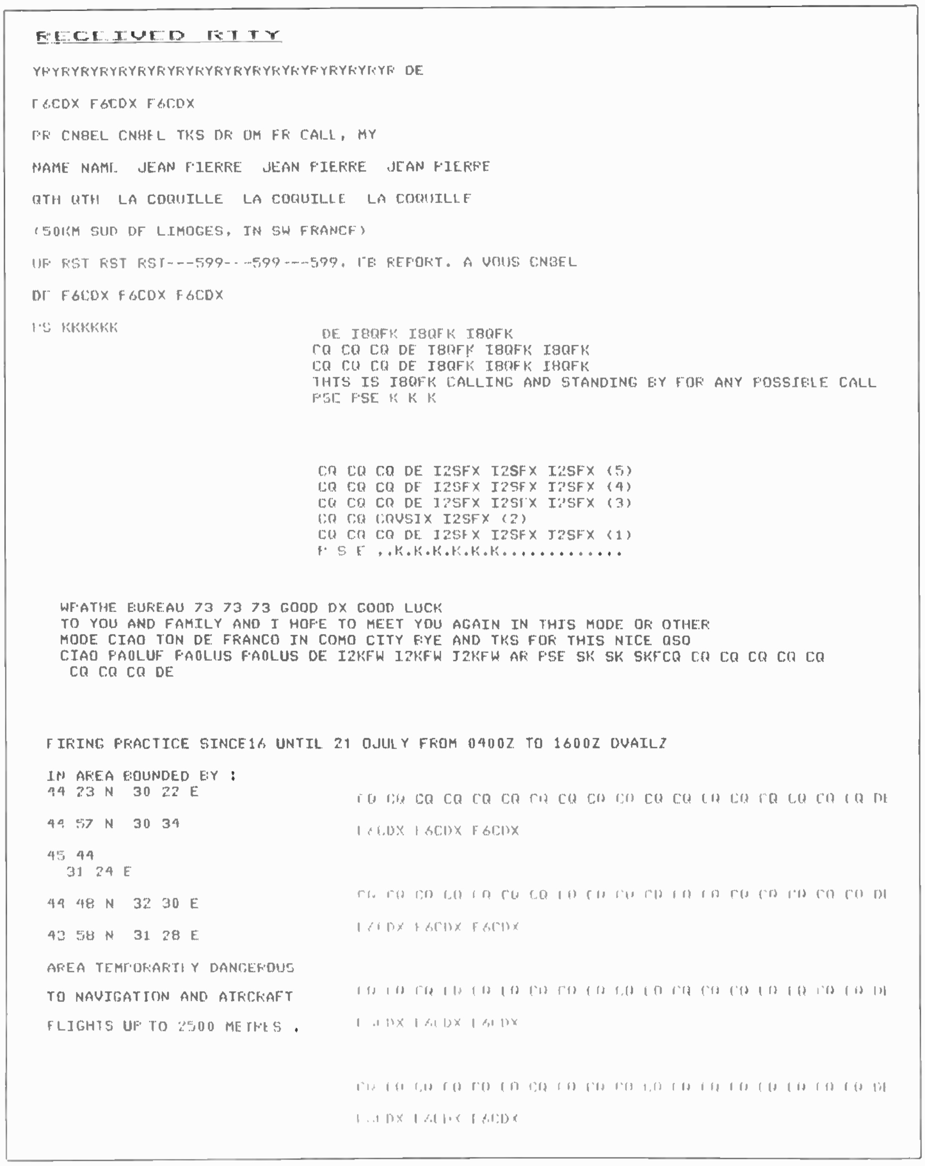


Figure 4. Fitting regulators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RECEIVED RTTY

YRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYR DE

F6CDX F6CDX F6CDX

PR CN8EL CN8EL TKS DR OM FR CALL, MY

NAME NAME  JEAN PIERRE  JEAN PIERRE  JEAN PIERRE

QTH QTH  LA COQUILLE  LA COQUILLE  LA COQUILLE

(50KM SUD DE LIMOGES, IN SW FRANCE)

UR RST RST RST---599---599---599, FB REPORT. A VOUS CN8EL

DE F6CDX F6CDX F6CDX

PS KKKKKK
                         DE I8QFK I8QFK I8QFK
                        CQ CQ CQ DE I8QFK I8QFK I8QFK
                        CQ CQ CQ DE I8QFK I8QFK I8QFK
                        THIS IS I8QFK CALLING AND STANDING BY FOR ANY POSSIBLE CALL
                        PSE PSE K K K


                         CQ CQ CQ DE I2SFX I2SFX I2SFX (5)
                         CQ CQ CQ DE I2SFX I2SFX I2SFX (4)
                         CQ CQ CQ DE I2SFX I2SFX I2SFX (3)
                         CQ CQ CQVSIX I2SFX (2)
                         CQ CQ CQ DE I2SFX I2SFX I2SFX (1)
                         P S E ,.K.K.K.K.K.K............

  WEATHE BUREAU 73 73 73 GOOD DX GOOD LUCK
  TO YOU AND FAMILY AND I HOPE TO MEET YOU AGAIN IN THIS MODE OR OTHER
  MODE CIAO TON DE FRANCO IN COMO CITY BYE AND TKS FOR THIS NICE QSO
  CIAO PAOLUF PAOLUS PAOLUS DE I2KFW I2KFW I2KFW AR PSE SK SK SKFCQ CQ CQ CQ CQ CQ
   CQ CQ CQ DE


 FIRING PRACTICE SINCE16 UNTIL 21 OJULY FROM 0400Z TO 1600Z DVAILZ

 IN AREA BOUNDED BY :
 44 23 N  30 22 E
                          CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ DE
 44 57 N  30 34
                          F6CDX F6CDX F6CDX
 45 44
   31 24 E

 44 48 N  32 30 E

 43 58 N  31 28 E
                          F6CDX F6CDX F6CDX
 AREA TEMPORARILY DANGEROUS

 TO NAVIGATION AND AIRCRAFT

 FLIGHTS UP TO 2500 METRES .
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Received RTTY messages

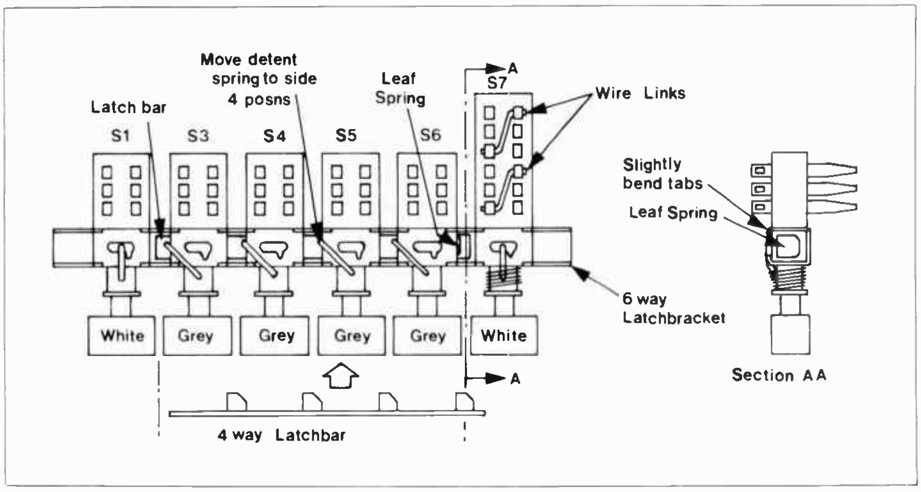
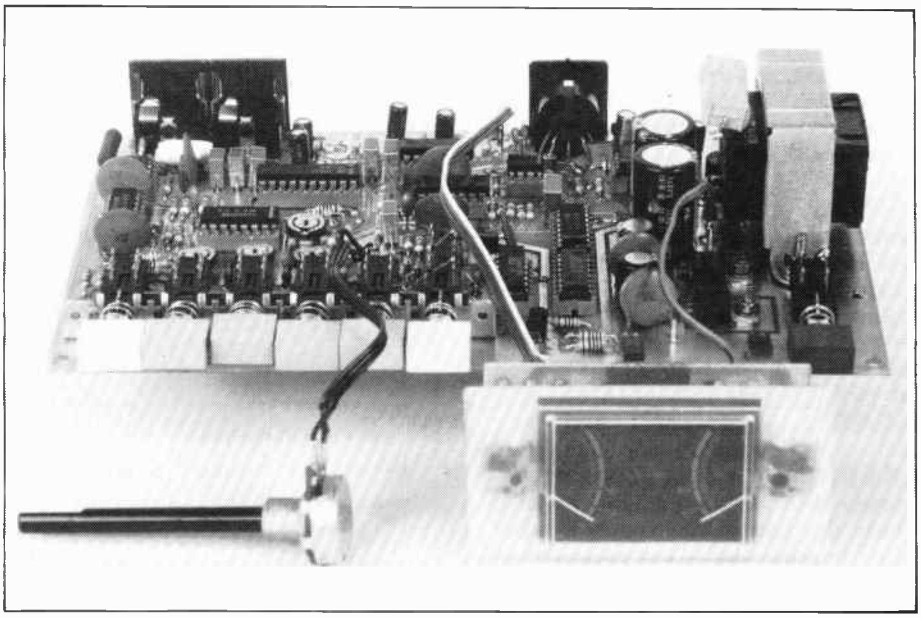


Figure 5. Switch sub-assembly



At switch position 6, install the leaf spring as shown in Figure 5. Using wire off-cuts from C21, solder two links onto S7. The switch assembly should not be mounted on the board at this stage.

Install the Veropins on the meter PCB in the same manner as the main PCB. As you will see from Figure 6, the pins protrude through side one of the board. The lamp is mounted on side two. This board is now fitted to the back of the dual meter by carefully bending the lugs of the meter over the board and soldering in position on one side. The meter assembly is also fitted at a later stage.

Returning to the main PCB, fit the resistors in their respective positions according to the legend and remove any excess wire after they have been soldered into position. The five preset potentiometers are fitted next. They are all of the same value and should be set at the halfway point of travel. The tantalum and the electrolytic capacitors are installed next. Make sure that they are correctly positioned according to their polarity. The remaining capacitors can be installed either way round and are fitted next.

Fit D3, a 10V zener according to its polarity marking. The remaining diodes are all of the same type (1N4148), and are fitted with the same consideration to polarity. The three transistors can then be fitted by matching the flat on the transistor with the flat on the board and soldering in place. The two RF chokes are mounted immediately behind the two 2-pin DIN sockets. The two LED's have to be mounted so that they will fit neatly through the holes in the front panel, see Figure 7.

Fit the mains switch, S2, pushing the switch leads into the board as far as they will go. Fit the switch assembly, S1, S3 to S7 in the same manner. Check that each of these switches is operating smoothly. Using Figure 8 as a guide, wire RV4, the 10k linear pot, using three lengths of wire from the ribbon cable to the three Veropins immediately behind S6.

The dual meter assembly is also wired according to Figure 8, using wire from the ribbon cable. Three connections are made from the meter to the three Veropins close to the 5-pin DIN socket and the remaining two 15V wires from the mains transformer are connected to the meter board at the points shown in the diagram. This completes the construction of the main PCB, but note that the IC's are not to be inserted yet.

Initial Tests

Visually check the circuit board for the correct installation of the components, unsoldered joints, solder bridges, dry joints, capacitor and diode polarisation, and transistor orientation. Place the PCB on a clean non-conductive surface, with the meter assembly and RV4 clear of the board. Temporarily solder the mains

