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Electronics
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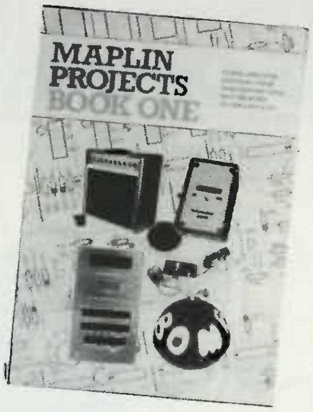

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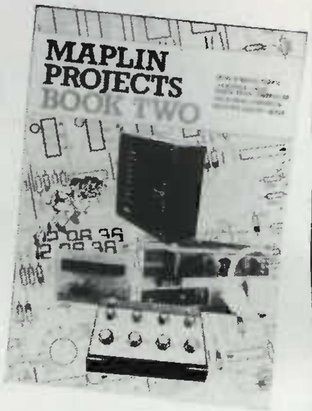

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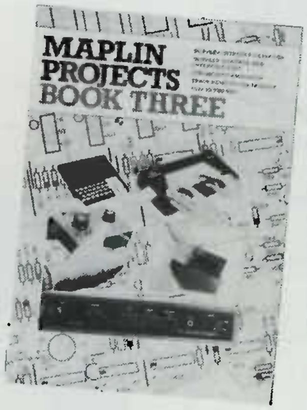

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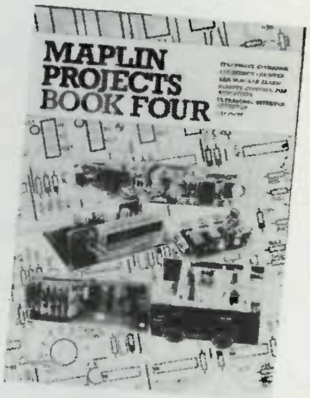

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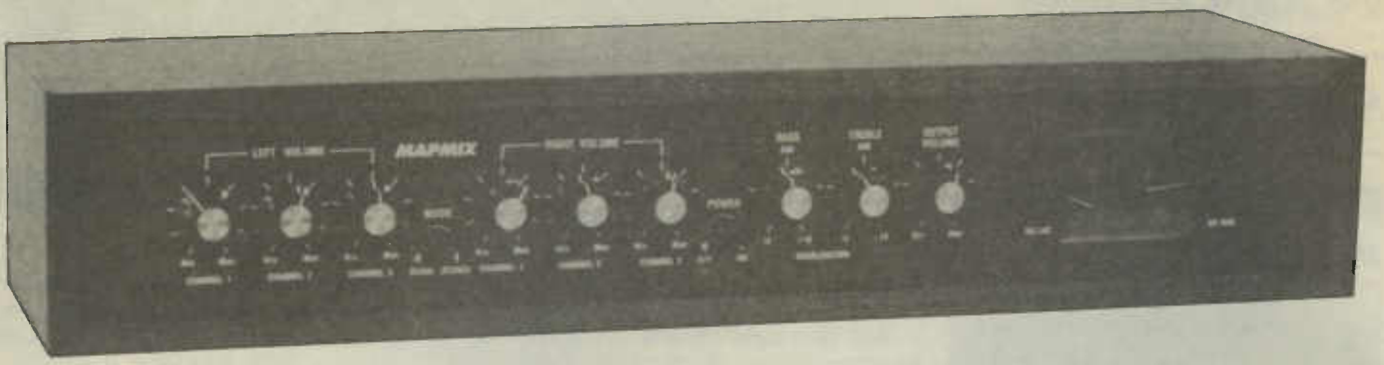


Mapmix - Six Channel Audio Mixer

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

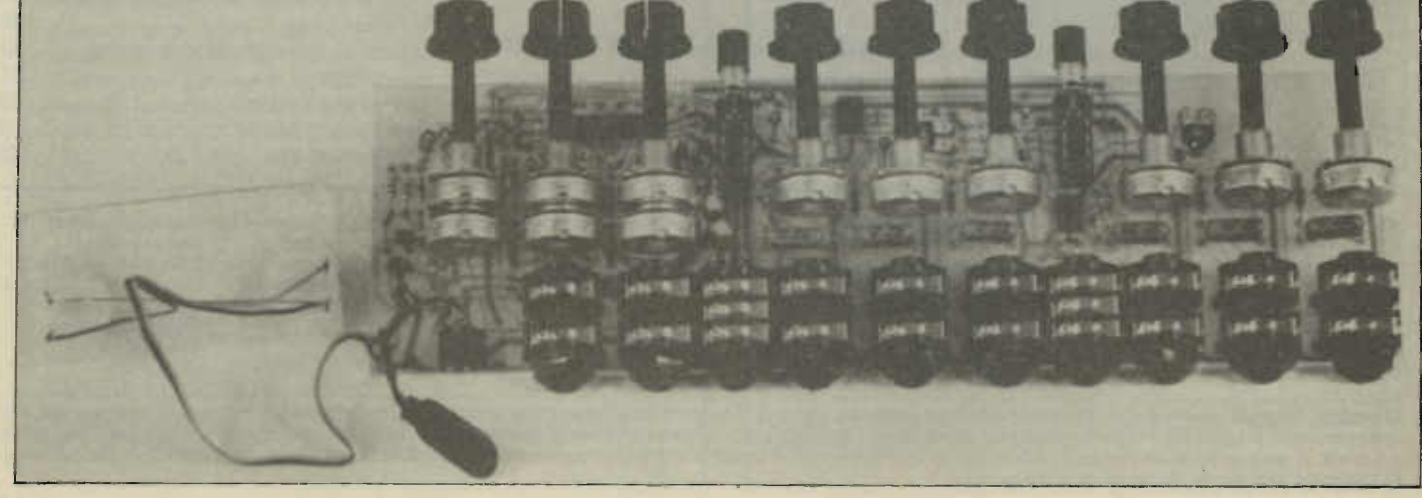
The Mapmix is a versatile six input mixer, in the stereo mode it has three inputs connected to the left channel and three inputs connected to the right channel. For mono use all six inputs are connected to both output jacks via the mode select switch. Both left and right channels have separate post-mix 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 current's 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 3 set to maximum, will produce the sum product of 300mV at C7; the signals being effectively 'added' together.

Blocking capacitors C1 to 3 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



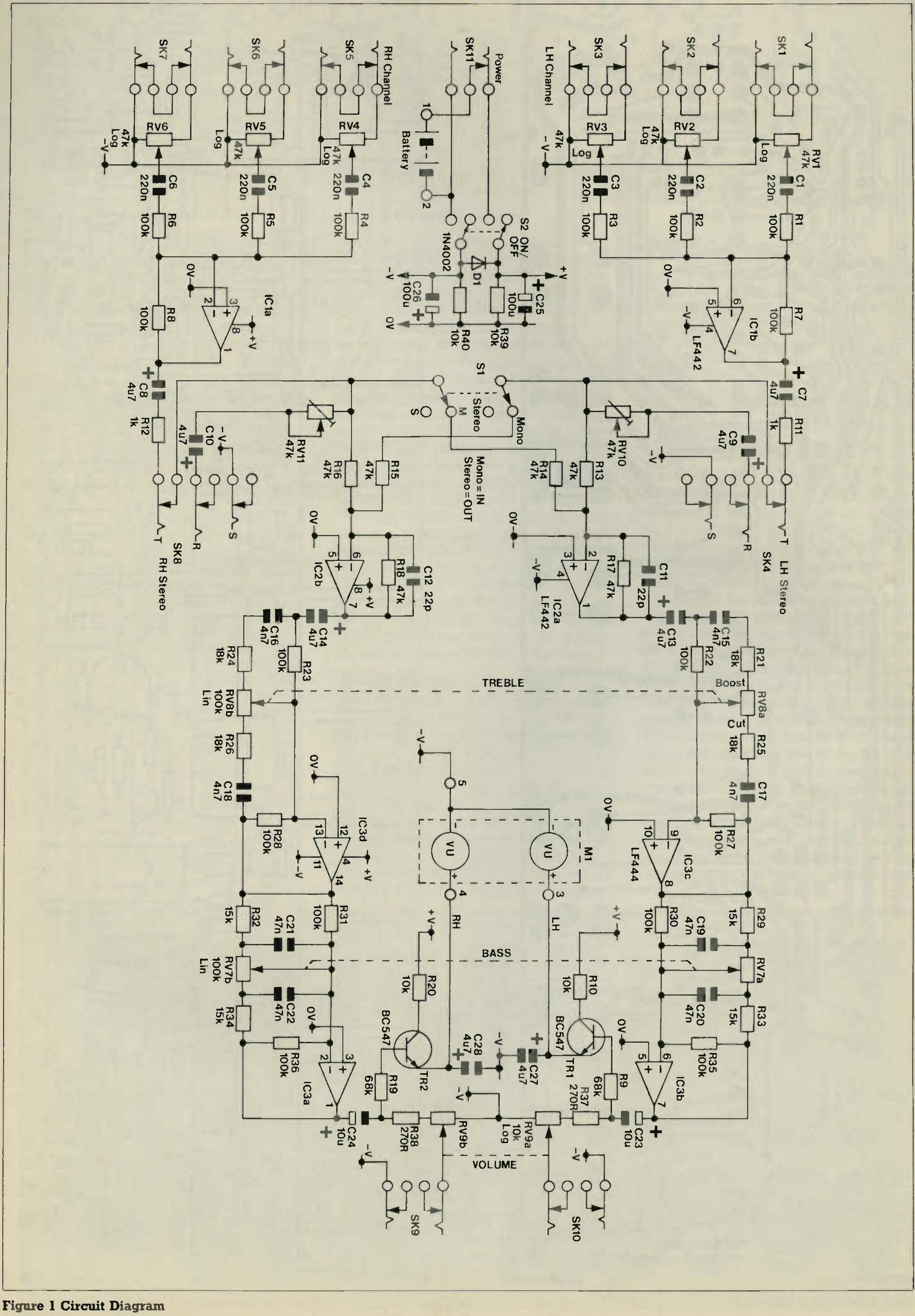


Figure 1 Circuit Diagram

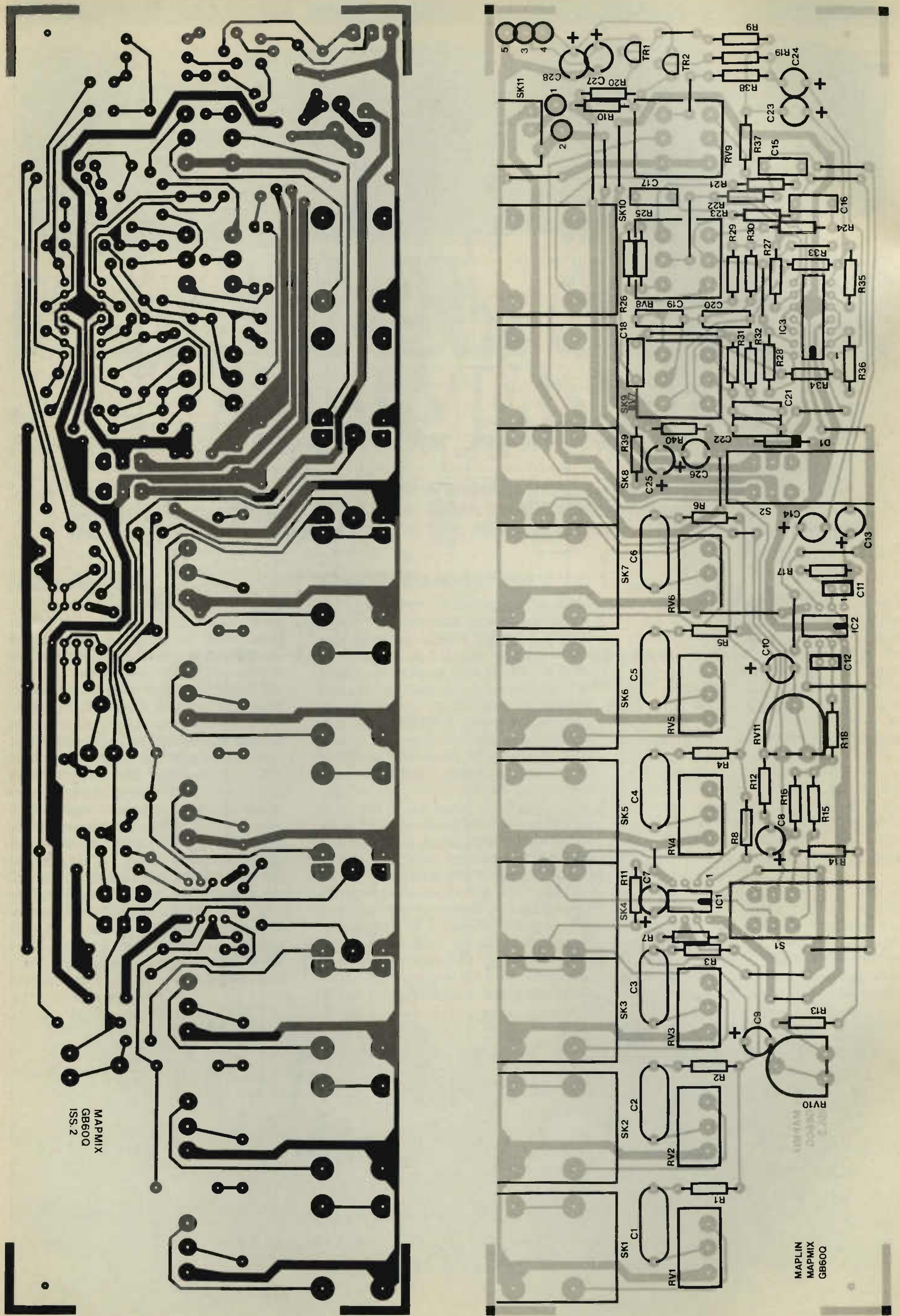


Figure 2 Artwork & Legend

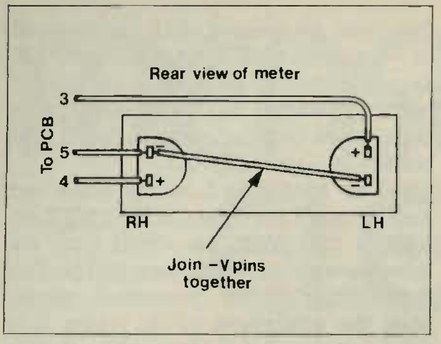


Figure 3 Meter Wiring

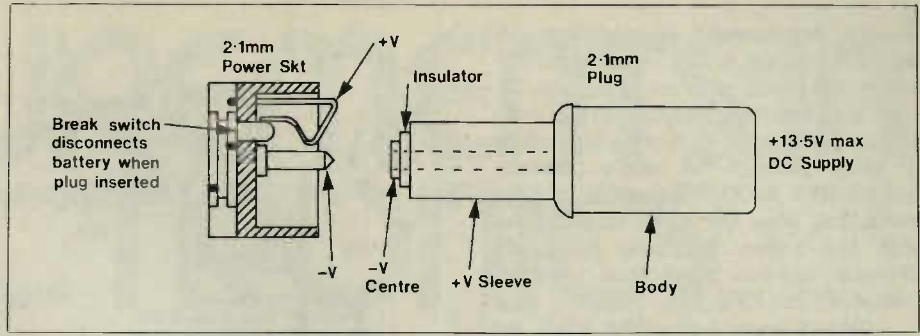


Figure 4 Power Plug & Socket

into the rest of the system. IC1a and IC2b 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.

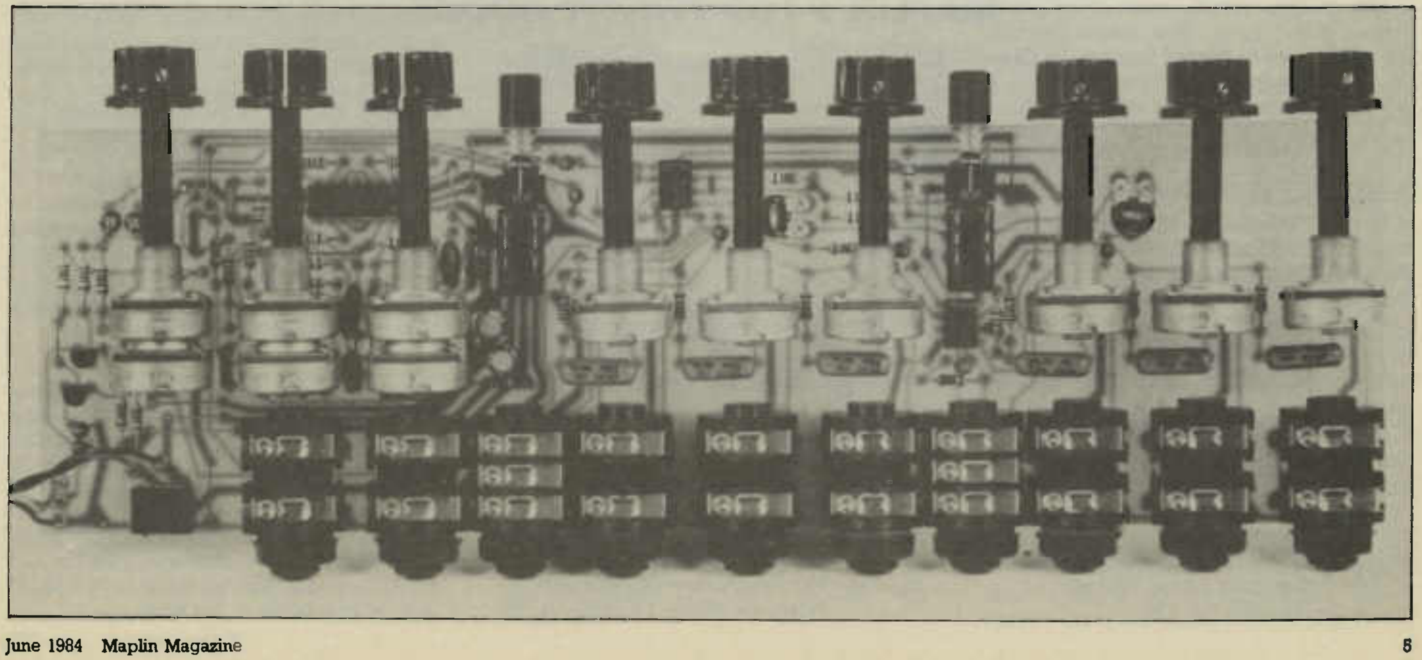
Prototype Specifications:–

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 & RV11, and diode D1 making sure of correct polarisation. Now fit IC's 1 to 3, these must be fitted correctly – pin 1 is usually marked with a small hole or indentation, occasionally a 'D' shaped concave slot is cut into one end of the body; if the IC is held with this slot facing to the left, with the pins facing down, then pin 1 is the first on the bottom row.

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 & TR2 and power socket (SK11) along with the five Vero pins which are inserted from the track side of the PCB, finally solder these components. The ten PC mounting jack



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 satisified 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 & 5 (see Figure 3) using hook-up wire. Both −V terminals on the meter movements should be joined together and connected to −V supply pin 5, as shown.

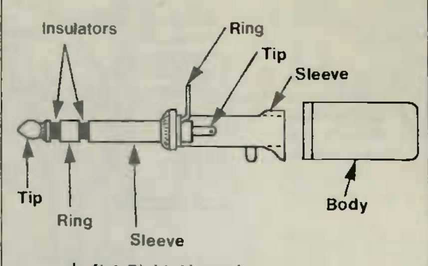


Figure 5 Stereo Jack Connections

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 0.4W 1% Metal Film			
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	47k Log Pot	6	(FW24B)
RV7,8	100k Lin Pot Dual	2	(FW88V)
RV9	10k Log Pot Dual	1	(FX08K)
RV10,11	47k Hor Sub-Min Preset	2	(WP60Q)
CAPACITORS			
C1-6	220nF Polyester	6	(BX78K)
C7-10,13,14,27,28	4μ7F Tantalum	8	(WW64U)
C11,12	22pF Ceramic	2	(WX48C)
C15-18	4n7F Polycarbonate	4	(WW26D)
C19-22	47nF Mylar	4	(WW20W)
C23,24	10μF 16V Minielect	2	(YY34M)
C25,26	100μF 10V PC Electrolytic	2	(FF10L)
SEMICONDUCTORS			
D1	1N4002	1	(QL74R)
IC1,2	LF442	2	(QY30H)
IC3	LF444	1	(QY31J)
TR1,2	BC547	2	(QQ14Q)
MISCELLANEOUS			
SK1-3,5-7,9,10	PCB Jack Skt Mono	8	(FJ00A)
SK4,8	PCB Jack Skt Stereo	2	(FJ05F)
SK11	PC Mtg Power Skt	1	(RK37S)
S1,2	Soft Latchswitch 2-Pole	2	(BW11M)
M1	Dual VU Meter	1	(YQ47B)
	Small Latchbutton Black	2	(BW13P)
	Knob K7A	9	(YX01B)
	Veropin 2141	1 pkt	(FL21X)
	Battery Clip	1	(HF28F)
	Mapmix PCB	1	(GB30Q)
OPTIONAL			
	Mapmix Case	1	(XG38R)
	Printed Front Panel	1	(FJ36P)

A kit of parts (excluding optional items) is available.
Order As LK49D (Mapmix Kit) Price £29.95

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MEASUREMENTS IN ELECTRONICS

by Graham Dixey C.Eng., M.I.E.R.E. **PART 3**

Introduction

The cathode-ray oscilloscope (or simply CRO) is justifiably considered the most versatile electronic instrument, both for servicing and circuit development. The range of measurements possible with it are very extensive and many books have been written on its use. My purpose in just 3000 words, is to illustrate the versatility of the CRO by describing its use in a variety of tasks. Perhaps other ideas will follow from this.

CRO Controls

The CRO has more front panel controls than most instruments and it is this plethora of knobs and scales that causes most problems. Many inexperienced users manage to get some form of display eventually but not always the optimium. A common fault is a display that 'slips' sideways due to lack of 'sync'. For convenience the CRO controls can be divided into groups:-

(1) Y1 Amplifier controls
(2) Y2 Amplifier controls
(3) X Timebase/amplifier controls
(4) Triggering facilities
(5) Miscellaneous controls

As far as (1) and (2) are concerned, since the signal amplitude can vary between a few millivolts and many volts, provision must be made either to amplify or attenuate the signal to a level that gives a display of sensible size. The Y amplifier gain control is usually stepped and is calibrated in mV/cm or V/cm with a range from, say, 2mV/cm to 10V/cm in a typical case. The relevance of the '/cm' is that the graticule (Figure 1) is squared off in cm and sub-divisions along the major axes. A Y gain expressed as 0.5V/cm, for example, means that every cm of screen height corresponds to a deflection of 0.5V. This allows for measurement of voltage by translating the linear dimension of the waveform (cm) to its electrical equivalent (volts); more of this later. Another control associated with the Y amplifier is 'Y shift', which allows the displayed waveform to be positioned vertically where required. For example, in a single-beam CRO, vertical adjustment of the display allows the peaks of a waveform to be lined up with the X axis, perhaps to measure the linear distance between the peaks. In a double beam CRO a pair of waveforms (e.g. input and output of a circuit) can be aligned one above the other, allowing a direct comparison to be made. Shift controls can sometimes confuse the novice because they may take the display well off-screen, especially when combined with too high a value of Y gain.

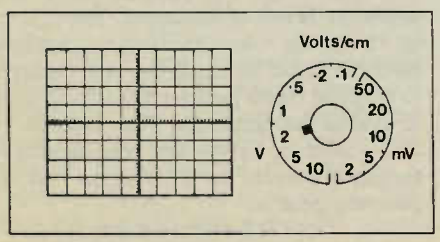


Figure 1. Graticule of CRO and typical Y gain control.

Deflection of the beam in the horizontal or X direction is accomplished by a linear sawtooth of voltage from a time base generator applied to the X plates of the CRT. Figure 2 shows an exaggerated form of this sawtooth because, in practice, the flyback time i.e. the time taken for the beam to return to the left-hand side of the screen, is negligible compared with the sweep time. Without any Y input the display is just a horizontal line, which can be moved left or right by the X shift control. The effect of the X gain control is to cause this trace to expand or contract in length. This is just another way of saying that the time of one sweep is being controlled. X gain may be continuously variable but is often just a choice of, say x 1 or x 5. Control of timebase speed is by two controls, one stepped and one continuous, which are course and fine controls respectively. The stepped control is calibrated in time/cm e.g. 1ms/cm, 20us/cm, etc. The continuous control usually has the mystic letters CAL at one end. It should always be set to this position when making measurements of time. Some users try to hold a steady trace with this control, which is quite wrong. It does not usually work very well and ignores the use of the triggering facilities which are there for that very purpose.

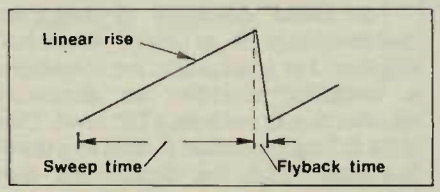


Figure 2. The sawtooth wave applied to the X plates.

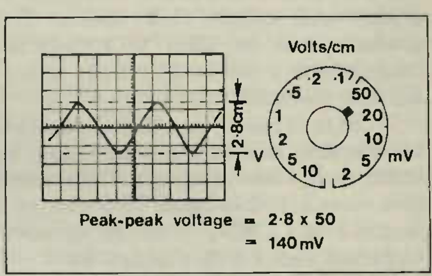


Figure 3. Measurement of alternating voltage.

Concerning the triggering facilities, these vary somewhat between different makes of CRO but there are some general principles to note. First, it is possible that only one channel of a double-beam CRO has a trigger facility – in which case this channel has to be used. Alternatively a switch may be provided to select triggering on either one amplifier or the other. In this case ensure that the selector switch is in the correct position. All of this may sound obvious but experience has shown that these are the points that newcomers to the CRO overlook. A continuously variable control usually marked 'trigger level' should then be slowly rotated until, suddenly, the display snaps into perfect sync. On very fast waveforms it may be necessary to use a further facility to 'freeze' the display. This may be the 'HF' (high frequency) position of a three position switch marked HF/NORM/TV, for instance, or a PULL/BRIGHTLINE/OFF switch, which is useful for catching fast pulses, etc. What it comes down to in the end is learning one's way around the trigger controls of one's own CRO in order to get the best out of it. In addition to the 'internal' trigger facilities, there is usually a provision for triggering from some external signal source instead.

Miscellaneous controls and facilities depend a great deal on the model of CRO in question but will always include 'focus' and 'brightness'. These two controls are the subject of much abuse. The general feeling seems to be 'the brighter the better', which is definitely not what is wanted. The brighter the display the worse the focus – usually. Check this by reducing the brightness until the trace is just visible; then re-focus and note that not only does the trace become pin-sharp but it now appears brighter too.

Remember that the CRO is not just for presenting 'pictures' of waveforms, it is for making measurements too. This it cannot do if the trace is thick and fuzzy.

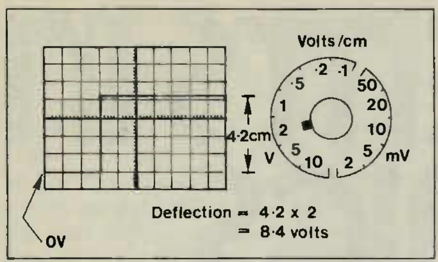


Figure 4. Measurement of d.c. potential.

There may also be a CAL waveform and a sawtooth output. The former might be a 1V peak–peak square wave which can be injected into the Y amplifiers to check and adjust their gains. The sawtooth can be used to sweep the frequency of a wobbulator when adjusting F.M. discriminators, etc.

CRO's of recent manufacture seem to be adopting new facilities not found on instruments a few years ago. There was a time when a double-beam CRO was just a double-beam CRO – two independent amplified traces with perhaps an X – Y position on the timebase range switch, to turn the timebase off and use Y1 as an X amplifier (of which more later). Now one may find a five position switch selecting the following functions.

X–Y	The mode as just defined
CH1	Displays channel 1 signal only
DUAL	Displays both signals together
CH2	Displays channel 2 signal only
ADD	Displays the sum of the channel 1 and channel 2 signals

This long but necessary preamble describes the facilities that one might reasonably expect to find on a moderately priced CRO, e.g. one costing a few hundred pounds. There are, of course, instruments of incredible sophistication and corresponding cost but it would be out of place to deal with them here. Instead we shall now look at ways in which the CRO can be made to earn its keep.

Measuring Voltage and Current

The CRO is not a substitute for a multimeter. Rather, it has unique advantages that a multimeter doesn't have. It can display the actual waveform; it has a very high input impedance; it has a very wide bandwidth; it has high gain, so can examine very small signals and it can measure AC or DC or both together.

The general principle of voltage measurement is:–
Signal amplitude (V) = Display height (cm) x Y gain (V/cm).

The display height referred to may be the peak-peak signal amplitude, its peak value or any other vertical dimension of the wave you like. The shift controls are used to position the waveform on the graticule in order to measure the height on the graduated scale – just like using a metric rule. Figure 3 shows an example of peak-peak measurement on a sinewave. The display height is found to be 2.8cm and the Y gain setting is 50mV/cm.

Thus, peak-peak amplitude = 2.8 x 50
= 140mV

If required this can be converted to the corresponding r.m.s. value by dividing by $2\sqrt{2}$, so that:–

R.M.S. Value = $140/2\sqrt{2}$,
= 49.5mV

Obviously this is not as convenient as reading the value directly from a meter scale but it is more than compensated for by the other facilities obtained.

Figure 4 shows the measurement of a DC potential e.g. at the collector of a transistor. In this case the position of 0V must be set first of all. The input leads of the CRO are shorted together, the appropriate Y amplifier gain selected and the input selector switch set to the DC position. This will normally be at the bottom of the graticule for positive supplies. The input leads are now connected between 0V and the test point whereupon the trace will be deflected upwards by so many cm. In Figure 4 this deflection is 4.2cm which, with a Y gain setting of 2V/cm, gives a DC value of:–

4.2 x 2= 8.4V

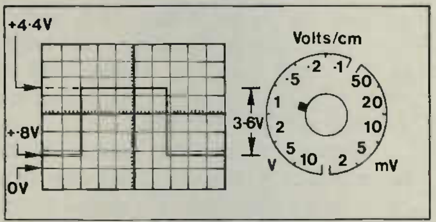


Figure 5. Measuring d.c. levels and signals together.

A useful extension of these two measurements is to make them both together. For example, at the collector of a transistor amplifier an alternating waveform may exist on a DC level. Thus, if the DC input position is used and the 0V line established, the display will show both the deflection due to the DC potential, and the signal waveform. This is only really satisfactory when the signal is not too small compared with the DC value; otherwise the Y gain is invariably too great for the DC level (display goes off-screen) or too small for the AC signal (it appears too small to observe accurately). It is most useful in pulse circuits where DC levels may be important and the pulses are of significant value. Figure 5 shows an example of such a measurement. A 3.6 volt pulse 'sits on' a 0.8V DC level.

On the subject of examining squarewaves or pulses, if the display looks like that in Figure 6, check whether the input selector switch is in the AC or DC position – it should be at DC. This distortion of the wave shape, known as 'differentiation' may, of course, be pres-

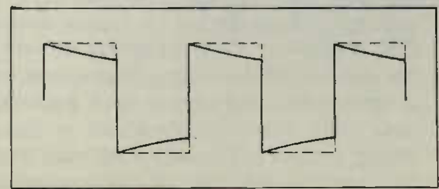


Figure 6. Square-wave distorted by differentiation.

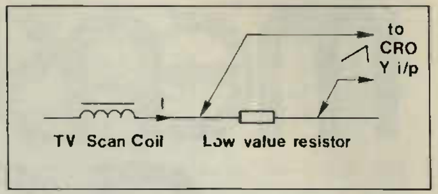


Figure 7. Observing a current waveform.

ent in the input waveform. However it can alternatively be caused by the input coupling capacitor of the CRO, which is in circuit at the AC position.

It is possible to observe and measure alternating current with a CRO, even though the instrument is voltage operated. The trick is a simple one and consists of putting a low value resistor in series with the current (small enough not to affect the value of the current significantly). The CRO is then connected across this resistor and displays the current waveform. Its value can, of course, be found using Ohm's law. One particular case where this technique can be useful is when the current flow is in a non-linear device e.g. an iron-cored coil. An example that springs to mind is the TV scan coil. Since deflection in electromagnetic tubes is by a linear sawtooth of current, looking at the waveform of voltage across the coil is no good as this is decidedly non-linear. However by wiring a small value resistor in series with the coil, as shown in Figure 7, the true current waveform can be observed since the resistor is a linear device.

Measuring Frequency, Time & Phase Angle

These measurements are made along the X axis, as one would expect, and use essentially the same principle as amplitude measurement. In other words, horizontal distance is measured in cm and converted to time using the stepped time

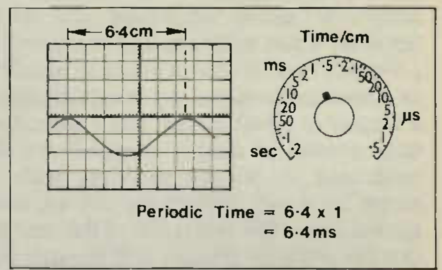


Figure 8. Measuring periodic time of a waveform.

base control calibration. As mentioned earlier the timebase fine control must be in the CAL position or the measurement will be invalid. Figure 8 shows an example where the periodic time of a sinewave is being measured. The distance between two successive positive peaks is found by using the shift controls to position these peaks on the calibrated X axis of the graticule. This distance is then found to be 6.4 cm. The timebase setting is seen to be 1 ms/cm so that the periodic time is:–

t = 6.4 x 1 = 6.4 ms.

To ensure a good degree of accuracy in any measurement of time, always

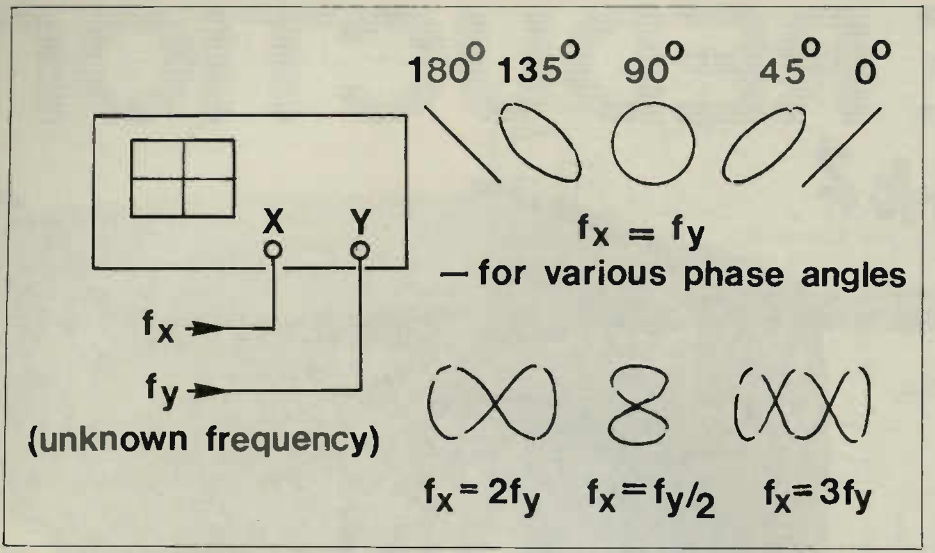


Figure 9. Lissajous method of measuring frequency.

select a timebase speed that allows the interval to be measured to occupy as much of the screen width as possible.

Once the periodic time t of any waveform has been found, frequency is obtained by taking the reciprocal of t.

i.e. frequency f = $1/t$ Hz

When frequency is measured in this way the accuracy is limited by the inherent accuracy of the CRO and by human errors in estimating the required distance. A more accurate method that can be used is a good old-fashioned standby known as the 'Lissajous method'. It requires the use of an accuratley calibrated signal generator as a comparison standard. The timebase is switched off and the calibrated signal source is applied to the X amplifier instead. The unknown frequency is applied to the Y amplifier. The X and Y gain controls are adjusted to give a reasonable size of display. The method depends upon recognising a pattern that relates the two frequencies. The calibrated source has its frequency adjusted to achieve this. The easiest pattern to recognise is the 1:1 pattern i.e. equal frequencies but; Figure 9 shows some other readily indentified relations. The accuracy of the measurement is quite independent of the CRO and human error (almost) and relies on signal generator calibration, which should be good.

Measurement of phase angle is essentially concerned with measuring the linear displacement in the X direction between two waveforms and converting this to an angle. However, this assumes the use of a double-beam CRO, which is not necessarily the case. It is worth looking, therefore, at the Lissajous methord first.

The two voltages, whose relative phase angle is required are connected to the CRO's X and Y inputs (timebase turned off). In this case, since the frequencies are obviously equal, the display is quite stationary. It will almost certainly be an ellipse but can be a diagonal straight line or a circle. The proportions of the ellipse give the phase angle according to the formula:—

$$\emptyset = \mathrm{SIN}^{-1}\, a/b$$

Figure 10 illustrates this method and as an example suppose that:—

$$a = 3\text{cm and } b = 6\text{cm}.$$

$$\text{Then } \emptyset = \mathrm{SIN}^{-1}\, 3/6$$

$$= \mathrm{SIN}^{-1}\, 0.5 \text{ or } 30°.$$

Using a double-beam CRO the two voltages to be compared are displayed, one on each channel. By using X expansion (if availble) it is possible to make the length of one cycle equal a convenient distance in cm, say x cm.The conversion from distance to angle is

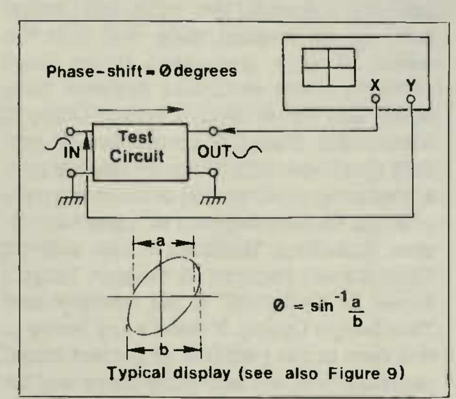


Figure 10. Measurement of phase angle by Lissajous figure.

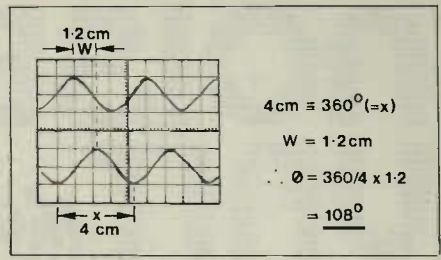


Figure 11. Measurement of phase angle by double-beam method.

obtained by remembering that one cycle contains 360° and since this is x cm long, each cm in the X direction is equivalent to $360/x°$. Thus, by measuring the horizontal displacement between the two voltages (e.g. between positive peaks) and calling this, say, W cm, the phase angle is found as follows.

$$\text{Phase angle } \emptyset = 360/x \times W \text{ degrees.}$$

For example if x = 4cm and W = 1.2cm,

$$\text{then } \emptyset = 360/4 \times 1.2$$

$$= 108°$$

This method is illustrated in Figure 11.

This issue's 'project' is not so much a constructional exercise as a demonstration of some interesting as well as useful patterns. They are based on the use of a circular timebase, which is shown in Figure 12.

The first pattern is called a 'modulated ring pattern' and looks like a gearwheel if you get:

(a) the relative amplitudes of f_Y and f_X right.

(b) $f_X = n.f_Y$ where 'n' is a whole number, say 10.

The number of 'teeth' then equals f_X/f_Y.

The second pattern, the 'broken ring pattern' needs a CRO with a Z-modulation input (usually on the back of the CRO). What you will get is a ring with gaps in it; the number of gaps = f_Z/f_Y.

In both cases f_Y should lie in the range 100—200Hz for the timebase components given in Figure 12.

I will leave you to experiment with these. In the next issue we will move on to the testing of digital circuits.

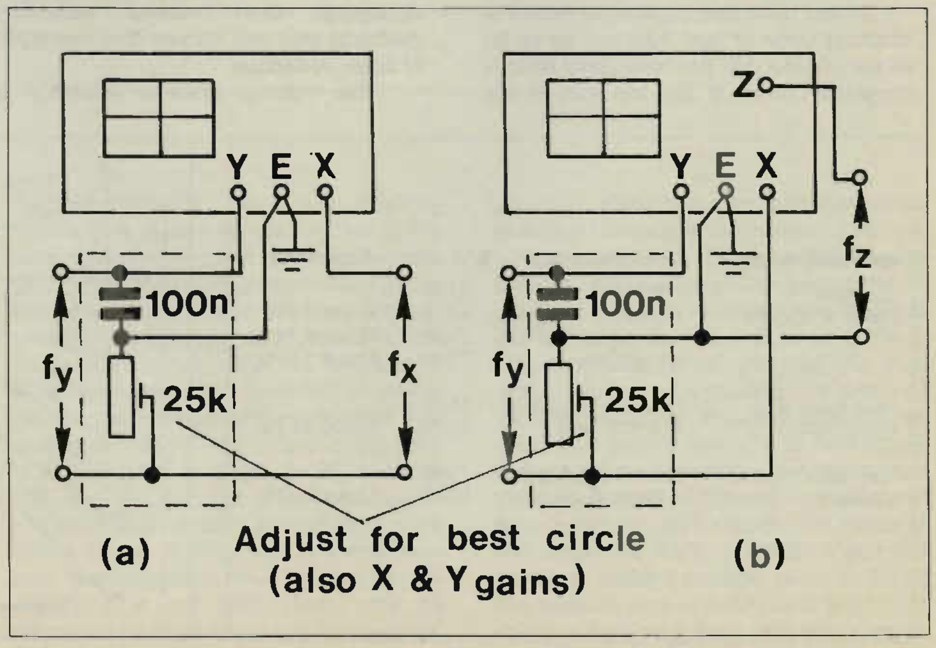


Figure 12. The Circular Timebase: (a) Modulated Ring Pattern (b) Broken Ring Pattern

NOISE REDUCTION UNIT *Mark 2*

Based on an original design, by Dr. David Ellis

- ★ **Simple Calibration**
- ★ **LED Peak Indicators**
- ★ **Full Hi–Fi Specification**
- ★ **Very Low Distortion Levels**
- ★ **Stereo or Four Channel Operation**
- ★ **30dB Improvement in Signal-to-Noise Ratio**

Introduction

This improved design for the Maplin/E&MM Noise Reduction Unit utilises fewer components and is easier to construct, yet still offers the same high specification. Calibration has been simplified, no test gear is required, although a distortion analyser will enable the lowest distortion levels to be achieved. (0.06% typical).

The compander PCB's are fully compatible with the original Noise Reduction Unit. The Mark II Unit is designed for stereo (2 channel) operation but power supply outputs via a DIN socket enable two units to be connected together, thus giving 4 channel operation. If required furthur units could be utilised to give more channels.

N/R Principles

Noise reduction systems reduce the irritating noise of tape hiss and so on by an encode/decode process. Quiet sounds especially those at the top end ot the spectrum, are easily swamped by tape hiss, so an encoder is used to artificially boost these signals before they are recorded. During playback the reverse process decodes the recorded sound back to its original state and rids the music of tape generated noise. Until recently, noise reduction systems have fallen into three distinct types: Dolby B (domestic), Dolby A (professional) and DBX (professional). However there is now a confusing proliferation of other systems offering various degrees of noise supression, including: Toshiba's Adres system, Telefunken's Highcom & Telcom, Sanyo's Super D, Dolby's C & HX systems and Tandberg's Dyneq. If there's any sense in this race to the pinnacle of perfect music reproduction, the hopefully there will be some common standards agreed upon! Table 1 gives the signal-to-noise ratios obtainable from various recording mediums with and without different types of noise reduction.

The various systems available at present basically work on the principle of complementary compression of the on-tape signal and expansion of the off-tape system. Compression involves reducing the dynamic range of the material that is being recorded, thus– with a 2:1 compression ratio, if the input to the compressor increases by 12dB, then the output of the compressor (on-tape signal) will increase by only 6dB. Conversely, expansion involves increasing the dynamic range, so that an increase of 6dB in the off-tape level will result in a 12dB increase in the output from the expander, thereby restoring the original dynamic range of the music. At the same time the noise introduced in the recording chain, particularly tape hiss, is rendered inaudible on expansion since this unwanted signal was not subject to the initial compression treatment and is therefore expanded downwards below the lowest dynamics of the music signal. This process is illustrated in Figure 1.

Another feature of the compression/

Recording medium	Noise reduction	S/N ratio	Comments
Cassette (Sony TCK55 II)	- Dolby B	57dB	
	+ Dolby B	67dB	Above 4 KHz
	+ Dolby C	75dB	Above 1 KHz
	+ HighCom	75dB	Above 1 KHz
Four-track tape (Teac 3440)	No noise reduction	55dB	
	MarkII unit	85dB	Above 30 Hz
Two-track tape (Studer)	No noise reduction	70dB	
	+ Dolby A	80dB	Above 20 Hz

Table 1. Comparison of Noise Reduction Systems

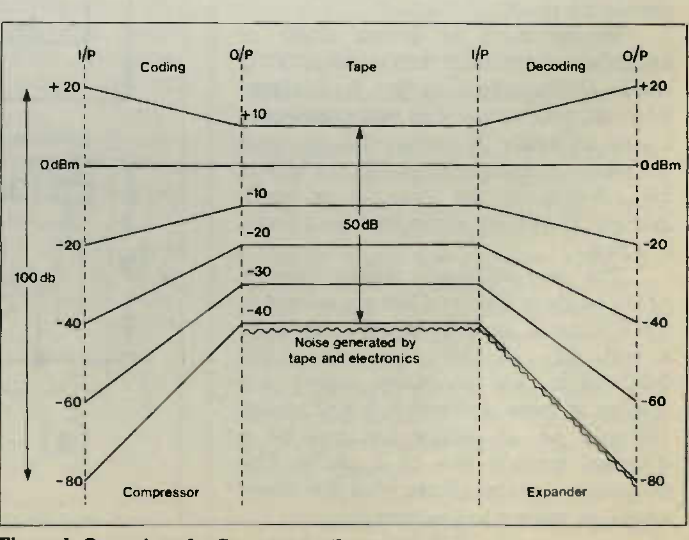


Figure 1. Operation of a Compression/Expansion System

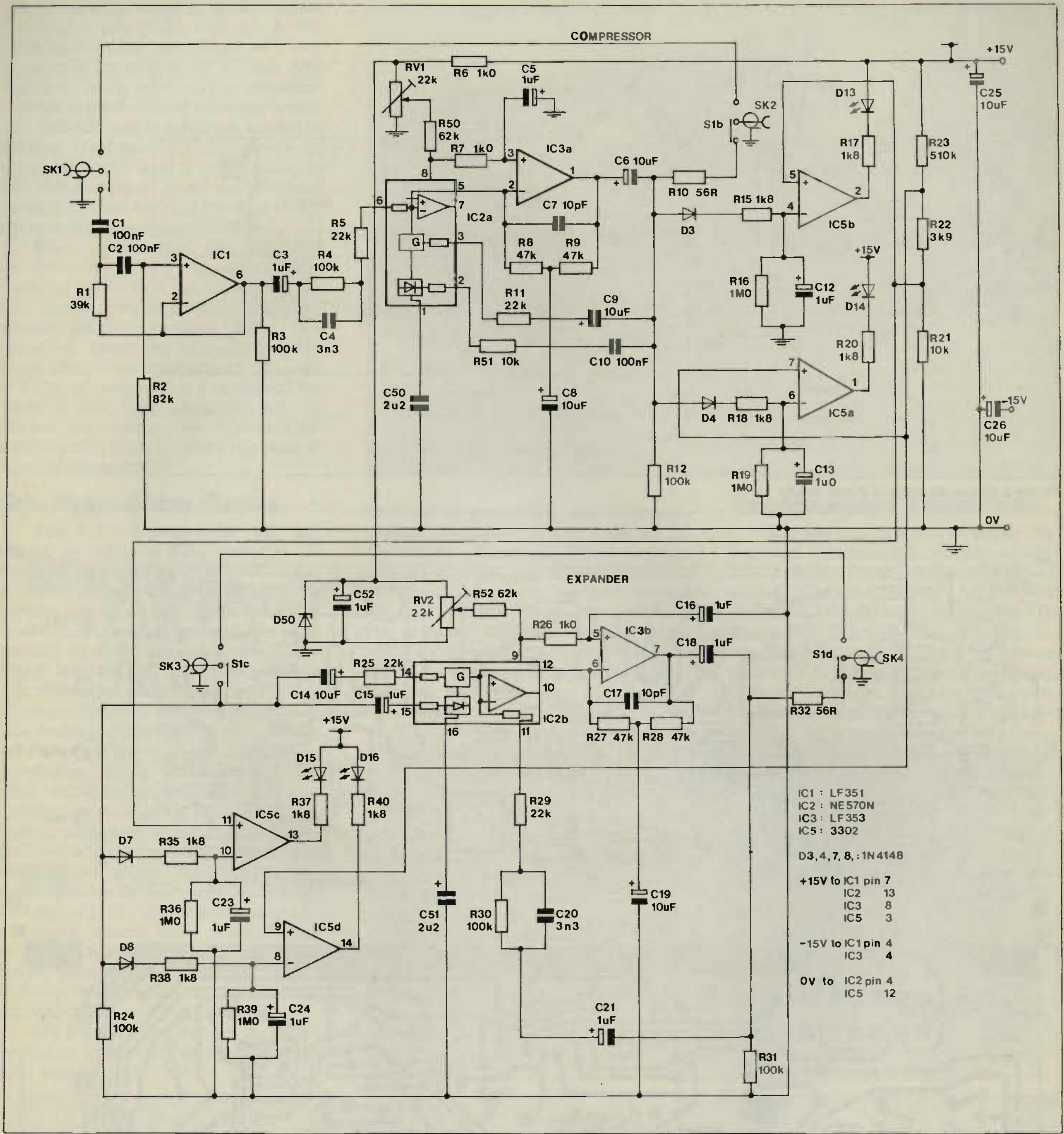


Figure 2. Circuit Diagram of Compressor/Expander

expansion process is that it allows the recording of signals with a dynamic range approaching the limits of audibility, i.e.100 to 120dB.

Circuit

The circuit diagram for the compressor and expander (compander) is shown in Figure 2. The power supply circuit is given in Figure 3.

The compressor input is routed via S1a, either directly to the output in the 'out' position, or to C1 in the 'in' position. IC1 and associated components form a second-order high pass filter with a 12dB/octave roll-off below 30Hz, This removes sub-audible signals (infrasonics) that might be generated from record warps or sub-octave tracking VCO's. The reason for this filtering is that once audio frequencies descend towards DC, the response of tape recorders drops off dramatically, and on playback a signal compressed in response to high level low frequency signals will be expanded, resulting in phantom modulation by the missing low frequency component lost during recording. The output of the filter is AC coupled to a simple RC network (C4, R4) which forms a high frequency pre-emphasis circuit, providing a 12dB treble boost. Without this pre-emphasis and corresponding de-emphasis in the expander, a low level signal may be swamped by high level bass frequencies, typically resulting in a heavy breathing or pumping effect as the expander attempts to adjust the gain accordingly.

