Electronics

THE MAPLIN MAGAZINE

MARCH – MAY 1984 PRICE 70p

AN INTRODUCTION TO CAR ELECTRICS

£70 Prize Draw in our Reader Survey

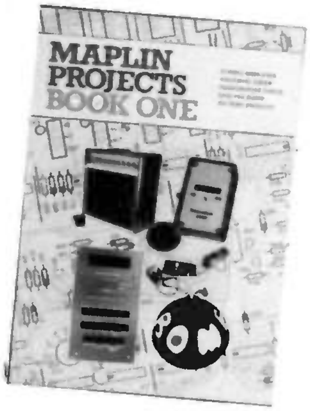
80m Amateur Receiver
Single-sideband, easy to align and construct

Spectrum Easyload
Ends cassette loading problems

Power Controller for Electrical Appliances up to 2.8kW!

Auto-Waa. Easy to use unit has wide range of musical effects

DID YOU MISS THESE ISSUES?



Copies of issue 1 are now sold out, but a reprint of the projects from issue 1 is available and contains:

Universal Timer. A comprehensive programmable controller for up to 4 mains appliances. There is storage for up to 18 program times, ons or offs and relay outputs. Complete construction details.

Combo Amplifier. Superb 120W MOSFET power amp with low-noise BI-FET pre-amp having built-in flanger, inputs for guitars, keyboards or microphones, and five step equaliser. Complete construction details.

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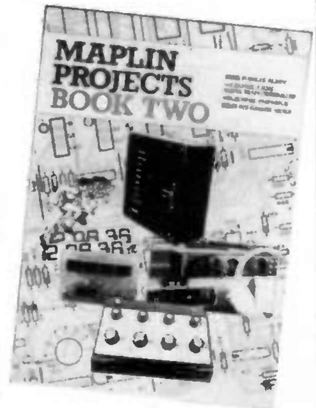
All this for just 70p. Order As XA01B (Maplin Project Book Volume 1 No. 1). Price 70p *NV*



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Digital Multi-Train Controller. Our superb digital train controller can control up to 14 locomotives individually on the same track. Any four loco's an be controlled simultaneously. The unit has automatic short-circuit protection and because it uses digital control a DC supply is present all the time for carriage light etc.
The locomotive modules will fit in most modern 00-scale engines. Complete construction details.

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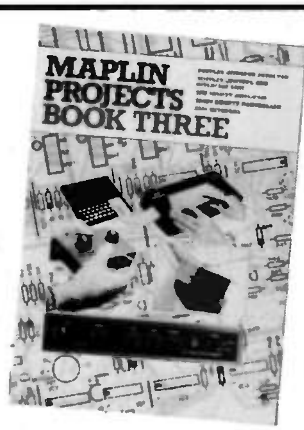


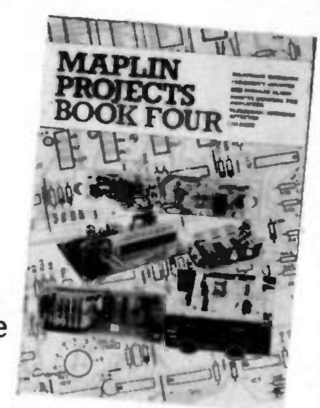
ZX81 Keyboard. A full size, full travel 43-key keyboard with the electronics to make graphic symbols, function mode and shift lock, single key selections. The two-colour legend for the keys is the same as the ZX81 keyboard. The keyboard plugs directly into the sockets in the ZX81 and a special adaptor is supplied to run the keyboard from the ZX81 power supply, so there's no soldering in the ZX81 at all. This full-size keyboard gives you fast, reliable entry — use it once and you won't be able to do without it again!

Stereo 25W MOSFET Amp. Supplied as a complete kit including wooden cabinet and printed and punched chassis, this superb 25W rms per channel amplifier has inputs for magnetic pick-up, tape deck, tuner and auxilliary. The kit is extremely easy to build, all but 5 components mounting directly on the pcb. There are only 7 interconnecting wires in all and when completed, no setting-up is required. With its superb frequency response, low noise, low distortion and the grandeur of MOSFET sound, the amplifier is second-to-none at the price.

Radar Doppler Intruder Detector. Home Office type-approved microwave unit gives coverage adjustable from about 2m to 20m. May be used on its own, or with our Home Security System.

Model Train Controller Remote Control Facilities. Full details of infra-red, radio or wired remote control units for our Digital Multi-Train Controller.

All this for just 70p. Order As XA03D (Maplin Project Book Volume 1 No. 3). Price 70p *NV*



Copies of issue 4 are now sold out, but a reprint of the projects from issue 4 is available and contains:

Telephone Exchange. A complete telephone exchange with up to 32 extensions on 2-wire lines. Ideal for the home, office, or small factory. Save £££'s on rental charges. Full construction details for up to 16 lines in this book.

Remote Control for Amplifier. Adjust volume, balance, and tone whilst you sit back and relax with our infra-red remote control. Designed for use with our 25W MOSFET Amp, but can be fitted to most amplifiers.

Frequency Counter. This superb, easy-to-use, low-cost, 8-digit frequency counter with superior specification covers the 10Hz to 600MHz band. Incorporates full push-button control, electronic switching, and one input for the whole range.

Ultrasonic Intruder Detector. This easy-to-build ultrasonic receiver covers up to 400 square feet; though more than one can be used for larger areas. The unit automatically adjusts itself to transmit at the frequency where the transducers give their maximum output. Up to three of these units may be connected to our home security system.

All this for just 70p. Order As XA04E (Maplin Project Book Volume 1 No. 4). Price 70p *NV*

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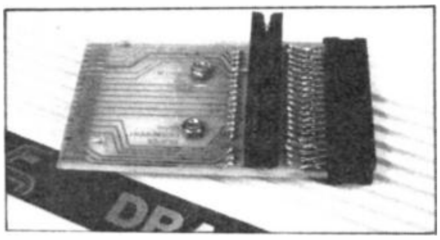
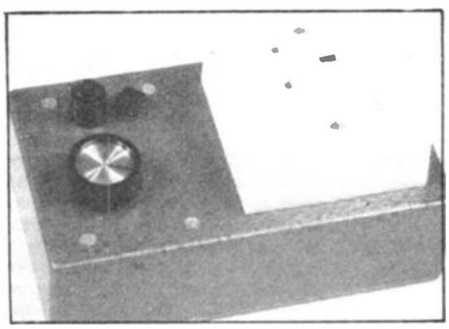
PROJECTS



This handy little project enables the cartridge socket on the Dragon 32 to be brought to a more accessible position.

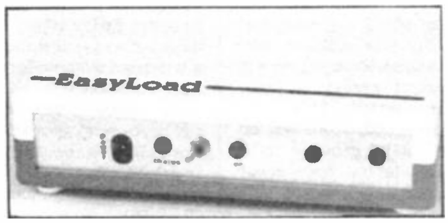
A low-cost Direct Conversion Receiver for the 80m Amateur Band. This easily constructed project features single-sideband operation and can be aligned without test gear. It offers an ideal introduction to the newcomer to Amateur Radio.



A versatile easy-to-build unit which will control appliances of up to 2.8kW, with minimal power loss.

This 8 Watt/12 Volt circuit gives highly efficient light output from a 12V car battery — ideal for camping etc.

An interface which enables you to connect the Maplin Modem to an Oric 1 computer, thus opening up a whole new range of opportunities for Oric owners.



Enhance cassette loading of programs on your Sinclair Spectrum, with this novel battery operated project.

Enables you to expand the Maplin Digi-Tel telephone exchange to accommodate 32 extensions.

Produce a wide range of waa-waa type musical effects automatically with this easily constructed design.

FEATURES

Part One of a new six part series which will give a brief history of the people and developments which have formed the basis of present-day electronics. The first part covers the period from ancient Greek times to the Eighteenth century.

Part two of this series discusses the measurement of Resistance, Capacitance and Inductance, and features some useful circuits.

Part One of our series describing the operation of the basic car electrical system. This issue introduces the fundamentals and covers the ignition system.

The fourth part of this series deals with Input/Output functions.

A light-hearted look at the visit by Maplin's HERO Robot to the Earls Hall Junior School in Southend.

The second part of this feature discusses record deletion and re-use and the production of a sorted list from the file.

Part five of our guide to logic design covers the circuitry required to make a simple timer/counter.

NEWS

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READERS LETTERS

Computers or Electronics?

The 'Computers versus Electronics' discussion continues unabated – below we publish a selection of readers' views on the subject. If you would like to express your opinion, we invite you to complete the Readers Survey in this edition of the Maplin Magazine.

Dear Sir,
With reference to the letter from S. North published in the last issue, entitled Micro Mania, I would like to say that as an Engineer of some twenty odd years experience, and as one who has only in recent years progressed to home computers, I object to being called a 'key bashing freak' or belonging to a sub-culture. Personally I have no interest in Hi-Fi or radio hamming but I would not call anyone who is so inclined obnoxious names or begrudge them space in any magazine. As for playing games I must admit I do on occasions and I have learnt a lot about how to write programs by doing so. This letter was written on a word processor of my own design and run on a computer which I built.
If you have not tried it, Mr. North, then don't knock it. Perhaps you have tried it but couldn't hack it. Anyway if only 40% of the articles were about computers then surely 60% were about other things, so what's the problem.

L. V. COOPER
Ruskington, Lincs.

Dear Sir,
I must agree with everything Mr. North has to say concerning your Magazine and its undue bias towards the computer. Doubtless he will be furthur displeased by the fact that the current issue contains yet two more such projects, thus increasing the number to eight. Anyone who has lived through the age when a simple school arithmetical problem involved the caculation of 3cwt 1qr 17lbs at £2 7s 11d per ton, must think the use of a computer to deal with household accounts positively ludicrous — especially in these days of decimalised everything.
Even a simple calculator is quite superfluous for this purpose and I can envisage no possible requirement in the house for any of the repetitive or sorting tasks at which the computer excels. In the domestic situation they cannot be cost effective and my view is that within a short period, of those microcomputers which have not already been scrapped, 99.9% will be used solely for childish games.
Therefore please let us have fewer items about them.

E. F. BROCK,
Birmingham.

Dear Sir,
I would like to congratulate you on your excellent magazine, but mostly on your coverage of the Commodore VIC 20, which most other magazines, both electronics and computing, seem to practically ignore. I was especially pleased with the RS232 interface and speech synthesiser circuits.
I have one suggestion to make: why don't you have a regular spot giving programming hints, hardware reviews and advice, not only for the VIC (which happens to be a better seller than the Spectrum and several other micro's which get more coverage), but for other micro's not very well covered elsewhere, such as the Oric and Lynx computers. I feel this would not only round off your great magazine, but it would increase its popularity.

CHRIS SPARKS
Ilford, Essex.

Thank you for your comments. The RS232 interface & speech synthesiser have proved very popular though we doubt that the VIC20 outsells the Spectrum. We shall be studying the results of our readership survey, with interest, to find out what other readers would like to see in the magazine.

Dear Sir,
With the rush of CB now tailing off and CB'ers migrating to the realms of Amateur Radio at the rate of several thousand a year, it would be nice to see a few more accessories devoted to our side of the fence.
I see readers' letters in the magazine still have complaints about your coverage of Micro's (being too much that is). I think it's a fact of life that they are now about in very large numbers and after Christmas even more so. They are not the minority that some constructors seem to think and my vote goes in favour of your coverage.

A. J. COLLIER, G8WZJ
Plymouth, Devon.

Ni–Cad Charger?

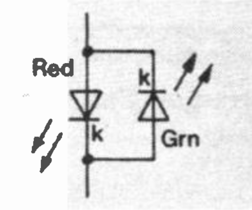
Dear Sir,
I am using ni–cad rechargeable cells in a hand-held CB radio. I find them less than ideal because once the 'top' has gone off the charge the transmitting range becomes limited fairly quickly. I understand that to frequently 'top–up' the charge may cause the cells to eventually refuse a full charge. It would seem best, if this is so, to discharge the cells completely before each charging session.
A gang of 10 battery holders connected to a 12V car bulb would achieve this, but what would be a suitable wattage for the bulb so as not to overheat the cells?
A friend of mine has a purpose-built recharger which discharges the cells to a low limit automatically when they are inserted. It then proceeds to recharge them fully, again automatically. Could you publish such a circuit in the Magazine.

E.G. GRAY,
Pudsey, West Yorkshire.

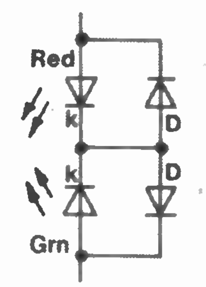
We have just such a project currently under evaluation and hope to publish details in a future issue.

Multicolour LED's

Dear Sir,
Sometimes a circuit diagram will specify a 2 terminal multicolour LED effectively a red and green pair in anti parallel:–



This can be replaced by the 3 terminal common cathode pair available from Maplin by connecting thus:–



The 2 extra diodes can be small signal types e.g. 1N914 (QL71N) or 1N4148 (QL80B).
Since your diagram on page 242 of the catalogue, shows common anode devices and the diodes available are both common cathode, perhaps a reference to this and the application above could be made in the Magazine.