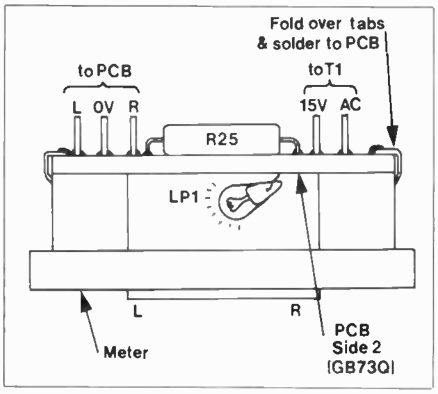


Figure 6. Meter illumination

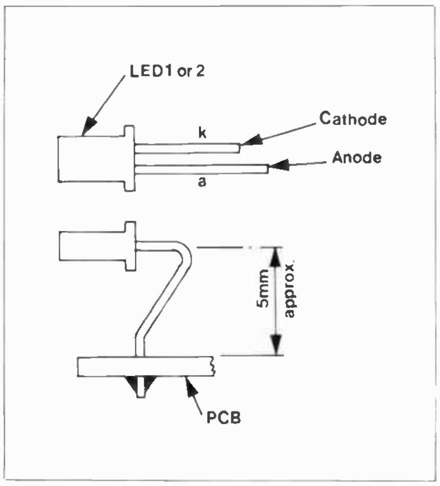


Figure 7. Fitting the LED's

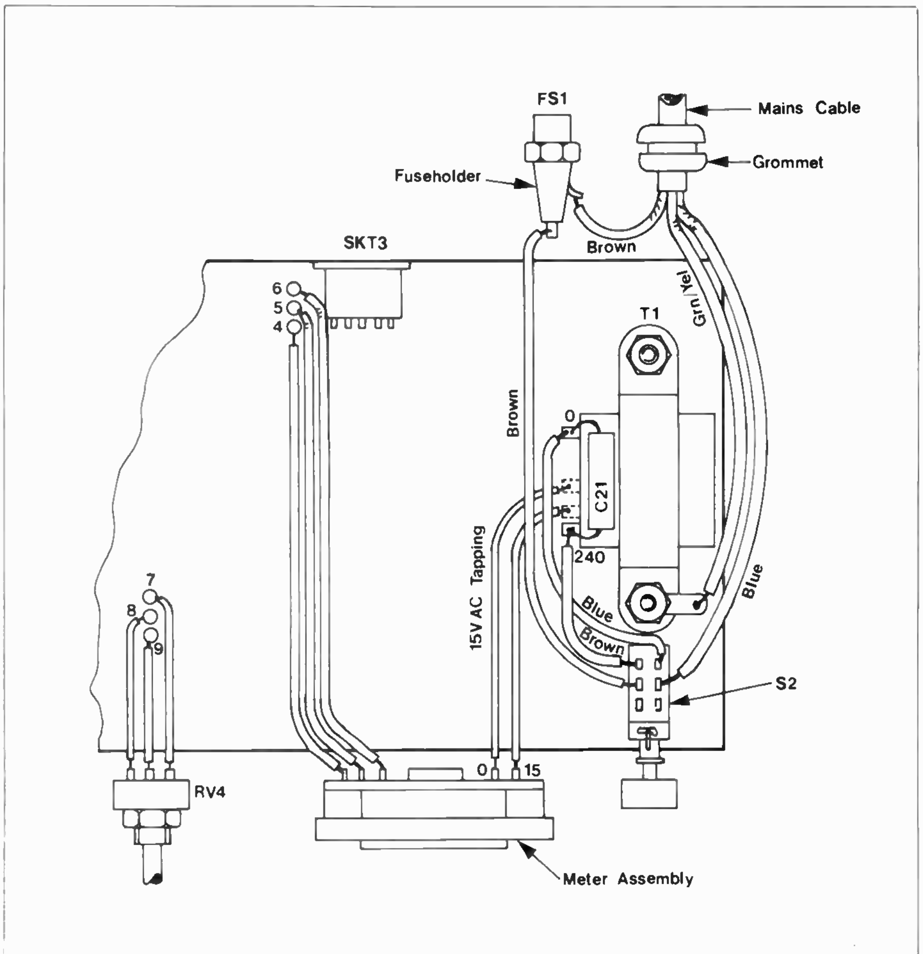


Figure 8. Wiring

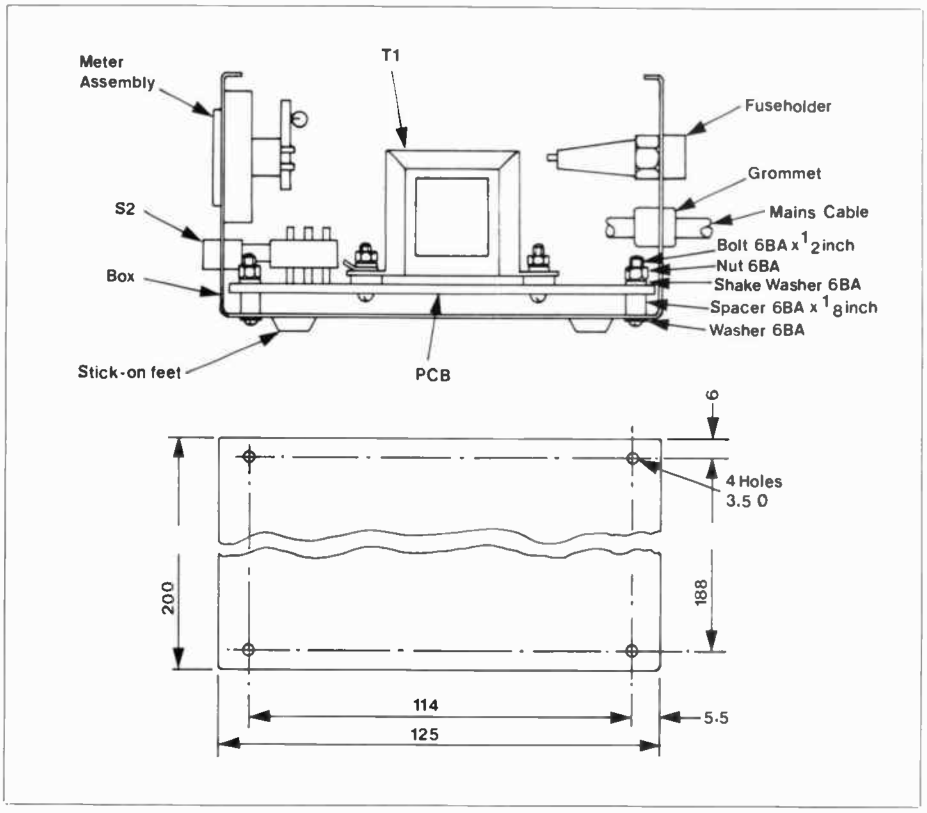


Figure 9. Case layout

cable to the transformer 0 and 240V tags and the mains earth lead to the solder tag installed on the transformer fixings. Insert a 3A fuse into a mains plug. WARNING!! *There will be live mains on the transformer, so please use extreme care.*

A voltmeter will be required in the following stages to check the power supplies to the various parts of the circuit. Plug the unit into the mains. At this stage LED1 and 2 will not light, but the meter bulb should. Set the voltmeter to cover a range suitable for 12V DC, connect the −V lead to Test Point 5 and the +V lead of the meter to Test Point 3, when a reading of between 11.5V and 12.5V should be seen. Reconnect the +V lead to Test Point 5 and the −V lead to Test Point 4, when a similar reading should be seen. Connect the −V lead to Test Point 5 and the +V lead to the cathode or banded end of D3. An approximate reading of 10V should be seen. If the readings you have obtained are within this range, the initial voltage tests are complete.

Disconnect the mains supply from the unit and insert all the IC's. You must be careful to insert these devices according to the notches on the IC and with the markings on the PCB. Check that all the pins are fitted into their respective holes, because they are easily bent under the IC. Reconnect the mains supply and LED1 should light, but not LED2. Repeat the voltage tests from the initial checks once more when you should obtain the same readings for each test as before.

These voltage tests allow us to proceed to the function tests. Set the following controls: S1 on (in), S3 on (in), RV4 set half way, and S7 off (out). Connect a piece of insulated wire between pin 5 of the 5-pin DIN socket and the round pin marked S on SKT1, one of the 2-pin DIN sockets. The left-hand meter should indicate a full scale deflection and LED1 should remain on. Connect another piece of wire between Test Point 6 and Test Point 3. LED1 and 2 should momentarily change state and the left-hand meter should go from full scale deflection to low, and the right-hand meter should go to full scale. If S7 is switched on (in), the meter conditions will be reversed. Repeat this test for S4, S5 and S6. Remove the wire from Test Points 3 and 6. This completes all the function tests. Disconnect the unit from the mains supply, desolder and remove the mains connections from the transformer and earth tag.

Final Assembly

Referring to Figure 9, drill the holes for the PCB mounting pillars, drill the front and rear holes and cut the window for the meter using the decorative front and rear labels as templates. Thoroughly clean any swarf from the holes, clean the case with detergent and warm water and give all surfaces a thorough going over with methylated spirit. Remove the backing from the decorative front and rear labels and carefully stick them in position.

Stick the rubber feet supplied with the case in place on the base of the case. Carefully scrape away the paint from around the holes in the bottom inside surface of the case. This will provide an earth connection between the PCB and the case via the pillars. The PCB is mounted as shown in Figure 9, using the 6BA hardware from the kit. Strip approximately 5 inches of the outer sleeving from the mains cable provided, and cut off a 3 inch length from the brown wire and discard it. Strip a ¼ inch length from all of the wires and twist and tin the ends with solder. Pass the prepared lead through the mains inlet hole and fit the strain relief grommet. Solder the green/yellow earth lead to the solder tag on the transformer, and the blue 'neutral' wire to S2 (Figure 8). Fit the fuseholder, and solder the brown 'live' wire to the terminal as shown in Figure 8. Locate the 6 inch length of blue and brown mains wire from the kit and complete the wiring according to the diagram. Because all of these connections are directly associated with mains voltages check all of them very carefully before connecting the unit to the mains. Bolt RV4 into position and cut the plastic shaft to fit the knob. Carefully put a coat of impact adhesive to the recessed portion of the meter (M1) and also a suitable area around the inside of the cut-out in the case, following the adhesive maker's instructions. If not already fitted, put the control buttons onto the switches. With the completion of this stage, we can now proceed to the alignment of the unit.

Alignment

There are two basic methods of alignment: with test gear, or tuning around on a radio and adjusting the presets until you can resolve the incoming data. Tuning around is the least accurate method of the two, but you can, in time, obtain quite good results.

Using test gear is much more accurate, and this method is to be preferred if the unit is to be used for transmitting. The only test gear required is a digital frequency counter, the resolution of which must be capable of reading down to at least 100Hz. Because the frequencies involved are below 1MHz, even a modest counter is more than adequate.

Connect the test lead of the counter to Test Point 5, ground. The signal input lead of the counter should be connected to Test Point 1 and RV5 adjusted to give a reading of 127.5kHz. This sets the frequency of the space filter and the space tone output for transmit. Now connect the test lead to Test Point 2 and push in S3, adjusting RV1 to produce a reading of 144.5kHz. Leaving the leads in this position, press S4 and adjust RV2 for a reading of 170.0kHz. The last preset shift is set by RV3 and with S5 pushed in, adjust this preset to give a reading of 212.5kHz. This completes the fixed shifts and if S6 is pressed, the front panel control, RV4, will produce a reading of about 127.5kHz in the fully anti-clockwise position and about 227.5kHz in the fully clockwise position. The alignment of the TU1000 is now complete and you may connect it up to a computer and a suitable receiver.

RTTY Software

The software necessary to receive and transmit RTTY data can be as complex as you care to write. Not many RTTY or communication programs have been published in the computer magazines, but the program included in this article is for use with an Atari home computer and the Atari 850 RS232 interface. Due to the large number of

```
100 CLR :REM R.T.T.Y BY Chris Barlow.
200 REM 850 INTERFACE MODULE RS-232 PORT 1.
300 TRAP 10900:CLOSE #2:OPEN #2,4,0,"K:"
400 GRAPHICS 0:POKE 710,180:POKE 709,0:POKE 712,180:POKE 559,0
500 SOUND 0,80,10,5
600 REM **** BAUDOT TO ATASCII SET-UP ****
700 DIM BA$(7):DIM ATASCII(64):DIM BAUDOT(128):DIM RT$(1000):
DIM RP$(5000)
800 LET RT$="":LET PO=0:LET KEY=49:LET RP=1
900 LET SX2=1:LET SY2=1:POKE 82,1
1000 FOR I=1 TO 64:READ DAT:LET ATASCII(I)=DAT:NEXT I
1100 REM **** ATASCII TO BAUDOT SET-UP ****
1200 FOR I=1 TO 128:READ DAT:LET BAUDOT(I)=DAT:NEXT I
1300 FOR I=0 TO 33:READ D:POKE 1556+I,D:NEXT I
1400 LOW=PEEK(106)-8:LOWZ=LOW+4
1500 HIGH=PEEK(106)-4:HIGHZ=HIGH+4
1600 POKE 1556+4,LOW:POKE 1556+19,HIGH
1700 POKE 88,0:POKE 89,HIGH:POKE 106,HIGHZ:PRINT CHR$(125)
1800 POKE 89,LOW:POKE 106,LOWZ:PRINT CHR$(125)
1900 POKE 560,20:POKE 561,6
2010 FOR LOOP=0 TO 17:READ D:POKE 1536+LOOP,D:NEXT LOOP
2020 MAC=USR(1536):POKE 559,34:POKE 712,0
2090 GOSUB 9300
2100 REM *** RECEIVE ***
2200 LET SHIFT=0
2300 LET SX1=1:LET SY1=3
2400 REM KEY TEST
2500 IF PEEK(53279)=5 THEN GOSUB 4000
2600 IF PEEK(53279)=3 THEN GOSUB 8900
2700 IF PEEK(764)<255 THEN GOSUB 11200
2710 STATUS #1,A
2800 IF PEEK(747)=0 THEN 2400
2900 GET #1,RECEIVE:GOSUB 3100
3000 GOTO 2400
3100 LET RECEIVE=ATASCII(RECEIVE-224+SHIFT+1)
3200 IF RECEIVE<0 THEN RETURN
3300 IF RECEIVE=0 THEN SHIFT=0:RETURN
3400 IF RECEIVE=1 THEN SHIFT=32:RETURN
3500 POSITION SX1,SY1:PRINT CHR$(RECEIVE);
3600 LET SX1=PEEK(85):LET SY1=PEEK(84)
3700 IF SX1>38 THEN PRINT CHR$(155);:LET SX1=1:
LET SY1=SY1+1
3800 IF SY1>10 THEN POKE 752,1:POSITION 1,1:PRINT CHR$(156):
LET SY1=10:POKE 752,0:POSITION SX1,SY1-1:PRINT
3810 LET RP$(RP)=CHR$(RECEIVE):LET RP=RP+1:IF RP>4999
THEN RP=4999
3900 RETURN
4000 REM **** SEND BUFFER ****
4100 CLOSE #1:OPEN #1,8,0,"R1:":LET AL=1
4200 IF LEN(RT$)<1 THEN 6300
4300 POKE 89,HIGH:POKE 106,HIGHZ:POKE 752,1:POKE 712,21
4310 POSITION 1,1:PRINT " "  <- You must enter 38 spaces between these quote marks.
4400 POSITION 1,1:PRINT " SEND BUFFER. BAUD RATE ";BA$
4500 FOR Q=1 TO LEN(RT$)
4600 IF PEEK(53279)=6 THEN 8500:REM START KEY TO RETURN TO
RECEIVE.
4700 KEY=ASC(RT$(Q)):LET OUT=KEY
4800 IF OUT>127 THEN LET OUT=OUT-128
4900 LET OUT=BAUDOT(OUT+1)
5000 IF OUT=0 THEN 4600
5100 IF AL=1 THEN 5500
5200 IF OUT<0 THEN 5700
5300 LET AL=1:PUT #1,31
5400 GOTO 5700
5500 IF OUT>0 THEN 5700
5600 LET AL=0:PUT #1,27
5700 PUT #1,ABS(OUT)
5800 IF OUT<>8 THEN 6100
5900 PUT #1,2:PUT #1,31
6000 LET AL=1
6100 NEXT Q:XIO 32,#1,0,0,"R1:"
6200 PRINT CHR$(125):PRINT " BUFFER SENT. KEYBOARD ON
LINE.":POKE 752,0:PRINT :LET SX2=1:LET SY2=3:GOTO 6420
6300 POKE 89,HIGH:POKE 106,HIGHZ:PRINT CHR$(125):LET SX2=1:
LET SY2=3
6400 POKE 752,1:PRINT " SEND. BAUD RATE ";BA$:POKE 752,0
6420 POKE 712,21
6500 IF PEEK(53279)=6 THEN 8500:REM START KEY TO RETURN TO
RECEIVE.
6600 IF PEEK(764)=255 THEN 6500
6700 GET #2,KEY:LET OUT=KEY
6800 IF OUT>127 THEN LET OUT=OUT-128
6900 LET OUT=BAUDOT(OUT+1)
7000 IF OUT=0 THEN 6500
7100 POSITION SX2,SY2:PRINT CHR$(KEY);
7200 LET SX2=PEEK(85):LET SY2=PEEK(84)
7300 IF SX2>38 THEN PRINT CHR$(155);:LET SX2=1:LET SY2=SY2+1
7400 IF SY2>10 THEN POKE 752,1:POSITION 1,1:PRINT CHR$(156):
LET SY2=10:POKE 752,0:POSITION SX2,SY2-1:PRINT
7500 IF AL=1 THEN 7900
7600 IF OUT<0 THEN 8100
7700 LET AL=1:PUT #1,31
7800 GOTO 8100
7900 IF OUT>0 THEN 8100
8000 LET AL=0:PUT #1,27
8100 PUT #1,ABS(OUT)
8200 IF OUT<>8 THEN 6500
8300 PUT #1,2:PUT #1,31
8400 XIO 32,#1,0,0,"R1:":LET AL=1:GOTO 6500
8500 CLOSE #1:OPEN #1,5,0,"R1:":XIO 40,#1,0,0,"R1:"
8600 PRINT CHR$(125)
8700 POKE 89,LOW:POKE 106,LOWZ:PRINT CHR$(125):LET SX1=1:
LET SY1=3:LET SX2=1:LET SY2=1:POKE 712,0
8800 PRINT " RECEIVE. BAUD RATE ";BA$:PRINT :LET PO=0:
LET RT$="":RETURN
8900 REM ..... BAUD RATE 45.5 TO 300...
9000 PRINT CHR$(125):POKE 752,1:PRINT " BAUD RATE 45.5 TO 300
- INPUT 1 TO 8 "
9010 PRINT :PRINT " PRESS P FOR PRINT-OUT "
9100 GET #2,KEY:IF KEY>127 THEN KEY=KEY-128
9105 CLOSE #1
9110 IF KEY=80 THEN LPRINT :LPRINT "RECEIVED RTTY":LPRINT :
LPRINT RP$:LET RP=1:LET RP$=""
9200 IF KEY<49 OR KEY>56 THEN 10200
9300 IF KEY=49 THEN BA$="45.5 "
9400 IF KEY=50 THEN BA$="50.0 "
9500 IF KEY=51 THEN BA$="56.875 "
9600 IF KEY=52 THEN BA$="75.0 "
9700 IF KEY=53 THEN BA$="110.0 "
9800 IF KEY=54 THEN BA$="134.4 "
9900 IF KEY=55 THEN BA$="150.0 "
10000 IF KEY=56 THEN BA$="300.0 "
10100 RATE=KEY-48
10200 BAUD=48+RATE
10300 OPEN #1,5,0,"R1:":REM PORT 1 INPUT ONLY (CONCURRENT
MODE)
10400 XIO 36,#1,BAUD,0,"R1:"
10500 XIO 40,#1,0,0,"R1:":REM PORT 1 CONCURRENT MODE SET
10600 XIO 38,#1,32,0,"R1:":REM NO TRANSLATION
10700 LET SX1=1:LET SY1=3
10800 PRINT CHR$(125):PRINT " RECEIVE. BAUD RATE ";BA$:
POKE 752,0:PRINT :RETURN
10900 SOUND 0,25,10,10
11000 POKE 752,1:PRINT :PRINT "< SYSTEM ERROR > ";
11100 LET E=PEEK(195):PRINT E:FOR I=0 TO 300:NEXT I:GOTO 100
11200 PO=PO+1:IF PO>1000 THEN PO=1000
11300 GET #2,KEY:LET RT$(PO)=CHR$(KEY)
11400 POKE 89,HIGH:POKE 106,HIGHZ
11500 POSITION SX2,SY2:PRINT RT$(PO);
11600 LET SX2=PEEK(85):LET SY2=PEEK(84)
11700 IF SX2>38 THEN PRINT CHR$(155);:LET SX2=1:LET SY2=SY2+1
11800 IF SY2>10 THEN POKE 752,1:POSITION 1,1:PRINT CHR$(156):
LET SY2=10:POKE 752,0:POSITION SX2,SY2-1:PRINT
11900 POKE 89,LOW:POKE 106,LOWZ:RETURN
12000 REM BAUDOT TO ATASCII DATA.
12100 DATA -1,69,-1,65,32,83,73,85,155,68,82,74,78,70,67,75,84,90,76,
87,72,89,80,81,79,66,71,1,77,88,86,0
12200 DATA -1,51,-1,45,32,39,56,55,155,36,52,39,44,33,58,40,53,34,41,
50,35,54,48,49,57,63,43,1,46,47,59,0
12300 REM ATASCII TO BAUDOT DATA.
12400 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,8,0,0,0,0
12500 DATA 4,-45,-17,-20,-9,0,-26,-11,-15,-18,0,-26,-12,-3,
-28,-29,-22,-23,-19,-1,-10,-16,-21,-7
12600 DATA -6,-24,-14,-30,0,0,0,-25,0,3,25,14,9,1,45,26,20,6,11,15,
18,28,12,24,22,23,10,5,16,7,30,19
12700 DATA 29,21,17,0,0,5,0,0,0,3,25,14,9,1,45,26,20,6,11,15,18,28,12,24
12800 DATA 22,23,10,5,16,7,30,19,29,21,17,0,0,5,0,0
12900 DATA 112,112,66,0,20,2,2,2
13000 DATA 2,2,2,2,2,2,2,2
13100 DATA 48,66,0,0,2,2,2,2
13200 DATA 2,2,2,2,2,2,2,65,20,6
13300 DATA 104,169,6,162,6,160,11,32,92
13400 DATA 228,96,169,0,133,77,76,95,228
```