The signal is then applied to the NE570 (IC2a) configured as a compressor using an internal variable gain cell and full-wave rectifier, as well as an external output op-amp (IC3a). The variable gain cell is similar to a standard operational transconductance amplifier (OTA), except that, unlike OTA's, it is 'linearised' and therefore insensitive to temperature changes as well as offering low noise and low distortion performance. The signal at the output of IC3a is rectified and the resultant control voltage used to adjust the variable gain cell. By placing the gain cell in a feedback loop with the op-amp, the variable current generated in propor-

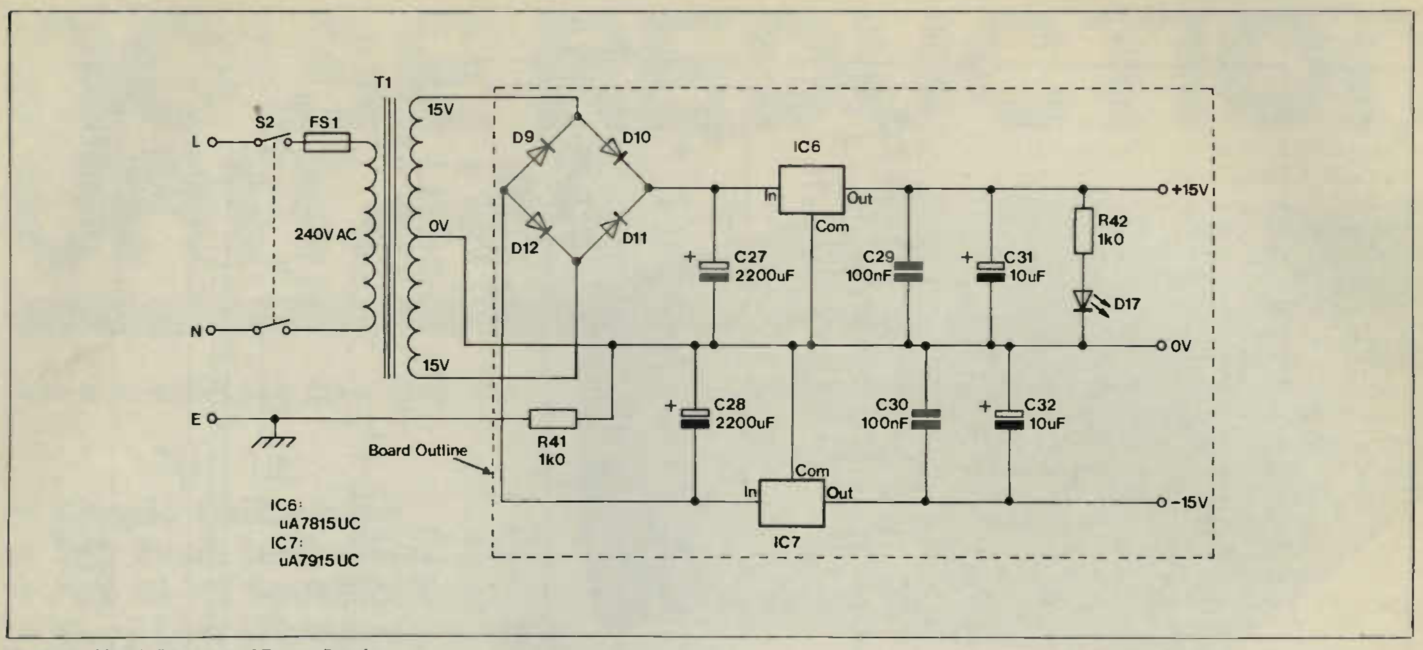


Figure 3. Circuit Diagram of Power Supply

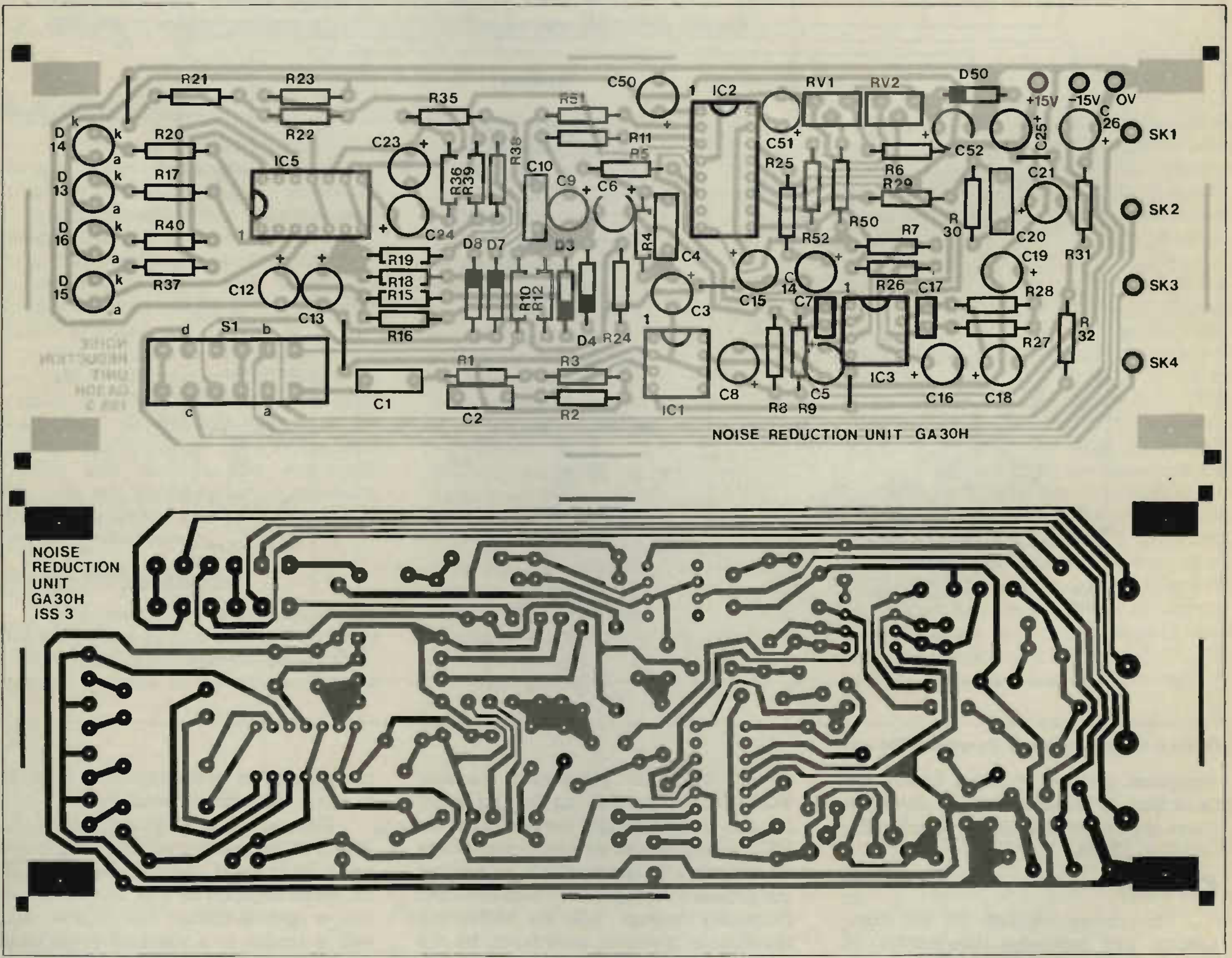
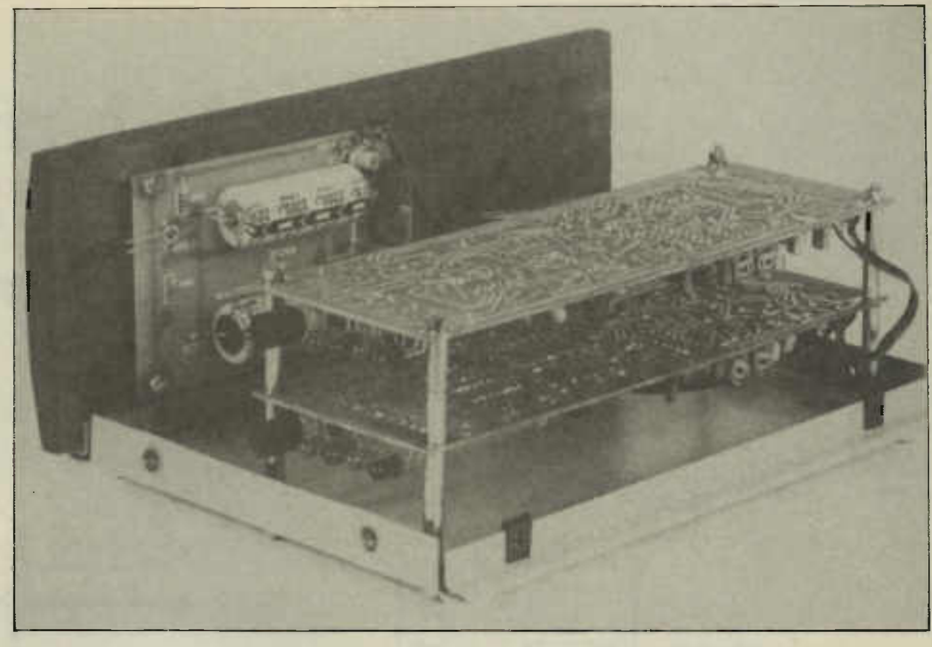


Figure 4. Compander PCB

signal which is compared with reference voltages derived from the potential divider network, R21, R22, and R23. The fast attack/slow decay operation of the comparators is determined by C13 and R19. IC5a and b respond to signal levels of, respectively, −3dBm and 0dBm.

The expander configures the other half of the NE570, IC2b, with a different arrangement of the various blocks. Once the off-tape signal has been routed via S1c to C14, the signal is applied to comparators, IC5c & d, to provide an indication of off-tape levels, and simultaneously to the full-wave rectifier and variable gain cell. The rectifier produces a control voltage that is used to adjust the gain cell, with a response time determined by C51. An RC network (R30, C20) is connected in parallel with the op-amp, IC3b, to provide a treble cut a 12dB, therefore de-emphasising the pre-emphasised signal emerging from the compressor via the tape recorder. When tion to the input signal is used to adjust the overall gain of the op-amp. A 6dB increase in output level produces a 6dB increase in the gain of the variable gain cell, since this is effectively an expander inserted in the feedback loop, this results in a 12dB increase in feedback current to the input of the op-amp. Consequently, an increase in input level of 12 dB results in only a 6dB increase at the output of the op-amp, thereby yielding the desired 2:1 dynamic range compression.

The current from the full-wave rectifier is averaged by an external filter capacitor (C50) with the result that the gain control is made proportional to the average value of the input signal. The speed with which this gain adjustment is made determines the transient response of the compressor and is a product of the value of the filter capacitor and an internal 10k resistor. The value of 2.2uF for C50 yields good transient response at average signal levels.



Op-Amp Slew Rates

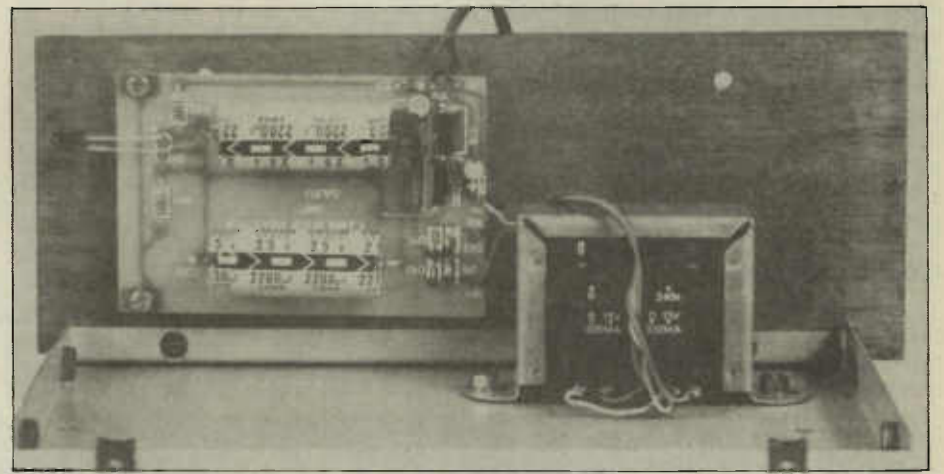
The RCR network (R8, C8, R9) around the op-amp, IC3a, provides DC feedback to bias the output at DC. C7 is an external compensation capacitor to provide stable operation over the audio bandwith. It may seem curious to use an external op-amp when the circuit diagrams indicate that the NE570 has its own. This is because the op-amps in this IC are equivalent to 741 types— with slew rate, noise, bandwidth, and output drive capability that are not really adequate for demanding audio applications. With weak signals, the compressor circuit operates at high gain and the NE570 op-amp runs out of loop gain. Furthurmore, a slew rate of 600mV per micro-second means that high frequencies will suffer. By using a J-FET op-amp, such as the LF351 with a slew rate of 13V per micro-second, these problems are eliminated. Additionally, the output swing can be larger since IC3a is powered by a dual supply rather than from the single-rail supply required by the NE570.

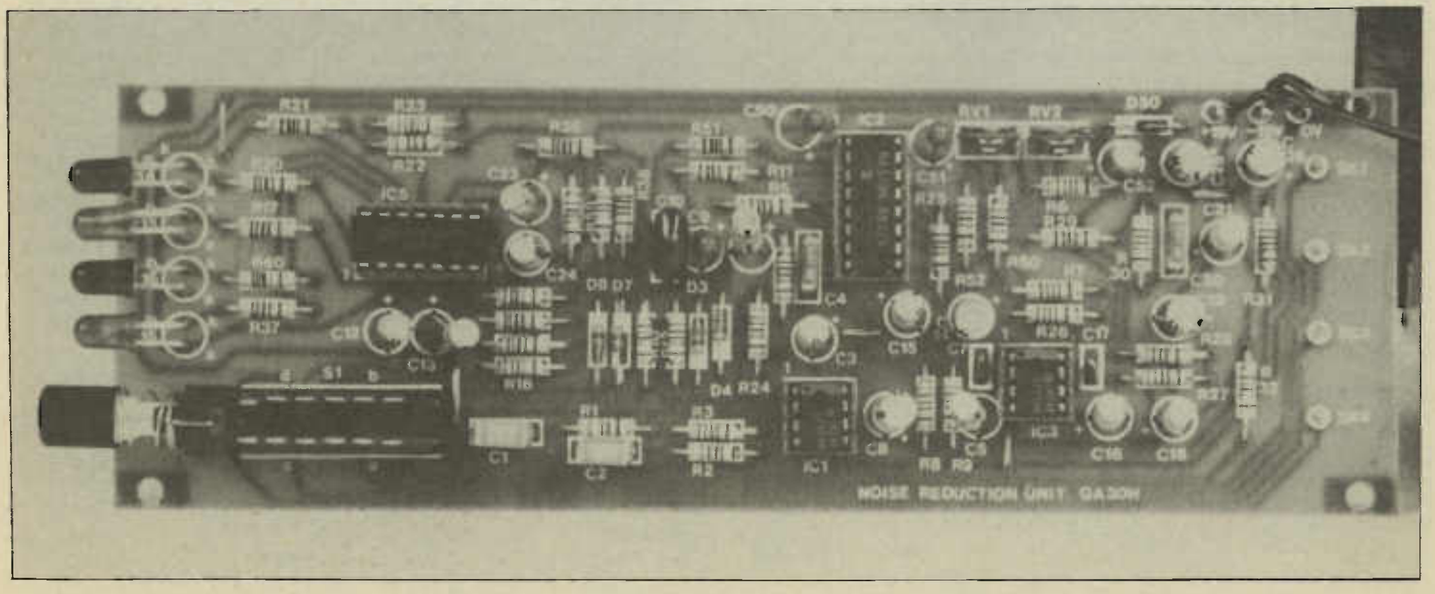
The non-inverting input of the NE570 op-amp is biased by an internal reference voltage of 1.8V. In the case of the external op-amp, IC3a, this is accomplished by tying it to pin 8 via an RC decoupling network (R7, C5) which filters out noise from the NE570 reference voltage. Pin 8 also serves another important function; providing the means for trimming distortion generated by IC2a. Even harmonic distortion is produced by voltage offsets in the variable gain cell, and RV1 enables adjustment of the offsets for minimum distortion.

Comparator Functions

The function of R10 is to isolate the output of IC3a from the potential capacitive load of a long length of screened cable connected to the compressor output which could lead to oscillation. S1b selects the 'in' or 'out' mode of operation.

Comparators IC5a and b provide an indication of the signal level at the output of the compressor. The inverting inputs receive the half-wave rectified output





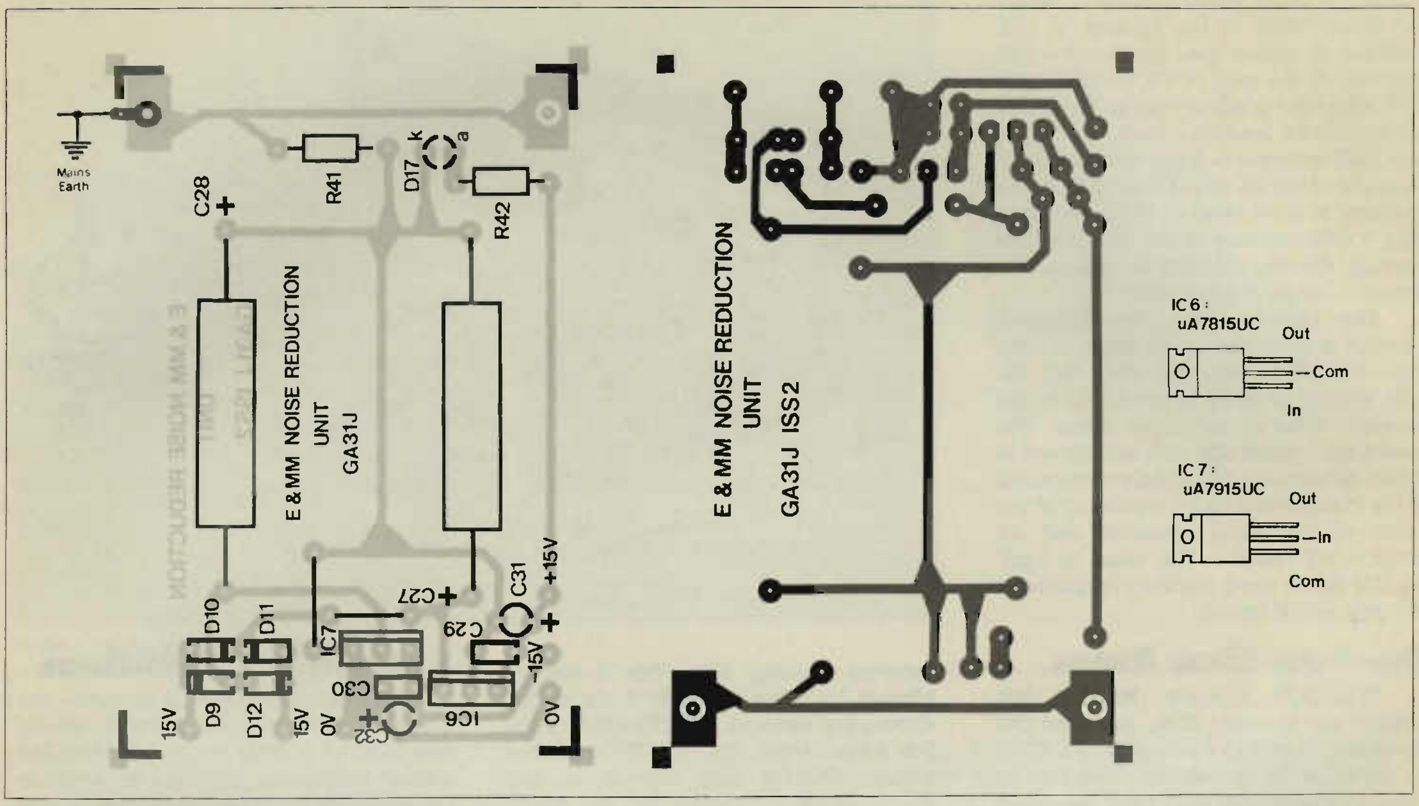
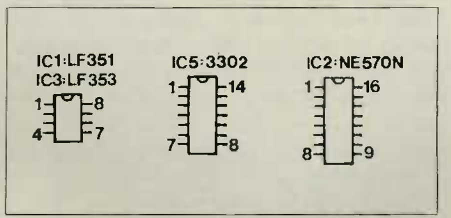


Figure 5. Power Supply PCB

the input signal increases by 6dB, the gain cell control current is raised by a factor of 2, resulting in an increase in gain of 6dB. Since the input of the external op-amp, IC3b, is derived from the gain cell, the output level increases by 12dB, thus giving the required 1:2 dynamic range expansion. RV2 enables adjustment of gain cell offsets for minimum distortion, as in the compressor. Finally, R32 isolates the output of IC3b from subsequent screened cable, and S1d selects the mode of use.

Construction

The unit is designed on a modular basis so that each PCB provides simultaneous compression and expansion for one channel. Single sided PCB's are used



to keep the cost down. In order that decoding should be the exact inverse of coding, it is important that components are well matched.

PCB designs and component overlays for the main board and PSU are given, respectively, in figures 4 and 5. Remember to fit the LED's to the compander and PSU boards with the leads at full length – so that they may be bent at right angles to allow the LED's to protrude through the front panel of the unit. The threaded phono sockets suggested for the unit have the advantage of small physical size and compatability with the connectors normally encountered in Teacs, Revoxes and the like. These sockets are mounted on the rear panel and connections to the signal pins are made via short lengths of unscreened wire from the relevant points on the PCB's. The phono socket earth connections are linked together and connected to the earth (0V) line on each compander PCB – again using short lengths of unscreened wire.

The PSU is utterly standard, though it's important to note that mains earth is connected directly only to the PSU PCB and then indirectly via a 1K resistor (R41)

Mark II Noise Reduction Unit Compander PCB Parts List

RESISTORS:- All 0.4W 1% Metal Film

R1	39k	1	(M39K)
R2	82k	1	(M82K)
R3,4,12,24,30,31	100k	6	(M100K)
R5,11,25,29	22k	4	(M22K)
R6,7,26	1k	3	(M1K)
R8,9,27,28	47k	4	(M47K)
R10,32	56Ω	2	(M56R)
R15,17,18,20,35, 37,38,40	1k8	8	(M1K8)
R16,19,36,39	1M	4	(M1M)
R21,51	10k	2	(M10K)
R22	3k9	1	(M3K9)
R23	510k	1	(M510K)
R50,52	62k	2	(M62K)
RV1,2	22k Vert S-Min Preset	2	(WR72P)

CAPACITORS

C1,2	100nF Polycarbonate	2	(WW41U)
C3,5,12,13,15,16, 18,21,23,24,52	1μF 50V Minelect	11	(YY31J)
C4,20	3n3F Polycarbonate	2	(WW25C)
C6,8,14,19,25,26	10μF 40V Minelect	6	(YY35Q)
C7,17	10pF Ceramic	2	(WX44X)
C9	10μF 16V Tantalum	1	(WW68Y)
C10	100nF Mylar	1	(WW21X)
C50,51	2μ2F 35V Tantalum	2	(WW62S)

SEMICONDUCTORS

IC1	LF 351	1	(WQ30H)
IC2	NE 570N	1	(QY10L)
IC3	LF 353	1	(WQ31J)
IC5	3302	1	(QH48C)
D3,4,7,8	1N4148	4	(QL80B)
D13,15	0.2in LED Green	2	(WL28F)
D14,16	0.2in LED Red	2	(WL27E)
D50	BZY88C3V9	1	(QH04E)

MISCELLANEOUS

	P.C.Board	1	(GA30H)
	D.I.L. Socket 8 Pin	2	(BL17T)
	D.I.L. Socket 14 Pin	1	(BL18U)
	D.I.L. Socket 16 Pin	1	(BL19V)
S1	Latchswitch 4-pole	1	(FH68Y)
	Latchbutton Black	1	(BW13P)
SKT1-4	Threaded Phono Socket	4	(YW06G)

N.B. Two Compander P.C. Boards are required for the Stereo Unit.

Power Supply PCB Parts List

RESISTORS:- All 0.4W 1% Metal Film			
R41,42	1k	2	(M1K)
CAPACITORS			
C27,28	2200µF 25V Axial Electrolytic	2	(FB90X)
C29,30	100nF Minidisc Ceramic	2	(YR75S)
C31,32	10µF 40V Minelect	2	(YY35Q)
SEMICONDUCTORS			
IC6	µA7815UC	1	(QL33L)
IC7	µA7915UC	1	(QL36P)
D9-12	1N4002	4	(QL74R)
D17	0.2in. LED Red	1	(WL27E)
MISCELLANEOUS			
	P.C.Board	1	(GA31J)

Miscellaneous Parts List

S2	DPDT Toggle Sub-Min E	1	(FH04E)
FS1	250mA Fuse 20mm	1	(WR01B)
	Safuseholder 20	1	(RX96E)
T1	Transformer 15V/15V	1	(LY03D)
	Hook-up Wire	3m	(BL00A)
	Mains Cable Black 3Amp	2m	(XR01B)
	Grommet Strain Relief	1	(LR48C)
OPTIONAL ITEMS			
	3 Pin DIN Socket	1	(HH32K)
	3 Pin DIN Plug	1	(HH30C)
RVA,RVB	10k Hor S-Min Preset	2	(WR58N)
	Case	1	(XG37S)
	Printed Front Plate	1	(FJ35Q)
	Stick-on-feet	1 pkt	(FW38R)

A complete kit of parts (excluding optional items) for a stereo Mark II N/R Unit is available.
Order As LK38R (Mark II N/R Unit) Price £39.95

to the 0V line. This should prevent the build up of any hum loop when using the noise reduction unit with earthed equipment. Power line buses are connected from the PSU to each compander PCB.

The power supply and two compander PCB's can be mounted in the optional case using the bolts and spacers, to form a stereo noise reduction unit.The front panel can be drilled using the optional, self adhesive, face plate as a template. If four channel operation is required power supply outputs are connected to a 3 pin DIN socket, a second N/R Unit consisting only of two compander boards can then be connected using a 3 pin DIN plug.

Setting-up and Use

The unit requires very little setting-up apart from adjustment of RV1 and RV2 which are simply set to mid-travel, thus ensuring a low distortion level of well within 0.1% typical. Furthur adjustment with a distortion analyser will allow minimum levels to be reached (0.06% typical).

If the unit is being used with a mixer and a tape recorder with variable line output, the mixer output is adjusted so that the compressor 0dBm LED's fire at peak sound levels. The record level is set to match the optimum for the tape being used. Playback levels are then adjusted so that the expander 0dBm LED's fire at approximately the same level as the compressor 0dBm LED's. When the noise reduction unit is used with an amplifier or tape recorder where the line output levels are not adjustable the 0dBm LED's should fire at peak sound levels, providing the equipment is to Hi-Fi specification. However, this level isn't critical since the level-adaptive response time circuits take care of possible mistracking, but it does ensure really accurate decoding of the encoded signal.

In order to adjust output levels and avoid overloading the input to equipment not to Hi-Fi standards, it may be necessary to insert preset potentiometers of 10k (RVa & RVb) in the output of the expander and compressor circuits (between R10 & S1b and between R32 & S1d)

A couple of points to note: the unit will not reduce the noise present in a noisy signal applied to the compressor input (this is territory best .served by dynamic noise limiters), and any difference in the signal between compressor output and expander input introduced by the recording process will be exaggerated by expansion, including such horrors as common-or-garden dropouts. Therefore to get the best out of the unit scrupulous attention should be paid to alignment and cleaning of tape heads!

NEW ITEMS PRICE LIST

The following is a list of all items introduced since our 1984 catalogue, excluding new items in this issue.

BOOKS

WK05F Mastering Visicalc by Douglas Hergert. **Price £10.98*NV***
WK06G Hart's Dictionary of BASIC by W.A. Hart. **Price £7.25*NV***
WK07H The Spectrum Pocketbook by Trevor Toms. **Price £7.95*NV***
WK08J The Spectrum Games Companion by Bob Maunder. **Price £5.95*NV***
WK09K Mastering CP/M by Alan Miller. **Price £13.52*NV***
WK10L Adventures with Digital Electronics by Tom Duncan. **Price £4.25*NV***
WK11M Assembly Language Programming for the BBC Micro by Ian Birnbaum. **Price £9.65*NV***
WK12N VIC Innovative Computing by Clifford Ramshaw. **Price £7.10*NV***
WK13P Understanding Your Spectrum by Dr Ian Logan. **Price £7.95*NV***
WK14Q Practical Design of Digital Circuits by Ian Kampel. **Price £12.20*NV***
WK15R Programming the BBC Micro by P. Williams. **Price £7.55*NV***
WK16S Programming Languages for Micros by G. Marshall. **Price £7.49*NV***
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WK18U Over the Spectrum. **Price £6.95*NV***
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WK20W Programming with Graphics by G. Marshall. **Price £6.75*NV***
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WM31J Audio Amplifier Construction by Robert Penfold. **Price £2.25*NV***
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WM44X Putting Your BBC Micro to Work by Chris Callender. **Price £5.30*NV***
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WM49D 21 Games for the Electron by James, Gee & Ewbank. **Price £6.35*NV***
WM50E The Aquarius and How to Get Most From It by Ian Sinclair. **Price £6.20*NV***
WM51F Software 64 (Commodore) by Owen Bishop. **Price £6.30*NV***
WM52G Spectrum Interfacing & Projects by Graham Bishop. **Price £7.63*NV***
WM53H DIY Robotics and Sensors with the BBC Computer by John Billingsley. **Price £6.84*NV***
WM54J Advanced Sound and Graphics for the Dragon Computer by Keith and Steven Brain. **Price £7.20*NV***
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WM56L Advanced Programming Techniques on the Commodore 64 by David Lawrence. **Price £6.95*NV***
WM57M Graphic Art on the Commodore 64 by Boris Allan. **Price £6.85*NV***
WM59P Linear Electronic Circuits and Systems by Graham Bishop. **Price £8.95*NV***
WM60Q Mastering Electronics by John Watson. **Price £4.35*NV***

Continued on page 44.

An introduction to CAR ELECTRICS

This article concludes our look at Car Electrics, although in the next issue we shall be discussing a simple and inexpensive method of adjusting dwell angle using a multimeter.

We would like to thank the Ford Photographic Unit for their assistance.

by Graham Bishop **Part II**

5. The Battery

A car battery is a real powerhouse and should always be maintained in prime condition. It is comprised of a series of six lead-acid 2 volt cells which, together, constitute 12 volts at capacities varying from about 30 to 100 ampere-hours. A 70 ampere-hour battery delivers a constant 70 amps for one hour, or one amp for 70 hours, or on a very cold day, 400 amps for a few seconds to start the engine.

The negative plates are constructed from spongy lead plates and the positive plates from lead dioxide. Dilute sulphuric acid with a specific gravity about 1.2 starts the chemistry into action, current from the battery turning the plates into lead sulphate. A battery charger, by way of the dynamo or alternator, reverses this process by restoring the battery plates to their original composition.

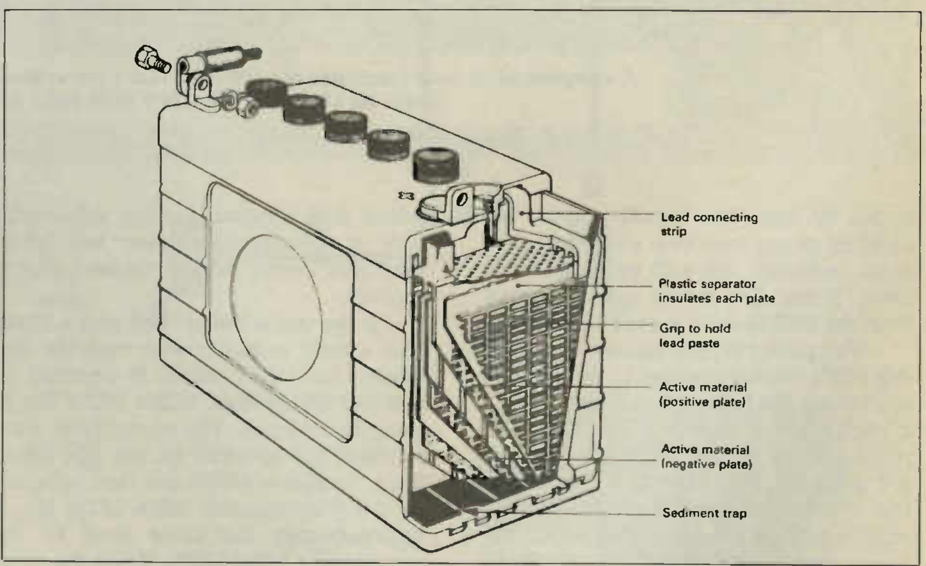


Figure 5.1. The Battery

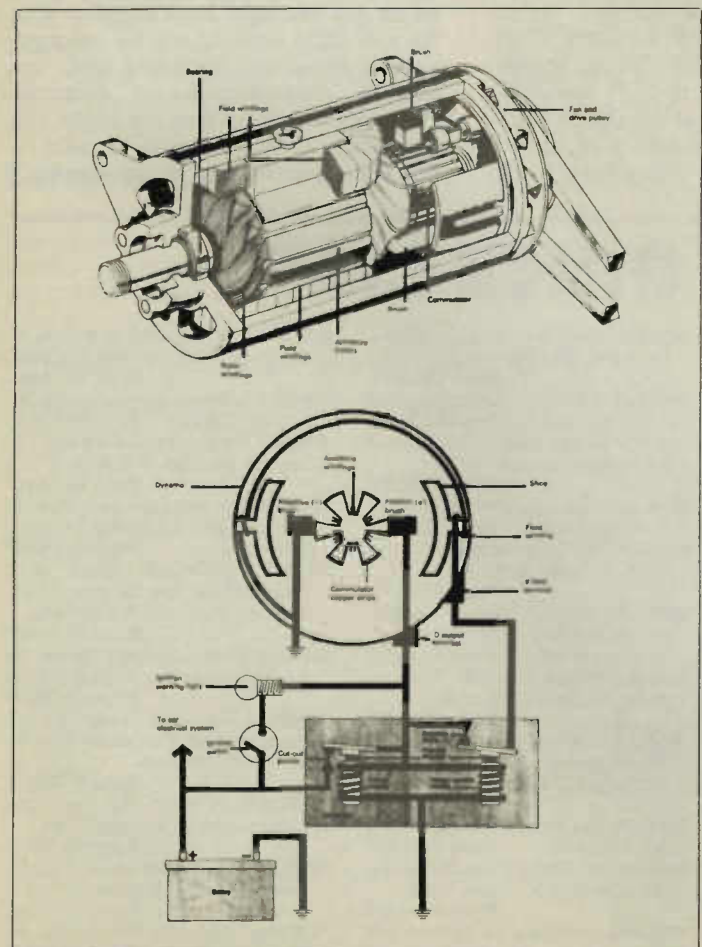


Figure 5.2. Dynamo and Control Box

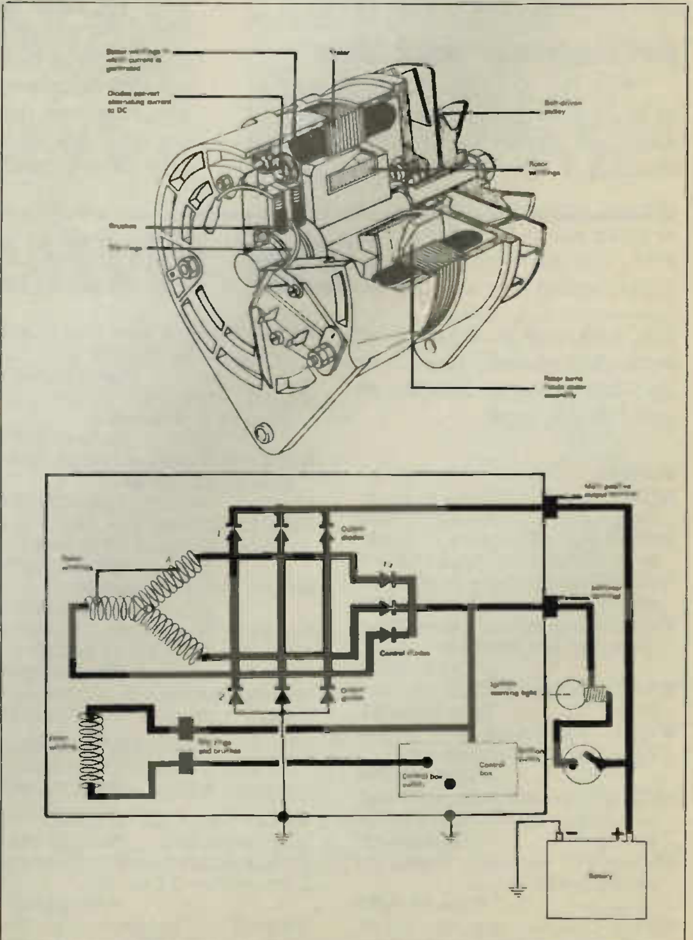


Figure 5.3. Alternator and Control Circuitry

Modern batteries are self-maintaining and the electrolyte (acid) levels remain constant. Older batteries are prone to deterioration and last only 3 or 4 years. The performance of a battery falls at low temperatures, giving problems on a cold morning and sulphation of the terminals which causes leakage currents to chassis; this is avoided by smearing Vaseline onto the terminals. A more common cause of battery trouble, other than an old and tired battery itself, is damp and dirty wiring, particularly around the starter motor which drains most of the battery power.

Battery charging is carried out in one of two ways:

The Dynamo — a dc generator, like a motor in reverse, which delivers current to the battery as long as the engine is running fast.

The Alternator — an ac generator which, although requiring an ac/dc rectifier circuit, has greater efficiency and charges the battery even when idling.

Figure 5.2 shows a cut away picture of the dynamo and the circuit which controls the charging of the battery called the cut-out or control box. This unit senses the dynamo output voltage and, if low, cuts the dynamo out of circulation. As the voltage rises the cut-out connects the dynamo to charge the battery and if it rises beyond a preset value, the regulator winding reduces the effective dynamo output by adjusting the current in the field winding, excessive current going directly to the car electrical circuits.

The alternator is shown in Figure 5.3 together with its control circuitry and rectifier diodes. The three stator windings are connected internally to the diodes and a dc output is obtained. A transistorised control circuit maintains a constant battery charging current by adjusting the current in the rotor winding.

Both systems have a built-in ignition warning light with one side connected to the battery +12V terminal, the other to the dynamo or alternator output. If the generator is not working, when the engine is switched off for instance, or when the fan-belt is slipping or broken, the 12V bulb has 12 volts across it and it lights. Normally the lamp has 12 volts on either side and it goes out.

6. Lighting

Little needs to be said about the normal lighting circuits except to say that the headlamp bulbs can consume several amperes each and so cable of the correct size must be used to prevent heating (or melting) of the wiring. Many bulbs, as in Figure 6.1, have two filaments for compactness. Quartz halogen bulbs, with a gas surrounding the tungsten filaments, give off greater brightness.

Since the headlamps between them consume several amperes, the headlamp (or flasher) switch has to be heavy duty and high current wires must be sent to the dashboard. Consequently a relay is often positioned near the headlamps, as in Figure 6.2, this being activated via a (preferred) low current switch and wiring. Operating the switch activates the relay which connects the headlamps directly to the battery terminal.

One final lighting device in common use is the spring steel flasher unit (see Figure 6.3) which turns the indicator lamps on and off.

While cold, the contacts are held together by the diaphragm. When current passes through the contacts, by indicating to turn left or right, the resistance metal heats up, expands and pushes the contacts apart. They then cool again, close and the sequence repeats 60 to 120 times a minute. Emergency light units are similar except that heavy duty contacts are used.

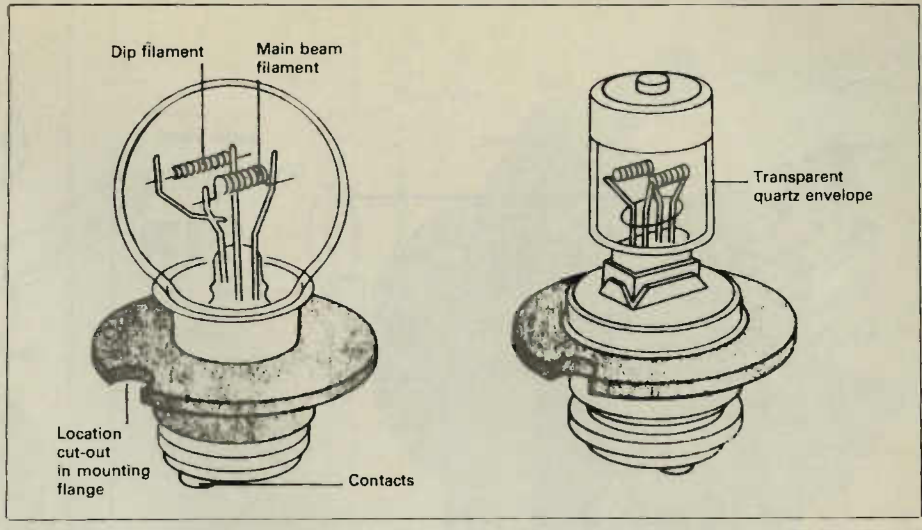


Figure 6.1. Dual Filament Bulbs

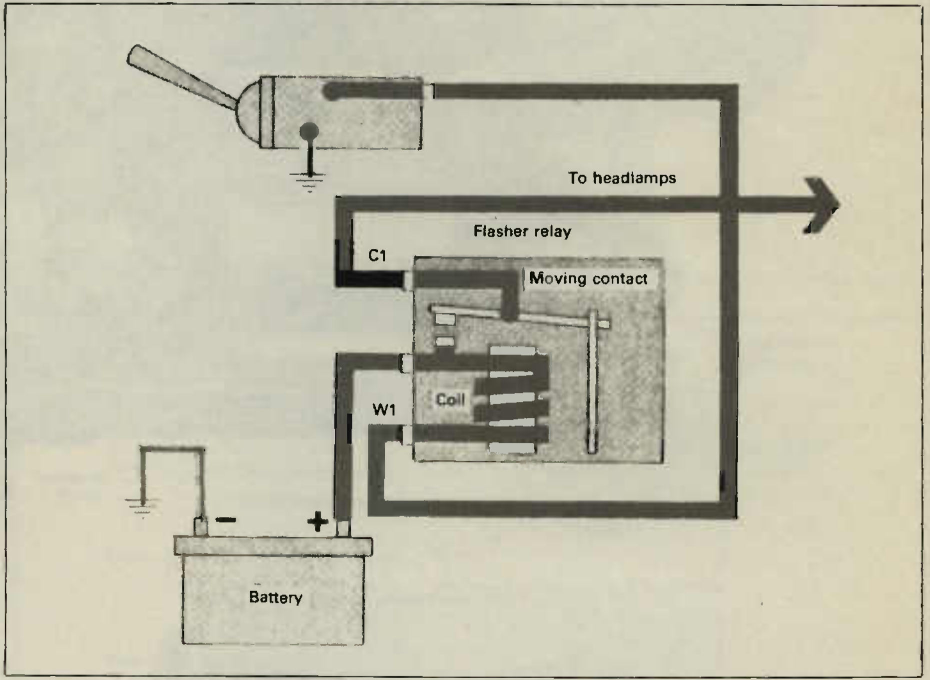


Figure 6.2. Headlamp Relay

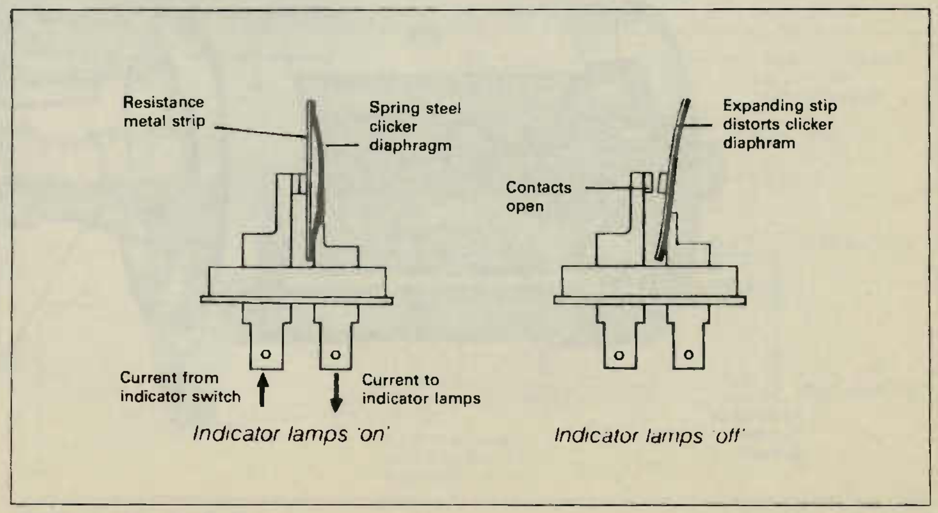


Figure 6.3. Flasher Unit

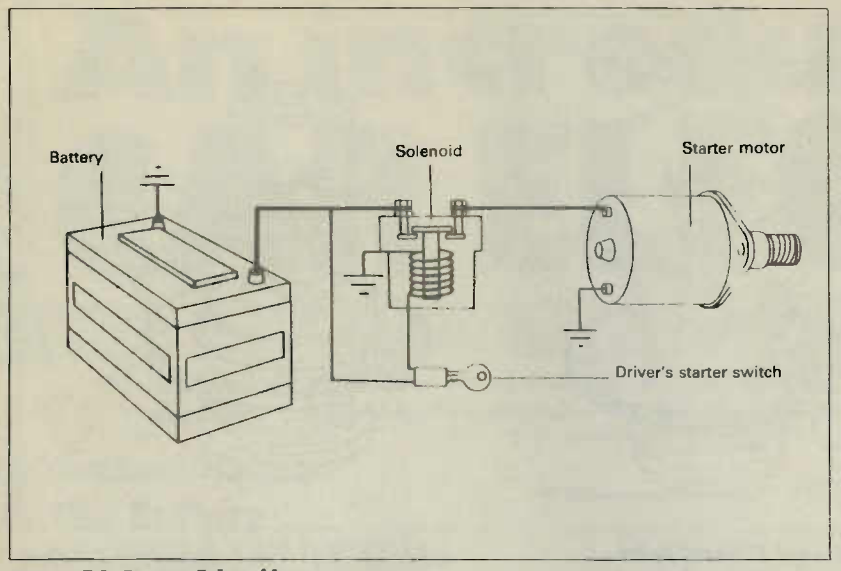


Figure 7.1. Starter Solenoid

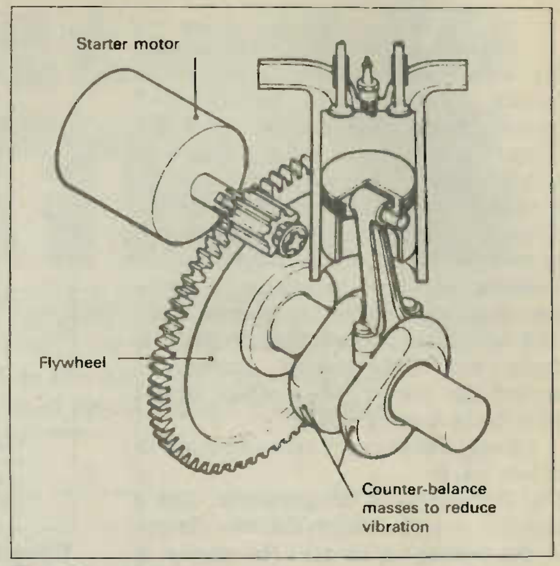


Figure 7.2. Flywheel

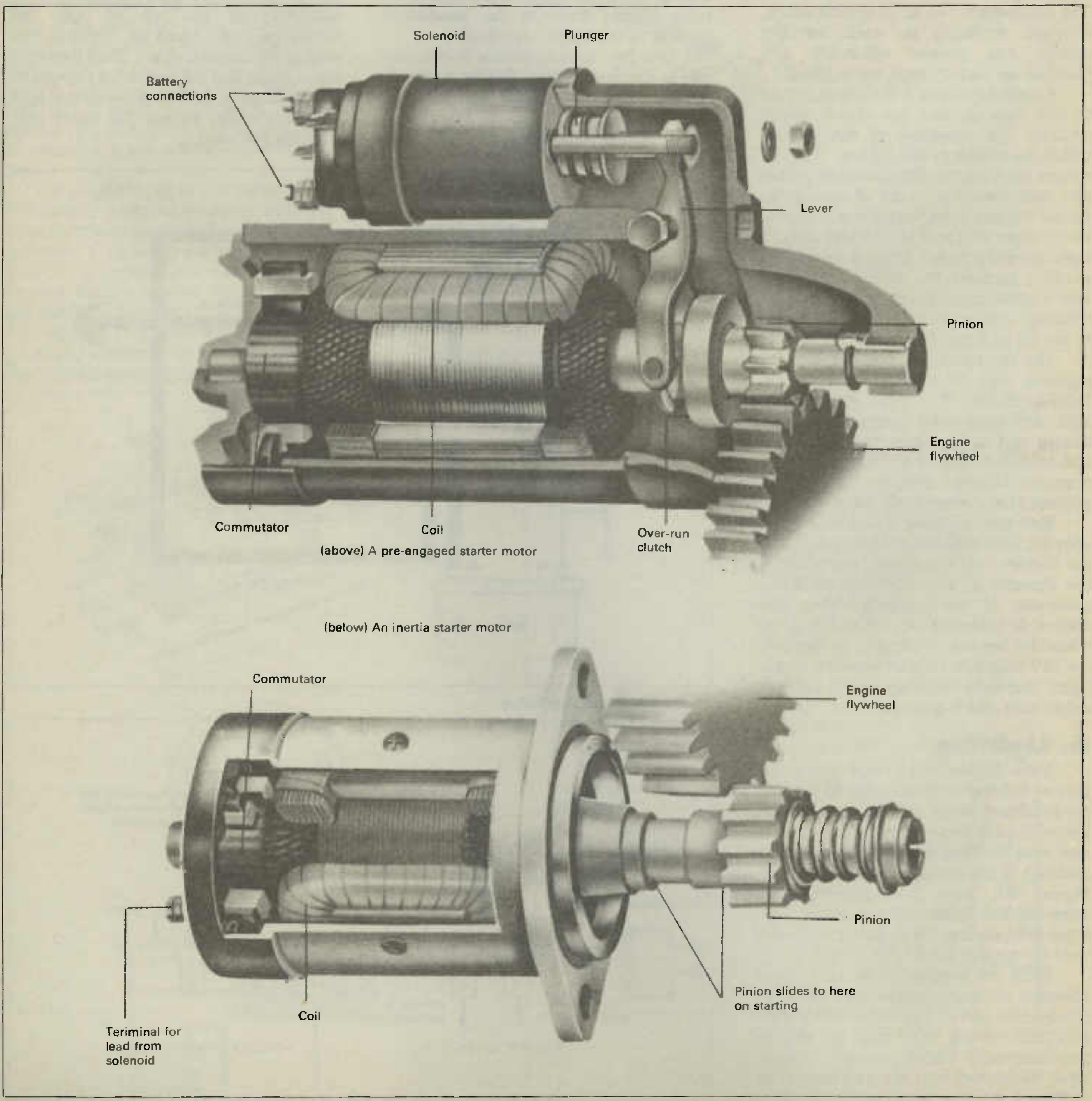


Figure 7.3. Starter Motors

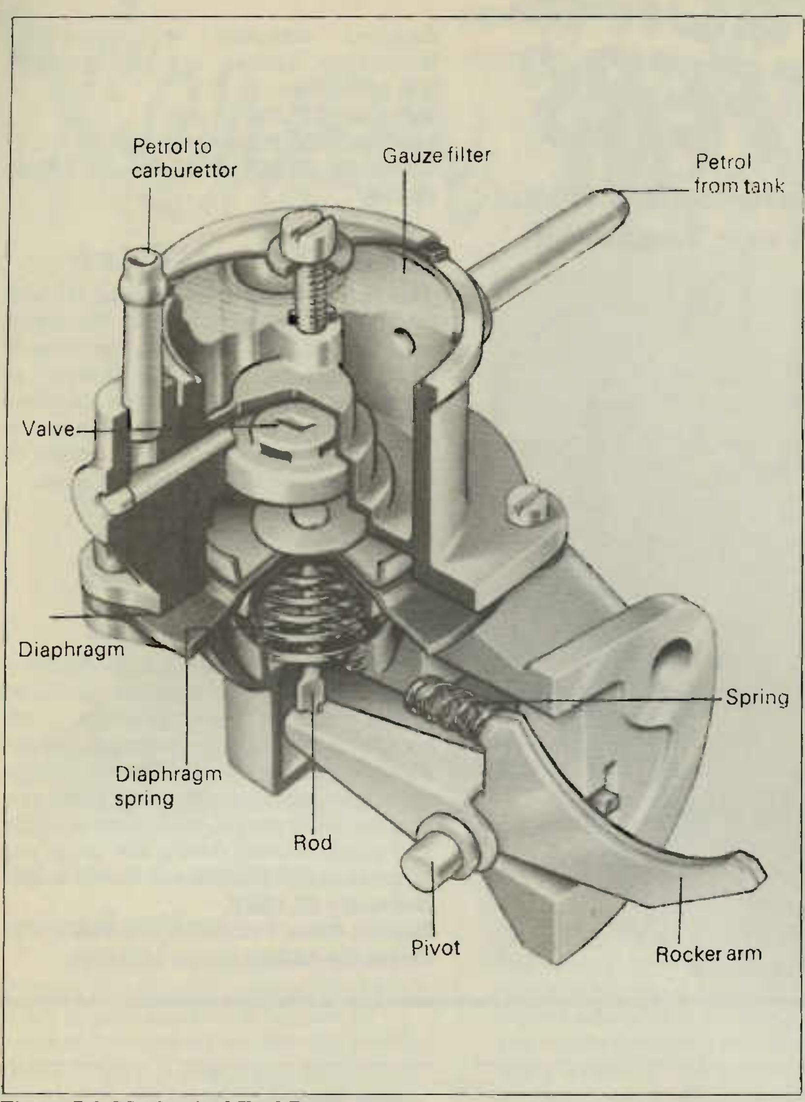


Figure 7.4. Mechanical Fuel Pump

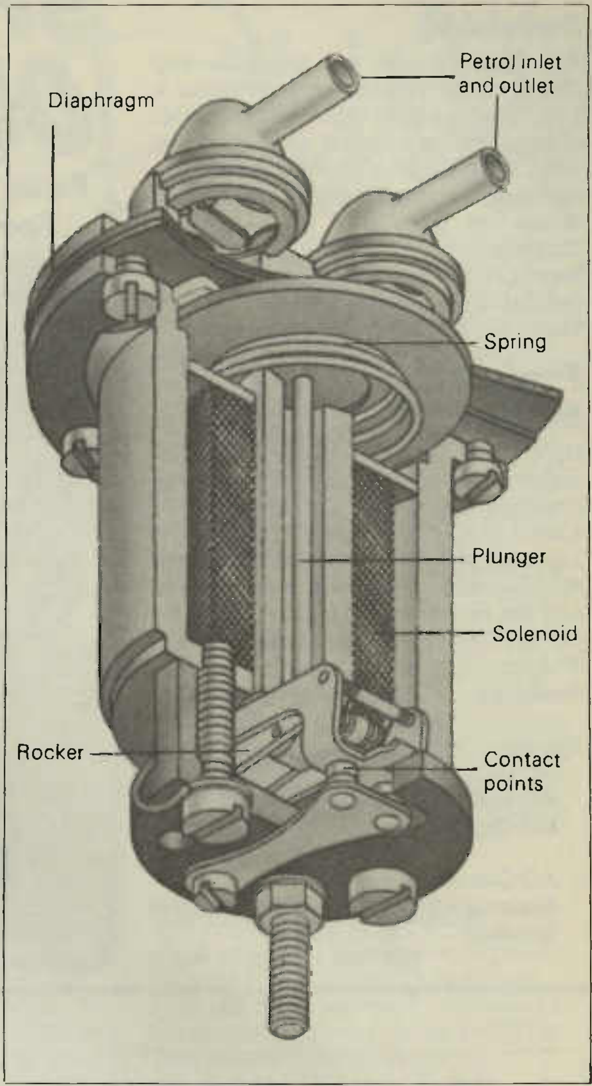


Figure 7.5. Electric Fuel Pump

7. Starter Motor and Other Accessories

In a similar way to the headlights being operated via a 'remote control' relay, a starter solenoid is used as in Figure 7.1 to switch the 400 amps to the starter motor. This wiring is the thickest to be seen under the bonnet and every step is taken to minimise any heat generated despite the costs of the thick copper wire. The starter motor engages with the engine via the flywheel to start the engine, as seen in Figure 7.2. If the ignition circuit is working well, a few turns of the engine should cause the engine to fire and continue under its own steam. The starter motor is then disconnected from the engine.