E. A. TURNER
Orpington, Kent.

I must admit that the diagram you mention on catalogue page 242 was not meant to have been included, but our Art Editor lovingly retreived it from the scrap as though it were akin to a Picasso or somesuch and tucked it into the page with such skill that I inadvertently missed it when I checked the page. In truth, a genuine cock-up.

AMENDMENTS TO 1984 CATALOGUE

Continued on page 63.

Please amend your copy of the 1984 catalogue as follows:-

Pages 24 & 25, Aerials. A new range has been introduced to cover 88 to 108MHz, in response to the extension of Band II frequencies to 108MHz. These latest models show improvements in performance data. XQ23A is now Mushkiller FM1083, with a forward gain of 4.5dB. Size: 0.864m long x 1.73m wide. XQ25C is now Mushkiller FM1085, with a forward gain of 6.5dB. It now has 5 elements. Size: 2.05m long x 1.73m wide. XQ27E is now Mushkiller FM1087, with a forward gain of 8dB. It now has 7 elements. Size: 3m long x 1.73m wide. XQ38R has undergone a specification change, forward gain is now 12dB. It now has an acceptance angle of ±17 to 28 degrees. XQ39N now has a forward gain of 16dB. XQ40T now has a forward gain of 16dB. XQ41U now has a forward gain of 17dB. XQ42V now has an acceptance angle of ±15 to 27 degrees and a front/back ratio of 26 to 29dB. XQ43N now has a forward gain of 18.5dB. XQ44X now has a forward gain of 18dB. XQ45Y now has a forward gain of 19dB. XQ46A has undergone considerable specification changes. Forward gain is now 15dB, front/back ratio is now 31dB, acceptance angle is now ±13 to 23 degrees. XQ50E now has a forward gain of 17dB, front/back ratio of 30 to 31dB, acceptance angle is now ±10 to 24 degrees. The 21dB stated in the text is now incorrect and should be 19dB.

Page 26, XQ26S is supplied as 10ft. x 1.5" and not the stated 6ft.

Page 27, BW51F UF020 Diplexer. This unit is for combining or separating UHF/VHF signals from downleads, and not for 'splitting' as described in the text.

Page 28, LB09K due to a change in supplier, instructions are no longer included with this item. To fit the balun to the co-axial downlead, proceed as follows:- To remove the plastic case from the balun, gently squeeze the two narrow plastic sides together until the wider sides have 'bowed out' enough to make removal of the insert possible. After threading the outer case on to the co-ax cable, the cable can be connected to the terminal and metal clamp on the balun circuit board.

Page 53, RW87U Knob KB4 is not discontinued. Price is 22p.

Page 70, WM36P Oric Machine Code Handbook is now retitled 'Getting to grips with Oric 1 Machine Code'. Price is now £7.95, but the book will not be available until April.

Page 71, YK70M. Small Display Box. This item is now availble. Price is £3.32 TQ25.

Page 73, FG41U PSU Box & Plug. This item is now supplied in black.

Page 76, All aluminium instrument cases are no longer supplied with the self-adhesive brushed aluminium strip.

Page 98, Can-type Electrolytic Capacitors. Due to a change in supplier, sizes for can-type capacitors are now as below.

Capacitor Code	Case Size (mm) Length	Diameter
FF19V	40	25
FF20W	40	20
FF21X	50	21
FF22Y	40	25
FF24B	50	25
FF26D	40	25
FF27E	50	30
FF28F	60	30
FF29G	100	35
FF30H	76	35
FF31J	50	30
FF32K	80	35

Page 104, XG10L PSU, text should read 13.8V not 18.8V.

Page 173, BNC Earth Tag is omitted. Code is QY22Y Price 20p.

Page 175, RK54J Chassis Socket, requires a 17mm panel cut-out not 20mm.

Page 182, WY16S Euroboard 4 way is supplied with 4 plugs. Price is £9.89. WY17T is not affected.

Page 191, YB19V Time Switch. The illustration for the time switch is incorrect. The time switch supplied will have its adjustments made by removing selector pins.

Page 207, HK11M is the assembled version not the kit.

DRAGON 32 EXTENDIPORT

by Dave Goodman

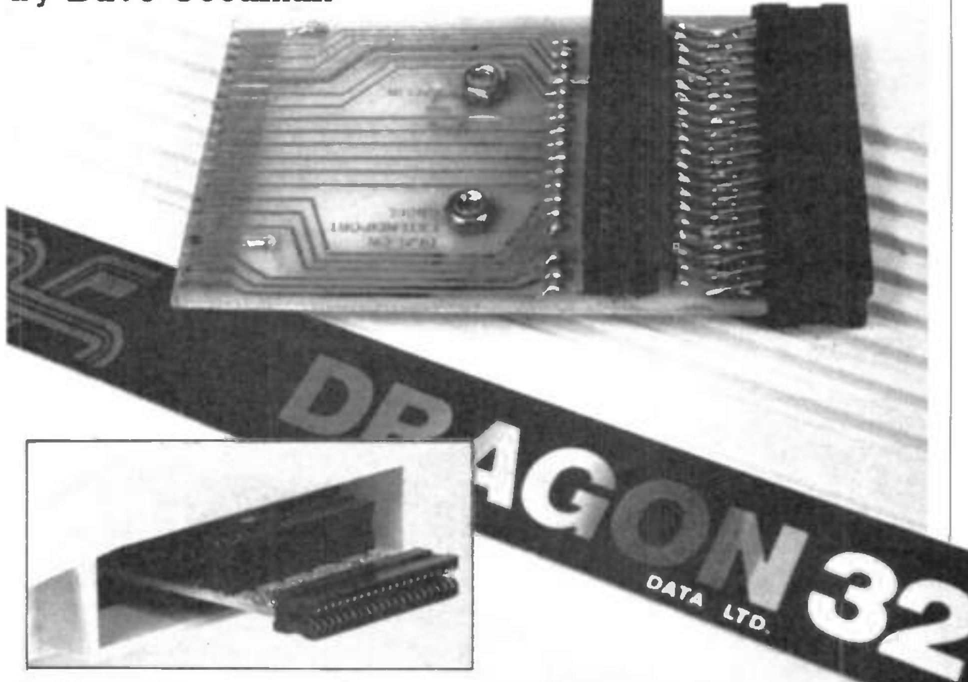
This simple to build project effectively brings the Dragon 32 cartridge socket to a more accessible position. As Dragon project builders will no doubt be aware, a great deal of peripheral device circuitry becomes inaccessible once inserted into the cartridge opening, thus making testing and troubleshooting somewhat difficult!

The Extendiport allows two (2 x 20 way) socket extensions, or one socket and one open PCB edge connector to be available for use by external devices. For the sake of simplicity, no buffering or $\overline{CE}$ switching has been fitted, so great attention must be paid when soldering on the board. There are forty track pins to be inserted from the top side; push them down to the track before soldering to ensure full penetration through the PCB. Solder both sides carefully and check for short circuits. A 2 x 20 way socket can be fitted to the top if required and/or to the edge connector to suit requirements. Again carefully solder all terminals and check for shorts. Two rubber feet can be fitted to side 1 with 2 x 4BA bolts and nuts. This will ensure a good fit into the Dragon socket and avoid excess movement and strain.

Once construction has been completed, it will be well worthwhile checking adjacent terminals for shorts, using a suitable ohm-meter or continuity tester. The Dragon's Address, Data and Control lines are not internally buffered and damage to the processor will result if any PCB faults are not found before inserting the Extendiport — therefore meticulous attention should be paid to the construction of this project.

PARTS LIST

Printed Circuit Board		(GB56L)
PC Edge Conn 2 x 20 way	2	(BK97F)
Track Pins	1 pkt	(FL82D)
Cabinet Feet	1 pkt	(FW19V)
Bolt 4BA ¼"	1 pkt	(BF02C)
Nut 4BA	1 pkt	(BF17T)



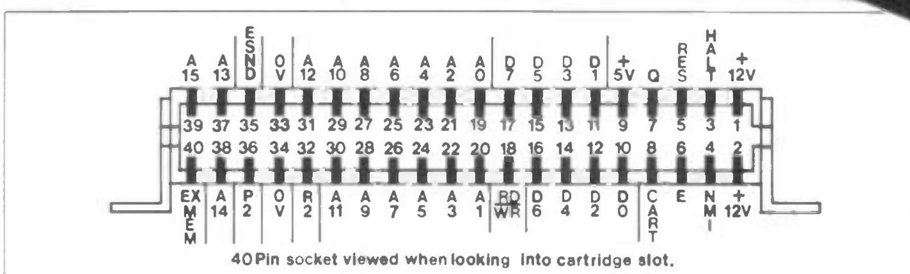


Figure 2. Cartridge slot pinouts.

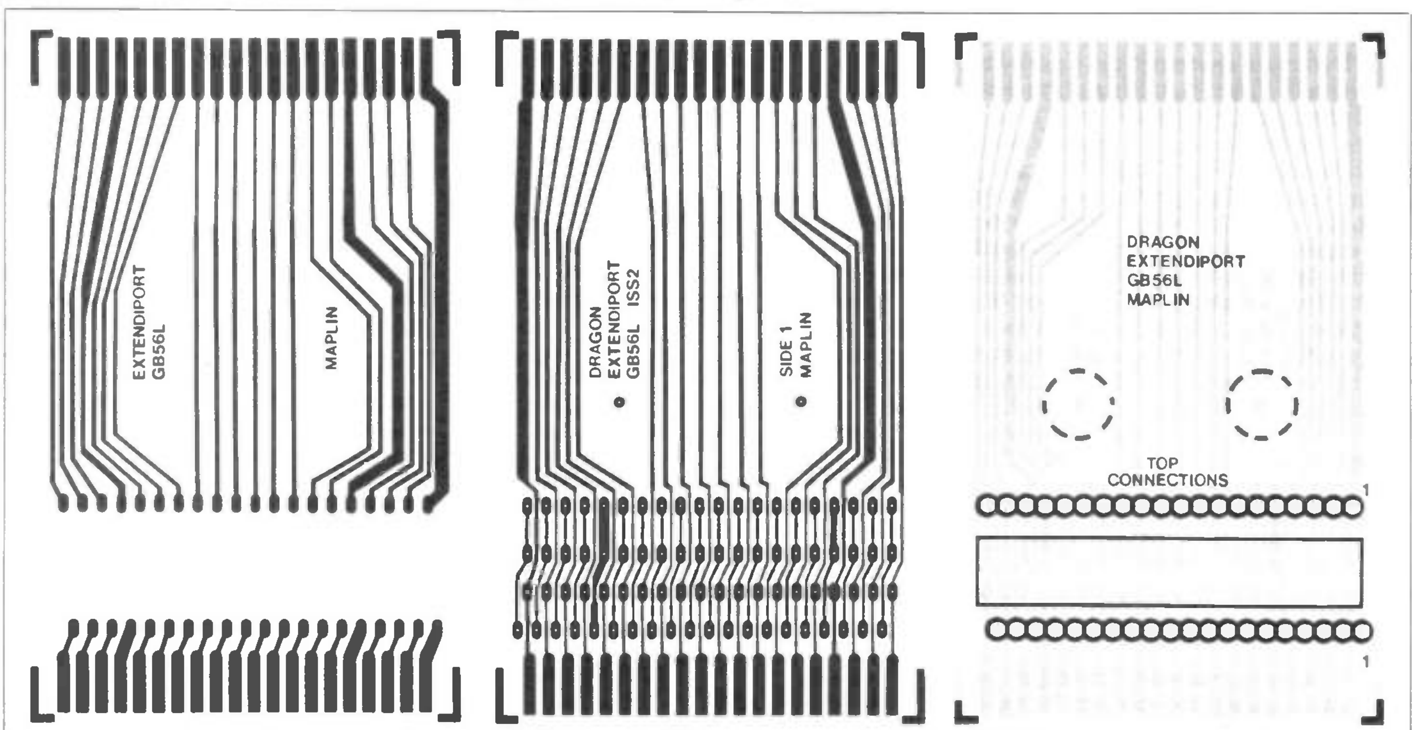


Figure 1. PCB artwork and overlay.

80 Metre Amateur Receiver

★ **Direct conversion design**
★ **Excellent introduction to amateur radio**
★ **Single-sideband and CW operation**
★ **Straightforward construction**
★ **Alignment without test gear**

The cost of amateur radio equipment is generally quite high these days, and this tends to give newcomers to the hobby the impression that amateur band transmissions can only be received using a vast array of the latest in ready-made gear. In fact quite good results can be achieved on the short wave amateur bands using relatively simple home-constructed equipment. Conditions on the short wave bands are, to say the least, rather difficult these days, principally due to the overcrowding and high output power of many commercial transmitters. Even using sophisticated receiving equipment a reasonable amount of skill is required in order to obtain good results, and when using a simple receiver the amount of patience and skill needed is that much greater. However, provided it is used carefully and sensibly, a simple receiver of the type described here can provide creditable results and a lot of fun.