RTTY Program for Atari

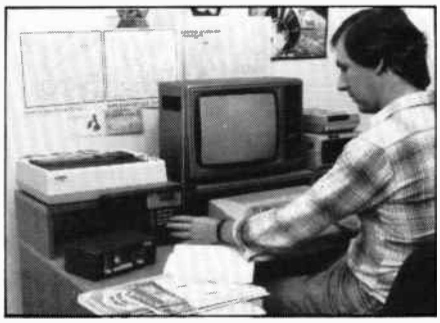
microcomputers used in the home, it is not possible to produce a program listing which will run satisfactorily on all machines. This is due to the various BASIC dialects and differing internal structures, such as port addressing and PEEK's and POKE's. It is hoped that sufficient interest will be generated in this article so that more computer systems might run RTTY software.

In order to help you write your own programs, here are a few guidelines. The program, if intended to be used for transmitting as well as receiving data, must have the ability to select either mode. If you intend to receive only, virtually half of the program may be discarded. As you can see from Figure 1 the decimal value allocated to each character is not the same as the ASCII value. For this reason, the value of one must be translated to the other for received codes as well as transmitted codes. A simple method for achieving this is to set up an array of sixty-four ASCII values, their positions in the array relating to the decimal value of the incoming or outgoing data. For example if the third value in the array was 65, this would represent the letter 'A'. When the 'figures shift' code is received, an additional offset must be added to select the correct position in the array to return the ASCII character codes for numbers and punctuation marks. If the program is written to support transmit facilities, an additional array of 128 values must be set up to convert ASCII values to the correct decimal value representing the outgoing data. The reason for the size of the ASCII array is due to the large number of possible values returned by a typical computer keyboard. Any non-valid key should be converted by the array, to a value of 0. This will inhibit values outside the range of the five-bit code.

This would be the minimal requirement for an RTTY program, but should really be used as the basis for additional refinements. Such refinements could be a split-screen to enable one, if transmitting, to compose your reply while the incoming message is being displayed on the other half of the screen, or it may be useful, if a printer is available, to add a hard copy option to the program. If you do not possess a printer, another manner of storage is to create a file on cassette, or preferably disk. Another very useful option is to be able to select the baud rate, if your system allows software control of the RS232 parameters. Prerecorded messages and tests (RYR) could be retrieved from cassette or disk – another useful feature if you are transmitting. It is also possible that you may require other features to be built into your program. The possibilities are quite large and limited only by one's imagination.

The TU1000 In Use

A receiver that is capable of resolving RTTY signals must have a BFO (beat frequency oscillator), although most communications receivers have a built-in CW or SSB position, and of course an antenna



to pick up the signals. The frequencies covered by a modern receiver are typically between 1 and 30MHz. It is within this range of frequencies that there are literally thousands of RTTY signals. Probably the best antenna to use for simple monitoring is a long wire, as long as possible and as high as possible. If you can orientate it South-West/North East, so much the better. It is advisable to tune the receiver against a good external ground system, such as a buried bare copper wire, or a ground rod.

The connection to the TU1000 is made through the headphone or loudspeaker socket. Provision has been made on the TU1000 for muting the sound output by pressing S1. This switches off the loudspeaker and introduces a 10Ω resistor which acts as a dummy load for the receiver audio circuit. The initial tuning is done by identifying the characteristic sound produced by RTTY transmissions and once this is done the data will be presented on the VDU avoiding the need to sit for hours listening to the tones.

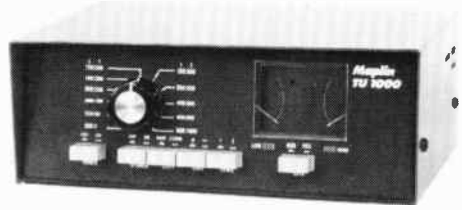
I would recommend that initially you tune into one of the amateur RTTY portions of the band. A good start would be to set the receiver to 14.090MHz. It is around this frequency that RTTY signals will be found 24 hours a day, except in the winter when they will tend to disappear around sunset or shortly after. RTTY is easy to identify from the other signals most likely to be found in this portion of the band, namely morse code. RTTY signals have a pronounced warble as one tone is transmitted and then the next. Amateur RTTY transmissions are set at 170Hz shift between mark and space tones. Using the main tuning control of the receiver, tune across the RTTY transmission and you will notice that the sound of the pitch of the signal will change, the S-meter on the receiver will peak and the twin meters on the TU1000 should also peak together, usually at full scale. At the same time the LED's on the front panel should flash.

Connect the TU1000's RS232 I/O port to your computer system. The normal rate of an amateur RTTY transmission is either 45.45 or 50 bauds. The majority of them are at 45.45 bauds. With this rate set

```
RECEIVED RTTY
E 9
PRAVDA ON INDIAN WHITE BOOK
M O S C O W , JULY 15 ADN - AN IMPORTANT DOCUMENT - THIS IS HOW THE
LEADING SOVIET PAPER PRAVDA ON SUNDAY CALLS THE WHITE BOOK PUBLISHED
BY THE INDIAN GOVERNMENT ON THE EVENTS IN THE COUNTRY IN THE PAST
THREE YEARS. THE CORRESPONDENT'S REPORT SAYS THE DOCUMENT POINTS TO
A GRAVE DANGER WHICH HAS ARISEN FOR INDIA FROM CONSPIRACIES OF
RELIGIOUS FANATICS AND OTHER DIVISIONIST FORCES RECEIVING SUPPORT
FROM ABROAD.

E 10
TUNISIAN PRESIDENT RECEIVES SPANISH PREMIER
T U N I S , JULY 15 ADN - PRESIDENT HABIB BOURGUIBA OF TUNISIA
RECEIVED THE SPANISH PRIME MINISTER, FELIPE GONZALES, ON SATURDAY.
THEY CONFERRED ON BILATERAL RELATIONS, THE SITUATION IN THE MIDDLE
EAST AND ON QUESTIONS OF MUTUAL INTERES' .
     THE PREMIER IS ON A PRIVATE VISIT IN TUNISIA.

E 11
FOUR TONS OF FALSE MONEY SEIZED
P A R I S , JULY 15 ADN - FRENCH CUSTOMS OFFICERS HAVE SEIZED A
LORRY AND TRAILER WITH 500,000 (500,000) FALSE TEN-FRANC COINS,
WEIGHING FOUR TONS, ON THE ITALIAN BORDER.

E 12
CHILEAN POLICE DENY ENTRY TO DAUGHTER OF LUIS CORVALAN
 B U E N O S   A I R E S  , JULY 15 ADN - THE CHILEAN POLICE HAS
REFUSED MARIA VICTORIA CORVALAN ENTRY INTO HER HOME COUNTRY, PRENSA
LATINA REPORTS.
     THE DAUGHTER OF THE GENERAL SECRETARY OF THE COMMUNIST PARTY OF
CHILE WAS PREVENTED FROM ENTERING THE COUNTRY AT SANTIAGO DE CHILE'S
INTERNATIONAL PUDAHUEL AIRPORT AND PUT BY POLICE ON A PLANE TO
ARGENTINA ALTHOUGH SHE HELD A VALID PASSPORT. MARIA VICTORIA
CORVALAN WANTED TO VISIT FAMILY MEMBERS IN CHILE.

E 16
TALKS BETWEEN CUBA AND UNITED STATES IN NEW YORK
H A V A N A , JULY 15 ADN - CUBAN AND UNITED STATES GOVERNMENT
OFFICIALS HELD TALKS IN NEW YORK ON JULY 12 AND 13, ACCORDING TO A
STATEMENT RELEASED BY THE CUBAN FOREIGN MINISTRY AT THE WEEKEND.
ACCORDING TO PRENSA LATINA, THE TALKS CENTRED ON ENTRY REGULATIONS
BETWEEN THE TWO COUNTRIES AND ON WAYS OF CUBANS WHO HAD COMMITTED
CRIMES RETURNING FROM THE U.S. TO CUBA. PREPAREDNESS FOR NEGOTIATING
THESE QUESTIONS WAS STATED BY FIDEL CASTRO DURING HIS MEETING WITH
U.S. PRESIDENTIAL CONTENDER JESSE JACKSON WHEN THE LATTER VISITED
CUBA AT THE END OF JUNE.
     THE CUBAN DELEGATION WAS LED BY DEPUTY FOREIGN MINISTER RICARDO
ALARCON.

E 17
SOLIDARITY WEEK IN PUERTO RICO
 S A N   J U A N  , JULY 15 ADN - A WEEK OF PEACE AND SOVEREIGNTY
BEGAN IN THE PUERTO RICAN CAPITAL SAN JUAN ON SUNDAY. IT HAS BEEN
SPONSORED BY THE PUERTO RICAN CENTRE FOR COORDINATING SOLIDARITY
WITH CENTRAL AMERICA AND THE CARIBBEAN AND BY THE NATIONAL
COMMITTEE FOR SOLIDARITY WITH CENTRAL AMERICA. THE EVENTS ARE BEING
MARKED BY SOLIDARITY WITH THE PEOPLES OF NICARAGUA AND CUBA.

E 18
OPERATIONS OF SALVADOREAN LIBERATION FIGHTERS
 S A N   S A L V A D O R  JULY 15 ADN   MEMBERS OF EL SALVADOR'S
NATIONAL LIBERATION FRONT FARABUNDO MARTI HAVE LAUNCHED FRESH
ACTIONS AGAINST LINES OF SUPPLY OF THE TROOPS OF THE DUARTE REGIME.
FORTY KILOMETRES NORTH OF HERE THEY STOPPED A TRAIN DURING WHICH
THEY PUT FORTY SOLDIERS OUT OF ACTION IN A SEVERAL HOUR
BATTLE.
```

News from every corner of the world

by your system and the software set to receive, the data should now be displayed on the screen. S7 will have to be pressed if the signal is garbled, because the tones may be reversed. If the transmission is idling, the mark tone will cause the meter to peak. Therefore if the right-hand meter is peaked, then the reverse tones are being transmitted and if it is the left-hand needle that is peaked then the tones are being transmitted in the normal manner. If, after trying these settings, the data is not being resolved, it is likely that the transmission is at 50 baud



and again could be normal or reversed. When it is not possible to peak both meters, it is likely that a shift other than 170Hz is being used, so try pressing the other fixed tone shift switches, or the variable control RV4.

If you would like to learn more about the subject, I would recommend contacting, The British Amateur Radio Teledata Group, c/o Mrs. Pat Beedie, GW6MOJ, Ffynnonlas, Salem, Llandeilo, Dyfed SA19 7NP, who would be best able to assist. There are numerous books on the subject and again the secretary of BARTG can supply a list. I can personally recommend 'Guide to RTTY Frequencies' by Oliver P. Ferrell and published by Gilfer Associates Inc.