Two methods are used, a pre-engaged motor whose pinion is always linked to the flywheel, a solenoid operating a plunger to engage the starter motor with its pinion (like a small clutch), and the inertia type whose pinion slides along the shaft to engage with the flywheel as soon as the starter motor operates.These are shown in Figure 7.3. Figures 7.4 to 7.8 illustrate a number of other electrical accessories which are essential, and some legally required, in the modern motor car.

Petrol pumps operate either via a mechanical rocker assembly coupled to the engine forming a small mechanical

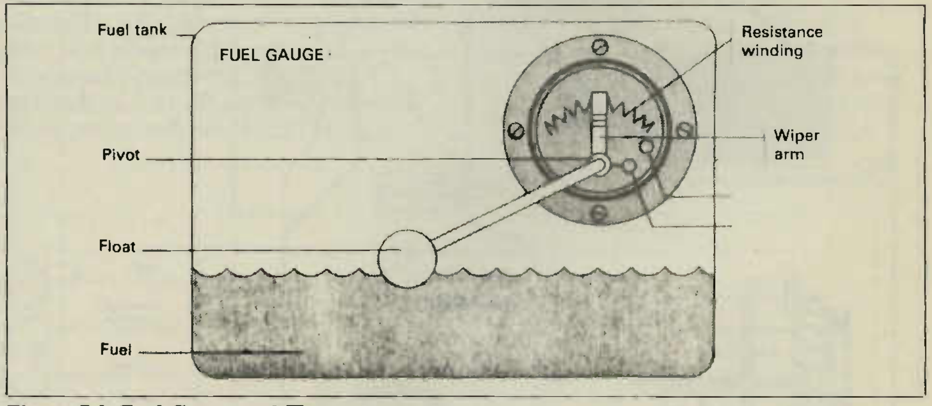


Figure 7.6. Fuel Gauge and Float

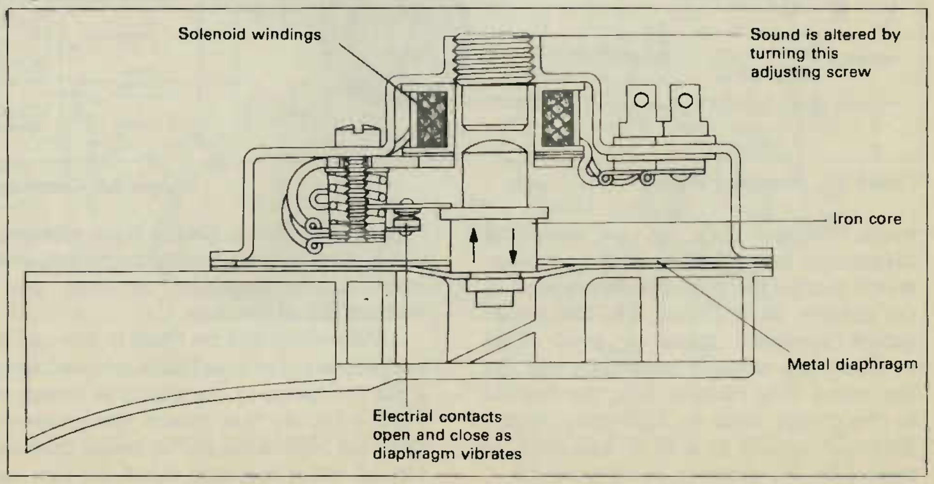


Figure 7.7. Horn Diaphragm

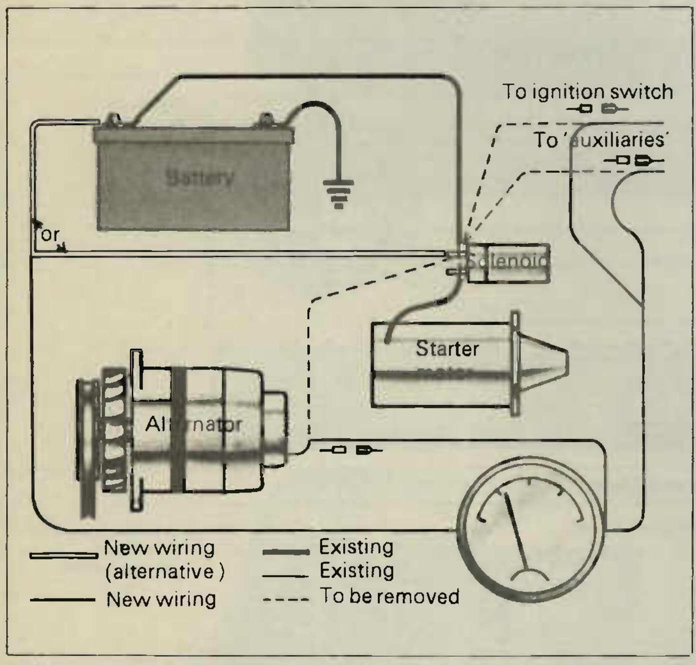


Figure 7.8. Ammeter Wiring

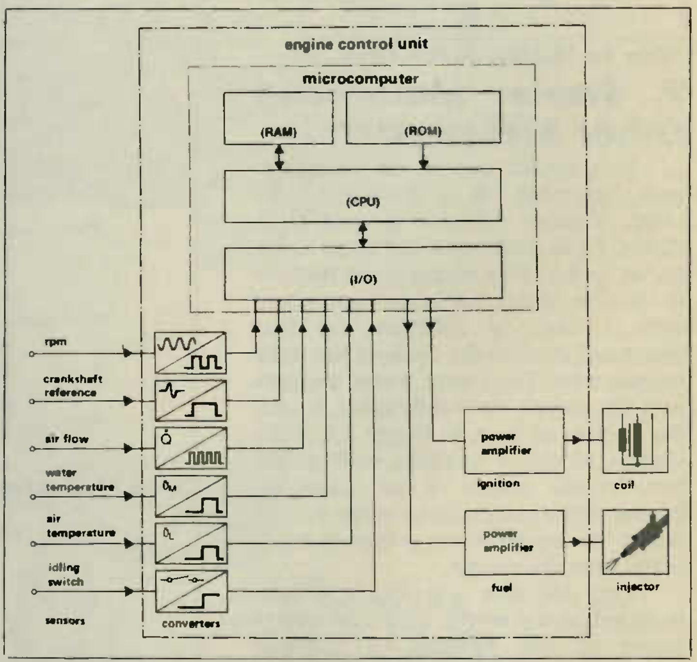


Figure 7.9. Computerised Dashboard

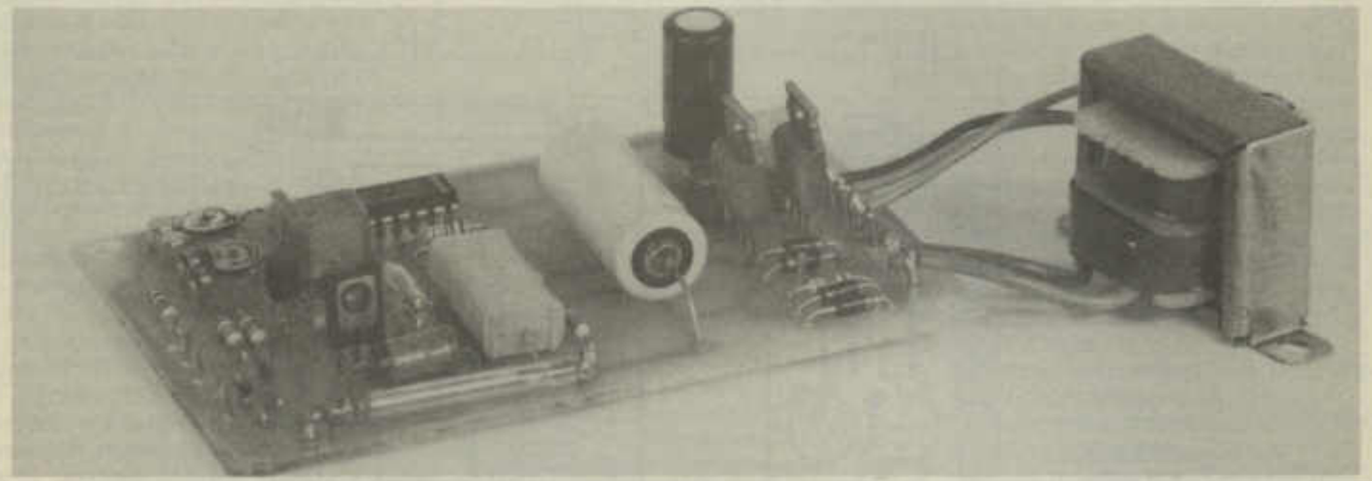
pump (Figure 7.4), or an electrical diaphragm pump, rather like a vibrator, which pumps the petrol from the tank to the engine, as in Figure 7.5. The petrol gauge operates using a small float coupled to a variable resistance unit. As the petrol level rises or falls, the current to the gauge rises or falls accordingly. This unit, similar to a W.C. ball-cock, is sealed for fire reasons, see Figure 7.6.

Horns come in all shapes and sizes, Figure 7.7 shows a simple type, working like a vibrator whose diaphragm output is mechanically amplified to blast pedestrians out of the way.

Ammeters can be fitted in any car: a simple means of installation necessitating a minor change to the wiring as shown in Figure 7.8. By this means the ammeter does not record the starter motor current, but all other currents taken by the car circuitry.

Finally, a look into the computerised dashboard now found in a number of high performance cars. Transducers constantly read rpm, pressures, temperatures and so on; these are monitored and the computer checks and warns the driver of impending trouble (see Figure 7.9). The day of the James Bond supercar or the Night Rider's 'Kit' looms nearer everyday.

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 & 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 & 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)

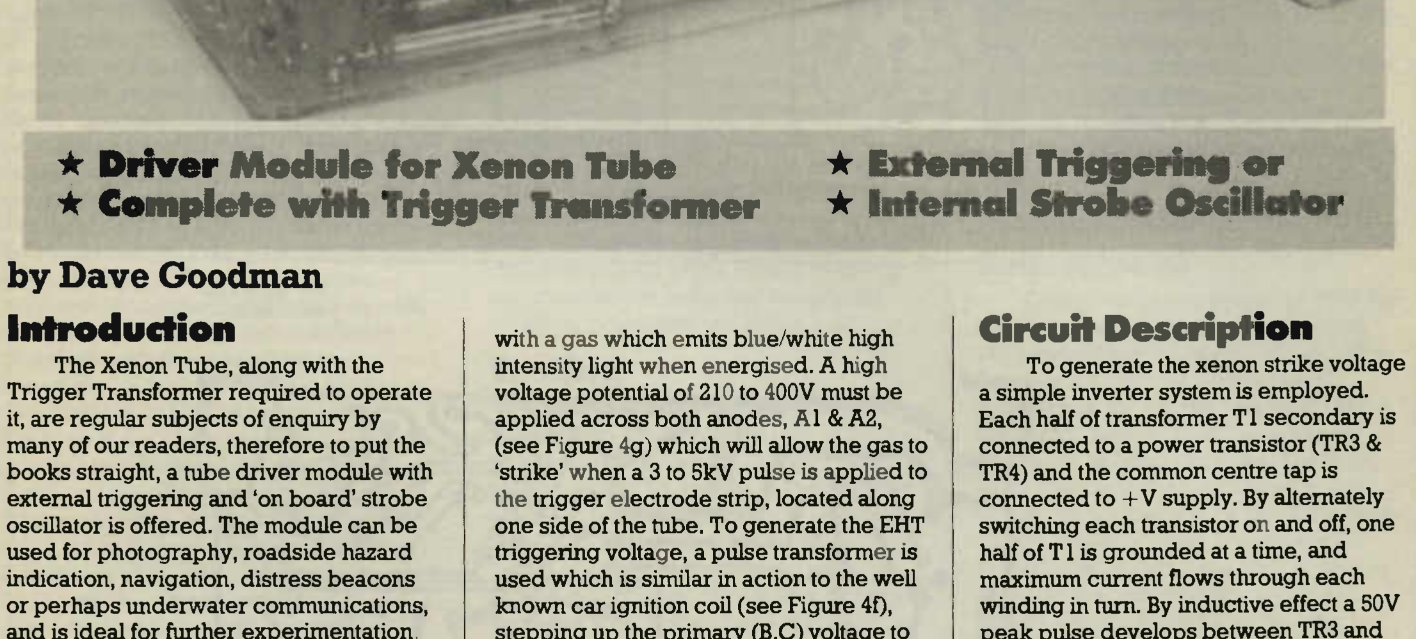
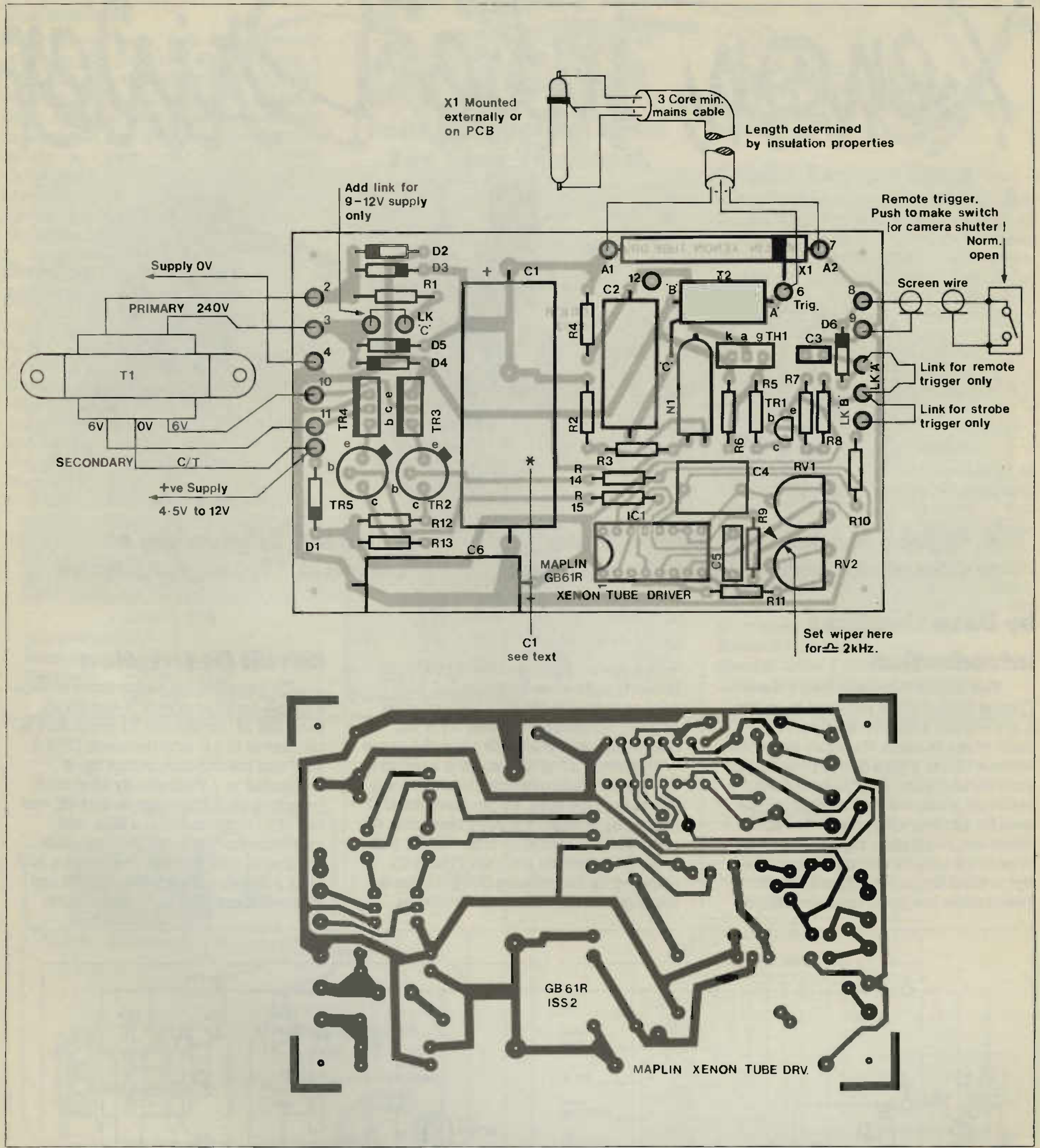


Figure 1. Circuit Diagram



Figures 2 & 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 & 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 & 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 25uS to 650uS, 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 & 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 – taking 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 & 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

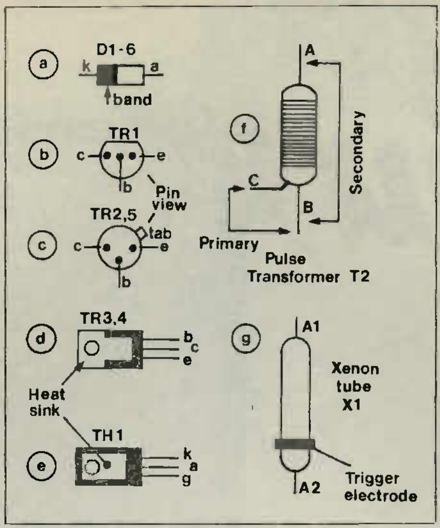


Figure 4. Component Reference

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

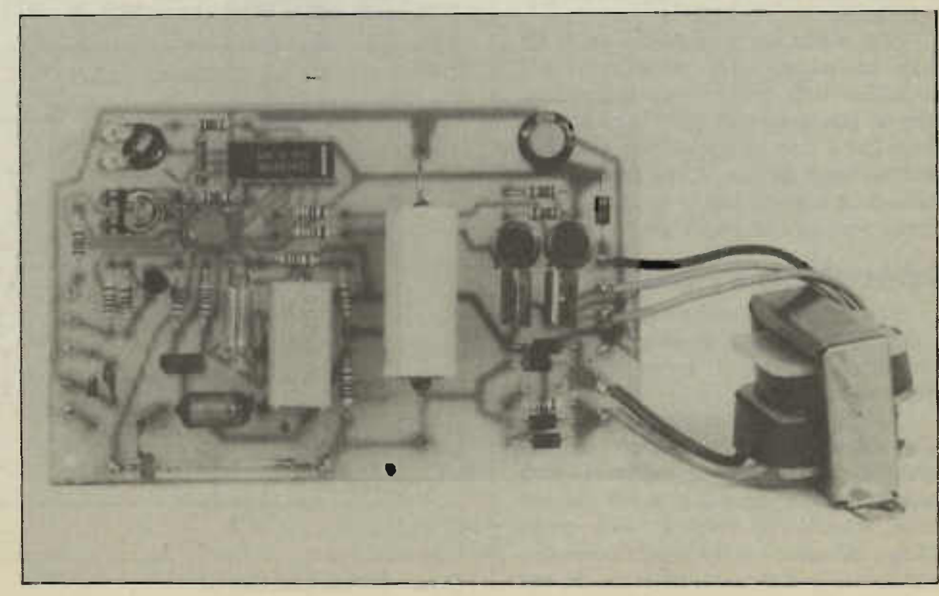
Connect a suitable power supply of from 4.5V to 12V with +V to pin 1 and 0V (−V) to pin 4. Adjust RV1 wiper to about half-travel and RV2 wiper to the arrow on the legend. Turn on the power whereupon a slight buzzing sound should be heard, after a few seconds the neon should start to glow. Now take a 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 dependant 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

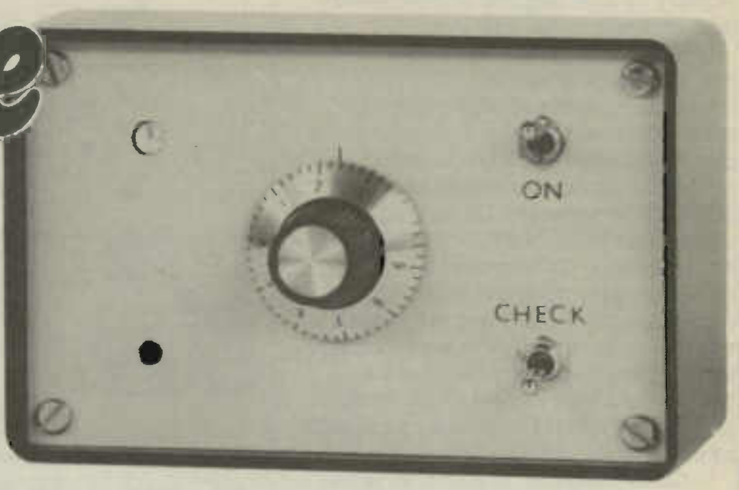
Capacitor C1 is supplied as 47uF but may be reduced in value providing its working voltage is kept at 450V or more. Because the inverter source is high impedance, the charge rate for C1 is slower for larger capacitance values and faster for smaller values. The final value chosen will depend upon the use to which the module is to be put. Thus faster strobe oscillator times will require C1 being lower in value, say 10uF 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 47uF value for C1, but light intensity needs to be variable, link 'C' can be inserted and the value of R1 decreased to suit.

Continued on page 26.



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

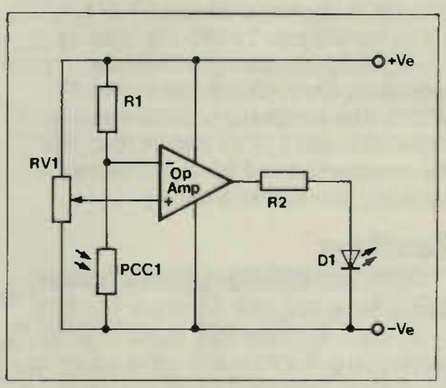


Figure 1. Voltage Comparator

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.

The input to 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 is comprised of 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 D1 is used to show the output state of the operational amplifier, and this switches on when the output is

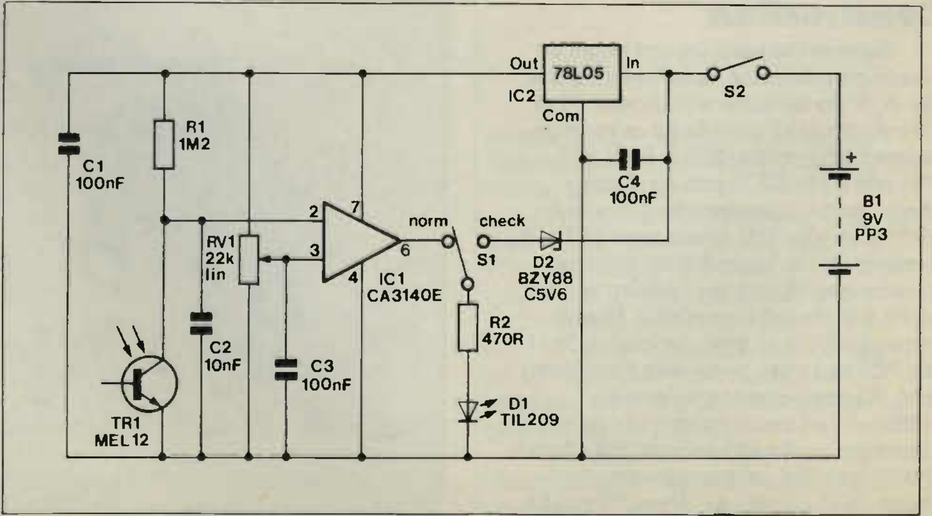


Figure 2. Practical Circuit

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 pratice 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

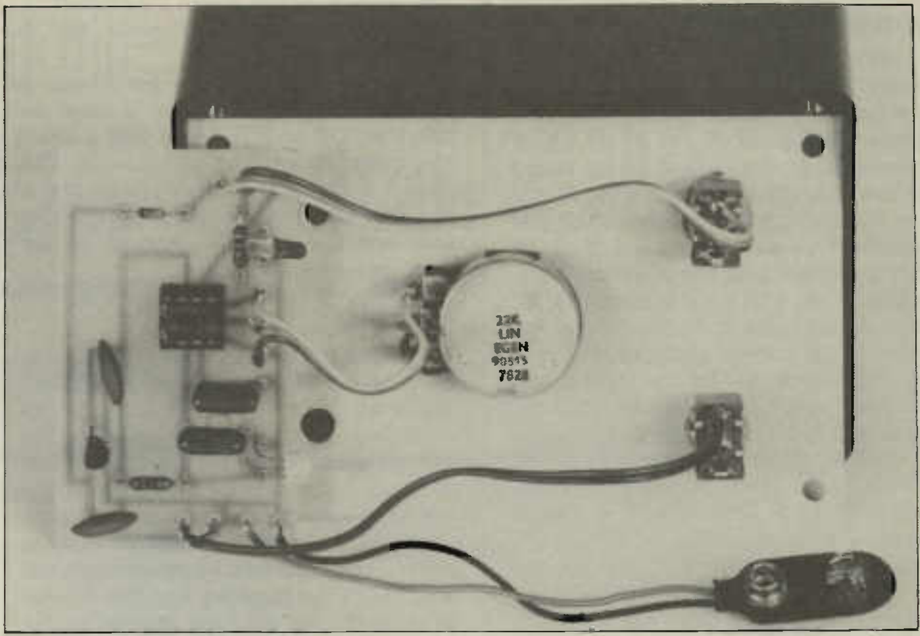
Figure 2 shows the full circuit diagram of the Enlarger Exposure Meter, and this has obvious similarities with the basic circuit. However, there are a few important differences.

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 pick-up of mains 'hum' 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 D1 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 D1 will pass any current at all, and about 8 volts is needed before it will light up reasonably brightly. Therefore, if D2 lights up brightly when S1 is set to the 'check' position the battery voltage is satisfactory. If D1 lights up only dimly the battery is nearly exhausted, and if D1 fails to light at all 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.



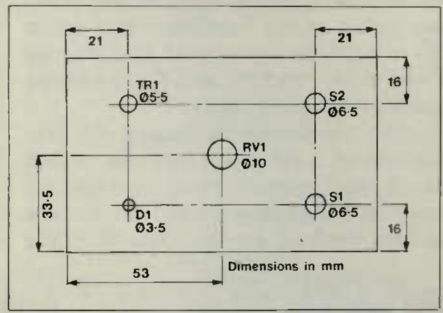


Figure 3. Front Panel Drilling

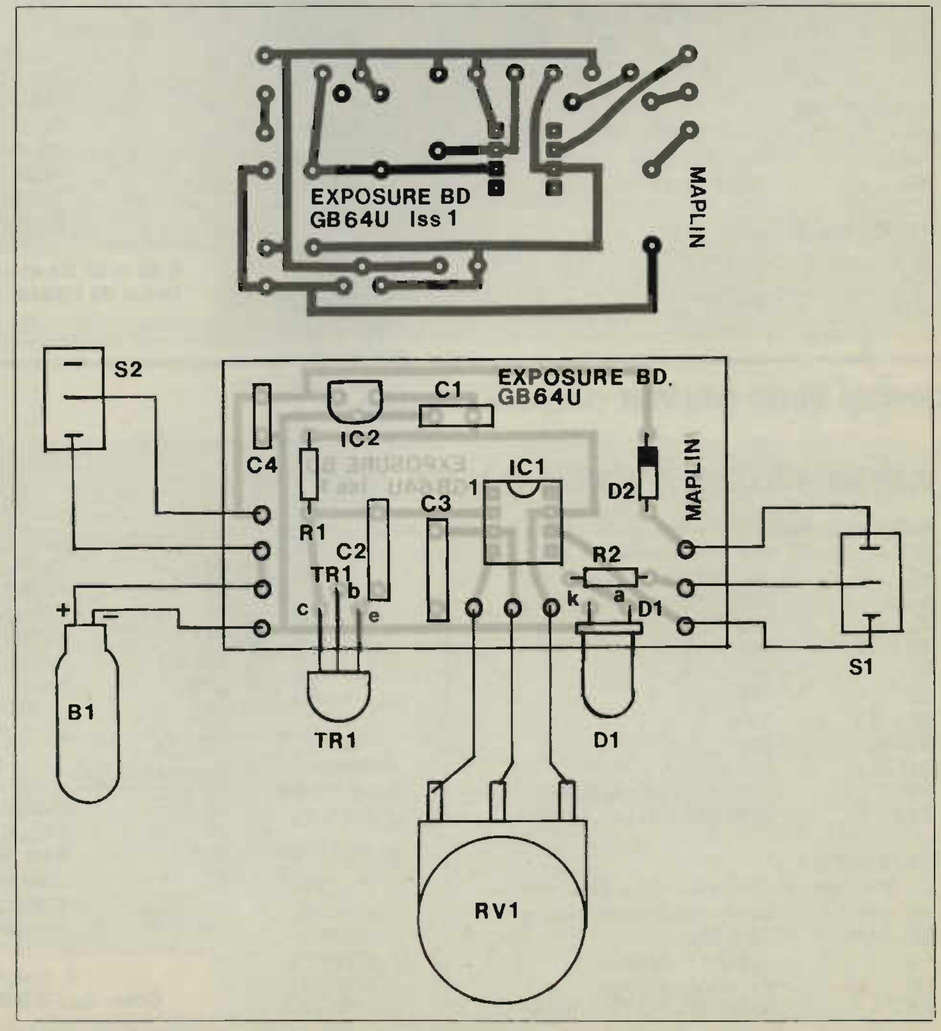


Figure 4. PCB Layout and Wiring

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 D1, 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. D1 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 D1 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 utilized 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 portion 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.

ENLARGER EXPOSURE METER

RESISTORS			
R1	1M2 ⅓W 5% Carbon Film	1	(B1M2)
R2	470Ω 0.4W 1% Metal Film	1	(M470R)
RV1	22k Pot Lin	1	(FW03D)
CAPACITORS			
C1,4	100nF Disc	2	(BX03D)
C2	10nF Polyester	1	(BX70M)
C3	100nF Polyester	1	(BX76H)
SEMICONDUCTORS			
D1	Mini LED Red	1	(WL32K)
D2	BZY88C5V6	1	(QH06G)
TR1	MEL12	1	(HQ61R)
IC1	CA3140E	1	(QH29G)
IC2	µA78L05AWC	1	(QL26D)
MISCELLANEOUS			
S1,2	Sub-Min Toggle A	2	(FH00A)
	Printed Circuit Board	1	(GB64U)
	Metal Panel Box M4004	1	(WY01B)
	Knob F10	1	(RW78K)
	DIL Socket 8-pin	1	(BL17T)
	Wire	1m	(BL00A)
	Veropins 2145	1pkt	(FL24B)
	Battery Clip (PP3)	1	(HF28F)

A Kit of all the above parts, including the case, is available.
Order As LK44X (Enlarger Exposure Meter) Price £7.95

XENON TUBE DRIVER *Continued from page 23.*

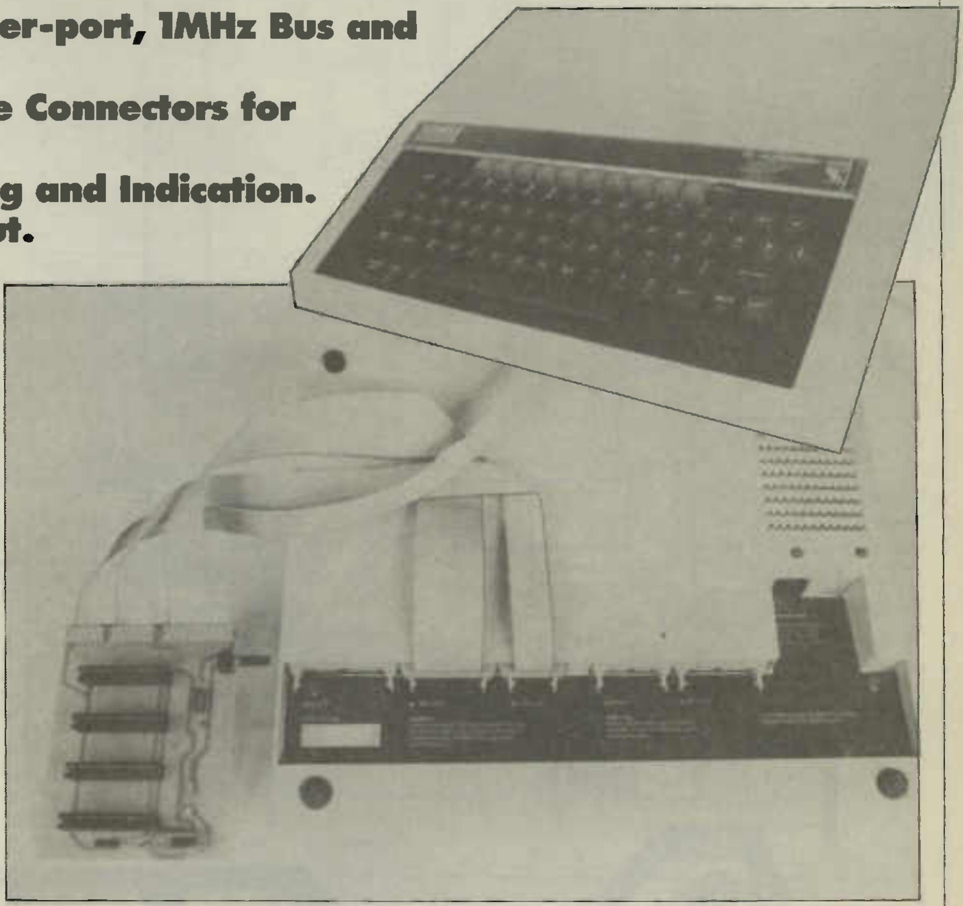
XENON TUBE DRIVER PARTS LIST

RESISTORS: All 0.4W 1% Metal Film unless otherwise stated.			
R1	47k ½W 5% Carbon Film	1	(S47K)
R2	4M7 ⅓W 5% Carbon Film	1	(B4M7)
R3	2M2 ⅓W 5% Carbon Film	1	(B2M2)
R4	1M0	1	(M1M0)
R5,10,11	10k	3	(M10K)
R6	4k7	1	(M4K7)
R7	47k	1	(M47K)
R8,9	100k	2	(M100K)
R12,13	1k0	2	(M1K0)
R14,15	5k6	2	(M5K6)
RV1	1M0 Hor. Sub-min Preset	1	(WR64U)
RV2	470k Hor. Sub-min Preset	1	(WR63T)
CAPACITORS			
C1 (See Text)	47µF 450V Axial Electrolytic	1	(FB43W)
C2	0.1µF Interference Supp.	1	(FF56L)
C3	10nF Disc	1	(BX00A)
C4	1µF Polycarbonate	1	(WW53H)
C5	1nF Polycarbonate	1	(WW22Y)
C6	470µF 16V PC Electrolytic	1	(FF15R)
SEMICONDUCTORS			
D1	1N4001	1	(QL73Q)
D2–5	1N4007	4	(QL79L)
D6	1N4148	1	(QL80B)
TR1	BC328	1	[illegible]
TR2,5	2N3053	2	(QR23A)
TR3,4	BD711	2	(WH15R)
TH1	C106D	1	(QH30H)
IC1	4049UBE	1	(QX21X)
MISCELLANEOUS			
T1	Transformer 6V Sub. Min.	1	(WB00A)
T2	Trigger Transformer	1	(YQ63T)
N1	Neon Bulb Wire Ended	1	(RX70M)
X1	Xenon Tube	1	(YQ62S)
	Veropin 2141	1pkt	(FL21X)
	Printed Circuit Board	1	(GB61R)

A complete kit of parts is available.
Order As LK46A (Xenon Tube Driver) Price £11.75

MOTHERBOARD FOR BBC MICRO

★ **Gives Easy Access to User-port, 1MHz Bus and Analogue Input.**
★ **Provides Standard Edge Connectors for Development Purposes.**
★ **+5V and +12V Switching and Indication.**
★ **Fused External 12V Input.**



by Robert Kirsch

The Acorn BBC computer is one of the most popular and versatile of the vast range of microcomputers at present available and is ideally suited for development work. The one drawback is the location of the 1MHz Bus and User Port underneath the computer. This project describes a Motherboard that brings both these ports as well as the Analogue Input out to 4 parallel double sided edge connectors on a board that can be located either in front of or behind the computer when in its working position. Power switching and protection are also provided. Figure 1 shows the circuit diagram and pin functions of the motherboard (only one of the 4 identically connected edge connectors is shown). Note that the pins are configured to keep the individual ports from the computer grouped together with power supplies at either end.

Construction

The construction of this project is fairly straightforward although care should be taken to ensure the correct polarity of the capacitor C1 and LED1 and LED2. Note also that the location guide on the edge connectors is towards the side of the PCB away from the external power input socket. The headers of the ribbon cables should be carefully inserted through the PCB to prevent bending under any of the pins during insertion. There are three wire links to be provided on the board and these can be made of any odd lengths of tinned copper wire about 24swg. Careful inspection of the completed project is recommended to ensure that there are no short circuits or unsoldered pins before connection is made to the computer.

NOTE: Always turn off the power before any connections are made to the computer ports or cards inserted into the motherboard. With the motherboard connected and no cards inserted the computer should function in the normal manner. This project is the first of several we hope to include for the BBC computer and we would be interested to hear from anyone having projects for the BBC particularly if they could be adapted to use the motherboard system shown here.

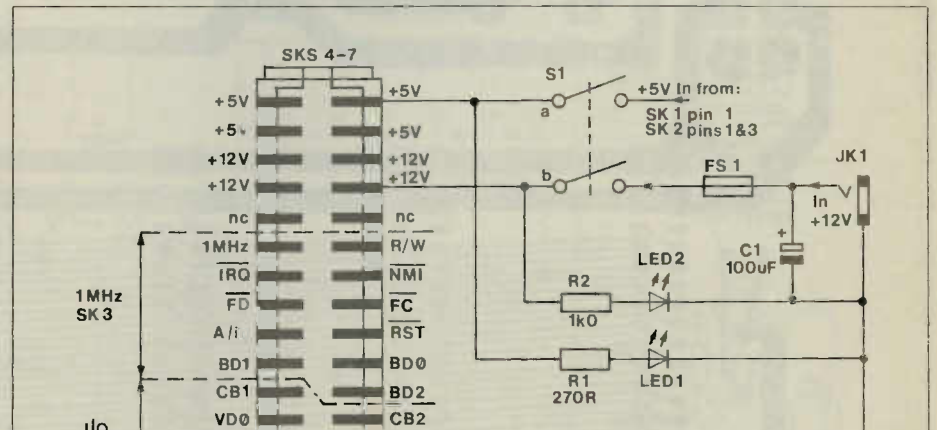


Figure 1. Circuit diagram

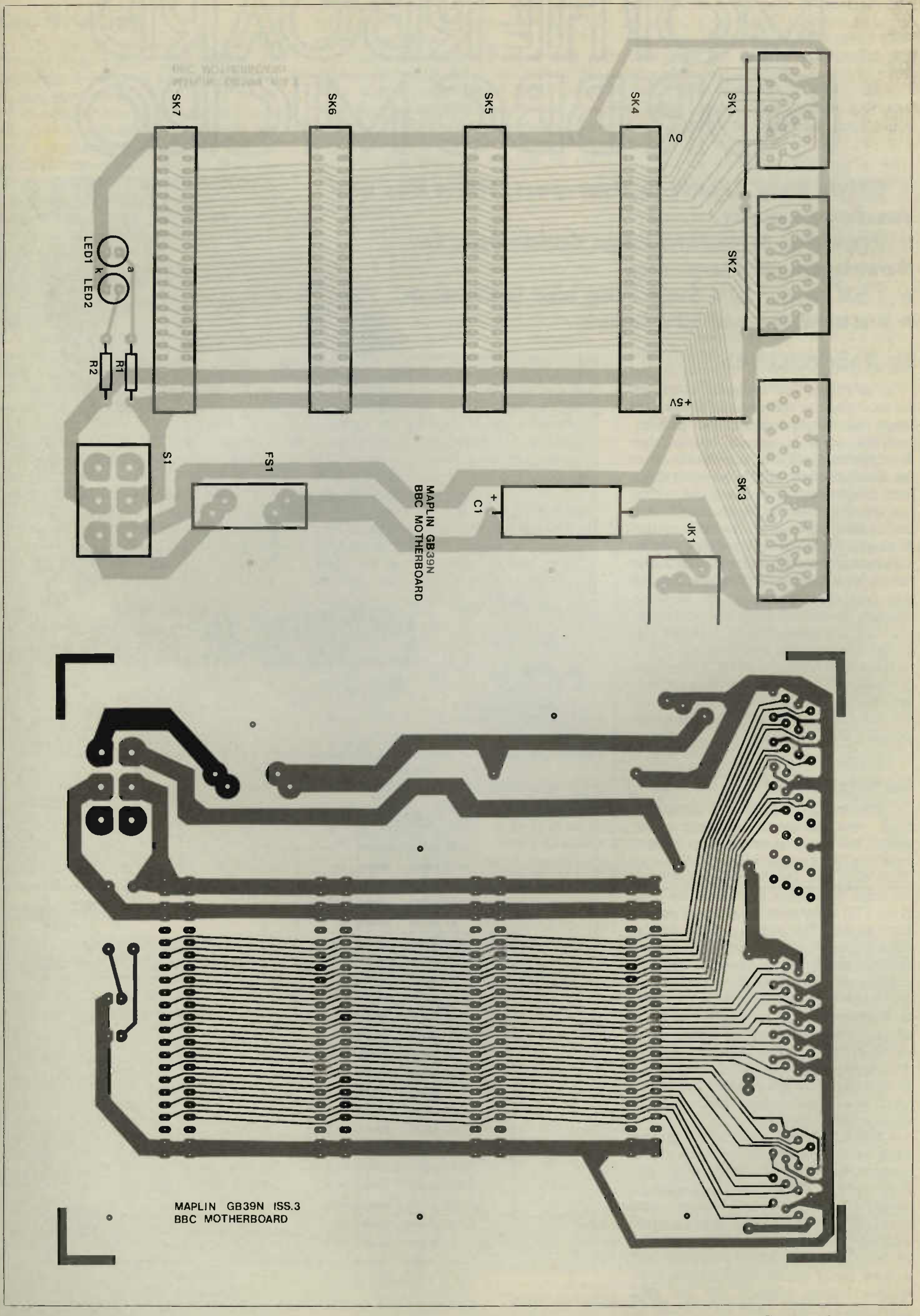


Figure 2. Track and overlay

Continued on page 53.

ZX SPECTRUM RS232/MODEM INTERFACE

In order to avoid possible problems with Series 3 Spectrums, when using this interface, please make the modifications described below.

Please note that with these modifications fitted the interface will still function correctly with Series 1 and 2 machines.

Modifications

Four small modifications are required (I to IV), these are shown in the revised circuit diagram (Figure 1), and the PCB layout diagram (Figure 2).

I) Remove the third track through pin situated alongside pins 6 & 7 of IC4. Reconnect IC4 pin 6, with a short length of insulated wire, to +5V, on IC2 pin 14

II) Remove the first track pin (same group of three) alongside IC4, pin 4. Re-connect IC4 pin 4, with a short length of insulated wire, to 0V, on IC4 pin 8.

III) A new Min. 15 ohm resistor (R11) must be connected in series with the +VE lead of C4 and the −12V terminal of the PCB edge connector (on the component side of the board – 6th terminal pin from the right). Cut the −12V track above the PCB slot and rejoin using R11 as shown, soldering directly to the track. Care should be exercised whilst cutting and soldering in this area.

IV) Resistor R5 (previously 150 ohm) must be increased to a Min. 1K0.

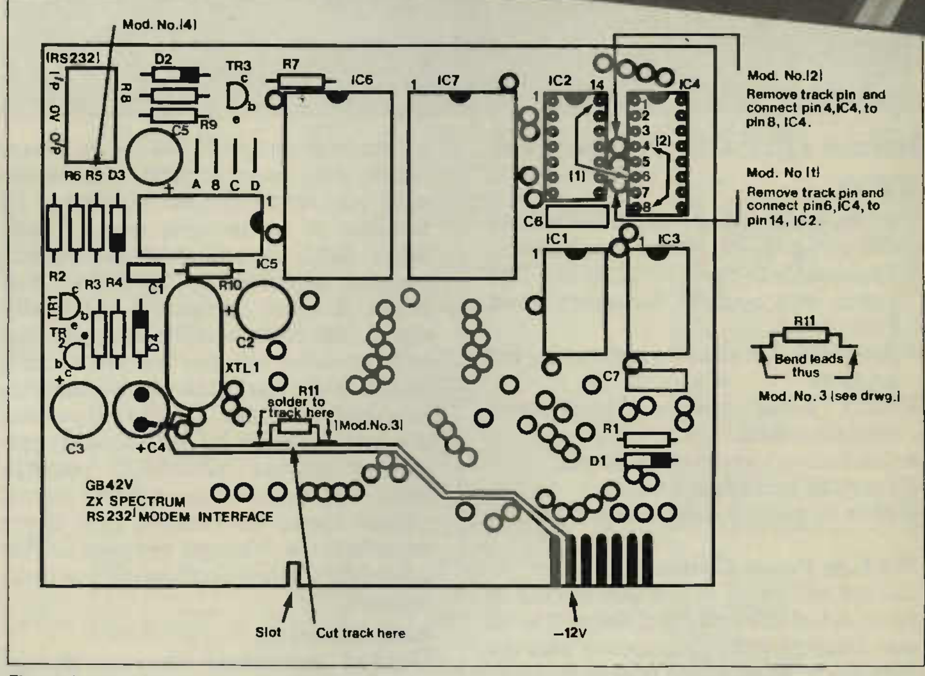


Figure 2.

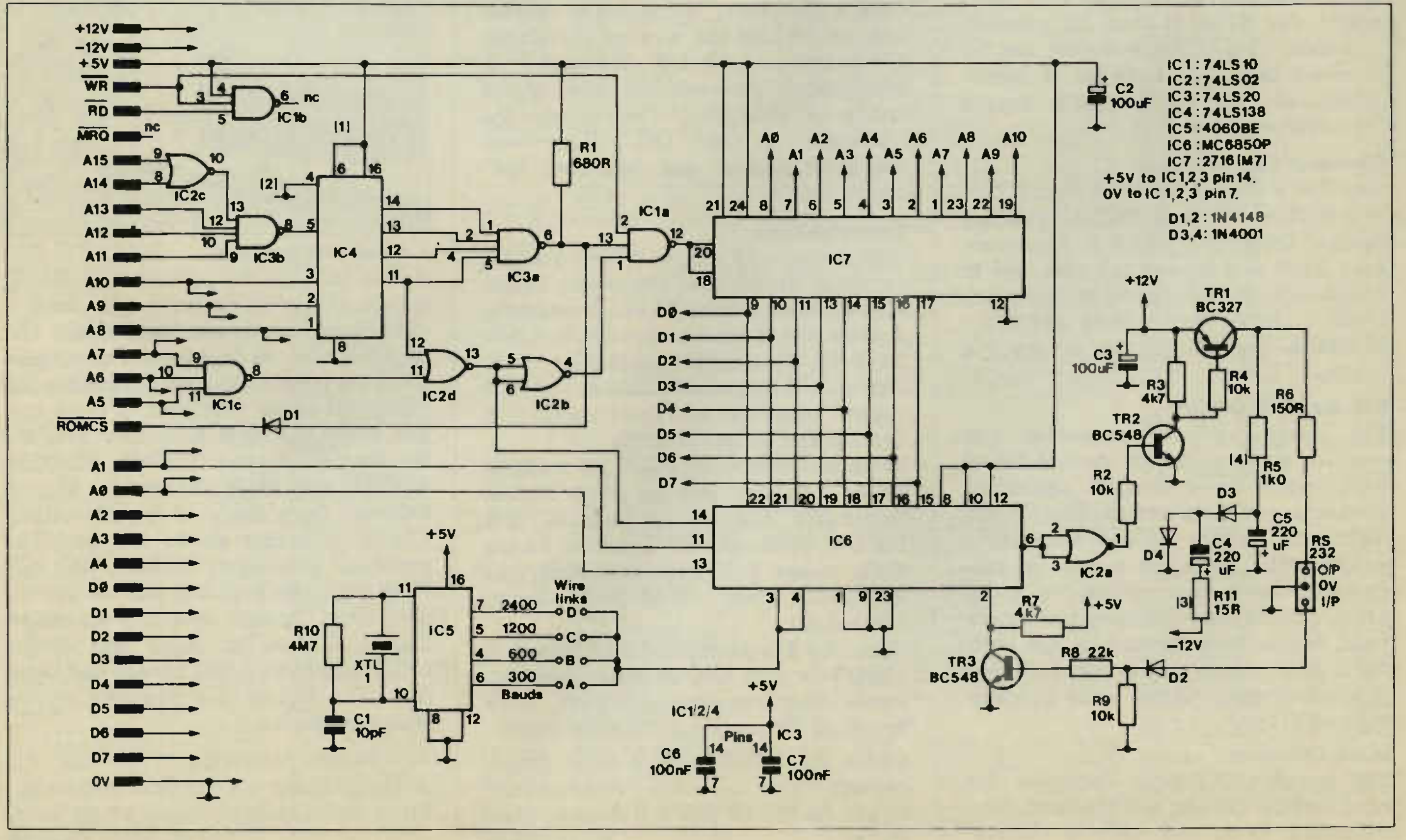


Figure 1.

« HEATHKIT »

Deluxe QRP CW Transceiver HW-9

- ★ Broad band circuits cover 250kHz of CW in the 80, 40, 20 and 15m bands.
- ★ Expandable to cover 30, 17, 12 and 10m bands with optional Accessory Band Pack.
- ★ Solid-state T/R switching allows for full break-in.
- ★ Front panel relative signal/power strength meter.
- ★ Continuously variable RF output.
- ★ Receiver incremental tuning.
- ★ Wide or narrow audio active filter.

The Low Power Challenge

Join the challenge of low power QRP in the world of five watts and below. The all new Heathkit HW-9 transceiver sets the standard for comparison in wide dynamic range performance. Rugged and lightweight, the HW-9 is ideal for portable operation. This QRP transceiver can be powered from 12V batteries, a lighter socket, or our XG10L power supply ('84 catalogue page 104).