In order to make the finished set as easy as possible to set up ready for use a single band direct conversion design has been adopted. The band chosen is 80 metres, which in the U.K. extends from 3.5 to 3.8MHz (the upper limit is 4MHz in the U.S.A. and some other countries). This is admittedly not the best band for long distance reception, and one of the high frequency bands would be better in this respect. On the other hand, it will provide reception of European stations after dark, with stations from further afield being received when conditions are favourable (North American stations have been received using the prototype). During the daytime there will often be transmissions from British amateurs, and there is unlikely to be a total lack of stations for long. The high frequency bands, especially now the current sunspot cycle is nearing its minimum, tend to be 'dead' for much of the time, and are not currently an attractive proposition for a single band receiver.

Single Sideband

Tuning an amateur band transmission properly tends to be rather more difficult than tuning in an ordinary AM broadcast station. The reason for this is the widespread use of SSB (single sideband) as the transmission mode. This is a form of AM transmission, but it is very different from the reception point of view. With an ordinary AM signal a small tuning error will probably give no more than a slight loss of audio quality, and might be totally unnoticeable. With an SSB transmission even a very small tuning error is usually sufficient to render the audio output completely unintelligible. It is not essential to understand the basics of SSB and the way it is resolved by this receiver, but it should certainly help to make the set easier to use, making the tuning of a station a less 'hit and miss' affair.

Probably the most convenient way of looking at an SSB transmission is to think of it as an audio frequency signal where the frequencies have all been raised by a certain amount to bring them into the radio frequency range. For example, if frequencies at 1kHz, 2kHz and 3.5kHz were to be fed into an SSB transmitter operating at 3.7MHz, the RF output frequencies would be at 3.701MHz (3.7MHz

+ 1kHz), 3.702MHz (3.7MHz + 2kHz), and 3.7035MHz (3.7MHz + 3.5kHz), bearing in mind that 1kHz is equal to 0.001MHz. The strengths of the RF output signals are proportional to the strengths of the corresponding audio input signals. Of course, with a voice input to the transmitter the audio signal would be comprised of a multitude of audio frequencies, and it would be changing from one instant to the next. However, the principle of operation remains unchanged, and with a complex audio input a correspondingly complex RF output is generated.

In practice there are actually two types of SSB, lower sideband (LSB) and upper sideband (USB). With the system described above the RF output signals are higher in frequency than the basic 3.7MHz transmission frequency, and this is upper sideband. With lower sideband the output frequencies are below the basic transmission frequency, or in the example given above this would give outputs at 3.699MHz (3.7MHz − 1kHz), 3.698MHz (3.7MHz − 2kHz), & 3.6965MHz (3.7MHz − 3.5kHz). Figure 1 shows these examples in diagrammatic form, and should help to clarify things.

In addition to SSB, the other main transmission mode used by amateurs on the short wave bands is CW (continous wave), which is a form of Morse Code transmission. It consists just of keying a radio frequency signal on and off, and this type of transmission can be resolved by any SSB receiver.

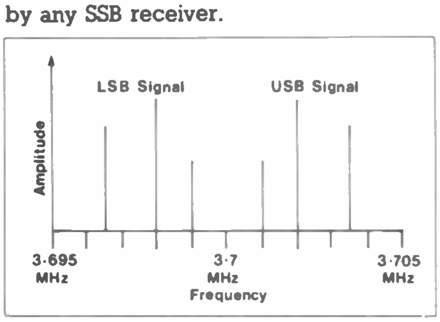


Figure 1. An SSB signal can be transmitted as upper or lower sideband.

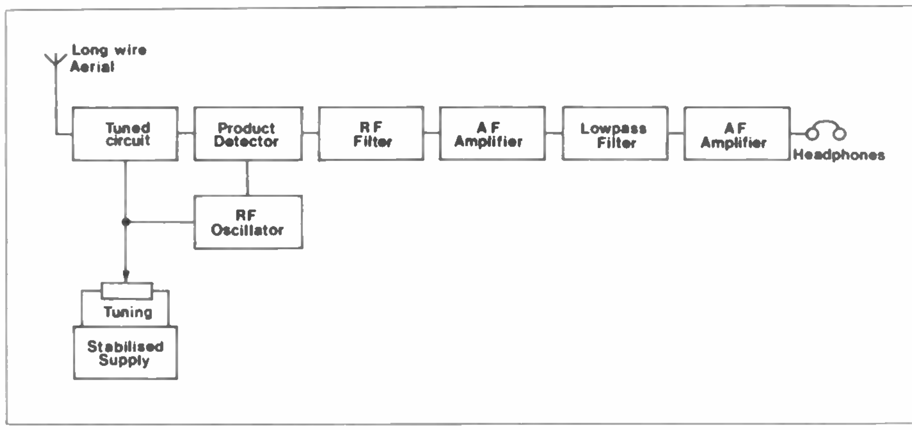


Figure 2. Block diagram of the Direct Conversion Receiver.

Direct Conversion

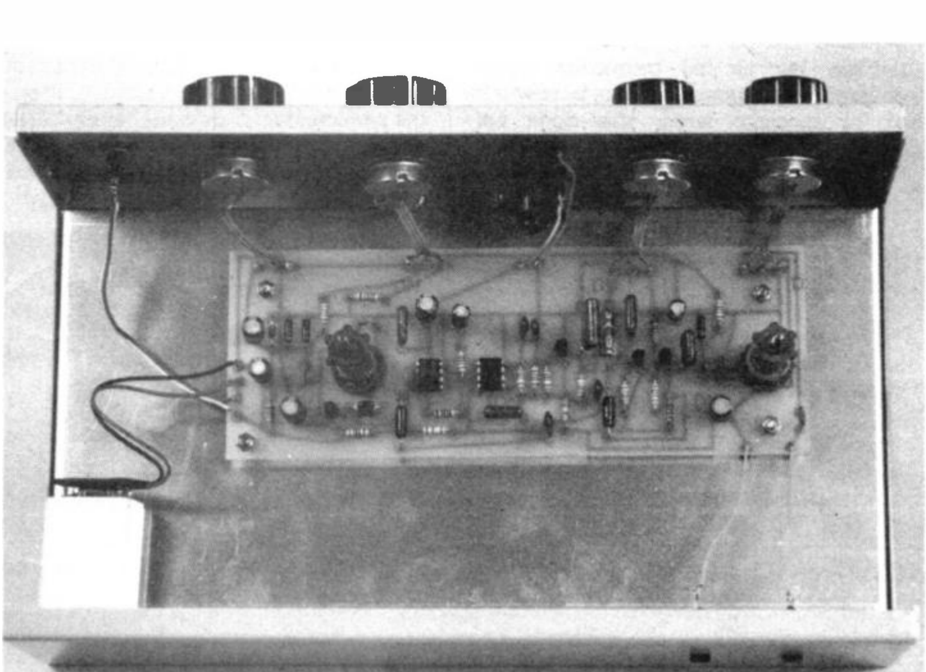
The most simple type of receiver which is suitable for single sideband reception is the direct conversion type, and it is a receiver of this kind which is featured here. Direct conversion receivers use the heterodyne effect to reverse the transmission process, and shift the received radio frequency signals back down to the original audio frequencies. Figure 2 shows the receiver in block diagram form, and this helps to explain the way in which incoming signals are processed.

Signals from the aerial are coupled to a tuned circuit which acts as a passive bandpass filter. This eliminates most signals that are well outside the frequency range that is of interest, but there are still a great many signals present at the output of the filter, and it does not significantly aid the selectivity of the set. Its purpose is to cut down the number of signals fed to the rest of the receiver to manageable proportions.

The product detector and RF oscillator stages are responsible for demodulating received signals. The output of the product detector contains all the input frequencies, plus the sum and difference frequencies. In this application it is the difference frequency that is of importance, as it is this that constitutes the demodulated audio output. For example, if a 3.7MHz SSB transmission is to be received, the RF oscillator must be set to operate at 3.7MHz. An audio input to the transmitter at (say) 1kHz would give an RF output at either 3.701MHz or 3.699MHz, depending on whether the signal is an upper sideband type or a lower sideband one. In either case the difference between the 3.7MHz operating frequency of the RF oscillator and the signal frequency will be 1kHz (3.701MHz − 3.7MHz = 1kHz and 3.7MHz − 3.699MHz = 1kHz

Provided the oscillator is tuned to the correct frequency, any audio input frequency at the transmitter will be converted back to the same audio frequency by this heterodyne process at the receiver. However, if the oscillator is not at quite the right frequency, all the audio output frequencies will be wrong. If the oscillator is placed slightly too far away from the SSB signal the difference frequencies are increased, as are the audio output frequencies. Due to the increase in the pitch of the audio output this is popularly known as the 'Donald Duck' effect. If the oscillator frequency is taken too close to the SSB transmission, the opposite occurs, with a lowering in the pitch of the audio signal. The oscillator frequency has to be placed just below an upper sideband signal, or just above a lower sideband signal. If it is placed on the wrong side, the high audio frequencies become low frequencies, and the low audio frequencies become high ones. This inversion of the signal 'scrambles' it completely so that the overall pitch is about right, but probably not a single word would be understandable. This is easily corrected by simply tuning through the transmission, and then with the oscillator positioned on the right side, the tuning is adjusted for an output of the correct pitch. In practice there is always going to be a small error in the pitch of the output signal, and there is no way of determining what is precisely the correct pitch anyway. It is therefore a matter of adjusting the tuning to produce the audio pitch that sounds best.

The reception of CW transmission is far less critical, and it is just a matter of tuning the oscillator close to the transmission frequency so that the difference frequency provides an audio output. The pitch is relatively unimportant, and you can adjust the tuning control for any audio



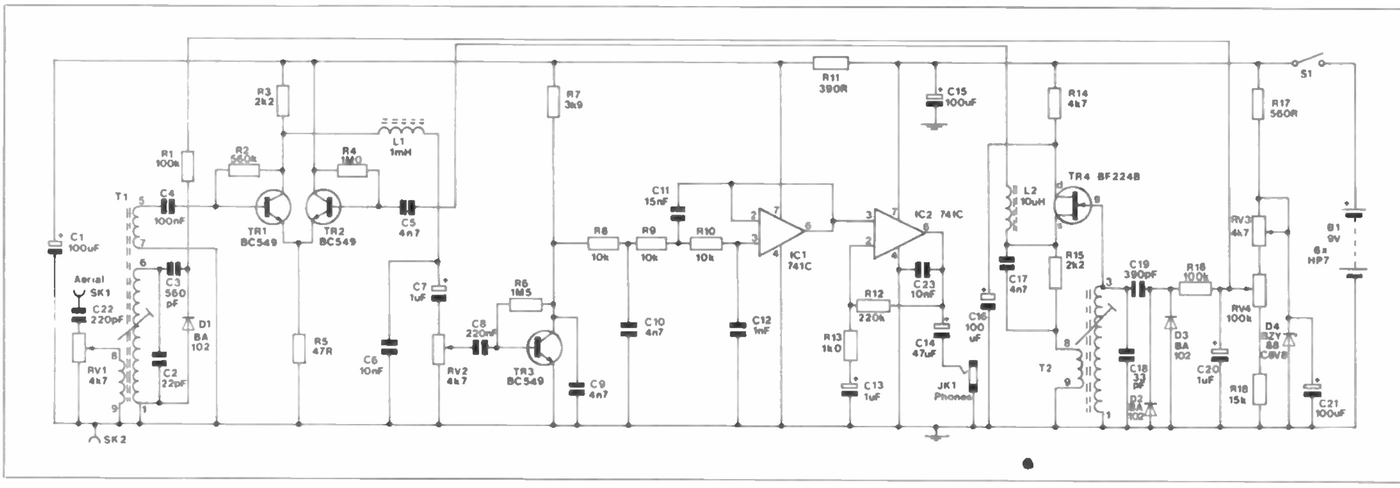


Figure 3. The Direct Conversion Receiver circuit diagram.

frequency you like. With a simple receiver of the type featured here it does not normally matter which side of the CW signal the oscillator signal is placed, although it may sometimes be found that one side suffers less from adjacent channel interference than the other.

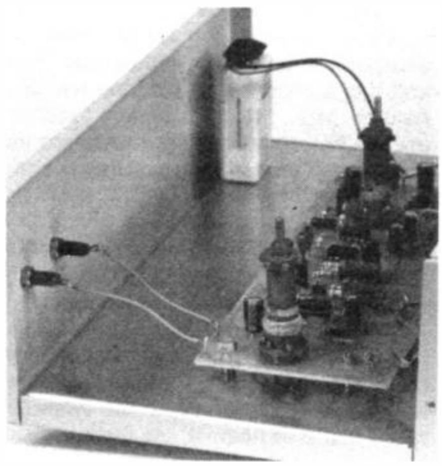
Apart from the audio signal, the sum signal and the input frequencies are present at the output of the product detector. These are easily removed though, as they are all radio frequency signals, and a simple passive filter is all that is needed to do this. An amateur band receiver requires a high level of overall gain, and with a direct conversion receiver the bulk of the gain is generally provided by the audio stages. Two high gain audio amplifiers are therefore included in the unit. A lowpass filter is fitted between these stages, and it is an active 18dB per octave type. The purpose of the filter is to cut down adjacent channel interference, and it is this filter which provides most of the receiver's selectivity.

Most low frequency band receivers have the tuning provided by ordinary variable capacitors, but in this case variable capacitance (varicap) diodes are used. In order to obtain good stability the tuning voltage is obtained from a regulated supply. In this application there is no technical advantage in using varicap tuning, and this method is used merely because it is less expensive than using variable capacitors of suitably high quality.