TU1000 RTTY UNIT PARTS LIST

RESISTORS: All 0.6W 1% Metal Film Unless Specified

R1	10Ω 3W Round Type	1	*Kit Only**
R2,5,7,50,66,68,69	1k	7	(M1K)
R3,57,60,61,65	10k	5	(M10K)
R4,6,8,9,34,35	100k	6	(M100K)
R10,12,13,15,39, 40,42,43,45,48	33k	10	(M33K)
R11,14,47	470k	3	(M470K)
R16	47Ω	1	(M47R)
R17,18	220Ω	2	(M220R)
R19,20,64	1M	3	(M1M)
R21,22	220k	2	(M220K)
R23,24,54	12k	3	(M12K)
R25	1W Res 47Ω	1	(C47R)
R26,27	30k	2	(M30K)
R28,31,32	20k	3	(M20K)
R29	16k	1	(M16K)
R30,36,41	15k	3	(M15K)
R33	11k	1	(M11K)
R37	390k	1	(M390K)
R38	56k	1	(M56K)
R44,46	2k2	2	(M2K2)
R49,59	4k7	2	(M4K7)
R51,55	150k	2	(M150K)
R52,56	2k7	2	(M2K7)
R53	27k	1	(M27K)
R58	22k	1	(M22K)
R62,63	8k2	2	(M8K2)
R67	47K	1	(M47K)
RV1,2,3,5,6	Hor Encl Preset 4k7	5	(UH02C)
RV4	Pot Lin 10k	1	(FW02C)

CAPACITORS

C1,2,5,31,32, 36,38	Ceramic 100	7	(WX56L)
C3,4	Poly Layer 0.022	2	(WW33L)
C6,7,8,11,12,26	Poly Layer 0.1	6	(WW41U)
C9,10	PC Elect 10μF 50V	2	(FF04E)
C13,14	PC Elect 2.2μF 100V	2	(FF02C)
C15,16	PC Elect 1000μF 35V	2	(FF18U)
C17,18	PC Elect 220μF 16V	2	(FF13P)
C19,20,39-44	Disc 0.1μF 50V	8	(BX03D)
C21	IS Cap 0.1μF	1	(FF56L)
C22,25	1% Polysty 1000	2	(BX56L)
C23,24	Ceramic 10,000	2	(WX77J)
C27	Ceramic 330	1	(WX62S)
C28,29	Tant 3.3μF 35V	2	(WW63T)
C30	Poly Layer 0.22	1	(WW45Y)
C33,34	Poly Layer 0.01	2	(WW29G)
C35	PC Elect 1μF 100V	1	(FF01B)
C37	PC Elect 0.47μF 100V	1	(FF00A)

SEMICONDUCTORS

D1,2,4-12	1N4148	11	(QL80B)
D3	BZY88C10/BZX55C10	1	(QH14Q)
LD1,2	Shape LED R1 Red	2	(YY45Y)
TR1,3	BC548	2	(QB73Q)
TR2	BC212L	1	(QB60Q)
BR1	W005	1	(QL37S)
RG1	μA78M12UC	1	(QL29G)
RG2	μA79M12UC	1	(WQ89W)
CH1,2	RF Supp Choke 1A	2	(HW04E)
IC1,11	LF351	2	(WQ30H)
IC2	MF10CN	1	(QY35Q)
IC3,4	4046BE	2	(QW32K)
IC5,6	3403	2	(QH51F)
IC7	1458C	1	(QH46A)
IC8	4011UBE	1	(QL04E)
IC9,10	4017BE	2	(QX09K)

MISCELLANEOUS

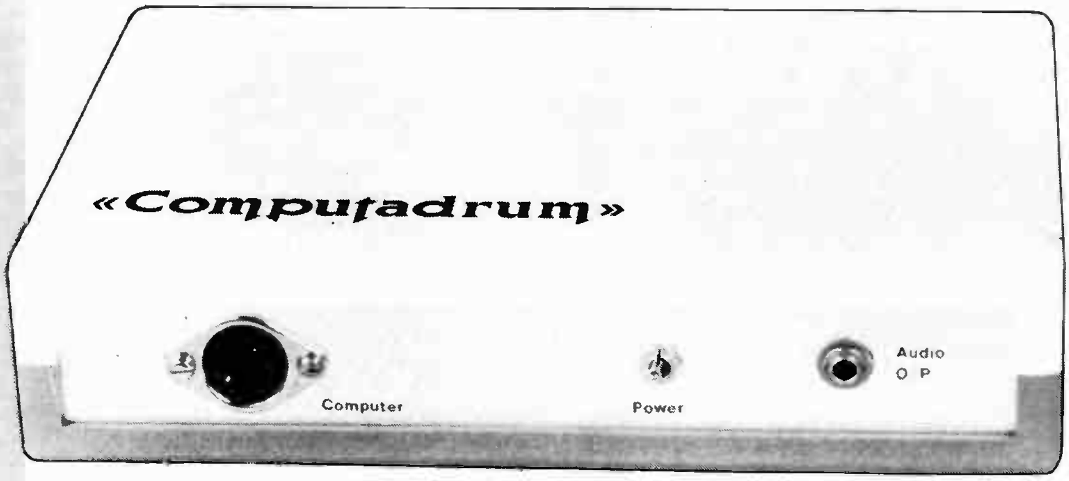
T1	Min Tr 15V	1	(WB15R)
M1	Dual VU Meter	1	(YQ47B)
LP1	Wire Bulb 12V	1	(WQ13P)
S1-6	Latchswitch 2-pole	6	(FH67X)
S7	Latchswitch 4-pole	1	(FH68Y)
FS1	Fuse 20mm 250mA	1	(WR01B)
SK1,2	PC DIN Skt 2-pin	2	(YX90X)
SK3	PC DIN Skt 5-pin A	1	(YX91Y)
	Latchbracket 6-way	1	(FH80B)
	Rct Latchbutton Grey	4	(FH62S)
	Rct Latchbutton Red	1	(FH63T)
	Rct Latchbutton White	2	(FH64U)
	Safuseholder 20	1	(RX96E)
	DIL Socket 8-pin	3	(BL17T)
	DIL Socket 14-pin	3	(BL18U)
	DIL Socket 16-pin	4	(BL19V)
	DIL Socket 20-pin	1	(HQ77J)
	SR Grommet 6W2	1	(LR49D)
	Knob K7B	1	(YX02C)
	Pin 2141	1 Pkt	(FL21X)
	Track Pins	1 Pkt	(FL82D)
	C6A Mains Black	2 Mtrs	(XR03D)
	Ribbon Cable 10 Way	1 Mtr	(XR06G)
	Bolt 6BA ¼in.	1 Pkt	(BF05F)
	Nut 6BA	1 Pkt	(BF18U)
	Shake 6BA	1 Pkt	(BF26D)
	Bolt 4BA ½in.	1 Pkt	(BF03D)
	Nut 4BA	1 Pkt	(BF17T)
	Shake 4BA	1 Pkt	(BF25C)
	Tag 4BA	1 Pkt	(BF28F)
	4BA Spacer ⅛in	1 Pkt	(FW30H)
	Washer 2BA	1 Pkt	(BF20W)
	RTTY Terminal PCB	1	(GB67X)
	Meter PCB	1	(GB73Q)
	TU1000 Front Panel	1	(FJ53H)
	TU1000 Rear Panel	1	(FJ54J)
	Wire 3202 Blue	1 Mtr	(XR33L)
	Wire 3202 Brown	1 Mtr	(XR34M)
	Constructors' Guide	1	(XH79L)
	TU1000 Ins	1	(XK73Q)

OPTIONAL

	Blue Case 222	1	(XY45Y)
	DIN Plug L/S	2	(HH24B)
	DIN Plug 5-pin	1	(HH27E)
	13 Amp Plug Nylon	1	(RW67X)
	Plug Fuse 3A	1	(HQ32K)

A complete kit of all parts, excluding optional items, is available:
Order As LK53H (TU1000 RTTY Kit)
**Not available separately*

COMPUTADRUM



by Robert Penfold

This is a six channel drum synthesiser which is designed specifically for use with a home computer. The computer acts as a sophisticated sequencer, and the unit can be directly driven from the BBC model B, VIC-20, Commodore 64, Atari 400/600XL/800/800XL, and Memo tech MTX500/512 machines.

It can also be used with machines such as the ZX81 and ZX Spectrum if they are fitted with an external input/output port that provides at least six digital outputs. The Computadrum only requires brief trigger pulses from the controller, and it could even be used with a non-computer based control circuit.

The sound generated by the unit is a simple fixed pitch drum sound rather than a falling pitch disco drum sound, but the pitch of each channel is tunable over a reasonably wide range using a preset control. Also, each channel has a resonance control which enables the output sound to be varied from a dull, short duration signal to a rich and resonant sound lasting a few seconds. Each drum has a different central pitch, and together they provide a very wide pitch range. The unit is battery powered and has an output for use with an external amplifier and loudspeaker.

Filters

Figure 1 shows the unit in block diagram form, and the circuit consists basically of six filters with their outputs combined by an active mixer stage. The output signal from the computer is a short pulse which gives a 'click' sound, and each filter is fed from a digital output of the computer. A lowpass filter is used to remove most of the high frequency content on each input pulse to give a lower pitched 'thud' sound, like the initial sound when a drum is struck. A bandpass filter close to oscillation is fed with this signal, which excites the filter giving a short burst of sinewave signal at the output. The signal has a fast attack and slower decay, with the latter being controlled by means of the resonance control.

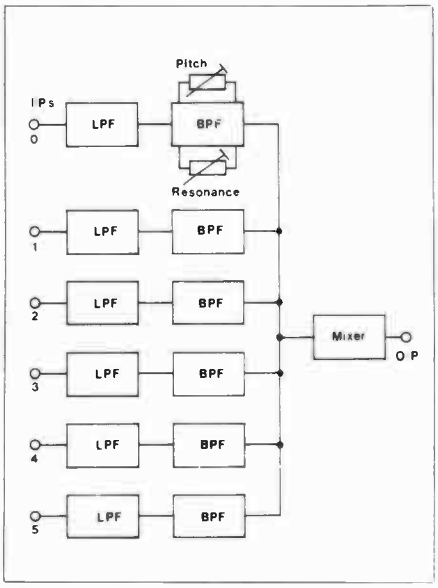


Figure 1. Block diagram

This gives a straightforward but quite realistic drum sound. The pitch and decay times can be controlled using the preset pitch and resonance controls, and the attack time is controlled by the cut-off

- ★ **Complete Electronic Drum Kit for Your Home Computer**
- ★ **Six Variable Pitch Drums**
- ★ **Resonance Control Varies Drum Timbre**
- ★ **Works With Many Makes of Home Computer**

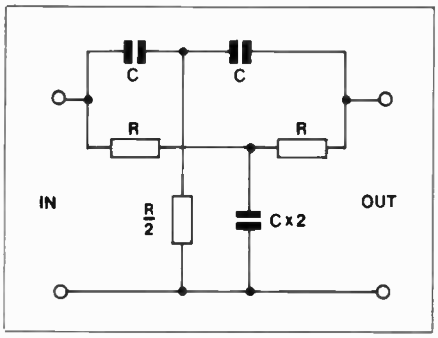


Figure 2. Twin T Filter

frequency of the lowpass filter. The operating frequency of each lowpass filter is not adjustable, but if desired the attack times can be altered by changing the value of the filter capacitor used in each lowpass filter. Thus, although this is an extremely simple way of generating a drum sound, it does give good control over the sound produced.

The bandpass filters are all based on the twin T arrangement shown in Figure 2, and the way in which this filter configuration obtained its name will probably be obvious. This passive filter circuit gives a notch of (theoretically) infinate attenuation at a certain frequency (the frequency at which the impedance of C is equal to that of R). This type of filter provides quite anarrow notch of attenuation, with losses of only a few dB being produced slightly 'off-tune'.

Of course, what we require in this application is a sharp bandpass response, which is the exact opposite of what the twin T configuration provides. However, by using a twin T filter in the negative feedback circuit of a reasonably high gain amplifier the required high Q bandpass response is obtained. All that happens here is that the twin T filter provides a low impedance path at frequencies outside the notch, giving a large amount of negative feedback and little voltage gain. At the notch frequency (and very close to it) the impedance through the twin T network is so high that there is no significant negative feedback, and the amplifier has its open loop voltage gain.

The Circuit

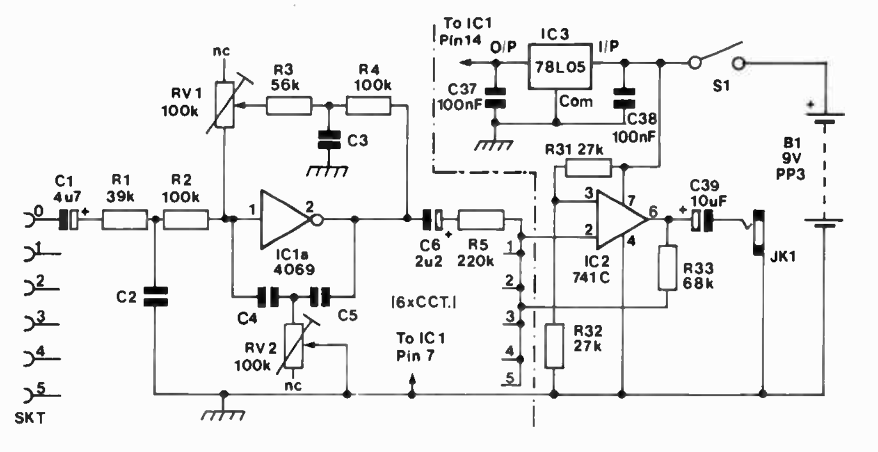
Figure 3 shows the circuit diagram of the Computadrum. The filters are each built around one section of a CMOS 4069BE hex inverter. Although not really intended for use in linear applications, a CMOS inverter will operate as a linear amplifier having a voltage gain of about 34dB (50 times) if a bias resistor is connected between its input and output terminals. In this case the bias resistance is provided by two resistors in the twin T circuit. The six filters are essentially the same, the only difference being the use of different values in each one so that a different pitch range is covered.

If we consider the filter based on ICIa, C1 provides DC blocking at the input while R1 and C2 from the lowpass filter circuit. C4, C5 and RV2 are one of the T networks, and RV2 acts as the resonance control. Using the theoretically correct value in the RV2 position the circuit oscillates at its resonant frequency. This is due to the phase changes that occur through the twin T circuit giving positive rather than negative feedback at the resonant frequency. RV2 is therefore used to give a somewhat higher resistance which prevents continuous oscillation from being produced. If RV2 is set just below the threshold of oscillation the input pulse will still produce strong oscillations that take several seconds to decay, giving a very resonant drum sound. If, on the other hand, RV2 is well backed off from this point, the filter will have a low Q and the oscillations will rapidly die away, giving a short, well damped drum sound.

The other T network is formed by RV1, R3, R4 and C3. RV1 enables the resonant frequency of the filter to be adjusted, but as only one resistive element of the T network is being varied this inevitably means that adjustment of RV1 has some effect on the resonance setting of the filter. Similarly, adjustment of RV2 has a small effect on the operating frequency of the filter. In practice this interaction is too slight to be a major drawback, and it does not result in the unit being difficult to set up ready for use.

IC2 is used in the mixer circuit which is a standard operational amplifier summing mode type. The output from each filter circuit is quite high at a few volts peak to peak, and the mixer circuit has therefore been given less than unity voltage gain to prevent overloading if more than one drum is activated at any one time. The input resistors of the mixer have been given high values so that a high input impedance (about 220k) is provided at each input. This is essential as an input impedance of several kilohms or less is sufficient to damp the filters to the point where a resonant drum sound cannot be achieved.

Power for the circuit is provided by a 9 volt battery, and the current consumption of the circuit is only about 7 milliamps. IC3 is used to provide a well stabilised supply to the filter circuits, and this is necessary because changes in supply voltage affect the gain of the amplifiers, and therefore the resonance setting. The use of a stabilised supply for the filters ensures that consistent results are obtained, as the battery voltage drops due to ageing.



SKT1	Values as circuit (or) as shown below (filter ccts. only)													IC1
0	R1	R2	R3	R4	R5	RV1	RV2	C1	C2 68nF	C3 15nF	C4 6n8	C5 6n8	C6	(a) 1 - 2
1	R6	R7	R8	R9	R10	RV3	RV4	C7	C8 100nF	C9 22nF	C10 10nF	C11 10nF	C12	(b) 3 - 4
2	R11	R12	R13	R14	R15	RV5	RV6	C13	C14 150nF	C15 33nF	C16 15nF	C17 15nF	C18	(c) 5 - 6
3	R16	R17	R18	R19	R20	RV7	RV8	C19	C20 220nF	C21 47nF	C22 22nF	C23 22nF	C24	(d) 9 - 8
4	R21	R22	R23	R24	R25	RV9	RV10	C25	C26 220nF	C27 68nF	C28 33nF	C29 33nF	C30	(e) 11 - 10
5	R26	R27	R28	R29	R30	RV11	RV12	C31	C32 330nF	C33 100nF	C34 47nF	C35 47nF	C36	(f) 13 - 12

Figure 3. Circuit Diagram

Construction

Details of the printed circuit board are provided in Figure 4. ICI is a CMOS device, and it should be fitted in a 14 pin DIL IC socket. Leave it in the antistatic packaging and do not fit it into the socket until the board is in other respects finished. Handle the device as little as possible. The only other point to watch when building the board is to make sure that components are inserted in the right position in the board. There are numerous resistors and physically similar capacitors, which makes it all to easy to produce mistakes. It is advisable to work through the components methodically and carefully, rather than just taking them at random and fitting them onto the board. Use Veropins at points on the board where connections to SK1, JK1, and S1 will eventually be made.