Operator Convenience

The HW-9 covers the 3.5-3.75, 7.0-7.25, 14.0-14.25 and 21.0-21.25MHz operating ranges. Install the HWA-9 Accessory Band Pack and expand the coverage to include the WARC bands at 10.1-10.15, 18.068 - 18.168, 24.89 - 24.99 and 28.0 - 28.25MHz. Use headphones or attach a speaker.

Totally New Design

The design of the transmitter and receiver sections brings state-of-the-art performance to avid QRP operators, newcomers and old timers alike. Microelectronic circuits reduce transceiver weight while providing a level of performance and features unexpected at this price. Among these features are: broadband design, wide dynamic range, automatic AGC, single conversion, balanced product detector, active audio processing and RIT.

Main Features

The broadband design eliminates the need to tune circuits within a band. The wideband front end uses a double-balanced mixer and 4-pole crystal filter to handle wide dynamic range signals with ease and eliminate the customary RF amplifier in the receiver section. Automatic AGC circuits provide superior receiver performance and audio response. A single conversion in the main signal path reduces spurious responses and maintains superior image rejection. Signals are pulled through the sensitive front end with ease. A balanced product detector followed by active audio processing provide outstanding performance. RIT (receiver incremental tuning) permits tuning the receiver 1kHz above or below the transmit frequency. Few other QRP CW transceivers offer as many features.

Kitbuilding Fun

Detailed instructions take you through assembly and alignment, step-by-step. Only a multimeter, a frequency counter and dummy load are required to align the HW-9 Deluxe QRP CW Transmitter to specification performance. After a few nights of kitbuilding fun, accept the challenge of QRP QSL-hunting with Heathkit's newest and best-ever low-power rig.

Specifications

Transmitter – RF Output Power: 4W (3W on 10m). Transmitter Frequency Offset: approx 700Hz. Antenna Load Impedance: At least 90% of rated power with less than 2:1 SWR. Protected against high SWR. Harmonic & Spurious Radiation: −35dB & −40dB minimum at rated output. T/R Operation: CW, full break-in.

Receiver – Sensitivity: 0.2μV for readable signal; 0.5μV or less for 10dB S+N/N. Selectivity: Wide, 1kHz max @ 6dB; Narrow, 250Hz @ 6dB. Dynamic Range: 85dB. Image & IF Rejection: 60dB min. Audio Hum Noise: −60dB. Audio Output: 1W into 8Ω.

General – Frequency Stability: Less than 150Hz/hour drift after 30-minute warmup. Power Requirement: 11-16VDC, 12.6V specified. Dimensions: 108x235x216mm.

Order As HS63T (HW-9 QRP Transceiver) Price £299.95

Order As HS64U (HWA-9 Access Band Pack) Price £49.95

Teach Yourself MS*-DOS On Your IBM-PC

- ★ Teaches MS-DOS in general and Z-DOS** specifically, using exercises for the HS100 series computers operating under Z-DOS.
- ★ Learn as you go with programs for your HS100 or IBM-PC.
- ★ Teaches the structure of MS-DOS with exercises in command use.
- ★ Complete coverage with how to access system routines to do console input/output and work with disk files.
- ★ Full section narration guides you through the course in everyday language even a beginner can understand.

Comprehensive Course

In seven units, the course teaches how MS-DOS is organised and all about how to use it. Directed toward the novice computer user, this course of study provides instruction in all the built-in commands and in the typical transient utilities. It will also provide an understanding of what assembly language is and how to use the system routines and the program debugger.

Course Description

About MS-DOS in general and Z-DOS specifically, this course begins with a disk operating system background and explains how the disk itself is organised. Then the most often used commands are discussed along with how to enter and edit command lines. Examined next are the frequently used CHKDSK, FILCOM, RDCMP and MAP commands. This is followed by a study of the file editor, EDLIN, including all its features. The program debugger, DEBUG, is then explained. The final unit teaches system interfacing through assembly language. Shown is how to input and output characters and strings, to read and write disk files and to use directory entries within programs.

Full Section Narration

Accompanying the MS-DOS course are three audio cassette tapes which intro-

Continued on page 35.

1984 CATALOGUE PRICE CHANGES

The price changes shown in this list are valid from 14th May 1984 to 11th August 1984. Prices charged will be those ruling on the day of despatch.

For further details please see 'Prices' on catalogue page 12. The letter in brackets after the price on some items, indicates the minimum trade quantity thus: A = 5; B = 10; C = 25; D = 50; E = 100; F = 250; G = 500; H = 1000. For further details see 'Trade Prices' on catalogue page 13.

Price Changes
All items whose prices have changed since the publication of the 1984 catalogue are shown in the list below. Those where the price has changed since the last Price Change Leaflet (dated 13th February 1984) are marked '•' after the price. A complete Price List is also available free of charge – order XF08J.

Key

NYA	Not yet available.
DIS	Discontinued.
TEMP	Temporarily unobtainable.
FEB	Out of stock; new stock expected in month shown.
†	To be discontinued when stocks are exhausted.
NV	Indicates that item is zero rated for VAT purposes.
★	See 'Amendments To Catalogue'. Note that not all items that require amendments are shown in this list.
$	Please add £6 carriage if your order contains one or items marked thus.

1984 Catalogue Page No.		VAT Inclusive Price

AERIALS

Page 24
★XQ23A Mushkiller FM1083 £13.96 (A)•
★XQ25C Mushkiller FM1035 £19.80 (A)•
★XQ27E Mushkiller FM1087 £23.60 (A)•
XQ29G Trucolour TC10 Grp A £11.20 (A)
XQ30H Trucolour TC10 Grp B £10.98 (A)
XQ31J TrucolourTC10 GrpC/D £10.95 (A)•
XQ32K Trucolour TC13 Grp A £12.95 (A)•
XQ34M TrucolourTC13 GrpC/D £12.60 (A)
XQ36P Trucolour TC18 Grp B £14.95 (A)•
XQ37S TrucolourTC18 GrpC/D £14.20 (A)
★XQ38R Extragain XG5 £17.95 (A)•

Page 25
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- FF35Q Clip Can 40 21p (G)
- FF36P Clip Can 50 68p (E)
- FF41U Twin OO £7.86 (B)
- FF46A SW Trim 60pF £6.30 (B)

Page 100
- FY77J FS Crystal 100kHz £7.84 (C)
- HX62S FS Crystal 1MHz £7.96 (B)
- FY78K FS Crystal 10MHz £3.36 (C)
- FY79L MP Crystal 1MHz £3.95 (C)●
- FY81C MP Crystal 2.4576MHz £2.24 (C)●
- FY82D MP Crystal 4MHz £1.45 (D)●
- HX32K MCR Crys Orange Pair £3.22 (C)
- HX33L MCR Crys Yellow Pair £3.85 (C)●
- HX34M MCR Crystal Green Pr £3.82 (C)
- HX99H Ceramic Fltr 10.7MHz £1.15 (E)●

CAR ACCESSORIES

Page 101
- LH99H Windscreen Aerial £3.45 (C)●
- XX37S Car Aerial Booster £6.98 (B)
- YW59P Car Power Lead £2.95 (C)●

Page 102
- WY09K Demister DIS (B)●
- FY01B Tyre Pressure Gauge £2.25 (D)
- XB44X Car Speakers Shelf £7.45 (B)●
- XQ75S 10W Car Stereo Spkrs DIS (A)

Page 103
- XG27E 15W Shelf Speakers £18.95 (A)●
- AF00A Booster Amp DIS (A)
- AF01B Booster Equaliser DIS (A)
- YX85G Speed Sensor £16.90 (A)

COMMUNICATIONS

Page 104
- ★XG10L 12V 3A Power Unit £16.95 (A)●

Page 105
- YQ73Q CB/Radio Aerial Cplr £2.95 (C)●
- XG13P 1.5m CB Aerial DIS (A)
- HL94C 30W Dummy Load £5.60 (C)●

Page 106
- YK00A 2m Scanning Receiver £69.95 (A)●
- WY12N 10W PA Amp £34.45 (A)●
- XY81C 40W PA Amp DIS (A)

Page 107
- XY82D 60W PA Amp DIS (A)
- XY76H Pistol Grip Megphone £59.95 (A)●
- LB72P Intercom 2-Station £11.45 (B)●

Page 108
- XY77J 4-Channel FM Intrcom £39.95 (A)●
- AF09K AM Radio DIS (C)●
- XG18U PB Telephone £23.95 (A)●

COMPUTERS

Page 110
- AF81C Atari 1050 Dsk Drive £239.95
- HY24B Printer 822 Paper £5.25
- AF42V 800 Cent I/F DIS●

Page 111
- AF44X 48K RAM Memry Module DIS
- AF45Y Atari 400 48K Upgrad DIS
- AF90X Starfighter Joystick £14.95●

Page 112
- AF89W Joystick Lead £4.95●
- BQ00A Adventure Land DIS●

Page 113
- KF95D Adv with Grphcs Disk DIS●

Page 114
- BG75S Galaxy Cassette DIS●

Page 116
- KH00A Strng Ddys Gphcs Dis DIS●
- KH38R Swordpoint Disk Atar DIS
- KH21X Telengard Cass DIS

Page 117
- KH07H Curse Crwly Mnr Cass DIS
- KB31J Zork III Disk DIS

Page 118
- KB74R Baja Buggies Cass DIS●

Page 119
- KH16S Controller Cass DIS
- KF10L Defender Cart DIS
- KT22Y Donkey Kong Atari DIS

Page 120
- KT33L Donkey Kong Jr. DIS
- BQ62S Galactic Chase Cass DIS●
- KH29G Gridrunner Cass Atar DIS

Page 121
- KT43W Joust Atari DIS
- KF68Y Jump Man Disk DIS
- BQ18S Lunar Lander Cass DIS

Page 122
- KT28F Ms. Pac-Man DIS
- KF93B Number Stumper Cass DIS
- KF94C Number Stumper Disk DIS
- KT34M Pengo Atari DIS

Page 123
- KT35Q Pole Position DIS●
- KF16S Qix Cart DIS
- BG99H Roadracer Cassette DIS●

Page 124
- BG19V Shoot Gallery Disk DIS
- KT47B Soccer Atari DIS
- BG42V Space Chase Cassette DIS●

Page 125
- KB94C Wizard Of Wor Cart DIS●
- KH18U Tank Arcade Cass DIS
- KT29G Tennis DIS
- KB63T Tutti Frutti Cass DIS
- KH36P Up Up & Away Cass AT DIS●

Page 126
- KF20W Zaxxon Cass DIS●
- KB38R Battle Normandy Cass DIS
- KT25C Eastern Front - 1941 DIS

Page 127
- KB00A Legionnaire Cassette DIS
- BG83E NA Convoy Raider Cs DIS
- KB01B Tigers in Snow Cass DIS●

Page 128
- BG87X Acquire Disk DIS
- KT23A Biorhythm Atari DIS
- KT31J Family Finances Atri DIS

Page 129
- KF52G Home Filng Mngr Disk DIS
- BQ39N Hickory Dickory Dock DIS●
- KH42V Mailing List Cass/At DIS
- YG48C Music Composer DIS●

Page 130
- BG92A Stocks and Bonds Dsk DIS
- BQ13P Sunday Golf DIS
- KT24B Timewise Atari DIS
- BQ45Y Pool DIS

Page 131
- BQ65V Financial Manager DIS

Page 132
- KH47B Book Keeper Disk /At DIS
- YL39N Visicalc DIS
- KT39N Atari Music I Cass DIS
- KT40T Atari Music I Disk DIS
- KT41U Atari Music II Cass DIS
- KT42V Atari Music II Disk DIS
- YG57M Euro Country & Caps DIS
- KF47B Juggles Rainbow Cass DIS
- KF48C Juggles Rainbow Disk DIS
- KF49D Juggles House Cass DIS
- KF50E Juggles House Disk DIS
- BG00A Kids 1 Cassette DIS●

Page 133
- BG02C Kids 2 Cassette DIS●
- KT26D Mickey Outdoors Cass DIS
- KT27E Mickey Outdoors Disk DIS
- KF51F Speed Reading Cass DIS
- KH67X Action Cart Atari DIS
- BQ27E Atari World DIS
- YL32K Assembler DIS●

Page 135
- KT30H Logo Atari DIS●
- KT32K Microsoft BASIC II DIS
- BQ75S Pilot Educator DIS

Page 136
- YG59P Telelink DIS●
- YL30H Disassembler Cass DIS●
- KH57M Coco Cass+Disk/Atari DIS
- KH58N Coco2 Cas+Disk/Atari DIS

Page 137
- BG06G Tricky Tutorial Cass DIS

Page 138
- KH60Q Advance Anim Disk/At DIS
- GG24B Analog Subscription £18.00 NV
- UG03D Atari User Grp Mag 3 DIS

Page 139
- KH75S BBC Conflict Cass DIS
- KH80B BBC Galaxy Conf. Cas DIS
- KH87U BBC Space Invadr Cas DIS●
- KH89W BBC Music Proces Cas DIS●

Page 140
- AF57M Dragon 32 Computer £149.00●

Page 141
- KL13P Doodlebug Cart (32) DIS
- KL16S Countdown Cass (32) £6.36

Page 143
- KL32K Android Attk Cas(32) DIS
- KL33L King Cass (32) DIS
- KL39N Eno/Stalag Cass (32) DIS

Page 144
- KL42V Shark Treas Cas (32) DIS
- BC76H Chess Cart DIS

Page 145
- KL49D Selection 4 Cas (32) DIS
- KL50E Ent Dregn Cas A (32) DIS●
- KL51F Ent Dregn Cas B (32) DIS

Page 146
- KL72P Alld Ed/Assem cas 32 DIS
- KL73Q Dream Ed/Ass Cas(32) DIS●
- BC44X Computavoice DIS●

Page 147
- AF56L Commodore 64 Computr DIS

Page 148
- KH94C Annihilator Cas (64) DIS
- KH95D Camel Attck Cas (64) DIS
- KH96E Centropods Cass (64) DIS
- KH98G Super Cassett B (64) DIS
- KH99H Cyclons 64 Cass (64) DIS
- KK62S Escape MCP Cass (64) DIS
- KK63T Galaxy Conf Cas (64) DIS

Page 149
- KK64U Gridrunner Cart (64) DIS
- KK65V Gridrunner Cass (64) DIS
- KK67X Pakacuda Cass (64) DIS
- KK68Y Rox 64 Cass (64) DIS
- KK70M Easy Script dsk (64) DIS
- KK52G Omnicalc (64) DIS

Page 150
- KK75S Basic Intr Cas1 (64) DIS
- KK55K Coco 2 Cart (64) DIS
- KK45Y Forth (64) DIS
- KK46A Machine Cde Mon (64) DIS
- KK81C Sprite Edit Cas (64) DIS●
- KK47B Turtle Graphics (64) DIS
- KK44X 6510 Assembler (64) DIS●
- KK86T Chemistry Cass (64) DIS●
- KK87U Dopth Charg Cas (64) DIS
- KK89W English Cass (64) DIS
- KK90X Geography Cass (64) DIS●
- KK91Y History Cass (64) DIS●
- KK92A Home Man Cas+Dsk(64) DIS
- KK93B Labyrinth Cass (64) DIS
- KK95D Maths 1 Cass (64) DIS
- KK96E Maths 2 Cass (64) DIS
- KK97F Maze Mast Cart (64) DIS
- KK98G Paint Brush Cart(64) DIS
- KK99H Physics Cass (64) DIS●
- KL00A Rat Race Cass (64) DIS
- KL01B Sea Wolf Cass (64) DIS
- KL02C Simons Bas Cart (64) DIS
- KL03D Snowman Cass (64) DIS
- KL04E Stellar Wars Cas(64) DIS
- KL05F Superblitz Cass (64) DIS
- KL06G Super Fruit Cass DIS●
- KL07H Swordpoint Disk (64) DIS
- KL08J Synthesound Cart (64) DIS
- KL09K Turtle Train Cart 64 DIS
- KL10L Turtle Tutor Cart 64 DIS

Page 152
- KS17T Cowboy/Barricade DIS
- KS18U Gutteng Guttong Cart DIS
- KS07H M5 Boxing DIS
- KS09K M5 Tennis DIS
- KS02C M5 BASIC F DIS
- KS00A M5 FALC DIS
- KS20W M5 Graphic Design DIS
- KS08J M5 Skiing DIS
- KS05F M5 Word Maze DIS
- KS06G M5 Super Baseball DIS

Page 153
- KL76H Arcadia Cass (SP) DIS
- KL78K Astroblastr Cas (SP) DIS
- KL80B Cent/Paint Cas (SP) DIS●
- KL82D Frenzy Cass (SP) DIS
- KL85G Hells Things Cas (SP) DIS
- KL86T Headbangers Cas (SP) DIS●
- KL87U Air Traffic Cas (SP) DIS●
- KL89W Maze Chase Cass (SP) DIS●

Page 154
- KL90X Mined Out Cass (SP) DIS
- KL91Y Nightflite Cass (SP) DIS●
- KL92A Penetrator Cass (SP) DIS
- KL94C Schizoids Cass (SP) DIS
- BC90X Space Intruders Cass £3.96
- KL99H Terrordacktil Cas SP DIS

Page 155
- KH30H Dungeon Master Cass DIS
- BC88V The Hobbit (48K) Cas DIS
- KH31J Trader Tril Cas (SP) DIS
- KH32K Quest Adv Cass (SP) DIS●
- KH41U Countries World Cass DIS

Page 156
- KH45Y Word Proc Cass (SP) DIS●
- KH48C Edit/Assem Cass (SP) DIS
- KH50E Spec Mach Lan Cas SP DIS
- KH51F Spect Mon Cass (SP) DIS●
- KH55K Manic Miner Cas (SP) DIS
- KM00A Vic Abductor Cass DIS
- KM01B Vic Andes Attck(+8k) DIS●
- KK17T Ant Eater Cart DIS

Page 157
- KM03D Vic Arcadia Cass DIS
- KM05F Vic Catch Snatch Cas DIS

Page 158
- KM10L Vic Games Pack Cass DIS
- KK34M VIC Games Pack 1 DIS
- KK35Q VIC Games Pack 2 DIS
- AC90X Gorf Cartridge DIS
- BC47B VIC Hoppit DIS
- KM13P Vic Inovative Cas. 2 DIS
- KM14Q Vic Inovative Cas. 3 DIS

Page 159
- KM18S Vic Matrix Cass DIS
- KK04E Night Crawler Cass DIS
- AC91Y Omega Race Cartridge DIS
- KK16S Princess & Frog Cart DIS

Page 160
- KK59P VIC Sub Commander DIS
- KK01B Skramble Cass DIS●
- KM22Y Vic Sky Hawk Cass DIS
- KK06G Space Phreeks Cass DIS

Page 161
- AC60Q VIC Star Battle DIS●
- KM53H VIC Tank Arcade Cass DIS
- KM09K Vic Skramble Cass DIS
- KM26D Vic Wacky Waits Cass DIS
- AC79L VIC Panic DIS●
- KK61R VIC War Games DIS
- AC86T VIC Adventureland DIS●

Page 162
- AC87U VIC Mission Impossbl DIS●
- AC84F VIC Pirate Cove DIS●
- AC89W VIC The Count DIS●
- KM27E Vic Wiz & Princs Cas DIS

Page 163
- AC88V VIC Voodoo Castle DIS●
- KM29G Vic Camels Cart DIS
- BC52G VIC Cosmic Jailbreak DIS
- KM31J Vic Kindercomp Cart DIS
- KM35Q Vic Necromancer Cart DIS
- KM36P Vic Pharoah Cart DIS
- KM37S Vic Slime Cart DIS
- KM38R Vic Story Machine DIS
- BC18U Garden Planner DIS
- BC19V Interior Designer DIS
- KK18U Typo Cart DIS
- BC51F VIC Pinball DIS
- BC97F Multisound Synth Cas DIS●
- AC77J VIC Sargon II Chess DIS

Page 164
- KK07H Chess (+16K) Cass DIS
- BC16S VIC Money Manager DIS

Page 165
- AC97F VIC Writer Cassette DIS●
- KK26D VIC Word Processor DIS●
- BC98G Jnr Maths: Birds Cas DIS●

Page 166
- BC99H Jnr Maths:Engine Cas DIS
- KK00A Jnr Maths:Lghthe Cas DIS
- KM51F Words Words Cass DIS

Page 167
- AC58N Intro To Basic Part2 DIS
- KK28F VIC Machine Code Mon DIS●
- AC56L Machine Code Mon DIS●

Page 168
- BK95D Data Cassette £1.95●
- AF38R Epson RX80 £286.35●

CONNECTORS

Page 169
- HF23A Alligator Clip Black 19p (G)●
- HF26D Charger Clip 28p (F)●
- YX47B Comcon Block 5-way 48p (F)
- YX48C Comcon Terminal 7p (H)●
- HF02C Terminal Post Black 45p (F)●
- HF03D Terminal Post Blue 45p (F)●
- HF04E Terminal Post Brown 45p (F)●
- HF05F Terminal Post Green 45p (F)●
- HF07H Terminal Post Red 45p (F)●
- HF09K Terminal Post Yellow 45p (F)●
- HF13P Press Terminal Black 34p (F)
- HF15R Press Terminal Green 34p (F)
- HF16S Press Terminal Red 34p (F)
- HF17T Press Terminal White DIS (F)
- HF18U Press Terminal Yellw 39p (F)●

Page 170
- WL57M 1mm Plug Black 24p (G)●
- WL58N 1mm Plug Red 24p (G)●
- HF46A 2mm Socket Green DIS (G)
- HF49D 2mm Socket Yellow 18p (G)●
- HF55K Wander Plug Yellow DIS (G)
- HF56L Wander Socket Black 16p (G)
- †HF57M Wander Socket Blue 16p (G)
- HF58N Wander Socket Green 16p (G)
- HF59P Wander Socket Red 16p (G)
- HF61R Wander Socket Yellow DIS (G)
- HF62S 4mm Plug Black 18p (G)●
- HF63T 4mm Plug Blue 18p (G)●
- HF64U 4mm Plug Brown 18p (G)●
- HF65V 4mm Plug Green 18p (G)●
- HF66W 4mm Plug Red 18p (G)●
- HF67X 4mm Plug White 18p (G)●
- HF68Y 4mm Plug Yellow 18p (G)●
- HF70M 4mm Socket Blue 18p (G)●
- HF71N 4mm Socket Brown 18p (G)●
- HF72P 4mm Socket Green 18p (G)●
- HF73Q 4mm Socket Red 18p (G)●
- HF74R 4mm Socket White 18p (G)●
- HF75S 4mm Socket Yellow 18p (G)●
- HH01B Scr Phono 19p (G)●
- YW06G Threaded Phono Skt 18p (G)●

Page 171
- BW74R Phono Socket Quad 42p (F)●
- BW76H Phono Socket 6-way 58p (E)●
- HH05F Phono Conn 24p (G)●
- HF77J 2.5 Plug Scr 29p (F)●
- HF78K 2.5 Jack Socket 18p (G)●
- HF80B Plug Plas 3.5 19p (G)●
- HF81C Plug Scr 3.5 28p (F)●
- HF82D Jack Socket 3.5 16p (G)●
- HF83E Line Socket Plas 3.5 16p (G)●
- RK51F Stereo Plas 3.5 Skt 38p (F)●
- HF85G Jack Plug Plas 24p (G)●
- HF87U Jack Plug Scr 45p (F)●

Page 172
- HF88V Jack Pl Sto Plas 36p (F)●
- HF89W Jack Pl Sto Scr 62p (E)●
- HF90X Jack Skt Brk 24p (G)●
- HF91Y Jack Skt Open 22p (G)●
- HF92A Jack Skt Sto 28p (F)●
- HF93B Stereo Open Skt 39p (F)●
- BW80B OPDT Jack Socket 60p (E)

Page 173
- YW08J Co-ax Plug Imp 16p (G)●
- HH17T BNC Plug 35p (E)●
- HH18U BNC Socket 35p (E)●
- YW03D BNC T Adaptor £2.45 (C)●
- BW81C Plug PL259 65p (E)●

Page 174
- BW84F UHF Socket Round 53p (F)●
- BW85G Socket SO239 58p (E)●
- YW04E Adaptor 239 £1.45 (D)●
- YW05F Adaptor 259 £1.48 (D)●
- YX53H Audio Conn 4-way £1.55 (D)●
- YX54J Audio Conn 5-way £1.95 (D)●

Page 175
- RK52G 10 Way Line Skt £2.98 (C)
- RK53H 10 Way Line Plug £3.95 (C)●
- ★RK54J 10 Way Chassis Skt £1.95 (D)●
- BW90X XLR Chassis Socket £2.95 (C)●
- HH26D DIN Plug 4-pin 22p (F)●
- HH27E DIN Plug 5-pin A 18p (G)
- HH29G DIN Plug 6-pin 22p (F)●
- HH32K DIN Socket 3-pin 14p (G)●
- HH37S DIN Socket 7-pin 37p (G)

Page 176
- HH40T DIN Line Skt 2-pin 12p (G)●
- YX90X PC DIN Skt 2-pin 26p (F)●
- YX91Y PC DIN Skt 5-pin A 22p (F)●
- BK58N D-Range 15-Way Plug £1.20 (D)
- RK61R D-Range 9 Way Skt 95p (D)●
- BK59P D-Range 15-Way Skt £1.43 (D)
- FG26D RA D-Rnge 15-Way Skt £2.62 (D)
- FG27E RA D-Rnge 25-Way Skt £3.95 (D)●
- FG67X RA D Range 15 Wy Plg £1.95 (D)●
- FG68Y RA D Range 25 Wy Plg £2.95 (C)●
- YQ51F D-Range 25-Way Latch 54p (F)●

Page 177
- WQ14Q PCB Conns 45 9p (H)●
- RK35Q PC Edgeconn 2x23-way £2.20 (C)●
- FG23A 0.1in 2x28 PC Edgcon £1.95 (C)●
- BK74R 2x12 Way PC Edgecon £2.20 (C)●
- FL85G Edge Conn 124 £1.62 (D)●
- FL91Y Edge Conn Feet G 22p (G)●
- FL92A Edge Conn Feet H 22p (G)●
- YR58N Edge Conn End Bkt 33p (F)●

Page 178
- YX36P Multicon Plug 15-way 58p (F)●
- YX37S Multicon Plug 24-way 89p (E)●
- YX38R Multicon Plug 36-way £1.20 (E)●
- YX39N Multicon Skt 2-way 23p (G)
- YX40T Multicon Skt 4-way 27p (G)
- HL01B Octal Ch Plug 96p (E)
- RK85V Minicon Latch Pl 2w 17p (G)●
- YW11M Minicon Latch Pl 4w 29p (G)●
- FY93B Minicon Latch Pl 5w 33p (F)
- YW12N Minicon Latch Pl 6w 39p (F)●
- YW13P Minicon Latch Pl 8w 39p (F)●
- RK66W Minicon Latch Pl 10w 52p (F)●
- BH61R Minicon Latch Pl 17w 95p (E)●

Page 179
- YW15R RA Lch Minicn Pl 3w 38p (F)●
- FY91Y RA Lch Minicn Pl 4w 42p (F)
- RK67X RA Lch Minicn Pl 5w 45p (F)●
- FB99H RA Lch Minicn Pl 6w 58p (F)●
- YW18U RA Lch Minicn Pl 8w 65p (E)●
- RK68Y RA Lch Minicn Pl 10w 69p (F)●
- YW21B Mncn Ltch Hsng 12way 21p (G)●
- RK69A Mncn Ltch Hsng 17way 29p (F)
- YW28F Minicon Skt 6-way 39p (F)●
- YW30H Minicon Skt 12-way 69p (E)●
- YW98G IDC Con 8-way 79p (E)
- YW99H IDC Con 12-way £1.20 (E)●
- YX49D IDC Insertion Tool £2.95 (C)●
- FG44X 2x8 dil IDC socket £1.22 (D)●
- FG84F 2x10 dil IDC Socket £1.24 (D)●
- FG85G 2x13 dil IDC Socket £1.62 (C)●
- FG86T 2x17 dil IDC Socket £2.24 (C)●
- FG87U 2x20 dil IDC Socket £2.42 (C)●

Page 180
- HL06G Wafercon Plug 6-pin 22p (G)●
- HL07H Wafercon Plug 8-pin 22p (G)●
- HL08J Wafercon Plug 12-pin 34p (F)●
- HL13P Wafercon Skt 12-way 32p (F)●
- RK38R 8-Way PC Terminal 65p (E)●
- YY22Y CB Pin Blue 44p (F)
- YY26D CT Pin White £1.62 (D)
- WQ10L Large Patch Plug 38p (F)

Page 181
- HH38R Universal Plug 95p (E)●
- HH60Q Std Power Plug 2.1 16p (G)●
- HH63T Long Pwr Plug 2.5 18p (G)●

Page 182
- RW64U Cas Lead Sharp DIS (E)
- RW65V Cas Lead Sony DIS (E)
- ★WY16S Euroboard 4-way £9.89 (B)●
- WY17T Euroboard 6 way £5.95 (B)●
- HL23A Mains Socket P430SE £1.52 (D)●

Page 183
- HL27E Mains Plug SA2190 58p (F)●
- HL30H Mains Plug SA2019A £1.64 (D)
- HL34M Mains Socket SA2368 98p (E)
- HL36P Mains Plug P635 £1.36 (D)●

Page 184
- HL39N Mains Plug P551 £3.40 (C)●
- HL40T Mains Socket P552 £1.20 (E)●
- HL50E Sleeve 8037 14p (G)
- FG28F Line Jack Unit £2.95 (C)●
- FG29G PTC Line Cord £1.95 (B)●
- RK84F Video Lead 1 £2.65 (C)●

Page 185
- FG18U Computer Lead 1 £2.22 (D)●
- RK87U Video Lead 5 £2.32 (C)

Page 186
- RW01B Adaptor B 45p (F)●
- YW38R Adaptor W DIS (E)
- RW07H Adaptor H DIS (F)●
- RW03D Adaptor D DIS (F)
- RW08J Adaptor J 39p (F)●
- YW35Q Adaptor T 95p (D)●
- RW05F Adaptor F 45p (F)●
- RW09K Adaptor K DIS (F)●
- RK55K Adaptor Y 45p (F)●
- RW26D Dinpak N DIS (D)●
- RW15R Dinpak B DIS (D)●

Page 187
- RW22Y Dinpak J 95p (E)●
- RW23A Dinpak K 95p (E)●
- RW18U Dinpak E 86p (E)
- RW17T Dinpak D £1.68 (D)●
- RW20W Dinpak G £1.68 (D)●
- RW49D Dinpak 280 DIS (D)
- RK58N Plugpak Y £1.84 (D)●

ELECTRICAL

Page 188
- RW67X 13 Amp Plug Nylon 69p (E)●
- HL61R Flex Connector £1.72 (D)●

Page 189
- HL62S Mains Adaptor 2-way £1.62 (C)
- HL63T Mains Adaptor 3-way £2.98 (C)
- HL64U Shaver Adaptor £1.46 (D)●
- HL67X Junction Box RM £1.24 (D)●
- HL68Y Single Skt Unswtched £2.22 (C)
- HL72P Double Sw Socket £5.62 (B)●
- HL73Q Trailing Skt Single £1.86 (D)
- HL74R Trailing Dble Skt £3.96 (C)
- HL78K Shaver Skt Isolated £22.64 (A)●

Page 190
- HL83E Switched Flex Outlet £4.75 (C)●
- HL86T Blanking Plate 92p (E)
- HL87U 20A Plateswitch £3.62 (C)
- HL88V 20A Water Htr Switch £5.26 (C)
- HL89W Light Swch ST Single £1.38 (D)
- HL91Y Light Swch Dual £2.94 (C)●
- FQ15R Security Dimmer £18.96 (A)
- FQ16S Auto Security Switch £17.98 (A)
- YB09K Fl Pattress 16mm Sgl 98p (E)
- YB10L Fl Pattress 25mm Sgl 79p (E)

Page 191
- YB14Q Sur Patt 20mm Sngl 84p (E)
- YB16S Sur Patt 29mm Dble £1.84 (D)
- YB17T Sur Patt 47mm Dble £2.98 (C)
- YB18U Conversion Pattress £2.82 (C)
- FQ00A Ceiling Switch 1-way £2.94 (C)
- FQ02C Lampholder 702 92p (E)
- FQ05F Ceiling Rose 98p (D)●
- ★YB19V Time Switch £18.95 (A)●

Page 192
- WY23A Timetouch £34.95 (A)●

HARDWARE

Page 193
- BF00A Bolt 2BA 1/2in 62p (F)●
- BF05F Bolt 6BA 1/4in 18p (G)●
- BF06G Bolt 6BA 1/2in 18p (G)●
- BF08J Bolt 8BA 1/4in 55p (F)●
- BF09K Bolt 8BA 1/2in 59p (F)●
- LR00A C/S Screw 8BA 1/2in 39p (F)●
- BF14Q Panel Screw 5p (H)
- LR75S C/S Panel Screw 8p (H)
- BF31J Pozi Screw M5 12mm 29p (F)●
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GB03D Freq Ctr Display PCB £2.20 (D)
BB72P Sine/Square Gen PCB £3.62 (C)•

Page 310
LK10L CMOS Xtal Clbrtr Kit £19.95 (A)•
LK06G Sweep Osc Kit £21.95 (A)
GB31J Probe Lower PCB £1.25 (E)•
QY54J Low Current Disp £3.45 (C)•
LK13P Logic Probe Kit £10.95 (B)•

Page 311
LK09K Minilab Kit £35.95 (A)•

Page 312
†XF56L E&MM February 1982 £1.10 NV•
XF58N E&MM April 1982 DIS•
†XF59P E&MM May 1982 £1.10 NV•
†XF60Q E&MM June '82 £1.10 NV•
†XF61R E&MM July 1982 £1.10 NV•
†XF62S E&MM August 1982 £1.10 NV•
†XF63T E&MM September 1982 £1.10 NV•
†XF65V E&MM November 1982 £1.10 NV•
†XF66W E&MM December 1982 £1.10 NV•
†XF67X E&MM January 1983 £1.10 NV•

PROTECTION

Page 314
RX97F Safuseholder 1.1/4in £1.98 (D)
RX49D Chassis F/H 20mm 14p (G)•
RX51F F/H Car 11p (G)•
WR19V Fuse A/S 1A 13p (G)•
WR20W Fuse A/S 2A 13p (G)•
HQ33L Plug Fuse 5A 13p (G)•

Page 315
BK22Y Thermal Breaker 3A £2.25 (D)•
BK23A Thermal Breaker 5A £2.10 (D)
BK20W Thermal Breaker 15A £1.95 (D)•
HB51F Fuse Wire 33p (F)•
HW06G RF Supp Choke 3A 44p (F)
HW07H Delta Cap £1.20 (E)•
★YW47B Surface BA Reed £1.95 (D)•

Page 316
XY33L Smoke Detectr Type 1 DIS (A)

RECORD & TAPE

Page 317
†XQ00A Autochanger £23.60 (A)•
XB25C Belt Drive Turntable £42.95 (A)•
LB75S Drive Wheel BSR £2.20 (D)

Page 318
FQ36P Garrard Drive Belt £2.72 (C)•
HR09K Ctrdg BSR SC12M £4.95 (C)•
HR17T Ctrdg Sono V100 £7.95 (B)•

Page 319
HR16S Ctrdg Goldring G800 £9.95 (B)•
FQ38R Ctrdg Goldring G800H £8.62 (B)•
FQ41U Cdg Tenorel T2001ED £9.62 (A)

Page 322
BK07H Stylus ATN3400 £7.45 (C)•
HR66W Stylus Acos SM6 £5.95 (C)•
BK09K Re-enter As FG88U £6.30 (C)•
HR39N Stylus BSR TC8 D DIS (D)•
HR74R Stylus BSR ST21 95p (D)•
HR76H Stylus D110E £5.95 (B)•
YX20W Styl Philps GP401Mk2 £5.95 (B)•
HR95D Stylus Sansui SN28 £5.95 (C)•
FG98G Sanyo ST26 Stylus DIS•
FG94C Sharp ST7123 Stylus £7.32•
YX26D Stylus Sonotone V101 £5.95 (B)•
HR53H Stylus KS40A DD £1.45 (D)•
FG96E Sony ND250 Stylus DIS•
BK18U Stylus ND200 £7.25 (B)•
YX27E Stylus Sony XL15 £4.95 (C)•
YX28F Stylus Sony ND126 DIS (C)
YB47B Hi-Fi Care Kit C72 £7.95 (C)•
LX06G Cleaning Arm C100 £3.45 (C)•
FR46A Stylus Cleaner C50 DIS (E)•

Page 323
FG71N Rollacleana £5.42•
LX10L Anti-Stat Mat C119 £2.95 (C)•

Page 324
FG74R Head + Capstan Kit £1.64
†FR62S Straight Demagnetzer £1.95 (C)•
YG25C Cassette Tape C60 65p (E)•

Page 325
FQ63T GF Cassette Head £9.62 (A)
FQ66W Cassette Erase Head £1.96 (C)
FQ65V Stereo Cassette Head £3.95 (C)•

RESISTORS

Page 327
W W/W Min 0.22R to 1R 37p (F)
W W/W Min 2R2 to 22K 22p (G)

Page 328
L 7W W/W 33p (F)•
H 10W W/W 42p (F)•
V HV Res 1M-33M 15p (G)•
V HV Res 47M 29p (F)•
YY12N Resnet 100R 89p (E)
YY15R Resnet 1k 89p (E)
YY20W Resnet 47k 79p (E)

1984 Catalogue Page No.		VAT Inclusive Price

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WR81C	Hor Skeleton 1k	28p (F)
WR82D	Hor Skeleton 2k2	33p (F)●
WR83E	Hor Skeleton 4k7	28p (F)
WR84F	Hor Skelton 10k	28p (F)
WR85G	Hor Skeleton 22k	28p (F)
WR86T	Hor Skeleton 47k	28p (F)
WR87U	Hor Skeleton 100k	32p (F)●
WR88V	Hor Skeleton 220k	14p (F)●
WR89W	Hor Skeleton 470k	31p (F)●
WR90X	Hor Skeleton 1M	31p (F)●
WR91Y	Hor Skeleton 2M2	28p (F)
WR92A	Hor Skeleton 4M7	28p (F)
WW00A	Vrt Skeleton 100R	31p (F)
WW01B	Vrt Skeleton 220R	33p (F)●
WW02C	Vert Skeleton 470R	33p (F)●
WW03D	Vrt Skeleton 1k	31p (F)
WW04E	Vrt Skeleton 2k2	31p (F)
WW05F	Vrt Skeleton 4k7	31p (F)
WW06G	Vrt Skeleton 10k	31p (F)
WW07H	Vrt Skeleton 22k	33p (F)●
WW08J	Vrt Skeleton 47k	31p (F)
WW09K	Vrt Skeleton 100k	31p (F)
WW10L	Vrt Skeleton 220k	31p (F)
WW11M	Vrt Skeleton 470k	31p (F)
WW12N	Vrt Skeleton 1M	31p (F)
WW13P	Vrt Skeleton 2M2	31p (F)
WW14Q	Vrt Skeleton 4M7	31p (F)
WR49D	15-Turn Cermet 10k	£1.20 (E)
WR50E	15-Turn Cermet 50k	£1.20 (E)
WR51F	15-Turn Cermet 100k	£1.20 (E)
BW06G	Edge Control Pot	DIS (E)●
BW09K	Edge Knob Large Blk	DIS (H)●
BW10L	Edge Knob Large Grey	DIS (H)●

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FW44F	Dual Pot Lin 4k7	£1.42 (D)●
FW45G	Dual Pot Lin 10k	£1.42 (D)●
FW86T	Dual Pot Lin 22k	£1.42 (D)●
FW87U	Dual Pot Lin 47k	£1.42 (D)●
FW88V	Dual Pot Lin 100k	£1.42 (D)●
FW89W	Dual Pot Lin 220k	£1.42 (D)●
FW90X	Dual Pot Lin 470k	£1.42 (D)●
FW91Y	Dual Pot Lin 1M	£1.42 (D)●
FW92A	Dual Pot Lin 2M2	£1.42 (D)●
FX08J	Dual Pot Log 4k7	£1.42 (D)●
FX09K	Dual Pot Log 10k	£1.42 (D)●
FX10L	Dual Pot Log 22k	£1.42 (D)●
FX11M	Dual Pot Log 47k	£1.42 (D)●
FX12N	Dual Pot Log 100k	£1.42 (D)●
FX13P	Dual Pot Log 220k	£1.42 (D)●
FX14Q	Dual Pot Log 470k	£1.42 (D)●
FX15R	Dual Pot Log 1M	£1.42 (D)●
FX16S	Dual Pot Log 2M2	£1.42 (D)●

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FW50E	W/W Pot 10R	DIS (C)●
FW51F	W/W Pot 25R	DIS (C)●
FW73Q	W/W Pot 500R	£2.49 (C)●
FX32K	Slide Pot Lin 5k	£1.48 (E)
FX33L	Slide Pot Lin 10k	£1.48 (E)
FX34M	Slide Pot Lin 25k	£1.48 (E)
FX35Q	Slide Pot Lin 50k	£1.48 (E)
FX36P	Slide Pot Lin 100k	£1.48 (E)
FX37S	Slide Pot Lin 250k	£1.48 (E)
FX38R	Slide Pot Lin 500k	£1.48 (E)
FX53H	Slide Pot Log 5k	£1.48 (E)
FX54J	Slide Pot Log 10k	£1.48 (E)
FX55K	Slide Pot Log 25k	£1.48 (E)
FX56L	Slide Pot Log 50k	£1.48 (E)
FX57M	Slide Pot Log 100k	£1.48 (E)
FX58N	Slide Pot Log 250k	£1.48 (E)
FX59P	Slide Pot Log 500k	£1.48 (E)
FX76H	Dual Slide Lin 5k	£1.48 (D)
FX77J	Dual Slide Lin 10k	£1.48 (D)
FX80B	Dual Slide Lin 100k	£1.48 (D)
HB02C	Dual Slide Log 10k	£1.48 (D)
HB04E	Dual Slide Log 50k	£1.48 (D)
HB05F	Dual Slide Log 100k	£1.48 (D)
HB07H	Dual Slide Log 500k	£1.48 (D)

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FX21X	Thermistor VA1055S	68p (F)
FX42V	Thermistor VA1066S	68p (F)
FX62S	Thermistor R53	£6.95 (B)●

SEMICONDUCTORS

Page 334

QB05F	AC142	45p (F)●
QB10L	ACY19	79p (E)●
QQ00A	ADC0804LCN	£5.95 (C)●
WQ19V	AY-5-2376	DIS (A)
QB27E	BA102	32p (F)●
QB31J	BC107B	18p (G)●
QB37S	BC140	39p (F)●
QB39N	BC142	39p (F)●
QB49D	BC161	45p (F)●
QB55K	BC182L	12p (G)●
QB56L	BC183L	15p (G)●
QB57M	BC184L	16p (G)●
QB60Q	BC212L	15p (G)●
QQ17T	BC558	15p (G)●
QF00A	BCY70	23p (G)●
QF75S	BD136	42p (F)●
WH16S	BD712	86p (E)●
QF10L	BF167	45p (F)●
QF16S	BF244	38p (F)●
QF17T	BF258	38p (F)●

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QF24B	BFX88	38p (F)●
QF25C	BFX87	38p (F)●
QF32K	BS170	29p (F)●
QF43W	BY164	82p (E)●
QF45Y	BZX61C4V7	17p (G)
QF46A	BZX61C5V1	17p (G)
QF47B	BZX61C5V6	17p (G)
QF48C	BZX61C6V2	17p (G)
QF49D	BZX61C6V8	17p (G)
QF50E	BZX61C7V5	17p (G)
QF51F	BZX61C8V2	17p (G)
QF52G	BZX61C9V1	17p (G)
QF53H	BZX61C10	17p (G)
QF54J	BZX61C11	17p (G)
QF55K	BZX61C12	17p (G)
QF56L	BZX61C13	17p (G)
QF57M	BZX61C15	17p (G)
QF58N	BZX61C16	17p (G)
QF59P	BZX61C18	17p (G)
QF60Q	BZX61C20	17p (G)
QF61R	BZX61C22	17p (G)
QF62S	BZX61C24	17p (G)
QF63T	BZX61C27	17p (G)
QF64U	BZX61C30	17p (G)
QF65V	BZX61C33	17p (G)
QF66W	BZX61C36	17p (G)
QF67X	BZX61C39	17p (G)
QF68Y	BZX61C43	17p (G)
QH69A	BZX61C47	17p (G)
QF70M	BZX61C51	17p (G)
QF71N	BZX61C56	17p (G)
QF72P	BZX61C62	17p (G)
QH26Q	CA3046	£1.22 (E)●
YH58N	CA3080E	74p (E)
QH28F	CA3130E	£1.38 (D)●
QH30H	C106D	66p (F)●
WQ23A	C122D	98p (D)
WQ24B	C206D	95p (D)●
QQ01B	DAC0801LCN	£4.45 (C)●
QQ23A	DV1210W	TEMP (A)●
YY75S	ICL7660CPA	£2.89 (C)
YY93B	ICM7045IPI	£21.95 (A)●
YY94C	ICM7216DIPI	£21.95 (A)
YH63T	ICM 7555	£1.95 (D)●
BL36P	J02	£2.40 (D)●
YY74R	L200	£1.82 (C)
WQ29G	LF347	£1.62 (D)
WQ30H	LF351	85p (E)●
QY27E	LF411CN	£1.22 (E)●
QY28F	LF412CN	£1.62 (D)
QY29G	LF441CN	98p (E)
QY30H	LF442CN	£1.54 (D)
YY69A	LF13741	62p (E)
QY09K	LM311N	£1.62 (E)●
YY73Q	LM335Z	£1.32 (D)
QH40T	LM380	£1.82 (E)●
QH41U	LM381	£1.80 (C)
WQ34M	LM384	£1.72 (D)
WQ35Q	LM387	£1.95 (D)●
QY19V	LM1035	£3.95 (C)●
QY33L	LM1037N	£2.30 (C)
YY99H	LM1830	£2.95 (C)●
YY71N	LM1871	£2.24 (B)
WQ38R	LM2917	£3.95 (C)●
QH42V	LM3900	£1.36 (E)●
WQ39N	LM3909	£1.68 (E)●
WQ41U	LM3914	£3.95 (C)●
YY96E	LM3915	£2.98 (C)
YY97F	LM3916	£2.98 (C)
YH64U	LM13700N	£1.95 (D)●

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YH89W	MC1488N	£1.38 (E)●
YH90X	MC1489N	£1.38 (E)●
QH47B	MC1496	£1.95 (E)●
QH48C	MC3302P	95p (E)●
QH49D	MC3340P	£3.62 (C)●
WQ44X	MC6802P	£5.95 (C)●
WQ46A	MC6821P	£2.86 (D)●
QQ03D	MC6845	£13.95 (B)●
WQ48C	MC6850P	£3.45 (C)●
WQ49D	MC6852P	DIS (C)
WQ50E	MC6875L	DIS (B)●
QY23A	MC10116P	£1.32 (E)●
QY35Q	MF10CN	£4.95 (C)●
QH54J	MJE340	45p (E)
WQ51F	MJE350	£1.20 (E)●
QH59P	MPF102	95p (E)●
QH60Q	MPSA14	21p (F)
QH63T	MPS3638A	22p (G)●
WQ53H	MVAM115	£3.24 (C)●
QH66W	NE 555	39p (G)●
QH67X	NE 556	78p (E)●
YY68Y	NE5534A	£2.48 (C)
QH70M	OA47	22p (G)●
QH72P	OA91	10p (H)●
QH85G	OC72	DIS (F)●
QH92A	OC171	DIS (E)
WQ58N	PW06	£1.20 (D)
QL05F	SC146D	£1.42 (D)
QL07H	SG3402	£4.98 (C)
★YH66W	SL490	£3.35 (C)●
QY50E	SP0256	£9.95 (A)
WQ64U	TCA4500A	£3.95 (C)●
YY76H	TDA1024	£1.95 (D)●
WQ71N	TIP33A	72p (E)●
WQ73Q	TIP122	95p (E)●
QH55K	TIP2955	98p (E)●
QL19V	TIS43	84p (E)●
WQ75S	TL170C	95p (E)●
WQ76H	TL172C	95p (E)●
YY77J	TL430C	£1.22 (E)●
YY78K	TL497A	£2.20 (D)●
YY88V	TMS1121	£11.95 (B)●
QY14Q	UAA170L	£3.95 (C)●
QL27E	uA78L15AWC	38p (F)●
QL29G	uA78M12UC	84p (E)
QL32K	uA7812UC	68p (E)
WQ80B	uA78H05KC	£7.86 (B)
WQ81C	uA78H12KC	£7.45 (B)
WQ84F	uA78P05SC	£9.36 (B)
WQ86T	uA79L12AWC	62p (E)●

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QL36P	uA7915UC	78p (E)
WQ95Q	uA79HGKC	DIS (B)
QQ27E	VN10KM	95p (E)●
QL40T	W04	45p (F)●
QY43W	XR2211CP	£3.64 (C)
QL43W	ZTX107	24p (G)●
QL44X	ZTX108	18p (G)●
QL54J	ZTX326	DIS (E)●
QL60Q	ZTX500	22p (G)●
QW00A	Z80-CPU	£3.98 (B)
QL73Q	1N4001	7p (H)●
QL74R	1N4002	5p (H)
QL80B	1N4148	5p (H)●
QL82D	1N5401	13p (G)
QL84F	1N5404	22p (G)●
QR10L	2N1893	72p (F)
QR11M	2N2219	37p (F)
QR12N	2N2369A	25p (G)●
QR14Q	2N2646	98p (E)●
[illegible]	2N3055	62p (E)●
BL45Y	2N3055	£1.10 (E)
QR25C	2N3525	£2.46 (D)●
QR27E	2N3703	15p (G)●
QR28F	2N3704	11p (H)
QR31J	2N3707	19p (G)●
QR36P	2N3819	85p (F)●
QR40T	2N3904	19p (G)●
QR44X	2N4060	DIS (G)●
QR45Y	2N4061	DIS (G)●
QR47B	2N4871	82p (E)●
QR49D	2N5458	62p (F)●
QR50E	2N5459	39p (F)●
[illegible]	2N6609	£4.25 (C)●
QY11M	2SC2547E	45p (F)●
QW10L	2SK135	£5.95 (C)●
WQ12N	2114 450ns	£1.99 (D)
QQ07H	2716 450ns	£4.62 (C)
QQ08J	2732 450ns	£7.95 (B)●
QQ09K	2764 450ns	£12.86 (B)●
QR52G	3N140	£3.95 (D)●
QH51F	3403	95p (E)●
QX00A	4000BE	32p (F)
QX01B	4001BE	32p (F)
QL03D	4001UBE	32p (G)
QX02C	4002BE	32p (G)
QX03D	4006BE	72p (E)
QX04E	4007UBE	32p (G)
QW14Q	4008BE	72p (F)
QX05F	4011BE	32p (G)
[illegible]	4011UBE	32p (G)
QX06G	4012BE	32p (G)
QX07H	4013BE	41p (F)
QW15R	4014BE	68p (F)
QW16S	4015BE	[illegible] (F)
QX08J	4016BE	41p (G)
QX09K	4017BE	63p (F)
QX10L	4018BE	85p (F)
QW17T	4019BE	41p (F)
QX11M	4020BE	72p (E)
QW18U	4021BE	68p (E)
QW19V	4022BE	68p (F)
QX12N	4023BE	32p (G)
QX13P	4024BE	51p (F)
QX14Q	4025BE	32p (F)