The Circuit

Figure 3 shows the full circuit diagram of the receiver. The main winding of T1, together with the capacitance provided by C2 and tuning diode D1, forms the input tuned circuit. The aerial signal is fed to the low impedance coupling winding on T1 via C22 and RF attenuator RV1. The latter can be used to reduce the aerial signal if the receiver is overloaded. C22 helps to prevent audio signals from being picked up at the input of the circuit.

TR1 and TR2 are used in a simple product detector configuration. Some more sophisticated circuits were tried, but although the least expensive and most simple, this one gave the best results. The



oscillator uses TR4 as a source follower stage with frequency selective positive feedback provided by T2. In order to obtain a large enough capacitance swing using BA102 varicap diodes. It is necessary to use two of these wired in parallel (D2 and D3). This permits coverage of the full 3.5 to 4.0MHz band.

R17 plus D4 provide a stabilised supply of 6.8 volts for the tuning circuit. RV4 is the main tuning control, and RV3, which provides only a limited tuning range, is used for fine tuning. Tracking between the RF and oscillator is not perfect, but as the frequency range covered is quite small, and the bandwidth of T1 is quite large, this does not significantly degrade the performance of the set.

L1 and C6 provide RF filtering at the output of the product detector, and the remaining audio signal is coupled to the volume control, RV2. TR3 is used as the basis of the first audio amplifier which is a straightforward high gain common emitter stage. The output of TR3 is taken to the lowpass filter which is a conventional third order design having a cutoff frequency of about 3.5kHz. IC1 is used as the unity gain buffer stage for the filter.

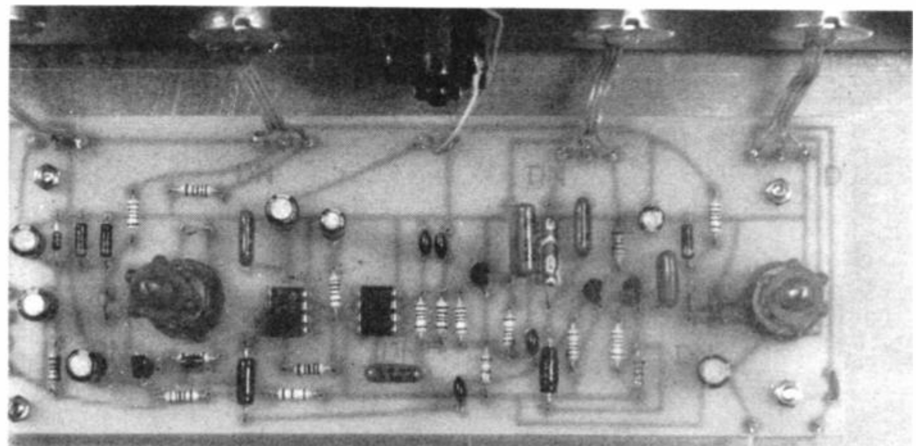
The second audio amplifier stage uses operational amplifier IC2 as a non-inverting amplifier having a voltage gain of about 220 times. C23 aids the stability of the circuit. The output of the set is intended for use with medium or high impedance headphones, although it also seems to work quite well with inexpensive low impedance types, or even with a crystal earphone.

Power is obtained from six HP7 batteries connected in series, or any other 9 volt battery of fairly high capacity. As the current consumption of the receiver is about 8 to 9 milliamps the use of a small 9V battery is not recommended.

Construction

Most of the components are mounted on the printed circuit board. Details of the circuit board and wiring are given in Figure 4.

Start by fitting resistors, capacitors, and the two inductors (L1 and L2). Then fit the semiconductor devices, taking care to connect each one the right way round. IC1 and IC2 are both inexpensive types and it



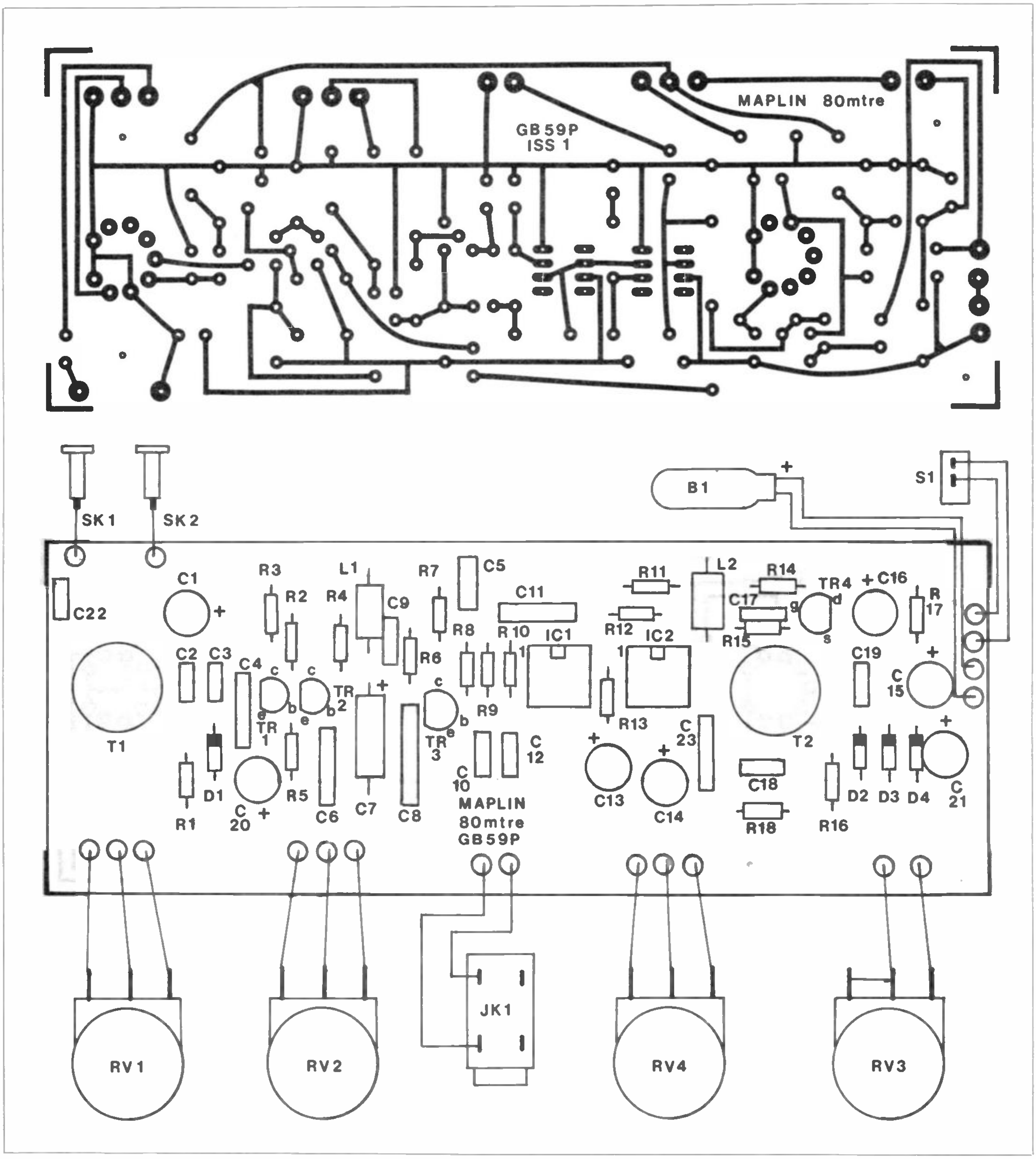


Figure 4. PCB track, legend and wiring diagram.

is probably not worthwhile using sockets for these. T1 and T2 are designed as plug-in coils (which fit a B9A valveholder) rather than for printed circuit mounting. Despite this they can be mounted direct on the board without too much difficulty. The only problem that might arise is getting solder to flow over the pins properly, and to avoid difficulty it is advisable to clean the pins prior to fitting and connecting the coils. This is easily done using fine sandpaper or by scraping the pins with the blade of a penknife. For packing purposes the coils are supplied with their cores fully screwed down, but in normal use the cores will need to be unscrewed somewhat. They should therefore be set so that about 10 millimetres of metal screwthread protrudes from the top of each one.

It will be easier to make the connections to the off-board components if Veropins are fitted to the board at the appropriate places.

A metal instrument case which measures about 250 by 150 by 75mm makes an ideal housing for this project, although it could be fitted into a somewhat smaller case if desired. The five controls and the headphone socket are mounted on the front panel, and the general layout can be seen from the photographs. It is advisable to adhere to this layout as the final wiring up of the unit will then be easier. The aerial and earth sockets are mounted on the rear panel of the case.

The printed circuit board is mounted on the base panel, or if the specified case is used, it is mounted on the aluminium chassis supplied with the case. It should be positioned so that the components mounted on the front panel are roughly aligned with the part of the board to which they will be connected. Spacers are used over the mounting bolts to keep the connections on the underside of the board clear of the metal case or chassis. Finally, the battery clip is wired to the board and the remaining wiring is added using ordinary multistrand connecting wire.

If the unit is powered from six HP7 cells these must be fitted into a plastic battery holder. Connections to the holder are made via an ordinary PP3 style battery clip. Alternatively, the receiver can be powered by a large 9 volt battery such as a PP7 or PP9, but note that these use the larger type of battery connector.

Aerial and Earth

It is not essential to use a very long aerial, and quite good results should be obtained using 10 or 20 metres of wire positioned as high as possible. It is also not essential to use proper aerial wire, and fairly heavy duty PVC covered connecting wire or about 18 swg enamelled copper wire should be perfectly satisfactory. In the long term it would be advisable to install the aerial properly, but initially a make-shift arrangement is perfectly satisfactory and it gives you the opportunity to determine what gives the best results. A short indoor aerial is far less than ideal, especially for a low frequency short wave band such as 80 metres. Apart from giving relatively weak reception, an aerial of this type is more prone to pick up interference from television sets etc.

An earth connection can provide a substantial improvement in results on the 80 metre band, but, nevertheless, good results can be obtained without one provided a reasonably efficient aerial is used. If you do wish to use an earth, this can consist of a length of metal rod or pipe pushed into the ground and connected to SK2 of the receiver via a piece of wire which should be as short as possible. Do not use the mains earth. Apart from the safety aspect, this would almost certainly introduce mains "hum" into the receiver.

Adjustment and Use

With the set installed and switched on, and with both RV1 and RV2 well advanced, by adjusting tuning control RV4 it will probably be possible to tune in a few stations of some kind. It should then be possible to adjust the core of T1 to peak the sensitivity of the receiver. Assuming that a suitable RF signal generator is not available, the only way to set the core of T2 for the correct frequency coverage is to use trial and error. This is a matter of searching for 80 metre amateur transmissions by adjusting RV4 and the core of T2, and then giving T2's core any setting which brings all these stations within the coverage of RV4. It is probably best to make the final adjustment after dark, and preferably at the weekend, as this is when the band is likely to be most heavily used. In general, the lower half of the band is used for CW transmissions, and the upper half is used for SSB. Remember to adjust the core of T1 for peak performance once the core of T2 has been given its final setting. The bandwidth of T1 is quite wide, and the setting of its core is not too critical.

As explained earlier, tuning in an SSB signal properly is quite tricky, but with a little practice it is something that is easily mastered. Very careful tuning is required in order to bring the audio output to the correct pitch, and the final tuning is much easier using fine tuning control RV3. With RV1 fully advanced the product detector may become overloaded, leading to the breakthrough of broadcast stations or other transmissions. It is obvious when this happens since the tuning controls will have no effect on a signal of this type. The breakthrough can be eliminated by backing off RV1 somewhat. With a receiver of this type it is generally better to have the volume control well advanced and the RF attenuator control advanced no further than necessary.

Amateur stations use callsigns, and the first one or two letters of the callsign denote the country in which the station is operating. All British callsigns start with the letter "G", and plenty of these should be heard on 80 metres. There should also be no shortage of other European stations, such as West Germany (DM/DL) and the USSR (U). Stations in the USA (W) may be heard in the early hours of the morning.

PARTS LIST FOR 80M RECEIVER

RESISTORS All 0.4W 1% Metal Film unless specified.