A Verocase measuring about 180 by 120 by 40 millimetres will comfortably accommodate all the components. SK1, JK1, and S1 are mounted on the front panel, as can be seen by referring to the photographs of the prototype. A 7 way

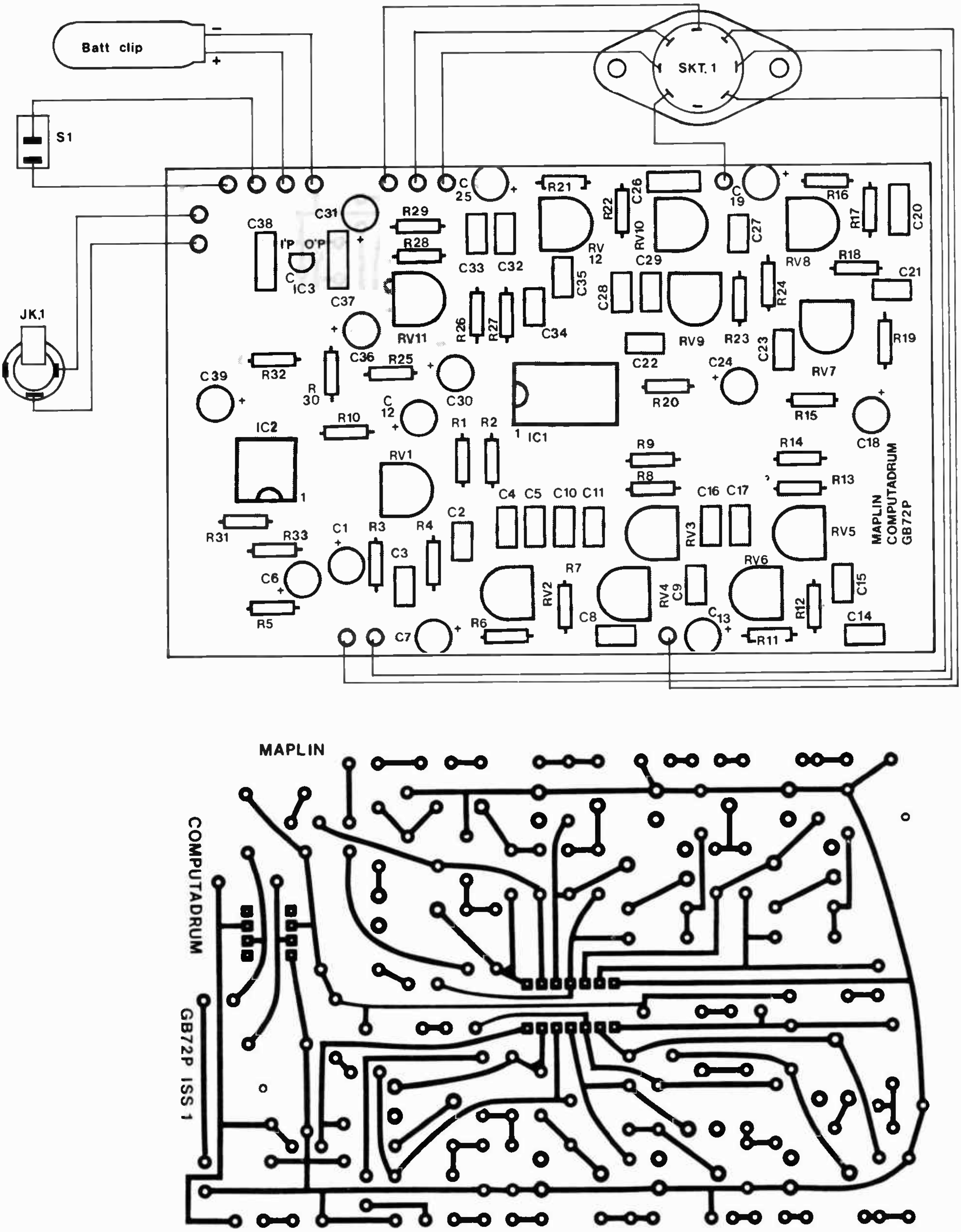


Figure 4. Artwork and wiring

DIN socket is specified for SK1, and this is likely to be the most convenient type to use in practice, but obviously any socket having 7 or more ways will do. Assuming a DIN connector is used, two 6BA ½ inch mounting screws plus nuts are required.

Mount the completed printed circuit board on the base panel of the case using 6BA or M3 mounting bolts about 12 millimetres long. There are four mounting pillars moulded into the lower section of the case, but these serve no useful purpose here, and may in fact get in the way. They can easily be drilled out using a bit of about 8 to 10 millimetres in diameter. Finally, the hard wiring is added using ordinary multistrand insulated hook-up wire.

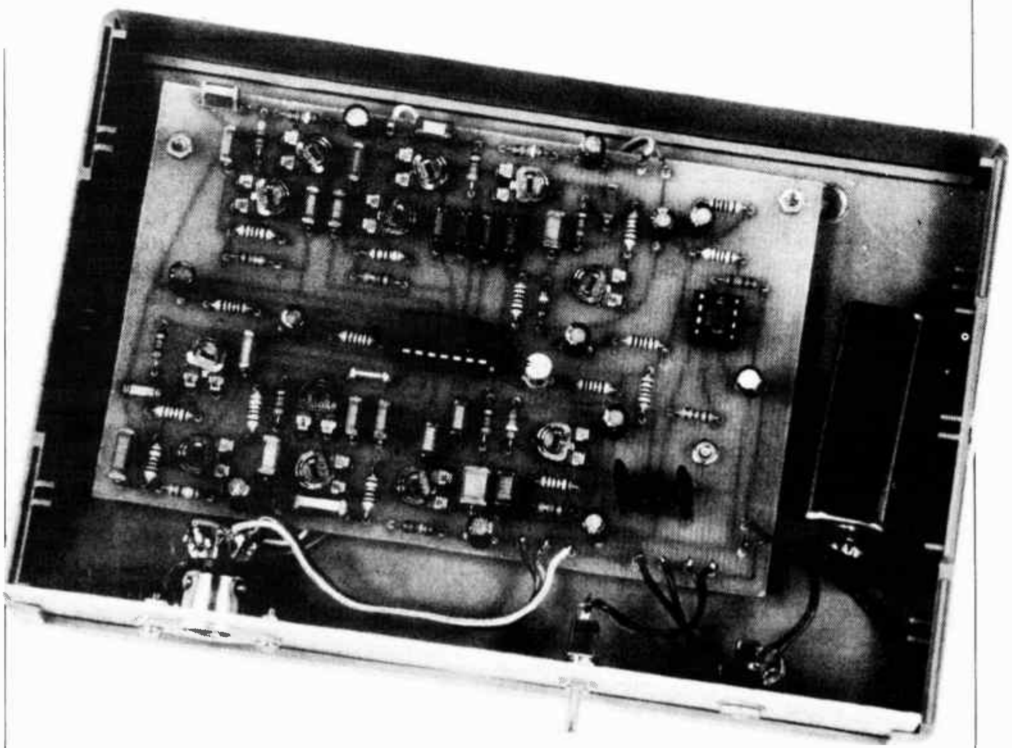
Connection

The audio output of the unit is coupled to the amplifier (or whatever) using an ordinary screened audio cable fitted with a 3.5mm jack plug which connects to JK1. Connection to the computer is via a piece of 7 way ribbon cable about 1 metre long, and fitted with a 7 way DIN plug at the end, which connects to SK1. The connector used at the other end of the lead must obviously be varied to suit the computer used as the sequencer. For a VIC20 or Commodore 64, a 2 by 12 way 0.156 inch edge connector is required; a 20 way IDC header socket is required for the BBC model B; the Atari machines need two 9 way D sockets; and for the Memotech machines a 14 pin DIL header plug is needed. Figure 5 gives connection details for all these computers. Note that the Memotech computers require a shorting lead from the output strobe terminal (pin 5) to ground (pin 16), to enable the outputs.

With any of the computers, an output pulse to trigger the unit is generated by setting an output line high and then immediately setting it low again. The speed of BASIC is such that a pulse of a few milliseconds in duration will be generated, and this is ideal. With machine code programs the output pulse generated will be too short unless a delay loop is used to suitably extend the pulse.

With the Memotech machine there is no setting up procedure required, and the Computadrum is controlled by writing data to the user port using the OUT 7,X instruction, where X is the value written to the port (e.g. OUT 7,2: OUT 7,0 would trigger channel 1).

With the VIC20, Commodore 64, and BBC model B computers the six lines of the user port that are used to control the unit must be set up as outputs. This is done by writing 63 to the data direction register which is at 37138, 56579, and &FE62 for the VIC20, Commodore 64, and BBC model B respectively. The Computadrum is then controlled by writing data to the user port which is at 37136, 56577, and &FE60 respectively. Joystick



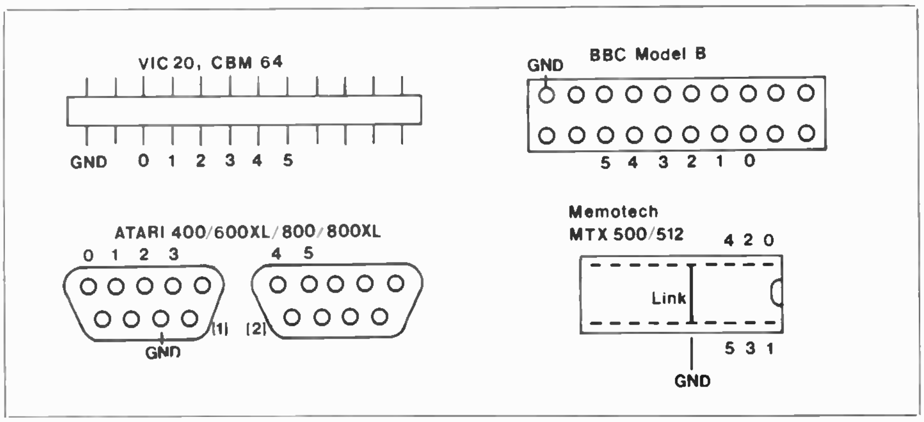


Figure 5. Connections to various computers

```
10 REM DRUMBEAT PROGRAM
20 REM FOR VIC20
30 REM SETUP
40 DIM ST(20)
50 POKE 37138,63
60 REM MAIN PROGRAM
70 GOSUB 1000:REM INPUT
80 GOSUB 2000:REM PLAYLOOP
90 GOTO 70
1000 PRINT "":REM CLEAR SCREEN
1010 INPUT "NUMBER OF DRUMBEATS";N
1020 FOR P=1 TO N*2 STEP 2
1030 INPUT "DRUM NO.";ST(P)
1040 INPUT "TIME INTERVAL";D
1050 ST(P+1)=D*50
1060 NEXT P
1070 RETURN
2000 PRINT:PRINT"PRESS ANY KEY TO STOP"
2010 FOR P=1 TO N*2 STEP 2
2020 POKE 37136,ST(P):POKE 37136,0
2030 FOR DE=0 TO ST(P+1):NEXT DE
2040 NEXT P
2050 GET A$:IF A$="" THEN 2010
2060 RETURN
```

For Commodore 64, change to:–

```
50 POKE 56579,63
2020 POKE 56577,ST(P):POKE 56577,0
```

```
10 REM DRUM CONTROLLER PROGRAM
20 REM FOR ATARI COMPUTERS
30 REM SETUP
40 DIM STORE(20)
50 POKE 54018,56
60 POKE 54016,63
70 GOSUB 1000:REM INPUT ROUTINE
80 GOSUB 2000:REM PLAY ROUTINE
90 GOTO 70
1000 ?CHR$(125):REM CLEAR SCREEN
1010 PRINT "NUMBER OF DRUMBEATS IN LOOP"
1020 INPUT N
1030 FOR P=1 TO N*2 STEP 2
1040 PRINT "DRUM ";
1050 INPUT DRUM:STORE(P)=DRUM
1060 PRINT "TIME INTERVAL ";
1070 INPUT DELAY:STORE (P+1)=DELAY*50
1080 NEXT P
1090 RETURN
2000 PRINT: PRINT "PRESS SELECT TO STOP"
2010 FOR P=1 TO N*2 STEP 2
2020 POKE 54016, STORE (P):POKE 54016,0
2030 FOR D=0 TO STORE (P+1):NEXT D
2040 NEXT P
2050 POKE 53279,8:IF PEEK (53279)<>5 THEN GOTO 2010
2060 RETURN
```

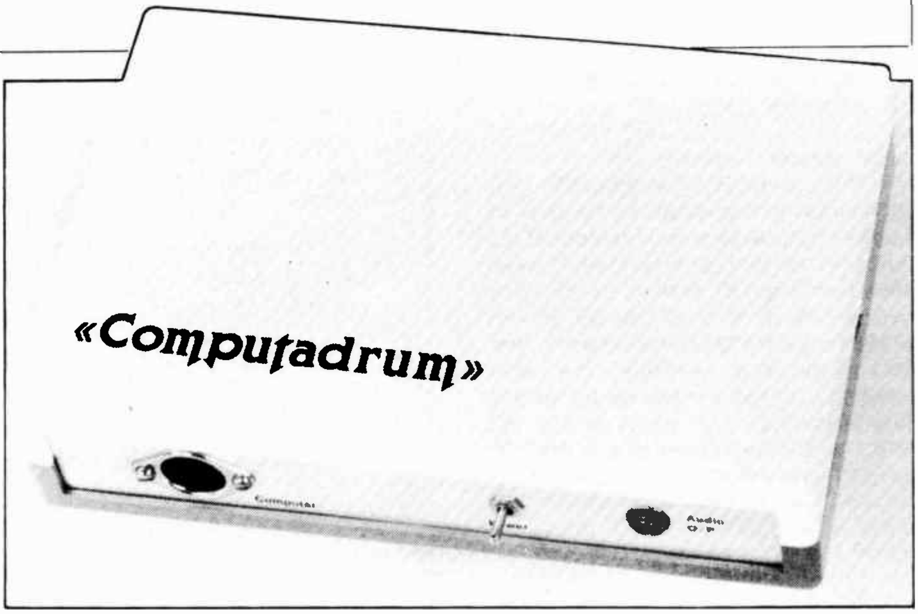
```
10 REM DRUMBEAT PROGRAM
20 REM FOR BBC MODEL B.
30 REM SETUP
40 DIM STORE (20)
50 ?&FE62=63
60 REM MAIN PROGRAM
70 REPEAT
80 PROCinput
90 PROCloop
100 UNTIL FALSE
1000 DEF PROCinput
1010 CLS
1020 INPUT "Number of drumbeats", N%
1030 FOR P=1 TO N%★2 STEP 2
1040 INPUT "Drum No.",STORE (P)
1050 INPUT "Time interval", D
1060 STORE (P+1)=D★100
1070 NEXT P
1080 ENDPROC
2000 DEF PROCloop
2005 PRINT"PRESS ANY KEY TO STOP":REPEAT
2010 FOR P=1 TO N%★2 STEP 2
2020 ?&FE60=STORE(P):?&FE60=0
2030 FOR delay=0 TO STORE (P+1):NEXT delay
2040 NEXT P
2045 UNTIL INKEY$(1)<>""
2050 ENDPROC
```

```
10 REM DRUMBEAT PROGRAM
20 REM MTX 500/512 VERSION
30 DIM STORE (20)
40 GOSUB 1000:REM INPUT
50 GOSUB 2000:REM PLAY LOOP
60 GOTO 40
1000 CLS
1010 INPUT "Number of drumbeats?";N
1020 FOR P=1 TO N★2 STEP 2
1030 INPUT "Drum No.?";STORE (P)
1040 INPUT "Time interval?";DELAY
1050 LET STORE (P+1)=DELAY★50
1060 NEXT P
1070 RETURN
2000 PRINT: PRINT "PRESS ANY KEY TO STOP"
2010 FOR P=1 TO N★2
2020 OUT 7,STORE(P): OUT 7,0
2030 FOR D=0 TO STORE (P+1): NEXT D
2040 NEXT P
2050 IF INKEY$="" THEN GOTO 2010
2055 PRINT "OUT OF LOOP"
2060 RETURN
```

ports 1 and 2 of the Atari machines are set up as outputs using the following routine:

```
POKE 54018,56
POKE 54016,63
POKE 54018,60
```