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QX15R	4026BE	95p (E)
QX16S	4027BE	41p (G)
QX17T	4028BE	61p (F)
QW20W	4029BE	78p (E)
QW21X	4031BE	£1.16 (D)
QW25C	4035BE	65p (F)
QW27E	4040BE	69p (E)
QW28F	4041UBE	69p (F)
QX19V	4042BE	56p (E)
QW29G	4043BE	72p (E)
QW30H	4044BE	63p (F)
QW31J	4045BE	£1.15 (E)
QW32K	4046BE	77p (F)
QW33L	4048BE	41p (F)
QX21X	4049UBE	41p (F)
QX22Y	4050BE	41p (F)
QW34M	4051BE	57p (E)
QW35Q	4052BE	57p (E)
QW36P	4053BE	72p (E)●
QW38R	4055BE	DIS (E)
QW39N	4056BE	95p (E)
QW40T	4060BE	80p (E)
QW41U	4063BE	83p (E)
QW42V	4067BE	£2.44 (C)
QX24B	4068BE	32p (G)
★QX25C	4069UBE	32p (F)●
QX26D	4070BE	32p (G)
QX27E	4072BE	32p (G)
QW44X	4073BE	32p (F)
QW45Y	4075BE	32p (F)
QW46A	4076BE	74p (E)
QW47B	4077BE	32p (F)
QX28F	4078BE	32p (G)
QW48C	4081BE	32p (G)
QW49D	4082BE	32p (F)
QW50E	4085BE	43p (E)
QW53H	4093BE	46p (G)
QW54J	4094BE	£1.22 (D)
QW57M	4099BE	96p (E)
QW61R	40103BE	£1.39 (D)
QW64U	40106BE	44p (E)
QW65V	40107BE	50p (E)
QW68Y	40110BE	£1.09 (D)
QW70M	40161BE	68p (E)
QW71N	40162BE	68p (E)
QW73Q	40174BE	63p (E)
QW77J	40193BE	DIS (E)
QW93B	4116 250ns	£2.48 (D)●
QQ06G	4164 250ns	£8.95 (C)●
QW81C	4502BE	99p (E)
QW82D	4508BE	£1.52 (C)
QX31J	4511BE	73p (E)
QW84F	4512BE	68p (D)
QW85G	4514BE	£1.31 (D)
QX32K	4518BE	72p (F)
QX33L	4520BE	72p (E)
QQ42V	4521BE	DIS (C)●
QQ44X	4526BE	98p (E)
QW89W	4532BE	78p (E)
QQ47B	4541BE	£1.98 (D)●
QW90X	4555BE	47p (E)
QW91Y	4556BE	47p (E)
QR55K	634SS2	£6.95 (C)●
QQ04E	6402	£5.95 (B)●
QX37S	7400	39p (G)●
YF00A	74LS00	39p (G)●
QX38R	7401	39p (G)●
YF01B	74LS01	39p (G)●
QX39N	7402	39p (G)●
YF02C	74LS02	39p (G)●
QX74R	7403	39p (G)●
YF03D	74LS03	39p (G)●
QY24B	74S03	78p (F)●
QX40T	7404	45p (G)●
YF04E	74LS04	43p (G)
QX41U	7405	39p (G)●
YF05F	74LS05	42p (G)●
QX15S	7406	95p (F)●
QX76H	7407	95p (F)●
QX42V	7408	45p (G)●
YF06G	74LS08	39p (G)●
YF07H	74LS09	39p (G)●
QX43W	7410	39p (G)●
YF08J	74LS10	39p (F)●
QX44X	7411	39p (F)●
YF09K	74LS11	39p (G)●
YF10L	74LS12	39p (G)●
QX45Y	7413	68p (F)●
YF11M	74LS13	68p (F)●
QX46A	7414	£1.10 (F)●
YF12N	74LS14	£1.19 (F)●
YF13P	74LS15	39p (G)●
QX78K	7416	64p (F)●
QX79L	7417	64p (F)●
QX47B	7420	39p (G)●
YF14Q	74LS20	39p (G)●
QX48C	7421	39p (F)●
YF15R	74LS21	39p (G)●
YF16S	74LS22	39p (F)●
QX80B	7425	56p (F)●
QX81C	7426	39p (G)●
YF17T	74LS26	45p (F)●
QX49D	7427	42p (F)●
YF18U	74LS27	39p (F)●
YF19V	74LS28	39p (F)●
QX50E	7430	39p (G)●
YF20W	74LS30	39p (G)●

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YF21X	74LS32	39p (G)●
YF22Y	74LS33	42p (F)●
YF23A	74LS37	62p (G)●
QX82D	7438	42p (F)●
YF24B	74LS38	42p (G)●
QX53H	7440	39p (F)●
YF25C	74LS40	62p (F)●
YF26D	74LS42	£1.24 (F)●
QX55K	7447A	£1.95 (E)●
QQ52G	74LS47	£1.49 (E)●
★QQ53H	74LS48	£1.49 (F)●
YF27E	74LS51	39p (G)●
YF28F	74LS54	39p (F)●
QX56L	7470	34p (F)●
QX57M	7472	65p (F)●
QX58N	7473	69p (F)●
YF30H	74LS73	54p (F)●
QX59P	7474	69p (F)●
YY83E	74ALS74	96p (E)●
YF31J	74LS74	56p (F)●
YF32K	74LS75	78p (F)●
QX61R	7476	95p (F)●
YF33L	74LS76	54p (F)●
†QX62S	7481	£2.55 (D)●
QX63T	7485	£2.42 (E)●
YF35Q	74LS85	£1.82 (E)●
YF36P	74LS86	65p (F)●
QX65V	7489	£3.40 (C)●
QX66W	7490	£1.15 (F)●
YF38R	74LS90	95p (F)●
QX86T	7491	£1.62 (D)●
QX67X	7492	£1.15 (F)●
YF39N	74LS92	95p (F)●
QX68Y	7493	£1.20 (F)●
YF40T	74LS93	95p (F)●
QX70M	7495	£1.38 (F)●
YF41U	74LS95	£1.20 (D)●
QX87U	7496	£1.55 (E)●
QX71N	74107	72p (F)●
YF43W	74LS107	82p (F)●
QX88V	74109	£1.18 (E)●
YF44X	74LS109	82p (F)●
YF45Y	74LS112	82p (F)●
YF46A	74LS113	62p (F)●
QX72P	74118	£1.80 (C)●
QX73Q	74121	82p (F)●
QQ54J	74LS122	£1.20 (E)●
WH01B	74123	39p (F)
YF48C	74LS123	£1.42 (E)●
YF49D	74LS125	72p (F)●
YF50E	74LS126	72p (F)●
WH03D	74132	£1.22 (E)●
YF51F	74LS132	£1.10 (F)●
YF52G	74LS136	72p (F)●
YF53H	74LS138	£1.20 (F)●
YF54J	74LS139	£1.15 (F)●
WH05E	74141	£1.62 (E)●
WH06G	74145	£1.82 (E)●
YF55K	74LS145	£1.82 (D)●
QX89W	74150	£2.82 (E)●
WH07H	74151	£1.42 (E)●
YF56L	74LS151	£1.62 (F)●
YF57M	74LS153	£1.62 (E)●
YF58N	74LS154	£1.95 (E)●
YF59P	74LS155	£1.20 (F)●
YF60Q	74LS156	DIS (E)●
YF61R	74LS157	95p (F)●
YF62S	74LS158	95p (F)●
WH09K	74160	£1.95 (E)●
YF63T	74LS160	£1.22 (F)●
YF64U	74LS161	£1.22 (F)●
YF66W	74LS163	£1.22 (F)●
WH10L	74164	£2.32 (E)●
YF68Y	74LS165	£1.95 (D)●
YF69A	74LS166	£2.95 (D)●
YF71N	74LS169	£1.84 (E)●
YF72P	74LS170	£3.40 (D)●
YF73Q	74LS173	£1.82 (E)●
WH11M	74174	£1.95 (E)●
YF74R	74LS174	£1.95 (F)●
YF75S	74LS175	£1.42 (F)●
YF76H	74LS181	£3.38 (C)●
YF78K	74LS190	£1.52 (E)●
YF79L	74LS191	£1.48 (E)●
YF80B	74LS192	£1.62 (E)●
QX90X	74193	£2.22 (D)●
YF81C	74LS193	£1.62 (E)●
WH13P	74194	£1.68 (E)●
YF82D	74LS194	£1.22 (E)●
YF83E	74LS195	£1.19 (F)●
YF84F	74LS196	£1.62 (E)●
YF86T	74LS221	£1.62 (E)●
YF87U	74LS240	£2.26 (E)●
YF89W	74LS242	DIS (D)
YF90X	74LS243	£1.95 (E)●
QQ56L	74LS244	£2.32 (E)●
YF91Y	74LS245	£3.42 (D)●
YF92A	74LS251	£1.18 (E)●
YF95D	74LS257	£1.19 (E)●
YF97F	74LS259	£2.62 (E)●
YH00A	74LS273	£2.22 (D)●
YH01B	74LS279	£1.19 (F)●
YH02C	74LS283	£1.45 (E)●
YH03D	74LS290	DIS (D)●
QY39N	74LS292	£12.98 (A)
YH04E	74LS293	DIS (E)
YH11M	74LS365	79p (F)●
YH12N	74LS366	43p (F)
YH13P	74LS367	78p (E)●
YH14Q	74LS368	79p (F)●
YH15R	74LS373	£2.38 (E)●
YH16S	74LS374	£2.42 (E)●
YH18U	74LS377	£2.42 (D)●
YH19V	74LS378	79p (D)
YH22Y	74LS393	£1.62 (D)●
WH02C	74LS629 74LS124	£1.98 (D)
YH30H	74C917	£9.60 (B)
QY08J	74C925	£6.95 (B)●
YH32K	76477	£5.95 (B)●
†YH35Q	8T95	70p (C)●
YH38R	8038 CCPD	£4.98 (C)
YH39N	8069 DCQ	£2.95 (C)●
YH41U	8085A	£8.20 (B)●
YH43W	8211 CPA	£2.95 (C)●
YH44X	8212	£2.25 (D)●
YH51F	8279	£6.95 (B)●

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YY68Y	NE5534A	£2.48 (C)
QH51F	3403	95p (E)●
QH42V	LM3900	£1.36 (E)●

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QH28F	CA3130E	£1.38 (D)●
YY69A	LF13741	62p (E)
WQ30H	LF351	85p (E)●
WQ29G	LF347	£1.62 (D)
QY27E	LF411CN	£1.22 (E)●
QY28F	LF412CN	£1.62 (D)
QY29G	LF441CN	98p (E)
QY30H	LF442CN	£1.54 (D)

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YH58N	CA3080E	74p (E)
YH64U	LM13700N	£1.95 (D)●
QY09K	LM311N	£1.62 (E)●
QH48C	MC3302P	95p (E)●

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QH40T	LM380	£1.82 (E)●
WQ34M	LM384	£1.72 (D)

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QH41U	LM381	£1.80 (C)
WQ35Q	LM387	£1.95 (D)●

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QY19V	LM1035	£3.95 (C)●

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QY33L	LM1037N	£2.30 (C)

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QH49D	MC3340P	£3.62 (C)●

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QY35Q	MF10CN	£4.95 (C)●

Page 378

YH32K	76477	£5.95 (B)●

Page 380

QY50E	SP0256	£9.95 (A)

Page 381

WQ64U	TCA4500A	£3.95 (C)●

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QY23A	MC10116P	£1.32 (E)●
QH47B	MC1496	£1.95 (E)●

Page 384

QL07H	SG3402	£4.98 (C)
QH26Q	CA3046	£1.22 (E)●
★YH66W	SL490	£3.35 (C)●

Page 386

BK66W	UM1286 Modulator	£11.90 (A)●
YY71N	LM1871	£2.24 (B)
YQ69A	LM1871 Xmitter PCB	£1.25 (D)●

Page 388

WQ76H	TL172C	95p (E)●
WQ75S	TL170C	95p (E)●
QR55K	634SS2	£6.95 (C)●

Page 389

YY99H	LM1830	£2.95 (C)●
YY73Q	LM335Z	£1.32 (D)

Page 390

WQ41U	LM3914	£3.95 (C)●
YY96E	LM3915	£2.98 (C)
YY97F	LM3916	£2.98 (C)

Page 391

QY14Q	UAA170L	£3.95 (C)●
YH30H	74C917	£9.60 (B)
YY93B	ICM7045IPI	£21.95 (A)●

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YY88V	TMS1121	£11.95 (B)●
QY08J	74C925	£6.95 (B)●

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YY94C	ICM7216DIPI	£21.95 (A)

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QH66W	NE 555	39p (G)●
QH67X	NE 556	78p (E)●

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YH63T	ICM 7555	£1.95 (D)●

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WQ39N	LM3909	£1.68 (E)●
YY76H	TDA1024	£1.95 (D)●

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YH43W	8211 CPA	£2.95 (C)●
YH39N	8069 DCQ	£2.95 (C)●
YY78K	TL497A	£2.20 (D)●
YY77J	TL430C	£1.22 (E)●

Page 399

YY75S	ICL7660CPA	£2.89 (C)
YY74R	L200	£1.82 (C)

Page 401

YQ39N	0.1A Reg PSU PCB	£1.45 (D)●
YQ40T	0.5/1A Reg +V PS PCB	95p (E)●
YQ41U	0.5/1A Reg -V PS PCB	95p (E)●

Page 403

WQ44X	MC6802P	£5.95 (C)●
WQ46A	MC6821P	£2.86 (D)●
WQ48C	MC6850P	£3.45 (C)●
WQ49D	MC6852P	DIS (C)
WQ50E	MC6875L	DIS (B)●

Page 404

QW00A	Z80-CPU	£3.98 (B)

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YH41U	8085A	£8.20 (B)●
YH51F	8279	£6.95 (B)●

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YH44X	8212	£2.25 (D)●
†YH35Q	8T95	70p (C)●
YH89W	MC1488N	£1.38 (E)●
YH90X	MC1489N	£1.38 (E)●

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WQ19V	AY-5-2376	DIS (A)
QQ04E	6402	£5.95 (B)●
QQ03D	MC6845	£13.95 (B)●

Page 408

QW12N	2114 450ns	£1.99 (D)
QW93B	4116 250ns	£2.48 (D)●
QQ06G	4164 250ns	£8.95 (C)●

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QQ07H	2716 450ns	£4.62 (C)
QQ08J	2732 450ns	£7.95 (B)●
QQ09K	2764 450ns	£12.86 (B)●

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YH38R	8038 CCPD	£4.98 (C)

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QY43W	XR2211CP	£3.64 (C)
QQ01B	DAC0801LCN	£4.45 (C)●

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QQ00A	ADC0804LCN	£5.95 (C)●
WQ38R	LM2917	£3.95 (C)●

Page 415

WR29G	Transkt 3-Lead TO18	22p (G)

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HQ77J	DIL Socket 20-pin	18p (G)
BL20W	DIL Socket 24-pin	20p (G)
HQ38R	DIL Socket 40-pin	30p (F)
YG29G	Header 24-pin	£1.45 (D)●
YX50E	ZIF Socket 24-Way	£4.95 (C)●

Page 417

FG52G	Clip on T0220	31p (F)
FG55K	Powerfin plastic	59p (F)●

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FG60Q	Heatsink T0220HP	88p (E)
FG63T	Dip Sink 40 pin	82p (E)●
FL41U	Heatsink 4Y	£2.30 (C)●
★FG64U	Coverslide 6W	38p (B)●

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FL42V	Flat Heatsink	£4.36 (C)●
FL54J	Heatsink 10DN	£2.48 (C)
FL77J	Heatsink 6W-1	£7.38 (B)●
★FG65V	Coverslide 4 Y	38p (D)●

SPEAKERS

Page 421

HY12N	Ultrasonic Transducr	£3.96 (B)

Page 422

YK58N	Large Dome Bell	£17.95 (A)●
YB25C	Baby Siren	DIS (B)
LH98G	Hawaii Five-O Siren	DIS (A)
YK61R	Staccato Elctrnc Sdr	£9.95 (B)●
†XQ71N	Re-entrant Horn Sndr	£26.50 (A)●

Page 423

LB23A	Mag Earpiece 2.5mm	19p (F)●
LB25C	Crystal Earpiece	62p (E)●
YW57M	Stethoscope	95p (E)●

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LH82D	Boom Mic Headphone	£15.45 (A)●
LH83E	Stereophone DH150P	£5.25 (C)●
WF13P	Stereophone HP110C	£6.45 (B)●
WF14Q	Stereophone DH207	£8.95 (B)●
LH84F	Stereophone M110B	DIS (B)

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LB13P	Headphone Adaptor	£3.45 (C)●
YW54J	15W Cone Tweeter	£3.20 (C)
WF43W	Dome Tweeter	£5.95 (B)●
WF44X	Rectangular Tweeter	£4.95 (B)●

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Page 426		
XG34M	Bullet Tweeter	£22 60 (A)
YK71N	10in Speaker Grille	£2 98 (C)
YK72P	12in Speaker Grille	£3 95 (C)●
WF48C	Hvy Duty Car Spkr	£6 98 (B)
Page 427		
WF50E	Elliptcal Spkr CM641	£3 62 (C)●
WF23A	Elliptcal Spkr CM852	£5.95 (B)●
WF00A	Rd Speaker LT530	£8.95 (B)●
WF52G	Rd Speaker LT610	£5 95 (B)●
WF11M	Rd Speaker LT830	£8 45 (B)●
XQ77J	Fane 50 4R	DIS (A)
Page 428		
XQ79L	Forte 1250TC 8R	£23.95 (A)●
XQ80B	Forte 1250TC 16R	£23.95 (A)●
XQ81C	Forte C1285TC 8R	£29.95 (A)●
XQ82D	Forte C1285TC 16R	£29 95 (A)●
AF35Q	15W Spkr Pair	£39 95 (A)●
Page 429		
★XY79L	Ceiling Speaker	£12 45 (A)●
YL15R	Bracket Minor 5	£9.95 (B)●
YK54J	Wallclamps Duo 220	£16 20 (A)
SWITCHES		
Page 430		
FH99H	DPDT Ultra Min Tggle	78p (E)●
FH00A	Sub-Min Toggle A	73p (E)
FF72P	Sub-Min Toggle L	£2 24 (C)
FH10L	Std Toggle SPST	52p (E)●
FH11M	Std Toggle SPDT	59p (E)●
Page 431		
FH17T	H/D Toggle Type 4	£3.42 (C)●
XX26D	DIL Switch SPST Dual	95p (E)●
XX28F	DIL Switch SPDT Sgl	98p (E)
XX29G	DIL Switch SPDT Quad	£3 25 (C)●
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FF73Q	Rotary SW12B	82p (E)●
FH43W	Rotary SW6	72p (E)●
FH45Y	Rotary SW3	92p (E)●
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FF79L	Long Chrome Slide	19p (G)●
FH36P	Std Slide Switch	19p (G)●
FH59P	Push Switch	18p (G)●
FH91Y	Motor-Start Press	45p (F)
Page 434		
YW43W	Square Psh Lck Red	95p (E)●
YW44X	Square Psh Lck Yllow	95p (E)●
FH92A	Press Toe Sw Type 1	£2 42 (D)●
BK31J	Press Toe SPST 2	£1 82 (D)●
FH93B	Press Toe Sw Type 2	£2 24 (D)●
Page 435		
FF90X	Click Cap Green	DIS (G)
HY34M	Click Key Black	26p (F)
FF64U	Keytop 3 Position	75p (F)●
BK72P	Membrane Switch	£9.95 (B)●
BK73Q	Flat Flex Connector	75p (E)●

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Page 436		
FL33L	Rd Latchbutton Grey	DIS (G)
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BW16S	Latchbush Green	DIS (F)●
LB91Y	Flasher Unit 2-Way	£8 72 (B)●
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LQ01B	Professl Morse Key	£6 26 (B)●
YR88V	Solenoid 12V	£6 82 (B)
BK48C	Ult-Mn Rlay 6V DPDT	£1 20 (D)
Page 439		
★YX99H	12V 30A Relay	£3 24 (C)●
FX23A	Open Relay 6V	£3 82 (C)●
FX24B	Open Relay 12V	£3 96 (C)
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FX49D	Power Relay 230V AC	£4.45 (C)●
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FX89W	Dil Reed Relay 1p12V	£1 98 (D)
FX90X	Dil Reed Relay 2p 5V	£2 95 (C)●
FX91Y	Dil Reed Relay 2p12V	£3 45 (C)●
FX71N	Magnet Small	48p (F)●
FX72P	Magnet Large	£1.24 (E)●
TEST GEAR		
Page 442		
HF22Y	Lo-Cost Test Probe	85p (E)●
YR93B	Test Lead Kit	DIS (C)●
FY73Q	Logic Probe	£12 45 (B)●
Page 443		
YB21X	Safebloc	£7 95 (B)●
BW05F	Scope Probe BNC	£14.56 (A)●
YR95D	Lo-Cost Scope Probe	AUG84 (C)●
Page 444		
XB82D	Crotech 3030	£195.95 (A)
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XB83E	Crotech 3131	£324.95 (A)
YK38R	Low-Cost Counter	£55.95 (A)●
YB82D	LCR Bridge	£27 50 (A)
LH05F	Transistor Testr HFE	£16 95 (A)●
Page 446		
YW93B	Low Cost Multimeter	£5 95 (B)●
FL60Q	Pocket Multimeter	£9 42 (B)●
Page 447		
YW68Y	Multimeter Type 320	£17 98 (A)
YB67U	100K Multitester	DIS (A)●
Page 448		
YB85G	Supertester 680G	£36 20
LH80B	Clamp Meter	£34 20 (A)
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YK32K	Multimeter DD601	£45 95 (A)●
YK34M	Auto Range Meter	£69 95 (A)●

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Page 451		
WY21X	SWR Meter 178	£27 95 (A)●
YK01B	RF Frequency Meter	£55 95 (A)●
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YB04E	Grid Dip Meter	£49.95 (A)●
TOOLS		
Page 453		
BR50E	Trim TT5	68p (E)
Page 454		
BR79L	Intrchgbl Scdrvr Set	DIS (D)
FY08J	Utility Set	£5 62 (C)●
YX74R	Min Screwdriver	11p (G)
BR52G	Small Screwdriver	39p (F)
BR53H	Large Screwdriver	42p (F)●
FY15R	Pozidriver P1	£1 98 (D)●
FY17T	Pozidriver P2	£2 45 (D)●
Page 455		
FY19V	Low Cost Min Cutters	£5 45 (C)●
FY22Y	Box JT Side Cutters	£8 98 (B)
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BR72P	Side Cutters S55	£4 95 (B)●
BK41U	Hooked Pliers	£8 45 (B)●
BR91Y	Electricians Pliers	£5 20 (C)
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BR76H	End Action Strippers	£6.95 (B)●
BR93B	Wire Strippers 3A	£2 56 (C)
BR96E	Stripmaster	£17 50 (A)
FY32K	Hand Wrap Tool	£7 62 (B)●
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FY40T	Box Spanner 2BA	£3 36 (D)●
FY42V	Box Spanner 6BA	£2 95 (D)●
FY43W	Box Spanner 8BA	£2 95 (D)●
FY49D	Needle File Flat Wrd	£1 86 (D)
FY02C	Utility Knife	£1 69 (D)
★FY04E	Knife Blades	76p (E)●
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YW64U	Snap-Off Blade Knife	£1 12 (E)
FY05F	Scalpel Handle	£2 86 (D)●
FY06G	Scalpel Bld Type II	48p (E)●
BR61R	Punch 1/2in	£5 24 (C)●
BR62S	Punch 9/16in	£5 30 (C)●
BR80B	Punch 5/8in	£5.36 (C)●
BW00A	Punch 1 1/2in	£9 65 (B)●
LH79L	Reliant Kit	£24 60 (A)
BW03D	Reliant Drill	£7 94 (B)
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BW02C	Titan Drill	£12 95 (A)●
XB12N	Drill Stand	£17 95 (A)
BR84F	Reliant Collar	78p (E)
BW04E	Drill Power Supply	£15 95 (A)●
BR65V	Twist Burr 0 8mm	45p (F)
BR66W	Twist Burr 1 4mm	44p (F)
BR85G	HS Twist Drill 0.8mm	82p (E)●
BR86T	HS Twist Drill 1mm	82p (E)●
BR87U	HS Twist Drill 1 4mm	78p (E)
YY28F	Long-Life Drill 1mm	£1 22 (D)

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LH77J	20-Piece Tool Kit	£8 98 (B)
LH78K	40-Piece Tool Kit	£17 95 (A)●
LH76H	Wishbone Sharpener	£7.42 (B)
HQ04E	HS Drill 3/32in	32p (F)●
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FY62S	Iron CS	£6.95 (B)●
FY63T	Element CX	£3 95 (C)●
FR30H	Bit 1106	£1 30 (E)●
FY64U	Bit 1100	£1 30 (E)●
FY65V	Bit 1101	£1 30 (E)●
FY66W	Bit 1102	£1 30 (E)●
FY67X	Bit 1103	£1 30 (E)●
FR01B	Element Type CN	£3.25 (C)●
FR02C	Handle Type CN	£1.65 (E)●
FR03D	Bit 102	£1 30 (E)●
FR04E	Bit 104	£1 30 (E)●
FR05F	Bit 106	£1.30 (E)●
FR06G	Bit 820	£1.30 (E)●
FR07H	Bit 821	£1,30 (E)●
FR08J	Bit 822	£1 30 (E)●
FR12N	Iron XS	£7 25 (B)●
FR13P	12V Iron MLXS	£9 49 (B)●
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FR14Q	Element X25	£2.95 (C)●
FR15R	Element MLX12	£3 45 (C)●
FR16S	Bit No. 50	£1 30 (E)●
FR17T	Bit No 51	£1 30 (E)●
FR18U	Bit No. 52	£1.30 (E)●
FR20W	Stand ST4	£2 93 (C)●
RK33L	Sponge ST4	35p (F)●
FR11M	Sponge ST3	24p (G)●
FY68Y	CS Kit SK5	£9.95 (B)●
FY69A	XS Kit SK6	£10.25 (B)●
WY05F	Rechargeable Iron	£33.95 (A)●
YX68Y	B50 Bit Angled	£3 98 (C)●
YX72P	B50 Sponge	35p (F)
FR10L	Heat Sink Tweezers	45p (F)●
FR23A	Solder Sucker	£4.72 (C)●
Page 463		
FR26D	Desolder Tool	£6.45 (B)
BK40T	Replacement D rings	74p (E)
FR63T	Desldr Washer Type 2	52p (F)
FY72P	Conductive Paint	£4.95 (B)●
LH03D	Switch Cleaner	£1.95 (D)●
LH02C	Aero-Klene	£1.95 (D)●
YB73Q	Aero-Duster	£1.95 (D)●
Page 464		
YB75S	Plastic Seal	£1 95 (D)●
YB76H	Foam Cleanser	£2 42 (C)
YB79L	Anti-Static Spray	£1 95 (D)●
FL43W	Evostik Impact	£1.40 (D)
FL44X	Araldite Rapid	£2.82 (C)●
Page 465		
FL47B	PVC Tape Black	52p (F)●
FL48C	PVC Tape Blue	52p (F)●
FL50E	PVC Tape Green	52p (F)●
FL51F	PVC Tape Red	52p (F)●
FL52G	PVC Tape White	52p (F)●
WOUND COMPONENTS		
Page 466		
LB40T	9 5 Coil Former	DIS (E)

1984 Catalogue Page No.		VAT Inclusive Price
LB18U	Former 450	32p (G)●
LB41U	Dust Core Type 4	14p (G)
LB42V	Dust Core Type 6	14p (G)
LB43W	Dust Core Type 8	28p (G)●
LB44X	Former Base	15p (G)●
LB36P	Screening Can 10	15p (G)
LB39N	Screening Can 15	18p (G)●
HX05F	Small Pot Core	£1 76 (D)
Page 467		
HX14Q	Mtg System Type 4	£1 28 (D)●
HX57M	GE Coil L8	DIS (C)
HW24B	GE Coil L14	£3 95 (C)●
HX56L	GE Coil L7	DIS (C)
Page 468		
HW27E	Choke 10H	£2 10 (D)
HX15R	Choke 1 5mH	75p (E)●
HX17T	Choke 5mH	68p (E)
WH25C	Choke 0 22uH	59p (E)●
WH37S	Choke 22 0uH	55p (F)●
HX42V	Toko YRCS 11098	69p (E)●
HX43W	Toko YHCS 11100	68p (E)●
YG31J	Toko CSK3464	75p (E)●
YG32K	Toko YMCS17104	75p (E)●
HX97F	Toko ACS 34342	£1 24 (E)●
YG36P	Toko KAC8449	DIS (F)
Page 469		
LB01B	IFT 14	£1 86 (D)
LB05F	IFT 18	£2 36 (C)
HX82D	Min Tr LT44	58p (E)
LB14Q	Min Tr LT700	58p (E)
YR91Y	Min Tr LT800	DIS (F)●
LR06G	Mc Xfm Typ2 200-600R	£21.95 (A)●
★YX84F	Z Changer	£6.40 (B)●
Page 470		
WB00A	Sub-Min Tr 6V	£1 65 (D)●
WB01B	Sub-Min Tr 9V	£1.65 (D)●
WB02C	Sub-Min Tr 12V	£1.65 (D)●
WB11M	Min Tr 9V	£4 45 (C)●
LY03D	Tr 10VA 15V	£5 45 (C)●
WB15R	Min Tr 15V	£3.46 (C)●
WB07H	Tr 34V 1A	£8.95 (B)●
WB25C	Tr 12V 1A	£6.36 (B)
YK02C	Tr 32-0-32 2A	£13 62 (A)
Page 471		
YK08J	Toroidal 30VA 6V	£7 58
YK09K	Toroidal 30VA 9V	£7 58
YK10L	Toroidal 30VA 12V	£7.58
YK11M	Toroidal 30VA 15V	£7.58
YK12N	Toroidal 30VA 18V	£7.58
YK13P	Toroidal 50VA 6V	£8.60
YK14Q	Toroidal 50VA 9V	£8 60
YK15R	Toroidal 50VA 12V	£8.60
YK16S	Toroidal 50VA 15V	£8.60
YK17T	Toroidal 80VA 18V	£9 64
YK18U	Toroidal 80VA 22V	£9 64
YK19V	Toroidal 80VA 30V	£9 64
YK20W	Toroidal 120VA 30V	£10 51
YK21X	Toroidal 160VA 35V	£11 67
YK22Y	Toroidal 300VA 35V	£14 87
YK23A	Toroidal 500VA 35V	£19 30
WB12N	Tr 20V 1A	£9 95 (B)●
WB17T	Tr 28V 1.1/2A	£10.98 (A)
Page 472		
YG13P	Small Motor	£1.68 (D)●

HEATHKIT *Continued from page 30.*

duce each section. In addition, the cassette narration guides the user through the course. In everyday language these cassettes help to provide a fuller understanding of how a computer operates. Fifteen computer exercises provide experience in using MS-DOS features and commands with the HS100 and the IBM Personal Computer. Includes 5¼ inch floppy disk.

*MS is a registered trademark of Microsoft Corporation.
**Z-DOS is a trademark of Zenith Data Systems Corporation.

Order As HS65V (EC-1121 MS-DOS Course) Price £109.95

Hero 1 Prices Reduced

The excellent new magazine 'Practical Robotics' thinks Hero is "probably the best personal robot at the moment." – a sentiment with which most informed observers would concur. And now, thanks to massive sales worldwide, we are pleased to announce a big price reduction to make Hero even better value for money. Now you can buy the kit in stages if you wish, the body first, then the arm and then the voice synthesiser, or you can still buy it all together at a saving. See '84 Catalogue page 213/4 for full details. We can also now supply Hero ready-built including arm and synthesiser, just compare our prices and facilities with the other robots around and we're certain you'll agree Hero is by far the best value!

ET-18 Body only HS77J Price £899.95.
ET-18-1 Arm only HS78K Price £399.95.
ET-18-2 Voice only HS79L Price £119.95

ETS-18 All above in one kit saving over £65. Order As HK20W Price £1349.95. ***– Saving £250 over previous price!***

ETW-18 As ETS-18, but factory assembled. HS80B Price £2199.95.

More Add-ons For Hero

In the next issue we'll have details of several state-of-the-art add-ons for Hero like an RS232 interface to enable direct connection to your home computer, more RAM to store larger programs and a voice recognition unit that allows you to command Hero directly just by talking to him! Also available now in addition to the add-ons shown on '84 Catalogue page 214, is a second plug-in demonstration ROM that allows Hero to move about a room avoiding all obstacles.

ET-18-7 Automatic Mode ROM
Order As HS67X Price £39.95.

More Courses In Classroom Format

Both of the self-instruction courses described in our last issue are now available in classroom format as follows:

Robot Applications Course EE-1812
Text EB-1812
Order As HS69A Price £25.95*NV*

Workbook EB-1812-40
Order As HS70M Price £15.95*NV*

Instructor's Guide EB-1812-50
Order As HS71N Price £13.95*NV*

Assembled Trainer ETW-18
See robot details above.

Parts Kit EB-1812-30
Order As HS72P Price £64.95

Microprocessor Applications Course EE-3405
Text EB-6405
Order As HS73Q Price £23.95*NV*

Workbook EB-6405-40
Order As HS74R Price £14.95*NV*

Instructor's Guide EB-6405-50
Order As HS75S Price £13.95*NV*

Assembled Trainer ETW-3400AE
See catalogue page 211.

Parts Kit EB-6405-30
Order As HS76H Price £64.95

-CAUTIOUS- NI-CAD CHARGER

by B. Puttock & D.J. Silvester

Introduction

The accepted life for most Ni-Cad cells is five hundred charge/discharge cycles, however this sort of life can only be achieved if some care is taken over the treatment of the cells. A number of chargers are available commercially and many High Street shops are now selling both batteries and chargers. These chargers are only able to charge a limited number of cells at one time (usually 4), have a fixed charge time of about 15 hours and no provision for high speed charging of scintered cells.

The overcharging of cells is detrimental to their useful life, most manufacturers state their cells must not be charged for more than 14 to 16 hours at the recommended charge current. However, no commercial charger appears to offer an automatic timing system. Partially used cells are normally treated as though they were completely discharged and will consequently be substantially overcharged by a commercial unit.

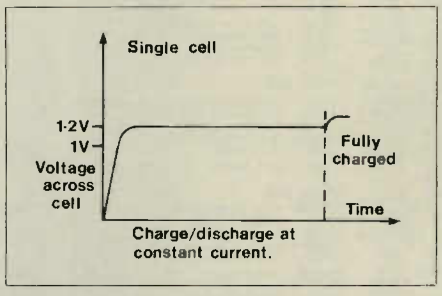
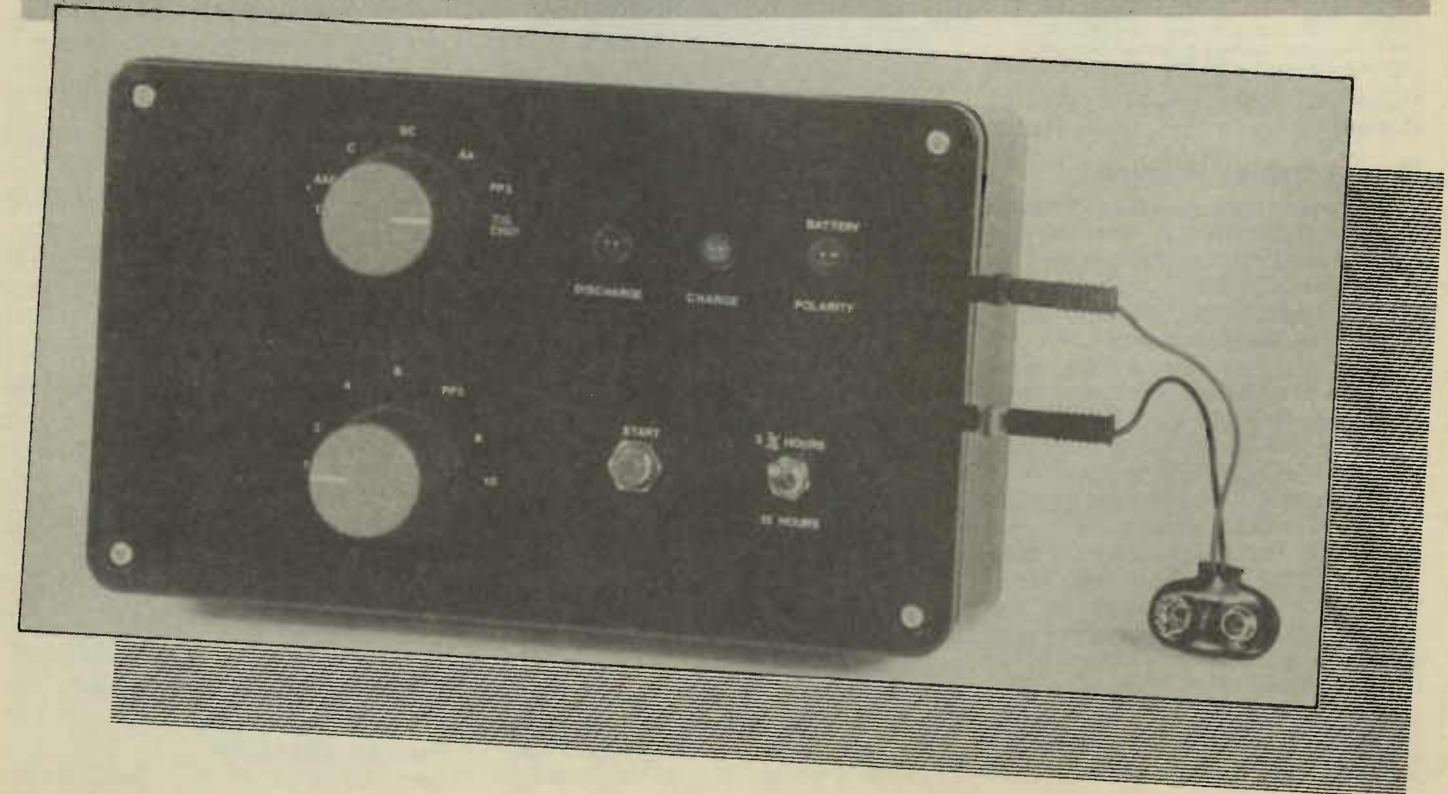


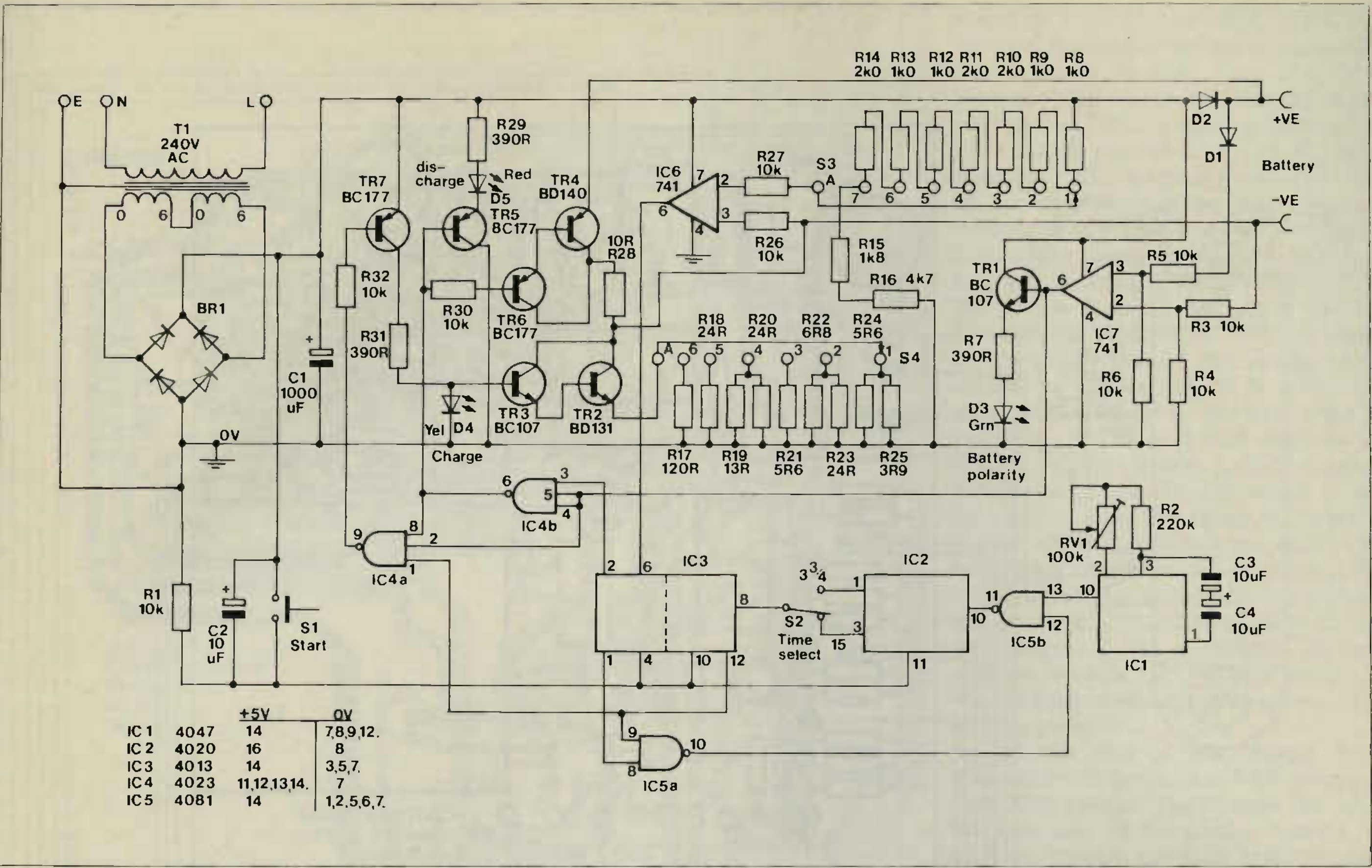
Figure 1 Single Cell Discharge

The discharge of a single cell at a constant current is shown in Figure 1. The voltage across the cell remains constant at about 1.2V until the remaining charge is below 10% of the full charge – then the voltage drops rapidly. Recharging the cell raises the voltage across the cell to between 1.3 and 1.4 volts very rapidly, where it remains until the cell becomes overcharged, the voltage then rises slightly before becoming constant again.

In order to charge a variety of batteries this design uses the discharge voltage of 1V per cell to initiate the charge cycle, which is then carried out at constant current for either 3¾ or 15 hours depending on cell type. To satisfy a number of interests, including photography and amateur radio, the unit is able to charge a range of batteries, from a single AA cell to a bank of up to 10 cells – which will provide a 12V supply. Consequently switched reference voltages are used to detect the end of the discharge cycle and various charge rates are

- ★ Battery Polarity Sensor
- ★ Constant Current Charging
- ★ Fast Charge for Scintered Cells
- ★ Electronic Timing of Charge Cycle
- ★ Will Accept up to 10 Cells or 1 PP3
- ★ Will Accept AA, AAF, C, D or SC Cells
- ★ Trickle Charge to Maintain Cells in Fully Charged Condition
- ★ Discharge Facility for Part Charged Cells to Prevent Overcharging





		+5V	0V
IC1	4047	14	7,8,9,12.
IC2	4020	16	8
IC3	4013	14	3,5,7.
IC4	4023	11,12,13,14.	7
IC5	4081	14	1,2,5,6,7.

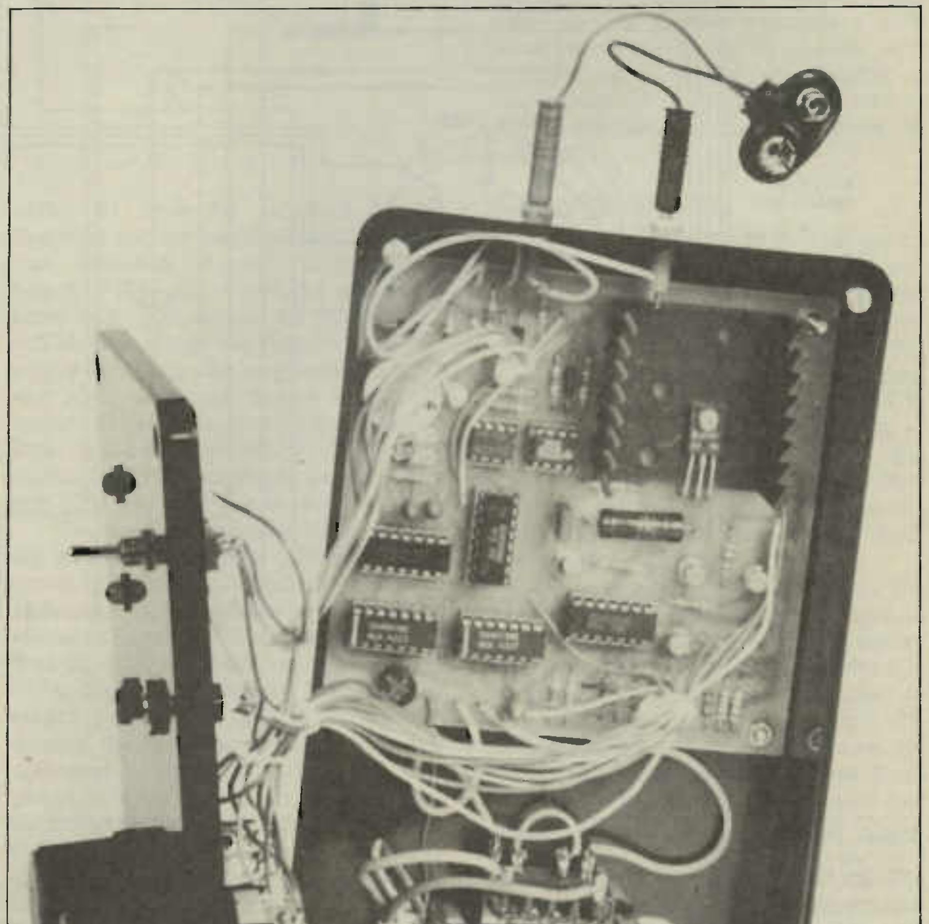
Figure 2 Circuit Diagram

offered. A discharge only facility is also offered for cases where a new battery pack is to be made up from old cells in various charge conditions. After discharging each of the cells individually, they can then be recharged as a battery pack so that each of the cells is equally charged.

To accommodate the charging of various types of batteries the output is connected to a PP3 type clip, which can then be connected to the required battery pack (although for certain single cells the connection to the battery holder will need to be soldered). For full details of battery holders see page 31 of the 1984 Maplin Catalogue.

Circuit Description

T1, BR1 and C1 are used to convert AC mains input to 16.5V DC, the voltage used to drive all of the logic circuitry and to charge the batteries (see circuit diagram Figure 2). The circuit consisting of D1, R3 to R6 and IC7 is used to detect that the battery to be charged is connected correctly. Normally when a battery is regarded as being discharged it in fact still produces a small potential difference across its terminals. R3 to R6 form a potential divider so that if the two battery contacts are shorted together the inputs to the voltage comparator IC7 will be the same, ignoring resistance tolerances. To ensure that in this condition IC7 produces an error signal, i.e. IC7 pin 6 is low voltage, D1 is introduced to unbalance the divider chain. The off-set is extremely low and will be overcome when a battery is connected to the charging terminals in the correct manner.



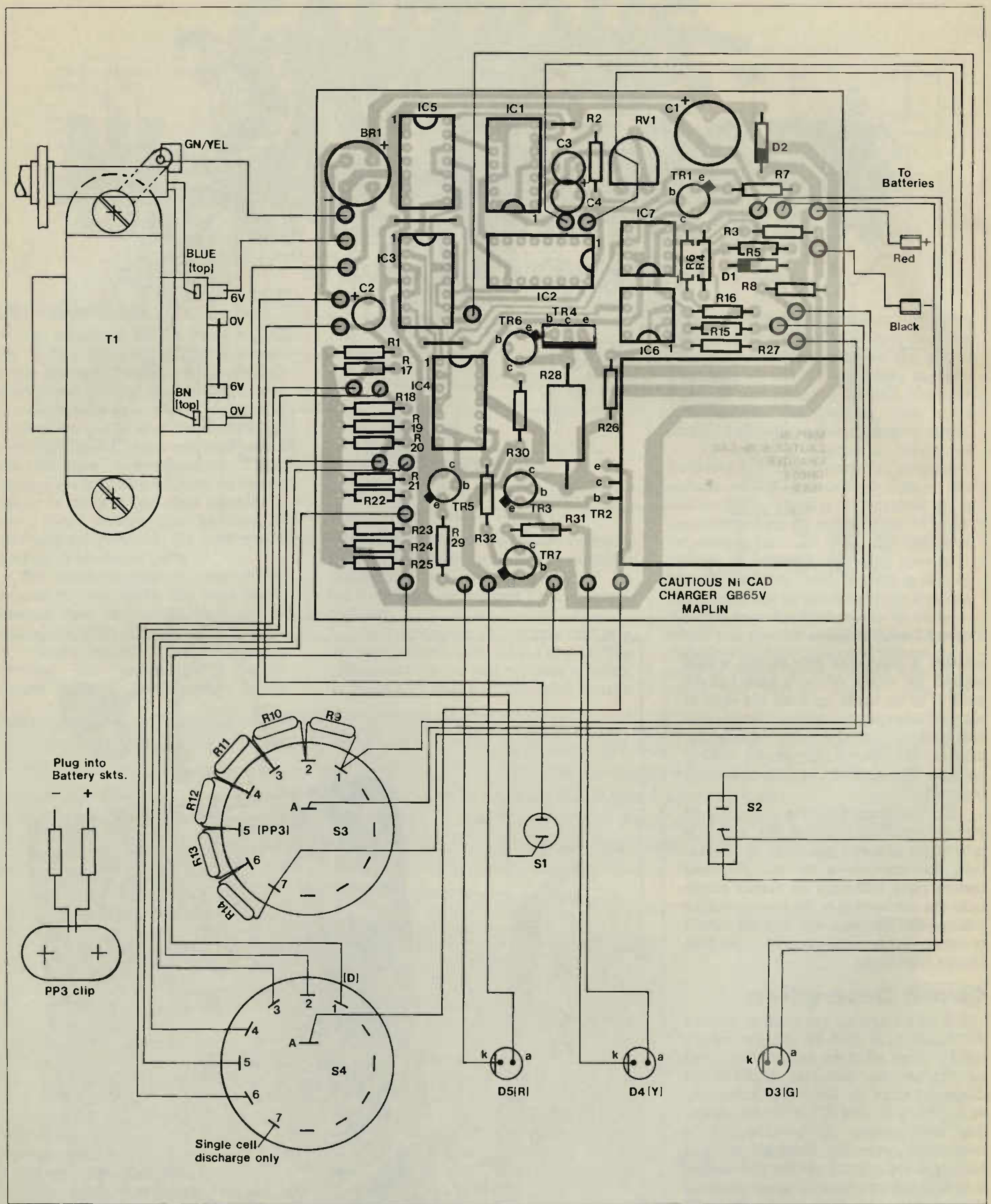
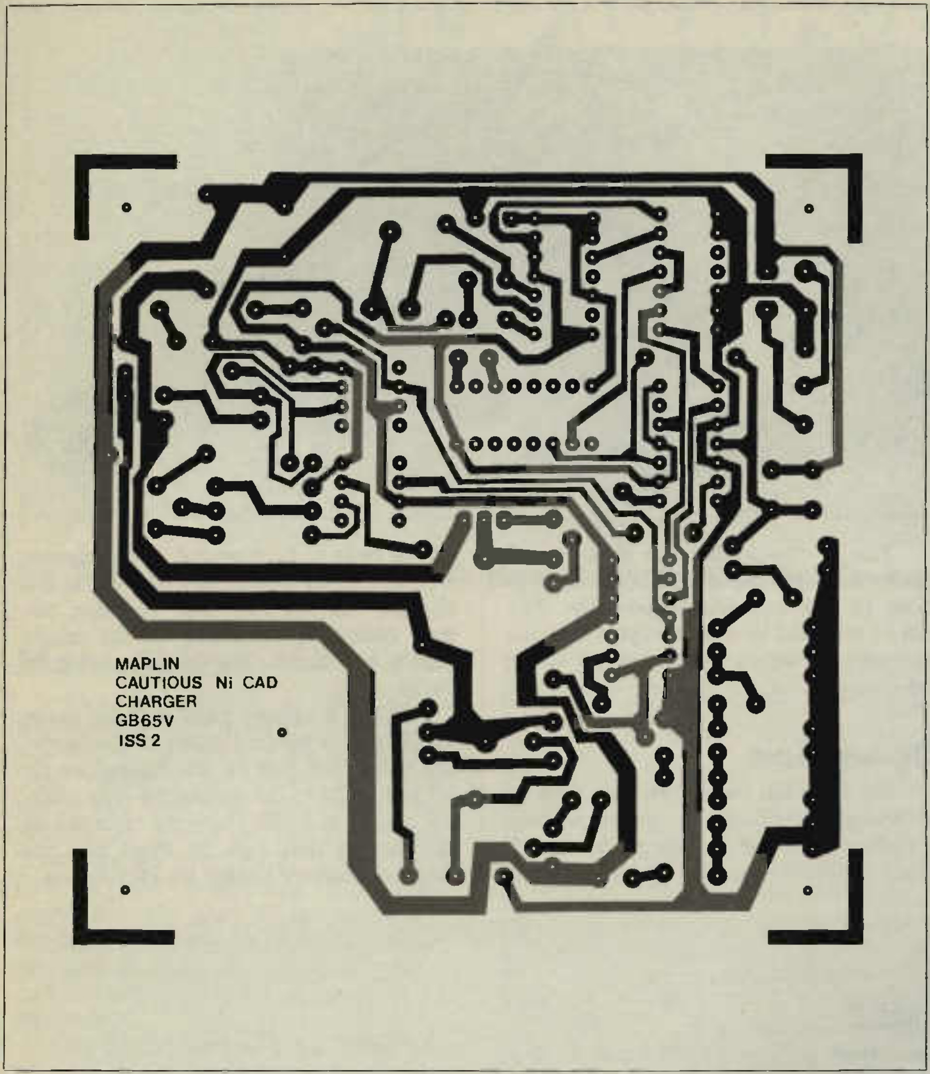


Figure 3 PCB Track Legend & Wiring Diagram

IC7 pin 6 will then become high. An incorrectly inserted battery will reinforce the off-set introduced by D1.