R1,16	100k	2	(M100K)
R2	560k		(M560K)
R3,15	2k2	2	(M2K2)
R4	1M0		(M1M)
R5	47R		(M47R)
R6	1M5 ⅓W 5% Carbon film		(B1M5)
R7	3k9		(M3K9)
R8-10	10k	3	(M10K)
R11	390R		(M390R)
R12	220k		(M220K)
R13	1k0		(M1K)
R14	4k7		(M4K7)
R17	560R		(M560R)
R18	15k		(M15K)
RV1,2	Pot lin 4k7	2	(FW01B)
RV3	Pot log 4k7		(FW21X)
RV4	Pot lin 100k		(FW05F)

CAPACITORS

C1,15,16,21	100uF 10V PC Electrolytic	4	(FF10L)
C2	22pF Ceramic		(WX48C)
C3	560pF Ceramic		(WX65V)
C4	100nF Polyester		(BX76H)
C5,9,10,17	4n7 Mylar	4	(WW17T)
C6,23	10nF Polyester	2	(BX70M)
C7	1uF 63V Axial Electrolytic		(FB12N)
C8	220nF Polyester		(BX78K)
C11	15nF Polyester		(BX71N)
C12	1nF Mylar		(WW15R)
C13,20	1uF 100V PC Electrolytic	2	(FF01B)
C14	47uF 25V PC Electrolytic		(FF08J)
C18	33pF Ceramic		(WX50E)
C19	390pF Ceramic		(WX63T)
C22	220pF Ceramic		(WX60Q)

SEMICONDUCTORS

IC1,2	uA741C (8 pin DIL)	2	(QL22Y)
TR1,2,3	BC549	3	(QQ15R)
TR4	BF244		(QF16S)
D1,2,3	BA102B	3	(QB27E)
D4	BZY88C6V8		(QH10L)

MISCELLANEOUS

L1	1mH Choke		(WH47B)
L2	10uH Choke		(WH35Q)
T1	Trans Coil 3T Blue		(HX77J)
T2	Trans Coil 3T Red		(HX78K)
S1	SPST Ultra Min Toggle		(FH97F)
SK1	2mm Socket Red		(HF47B)
SK2	2mm Socket Black		(HF44X)
JK1	¼" Jack Socket Brk		(HF90X)
	Printed Circuit Board		(GB59P)
	Veropin 2145	1pkt	(FL24B)
	Knob K7B	2	(YX02C)
	Knob K7C	2	(YX03D)
	9V Battery Holder		(HQ01B)
	PP3 Clip		(HF28F)
B1	(HP7 Batteries 6 reqd)		
	Wire	1m	(BL00A)

OPTIONAL

	Case Blue Type 233		(XY48C)
	Bolt 6BA x ½"	1 Pkt	(BF06G)
	Nut 6BA	1 Pkt	(BF18U)
	Spacer 6BA x ¼"	1 Pkt	(FW34M)

A kit of parts (excluding case, fittings & batteries) is available.
Order As LK41U. Price £15.95

ELECTRONIC CHRONICLES

A Brief History of Electronics

by Mike Wharton

Part 1

Introduction

The basic substance of our interest and hobby has been around since the beginning of time. Electricity is a manifestation of one of the fundamental states of matter, that is, the flow or movement of electrons. It is only recently in man's history that the nature of this 'beastie' has become understood and tamed for his own use. This has been achieved by the painstaking work of many people, some famous and some obscure, but all with an underlying desire to further our knowledge of this most intangible subject.

Over the next six issues of the Maplin Magazine, we shall take a leisurely stroll through the bye-ways of history and examine the people and developments which have led to the present-day subject of electronics. In particular we shall pay attention to those individuals who have made significant contributions to the subject, and who may have been remembered by having an electrical unit named after them.

The Early Beginnings

Despite the fact that electricity was known to the ancients in the form of lightning, it was not at all understood in the way it is now. All ancient civilizations

Luigi Galvani 1737-1798

Count Alessandro Volta 1745-1827

had a rather simplistic view of the forces of nature, and would rather place such natural phenomena at the door of some mystic deity or god than attempt any rational explanation. Of course it is very difficult to put ourselves in the place of someone living, say, two thousand years ago, and try to imagine how he would view the world divested of all our present sophistication. At face value, there are few aspects of nature which fit into a simple pattern. Take, for example, the weather; although the underlying trends of climate soon become apparant to even the most casual observer, the ability to predict what the weather is likely to do over the next 24 hours taxes present day technology almost to the limit. It may well have seemed to people living at that time that the course of the weather owed as much to a chicken's entrails as it does to the infinitely complex system of the atmospheric 'weather machine'.

Thus all ancient cultures had their own explanation of the cause of lightning and the associated thunder; for the Norsemen it was Thor hammering and banging away on his anvil in the sky, for the Romans it was Vulcan, but doing much the same thing, whilst for the Greeks it was Zeus having an almighty temper tantrum!

Of course, the Greeks knew a thing or two, but the problem with trying to understand the nature of electricity is that you simply cannot get to grips with it, particularly when it's hurled at you in great dollops which only last a few milliseconds. We have a lot to thank the ancient Greeks for, (or blame, depending on your point of view). They were great thinkers, and had devised a view of the world around them and the universe which scholars were to cling on to for centuries to come. For instance, they had an idea that all matter was divided into four types, which they called Earth, Air, Fire and Water. These represented the Elements, while it is realised nowadays that there are nearly one hundred naturally occuring examples. Some chemical reactions were explained on the basis of one Element being changed into another, such as when wood burned it produced Fire, one element, and left behind another one, Earth, in the form of ash. This rather peculiar view of the world surprisingly also gave rise to the idea of the atom, which comes from the Greek words meaning 'not cut', or indivisible.

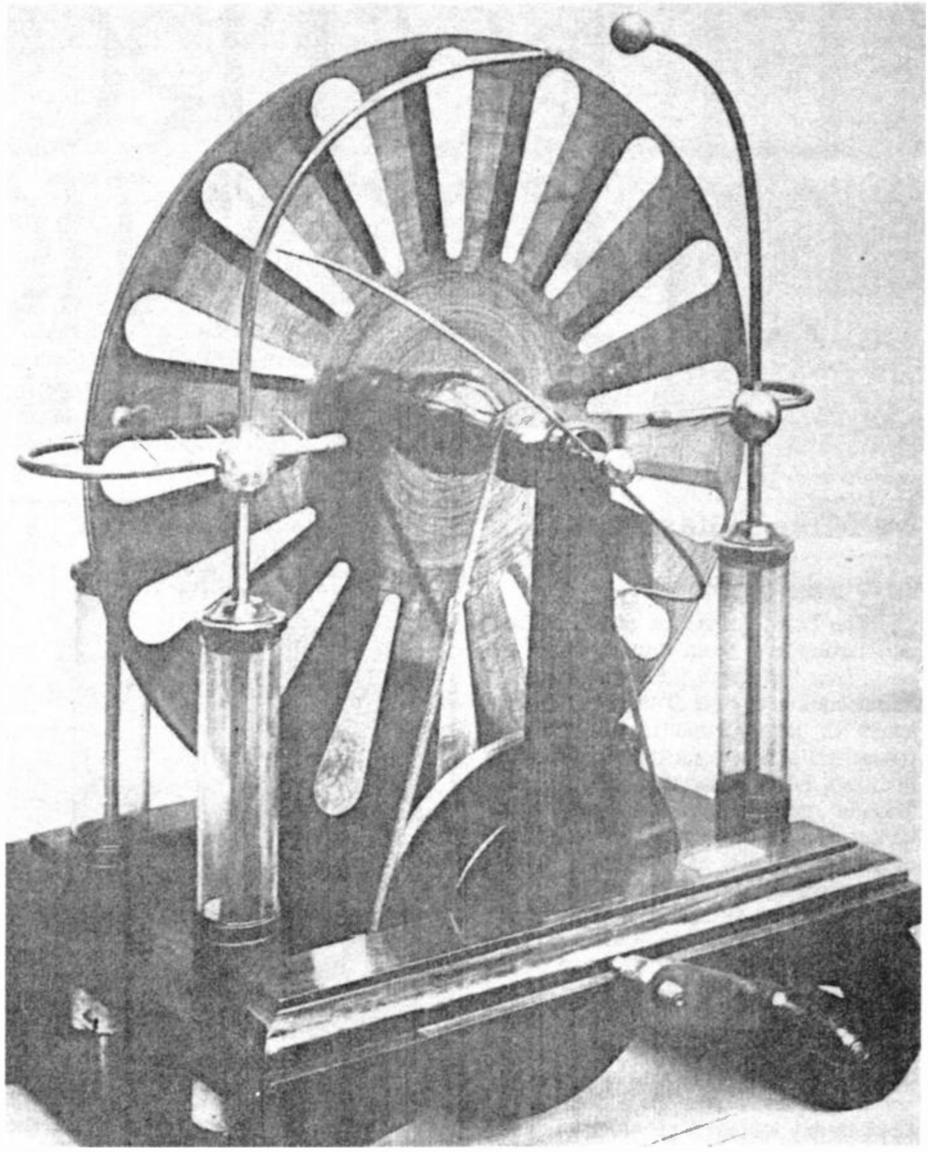
The modern view of the atom is that it contains a nucleus, consisting of protons and neutrons, around which circle tiny, planetary electrons. It is these electrons, removed from the constraints of the atom and allowed to move freely, that produce what we call an electric current. One observation which is credit-

André Marie Ampère 1775-1836

ed to the Greeks is connected with static electricity. It seems to have been a fairly common observation that certain materials would take on remarkable properties when treated in the right way. One such material was amber, which is fossilized pine resin, and which was prized by people at that time as a precious stone. When rubbed with fur or silk cloth it gained the ability to attract small fragments of hair or parchment. The same effect is produced, of course, when a rubber balloon or a plastic rod is rubbed on a woollen sweater, and is caused by a redistribution of charge due to the friction involved. The Greek name for the substance we call amber was 'elektron' and it was this name which was taken up centuries later in naming the charged atomic particle responsible for these effects, the electron.

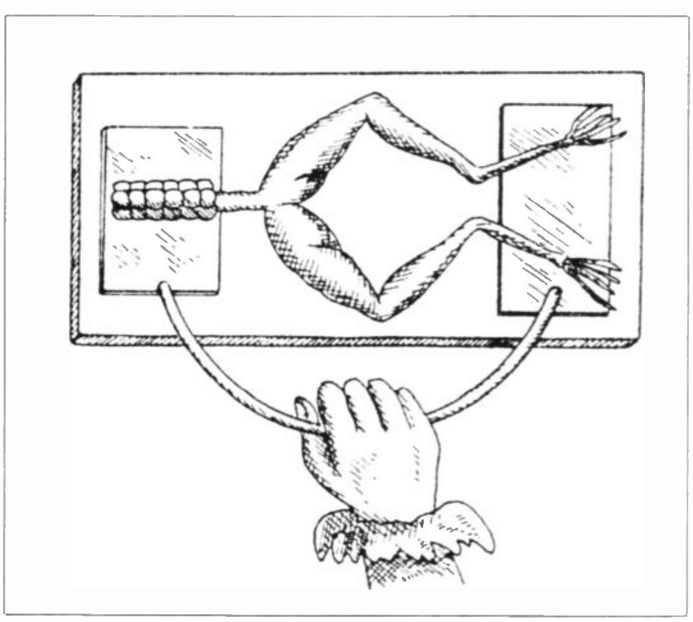
Perhaps one of the greatest faults of the Greeks was that they were not really interested in making observations and then attempting to draw conclusions from them in order to build up a rational picture of the natural world. This is the scientific method which would be used these days, and has many hundreds of years of information and knowledge upon which to draw. To the Greeks the force of a scientific argument was more dependent on the persuasive powers of the person trying to promote it, than the weight of scientific evidence. Again, this is possibly more understandable if we recall that few natural phenomena appear to have a simple, underlying cause. However, without this sort of approach, it is virtually impossible to obtain an understanding of something which cannot be observed directly, like electricity, and it seems not to have occurred to the Greeks that there may be things in the physical world that cannot be observed by direct methods.

Thus progress in the study of 'electronics' was to range from slow to non-existent over the next several centuries, after the Greek and Roman

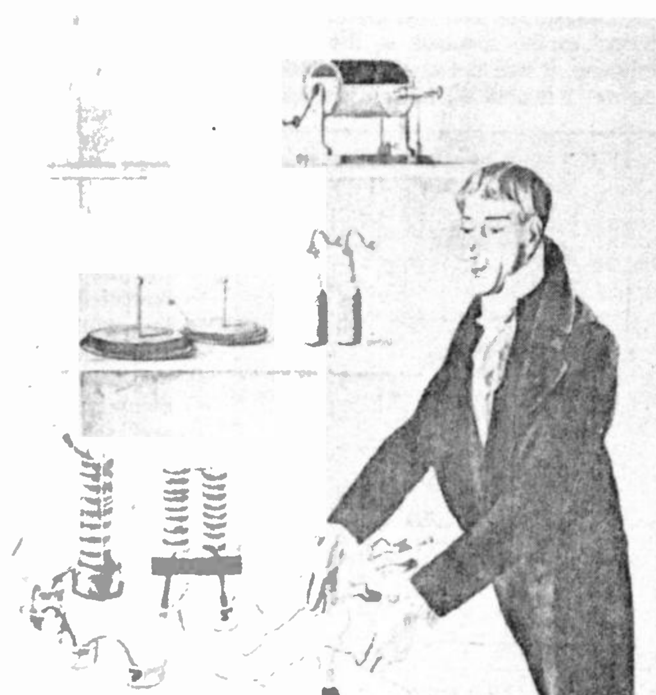


Wimshurst machine generating static electricity

Empires collapsed, and any scientific study of nature was overtaken by the sorcery and witch-craft of the Dark Ages. During these hundreds of years there were to be no new discoveries relating to electricity, and the phenomenon of static electricity continued to be just a curiosity. It was not until the beginning of the 18th century that we can trace a resurgence of interest in the subject, and the start of the



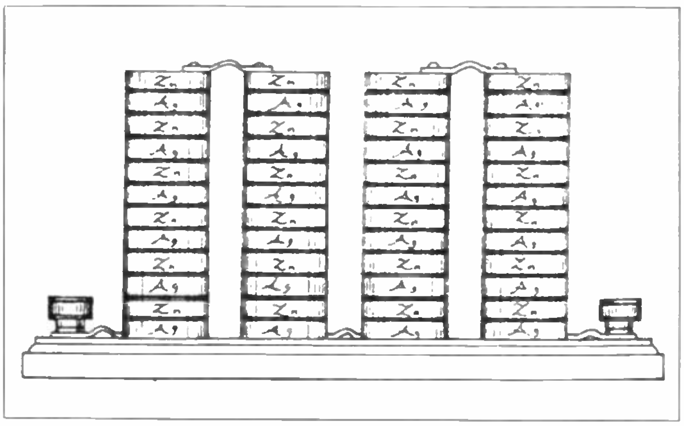
Galvani demonstrates the effects of electricity on frog's legs



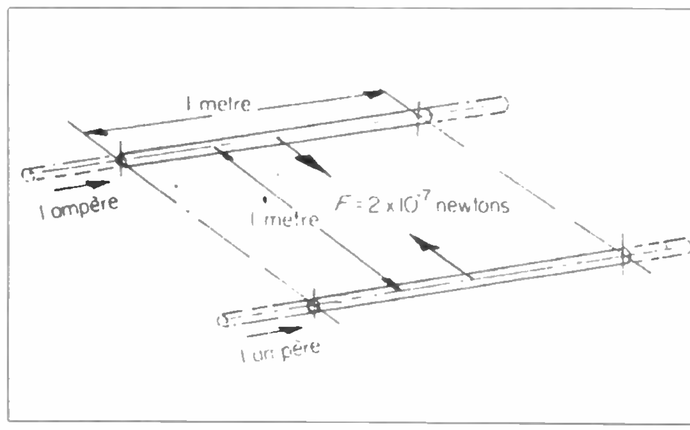
Volta experimenting with electricity

road that was to lead to our present day understanding.