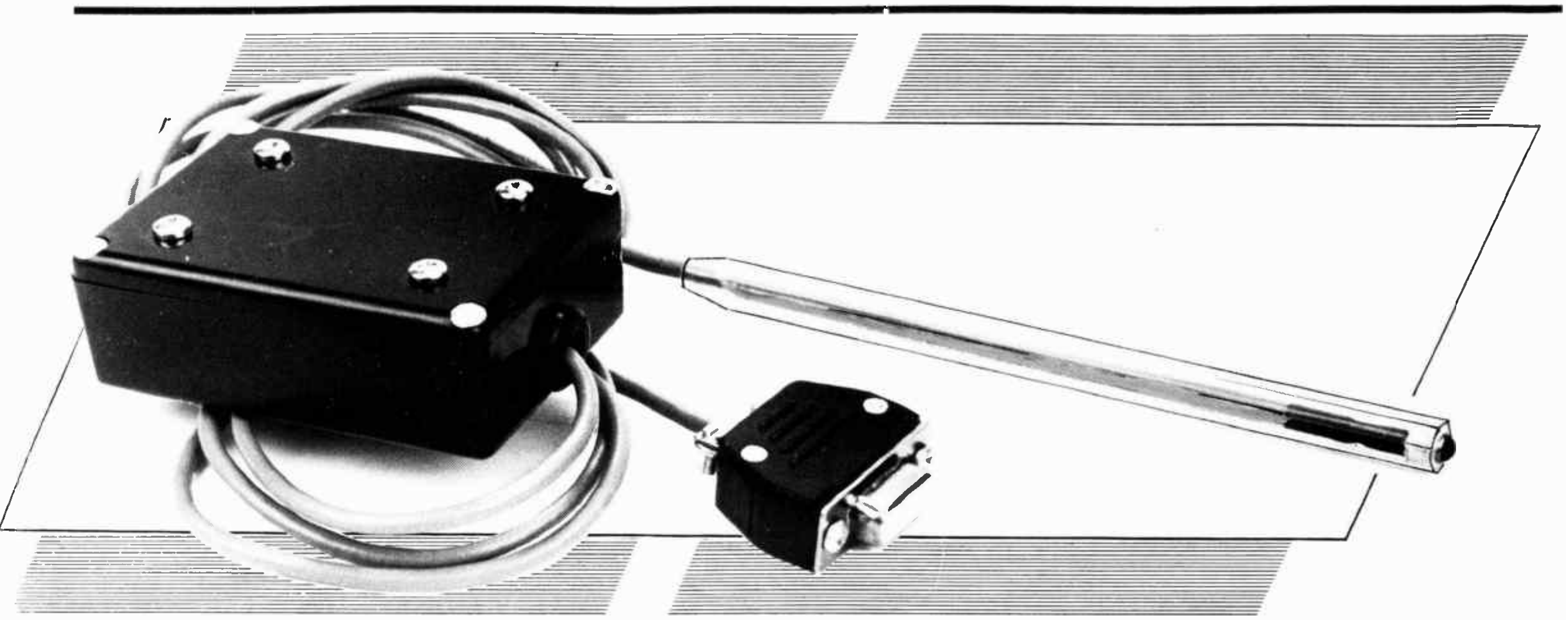
Data is then written to the outputs at address 54016. When initially testing the unit it is probably best to start with all the presets at about half maximum resistance. Then use a short loop program to repeatedly trigger one channel, and set up the two presets for that channel to give the desired pitch and reasonance. Then repeat this procedure for the other five channels. For those who do not wish to devise their own software the accompanying listings give suggested software for each of the machines mentioned, these programs are self explanatory in use.



COMPUTADRUM PARTS LIST

RESISTORS: All 0.6W 1% Metal Film Unless Stated			
R1,6,11,16,21,26	39k	6	(M39K)
R2,4,7,9,12,14,17,19,22,24,27,29	100k	12	(M100K)
R3,8,13,18,23,28	56k	6	(M56K)
R5,10,15,20,25,30	220k	6	(M220K)
R31,32	27k	2	(M27K)
R33	68k	1	(M68K)
RV1-12	Hor Encl Preset 100k	12	(UH06G)
CAPACITORS			
C1,7,13,19,25,31	PC Elect 4.7μF 63V	6	(FF03D)
C2,27	Poly Layer 0.068	2	(WW39N)
C3,16,17	Poly Layer 0.015	3	(WW31J)
C4,5	Poly Layer 0.0068	2	(WW27E)
C6,12,18,24,30,36	PC Elect 2.2μF 100V	6	(FF02C)
C8,33	Poly Layer 0.1	2	(WW41U)
C9,22,23	Poly Layer 0.022	3	(WW33L)
C10,11	Poly Layer 0.01	2	(WW29G)
C14	Poly Layer 0.15	1	(WW43W)
C15,28,29	Poly Layer 0.033	3	(WW35Q)
C20,26	Poly Layer 0.22	2	(WW45Y)
C21,34,35	Poly Layer 0.047	3	(WW37S)
C37,38	Minidisc 0.1μF 16V	2	(YR75S)
C39	PC Elect 10μF 50V	1	(FF04E)
C32	Poly Layer 0.33	1	(WW47B)
SEMICONDUCTORS			
IC1	4069UBE	1	(QX25C)
IC2	μA741C 8-pin DIL	1	(QL22Y)
IC3	μA78L05AWC	1	(QL26D)
MISCELLANEOUS			
SK1	DIN Socket 7-pin	1	(HH37S)
JK1	Jack Socket 3.5	1	(HF82D)
S1	SPST Ultra Min Toggle	1	(FH97F)
	Computadrum PCB	1	(GB72P)
	Pin 2145	1 Pkt	(FL24B)
	PP3 Clip	1	(HF28F)
	DIL Socket 14-pin	1	(BL18U)
	DIL Socket 8-pin	1	(BL17T)
	7/0.2 Wire 10M Blk	1 Pkt	(BL00A)
	Constructors' Guide	1	(XH79L)
	Computadrum Instructions	1	(XK74R)
OPTIONAL			
	Verobox 214	1	(LQ07H)
	Bolt 6BA ½in.	1 Pkt	(BF06G)
	Nut 6BA	1 Pkt	(BF18U)
	6BA Spacer ⅛in.	1 Pkt	(FW33L)
	Plug Metal 3.5mm	1	(HF81C)
	DIN Plug 7-pin	1	(HH30H)

A complete kit of all parts is available for this project:
Order As LK52G (Computadrum Kit)
Also available separately:
Computadrum PCB **Order As GB72P**



LIGHT PEN

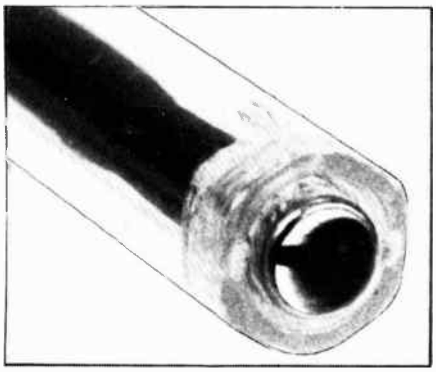
by Chris Barlow

for the Atari, VIC20, and Commodore 64

If you own an Atari, VIC20, or Commodore 64, you possess a computer with the ability to accept a light pen input. But if you have ever tried to obtain a ready-built unit, you will probably have been amazed at the cost even if you found a source at all. This is partly due to the lack of software that the device requires, and the difficulty in manufacturing a reliable piece of hardware. Some manufacturers have attempted to produce such a device, but due to marketing considerations (i.e. cost and potential sales), the resulting hardware leaves a lot to be desired. In this article I present a Light Pen which should cost in components, less than half the price of a commercially available unit, with, in my opinion, a considerably better performance. I have written the article with reference to my own computer, which is an Atari 800, but I have also tried the Light Pen on a VIC20 and a Commodore 64 and it works perfectly.

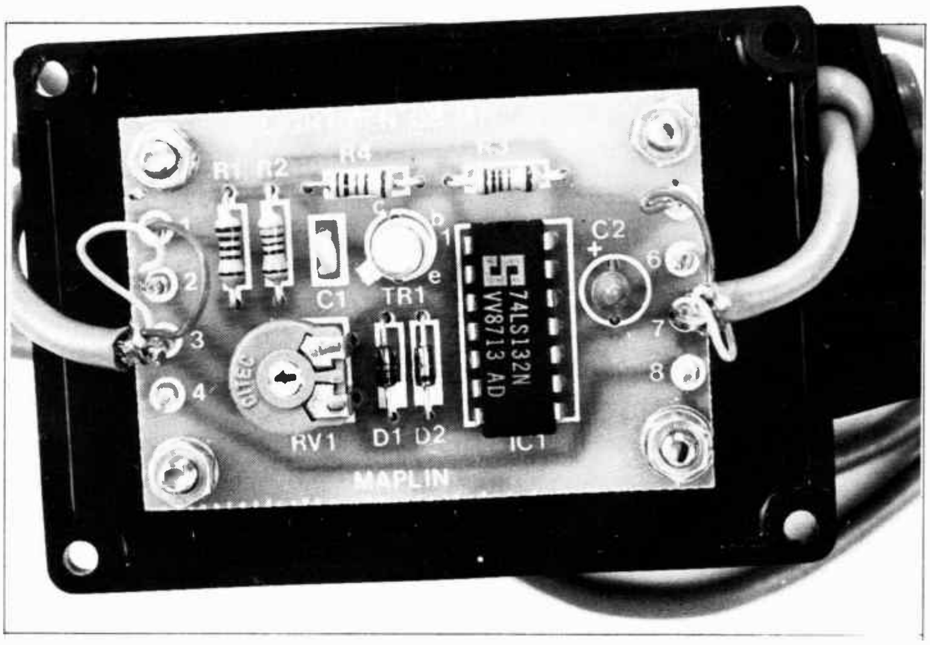
Method

To explain how a light pen works, you must first have an idea of how the television picture system is generated. A TV picture is basically constructed from a number of lines produced on the phosphor coating on the inside of the screen. The original TV system in this country used 405 lines, but today 625 lines is used. The phosphor on the screen glows when struck by the high speed electrons given off by the hot cathode wire (gun) in the tube. This is focused by a magnetic field around the tube to produce a single spot of light on the TV screen. A set of electro-magnets called horizontal deflection coils are used to move the spot of light across the screen to produce a horizontal line (X axis). When the spot reaches the right-hand side of the screen, it is deflected back to the left-hand side



at high speed and during this period the gun is blanked to prevent spurious fly-back lines being generated. A vertical deflection coil is slowly moving the spot down the screen as well so that by the time the spot gets back to the left-hand side again it is slightly below its previous start position and thus ready to draw a new line. The downward scan (Y axis) continues until all 625 lines have been drawn, at which point the beam is made to return to its top left starting position. This is a highly simplified description; in a real TV set the actual procedure is far more complex.

The Light Pen is designed to detect the spot of light which moves over the screen. The computer has the job of determining the X and Y co-ordinates of the spot as it passes the pen. These values are obtained in an Atari from the internal register set of the 'Antic' display processor. Since the position of the light spot on the screen is directly related to the time it took to get there from the beginning of the first scan position, the hardware can determine X and Y values and store them in two hardware registers.



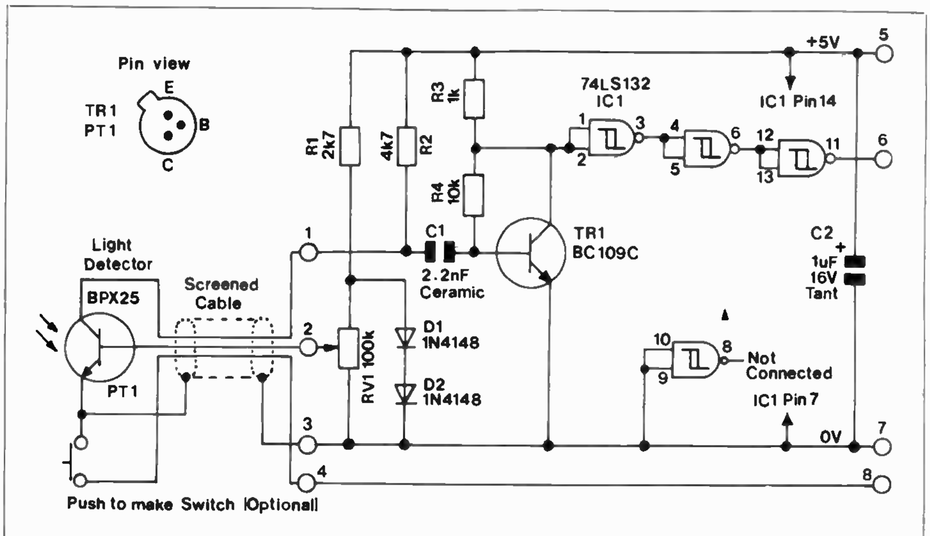


Figure 1. Circuit Diagram

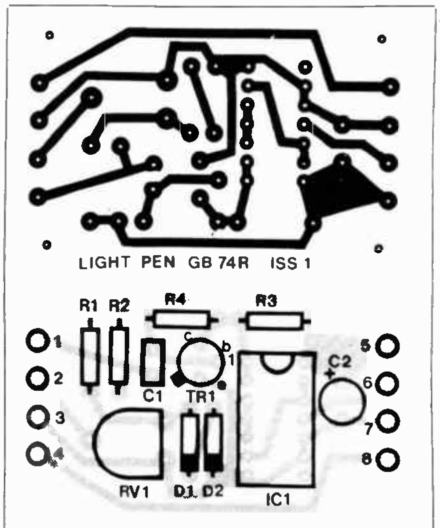


Figure 2. Artwork and Legend

HT PEN LIGHT PI

When programming in BASIC, the X and Y values are obtained by PEEKing locations 564 for X and 565 for Y.

The user's software then has to interpret these values in order to obtain screen position related values. The horizontal or X location (564) will return a value of 78 for the extreme left-hand side of the screen, increasing by 1 up to a value of 227. Then something rather strange happens; the value jumps to 0 and then increments to a final value of 8 for the extreme right-hand side. Although this is a problem, it can be allowed for in the software. The vertical or Y location (565) will return a value of 16 for the extreme top of the display, incrementing by 1 to a value of 111 at the extreme bottom of the display. The values stored at these two locations are updated when any of the four joystick trigger inputs are used.