TR1, R7 and green LED D3 are used to indicate the voltage level, i.e. logic state, of the output of IC7 – when D3 is illuminated the battery has been inserted correctly. The output from IC7 is also used to disable the charge/discharge logic (IC4a and IC4b) thus preventing damage to an incorrectly inserted battery.

IC6 with its associated resistors R8, R15, R16, R26, R27 and the resistor chain R9 to R14 which is connected onto the switch S3 (see S3 diagram in Figure 2) form a second voltage comparator system. This provides the voltage standard against which the voltage of the battery is checked. The total resistance across the supply is the sum of R8 to R16 which equals 16.5k ohms. The current through the chain is 1mA and therefore a 1k resistor will produce a 1 volt potential difference. Hence position 1 of S3 gives a 1 volt input to IC6 pin 2, against which the battery voltage is compared. Similarly switch positions 2 to 7 give 2,4,6,7,8 and 10 volts respectively, for checking larger battery packs. If the battery voltage is



greater than 1 volt per cell the output of IC6 pin 6 will be low and if less than 1 volt per cell it will be high.

The timing and control logic receive the outputs of IC's 6 and 7 which are used to initiate the charge/discharge operations.

IC1 is a free running multivibrator the output cycle time of which is controlled by the values of R2, RV1, C3 and C4; it requires low leakage non-polarised capacitors across pins 1 and 3, as a high value of capacitance is required in this case, back to back tantalum bead types are used. The resistance needed across IC1 pins 2 and 3 is provided by R2 and RV1, the variable component is used so that the output square-wave from pin 10 can be made as close as possible to 6.59 seconds per cycle – to allow reasonably accurate charge times.

IC2 is a 14 stage binary counter which is used to divide down the 0.152 cycles per second from IC1; the output voltage at pin 1 becomes high after 2^{11} input pulses, i.e. 3¾ hours and that at pin 3 high after 2^{13} input pulses, i.e. 15 hours. IC5b and the associated logic loop of IC2 and IC3 prevent the timer restarting after 2^{12} and 2^{14} counts respectively, thus preventing a second charge cycle.

Consider the situation where a partially charged battery is connected to the charger. S3 must be switched to the correct number of cells (PP3 equals 7 cells). S4 must be switched to the charging current required and S2 to the time needed. If the polarity is correct the output of IC6 will be low and as there is more than 1 volt per cell the output of IC7 will be high, which will illuminate D3. The output of IC7 is also connected to IC4a and IC4b, when this output is low the outputs of both IC4a and IC4b are forced high, disabling the charge /discharge circuitry. With a correctly inserted battery IC4a and IC4b are enabled.

Pressing and releasing S1 or switching on the mains supply forces the reset inputs of IC2 and IC3 high and then low again, in a time period controlled by the values of R1 and C2. The outputs $\bar{Q}$ of the dual flip-flop, IC3, become high whilst Q of flip-flop (F/F2) becomes low. This low output passes via IC5a and IC5b to disable the counting of IC2 during the discharge cycle. The $\bar{Q}$ signal of F/F2 passes to IC4b, the output of which forces the output of IC4a high. This then turns off the charge circuit. The low output of IC4b enables the discharge circuit consisting of R28,R29,R30,TR4,TR5 and TR6 thus illuminating the red LED D5.

The discharge circuit remains on until the voltage across the battery drops below 1 volt per cell. This voltage drop causes the output of IC6 to go high thus causing the outputs of F/F2 in IC3 to change.

When $\bar{Q}$ of F/F2 becomes low, the output of IC4b becomes high, disabling the discharge sequence and enabling the charge circuit via IC4a. Since Q of F/F2 becomes high and $\bar{Q}$ of F/F1 is still high, the counting of IC2 is enabled by the high input to IC5b derived from IC5a. IC2 now begins to count the pulses from IC1, with S2 selecting whether the high signal is passed on to IC3 after 2^{11} or 2^{13} pulses. During this period all inputs to IC4a are high and its output is low, thus turning on the charge circuit consisting of R17 to R25, R31,R32,TR2,TR3,TR7 and illuminating the yellow LED D4. The voltage drop across the illuminated D4 is about 2.4 volts and as each of the base-emitter junctions of TR2 and TR3 produce a voltage drop of 0.7 volts, 1 volt is applied across the switch (S4) selectable resistors, R17 to R25. The range of currents passing through TR2 is quite large and therefore a variable voltage drop actually occurs across the base-emitter junction of this transistor. The values of the resistors are chosen so that a constant current suitable for charging the cell selected, will be passed through themselves, TR2 and the battery.

At the end of the charge time selected by S2 the input of F/F1 becomes high. This causes $\bar{Q}$ to become low and via IC4a turn off the charge system. In addition, via IC5a and IC5b, furthur timing is prevented. The unit now remains in this state and the battery receives a very small trickle charge via R3 and R4. D2 is included so that when the charger is disconnected from the mains the battery cannot discharge through the rest of the circuitry.

Construction

Before starting the PCB construction the bottom of the box should be marked with the positions of the transformer, the PCB mounting screws, the mains input cable and the charger power output sockets. All these holes should be drilled and the components (excluding the PCB) mounted into position, not forgetting to locate the mains cable through the grommet. Next mark the positions of the 3 switches and the LED's on the lid of the box, drill the holes and mount these components.

Assemble the PC board in the following order: first locate the positions of the IC sockets and carefully solder them onto the PCB. Do not insert the IC's at this stage! Next mount and solder in turn, the resistors and capacitors, the bridge rectifier and the transistors except TR2. Once these components are fitted TR2 can be attached to the heat-sink and the two items screwed to the PCB – after bending the transistor leads to pass through the holes in the board. Finally solder TR2 and fit the wires connecting the PCB to the sockets and transformer, and also the switches and LED's in the lid (see Figure 3, PCB track legend and wiring diagram), then fix the PCB into the box.

Now wire the switch S3 with the resistor chain as shown in Figure 3, and ensure that 7 switch positions are available. If not there is a small movable stop under the mounting nut of the switch which should be placed in the position marked 7. Incidentally S4 should also rotate through 7 positions and should be adjusted if required. Before testing, all wiring should be checked and the wires between the PCB and other components secured with cable ties.

Testing

Having completed construction the supply voltage to each of the IC's should be checked – there should be a reading of 16 volts between pin 14 (positive) and pin 7 of IC's 1,3,4 & 5, and between pin 16 (positive) and pin 8 of IC2. For IC6 and 7 the 16 volt supply should be across pins 4 and 7 (positive). If these readings are satisfactory plug in all the IC's.

With the output sockets disconnected the green and yellow LED's should light. Shorting the sockets should turn off all the LED's – proving that the polarity checker is working.

Connect a part charged cell to the charger and check that the unit transfers from discharge to charge when the voltage drops to 1 volt and that the charge current is correct for the cell being used. Each time a new size of cell is charged the charge current should be checked.

Finally check that the time for 10 cycles from the output of IC1 (pin 10) is as close to 65.9 seconds as possible. RV1 can be adjusted to alter the cycle time the accuracy of which will obviously affect the charge time.

Operation

Set S4 to the correct battery type to be charged. Set S3 to the correct number of cells, or PP3. Set S2, charge time, to 15 hours – or 3¾ hours for scintered cells. Fit the cells to be charged in the correct type of battery holder and connect to the charger via the PP3 clip. Pressing the start button or switching on the mains supply will initiate the discharge/charge cycle.

When a battery pack is to be made up of cells in varying states of discharge, the cells must first be discharged singly by setting S4 to the discharge only position and S3 to 1 cell. Once the cells are all discharged they can be fitted into the required battery holder for recharging.

NI-CAD CHARGER PARTS LIST

RESISTORS: All 0.4W 1% Metal Film unless otherwise stated.

R1,3,4,5,6,26,27,30,32	10k	9	(M10K)
R2	220k	1	(M220K)
R7,29,31	390Ω	3	(M390R)
R8,9,12,13	1k0	4	(M1K)
R10,11,14	2k0	3	(M2K)
R15	1k8	1	(M1K8)
R16	4k7	1	(M4K7)
R17	120Ω	1	(M120R)
R18,20,23	24Ω	3	(M24R)
R19	13Ω	1	(M13R)
R21,24	5Ω6	2	(M5R6)
R22	6Ω8	1	(M6R8)
R25	3Ω9	1	(M3R9)
R28	10Ω 7W 5% Wirewound	1	(L10R)
RV1	100k Hor S-Min Preset	1	(WR61R)

CAPACITORS

C1	1000μF 25V PC Electrolytic	1	(FF18U)
C2,3,4	10μF 25V Tantalum	3	(WW69A)

SEMICONDUCTORS

D1,2	1N4001	2	(QL73Q)
D3	LED Green	1	(WL28F)
D4	LED Yellow	1	(WL30H)
D5	LED Red	1	(WL27E)
TR1,3	BC107B	2	(QB31J)
TR2	BD131	1	(QF03D)
TR4	BD140	1	(QF08J)
TR5,6,7	BC177	3	(QB52G)
IC1	4047BE	1	(QX20W)
IC2	4020BE	1	(QX11M)
IC3	4013BE	1	(QX07H)
IC4	4023BE	1	(QX12N)
IC5	4081BE	1	(QW48C)
IC6,7	μA741C 8-pin DIL	2	(QL22Y)
BR1	W005	1	(QL37S)

MISCELLANEOUS

S1	Push Switch	1	(FH59P)
S2	Sub-Min Toggle Switch 'A'	1	(FH00A)
S3,4	Rotary Switch 12B	2	(FF73Q)
T1	Min Transformer 6V	1	(WB06G)
	Heatsink Vaned	1	(FL59P)
	LED Clips	3	(YY40T)
	DIL Socket 8-pin	2	(BL17T)
	DIL Socket 14-pin	4	(BL18U)
	DIL Socket 16-pin	1	(BL19V)
	Knob K7C	2	(YX03D)
	Feet Stick-on	1 pkt	(FW38R)
	Grommet Small	1	(FW59P)
	Tie Wrap 92	4	(BF91Y)
	Cable C6A Mains White	2m	(XR04E)
	Wire	1 pkt	(BL00A)
	Veropin 2145	1 pkt	(FL24B)
	Socket Black 2mm	1	(HF44X)
	Socket Red 2mm	1	(HF47B)
	Plug Black 2mm	1	(HF38R)
	Plug Red 2mm	1	(HF41U)
	Printed Circuit Board	1	(GB65V)
	PP3 Battery Clip	1	(HF28F)
	Bolt 6BA ½in.	1 pkt	(BF06G)
	Nut 6BA	1 pkt	(BF18U)
	Spacer 6BA ¼in.	1 pkt	(FW34M)
	Tag 6BA	1 pkt	(BF29G)

OPTIONAL

	Case Verobox 305	1	(LH51F)
	Battery Holders – see Maplin Catalogue		

A complete kit of parts (excluding the case and battery holders) is available.
Order As LK50E (Cautious Ni-Cad Charger Kit) Price £19.95

FIRST BASE

by Mike Wharton **A Beginner's Guide To Logic Design.** **Part Six**

More Chips

The first article in this series explained something of the meaning of the various numbers to be found on a 'chip' package. So far we have dealt exclusively with TTL devices and described the use of the two main types. These are the standard 74' type devices and the 74LS' range, that is the Low-power Schottky ones So far no mention has been made of any of that other vast family of devices, the CMOS integrated circuits, and this will be remedied in the next article.

During the last few years there have been great advances in the technology involved in the manufacture of integrated circuits and this in turn has led to the production of other types of device. Many of these are made as pin compatible versions of the original 74' variety, but with some particular feature. Table 1 gives a list of the types of devices available along with a brief summary of their characteristic features. The last of these, the 74HC and 74HCT series are really a development of the CMOS types mentioned above, but the continued improvements have been such that the previously clear-cut distinction between TTL and CMOS types has been eroded. It seems very likely that it will not be long before there is only one range of devices, probably based on the 74HC variety, incorporating most of the advantages of the other types.

74	Original 'standard' TTL range.
74L/74H	Obsolete ranges offering lower power consumption or higher speed respectively.
74S	High speed devices using Schottky diode techniques, but increased power consumption.
74LS	Improved version featuring both low power consumption and increased speed.
74ALS/74F	Advanced Low-power Schottky (or Fairchild 'Fast') featuring improved speed & power consumption.
74C	CMOS versions of standard TTL devices, but with many devices in the TTL range not available.
74HC	High speed CMOS devices; one of the latest ranges offering most of the best features of both CMOS and TTL devices i.e. low power and high speed.
74HCT	The very latest range, being a development of the 74HC devices, but where the input logic levels have been tailored to match the standard TTL range.

Table 1. Summary of available TTL types

Pro's and Con's

Perhaps this would be a suitable point at which to mention further some of the reasons why two ranges of devices have been developed in the first place. The standard TTL devices were the first on the scene, and arose out of the development of bipolar transistors, on which they are based. This was quite some time before MOS (Metal Oxide Semiconductor) devices had been invented. Although TTL got off to a head start, it soon became apparent that this technique had a natural limitation to the number of individual transistors that could be packed on to the silicon chip. This mainly revolved around the amount of power dissipated by each tiny transistor, and the associated problem of removing the heat generated as a consequence. If the transistors were packed too closely on the surface of the chip then the temperature would rise to levels that easily destroyed the delicate structures. On the other hand, MOS transistors consumed very little power and hence could be packed more closely together without creating the problem of an intolerable temperature rise. Needless to say, the fabrication of MOS-based integrated circuits was not without other problems, for instance, their susceptibility to static discharges, which was not shared by the TTL types.

The ability to pack more MOS and later CMOS (Complementary Metal Oxide Semiconductor) devices led to the production of more complicated devices; that is with even larger scales of integration. Thus although TTL are generally limited to small and medium scales of integration, SSI and MSI, the CMOS devices and their offspring are able to be produced with large, very large and now ultra large scales of integration, LSI, VLSI and ULSI. It is this sort of advance which, of course, has led in turn to the advent of the microprocessor chip, and all that it has brought in its wake.

The upshot of all this is that both sets of devices have had some real advantages over the other; viz:

1. TTL are much faster than CMOS.
2. CMOS consume much less power than TTL.
3. TTL are not likely to be destroyed by static.
4. CMOS devices are available with higher scales of integration.

As mentioned before we shall be diverting our attention to the CMOS devices in future articles.

Three-State Outputs

Before moving on to the main topic, it is appropriate to explain about one more type of logic output arrangement. In the last issue, mention was made of the decidedly ill-effects which can be caused if standard TTL outputs are connected together. One way round this which was described, is to use what are called open-collector outputs. In many computer or microprocessor based systems it is often necessary for devices to share a common line in order to form what is called a 'bus'. Although it is perfectly possible to do this using devices with open collector outputs, this method is now somewhat old-fashioned, and has been superseded by a much better one. Many devices are now produced which are specifically designed with outputs suitable for connection to a common bus. These are commonly called 'three-state' outputs, since the output may be at a logic 0, a logic 1, or a third state which is neither 0 nor 1, but a high impedance state. Forcing the output to this third state is effectively equivalent to disconnecting the device from the bus. This makes the interconnection of many devices sharing a common bus a much easier task, and only requires the inclusion of an extra control signal to select those devices who may have access to the bus without causing any problems over bus contention. Thus at any one time only two devices will be connected together, a sender and a receiver, (or a 'talker' and a 'listener') whilst all the rest are 3-stated. Other descriptions of devices with this type of output which may be encountered are Tri-State, which is actually a trade mark of National Semiconductor, TSL, three-state logic and three-state TTL.

The extra control pin required by such devices is usually labelled Enable/Disable, Output Enable or Chip Select, and permits the logic devices to behave normally, or else disconnects the output of the device from the rest of the circuit. One group in particular which make use of this feature are memory devices, and it is to these we now turn our attention.

Memory

The idea of an electronic component which can store 'data' is not of recent origin, but its implementation in a physically small device was yet another step along the road to the implementation of the modern digital computer. It must be admitted at the outset though, that most of these devices are based on MOS technology and are not suitable for breadboard experimentation. There are, however, a number of standard TTL devices which are eminently suitable for such an application. One reason why they are useful is that their memory capacity is limited, just the reason why they are not to be found in a microcomputer!

The particular chip we shall use to investigate the function of similar memory types is the 7489 (QX65V).

Static RAM

The 7489 is described as a 64 bit static RAM, and this needs a little explanation. Firstly, remember that we are dealing with digital devices and that the 'data' will be stored as BInary digiTS or bits. The significance of any stored data can be what we want it to be; it may be just numbers stored in their binary form, or it could be that the numbers represent the letters of the alphabet, or whatever. This

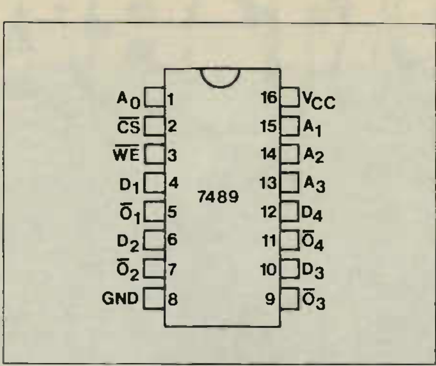


Figure 1a. Pin out of 7489, 64-bit static RAM

device then, can hold just 64 bits, each either a 0 or a 1. The 'static' part of the description is not an indication that it will stand still while you look at it! Rather it serves to put it into one family of memory devices, the other most common type being described as 'dynamic'. This second type of memory works in a rather different manner to the static variety and continually needs to be 'refreshed', otherwise it would forget what data it contained. The two types of device store bits in different ways. The static variety, for example,store bits by setting or resetting little bistable flip-flops. The dynamic type are based on CMOS technology, and store their bits as an electric charge on a tiny capacitor. Since the charge which can be held is so small and tends to leak away, it has to be 'topped up' every so often to maintain the data intact. Typically, the time between successive refreshes will be about 1 millisecond, and in a microprocessor-based system this will be carried out automatically, and is one reason why they are unsuitable for breadboard experiments.

The RAM part of the description, as some readers may well know, stands for Random Access Memory. This again puts it into a particular family of memory devices, the other main family being the ROM's or Read Only Memories. These two descriptions are a little misleading, especially in the case of the RAM's. Essentially what it means is that any location within the devices can be accessed with equal ease, rather than them each having to be accessed in sequence until the desired location is reached.

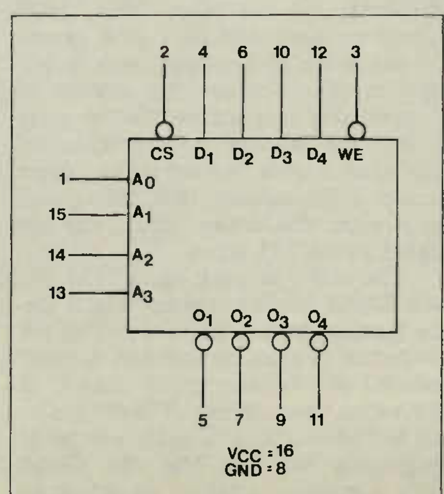


Figure 1b. Logic diagram of 7489

Functional Groups

So much for a general description of semiconductor memory, now for a look at the 7489 in particular. Figures 1a and 1b show two pin-outs of this device. Figure 1a is the usual one, showing the function of the various pins. Figure 1b is simply a rearrangement of the pins into their respective groups. Here again, some explanation will be in order for the beginner.

The arrangement of pins on the package is arrived at for the convenience of the manufacturer, and Figure 1b shows a logic diagram which is more helpful when drawing up complicated circuit designs, rather than slavishly following the pin-out and ending up with a 'rats nest' of interconnecting lines. The groups of connections associated with any memory device are:

1. Address lines.

There are four of these on the 7489, shown on the diagram as A0 to A3.

2. Data lines.

These are shown as D1 to D4 and also $\overline{O1}$ to $\overline{O4}$. In the case of the 7489, data being fed into the device enters along the Input lines D1 to D4, whilst data leaves along Output lines $\overline{O1}$ to $\overline{O4}$. The over-bar on this last set indicating that the data leaving any location is the inverse of that which was fed in. Thus a 0 will be output as a 1, and vice versa.

3. Control lines.

The 7489 has two control lines, labelled as $\overline{CS}$ and $\overline{WE}$; here again the over-bar indicating that they are both active low and need to be taken to logic 0 to have the required action. CS stands for 'Chip Select' and WE for 'Write Enable'.

4. Power lines.

Finally, of course, power needs to be supplied to the chip, which in this case is just +5V to V_{CC} and 0V to GND; many other memory devices often require several other voltages.

Memory Circuit

The design of the circuit to put the 7489 through its paces is shown in Figure 2. This is slightly complicated and requires careful assembly on a breadboard. One tip for anyone wishing to assemble this circuit is to make a copy, (a photo-copy if you're that lucky) and to check off each connection on the diagram as it is made. Also it pays to be neat and methodical, by making connections to each pin of a device in order, starting at pin 1 and working round the pins in turn. Neatness alone is no particular virtue, but it makes life a little easier if your circuit doesn't work perfectly first time; if the only way to sort out a rat's nest of wires is to dismantle it and start again you might just as well have taken the time to do it right in the first place!

The purpose of this circuit is quite straight-forward; that is, to fill each location or 'address' in the 7489 with a binary number or 'data'. This is achieved by setting the address lines to a particular binary value, then setting the data lines in a similar fashion, and finally writing the data into the address by pulsing the Write Enable pin low momentarily. The address and data line logic levels could be set up using wires which are swapped over between logic 1 and 0 in order to produce the desired combination, but at this stage it would be a lot more convenient if DIP switches were used. A total of eight switches are needed, four for addresses and four for data, and an octal version (XX27E) would be suitable.

The data output from the device is inverted, and the purpose of the four gates from the 7404 is to invert it back to its true form. The outputs of the 7404 are then connected to the four LED's in order to display the value of the binary data at any particular address; as usual, a logic 1 is represented by a lit LED. Although not shown on the circuit diagram, four more LED's could be connected across the address lines in order to display the value of the address selected on the DIP switches, but this is by no means essential.

The sequence of Writing to a memory location is to set the DIP switches to the required value, say all at logic 0 for the first address. As the switches are changed, with the power turned on of course, the Output LED's may change, indicating the contents of any other addresses selected. After first switching on it is very likely that the addresses will contain random numbers or all logic 1's or 0's. Having set the address then set the required Data using the other four DIP switches. This data is then written into the chosen address by taking the Write Enable pin to logic 0. This can be done simply by moving a wander lead from logic 1 to logic 0, or by using a push switch as shown in the diagram; it is immaterial whether it is debounced. On pulsing the $\overline{WE}$ pin low like this, the LED's indicating the data output should change to the same value as that set on the data input switches. With the $\overline{WE}$ pin back at logic 1 the next address and data value can be set up, and then written into memory by pulsing $\overline{WE}$ low. This procedure may then be repeated for the whole of the 16 possible addresses.

In order to inspect the contents of a particular address it is only necessary to set up the appropriate value on the DIP switches, when the output LED's will display the data contained at that address. If the power is disconnected, even for a fraction of a second, then all the data stored will be lost and replaced by random 'garbage'. For this reason such memory devices are also known as 'volatile', since if power is removed the stored data 'evaporates'!

Organisation Of Memory

This arrangement of setting data and addresses by the use of switches is rather tedious, but it does demonstrate the basic steps involved with nearly all memory

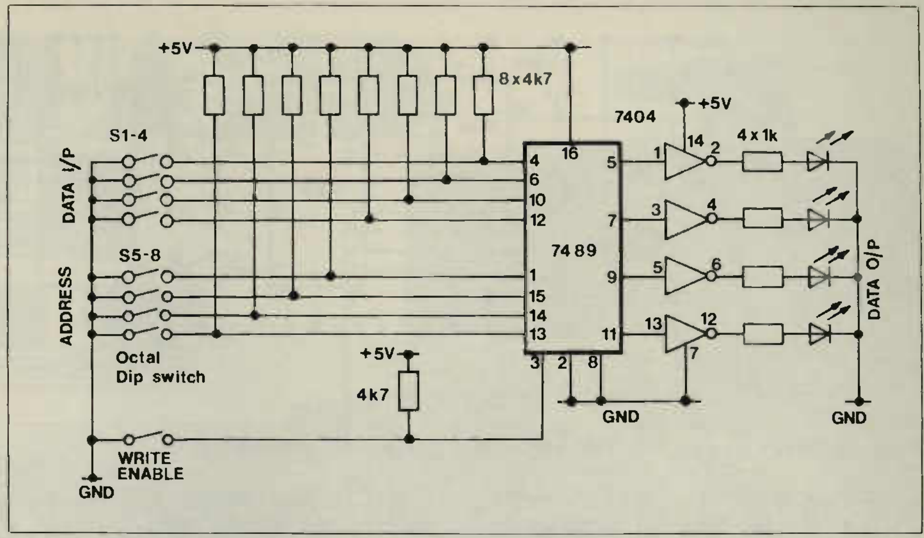


Figure 2. Circuit for investigating the 7489

devices in filling them with information. Of course in this device which has four address lines there are only 16 possible unique locations at which to store data. Each location is arranged to hold four bits of data, hence 16 x 4 = 64 bits in total. An important aspect of any device is how the memory is organised; in this instance it is as sixteen 4-bit words. A typical device which might be found in a microcomputer is the 2114 static RAM. This is described as a 4K memory chip, and this means that it can hold a total of 4096 bits, since in computer parlance 1K (not 1k) is not 1000 but 1024, being 2 raised to the power of ten. These 4096 bits are organised as 1024 4-bit words. Another common device found in similar applications is the 4116 dynamic RAM. This one is described as a 16K device, and in this case the memory is organised as 16384 x 1-bit words (16 x 1024 = 16384). For this device to be used in practical designs, where useful word lengths are needed, it is necessary to connect them in parallel. For example, if an 8-bit word is required then eight 4116's are used, giving a total amount of memory of 16 Kilobytes, usually written as 16K, as eight bits equal 1 byte. In fact a byte can be any length, but if other than eight it is usually first stated in the manner: 4-bit byte or 16-bit byte for example.

Sequential Addressing

The method of setting the Address and Data lines with switches can be improved upon by the use of a device which was used in the last article. This is the 7493 counter, and Figure 3 shows how two such devices can be used to replace the eight DIP switches of the previous circuit with just two push switches. With this design it is possible to obtain the required values of address and data by sequencing the 7493's in turn and then pulsing the $\overline{WE}$ pin low, as before. This makes entry of the sixteen values much quicker and easier, even though the full range of addresses has to be sequenced through until a particular one is obtained.

The final circuit, shown in Figure 4, is a combination of this design and the one from the last issue. To refresh your memory, this was using a 7493 to produce a 4-bit binary sequence to drive a 7448 7-segment decoder/driver. The 7493 produces a fixed sequence of binary outputs, being the binary equivalent of the numbers 0 to 15. In Figure 4 the 7489 memory chip has been inserted between the output of the 7493 counter and the input to the 7448 decoder/driver. Now, by sequencing through the addresses to the 7489 it is possible to enter any value of 4-bit word, and this will then be produced

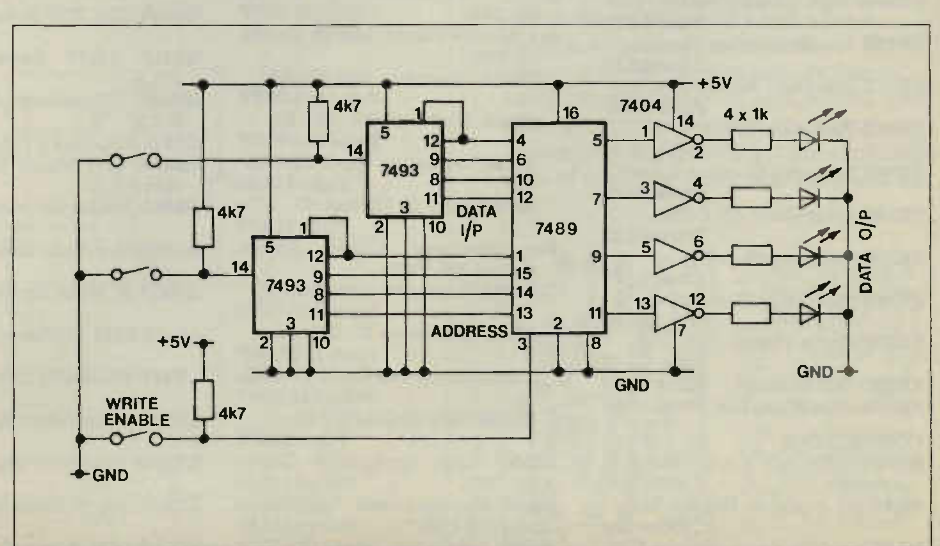


Figure 3. Use of a 7493 to sequence the address and data lines

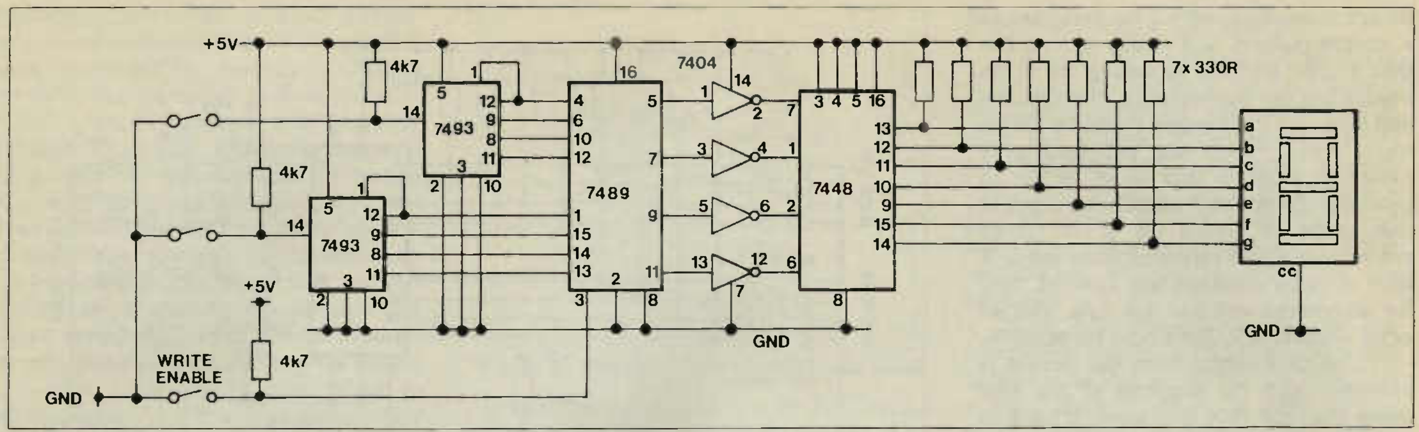


Figure 4. Circuit for using the 7489 with a 7448 7-segment decoder/driver

as the input to the 7448. Thus, it is easily arranged to alter the fixed sequence of numbers on the 7-segment LED to any that is desired. For example, by storing the binary equivalents of 15 down to 0, the display will count down as the addresses are sequenced, rather than count up. Alternatively, data may be stored which produces a random counting sequence, or one which replaces the six illegal inputs for the 7448, i.e. those which produce either a blank or a meaningless display, with a repeat of other numbers.

This last circuit will require a fair amount of time and patience to wire up on a breadboard, and if it doesn't work properly first time then you will have to supply the necessary logic to sort out the errors! This again requires a methodical approach, trying to narrow down the area containing the mistake(s). Avoid the temptation to change connections at random or without any plan of action; the first thing to check is if you have made the correct connections to V_{CC} and Ground to each chip before you set about wholesale dismantling of the circuit. Hopefully you will meet with success and have gained invaluable first-hand experience in the use of these devices, and be well prepared to tackle those contained in the next article.

SERVO AND DRIVER MODULE

- ★ **Compact Lightweight Unit**
- ★ **Easy Construction – Reasonably Priced**
- ★ **Ideal for Model Aircraft/Boats etc**

by Dave Goodman

Electro-mechanical interfaces for use in modelling, robotics and control systems can be difficult to produce with any accuracy, especially if facilities or finances are limited; therefore this article describes construction of a complete servo mechanics kit and small driver module (37 x 25mm). The project is easy to build and the cost very reasonable. Both servo and PCB are small and lightweight, these being important criteria for use with such models as aircraft or small power boats, although the PCB is not so small that construction requires a degree in micro-technology!

Robotics 'buffs' could find servo's useful for producing arm lift and rotational movement or perhaps steering control of wheels. The necessary electrical control signals are generated from port scanning routines and FOR–NEXT loops in BASIC, which is quite fast enough for successful operation.

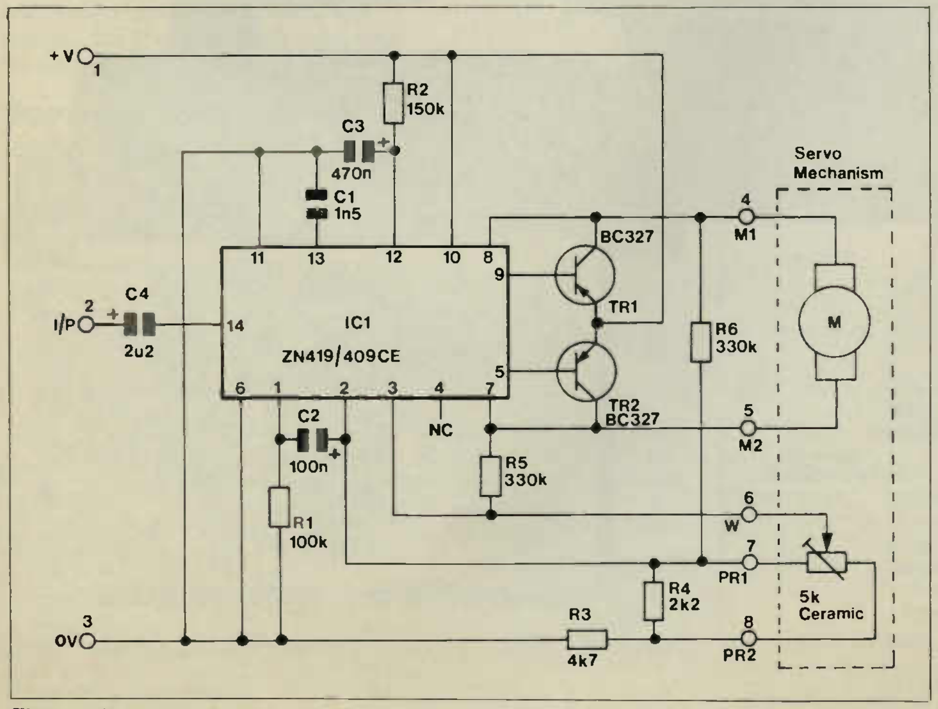


Figure 1 Circuit Diagram

Proportional Control

A servo consists of an electric motor with gear box, rotating arm, for transferring movement, and a feedback potentiometer. Connecting a suitable voltage across the motor causes high speed rotation which is geared down to produce a final drive of one revolution every two seconds – at high torque. The drive arm continues rotating as long as power is applied, this is not the required state of affairs, as positional control of the

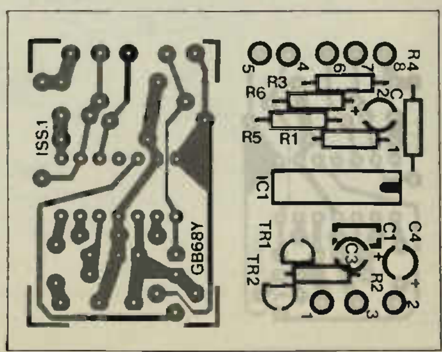


Figure 2 Artwork & Legend

arm is necessary. Positional or proportional control is achieved by continuously pulsing the motor in small steps. The gearbox drives the wiper of a potentiometer the resistance of which varies with each step, this variation is sampled by the control module. When the arm reaches the desired position, drive signals to the motor are inhibited, preventing further movement.

Circuit Description

IC1 requires a positive going, pulse width modulated signal of between 0.5 and 2.5mS repeated every 20mS (50Hz). This 20mS repetition, or frame rate, is standard for most proportional radio control transmitter/receiver systems (Figure 7). Servo arm rotation (of 0 to 180 degrees) is determined by the pulse width, with the centre position (90 degrees) equal to half maximum pulse width, viz. 1.5mS. R1 and C2 are mono-stable timing components which produce a fixed time period, used for reference and comparison of the incoming signal. C1 sets the 'dead band' or area of non-movement, which corresponds to a centre loaded joystick used with radio control transmitters. This area around 1.5mS can be increased or decreased by altering the value of C1, but it should be kept below 2.2nF – otherwise the pulse expansion timing becomes obscured. R2 and C3 expand the control pulse to suit the servo motor used, the values given are correct for the system described in this article. IC1 output pins 7 and 8 both sit at 1.75V DC under quiescent conditions. During operation one of these outputs pulses high and the other pulses low, e.g. increasing pulse width from 0.5mS to 2.5mS causes pin 7 to = 0V (not Q) and pin 8 = +V (Q). Decreasing pulse width from 2.5mS to 0.5mS causes pin 7 to = +V (Q) and pin 8 = 0V (not Q). Putting the servo under a heavy load condition will produce supply current drains of 150mA or more which the IC, with 7mA max. output drive, is unable to cope with. Therefore TR1 and TR2 are used to switch the +V rail to the motor, receiving base drive from pins 5 and 9. A regulated +2.2V reference voltage level is derived from pin 2 and connects to the servo potentiometer. As the wiper moves a voltage swing of +1.7V to +2.2V is developed on pin 3 this modifies the monostable timing thus increasing or decreasing output drive to the motor. A percentage of back EMF signals from the motor are connected via R5, along with the controlling signal, to the monostable reference input; this helps to prevent overshoot on faster servo mechanisms. The values of R5 and R6 can be altered by up to 10%, if necessary, to accomodate this.

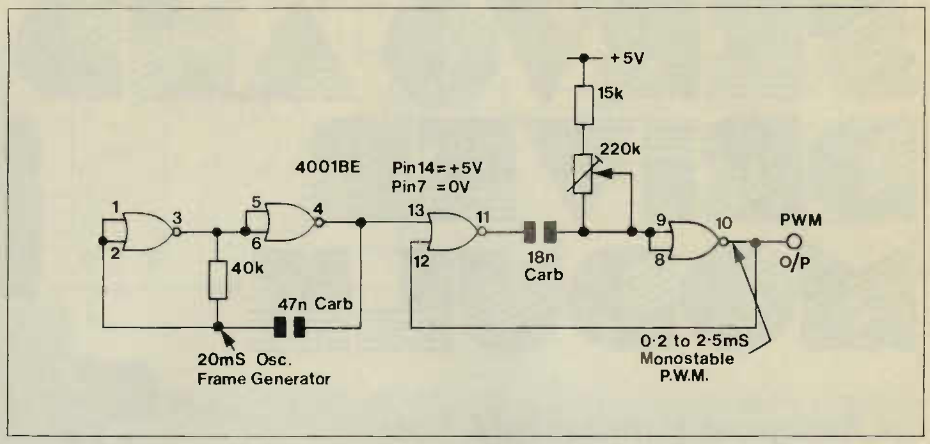


Figure 3 Test Circuit

PCB Construction

Insert resistors R1 to R6 and capacitors C1 to C4. C2 to C4 are polarised types and must be fitted correctly, with the longest lead marked with a + sign to the + sign on the PCB. Insert 8 Vero pins (if required) from the track side of the PCB and press home with a soldering iron. Solder these pins and components

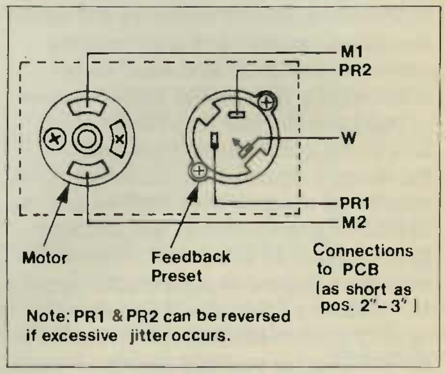


Figure 5 Servo to PCB Wiring

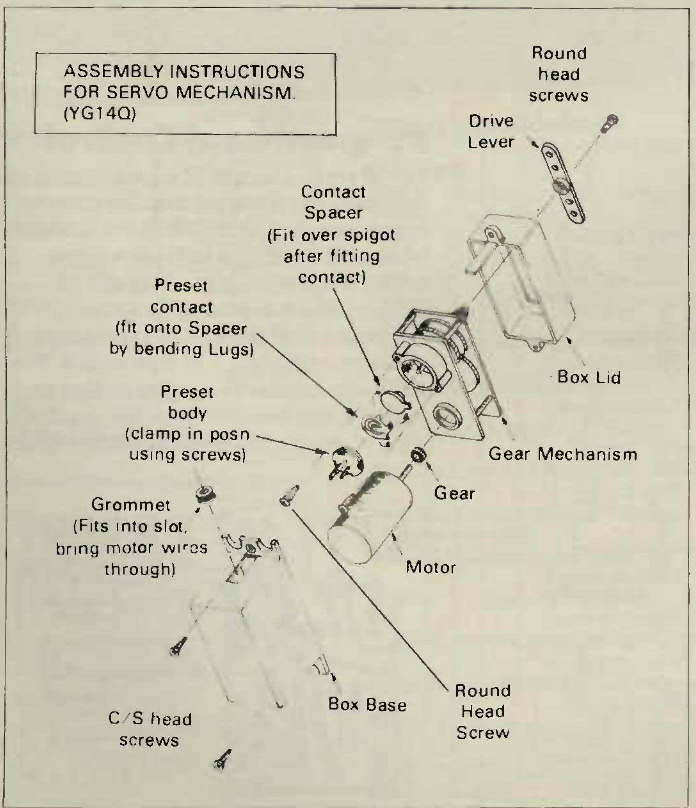
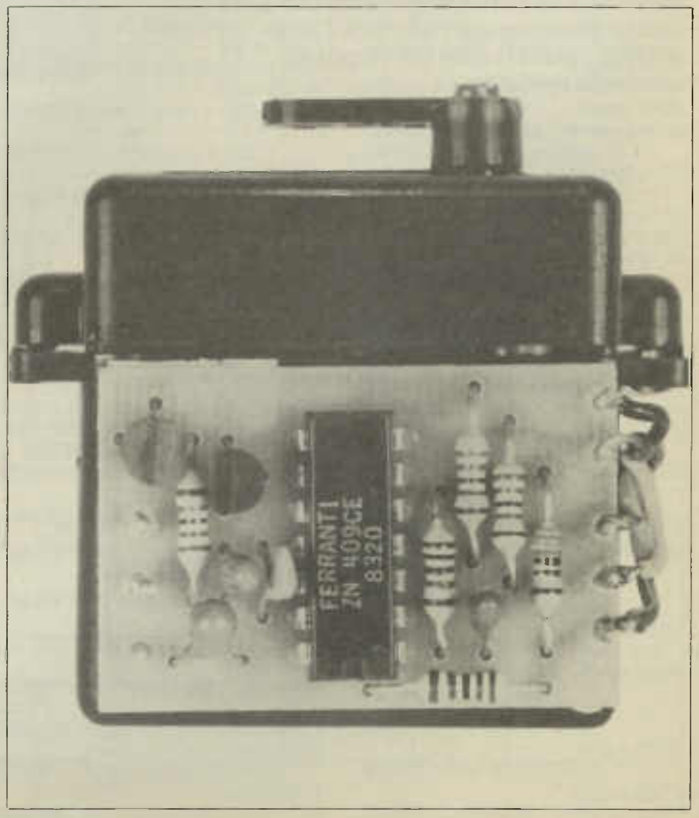


Figure 4 Mechanics Assembly



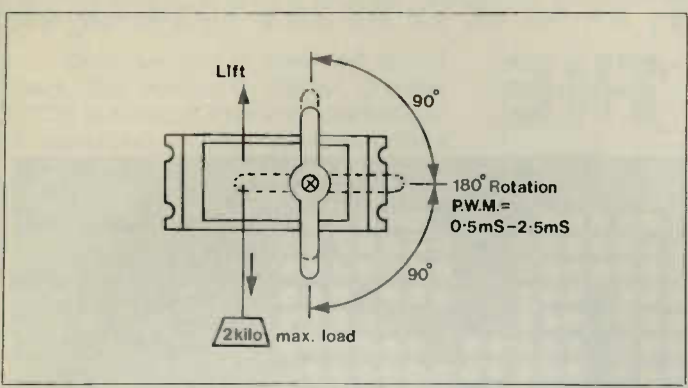


Figure 6 Servo Operation

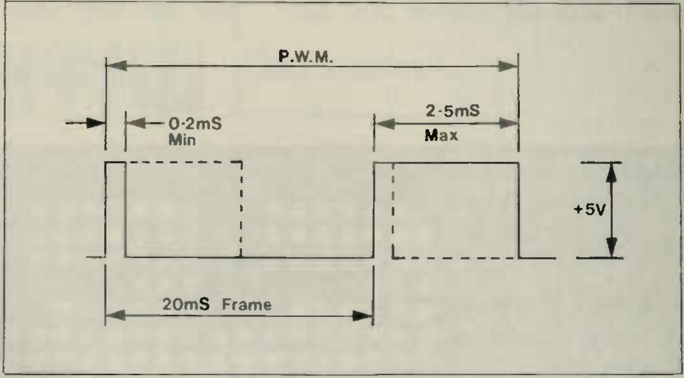


Figure 7 Control Signal

and remove excess wire ends. Fit IC1 and both transistors and carefully solder them in place. Clean the board and inspect for mistakes, short circuits, etc.

Servo Construction

The diagram in Figure 4 shows the servo assembly, but a few points need explaining in more detail. Snap off one of the contact spacers and remove the casting piece. Fit the brass preset contact over the spacer so that the key fits into the slot. Note that the contact mounts over the face moulded with a small bush protrusion – not the larger bush face! Gently bend both brass lugs over so that the contact is held firmly to the spacer. Next carefully press the assembly onto the gearbox spigot as shown, ensuring that the wiper is facing outwards. This job is a bit fiddly and great care must be taken to avoid damaging the wiper. Place the cermet preset (terminals facing outwards!) over the wiper and line up two of the four available slots with two screw mounting holes. Insert the self tapping cross-head screws and tighten down just enough to grip the preset edges, over-tightening will break the body and obviously should be avoided. Place the small brass gear over the motor shaft and press home. Fit the motor onto the mechanism housing by pushing and twisting, the fit is made tight to prevent the motor from turning when in use.

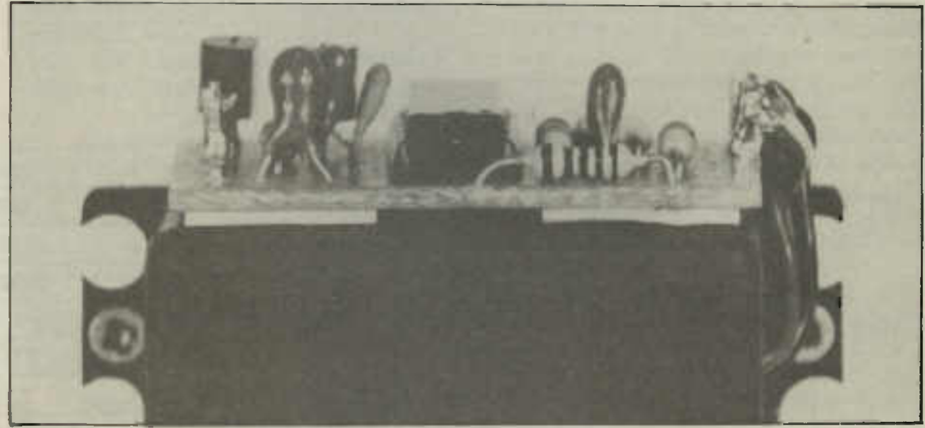
Servo and PCB Wiring

Figures 2 and 5 show the five connections between the servo and PCB. In fact motor connections M1 and M2 can be reversed as can preset connections PR1 and PR2 although the wiper W connection must be as shown. Keep wiring between the units as short as possible to prevent excessive motor RF from being induced into the preset circuitry, otherwise operation may be erratic. The PCB has been made the correct size for fitting onto the side of the servo box and quick stick pads can be used here to advantage – as shown in the photograph.

Testing

A suitable +V pulse transmitter/receiver system can be used, or for convenience the test circuit shown in Figure 3 can be constructed – to produce a 20mS frame and variable 0.5 to 2.5mS pulse width, using the values given. A suitable 4.2 to 6.5V supply will be required, such as four AA Ni-Cads or a 126 type dry battery. The power supply used should be capable of delivering up to 1 Amp without the +V rail dropping, otherwise problems will be encountered.

Connect up the supply rails and switch on, a slight 'glitch' may occur, but nothing more. Input the PWM signal and make a return path by connecting the servo ground (0V) to the signal source ground. If using the test circuit (Figure 3) from the same power supply you will require a large de-coupling capacitor fitted across pins 7 and 14 of the 4001 IC, to prevent amplitude modulating the PWM signal; 470uF to 1000uF should suffice. Move RV1 or your transmitter joystick from centre to full clockwise or full anti-clockwise, whereupon the servo arm should follow suit. If the motor drives continuously or jitters excessively, reverse PR1 and PR2 connections. In case of malfunction various voltage levels should be checked with a high impedance voltmeter or oscilloscope, referring to the circuit description as a guide.



SERVO & DRIVER MODULE PARTS LIST

RESISTORS:– All 0.4W 1% Metal Film			
R1	100k	1	(M100K)
R2	150k	1	(M150K)
R3	4k7	1	(M4K7)
R4	2k2	1	(M2K2)
R5,6	330k	2	(M330K)
CAPACITORS			
C1	1n5F Ceramic	1	(WX70M)
C2	100nF 35V Tantalum	1	(WW54J)
C3	470nF 35V Tantalum	1	(WW58N)
C4	2μ2F 35V Tantalum	1	(WW63S)
SEMICONDUCTORS			
IC1	ZN419CE	1	(YH92A)
TR1,TR2	BC327	2	(QB66W)
MISCELLANEOUS			
	Servodriver PCB	1	(GB68Y)
	Veropins 2145	1 pkt	(FL24B)
	Servo Mechanism	1	(YG14Q)
	Miniature Motor	1	(YG12N)

A complete kit of parts is available.
Order As LK45Y (Servodriver Module Kit) Price £9.75

MACHINE CODE PROGRAMMING WITH THE 6502

by Graham Dixey C.Eng., M.I.E.R.E. Part Five

The 6522 Versatile Interface Adapter (VIA)

This member of the 6502 'family', whose architecture is shown in Figure 1, allows the 6502 MPU to be connected to the outside world in order to perform useful functions. In Part Four of this series we saw how to program the input/output ports of the computer in order to decide which lines were inputs and which outputs, and also how to send data to or fetch data from external devices. The two input/output ports, which we referred to as Port A and Port B, actually occupy space on a chip such as the 6522 (there are alternatives) and are represented by the Data Registers and the Data Direction Registers for these ports. However there are other functions on this particular chip which earn it its description – versatile.

Figure 2 shows that the 6522 has sixteen registers, the low bytes of their addresses occupying the range 00 to 0F. For example, DRB (data Register B) has its low byte as 00 so that, if the 6522 is located on Page 9 of the memory map (as it was in the last article and will be in future), then its full address will be 0900; similarly DDRB is at 0902, DRA and DDRA are at 0901 and 0903 respectively. But you may have spotted that there are actually TWO DRAs, the other being located at 090F. This is because the DRA at 0901 has a 'hand-shaking' facility whereas the one at 090F doesn't – more of this later. The important thing to grasp at the moment is that there are sixteen memory-mapped registers i.e. registers that are accessible to the programmer merely by treating them as any other memory locations. What we must now find out is what these registers do and how to make use of them. However, I do not propose to describe each of them now but will treat them as they arise in the process of actually making use of them. The first ones that we will consider are the control registers.