A number of people had studied the production of static electricity by friction, and had made a variety of machines whose purpose was to generate ever greater charges. One of these was made by a gentleman by the name of Wimshurst. It consisted of a disc of insulating material with metal pads around both sides, near to the edge. The disc was turned by hand and the charge generated was picked up by a pair of metal 'brushes' and then discharged between two metal spheres. Some readers who have studied science at school may recall having seen or even used such a machine for generating large static electric charges. Alternatively, you may have come across a model of a van der Graaff generator. This is somewhat similar, in that the charge is produced by friction, but in this case by a rubber belt. This acts as a kind of conveyor belt, carrying the charge vertically upwards to a large, hollow metal sphere. The accumulated static charge may then be discharged to earth, and this type of machine is still used today by physicists to produce electric charges of millions of volts.



Voltaic pile



Definition of the ampere

Galvani

Up to this point, that is about the mid 1700's, all the experiments had been concerned with static electricity, and the idea of charge flowing to produce an electric current had not really been hit upon. Also, some of the ideas which had been connected with the subject of electricity were based upon complete misconceptions. These were due in part to the work done by one famous man, Luigi Galvani. He lived and worked in the Italian town of Bologna during the 18th century. Galvani was a doctor of medicine who lectured at the University, and he had shown that the muscles in a frog's legs could be made to respond to the discharge from an electrical machine some little distance away. The only possible source of energy must have been electro-magnetic radiation, or radio waves. This was an example of electro-magnetic induction some forty years before it's discovery by Faraday! Galvani was also able to show the same effect in frog's legs which were attached to plates of different metals, and without any static electrical discharges taking place. What was happening in this case was that the muscles were being stimulated by an electrical current produced by contact with the two metals, forming a simple cell. However, Galvani came to the conclusion that the source of electricity was inherent in the nerves or muscles, due to a phenomenon which he called 'animal electricity'.

This was a popular idea for some time, and gave rise to the idea that this mysterious force of electricity might be the source of life itself. An Englishman working at the same time, but never to become as famous as Galvani, was Andrew Crosse. He carried out experiments using lightning to stimulate muscles in a similar fashion to Galvani. A popular fear which arose out of such work was that eventually scientists like Crosse might stumble across the 'Life Force', and impart life into a hitherto dead creature. This idea was used to great effect by the author Mary Wolstonecraft Shelley, who is reputed to have based the famous character of Dr. Frankenstein on Andrew Crosse. Fortunately these fears were quite unfounded, and were finally laid to rest by another famous name, Alessandro Volta.

Despite the misunderstandings, Luigi Galvani has lent his name to several electrical instruments, including the galvanometer and the galvanoscope, as well as the process of electro-plating iron with a layer of zinc called galvanising.

The belief that electricity was inextricably connected with live animals was disproved when Volta, another Italian, made a crude battery which was able to produce a steady electrical current. Volta lived at the same time as Galvani, and there was a fierce argument between the two men and their supporters as to which had the correct idea. In 1799 Volta constructed his famous battery or 'Voltaic Pile', which consisted of alternate discs of silver and zinc separated by absorbent pads soaked in water. Previously, although the voltages produced by the friction machines had been enormous, the current had been minute. Now it was possible for the first time in history to generate a sizeable current, without resorting to frog's legs!

This invention of Count Alessandro Volta immediately opened up the possibility of carrying out experiments in electro-chemistry, electro-magnetism and electrical machines. Without this source of power, Faraday would not have been able to make his own discoveries during the 19th century, but more of him later. The name of Volta is associated mainly with the unit of electric potential, the 'volt', from which a whole range of devices are named, including the voltmeter and the voltameter (these last two sound similar but are quite different).

Ampere

We cannot leave the scene of the blossoming interest in electricity in Europe at the close of the 18th century without mentioning the name of Andre Marie Ampere. Although primarily a mathematician, he became very interested in electricity towards the end of his academic career.

Born in 1775, Ampere was something of an infant prodigy, and was mainly self-taught in the subjects of mathematics, physics and chemistry. In 1793, when he was 18, Ampere's father was declared an enemy of the French Republic, tried, found guilty and guillotined. This and other tragedies had a serious effect on his health, leading to a prolonged nervous breakdown from which he never really recovered. In 1820 he observed an experiment in electro-magnetism which immediately attracted him to the subject. After only a couple of years experimentation he was able to demonstrate that a force exists between two conductors carrying an electrical current. He also came very close to finding the relationship between current and voltage in a conductor which was to be discovered later by Georg Simon Ohm. The contribution of Ampere to the study of electricity is remembered in the unit of current, which bears his name. Further, the legacy of his work was to put the study of electricity on a firm mathematical footing, and throw off any remaining ideas that it had any sinister connections with the 'Life Force' and Frankenstein's monster.

The work of Ampere, Volta and the others was the foundation upon which the great discoveries and inventions of Faraday were later to be laid. In the next article we shall examine his work in particular, along with some of his contemporaries, during the first part of the 19th century.

2.8KW POWER CONTROLLER

★ **Controls up to 12 Amps at 240VAC**
★ **99% Power Transfer**
★ **R.F.I. Suppression**
★ **Simple Construction**

by Dave Goodman

By utilising the PC12 thick film IC this Power Controller can handle loads up to 2.8kW — much greater than most, reasonably priced, commercially available units. Voltage levels are continuously variable from 240V down to between 2 and 20V, this final level being dependent on the load applied, up to a maximum of 12 amps. The unit is therefore suitable for controlling lamps, electric drills, soldering irons, bar type electric fires and many other electrical items. The module may be incorporated into a complete project, to provide a self-contained power controller, as described later in this article. Alternatively it may be used to suit a particular application.

Circuit Description

IC1 is a thick film hybrid device with an integral heat sink mounting plate, requiring RV1 for varying the conduction phase angle between 160 and 0 degrees. The Triac is turned on after an applied ac waveform has passed through zero volts and it remains on until, after passing through its peak, the waveform again reaches zero thus turning the triac off again. This process is repeated during the next half-cycle as shown in Figure 1. Triacs differ from thyristors in that they are able to conduct during positive and negative half cycles (effectively a switched diode). This means that full cycle control and hence 99% power transfer is available at maximum current.

Full power is available with RV1 set fully clockwise i.e. minimum resistance (see circuit diagram, Figure 2). Increasing resistance between output pin 2 and control input pin 1 determines the phase angle or position along the waveform where IC1 will turn on. At maximum resistance the phase angle is in direct opposition and no power is delivered, but this action must not be compared with that of a mechanical switch, as full mains potential is available with no load connected.

Due to the fast switching action of IC1, harmonics are generated especially at 50% power setting. These harmonics are extended up into the R.F. range and are radiated along the connecting cables and into the air producing R.F. interference and a loud buzz in audio equipment! Not only is R.F.I. an annoyance, it must meet Department of Trade and Industry requirements, so L.C. filtering of the harmonics is performed by C1, C2 and RFC1 to 4. Four 3 amp chokes handle the 12A maximum current availability, offering a low impedance at 50Hz and a high impedance to high frequency signals. A neon lamp N1 indicates permanently when mains is applied without a load, but will not be on if fuse FS1 blows. With a load connected, N1 indicates fully at maximum power and dims progressively as power levels are reduced by RV1 down to a minimum.

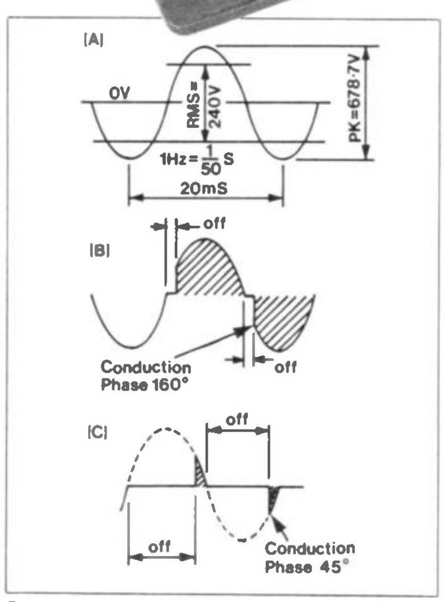


Figure 1. Triac conduction waveforms

PCB Construction

Insert all five Veropins (P1-5) into the holes marked with a circle, (see Figure 3, pcb artwork and legend) push the pin heads firmly down to the board and solder in place. Mount the four chokes (RFC1-4) and the suppressor caps C1 and C2, solder these components in place and remove excess wire ends. It is important to push all components down on to the board so that they cannot be moved about and cannot break away from their positions. Remove the nut and washer from RV1 and insert into the board from the component side. As shown in Figure 5, two terminals are soldered to pins 4 and 5 and the third is not used and may be cut off or bent away.

Replace both washer and nut on RV1 and tighten up to the PCB.

IC1 pins 1, 2 and 3 are inserted and soldered from the track side of the PCB and IC1 is set approximately 12mm away from the board (see Figure 5). The heatsink bracket is completely isolated and can be connected to mains earth without problem. Note that IC1 must be bolted onto a suitable heatsink and for use with high load currents, the heatsink will need to be rated at between 3° and 4°C per Watt.

Box Drilling and Assembly

The parts list gives details of a suitable box, neon lamp, fuse holder, 13A switched socket and miscellania. Figure 4 shows drilling instructions for the box; there are twelve holes to be drilled. To make life easier the PCB could be used as a template (before assembly of course!) by placing it inside the box and marking each hole with a pencil or scriber. The same applies to the socket pattress. After marking out, drill all required holes, noting that holes type 'b' require countersinking on the outside of the box.

With reference to Figure 5, fit grommets into the 13mm holes and place the socket pattress over the holes marked 'a', insert half-inch x 4BA countersunk screws into both holes and secure the top one only with a 4BA nut and washer. Spread a thin layer of heatsink compound over IC1 mounting plate and place over the bottom screw. Fit a 4BA solder tag in place and secure the assembly with a 4BA nut. Remove the lock nut from the neon lamp N1 before inserting it into the 11mm hole; this also applies to the fuse holder which is placed in a 14mm hole. Refit both locknuts and tighten down. Insert 1 inch x 6BA countersunk screws into the four holes marked 'b', and slide a spacing collar over each one. The assembled PCB is positioned over these screws with the spindle of RV1 protruding through the 7mm hole. Secure the PCB with 4 x 6BA nuts and washers.