Circuit

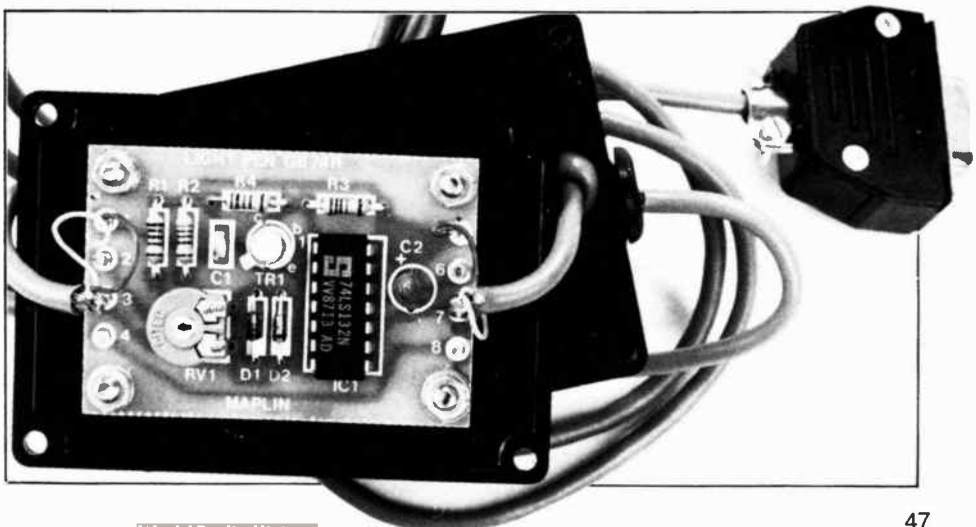
As can be seen in the circuit diagram (Figure 1), there are very few components necessary to obtain a working Light Pen. The most important is the light detector. It must have good sensitivity and fast reaction characteristics. The BPX25 phototransistor meets both requirements at a modest cost. This device is equipped with its own built-in optical lens which is made of glass. This point is worth noting, since, if direct contact is made with the glass of the TV screen, scoring may occur. To prevent this, the BPX25 should be recessed into a plastic tube of some description. To obtain maximum sensitivity and operating speed, it is necessary to bias the base of the transistor. The voltage required is quite small, about 0.5V. This voltage is adjustable with the 100k preset (RV1) from 1.2V down to 0V. In practice the preset wiper position comes out at about half way round its travel. The 1.2V at the top end of the preset is generated by two silicon diodes in series, and forward biased. The current through the diodes is limited by R1 connected to the +5V supply taken from pin 7 of the joystick port (PCB pin 5).

When the phototransistor detects a light pulse, the amount of current flowing through it changes. The current through the device is limited by R2 in the collector. These changes in current cause a voltage change at the collector of the phototransistor. The voltage pulses are then coupled by C1 into the base of a BC109C, TR1. This device performs the necessary voltage amplification to obtain TTL logic levels. The final stage of shaping the pulse is left to IC1, a quad 2-input NAND Schmitt trigger, 74LS132. As can be seen, only three of the four gates are used. The final component in the circuit is C2, a tantalum bead capacitor across the supply rails to remove any spurious noise on the rails. The output of the final gate is fed to pin 6 of the joystick port. The ground connection is made from PCB pin 7 to pin 8 on the joystick port.

In the prototype, a push-to-make switch was used as the trigger for the Light Pen. The switch was simply connected between pin 1 and pin 8 of the joystick port. The final construction and choice of housing is left to you, but an old Biro or felt-tip pen case is ideal for the pen itself, and the electronics can be housed in a small plastic box. The cable linking the phototransistor to the circuit board must be screened to prevent stray interference pick-up. The prototype used 4-core overall screened cable. Connection to the joystick port is via a standard D-type 9-way connector. Please note that if you have one of the Atari XL range of computers, due to the case moulding around the joystick ports, the standard D-range connector supplied in the kit will not fit and will either have to be modified or a suitable substitute found.

Programs

Included in this article are three very



simple programs for the Atari, the first of which is used to set up RV1 in the circuit. In all three programs we have used joystick port 1, because the Light Pen's switch controls the value of STICK (0). However, the Light Pen will work in any of the four joystick ports, except on the 400 where it will only work on port 4, so STICK(3) should be used in the programs in this instance. Program 1 is a simple drawing utility which will produce lines or dots depending on the state of the function keys. Holding Select down will put the drawing program into dot mode and the Option key will clear the screen and reset the starting position to the current pen position. Pressing the Light Pen's own button will produce continuous line drawing. To set a new starting point, simply place the pen on the screen and press the Select key. To adjust the preset to obtain the correct results simply hold the Light Pen against the screen, press the switch on the Light Pen and move the pen slowly. If the line does not trace the movement, adjust the preset until it does. If you cannot obtain a satisfactory result, try increasing the brightness and contrast controls on your TV. If there is still no response, recheck your soldering and construction.

Program 2 is an example of how a Light Pen can be used for menu-driven software. Position the pen over the number you wish to choose and press the Light Pen switch. If all is well, a tone will be heard and your selection will be shown at the bottom of the screen.

The final program (3) is a very simple musical instrument, in which you can select both volume and pitch. The sound will only be present whilst pressing the Light Pen switch. The display on the screen is a matrix of square dots with volume increasing down the screen and pitch increasing across the screen, right to left.

In conclusion I must point out that the programs shown are by no means good examples of what can be achieved, but are adequate for testing purposes and demonstrating the principles behind Light Pen Software implementation. When writing your own software, you must bear in mind where the screen is dark, no information can be detected by the Light Pen.

Atari Program 1

```
10 GRAPHICS 24:COLOR 1
20 X=PEEK(564):X=X-155+X:IF X<1 THEN X=1
30 Y=PEEK(565):Y=Y-30+Y:IF Y>190 THEN Y=190
40 IF PEEK(53279)=3 THEN GOSUB 80
50 IF PEEK(53279)=5 THEN PLOT X,Y
60 IF STICK(0)<>15 THEN DRAWTO X,Y
70 GOTO 20
80 GRAPHICS 24:COLOR 1
90 PLOT X,Y:RETURN
```

Atari Program 2

```
10 REM MENU
20 GRAPHICS 2+16:SETCOLOR 0,0,12:SETCOLOR 4,4,1
30 PRINT #6;" atari 1"
40 PRINT #6;" atari 2"
50 PRINT #6;" ATARI 3"
60 PRINT #6;" ATARI 4"
70 PRINT #6;" atari 5"
80 PRINT #6;" atari 6"
90 PRINT #6;" ATARI 7"
100 PRINT #6;" ATARI 8"
110 PRINT #6;" atari 9"
120 PRINT #6;" atari 10"
130 IF STICK(0)<>15 THEN 150
140 GOTO 130
150 LET I=PEEK(565)
160 IF I<18 OR I>94 THEN 150
170 IF I=18 OR I=19 OR I=20 OR I=21 OR I=22 THEN
 M=1:GOSUB 280
180 IF I=26 OR I=27 OR I=28 OR I=29 OR I=30 THEN
 M=2:GOSUB 280
190 IF I=34 OR I=35 OR I=36 OR I=37 OR I=38 THEN
 M=3:GOSUB 280
200 IF I=42 OR I=43 OR I=44 OR I=45 OR I=46 THEN
 M=4:GOSUB 280
210 IF I=50 OR I=51 OR I=52 OR I=53 OR I=54 THEN
 M=5:GOSUB 280
220 IF I=57 OR I=58 OR I=59 OR I=60 OR I=61 THEN
 M=6:GOSUB 280
230 IF I=65 OR I=66 OR I=67 OR I=68 OR I=69 THEN
 M=7:GOSUB 280
240 IF I=74 OR I=75 OR I=76 OR I=77 OR I=78 THEN
 M=8:GOSUB 280
250 IF I=82 OR I=83 OR I=84 OR I=85 OR I=86 THEN
 M=9:GOSUB 280
260 IF I=90 OR I=91 OR I=92 OR I=93 OR I=94 THEN
 M=10:GOSUB 280
270 GOTO 130
280 IF MM=M THEN RETURN
290 POSITION 4,11:PRINT #6;"ATARI=";M;" "
300 FOR V=15 TO 0 STEP -1:SOUND 0,M*10,10,V:NEXT
 V:LET MM=M:RETURN
```

Atari Program 3

```
10 GRAPHICS 4+16:COLOR 1
20 SETCOLOR 4,2,3:SETCOLOR 0,0,15
30 FOR Y=0 TO 47 STEP 4
40 FOR X=0 TO 70 STEP 4
50 PLOT X,Y
60 NEXT X:NEXT Y
70 IF STICK(0)<>15 THEN 90
80 SOUND 0,0,0,0:GOTO 70
90 SOUND 0,PEEK(564)/3,10,PEEK(565)/10
100 GOTO 70
```

LIGHT PEN PARTS LIST

RESISTORS: All 0.6W 1% Metal Film Unless Specified

R1	2k7	1	(M2K7)
R2	4k7	1	(M4K7)
R3	1k	1	(M1K)
R4	10k	1	(M10K)
RV1	Hor Encl Preset 100k	1	(UH06G)

CAPACITORS

C1	Ceramic 2200	1	(WX72P)
C2	Tant 1.0μF 35V	1	(WW60Q)

SEMICONDUCTORS

TR1	BC109C	1	(QB33L)
D1,2	1N4148	2	(QL80B)
IC1	74LS132	1	(YF51F)
PT1	BPX25	1	(QF30H)

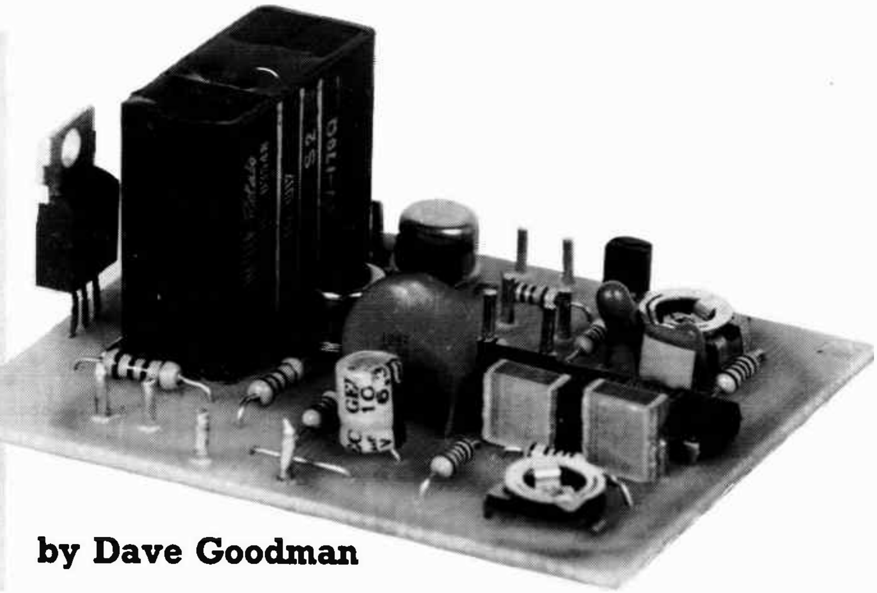
MISCELLANEOUS

Light Pen PCB	1	(GB74R)
Pin 2145	1 Pkt	(FL24B)
Multi-Core 4-Way	2 Mtrs	(XR25C)
Verobox 301	1	(LL12N)
Bolt 6BA ½in.	1 Pkt	(BF06G)
Nut 6BA	1 Pkt	(BF18U)
6BA Spacer ⅛	1 Pkt	(FW33L)
Thk Grommet 6.4mm	2	(FW59P)
D-Range 9-Way Skt	1	(RK61R)
D-Range 9-Way Cover	1	(RK62S)
Shakeproof 6BA	1 Pkt	(BF26D)
Constructors' Guide	1	(XH79L)
Light Pen Instructions	1	(XK16S)

A complete kit of all parts is available for this project:
Order As LK51F (Light Pen Kit)

Also available separately:
Light Pen PCB **Order As GB74R**

PWM MOTOR DRIVE MODULE



by Dave Goodman

- ★ 6 - 12V Forward and Reverse Model Motor Driver
- ★ Proportional Control Offers Smooth Transition from Off to Full Speed
- ★ Ideal for Model Boats, Cars and Robotics

Following on from the previous issues PWM Servo Driver, this model speed controller will drive low voltage electric motors from a suitably encoded pulse width modulated signal. Both 6V and 12V systems are catered for by the output drive circuitry which will handle motor stall currents up to 5 amps, while the front end decoding section connects separately to a low voltage 4.8 – 6V supply obtainable from radio control Rx battery packs for instance. Although primarily intended for Radio Control model use, the project also finds application in Robotics projects where computer control of movement and direction is required.

Proportional Control

Unlike servo's, the speed controller does not require positional feedback information. Essentially all that is required to start and stop an electric motor is to apply then disconnect power via a switch, and toggling the switch will alternately increase then decrease the speed at which the motor is running. If the switch could be held closed for a set time period and then held open for the same time, so that its 'mark' (closed) to 'space' (open) ratio becomes even, then the motor would be expected to run at approximately half power allowing for over-run and starting losses.

Lengthening the switch make time and reducing the switch break time repeatedly will therefore mean that power is applied for longer periods and the motor will increase its speed accordingly. Conversely, reducing the switch make time and lengthening the break time will slow the motor. This principle is applied in PWM systems as shown in Figure 7.

The repetition rate, or switch on and switch off cycle, is standardised at 20ms and each complete cycle is called a Frame. The reciprocal value from this (1 ÷ 0.02) produces the Frame Rate and is 50 frames per second. During each 20ms frame cycle the positive going pulse can be increased from a minimum width of 0.2/0.5ms, up to a maximum width of 2.0/2.5ms, the latter corresponding to maximum speed and the former to minimum. Obviously, manually operating a switch in the motor supply line at 50 times a second is slightly impractical and use of electronic switching IC's becomes desirable.

Circuit Description

In Figure 1, IC1 is a linear pulse width amplifier and expands the incoming signal at pin 14 into a pulse train whose mark/space ratio can be varied between zero (0V) and one (+V). Preset RV2 and C4 set the internal monostable timing period and input pulses less than or greater than this period determine motor speed. Because both forward and reverse drive are necessary, a 'no drive' or zero position is required and RV2 can be adjusted to determine this. RV1 sets the 'dead band' area, or the relationship between motor speed and control 'stick' movement. Along with the pulse expansion component, C3, this preset can be adjusted for maximum speed and zero positions. IC1 pin 4 output determines motor direction and has a high (+V) output in one direction and a low (0V) output in the other.