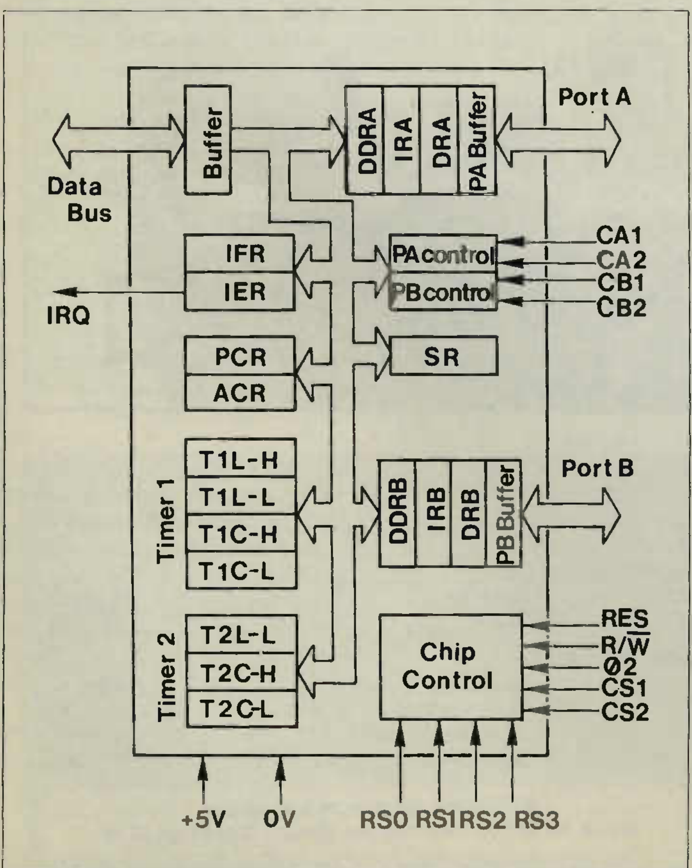


Figure 1. 6522 Architecture

00	DRB	Port B
01	DRA	Port A (with handshake)
02	DDRB	Data direction
03	DDRA	
04	T1L-L / T1C-L	Timer 1
05	T1C-H	
06	T1L-L	
07	T1L-H	
08	T2L-L / T2C-L	Timer 2
09	T2C-H	
0A	SR	Shift register
0B	ACR	Auxiliary control
0C	PCR	Peripheral control
0D	IFR	Interrupt flags
0E	IER	Interrupt enable
0F	DRA	Port A (no handshake)

Figure 2. The 6522 Registers and Addresses

The 6522 Control Registers

There are two of these and one of them, the Peripheral Control Register (PCR) is shown in Figure 3. This register is associated with the four control lines CA1, CA2, CB1 and CB2 which appear on the right of Figure 1. It is the use of this register that allows the hand-shaking procedure mentioned earlier to be carried out. The question then is 'what is hand-shaking'?

Suppose a printer is being fed with data from the micro. If the printing speed is 80 C.P.S.(characters/sec.), then it takes 1/80s or 12.5ms to print out a single character. This may not sound long but, to put it into perspective, remember that it takes only 2 or 3 micro-seconds to carry out a single instruction within the 6502. To determine when the printer is ready for a new character the printer sends a READY signal to the 6522. This is in the form of a pulse or level transition which is detected and latched by the 6522 and tested by the program. This READY signal is received at either CA1 or CB1 depending upon which port has the printer connected to it. Upon its receipt an internal 'interrupt flag' is tripped. As already mentioned this signal can be either a pulse or a level transition. It is possible to determine whether the events are to be initiated by a high-low or a low-high transition or, in the case of a pulse, whether it is the leading edge or the trailing edge that makes things happen. This is done by programming the bits 0 and/or 4 of the PCR (see Figure 3). Programming a '0' into either of these two bit positions specifies a response to a high-low transition, while programming a '1' into either position makes the system respond to a low-high transition. This can be illustrated by a short segment in Assembly Code.

Suppose that for Port A the response should be to a high-low transition, while Port B must respond to a low-high transition. This situation can arise if two different peripherals are separately connected to the two ports. This is carried out as follows.

```
LDA     #XXX1XXX0 (in binary)
STA     PCR
```

The Xs merely indicate that, for the moment anyway, bits 1–3 and bits 5–7 have not been specified. Naturally, we would have to know what they should be in order to specify the HEX data for the LDA operation. For example, if it could be assumed that the Xs could, in fact, all be 0s, then the data in HEX would be 10.

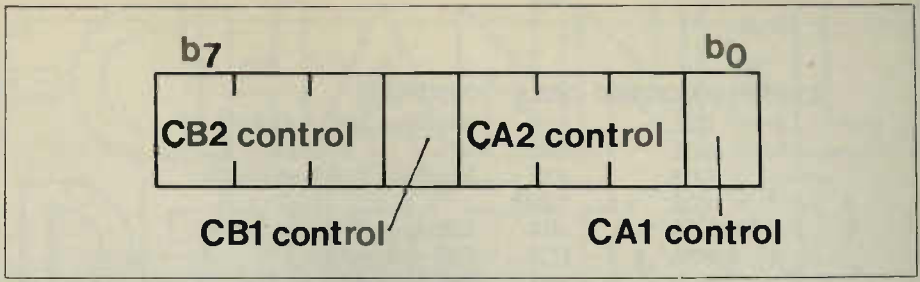


Figure 3. The Peripheral Control Register (PCR)

But, for the moment, let us just focus attention on bits 0 and 4. What we have now achieved is to set up control lines CA1 and CB1 so as to make the 6522 respond to the appropriate level changes from the peripherals.

It has been mentioned that, when such a signal is received, an internal interrupt is triggered. This event takes place in the Interrupt Flag Register (IFR) (see Figure 4) and affects the status of either bit 1 or 4 of this register (for controls CA1 or CB1 respectively). These bits are normally '0' but go to the logic '1' level when a transition on either CA1 or CB1 has been detected. Therefore, by checking these bits (flags) it is possible to find out whether a peripheral has signalled the micro for attention. Once data has been sent or received via the Data Register the flag automatically resets ready for the next time that a signal is sent out.

The question that now naturally arises is 'how can the flags in the Interrupt Flag Register be tested'? Since this register is memory mapped, it can be treated exactly as any other memory location and its contents can be loaded into the Accumulator. Then, in order to test the flag for CA1, for example, this bit must be selected by, say, a masking operation. e.g.

```
LDA  IFR   Load contents of IFR into A
AND  #02   makes all bits other than bit
           1 equal to zero (02=00000010)
```

The next instruction would probably be a branch to act upon the result of the AND operation. (This 'masking' operation was dealt with in Part Four of this series, if you are unsure of it you are recommended to refer back).

The Input/Output Latches

Figure 1 shows that associated with each port is an input latch (IRA and IRB). This reveals a slight curiosity. Data output from the micro to a peripheral is always 'latched' (held in DRA or DRB) but data input to the micro from a peripheral need not necessarily be latched. It is the choice of the programmer. Whether input data is latched or not is determined by the values of bits 0 and 1 of the Auxiliary Control Register (ACR), shown in Figure 5. Bit 0 controls the Port A latch while bit 1 controls Port B latch. Programming these bits to be '1s' causes latching to occur; programming them as '0s' means that latching does not take place. In the latter mode the program reads the data actually present at that instant on the input lines to the micro. When latching is employed, enabling of the latch occurs each time that a transition on CA1 or CB1 is detected, depending on the port in question.

Having now digested (one hopes!) the above information, it can now all be tied together with an application example. Figure 6 shows two peripherals, A and B, connected to ports A and B respectively of a 6522 VIA. Each peripheral has a READY line, CA1 and CB1 respectivly. Peripheral A supplies data to the micro at a rate determined by some time-constant which is capable of variation. The data, in analog form, comes from a transducer which could be measuring temperature, wind speed, liquid level, or any other quantity you wish to name. A conversion is made from analog to digital form and this is input to Port A of the 6522. Control CA1 goes down from logic 1 to logic 0 whenever the micro is to receive a data sample. This sample is read by the computer which classifies it and sends out to the printer a character which typifies the class. The printer has a READY line which connects to CB1 and indicates the READY state with a low-high transition. The output to the printer is in 8-bit parallel format. Input data is to be latched.

What has to be done is to write a program that achieves the objectives outlined in the foregoing description. To do this well requires a tidy, logical approach. The first step is to state the objectives clearly so that it is obvious exactly what the program is expected to achieve. This will now be done for the data transfers between the micro and the peripherals; the data handling part of the program is outside the scope of the

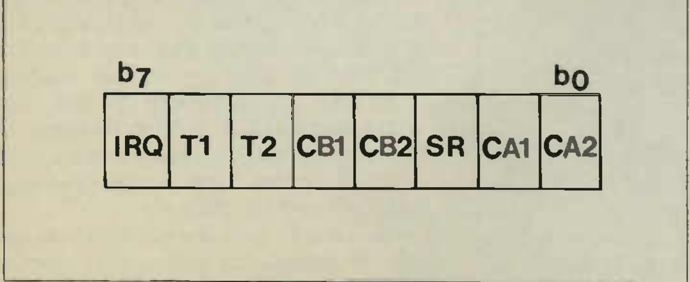


Figure 4. The Interrupt Flag Register (IFR)

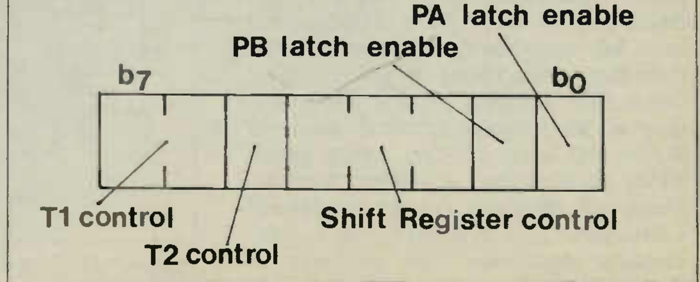


Figure 5. The Auxiliary Control Register (ACR)

LABEL	MNEMONIC	DATA	COMMENTS
	LDA	#00	Initialises Port A as input
	STA	DDRA	
	LDA	#FF	Initialises Port B as output
	STA	DDRB	
	LDA	#10	Initialises CA1 −ve acting
	STA	PCR	CB1 +ve acting
	LDA	#01	Initialises ACR bit 0 so that
	STA	ACR	data input to Port A is latched.
(This completes the initialisation block on the flow-chart)			
WAIT1	LDA	IFR	Load A with contents of interrupt flag register
	AND	#02	Mask all bits except bit 1
	BEQ	WAIT1	Test whether bit 1 is '0' or '1'
	LDA	DRA	Fetch input data from Port A
(This completes the next two blocks on the flow-chart)			
	JSR	SUB1	Go to data handling sub-routine and return
WAIT2	LDA	IFR	Load A with contents of interrupt flag register
	AND	#10	Mask all bits except bit 4
	BEQ	WAIT2	Test whether bit 4 is '0' or '1'
	STX	DRB	Send X register contents to Port B
(This completes the next two blocks on the flow-chart)			
	JMP	WAIT1	Go round again
(This completes one cycle and returns to start)			

Figure 8. Assembly Code Program

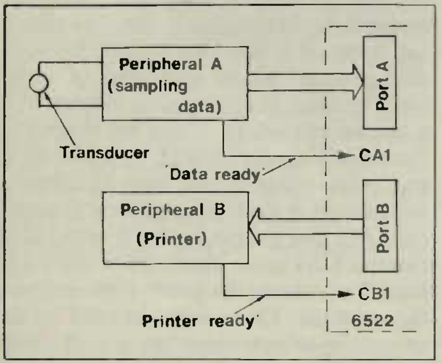


Figure 6. Using the 6522 with Peripherals

present discussion.
(a) Initialise DDRA and DDRB so that Port A acts as inputs; Port B acts as outputs
(b) Initialise PCR so that
  (i) CA1 is negative acting
  (ii) CB1 is positive acting
(c) Initialise ACR so that input data is latched.
(d) Program must include
  (i) loading A with data at Port A
  (ii) sending characters to printer
  (iii) in both cases (i) and (ii)
  test the flags for the READY state.

A flow-chart often helps to clarify ideas and test the logical process on paper. Figure 7 shows the essential main steps and includes three loops which must be considered. First, there is the main loop, which keeps the process going indefinitely, 'jumping' back to the beginning of the program for fresh samples. Within this loop are two minor loops, which each perform a 'waiting' function. These will obviously contain conditional instructions (i.e. branches) since they embody decisions. The program in Assembly Code is shown in Figure 8.

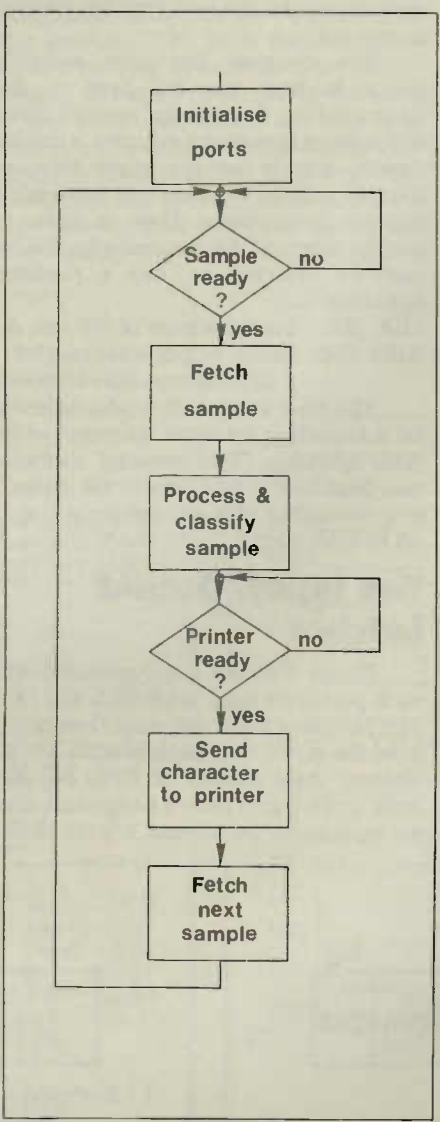


Figure 7. Flow-Chart for the System in Figure 6.

Note the following:
(a) Once the ports have been initialised, this procedure is not repeated. If the return loop went back to line 1 instead of WAIT1, the program would still work but it would be slowed down.
(b) The X register has been used to hold the character ready for the printer (it would have been loaded with this character during the sub-routine). Had the character been held in a memory location instead it would have been necessary to perform, say, an LDA operation once the test on the accumulator had established the presence of an interrupt (thus wasting time). It is not possible to transfer data direct from a memory location to the ports, only from A, X or Y. Since A is in use to test flag status, it is better to use either X or Y instead.

The program can now be encoded into Machine Code. It will reside on Page 0 (though it doesn't have to) and will start at location 0020. The data handling subroutine is assumed to start at location 0300.

Machine-Code Program

Program Counter	Op-Code	Byte 2	Byte 3
0020	A9	00	–
0022	8D	03	09
0025	A9	FF	–
0027	8D	02	09
002A	A9	10	–
002C	8D	0C	09
002F	A9	01	–
0031	8D	0B	09
0034	AD	0D	09
0037	29	02	–
0039	F0	FA	–
003B	AD	01	09
003E	20	00	03
0041	AD	0D	09
0044	29	10	–
0046	F0	FA	–
0048	8E	00	09
004B	4C	34	00

It is strongly suggested that you check the encoding of this program against the tables of op-codes given previously. This is quite easy as it is just a line-for-line comparison with the Assembly Code program. Check the data for the branch lengths at addresses 003A and 0047 (FA in both cases) to make sure that you understand how this data was calculated. If necessary refer back to Part Two of this series to brush up on the procedure. Check the addresses used for the various 6522 registers against Figure 2, remembering that, for our purpose, the VIA has been assumed to be on Page 9 of the memory map so that all register addresses are preceded by 09; e.g. address of the ACR is 090B. However, in the machine-code program any address specified by two bytes is always written 'low-byte first' i.e. 0B09.

In the next part we will return to the 6522 to discuss the timers, shift register and subleties.

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. When building a darkroom and workshop into a garage recently, it was deemed necessary to have 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.

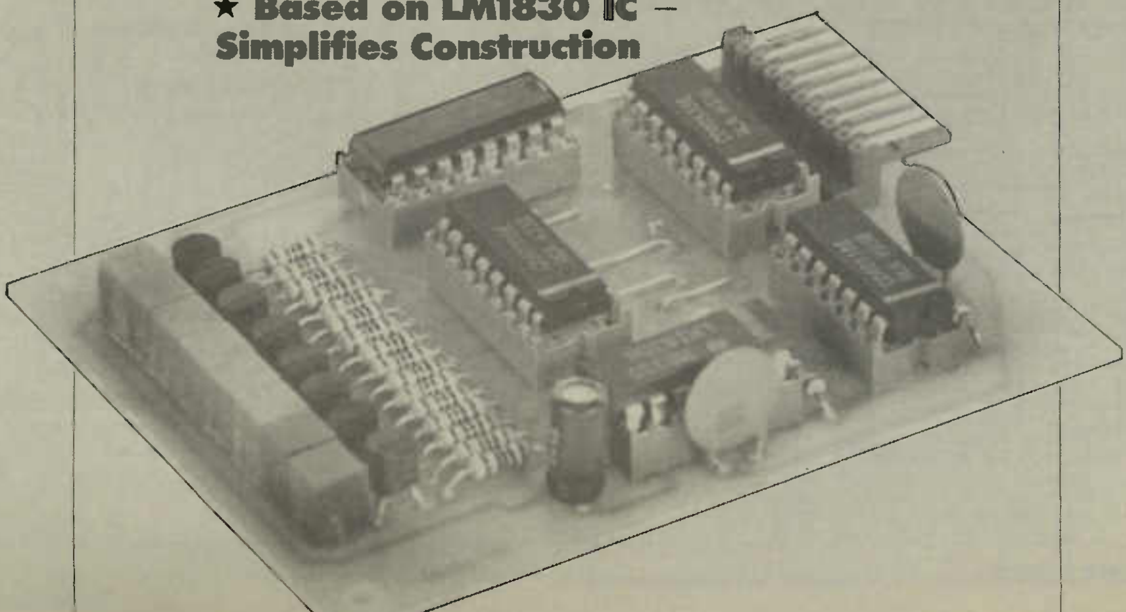
Circuit Description

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 smoothes 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 then 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 – Simplifies 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, many of the circuits shown in back issues of this magazine will reveal a suitable design (i.e. Digital Enlarger Timer/Controller in the June to August 1983 issue, Vol.2 No.7). 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 bottommost strip.

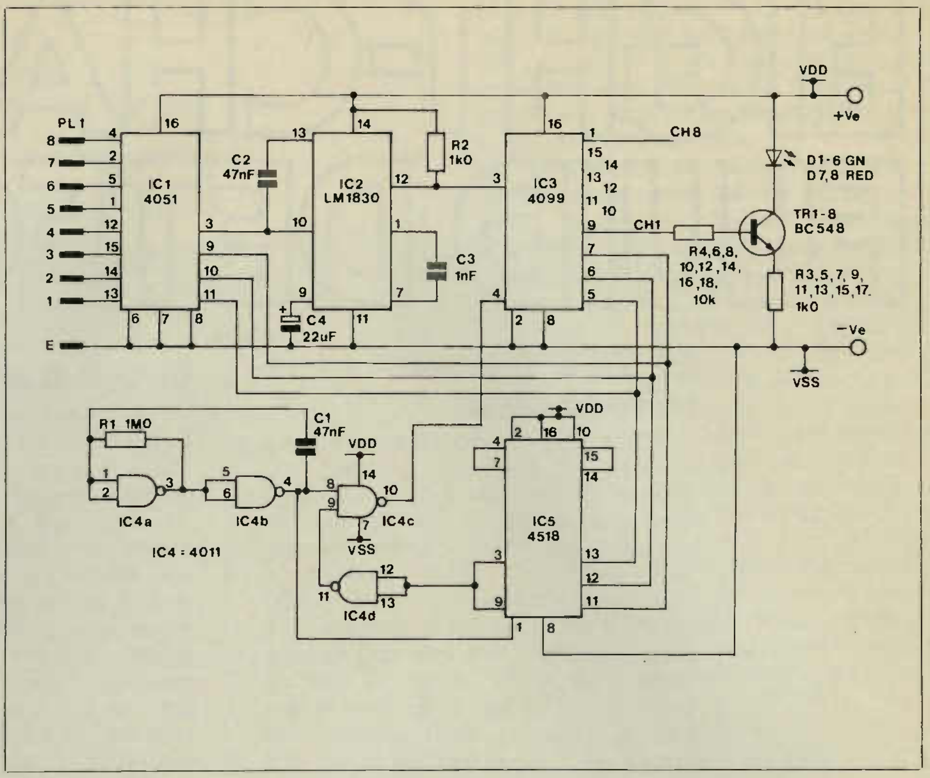


Figure 1. Circuit diagram

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 novelty idea. The pupose 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

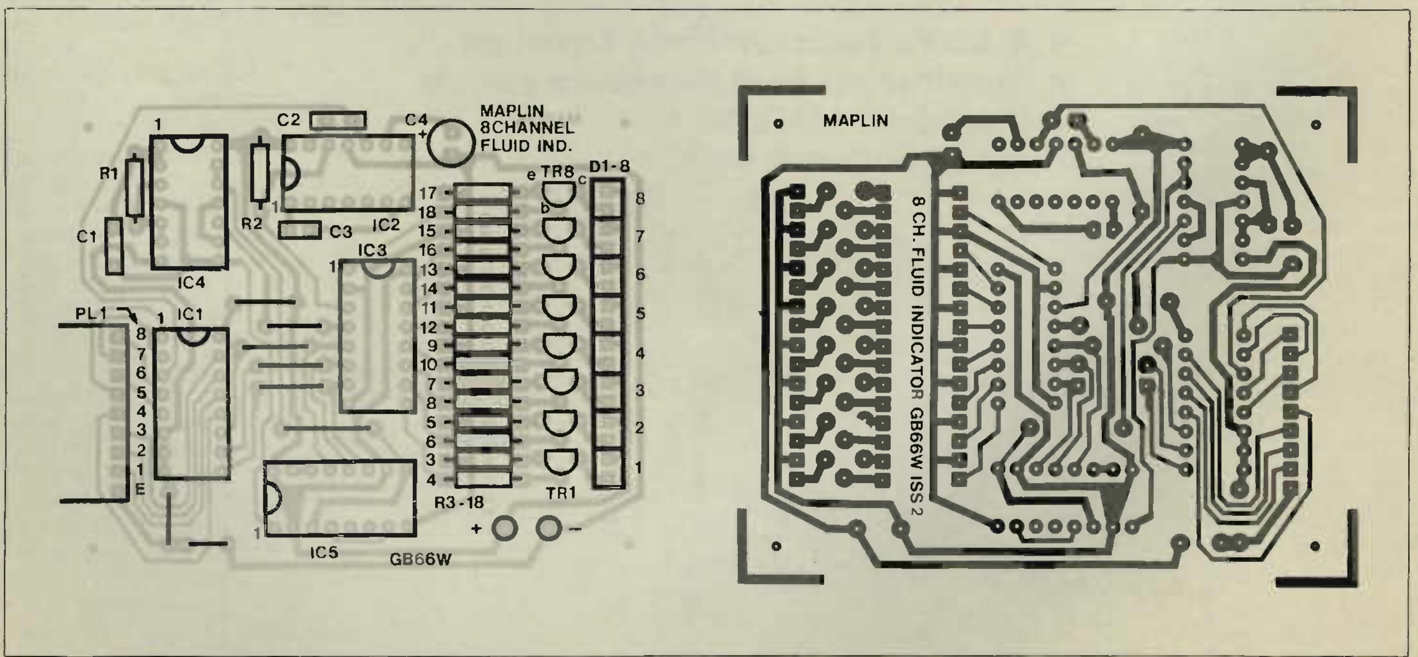
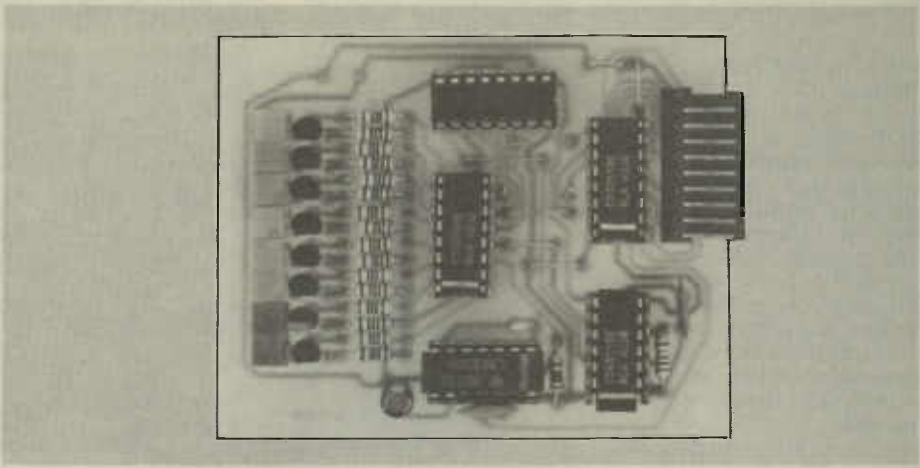


Figure 2. PCB track & layout

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 spayers 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 tempara-tures 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 0.4W 1% Metal Film			
R1	1M	1	(M1M)
R2,3,5,7,9,11,13,15,17	1k0	9	(M1K)
R4,6,8,10,12,14,16,18	10k	8	(M10K)
CAPACITORS			
C1,2	47nF Minidisc	2	(YR74R)
C3	1nF Ceramic	1	(WX68Y)
C4	22µF 16V PC Electrolytic	1	(FF06G)
SEMICONDUCTORS			
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)
MISCELLANEOUS			
PL1	RA Minicon Latch Plug 10-Way	1	(RK68Y)
	DIL Socket 14-pin	2	(BL18U)
	DIL Socket 16-pin	3	(BL19V)
	PC Board	1	(GB66W)
	Strapping Wire	1 roll	(BL13P)

A complete kit of parts is available for this project.
Order As LK48C (8-Channel Fluid Det Kit) Price £12.95

MOTHERBOARD FOR BBC MICRO *Continued from page 28.*

Motherboard for BBC Parts List

RESISTORS: All 0.4W 1% Metal Film			
R1	270Ω	1	(M270R)
R2	1k0	1	(M1K)
CAPACITORS			
C1	100µF 25V Axial Electrolytic	1	(FB49D)
SEMICONDUCTORS			
LED1,2	LED Red	2	(WL27E)
MISCELLANEOUS			
SK1	Analogue Port Cable	1	(FJ24B)
SK2	I/O Port Cable	1	(FJ26D)
SK3	1MHz Port Cable	1	(FJ25C)
SK4-7	2 x 23 Way PC Edgecon	4	(RK35Q)
FS1	Fuse 20mm 250mA	1	(WR01B)
	Fuse Clip	2	(WH49D)
JK1	PC Mtg Power Skt	1	(RK37S)
S1	DPDT Slide Switch	1	(FH36P)
	Motherboard PCB	1	(GB39N)
	Std Power Plug 2.1mm	1	(HH60Q)
	Strapping Wire 20 SWG	1 roll	(BL13P)

A complete kit of the above parts is available.
Order As LK47B (Motherboard for BBC Kit) Price £27.95

PRICE LIST OF NEW ITEMS IN THIS ISSUE

FJ00A	PCB Mono Jack Socket	25p
FJ05F	PCB Stereo Jack Socket	35p
FJ24B	BBC Analog Port Cable	£5.85
FJ25C	BBC 1MHz Port Cable	£4.99
FJ26D	BBC I/O Port Cable	£3.30
FJ35Q	Mark 2 N/R Unit Front Panel	£2.25
FJ36P	Mapmix Front Panel	£3.85
GB39N	Motherboard for BBC PCB	£5.40
GB60Q	Mapmix PCB	£5.35
GB61R	Xenon Tube Driver PCB	£2.45
GB64U	Enlarger Exposure Mtr PCB	99p
GB65V	Ni-Cad Charger PCB	£2.55
GB66W	8 Ch Fluid Detector PCB	£3.10
GB68Y	Servodriver PCB	£1.35
LK38R	Mk 2 Noise Reduction Kit	£39.95
LK44X	Enlarger Exposure Mtr Kit	£7.95
LK45Y	Servodriver Kit	£9.75
LK46A	Xenon Tube Driver Kit	£11.75
LK47B	Motherboard for BBC Kit	£27.95
LK48C	8 Ch Fluid Detector Kit	£12.95
LK49D	Mapmix Kit	£29.95
LK50E	Ni-Cad Charger Kit	£19.95
XG37S	Mk 2 Noise Reduction Case	£8.95
XG38R	Mapmix Case	£8.95

New Books

How to Design Electronic Projects
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An interesting new book which aims to help the reader put together projects from standard circuit building blocks, with the minimum of trial and error and without resorting to advanced mathematics. A series of simple and practical examples are taken, each circuit is analysed and practical designs, including component values, are evolved. A selection of useful circuits are also included.
178x110mm, 102 pages, illustrated.
Order As WM67X (Design Electronic Projects) Price £2.40*NV*

An Introduction to Programming the Acorn Electron
by R.A. & J.W. Penfold
This book covers programming the Electron in BASIC one step at a time, with examples to demonstrate the various instructions and functions, and show how they can be applied. Eleven chapters deal with all aspects of BASIC programming including Variables, Formatting, Sound Generation, Graphics, File Handling, etc.
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Order As WM68Y (Intro to Program Electron) Price £2.10*NV*

Programming the M68000
by Tim King & Brian Knight
This comprehensive guide explains how to program the M68000, which is one of the most advanced microprocessors available at the present time. It is written in a clear and readable manner and provides a wealth of information. The basic M68000 architecture is introduced and then each instruction is explained. Many practical programs are given and readers are encouraged to write effective programs. A complete small monitor program which will handle input & output, test programs etc. is also included.
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Electronically Speaking: Computer Speech Creation
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by P. Cornes & A. Cross
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178x110mm, 109 pages, illustrated.
Order As WM70M (Secrets of the Commodore 64) Price £2.15*NV*

ELECTRONIC CHRONICLES

A Brief History of Electronics

by Mike Wharton Part 2

The Dawn of a New Era

The start of the 19th century saw the beginning of a new era in the study of electricity. The pioneer work carried out by Volta, Galvani and others during the close of the 18th century set the groundwork for the next generation. Gradually the superstitious attitudes about natural phenomena were replaced by scientific study. This in turn led inevitably to a greater understanding of intangible subjects, like electricity.

At this time a vast number of discoveries were being made and it was not immediately realised that they were all connected with electricity. Nowadays we all take very much for granted the various manifestations of the passage of an electric current, such as the heating and the magnetic effect, but these all needed to be drawn together into a coherent picture.

Ampère had shown that the study of this new subject would yield to a mathematical analysis and this no doubt helped to speed the pace of developments. Many of the discoveries made during the early part of the 19th century were connected with the measurements associated with an electric current. Indeed, it was at this point that the fundamental ideas regarding the basic concepts were laid down; for example, that something 'flowed' when electricity passed, the very use of the term 'current', like the flow of water. Likewise, it became appreciated that in order for a current to flow there must be something else causing it to be pushed along. For this reason terms like electro-motive force were coined, usually abbreviated these days simply to e.m.f.

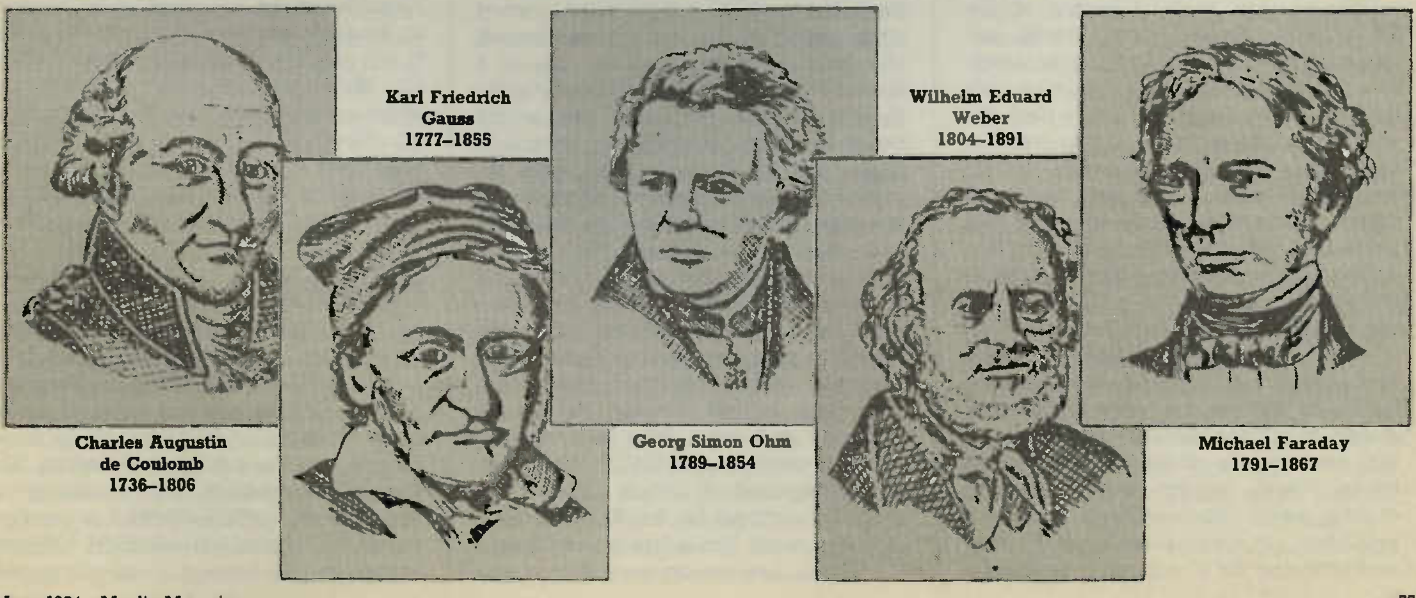
As soon as one begins to make measurements then a system of units is required in which to express them. Since the inter-relation of the various effects had not yet been sorted out, a wide range of systems were devised. This in turn led to separate units for measuring electrostatic effects, magnetic effects and electrochemical effects. Fortunately, these have long since been abandoned in favour of the unified system we now all enjoy.

Coulomb

One of the pioneers who played an extremely important role in developing the hitherto vague and fragmentary knowledge of electricity and magnetism was Charles Augustin de Coulomb. By his brilliant experimental work he was able to introduce scientific laws relating to electrostatic and magnetic attraction, upon which men like Gauss and Weber could build. It was a century after Isaac Newton had published his law of gravitation that Coulomb discovered exactly analogous laws for electricity and magnetism. He showed that the force of attraction between electric charges and magnetic poles was proportional to the square of the distance between them. These apparently simple laws required a tremendous amount of experimental skill and extremely accurate measurement of the minute and fleeting quantities involved.

Coulomb was born in 1736 in the town of Angouleme, about 70 miles from Bordeaux, France. His father had not been very interested in his education, and he flitted from one school or college to another, giving him the name of 'martinet'. After a series of disastrous financial speculations, which left the family almost penniless, he moved with his father to Montpellier. Here more affluent members of the family gave them assistance, including an introduction to the thriving scientific circle there.

At the age of 21, Coulomb was faced with choosing a suitable career. The possibilities for a young bourgeois at that time were the Church, Army or Civil Service. He joined the Army, and hoped that in the Engineering Corps he would be able to practise his scientific talents. He entered a military college from which



Charles Augustin de Coulomb 1736–1806

Karl Friedrich Gauss 1777–1855

Georg Simon Ohm 1789–1854

Wilhelm Eduard Weber 1804–1891

Michael Faraday 1791–1867

$$F \propto \frac{Q_1 Q_2}{\epsilon d^2}, \quad F \propto \frac{M_1 M_2}{\mu d^2}$$

where: Q = Electric charge
ϵ = Relative permittivity
M = Magnetic pole strength
μ = Relative permeability
d = Distance between poles or charges
F = Force of attraction

Coulomb's laws of electricity and magnetism

he graduated two years later and was sent to Martinique in the West Indies. His job was to supervise the building of Fort Bourbon, but the conditions were appalling and he became seriously ill. After about eight years in Martinique, Coulomb returned to France to continue his career in the Army. During this important period in his life he wrote his 'opus magnum' on statistics and dynamics, "The Theory of Simple Machines".

It was during the five years leading up to the French Revolution in 1789 that Coulomb wrote his famous works on electricity and magnetism, when he was around 48 years of age. With the Revolution, he resigned all his posts, including that of Lieutenant Colonel of the Army, and was one of the nobles who was expelled from Paris. He retired to a small estate in Blois and settled down to a quiet life of scientific investigation. However, in 1795, he was invited by Napoleon to return to Paris, where he was made an Inspector-General of Public Instruction. Coulomb continued to devote his life to scientific work until his death in 1806 at the age of 70.

Gauss

Another of the great luminaries of this age was Karl Friedrich Gauss. He was born in 1777, the son of a poor gardener in Brunswick in what is now Germany. He was a very intelligent child and grew up to become a mathematician, astronomer and physicist of the highest order. The young Karl Gauss was given financial assistance to attend a good school where by his early twenties he had mastered the works of Newton and others. He then attended University at Gottingen, after which he was made Director of the Observatory. In this post, Gauss had responsibility for carrying out geomagnetic surveys, that is, measuring the strength of the Earth's magnetic field. He was able to draw on the earlier work of Coulomb, and he has come to be associated with the measurement of magnetic effects. Formerly, his name was associated with the unit of magnetic flux density, but with the introduction of the SI units this honour was lost to Nikolai Tesla, the unit now being called the 'tesla' (T).

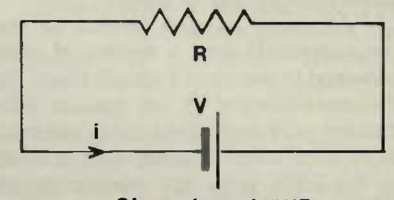
Many of Gausses greatest mathematical papers were not published until after his death. Indeed, his name is also well known to mathematicians, particularly in the form of the Gaussian distribution curve. These papers were found to contain many theories which had been published by other people, which was embarrassing for a number of them who had become famous as a result of what they thought was original work!

Although the name of Gauss has been relegated from the 'first division' of electrical units, it is still synonymous with magnetism. The term 'degaussing' was coined during the Second World War, when steel ships were demagnetised to prevent them setting off magnetic mines. Its most modern application is to be found in colour television sets, where a degaussing coil is fitted around the flare of the cathode ray tube to demagnetize the shadow mask.

Much of the work done at this time by men such as Gauss was carried out on permanent magnets and the connection between magnetism and electric current was yet to be fully explained.

Ohm

One of the most famous men working on electricity during the first half of the 19th century was Georg Simon Ohm. His name is enshrined in the unit of resistance and the law which relates this quantity to voltage and current, and is one of the cornerstones of electrical theory.



Ohms Law i=V/R

Georg Simon Ohm was born in Bavaria in 1789. He went to school there and later taught maths and physics at several schools in the neighbourhood before attending University at Erlangen. In 1817, at the age of 28, he was appointed Head of the Department of Physics at the Polytechnic Institute of Cologne. Here he began his studies of the flow of electricity through various metals. These experiments were carried out entirely on his own, using apparatus which he had built himself. In these experiments Ohm found that the voltage from the cell he was using varied considerably as the current was varied, and he had to resort to the use of a thermocouple to measure the current. He discovered the empirical law which bears his name in 1826, but when he announced his findings they were received with little response. He repeated the experiments the following year, this time taking into account the internal resistance of the cell which solved the problem of voltage variation. Again his results met with little interest, and some scientists even called it a fantasy. His work was given a bad reception universally, and he was forced to live in obscurity and poor financial circumstances. It was not until 1841 that his work was recognised in Britain and he was awarded a medal by the Royal Society, who also made him a foreign member.

Ohm's Law seems very simple and straightforward nowadays and can be demonstrated with quite simple apparatus: it seems strange that it should have had such a difficult birth. Germany rewarded this great physicist rather belatedly, by appointing him to the Chair of Physics at Munich University only two years before his death in 1854.

Weber

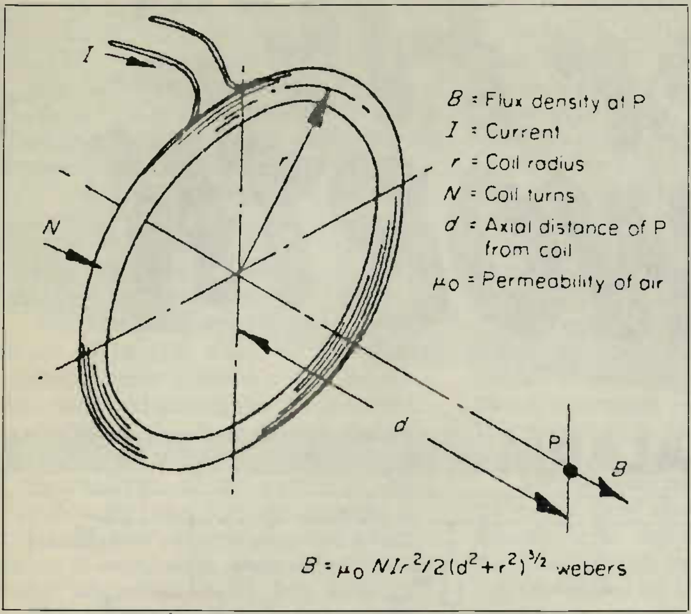
Another German scientist, a contemporary of both Gauss and Ohm, was Wilhelm Eduard Weber. Weber was born in 1804 at Wittenburg, the fifth child of a Professor of Divinity. He studied science at a place called Halle, where he eventually became an Assistant Professor. In 1831 he moved to the University of Gottingen at the suggestion of Karl Gauss, and with whom he later worked on studies on magnetism. In 1833 Weber's laboratory and Gauss's observatory were connected together by Weber's electric telegraph. This was the first practical, working system and used only two wires rather than other methods which used many more. In 1837 the King of Hanover abolished the parliamentary constitution by an autocratic decree. Some members of the staff of the University, as well as the brothers Grimm (of fairy tale fame) denounced this action and were immediately sacked.

For five years Weber was without a post and a collection was made for him throughout Germany, but he refused to accept the money and lived in near poverty. It was not until he was in his eighties that he used this money to buy apparatus which he used to establish an absolute unit of electric current, the ampére. Towards the end of his life he returned to the University at Gottingen and continued the work on electricity. There he established the absolute unit of electro-motive force, the volt, and was hence able to fix the unit of resistance, the ohm. Thus we are indebted to this great man for the units used in all measurements of electric currents and which today we take so much for granted. In spite of his tireless work on the unit of current, Weber was rather unfairly denied the honour of having his name used for it, the glory going to Ampère instead. In recent years, however, his name has been remembered in the SI unit of magnetic flux, the weber (Wb).

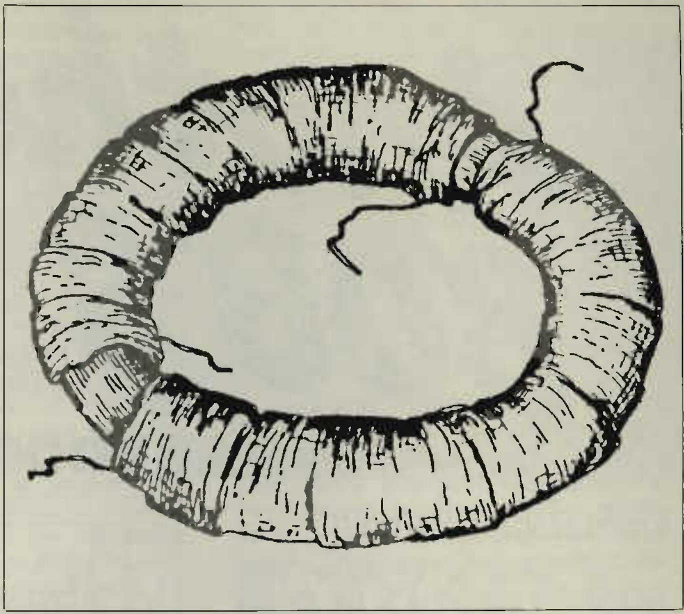
Weber was undoubtedly the founder of the accurate measurement of electrical quantities such as current, voltage, resistance and also capacitance. He was also the first to define elementary electric particles and ascribe mass and charge to them.

Faraday

Possibly the most famous person whose name is always connected with work on electricity is Michael Faraday. Because of his great contributions to the study of electrical phenomena he is often regarded as the Father of Electricity. His name is connected with a variety of experiments and effects, and is remembered in two electrical units. Almost anyone with an interest in electronics will



Flux Density Near Coil



Faraday's First Transformer

have encountered the unit of capacitance, the Farad. This is usually encountered in the practical smaller quantities of micro-Farads, nano-Farads and pico-Farads which all take their name from that of Faraday.

It is a measure of his influence and the high regard for his work by others in the field that he has been honoured by a second unit, the faraday. This is related to his studies in the subject of electro-chemistry, that is, the passage of electricity through solutions of salts. It was Faraday's investigations into this subject which led him to formulate his Laws of Electrolysis. The faraday is actually a specific quantity of electricity which will liberate a specific amount of a substance from a solution, and turns out to be equal to 96,500 coulombs.

Faraday was born in 1791 of relatively humble parents. His father was a blacksmith who had moved to London from Yorkshire with his wife who was a farmer's daughter. At school he was taught only the rudimentary subjects of reading, writing and arithmetic. He didn't show any great academic qualities during his school years, in fact he is reported to have spent most of his spare time playing marbles in the street! On leaving school he took the job of errand boy and then, shortly after, became apprenticed to a book-binder. One of the books he had the task of binding was an Encyclopædia of Electricity and young Faraday started to read it. He had an interest in science and, no doubt, it was reading books such as these which stimulated his interest even further. He pursued his chosen subject by attending evening lectures, which cost him one shilling; quite a large amount in those days. He attended lectures given by the well-known Sir Humphrey Davy at the Royal Society in London. He made copious notes of these lectures which he then bound into a book.

He decided at this time that he would like to get a job doing scientific work and so wrote to Davy, enclosing the bound book of lecture notes. Davy could not have been impressed by this approach for he didn't even bother to reply to Faraday's letter. Fate must have been on his side though, for shortly afterwards a relative of Faraday's who was also acquainted with Davy, heard that the great man was in need of an assistant. He promptly put Faraday's name forward and he was very reluctantly taken on at a wage of 25 shillings per week.

At first he was given little work that interested him and spent most of his time rebinding the books in the library at the Royal Society. Then fate played another card, for when one of the other assistants was sacked Faraday was able to take his place and work alongside his mentor Davy. From now on much more interesting work came his way; he travelled abroad with Davy and met such people as Ampère. Under Davy's guidance he commenced a career of research into chemistry, metallurgy and electricity. In 1817 he discovered electro-magnetic induction and made the first transformer and dynamo.

His ideas about lines and 'tubes' of magnetic flux were later to influence James Clerk Maxwell, and lead him to formulate his theories of electro-magnetic fields, which ultimately led to modern radio communication. Many of Faraday's inventions were directly applicable to the emerging electro-mechanical and chemical industries. He could have become very wealthy, but he shunned wealth and power throughout his life.

Michael Faraday led a simple private life. He was a religious person, being a member of a strict sect called Sandemanians, after their founder. His father was an elder of the sect, and they regarded saving money as a serious sin. This probably explains why Faraday never patented any of his inventions, and what little money he did make was given to charity. There is little doubt that he could have made a fortune from the industrial application of his inventions.

Faraday showed little interest in the opposite sex until he met Sarah Bernard, who was a member of the same sect. They were married when Faraday was 29 in 1820 and settled down to a quiet life in accordance with their religious beliefs, but had no children.

In 1857 he was invited to become President of the Royal Society, a most prestigious position, but he turned it down because he disagreed with the way the Society was run. He also turned down the offer of a knighthood, probably because of his religious beliefs.

Faraday's impact on the study of electricity is unquestionable, but his effect on the scientific community of the day was less spectacular. This was mainly due to his humble attitude and intolerance of what he often saw as arrogant 'humbug' in some of his contemporaries. When the famous politician Gladstone attended one of his lectures and asked Faraday what use his discovery of electricity might be, he replied, "at least you will be able to put a tax on it!" On another occasion an elderly lady asked a similar question, to which he is reputed to have replied, "madam, what use is a new born baby?" This answer gives some insight into his attitude to the subject, and indicates that he was more aware than most of the great potential that lay in the development of electricity. No doubt even he would be pleasantly surprised at the way in which electronics, for he helped to lay the foundation, has so revolutionised everyone's lives.

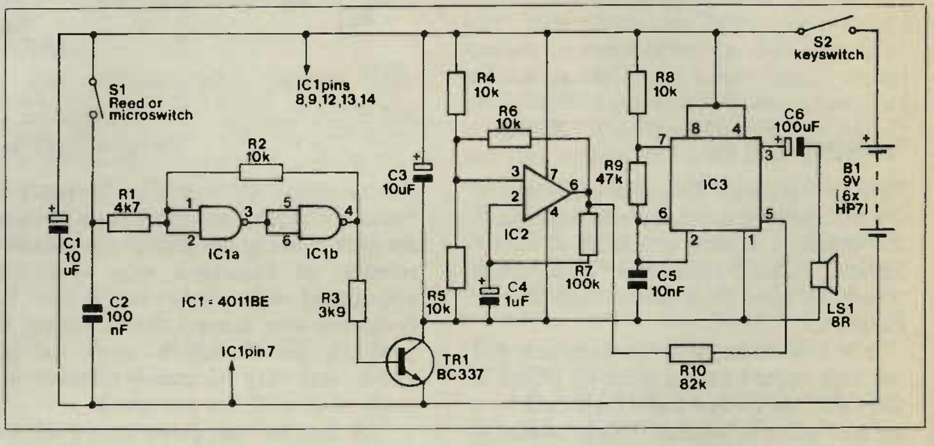
His last work, on the refraction of light in a magnetic field, was completed in 1862, when he was 71. Shortly after that his health deteriorated and he lived a further five years until his death in 1867; he is buried in Highgate Cemetary.

Faraday and the others had lain the groundwork during the early part of the 19th century for the development of the study of electricity. They had pointed the direction for the future inventions and discoveries to be made later in the century which were to have such far-reaching effects. Next time we shall have a look at some more of the famous, and not so famous, who continued the story during the latter half of the last century.

Another FIVE BOB'S WORTH

DOOR ALARM

From Robert Penfold



This circuit is a slightly more sophisticated alternative to the popular door-chain alarms. Units of this type have a microswitch that is operated when any tension is placed on the door-chain, and the microswitch in turn operates an audio alarm generator. With this circuit a reed switch or microswitch is directly operated when the door is opened so that the alarm is activated, even if the door is opened by just a few millimetres. Furthermore, once activated, the alarm latches in the ON state so that closing the door again will not silence it.

IC1 is a CMOS 4011BE quad 2 input NAND gate, but in this circuit two of the gates are used as simple inverters and the other two are unused. The two inverters are connected to act as a bistable circuit, and C2 ensures that the output of the bistable always goes low at switch-on. If S1 should close, even momentarily, the output of the bistable will trigger to the high state, and latch in that state. TR1 is then biased hard into conduction, and it provides the alarm generator with virtually the full supply voltage.

The alarm generator is based on IC2 and IC3. The latter is a 555 astable circuit operating at a fairly high audio frequency and having its output coupled to a loudspeaker by C6. The 555 can provide a strong output current into a low impedance load such as LS1, and this gives quite a loud alarm signal.

The alarm is made even more effective by frequency modulating the tone generator. IC2 is a 741C operational amplifier used in a standard relaxation oscillator circuit, and the low frequency square-wave output from pin 6 is loosely coupled to pin 5 of IC3 by R10. This gives an increase in the output frequency of the tone generator when the output of IC2 is low, and a reduction in frequency when it is high, giving a two-tone output signal.