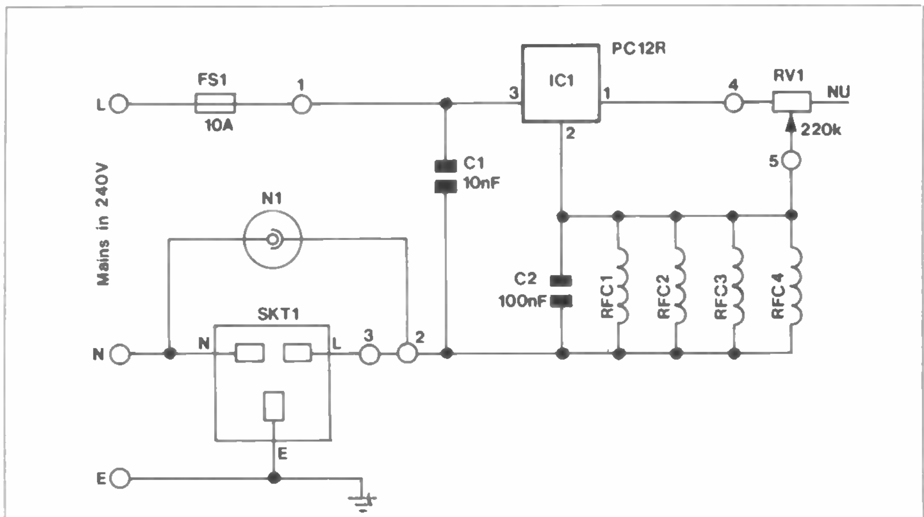


Figure 2. Circuit diagram

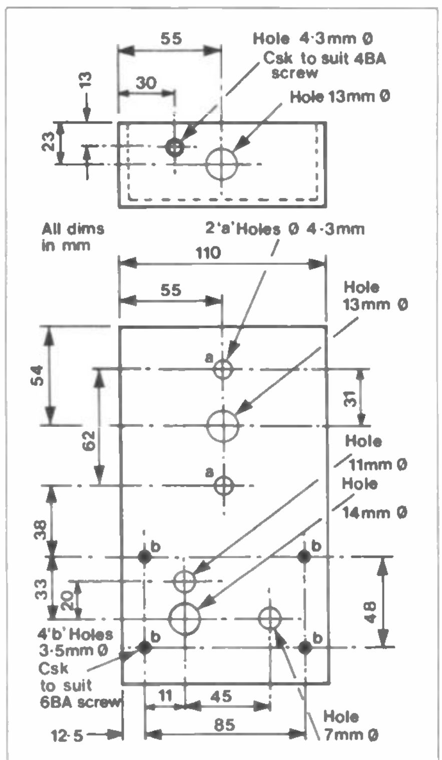


Figure 4. Case drilling details

Wiring Details

Refer to Figure 5. Strip away approx. 18 inches of insulating sheath from one end of the 13A connecting cable. Pass this end through the top grommet into the box and clamp in place with a 5⁄16 inch 'P' clip and ½ inch x 4BA countersunk screw, nut and washer. Measure and cut the live (brown) wire and solder it to a terminal on FS1. Use three inches of brown wire and join the other FS1 terminal to PCB pin 1. Connect another wire length between one terminal of N1 and pin 2. Solder the remaining 5 to 6 inches to PCB pin 3 and feed through the grommet for connection to SKT1. Both the blue and green/yellow wires from the cable should now be cut to approx. 8 inches long and placed through the grommet.

Solder one end of neutral (blue) wire to the unused terminal of N1 and solder one end of the earth (green/yellow) wire to the 4BA tag on IC1. Thread both wires through the grommet to SKT1. There should now be five wires protruding through the box: 1 brown, 2 blue and 2 green/yellow. Terminate both blue wires to terminal N (neutral), both green/yellow wires to terminal E (earth) and the Brown wire to terminal L (live) on the switched

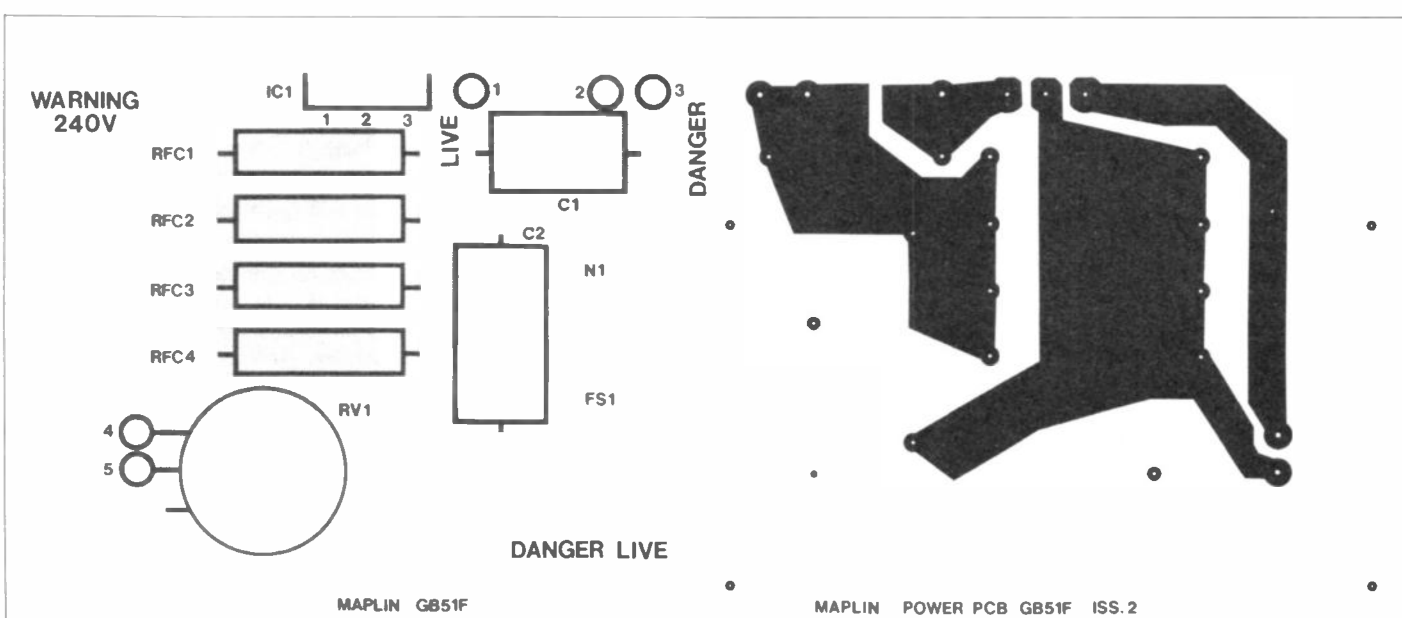


Figure 3. Artwork and legend

socket SKT1, then secure to the pattress with both screws provided. Finally cut off RV1 spindle half an inch above the box and fit a control knob. Insert a 10A 1¼" fuse into FS1 holder and bolt on the bottom box cover.

Testing and Use

Connect the 13A cable to the mains supply and switch on. N1 should light up, but note that varying RV1 will slightly alter the light output of N1. Unscrew the terminal post in FS1 and let it pop up — do not remove it — and N1 will go out. Retighten the terminal post. If you have a bedside or table lamp available plug it into SKT1, ensuring that its own switch is on! Turn SKT1 switch off and RV1 fully anti-clockwise. N1 should be illuminated until SKT1 is switched on, whereupon it will go out. Slowly turn RV1 clockwise. Neon N1 will gradually brighten, as will the test lamp. Do not worry if a quiet buzz is heard with RV1 at maximum — this is quite normal.

Problems can be encountered when controlling inductive loads such as pump motors. Changing the power factor causes the triac to fire intermittently and heavy currents will be passed, which may blow FS1, even for a small load. Finally, remember that the switch on SKT1 only disconnects output power to the load and does not remove mains supply from the unit. Therefore keep loose wires, fingers etc. away from the PCB as full mains is present and potentially dangerous!

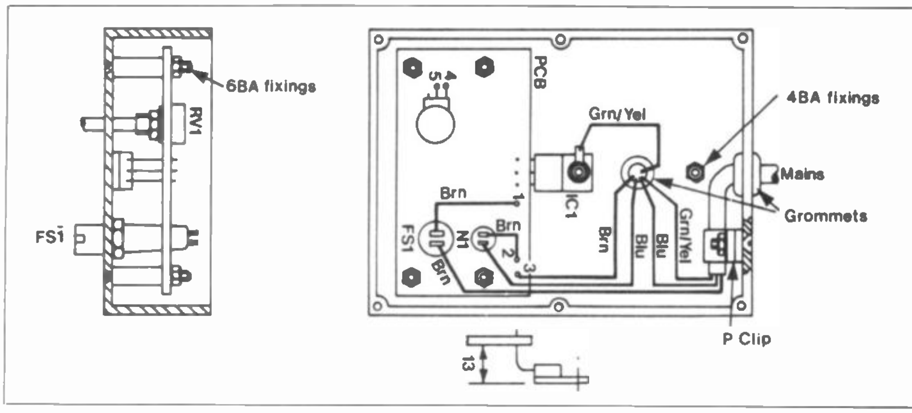
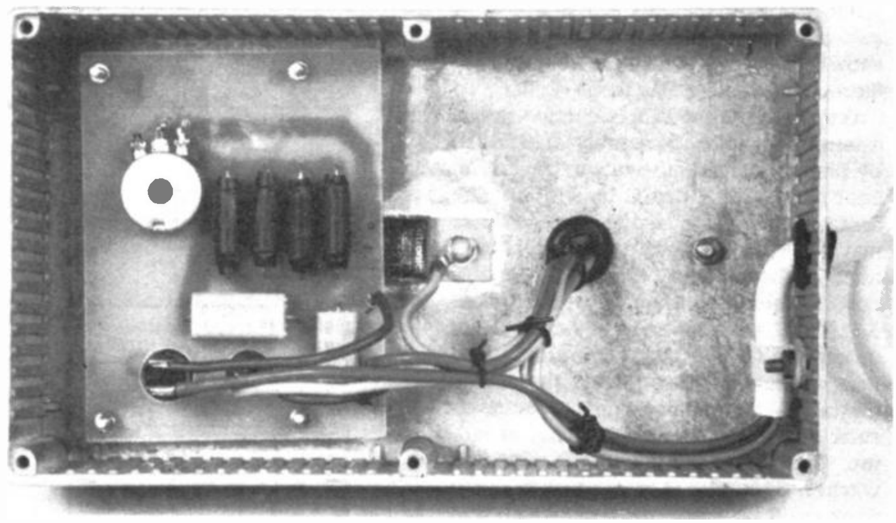


Figure 5. Assembly and wiring



POWER CONTROLLER PARTS LIST

RESISTORS			
RV1	220k Lin Pot		(FW06G)
CAPACITORS			
C1	10nF I/S Cap 250V AC		(FF53H)
C2	100nF I/S Cap 250V AC		(FF56L)
SEMICONDUCTORS			
IC1	PC12R		(QY38R)
MISCELLANEOUS			
RFC1-4 inc	RF Supp Choke 3A	4	(HW06G)
	Power P.C.B.		(GB51F)
	Veropin 2141	1 pkt	(FL21X)
N1	Pan Neon Red		(RX83E)
FS1	1¼" Fuse 10A		(WR16S)
	Safuseholder 1¼"		(RX97F)
SKT1	Single Switched Socket		(HL71N)
	Surface Pattress 29mm Single		(YB15R)
	Grommet Large	2	(FW60Q)
	6BA x 1" Countersunk Screw	1 pkt	(BF13P)
	4BA x ½" Countersunk Screw	1 pkt	(BF10L)
	6BA x ½" Spacer	1 pkt	(FW35Q)
	4BA Tag	1 pkt	(BF28F)
	6BA Washer	1 pkt	(BF22Y)
	4BA Washer	1 pkt	(BF21X)
	6BA Nut	1 pkt	(BF18U)
	4BA Nut	1 pkt	(BF17T)
	Knob K2		(HB24B)
	13A HD Mains Cable	As req	(XR10L)
OPTIONAL			
	Case DCM5006		(LH74R)

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MEASUREMENTS IN ELECTRONICS PART TWO

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

Measuring Passive Quantities

Perhaps it would be as well to start by defining the word 'passive'.This term is normally employed to describe the electrical quantities of resistance, capacitance and inductance. It is in that context that it is used here. Measurement of these quantities may need to be carried out during the development of new circuits or while servicing excisting ones. In the latter case it is often desirable to carry out the measurement with the minimum of disturbance to the circuit. When making 'in situ' measurements it is necessary to allow for the presence of other circuit components in order to avoid drawing incorrect conclusions. Measurements of extreme values of quantities often introduce difficulties as well. For example, it is quite easy to measure with reasonable accuracy a resistance of the order of a few thousand ohms; it is quite another matter to measure, with similar accuracy, a fraction of an ohm or tens of Megohms. It is worthwhile finding ways of solving such problems.

Measurement of Resistance

Probably the most convenient method of measuring resistance is with a multimeter. After all, if an experimenter has nothing else in the way of test gear, he should at least have one of these. Quite a wide range of resistance, from a few ohms to several hundred kilohms can be measured in this way. The significant word here is 'measured'.

How accurate is the measurement intended to be? Are we looking for a short-circuit condition or an open-circuit condition? Is it a case of a resistor whose value is not clear – is it 22k or 220k? These measurements do not require a great degree of accuracy. But the situation is quite different if we are trying to differentiate between close values or measure specific values, such as when choosing the resistors for the various ranges of a voltmeter that we are making. A much greater degree of accuracy is then needed.

The circuit of Figure 1 shows the general principle of the ohmmeter, uncomplicated by the switches, shunts and multipliers that make up the full circuit of a multimeter. Only two resistance ranges are shown, merely to illustrate what needs to be switched from range to range.