One of two links A or B are inserted for operating RLA via TR1, TR2, and IC2b or IC2c, and are fitted according to the required direction of rotation of the motor armature. Pins 5 and 9 are NANDed by IC2a and produce a positive pulse train which switches TR3, TR4 and TR5. Either pin 5 or pin 9 is active, but not both together, and each signal is complementary to the other depending on forward or reverse direction signals. TR5 must be capable of switching high currents to the motor and R10 will supply drive signals to external NPN transistors if larger current handling becomes necessary (pin 10). Pin 4 output is either high or low with a selected direction and could be buffered for reversing-lights on a model car for example. Both relay contacts reverse connections to the motor when operated by RLA from IC1 pin 4, so that the same drive signal at TR5

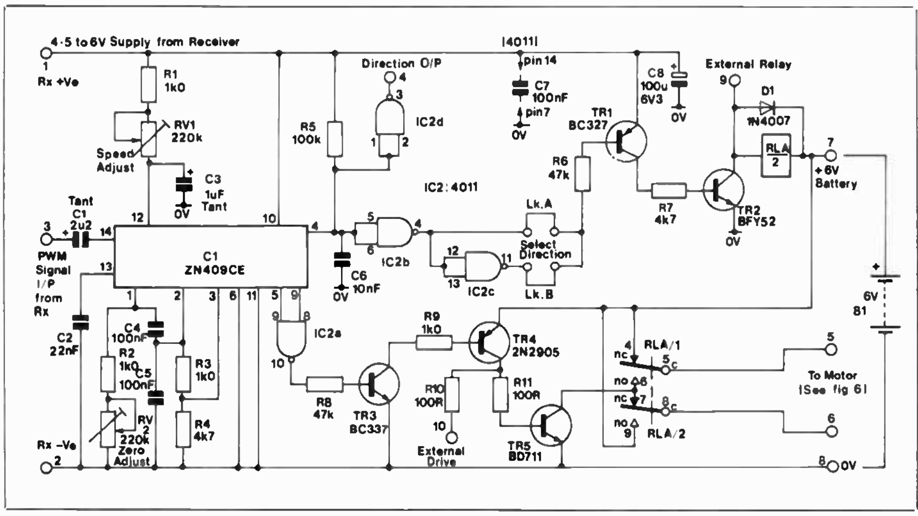


Figure 1. Circuit Diagram

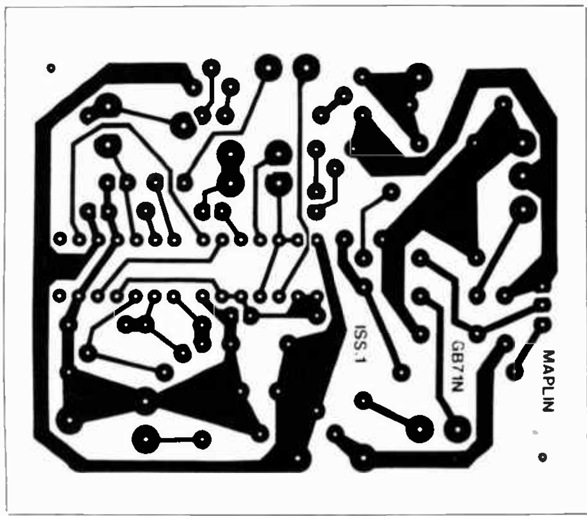


Figure 2. Artwork

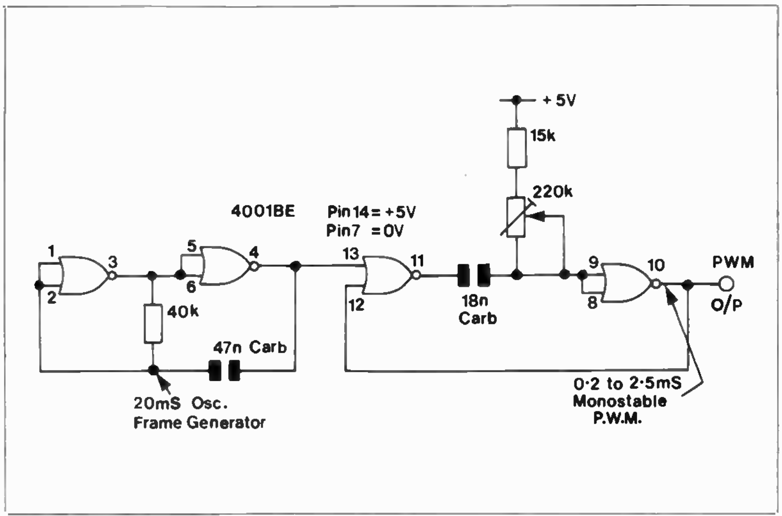


Figure 3. Test Circuit

collector is available for both forward and reverse modes. Output pin 9 may be connected to an externally mounted relay if larger current switching is required.

Construction

Two links are initially required to be inserted directly into the PCB and are best formed from 24swg tinned copper wire. Excess lengths removed from resistor leads could be utilised for this. Next fit R1 to R9 and standard resistors R10 and R11 followed by D1, which must be correctly aligned as per the PCB legend. It may be convenient at this stage to solder these components and cut off excess leads, thus avoiding the inevitable jungle that would otherwise result.

Fit the fourteen pins from the track side and push the heads down to the respective pads with a soldering iron apply solder. Fit both presets RV1, RV2 and IC1, IC2. Be sure to fit IC's correctly by aligning the end notch with the legend otherwise they will be damaged in use and are not easy to remove after soldering! Fit all capacitors and note that C1 and C3 are polarised and must be fitted correctly with the +V markings in line. Polycarbonate capacitors C4 and C5 can either have their terminals broken quite easily, so exercise care when fitting both to the PCB. Again, solder all components in place, remove surplus wires and fit RLA, which can only be inserted in one position.

The parts list offers both 6 volt and 12 volt versions for the relay and is a matter of choice to suit individual requirements, but note that only the 6V version is supplied in the kit. Next, mount the five transistors. TR5 is positioned with its mounting bracket facing outwards, away from the PCB and the plastic body facing inward towards RLA. Later on, it may be necessary to heatsink TR5, so ensure reasonable length leads between the PCB and bottom of TR5. This will allow it to be manoeuvred over the edge of the PCB for easier mounting.

Finally, solder all remaining components, clean the track surface with solvent, to remove flux and solder splashes, and inspect the work. When satisfied that all is correct, proceed with testing the module. It is worth pointing out that many problems develop from incorrect component recognition, poor soldering and messy track surfaces. Always carefully inspect and re-check parts for mistakes before applying power and this will ensure that any problems can be rectified before damage occurs.

Testing

Initial checks concern voltage and current measurements, and a multimeter is the minimum item of test equipment that should be available. Refer to Figure 4 connections diagram. Connect a 5V supply with −V to Pin 2 on the PCB, and +V to the + lead of a multimeter. Set the meter to measure DC current (100mA), connect its negative lead to Pin 1, and turn on the power. Set RV1 wiper to approx. 7 o'clock and RV2 wiper at approx. 11 o'clock as depicted by the arrows in Figure 4. A current reading of 5 – 6mA should be seen on the meter.

Remove power and meter, reconnect the supply +V to Pin 1 on the PCB and connect the meter with +V lead to Pin 1 and −V lead to Pin 7. Re-apply power and check the meter for a zero reading. Temporarily connect Link A and listen for a click in the relay. The meter should read approx. 10mA when using the 12V relay, or 55 – 60mA when using the 6V relay. Remove Link A. The meter should drop to zero and the relay should click as it releases. These checks should give an indication that the module is basically functioning, providing the above figures correspond to within a few percent.

With the absence of a suitable +V pulse PWM system, such as a radio control Tx and Rx, a simple CMOS test circuit is shown in Figure 3. This too requires a 5V supply and serves as a 20ms frame generator and variable monostable. Please note that the Figure 3

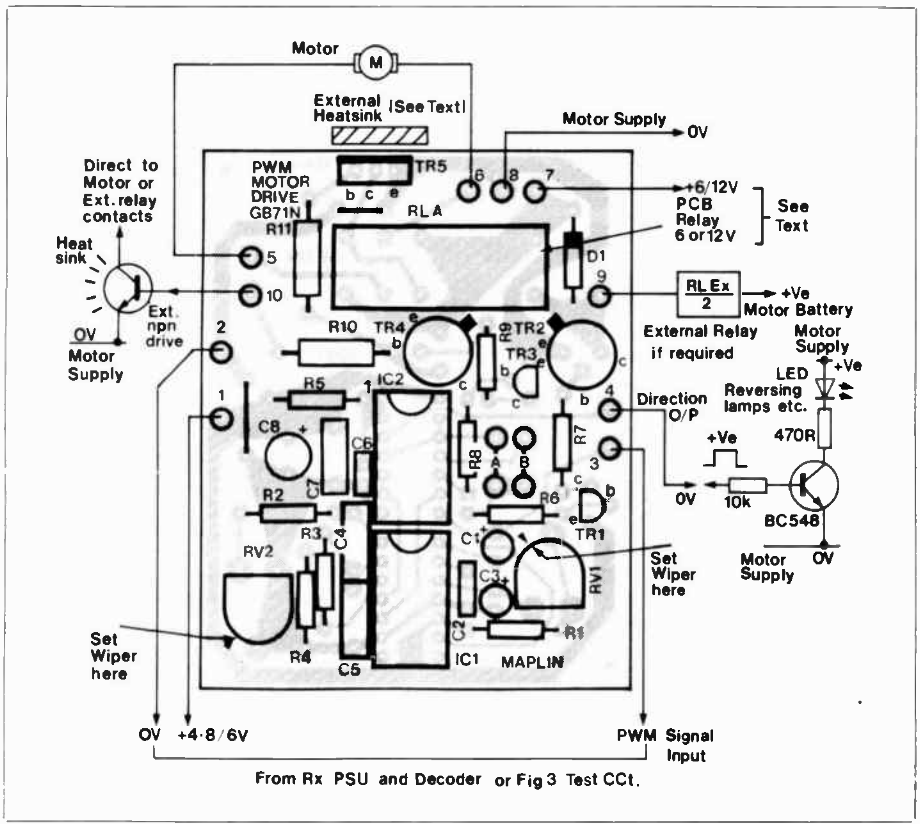


Figure 4. PCB Wiring and Legend

circuit is not a project or kit and exists solely as a guide to assist with testing the module. Whatever system is used, connect the PWM O/P to Pin 3 on the module, and ensure a signal return path exists along Pin 2 (0V) connection. Figure 8 can be used for reference. Fit Link B only onto the module and apply both low and high power supplies as shown.

It is certainly not advisable to take the motor supply +V from module input or receiver supplies, as large current surges will affect both, causing glitching at least, or battery failure at worst. In use, low power Nicads (4.8 – 6V) are perfectly adequate for the input supply, but larger battery packs (if used) will need to be either high power Nicads or Lead Acid/Cadmium varieties for driving the motor. Remember to choose the motor supply voltage to suit both relay and motor ratings (6 – 12V). Do not connect the motor just yet, but switch on all supplies. Adjust either the appropriate transmitter stick, or preset (in the case of Figure 3) from centre zero, which should correspond to an approximate 1.5ms frame pulse down to 0.5ms, whereupon the relay should operate with a click. Reverse stick or preset back through zero in the opposite direction, and the relay will release. When using Link A instead of Link B the relay will normally be in the operated state at first, and release during the test; this being the opposite condition. So Link A holds the relay operated for release mode and Link B holds the relay released for operate mode. In either case, connect a voltmeter adjusted to read 10 – 20V between 0V and PCB pin 4. The reading should be normal at 0V and +5V when moving the stick (pot!).

Connect a motor to PCB pins 5 and 6, and again with all supplies connected ensure full forward, zero and full reverse conditions can be established by varying the control stick or pot. It may be found necessary to re-adjust RV1 and RV2 on the module to ensure these conditions are met with a wide zero or motor off position, therefore trial and error settings will indicate optimum performance for your particular system.

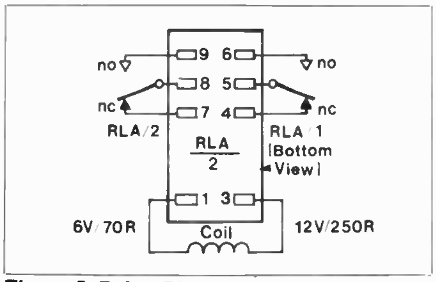


Figure 5. Relay Pinouts

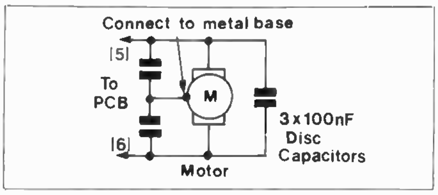


Figure 6. Motor Suppression

Motors

Owing to the wide variety of motors and applications that could be used, it would be best to examine the limitations of the module rather than discuss individual requirements. For instance, Bullett type motors used with large model aircraft can draw 30 Amps or more and relays, drive transistors and PCB tracks must be capable of handling this for long periods. On the module, RLA can comfortably switch 5 Amps although TR5 will dissipate large amounts of power, especially under low speed or stall conditions, so without extra relays and drive transistors fitted, smaller motors of 1 to 2 Amps only should be used. As explained previously, Pin 10 can supply a further three or four NPN power transistors, and Pin 9 a second relay, should it be required to drive larger motors. Simply connect the transistor's emitter to Pin 8, base to Pin 10, and collector to collector of TR5: in other words in parallel with TR5. Figure 6 offers a simple suppression circuit which should prove adequate for most motors without adversely affecting performance too much. Excessive capacitive loading will affect the pulse waveform at low speeds, so bear this in mind when using suppression.

Heatsinks

TR5 may tend to run hot under heavy load conditions and heatsinking will have to be used to prevent damage or loss of power. Any method used will depend entirely on the space available, and the weight allowance within the model. Model boats generally have plenty of space and buoyancy, and a large heatsink may add ballast for stability. One eighth and half scale cars often have a metal chassis and this could be utilised for heatsinking, but plastic kits may melt around TR5 or its heatsink, so allow plenty of airflow to keep temperatures down.

In conclusion, always keep batteries for the motor drive supply and logic drive separate; only use low power 1 – 2 Amp motors unless adding further power transistors; ensure adequate heatsinking and ensure all supplies are switched off after use.

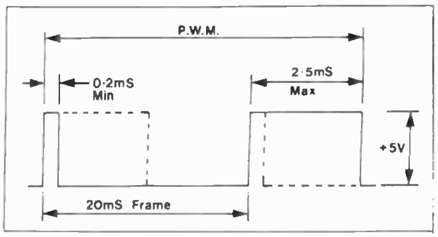


Figure 7. Control Waveform

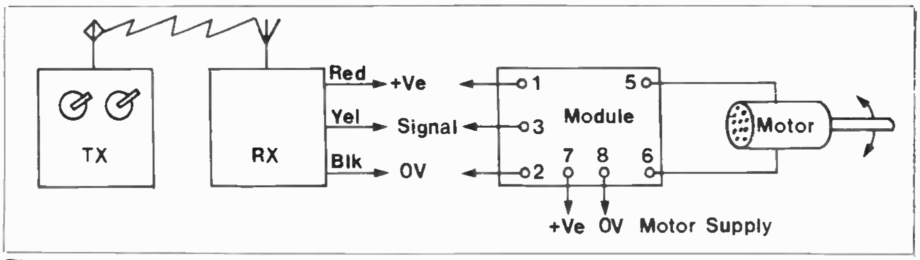


Figure 8. Block Diagram

PWM MOTOR DRIVE PARTS LIST

RESISTORS: All 0.6W 1% Metal Film Unless Specified

R1-3,9	1k	4	(M1K)
R4,7	4k7	2	(M4K7)
R5	100k	1	(M100K)
R6,8	47k	2	(M47K)
R10,11	100Ω	2	(M100R)
RV1,2	Hor Encl Preset 220k	2	(UH07H)

CAPACITORS

C1	Tant 2.2μF 35V	1	(WW62S)
C2	Ceramic 22,000	1	(WX78K)
C3	Tant 1.0μF 35V	1	(WW60Q)
C4,5	Poly Layer 0.1	2	(WW41U)
C6	Ceramic 10,000	1	(WX77J)
C7	Disc 0.1μF 50V	1	(BX03D)
C8	Minelect 100μF 10V	1	(RK50E)

SEMICONDUCTORS

D1	1N4007	1	(QL79L)
TR1	BC327	1	(QB66W)
TR2	BFY52	1	(QF29G)
TR3	BC337	1	(QB68Y)
TR4	2N2905	1	(QR17T)
TR5	BD711	1	(WH15R)
IC1	ZN419/409CE	1	(YH92A)
IC2	4011BE	1	(QX05F)

MISCELLANEOUS

RLA	Min 6V 6A Relay	1	(FJ42V)
	PWM Motor Drive PCB	1	(GB71N)
	Pin 2141	1 Pkt	(FL21X)
	Constructors' Guide	1	(XH79L)
	PWM Motor Driver Instructions	1	(XK17T)

OPTIONAL

Ca,b,c	100nF Disc	3	(BX03D)
	Min DPDT 6A 12V Relay	1	(FJ43W)

A complete kit of parts, excluding optional items, is available:
Order As LK54J (PWM Motor Drive Kit)

Also available separately:
PWM Motor Drive PCB **Order As GB71N**

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