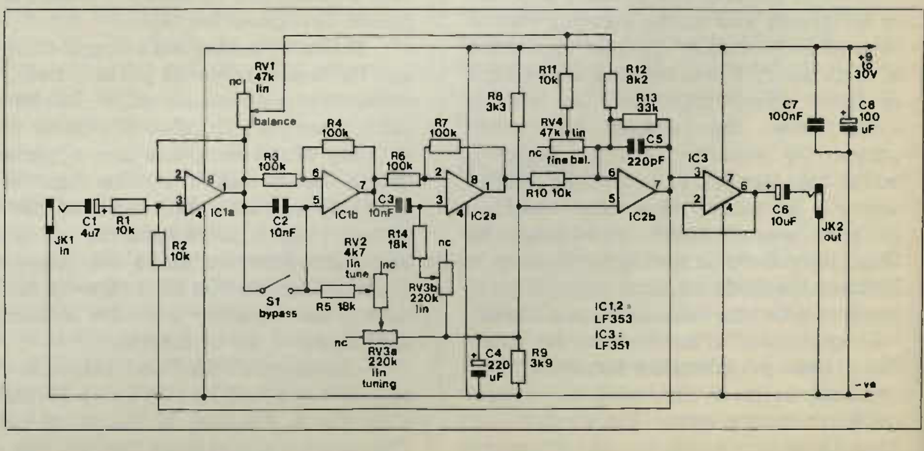
The unit is reset by switching off and then switching on again. On/off switch S2 should ideally be a key-operated switch, and the unit should be housed in a fairly tough case such as a diecast aluminium type, so that there is no quick and easy way for an intruder to silence the unit.

The most convenient type of switch to use for S1 is a reed switch having changeover contacts. The unit can then be arranged so that the activating magnet is next to the switch when the door is closed, but the pair of contacts that provide a normally closed action are used, so that the alarm is not activated. When the door is opened the magnet and reed switch become separated, the contacts close, and the alarm is activated.

As the unit will be left switched on for long periods of time it is obviously essential for it to have a low stand-by current consumption. Under quiescent conditions the only supply current that flows is the leakage currents through C1 and TR1, plus the supply current of IC1. This is not likely to total more than a few microamps, and in practice each set of batteries will give months of use.

THD FILTER

Equipment for the measurement of total harmonic distortion (THD) tends to be quite complex and expensive. However, anyone who has a high quality (sinewave) audio signal generator and an AC millivoltmeter has the basis of a THD measuring set-up. The only other major item of equipment required is a high quality notch filter, such as the one shown in the accompanying circuit. To measure THD the signal generator is used to supply a sinewave signal to the amplifier under test, and the output of the amplifier is fed to the millivoltmeter via the notch filter. Initially the filter is bypassed and the millivoltmeter is used to measure the output signal level. Then the filter is used to notch out the sinewave signal, leaving



only the noise and distortion, which is measured using the millivoltmeter. The ratio of the output signal to the noise and distortion level gives the distortion factor (which is normally expressed as a percentage). The millivoltmeter can then be used to measure the output noise level of the amplifier. Deducting this from the noise and distortion figure gives the THD level, and again this is normally compared with the output signal level and specified as a percentage.

The filter is based around two phase shifters (IC1b and IC2a). At a certain frequency these provide a 180 degree phase shift, and mixing the phase shifted and unshifted signals at IC2b therefore produces a cancelling effect and a notch in the response of the circuit at this frequency. RV1 and RV4 are adjusted to provide precise cancelling so that a high degree of attenuation is provided. With careful adjustment more than 80dB of attenuation can readily be achieved. IC3 is an output buffer stage.

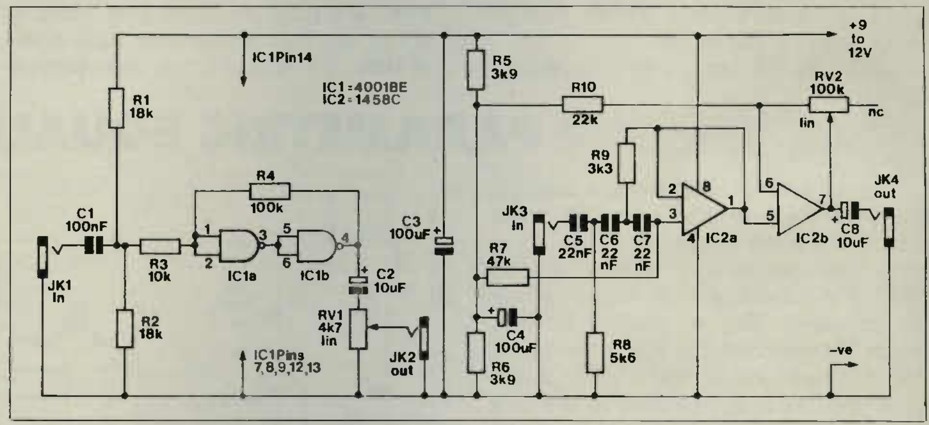
A problem with this basic filter is that it provides significant attenuation at double the notch frequency, and therefore tends to reduce any second harmonic content that is generated in the amplifier, and consequently a slightly low THD reading is produced. This is overcome by using a small amount of overall negative feedback. This tends to flatten the frequency response of the circuit, but near the centre of the notch the degree of attenuation is far too high for the negative feedback to have any significant effect. R1 and R2 provide the overall negative feedback and give the circuit a nominal voltage gain of unity. The reduction in gain at twice the notch frequency is less than 1dB.

RV3 enables the notch frequency to be varied from about 100Hz to approximately 1kHz, which is the frequency band that is likely to be of prime interest, but the values of C2 and C3 could be changed to provide operation at other frequencies. Changes in the values of these components have an inversely proportional effect on the band of frequencies covered (e.g. a value of 5nF gives coverage from about 200Hz to 2kHz).

RV2 is the fine tuning control, and together with the fine balance control (RV1), need to be adjusted very carefully in order to accurately notch out the fundamental signal. S1 is the bypass switch, and this renders the first phase shifter inoperative so that the notch is eliminated and the fundamental signal can pass unhindered to the output of the unit.

A supply voltage of between 9 and 30 volts is needed, and in order to give optimum large signal handling ability, a high supply voltage is preferable. If a mains power supply is used it should have a low noise and ripple content on its output. Bifet operational amplifiers are used in the filter so that it has minimal noise and distortion levels.

CASSETTE PROCESSOR



Loading programs from a cassette recorder seems to be a major problem for many home-computer users. While some machines, such as the Dragon 32 or 64, seem to operate well with practically any cassette recorder over a wide range of volume and tone control settings, some others seem to be far less co-operative. There are various ways of processing the output of a cassette recorder to (hopefully) provide more reliable results. The circuit shown here is quite simple and inexpensive to construct, but provides two types of signal processing. Of course, how well (or otherwise) any cassette processor operates depends on the precise nature of the problem, and whether or not the applied processing is appropriate for that problem, but the circuit described here will effect an improvement in most cases.

IC1 is a CMOS 4001BE quad 2-input NOR gate, but here only two of the gates are used, and each of these has its two inputs connected together so that it functions as a straightforward inverter.

The two inverters are connected in series, and R1 plus R2 are used to bias the input to about half the supply voltage. R4 provides DC positive feedback over the circuit, which operates as a sort of Schmitt trigger. The signal from the cassette recorder is capacitively coupled to the input of the circuit by C1, and provided an input of around 1 volt RMS or more is provided, a good quality squarewave signal is produced at the output of the circuit. This type of signal seems to work much better with some home-computers than the direct output from the cassette recorder which has much slower rise and fall times, as well as a higher noise content. RV1 is used to set the output level of the circuit for optimum reliability.

The second processor is based on IC2, and is simply a highpass filter having a cut-off frequency of about 700Hz, followed by a voltage amplifier stage. The filter is a third order (18dB per octave type), and it removes any 'mains hum' or any other low frequency noise, which can often prove troublesome. Noise of this type can be caused by hum loops, stray pick-up in the connecting leads or the computer itself, and can be very difficult to prevent. However, an active filter of this type should attenuate any low frequency noise to an insignificant level.

With RV2 at minimum resistance, IC2b operates as a unity gain buffer amplifier, but advancing RV2 increases the voltage gain up to a maximum of about 5 times. It can sometimes be beneficial to advance RV2 to the point where the output signal becomes clipped, as this can give a more regular waveshape having a reduced risetime. However, in many cases results will be best with RV2 set for minimum resistance, and it is probably best to initially try out the circuit with RV2 at this setting.

VOLUME EXPANDER

Although modern digital recordings are capable of reproducing the full dynamic range of even the most demanding music, most recordings cannot achieve the required 70dB or so dynamic range. In order to prevent the signal from either dropping down into the background noise level during quiet passages or producing overloading on volume peaks, most recordings have to be subjected to a degree of compression.

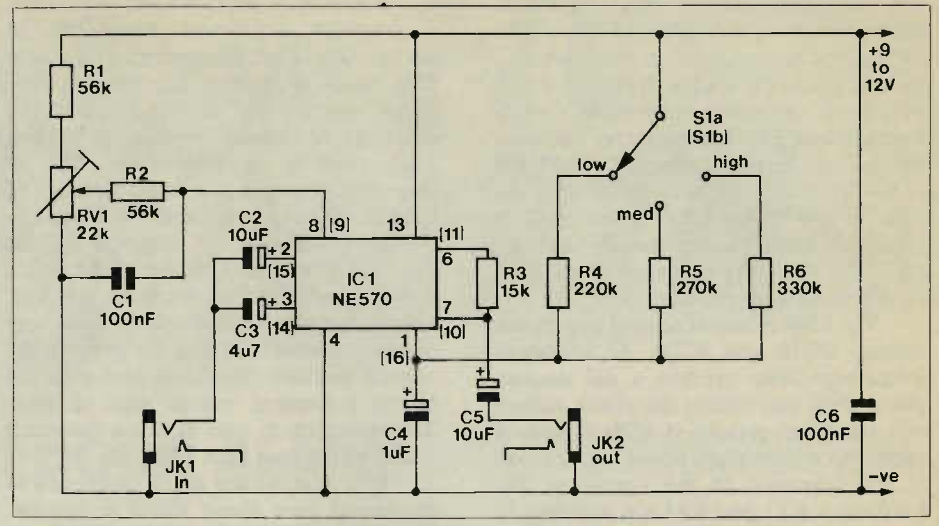
A volume expander can be used to increase the dynamic range of a signal, and restore some of the 'impact' that is lost during the recording process. There is no way of exactly counteracting the original compression, since the compression characteristic will vary considerably from one recording to another. However, in many cases the use of a certain amount of volume expansion will provide a worthwhile improvement in results with an apparent increase in the signal to noise ratio as well as the boosted dynamic range.

This volume expander is based on an NE570 compander (compressor-expander) device. This is primarily intended for use in noise reduction systems with one of the identical sections of the device used as a compressor and the other configured as an expander. In this case both sections are used as expanders, with one being used to process each stereo channel. Only one channel is shown in the circuit diagram, but the numbers in brackets show the equivalent pin numbers for the other channel, which is in other respects identical.

There are three stages in each section of the NE570; a voltage controlled gain block, a precision fullwave rectifier, and an operational amplifier. When used as an expander the input signal is coupled to the rectifier and gain block stages by C2 and C3 respectively. C4 is the smoothing capacitor for the rectifier, and this has a value which gives suitably fast attack and decay times, without either being so fast that distortion is caused. The output of the rectifier is used to control the gain block. As the input signal level is increased, the output voltage from the rectifier rises, the gain block provides increased gain, and the expansion is obtained. R3 is used in the bias and feedback circuit of the operational amplifier, which is utilized here as just a buffer at the output.

The NE570 has a 2 to 1 expansion characteristic. In other words, a rise in the input level of (say) 20dB (10 times) gives a 40dB (100 times) increase in the output. This gives far too much expansion for this application, but a bias register from the positive supply to the smoothing capacitor of the rectifier can be used to give reduced expansion. In this circuit there are three switched bias resistors (R4 to R6). With a maximum input signal of about 500 millivolts rms, these provide expansion levels of about 6, 9, and 12dB. 12dB is about the maximum that can be used in practice without the expansion becoming too obvious.

RV1 is adjusted to minimise distortion, and the NE570 has a typical trimmed THD of only 0.05%. If R1, R2 and RV1 are omitted, the typical THD is still only 0.3%, which is adequate for most purposes. Input levels of up to about 1 volt rms can be handled before clipping occurs.



PARAMETRIC EQUALISER

A parametric equaliser is a versatile form of tone control which is used principally in the production of electronic music, but circuits of this type can also be used in hi-fi systems. Both lift and cut can be provided, like an ordinary bass or treble tone control, but it is a frequency band somewhere in the middle of the audio range that is controlled by this type of filter, rather than one end of the audio spectrum. The centre frequency is tunable (usually over a fairly wide frequency range), and the filter is really a bandpass and notch type, with the type of filtering provided depending on whether the circuit is set for lift or cut. Circuits of this type invariably have variable Q, so that a very narrow range of frequencies, a broad frequency range, or anything in between these two extremes can be controlled.

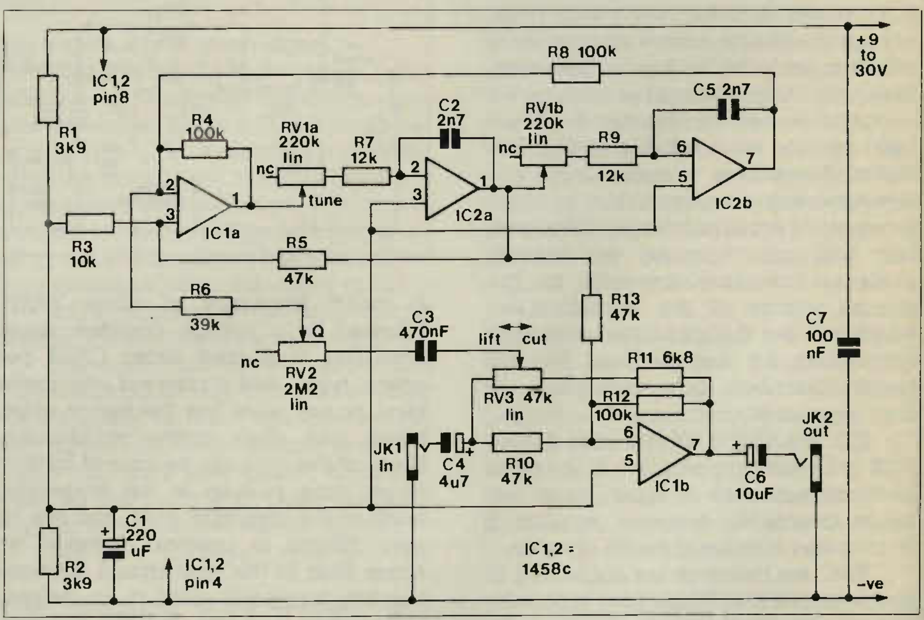
In electronic music, a parametric equaliser can obviously be used to radically alter the sound of an instrument, and can modify the sound in a variety of ways. When used with a hi-fi system it could be used to counteract a resonance or other irregularity in the frequency response of the system.

Although quite simple, the design featured here has a respectable level of performance with a tuning range which extends from about 200Hz to approximately 4kHz. Up to about 15dB of boost and cut can be provided and the Q can be varied over wide limits.

In common with other designs of this general type, the circuit is based on a state variable filter. This is formed by IC1a, IC2a and IC2b, and it is the bandpass output at pin 1 of IC2a that is utilised here. The frequency of the filter is governed by the values of C2 and C5, plus the series resistances of R7 plus RV1a and R9 plus RV1b. By making the resistive elements variable, the operating frequency can be adjusted over the nominal range specified above, with minimum resistance corresponding to maximum operating frequency.

The signal is not actually handled directly by the bandpass filter, but instead passes through inverting amplifier IC1b. The bandpass filter is effectively used as a sort of frequency selective network in the negative feedback circuit of IC1b. The point of doing this is that it enables the notch response to be obtained in addition to the bandpass response, with the type of filtering obtained depending on whether RV3 is adjusted for lift or cut. Feedback over the filter (and hence its Q value) is controlled by R5, and R6 plus RV2. The Q can therefore be controlled using RV2, with minimum resistance corresponding to maximum Q (and a narrow response).

The circuit will operate on any supply voltage in the range 9 to 30 volts, but a supply of around 15 to 30 volts is preferable as it enables high output levels to be handled without clipping and serious distortion resulting. Bear in mind that when set for maximum boost the circuit provides a significant amount of voltage gain at the centre of the response, and it is then more vulnerable to overloading.



DOOR ALARM PARTS LIST

RESISTORS:- All 0.4W 1% Metal Film			
R1	4k7		(M4K7)
R2,4,5,6,8	10k	5	(M10K)
R3	3k9		(M3K9)
R7	100k		(M100K)
R9	47k		(M47K)
R10	82k		(M82K)
CAPACITORS			
C1,3	10uF 35V PC Electrolytic	2	(FF04E)
C2	100nF Polyester		(BX76H)
C4	1uF 100V PC Electrolytic		(FF01B)
C5	10nF Polyester		(BX70M)
C6	100uF 63V PC Electrolytic		(FF12N)
SEMICONDUCTORS			
IC1	4011BE		(QX05F)
IC2	741C 8 pin DIL		(QL22Y)
IC3	555		(QH66W)
TR1	BC337		(QB68Y)
MISCELLANEOUS			
S1	Reed Switch Miniature		(FX70M)
S2	Key Switch		(FH40T)
B1	HP7 Battery	6	—
LS1	L/S Lo-Z 768		(YW53H)
	Magnet small		(FX71N)

THD FILTER PARTS LIST

RESISTORS:- All 0.4W 1% Metal Film			
R1,2,10,11	10k	4	(M10K)
R3,4,6,7	100k	4	(M100K)
R5,14	18k	2	(M18K)
R8	3k3		(M3K3)
R9	3k9		(M3K9)
R12	8k2		(M8K2)
R13	33k		(M33K)
RV1,4	Pot Lin 47k	2	(FW04E)
RV2	Pot Lin 4k7		(FW01B)
RV3	Dual Pot Lin 220k		(FW89W)
CAPACITORS			
C1	4u7F PC Electrolytic		(FF03D)
C2,3	10nF Polyester	2	(BX70M)
C4	220uF 63V PC Electrolytic		(FF14Q)
C5	220pF 1% Polystyrene		(BX49D)
C6	10uF 35V PC Electrolytic		(FF04E)
C7	100nF Polyester		(BX76H)
C8	100uF 63V PC Electrolytic		(FF12N)
SEMICONDUCTORS			
IC1,2	LF353	2	(WQ31J)
IC3	LF351		(WQ30H)
MISCELLANEOUS			
JK1,2	¼" Jack Socket	2	(HF90X)
	¼" Jack Plugs	2	(HF85G)
S1	Sub-Min Toggle A		(FH00A)

VOLUME EXPANDER PARTS LIST

RESISTORS:- All 0.4W 1% Metal Film			
R1,R101,R2,R102	56k	4	(M56K)
R3,R103	15k	2	(M15K)
R4,R104	220k	2	(M220K)
R5,R105	270k	2	(M270K)
R6,R106	330k	2	(M330K)
RV1,RV101	Hor Preset S-Min 22k	2	(WR59P)
CAPACITORS			
C1,C101,C6,C106	100nF Polyester	4	(BX76H)
C2,C102,C5,C105	10uF 35V PC Electrolytic	4	(FF04E)
C3,C103	4u7F 63V PC Electrolytic	2	(FF03D)
C4,C104	1uF 100V PC Electrolytic	2	(FF01B)
SEMICONDUCTORS			
IC1	NE570		(QY10L)
MISCELLANEOUS			
JK1,JK2	¼" Jack Socket Stereo	2	(HF92A)
	¼" Jack Plug Stereo Plastic	2	(HF88V)
S1	Switch Rotary SW3B		(FF76H)

CASSETTE PROCESSOR PARTS LIST

RESISTORS:- All 0.4W 1% Metal Film			
R1,2	18k	2	(M18K)
R3	10k		(M10K)
R4	100k		(M100K)
R5,6	3k9	2	(M3K9)
R7	47k		(M47K)
R8	5k6		(M5K6)
R9	3k3		(M3K3)
R10	22k		(M22K)
RV1	Pot Lin 4k7		(FW01B)
RV2	Pot Lin 100k		(FW05F)
CAPACITORS			
C1	100nF Polyester		(BX76H)
C2,8	10uF 35V PC Electrolytic	2	(FF04E)
C3,4	100uF 63V PC Electrolytic	2	(FF12N)
C5,6,7	22nF Polyester	3	(BX72P)
SEMICONDUCTORS			
IC1	4001BE		(QX01B)
IC2	1458C		(QH46A)
MISCELLANEOUS			
JK1,2,3,4	¼" Jack Socket	4	(HF90X)
	¼" Jack Plug	4	(HF85G)

PARAMETRIC EQUALISER PARTS LIST

RESISTORS:- All 0.4W 1% Metal Film			
R1,2	3k9	2	(M3K9)
R3	10k		(M10K)
R4,8,12	100k	3	(M100K)
R5,10,13	47k	3	(M47K)
R6	39k		(M39K)
R7,9	12k	2	(M12K)
R11	6k8		(M6K8)
RV1	Dual Pot Lin 220k		(FW89W)
RV2	Pot Lin 2M2		(FW09K)
RV3	Pot Lin 47k		(FW04E)
CAPACITORS			
C1	220uF 63V PC Electrolytic		(FF14Q)
C2,5	2n7F 1% Polystyrene	2	(BX61R)
C3	470nF Polyester		(BX80B)
C4	4u7F 63V PC Electrolytic		(FF03D)
C6	10uF 35V PC Electrolytic		(FF04E)
C7	100nF Polyester		(BX76H)
SEMICONDUCTORS			
IC1,2	1458C	2	(QH46A)
MISCELLANEOUS			
JK1,2	¼" Jack Socket	2	(HF90X)
	¼" Jack Plug	2	(HF85G)

TELEPHONE ACCESSORIES

See Back Cover

a) Flush Fitting Master Line Jack Unit (3/4A)

Standard BT type Master Line Jack Unit, including bell capacitor, surge arrestor and 'out of service' resistor, for flush fitting to wall; with screw terminals.
Order As FJ27E (Flush Master Line Jack 3/4A) Price £3.99 TQ 25

b) Three Metre Line Cord & Line Plug

Standard PTC Line Cord with Line Plug at one end and spade terminals at the other. See also page 184 of the '84 Maplin Catalogue.
Order As FG29G (PTC Line Cord) Price £1.95 TQ 50

c) Four Way BT Type Jack Plug (420)

Standard BT Type 4 Way Jack Plug. Each terminal is colour coded – requires soldering.
Order As FJ28F (Jack Plug 420) Price £1.65 TQ 50

d) Dual Outlet Adaptor (10/3A)

Fits any BT type 4/6 way Line Jack Unit and converts it to a dual outlet.
Order As FJ30H (Dual Adaptor 10/3A) Price £5.30 TQ 10

e) Line Plug/Screw Terminal Adaptor (ILL/BT)

Adapts existing telephone equipment to standard BT type Line Plug. The screw terminals are contained in a small box for neat and easy connection to telephone spade terminals.
Order As FJ31J (Line Plug/Screw Terminal Adaptor ILL/BT) Price £4.15 TQ 25

f) Line Plug/USA Socket Adaptor (USA/BT)

Allows equipment fitted with American type phone plugs to be connected to standard BT type Line Jack Units.
Order As FJ32K (Line Plug/US Socket Adaptor USA/BT) Price £4.20 TQ 25

g) Coiled 5m Line Cord (4/504)

A 5 metre PTC 4 way Line Cord, coiled for part of its length. Fitted with standard 4 way line plug at one end and spade terminals at the other.
Order As FJ29G (5m line cord 4/504) Price £3.45 TQ 25

h) Secondary Line Jack Unit (2/4A)

A surface mounting Secondary Line Jack Unit, see also page 184 of the '84 Maplin Catalogue.
Order As FG28F (Secondary Line Jack Unit 2/4A) Price £2.95 TQ 25

i) Standard 4 Way Line Plug (431A)

A standard BT type 4 way Line Plug using Insulation Piercing Contact (IPC), with strain relief. Ideally for assembly an IPC plug hand tool should be used. However the plug can be fitted by removing the outer insulation of the cable to the correct length, carefully lifting the contacts, inserting the wires and then clamping the contacts onto the wires – using a small pair of pliers. The strain relief members immediately behind the contacts can then be pushed down using a small screwdriver.
Order As FJ33L (Line Plug 4 way 431A) Price 50p TQ 250

j) Flush Fitting Secondary Line Jack Unit (3/6A)

Standard BT type Secondary Line Jack Unit for flush fitting to wall; with screw terminals.
Order As FJ34M (Flush Secondary Line Jack 3/6A) Price £2.65 TQ 25

Telephone Cable

Please note that Telephone Cable (4 way with cream coloured outer insulation) is also available, please see page 85 of the '84 Maplin Catalogue for full details.
Order As XR66W (4 Wire Phone Cable) Price 21p per metre TQ 250

AMENDMENTS TO 1984 CATALOGUE

SOLDERING IRONS FY62S The CX iron is now discontinued and replaced by the newer CS model which features a lower leakage current (<2μA), a shatterproof anti-roll handle and a detachable hook. The iron is designed to use the same bits as the CX. The replacement element for the CX iron is still available (FY63T); the CS requires a different element, should you need a replacement please order FY95D (Element CS 240V). Price £3.25.

FR12N The X25 iron is now discontinued and replaced by the newer XS model which features a lower leakage current (<1μA), a shatterproof anti-roll handle and a detachable hook. The iron is designed to use the same bits as the X25. The replacement element for the X25 iron is still available (FR14Q); the XS requires a different element, should you need a replacement please order FY96E (Element XS 240V). Price £3.25.

FR13P The MLX12 iron is now discontinued and replaced by the newer MLXS model which has the same improvements as the XS, described above. The replacement element for the MLX12 is still available (FR15R); the MLXS requires a different element, should you need a replacement please order FY97F (Element MLXS 12V). Price £3.65.

FY68Y The CX Kit is now discontinued and replaced by the newer CS Kit. The only change is the replacement of the CX iron by the CS iron (described above).

FY69A The X25 Kit is now discontinued and replaced by the newer XS Kit. The only change is the replacement of the X25 iron by the XS iron (described above).

TOP TWENTY KITS

THIS	LAST MONTH	DESCRIPTION OF KIT	ORDER CODE	KIT PRICE	DETAILS IN PROJECT BOOK
1.	(1)	75W Mosfet Amp Module	LW51F	£12.95	Best of E&MM
2.	(2)	Modem	LW99H	£44.95	5 XA05F
		Case also available: YK62S Price £9.95.			
3.	(3)	Car Burglar Alarm	LW78K	£6.95	4 XA04E
4.	(4)	Partylite	LW93B	£9.45	Best of E&MM
5.	(5)	ZX81 I/O Port	LW76H	£9.25	4 XA04E
6.	(7)	Syntom Drum Synthesiser	LW86T	£11.95	Best of E&MM
7.	(6)	Spectrum Keyboard	LK29G	£28.50	9 XA09K
		Also required: LK30H £6.50; Case: XG35Q £4.95 — Total £39.95. Also available complete ready-built: XG36P £44.95.			
8.	(50)	Spectrum Easyload	LK39N	£9.95	10 XA10L
9.	(9)	8W Amp Module	LW36P	£4.45	Catalogue
10.	(11)	Logic Probe	LK13P	£9.95	8 XA08J
11.	(13)	Ultrasonic Intruder Detctor	LW83E	£10.95	4 XA04E
12.	(8)	VIC20/64 RS232 Interface	LK11M	£9.45	7 XA07H
13.	(10)	Harmony Generator	LW91Y	£17.95	Best of E&MM
14.	(14)	Spectrum RS232 Interface	LK21X	£17.95	8 XA08J
15.	(12)	Keyboard for ZX81	LW72P	£23.95	3 XA03D
		Case also available: XG17T £4.95. Complete ready-built: XG22Y £32.50			
16.	(16)	Noise Gate	LK43W	£9.95	Best of E&MM
17.	(28)	Burglar Alarm	LW57M	£49.95	2 XA02C
18.	(15)	Hexadrum	LW85G	£19.95	Best of E&MM
19.	(17)	Guitar Tuner	LW90X	£10.75	Best of E&MM
20.	(30)	Synwave Sounds Synth	LW87U	£10.95	Best of E&MM

Over 80 other kits also available. All kits supplied with instructions.
The descriptions above are necessarily short. Please ensure you know exactly what the kit is and what it comprises before ordering, by checking the appropriate Project Book mentioned in the list above.

NEW PRODUCTS

Carrying Case

A sturdy carrying case in black 'leather look' PVC which will hold a wide range of multimeters and other test gear. Fitted with buckle and carrying strap.
Internal Size: 118 x 150 x 58mm
Order As BK78K (Carrying Case MC20) Price £3.32 TQ 25

PCB Mounting Phono Socket

A compact phono socket which mounts directly onto printed circuit boards.
Overall Size: 22 x 15 x 10mm
Order As HF98H (PCB Phono Skt) Price 28p TQ 500

RF Transistor Type BFY90

An NPN silicon planar epitaxial transistor in TO-72 metal envelope. Has very low noise over a wide current range, plus very high power gain. Can be used in aerial amplifiers, TV distribution amplifiers, RF amplifiers and mixers, etc.
V_{CEO} = 15V max;
V_{CBOM} = 30V max;
V_{EBO} = 2.5V max;
I_C = 25mA max;
P_{tot} = 200mW max;
h_{fe} = 25 to 150 @ I_C 2mA;
typ f_T = 1.1 GHz.
Order As QQ64U (BFY90) Price 95p TQ 100

PVC Beading Section

Flexible black PVC beading section for edging metal sheets, chassis, etc.
Order As XR78K (PVC Beading Section) Price 25p per metre TQ 500

IDC Connectors & Cable

A range of Flat Cables and IDC's to complement those already available in the 1984 catalogue. Conforming to BS9525, all connectors are moulded from thermoplastic resin and glass fibre filled.
Max Working Voltage: 750V DC.
Max Working Current: 2A.
Spacing: 0.05 inch.
IDC sockets fitted with ¼ metre (approx. 10") of cable and a strain relief clamp. Four types are available. 16 Way, 20 Way, 26 Way and 40 Way.
Order As FJ01B (16 Way IDC Skt & Cable) Price £2.45 TQ 25
Order As FJ02C (20 Way IDC Skt & Cable) Price £2.65 TQ 25
Order As FJ03D (26 Way IDC Skt & Cable) Price £2.98 TQ 25
Order As FJ04E (40 Way IDC Skt & Cable) Price £3.95 TQ 25

IDC PCB Mounting Header Plugs are now available in five types. 16 Way, 20 Way, 26 Way, 34 Way & 40 Way.
Order As FJ13P (IDC PCB Header 16 Way) Price £1.40 TQ 50
Order As FJ14Q (IDC PCB Header 20 Way) Price £1.60 TQ 50
Order As FJ15R (IDC PCB Header 26 Way) Price £1.80 TQ 50
Order As FJ16S (IDC PCB Header 34 Way) Price £2.30 TQ 25
Order As FJ17T (IDC PCB Header 40 Way) Price £2.60 TQ 25

IDC Flat Cable is available in 16, 20, 26, 34 and 40 way, in grey with a red identifying strip on one edge. Priced in 30cm lengths (approx. 1 Foot).
Order As XR73Q (16 Way IDC Cable) Price 29p per 30cm. TQ 100ft Reel
Order As XR74R (20 Way IDC Cable) Price 35p per 30cm. TQ 100ft Reel
Order As XR75S (26 Way IDC Cable) Price 45p per 30cm. TQ 100ft Reel
Order As XR76H (34 Way IDC Cable) Price 58p per 30cm. TQ 100ft Reel
Order As XR77J (40 Way IDC Cable) Price 68p per 30cm. TQ 100ft Reel

Connectors for the BBC Motherboard project which are also suitable for many other applications.
BBC Analog Port Cable consisting of a 15 Way 'D' range plug connected by ½ metre of flat cable to a 16 Way four row PCB transition header.
Order As FJ24B (BBC Analog Port Cable) Price £5.85 TQ 10

BBC 1MHz Port Cable consisting of a 34 Way IDC socket connected by ½ metre of flat cable to a 34 Way four row PCB transition header.
Order As FJ25C (BBC 1MHz Port Cable) Price £4.99 TQ 10

BBC I/O Port Cable consisting of a 20 Way IDC socket connected by ½ metre of flat cable to a 20 Way four row PCB transition header.
Order As FJ26D (BBC I/O Port Cable) Price £3.30 TQ 10

NEW KITS

Two more projects from 'Best of E&MM Vol. 1' – XH61R – are now available as complete kits.

Car Battery Monitor

Kit contains all parts including case.
Order As LK42V (Car Batt Mon Kit) Price £6.95 TQ10

Noise Gate

Kit contains all parts excluding the case which is available as LH71N (Case Type M5004) price £3.54.
Order As LK43W (Noise Gate Kit) Price £9.95 TQ5

Video Cassette Recorder Drive Belts

A range of kits containing a complete set of drive belts, available for most popular video recorders.

Ferguson 3292; Baird 3V22; JVC HR3300/3320/3330/3600.
Order As FJ06G (Video Belts VSK9707) Price £6.95 TQ 10

Sony SL8000/8080.
Order As FJ07H (Video Belts VSK9806) Price £7.95 TQ 10

Sony SLC7/SLJ7.
Order As FJ08J (Video Belts VSK9876) Price £7.95 TQ 10

Ferguson 3V16; JVC HR3360/3660; Telefunken VR440.
Order As FJ09K (Video Belts VSK9708) Price £6.95 TQ 10

Sanyo VTC9300; Fisher VRS7000.
Order As FJ10L (Video Belts VSK9794) Price £6.95 TQ 10

National Panasonic NV7200.
Order As FJ11M (Video Belts VSK9605) Price £7.95 TQ 10

National Panasonic NV7000.
Order As FJ12N (Video Belts VSK9635) Price £7.95 TQ 10

Record Turntable Drive Belts

A range of record turntable drive belts for the most popular Japanese record decks – to complement those already available in the '84 Catalogue.

National Panasonic
Flat cross-section:

Diameter:	187mm
Thickness	0.6mm
Width	4mm
Inside circumference	588mm

Order As FJ18U (Drive Belt Nat/Pan AS8187) Price £2.85 TQ25

Pioneer
Flat cross-section:

Diameter:	189mm
Thickness	0.6mm
Width	5mm
Inside circumference	594mm

Order As FJ19V (Drive Belt Pioneer AS8189) Price £2.45 TQ25

Sony / National Panasonic
Flat cross-section:

Diameter:	195mm
Thickness	0.6mm
Width	5mm
Inside circumference	613mm

Order As FJ20W (Drive Belt Sony AS8195) Price £2.45 TQ25

Trio / Sharp SG400
Flat cross-section:

Diameter:	201mm
Thickness	0.6mm
Width	6mm
Inside circumference	632mm

Order As FJ21X (Drive Belt Trio AS8201) Price £2.45 TQ25

Sansui
Flat cross-section:

Diameter:	205mm
Thickness	0.6mm
Width	6mm
Inside circumference	644mm

Order As FJ22Y (Drive Belt Sansui AS8205) Price £2.45 TQ25

Hitachi
Flat cross-section:

Diameter:	210mm
Thickness	0.6mm
Width	4mm
Inside circumference	660mm

Order As FJ23A (Drive Belt Hitachi AS8210) Price £2.45 TQ25

CLASSIFIED

VARIOUS FOR SALE

MAPLIN EQUALISER, case, 2 PCB's, part built, all as new. Any reasonable offers? First decent offer secures. Box No X110.

PAIR 10 WATT Sony Speakers, 8 ohms impedance, teak casings, hardly used in excellent condition. Bargain £20. Tel Upminister 28710.

SERVICE SHEETS. Private collection of numerous Radio and TV service sheets 1955 to 1980. No list, please send S.A.E. for enquiries. F. Harrop, 15 Keymer Road, Brighton, BN1 8FB.

TRANSFORMER, Step-down 240V to 120V, 15 Amp. Brand new still in box £30. Tel. 0283 216519.

WEALTH OF Projects. Back issues of Practical Wireless '75 to '79, Practical Electronics '74 to '79, Everyday Electronics '71 to '74. Offers for some or all. Tel. Salisbury (0722) 710836.

CLUBS

TECHNICAL AUTHORS, non-profit Group. Share your knowledge worldwide. Collaborations, personalised projects, writing and publishing assistance. Describe your abilities, experience, interests. S.A.E. appreciated. T.A.G., Moat Farm, Burgh, Woodbridge, Suffolk, IP13 6JW.

ATARI OWNERS, issue 5 of the U.K. Atari Computer Owners Club Magazine is now available. Learn how to protect your BASIC programs, improve picture and sound quality on your machine, start to learn machine code. Program listings include: GIL-BERT, DRAGON-FIRE, LABEL MAKER, ELECTRIC SHOCK and many more. Send £1 plus 30p postage to, P.O. Box 3, Rayleigh, Essex and ask to receive your copy of Issue 5.

If you would like to place an advertisement in this section, here's your chance to tell Maplin's 200,000 customers what you want to buy or sell, or tell them about your clubs activities – absolutely free of charge. We will publish as many advertisements as we have space for. To give everyone a fair share of the limited space, we will print 30 words free of charge. Thereafter the charge is 10p per word. Please note that only private individuals will be permitted to advertise.

Commercial or trade advertising is strictly prohibited in the Maplin Magazine.
Please print all advertisements in bold capital letters. Box numbers are available at £1.50 each. Please send replies to Box Numbers to the address below. Please send your advertisement with any payment necessary to: Classifieds, Maplin Mag., P.O. Box 3, Rayleigh, Essex SS6 8LR.
For the next issue your advertisement must be in our hands by 6th July 1984.

COMPUTERS FOR SALE

MICROTAN 65 + Tanex fully Exp. Programmable Graphics Module, EPROM storage card with EPROMS, Soundboard, Video 80/82 High Definition Graphics Board, System Motherboard, full size QWERTY keyboard with numerical keypad, EPROM programmer, multi-rail power supply. Plus a quantity of software and all manuals. Also Teletype and Word Processor package £300. G. Hemmings, 110 Birks Street, Stoke-on-Trent, Staffs. ST4 4HF.

MUSICAL FOR SALE

MAPLIN SPECTRUM Synthesiser, complete and calibrated, professionally built – great sound. Can deliver to surrounding area, genuine reason for sale. Offers around £225. Tel. Rochdale 50223.

DIGISOUND Modular Synthesiser, keyboard, speakers, leads and users manual. 18 modules including Alphadec. Very good condition cost over £900. Offers, Brighton (0273) 673301, evenings and weekends.

KIMBER-ALLEN 61 note keyboard and contact wires for electronic piano (or organ), new. £20. Mr. H.F. Howard, 41 Thingwall Park, Fishponds, Bristol, BS16 2AJ.

MATINEE ORGAN Cabinet, stool, drawbars and full set of MES53 assembled circuit boards, keyboards, marble effect key tabs (20) etc. Offers? Tel. (0384) 262537, (West Midlands) evenings.

MAPLIN MATINEE Organ, why build it when you can buy my professionally built one. Virtually unused, including stool. £325 O.N.O. Tel. Uckfield (0825) 4001.

MAPLIN MES52, all boards, key-switches, swell pedal, contacts. £25. MES55 Auto Organ, all boards, switches etc. £25. 37 note C-C keyboard, new and boxed plus contacts. £25. Maplin stereo cassette recorder kit, boards built but never used. £25. Tel. 031 669 2115.

FOR MES ORGAN: £200 worth of parts, including one keyboard and contacts, divider and sawtooth boards (assembled), two assembled tone boards (type A), tone boards C,E,D (2), swell pedal, power supply with transformer and miscellaneous parts.
£100 O.N.O. MAPLIN 3800 synthesiser, tuned and working, except for VCA and VCF, in home built cabinet.
£200 O.N.O. All the above built to a professional standard. FARFISA 256RK Electronic Organ, immaculate.
£1100 O.N.O. Tel. 01 764 5360.

FUZZ-BOX, custom built, for use between guitar and amplifier. Price £8 (£2 off because case is cracked), write to: A. Gonnet, Sun Cottage, Bellingdon, Bucks.

WANTED

WANTED: service information for Hacker Sovereign II transistor portable. Please contact F. Cosgrove. Bournemouth 432973.

WANTED: a small quantity of Mullard FX1593 ferrite rings or address of suppliers. R.E. Sharp, Hope Hall, Prince of Wales Road, Exeter, Devon.

WANTED: circuit diagram, service/operating diagram and/or plug for R1132A and CR100 (Naval B28) receivers. Richard Hughes, 43 Naylor Road, London N20 0HE.

WANTED: a copy of Spectrum Computing No 2 (Electronics Magazine), published by Argus Publications. Will pay up to £5 by cheque, on receipt. Raymond Betz, Chemin du Moulin 38, 1328 Ohain, Belgium.

DID YOU MISS ISSUE 9?

Copies of issue 9 are still available for just 70p and include all these projects:

Spectrum Keyboard. A full size, full travel, 47 key, keyboard for the Sinclair Spectrum that plugs directly into the expansion port thus no soldering or dismantling of the Spectrum itself is required. Features include single-key operation for Graphics, Shift Lock, Caps Lock, Delete & Extend. Provision for sockets to accept joysticks.
VIC Extendiboard. Expand your VIC — three expansion sockets one of which is switchable. The board can also be fitted with 3K of extra RAM.
Oric Talkback. A speech synthesiser for the Oric 1 with virtually unlimited vocabulary.
Infra-Red Movement Detector. Fitted outside, this unit can detect a human body up to 30 metres away.
TDA7000 FM Radio. Easily built FM radio — requires no alignment.
ZX81 High Resolution Graphics. A full 256 x 192 fine pixel display for the ZX81. Draws lines, circles & triangles, fills & textures, plus user defined graphics. Operates from extended BASIC.
Ten more projects! including Personal Stereo Dynamic Noise Limiter for Walkman-type cassette players. Inexpensive easy-to-use Logic Pulser. Low-cost easily built 1K Extendi-RAM for the ZX81. Frequency Meter Adaptor for digital multimeter. TTL/RS232 Converter. Pseudo Stereo AM Radio, Ni-Cad Charger Timer, Syndrum Interface, plus lots more.

Issue 9 also included articles on Machine Code Programming with the 6502, Measurements in Electronics, the conclusion of our series on Rewiring Your House, and all our usual news and reviews.

All this for only 70p. Order As XA09K (Maplin Magazine Volume 3 Issue 9). Price 70p *NV*.

DID YOU MISS ISSUE 10?

Copies of issue 10 are still available for just 70p and include the following:

Spectrum Easyload. This novel battery powered unit will greatly enhance cassette loading of programs on the Sinclair Spectrum.
80m Amateur Receiver. A low cost Direct Conversion design, for the 80m Amateur Band. This easily constructed project features single-sideband operation and can be aligned without test gear. It offers an ideal introduction to Amateur Radio for the newcomer.
Fluorescent Tube Driver. An 8 Watt 12 Volt unit which offers efficient light output from a car battery; ideal for camping, caravanning, boating etc.
2.8kW Power Controller. A versatile easy-to-build device which will control appliances of up to 2.8kW with minimal power loss.
Auto-Waa. This easily constructed unit will produce a wide range of Waa-Waa type effects automatically.
Digi-Tel Expansion. Enables the Maplin Digi-Tel telephone exchange to be expanded to accommodate 32 extensions.
Oric 1 Modem Interface. Connect the Maplin Modem to your Oric 1 Computer using this inexpensive project.
Dragon Extendiport. This handy little project enables the cartridge socket on the Dragon 32 to be brought to a more accessible position.

Issue 10 also included features on Car Electrics, the History of Electronics, Hero the Heathkit Robot, and the continuation of the series' on Measurements in Electronics, Machine Code Programming the 6502 and First Base – for beginners. Plus the completion of 'Data Base Management' and all our usual news and reviews.

All this for only 70p. Order As XA10L (Maplin Magazine Volume 3 Issue 10). Price 70p *NV*.

DID YOU MISS THESE ISSUES?

Copies of issue 5 are still available for just 60p, and include the following projects:

Modem. With this low-cost, high quality modem, transmission speeds of 300 baud are obtainable over ordinary telephone lines. Send data to your friends anywhere in Europe, or talk to our computer.

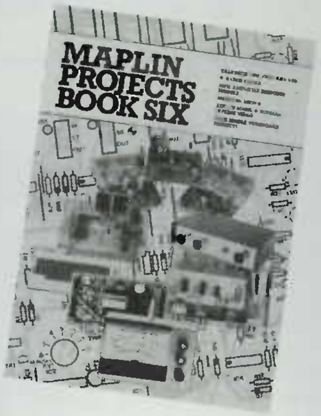
Inverter. Ideal for camping or caravanning, this inverter uses MOFSET transistors for the ultimate in reliability. During emergency power cuts, use the inverter to keep your central heating going.

ZX81 Sound Generator. Here's a really noisy project for micro-computer enthusiasts. It plugs straight in to our ZX81 extension board and is really easy to make. Your ZX81 will have full BASIC control over three tone generators, with single address access.

Central Heating Controller. Four our more experienced constructors, this project will give your central heating system optimum performance and could save you a lot of money this winter.

Panic Button. A useful add-on for our Home Security System that will give many of our older citizens peace of mind. Issue five also included features on the Compact Digital Disc, Interfacing Microprocessors, and choosing the right wires for projects, and the last part of the Starting Point series, along with Basically Basic, Say it with Satellites, and Working with Op-Amps.

All this for just 60p. Order As XA05F (Maplin Magazine Volume 2 Issue 5). Price 60p *NV*



Copies of issue 6 are now sold out, but a reprint of the projects in that issue is available, the contents are:–

VIC20 and ZX81 Talkbacks. Projects to enable these micro's to speak! Allophone based system gives unlimited vocabulary. Plus a fascinating article on speech synthesis techniques using allophones.
Scratch Filter. This tunable design will make those old scratched records playable again.
Bridging Module. Use this kit and two Maplin 75W MOSFET amplifier modules to make a superb 400W stereo amp. – with loudspeaker protection.
Moisture Meter. A low cost project which enables you to check walls and floors for damp.
ZX81 TV Sound and Normal/Inverse Video. Your ZX81 can now give you sound directly on a TV, plus inverted video display facility.
Four Simple Veroboard Projects:– Portable Stereo Amplifier, Sinewave Generator, Headphone Enhancer and Stylus Organ.

All this for only 70p. Order As XA06G (Maplin Project Book Volume 2 No. 6) Price 70p *NV*.

Copies of issue 7 are still available for just 70p, and include the following projects:

CMOS Crystal Calibrator. A radio amateur project to allow calibration of receivers and checking of the position of the edges of amateur band allocations.

DXers Audio Processor. Will improve the performance of many communications receivers without the need for modifications. Enlarger Timer/Controller. An accurate timer with a display that enables it to be used in colour printing, it will also control the switching on and off of the enlarger.

Sweep Oscillator. A useful, easy-to-build, piece of equipment to complement your fault-finding test gear.

VIC20/RS232 and ZX81 Interfaces will allow you to connect to modems, printers, VDUs, or any other RS232 compatible device. It will even let you use Maptel and Cashtel!

Issue 7 also included features on Heathkit, programming the Commodore 64, and the start of a new series on machine code programming with the 6502. First Base, Working with Op-Amps, Say it with Satellites, and all our usual news and reviews were also in this issue.

All this for just 70p. Order As XA07H (Maplin Magazine Volume 2 Issue 7). Price 70p *NV*

Copies of issue 8 are still available for just 70p and include the following projects:

RS232/Modem Interface for ZX Spectrum will run at 300, 600, 1200 or 24000 bits per second and has its own completely self-contained operating system so no programming, LOADing or SAVEing is required. The interface plugs directly into the Spectrum expansion socket.
Synchime makes metallic chiming sounds like bells and gongs and complements our Syntom and Synwave projects.
Dragon 32 RS232/Modem Interface has a programmable word format and plugs directly into the ROM expansion socket.

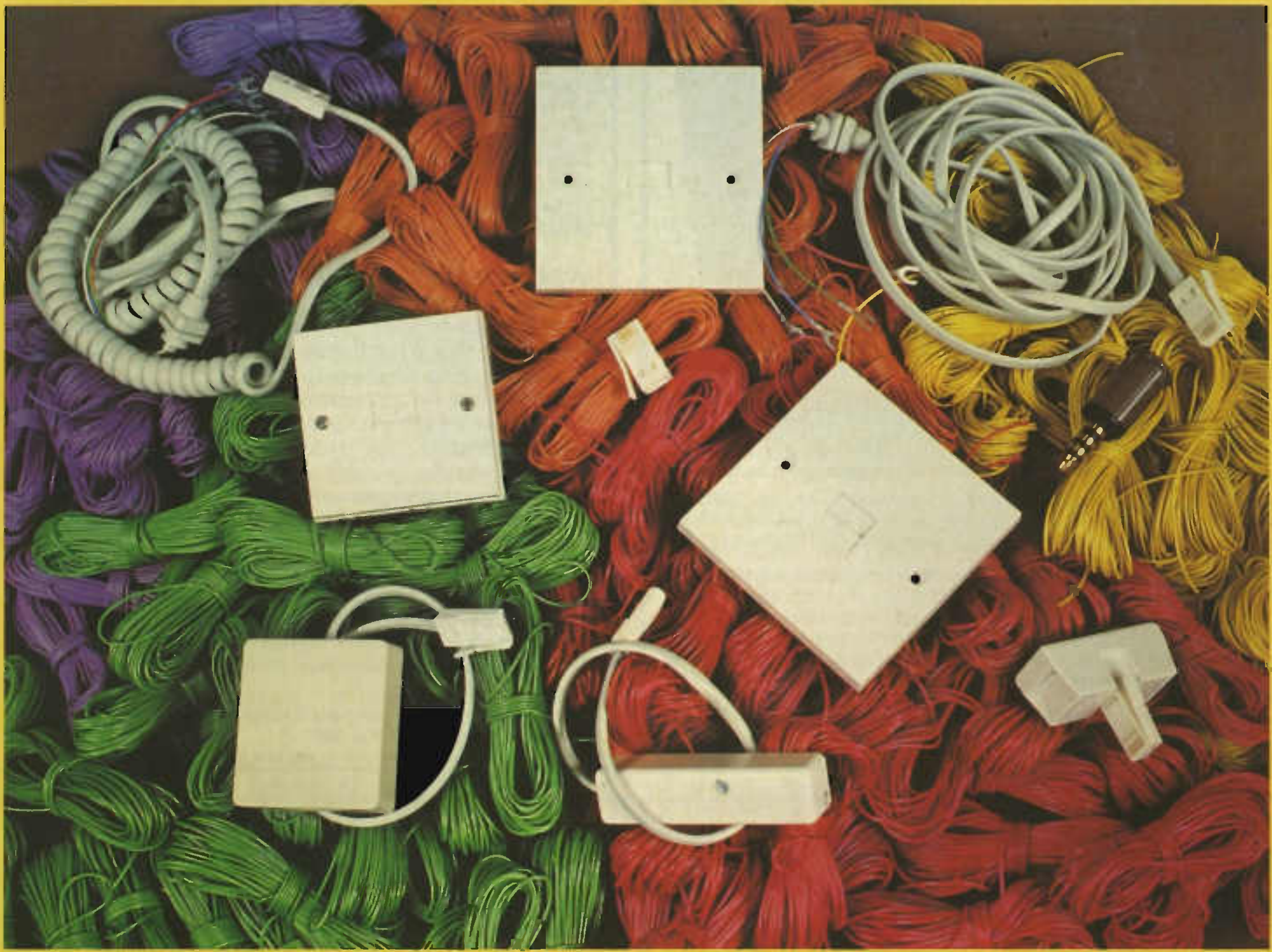
Dragon 32 I/O Ports has two 8-bit ports with TTL and tri-state bus compatibility, four norm/inv latched ports, two opto and two relay switched ports for maximum flexibility. The module plugs directly into the cartridge socket and is fully programmable from BASIC using PEEK and POKE.

Four other projects include a low-cost Logic Probe with instantly recognisable readout on a 7-segment display; a versatile bench-top power supply, the Minilab; the Codelock, an electronic security lock with 10,000 easily programmed different combinations; and a Doorbell for the Deaf which flashes a mains light bulb to attract attention.

Issue 8 also included features on Using the Commodore 64, Rewiring Your House Part 1, more Heathkit products, and Interfacing the BBC Micro. The issue also included the continuations of our series Machine Code Programming with the 6502, First Base and Say It With Satellites, and all our usual news and reviews.

All this for just 70p. Order As XA08J (Maplin Magazine Volume 2 Issue 8). Price 70p *NV*.

TELEPHONE FITTINGS



Now you can move your telephone, fit sockets in every room, connect U.S.A. type 'phone plugs to U.K. sockets or even connect your modem – at a fraction of the previous cost. Maplin now offer a complete range of BT approved 'phone accessories at budget prices, please see page 62 for full details.

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(c) Four Way BT Type Jack Plug (FJ28F)
(d) Dual Outlet Adaptor (FJ30H)
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(h) Secondary Line Jack Unit (FG28F)
(i) Standard 4 Way Line Plug (FJ33L)
(j) Flush Fitting Secondary Line Jack Unit (FJ34N)