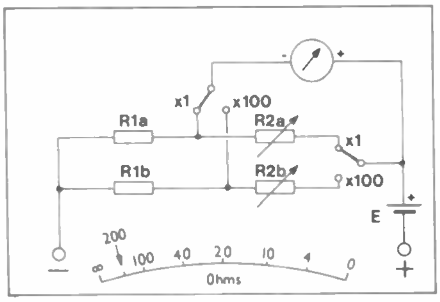


Figure 1. The Ohmmeter

Most multimeters have at least three resistance ranges, some have five or six. For the high resistance ranges a larger value battery is often switched in, to develop enough current to drive the meter to full scale. The moving-coil meter is in series with some resistance (R1) and a battery (E). A shunt variable resistor (R2) bypasses some of the battery current. If the terminals are shorted together, R2 can be adjusted so that the meter reads exactly full-scale. Therefore, since the aim in using the instrument is to measure the resistance between its terminals (which in this case is zero), then zero ohms is at the extreme right hand of the scale. Any resistance value greater than zero will reduce the circuit current; the larger the resistance value, the smaller the deflection. Infinite resistance (open circuit) gives no deflection. A typical scale for 'low ohms' is also shown in Figure 1, and is obviously non-linear.

This non-linearity is a limiting factor in accuracy of reading. For example, it is virtually impossible to do more than guess the value of a resistor lying between 100 and 200 ohms, making it necessary to select the next range up. Accuracy is therefore dependent upon, among other things, having a range available where the value can be read on an 'open' part of the scale. Bearing in mind the possible limitations of the multimeter, it is worth looking at an alternative method.

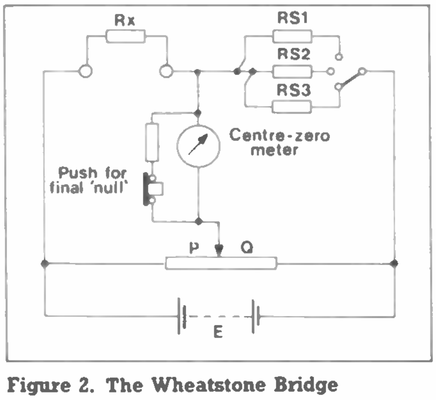


Figure 2. The Wheatstone Bridge

Figure 2 shows the well-known Wheatstone Bridge. From a little simple theory we can deduce the result that

Rx (the unknown resistance) = Rs . (P/Q)

A selection of different values of the 'standard' resistor Rs can be used to give different ranges. The variables P and Q merely represent the proportions of potentiometer resistance on either side of the wiper when the balance condition (meter reading = 0) is found. For example, when the wiper is at the centre of the track, the ratio P/Q = 1, so that Rx = Rs. It is probably safe to say that a practical range for P/Q lies between 0.1 and 10. This means that, if Rs = 100 ohms, Rx can be measured if its value lies between (0.1 x 100) = 10 ohms and (10 x 100) = 1000 ohms. By having several values of Rs e.g. 100ohms, 10k, 1M a very wide range of resistance can be covered.

When Rs = 100 ohms, Rx can lie in the range 10 – 1000 ohms

When Rs = 10k, Rx can lie in the range 1000 ohms – 100k

When Rs = 1M, Rx can lie in the range 100k – 10M

This illustrates that the bridge allows a resistance range of 'one million to one' to be measured using only three standard resistors. Accuracy of measurement is not governed by meter accuracy at all; all that is needed is that the meter is reasonably sensitive so that the 'null' can be found easily. The measurement accuracy then hinges on two factors:

(i) the accuracy of the P/Q scale (a matter of drawing)
(ii) the precision of Rs

Consider the P/Q scale first. Drawing a circular scale is just a question of care and application. What will limit the accuracy is the linearity of the potentiometer used. It must be a good quality wirewound type to guarantee any real chance of accuracy. That leaves the question of Rs. In each case, for the examples quoted, the value is a standard

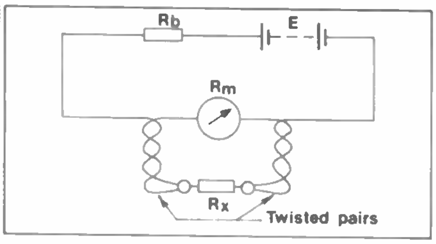


Figure 3. Arrangement to measure low values of resistance.

one. If 1%, high stability, types are bought then the maximum error due to this source should be better than 1% in general. The main disadvantage of this simple bridge is that it is not direct reading – really quite a minor criticism, since in a hobby, time is not vital. The result is obtained, of course, by multiplying the selected value of Rs by the P/Q scale reading.

For example, if the selected value of Rs = 100 ohms and the P/Q reading = 6.73, then Rx = 100 x 6.73 = 673 ohms. What could be simpler?

Since a sensitive meter such as a centre zero micro-ammeter must be used to indicate balance, care should be taken to protect it. This is especially relevant when the bridge is initially well off balance. A simple solution is to wire a low value resistance and normally-closed push-button switch in series across the meter. This resistor diverts the excess current during initial adjustment. The push-button is then pressed while the final balance is obtained. Measuring low values of resistance, i.e. down to a fraction of an ohm, cannot be done accurately using a bridge but, nonetheless, can be done with very good accuracy with the simple circuit in Figure 3.

A source of voltage E in series with a resistor Rb provides a more or less constant current to the meter, if the value of Rb is substantially larger than meter resistance Rm. When Rx is open-circuit to start with, the meter reads this constant current, say I_1, which may equal full-scale current but doesn't have to. Obviously it shouldn't exceed it. When an actual value of Rx is connected, it shunts part of this current away from the meter. As a result, the meter reading drops to a lower value, say I_2. The actual drop depends upon the relative values of Rx and Rm. To take a simple example, if Rx and Rm happened to be equal, I_1 would halve its value. The unknown resistance is found from the simple formula.

$$Rx = Rm\,[I_2/(I_1 - I_2)]$$

Using this method it is quite possible even to measure the resistance of switch contacts. Note that connecting lead lengths can be important; Rx must be connected using twisted leads as shown in Figure 3. One question remains, of

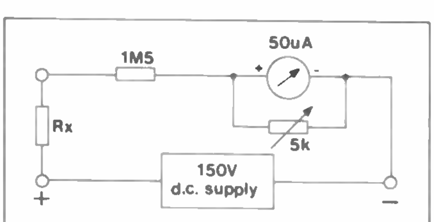


Figure 4. An insulation tester.

course. How do you find the value of Rm if you don't happen to know it? Simple; obtain a known low resistance, substitute it for Rx, read I_1 and I_2 and then find Rm from the above formula.

Measurements of very high values of resistance usually mean measurements of insulation resistance. It is not so much a case of precise measurement as establishing a technique at all. Bridge methods are not generally reliable and the ohmmeter method requires a high voltage (too high for internal batteries) in order to push a readable current through the meter. Nonetheless, it is the latter method that can be extended to provide this facility. The internal battery is switched out and a high value resistor switched in. An external voltage supply of about 150V

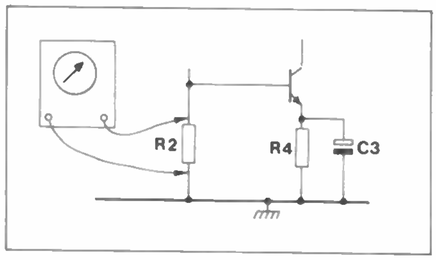


Figure 5. Measuring resistance 'in situ'.

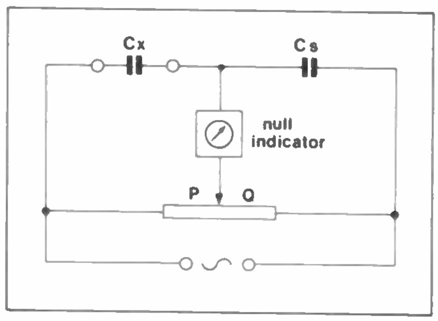


Figure 6. The de Sauty capacitance bridge.

(but negligible current capacity) is connected in series with the meter and the unkown resistance. This does mean a special facility on the multimeter, not provided in all cases. However, a purpose-built instrument can be put together quite easily – details in Figure 4. It is obviously important to take care when using an instrument of this sort to avoid shock; accidental contact with even 150V can be quite unpleasant. It is quite a good idea to wire, in series, a resistor of value, say 150k to limit the current to a safe value.

There is another alternative to this method and that is the use of the Megger. This is a form of ohmmeter which incorporates a hand-cranked generator to produce the high voltage (e.g. 250V) needed for the test. I am, however, not describing this instrument in detail. It is expensive to buy and it's an expense that is hardly justified unless a great deal of use is to be made of it.

Earlier I mentioned measurements in situ, a procedure which might be adopted if it is difficult or undesirable to unsolder a resistor on a circuit board. This is perfectly alright as long as two things are remembered. First, don't do it with the power on! Secondly, check for

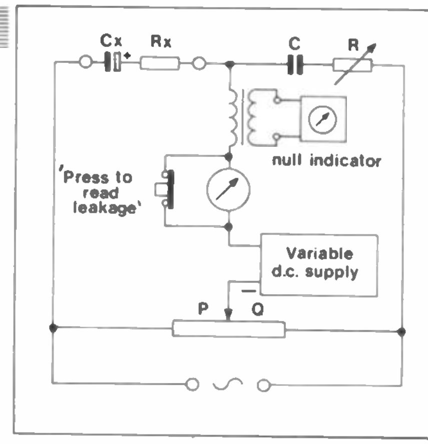


Figure 7. Bridge for measuring electrolytic capacitors.

other components that might appear in parallel. This is particularly so where semiconductor junctions are concerned. The voltage applied to the test circuit could cause the junction to conduct, giving a lower resistance reading than is expected. In Figure 5, for example, an attempt to read the value of R2 (10k) can give two quite different answers, depending upon which way round the test meter is connected. If connected with the positive lead to the base the base-emitter pn junction will be non-conducting and the meter will read close to the correct value. However, if the meter leads are reversed this junction then conducts and the meter will read a value close to that of R4. The reason for this is easily seen by referring back to Figure 1. The internal battery causes a voltage to appear at the multimeter terminals such that the positive terminal actually has a negative potential and vice-versa for the negative terminal.

This is worth remembering as a simple test on semiconductors anyway. If a junction is checked with both polarities of connection and found to exhibit low resistance one way and high resistance the other, then the junction is almost certainly alright. The idea can be used to identify the base lead of a transistor. For example, for an NPN transistor, find the lead which, with the negative meter terminal connected to it and the positive meter terminal touched on the other two leads in turn, causes a low resistance reading in both cases. This is the base lead. Reverse all polarities for a PNP transistor.

Measurement of Capacitance and Inductance

Measuring reactive components poses quite different problems from

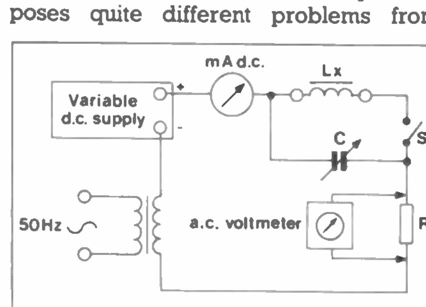


Figure 8. Turner's method for measuring large inductors.

measuring resistance. For one thing it is very difficult to find a reliable d.c. method of doing it. An a.c. source is therefore necessary. The second problem is that the components may not be 'pure'. This is particularly true of inductors which, being wound components, also have some resistance. With the exception of some electrolytics, this is less true of capacitors which generally have negligible resistance. A further complicating factor in the case of inductors is that, when they are iron-cored, the inductance is not at all constant but depends upon any d.c. flowing in the winding/s. With these points in mind, we can now investigate ways of making these measurements.

If we consider capacitance measurement first, a bridge method is shown in Figure 6. This is the de Sauty Bridge and its relation to the Wheatstone Bridge is obvious. The same P/Q potentiometer is used but a standard capacitor Cs is compared with the unknown capacitor Cx. The bridge is balanced when:

$$Cx = Cs.(P/Q)$$

Using the same range of P/Q as for the Wheatstone Bridge, suitable values of Cs can be worked out to give a wide range of capacitance measurement.

For example:
If Cs = 1000pF, Cx can lie in the range 100pF – 10nF.
If Cs = 100nF, Cx can lie in the range 10nF – $1\mu F$

This range from 100pF to $1\mu F$ covers most requirements but the individual experimenter can extend the range as needed by using alternative values for Cs.

The a.c. source and indicator need some comment. Any oscillator giving about a volt at 1KHz is suitable; an audio signal generator can be used if available or a simple circuit made up for the purpose. The indicator must respond to a.c. and have reasonable sensitivity to indicate an accurate null. An electronic voltmeter or oscilloscope can obviously be used. Another alternative, quite suitable but rarely used nowadays, is a high impedance headphone. A very real advantage of this method is that the human ear is most sensitive at 1KHz and can also readily distinguish the 1KHz signal from circuit 'noise', thus giving an accurate null.

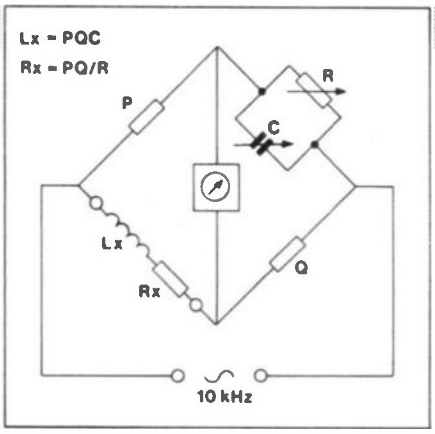


Figure 9. The Maxwell inductance bridge.

The above simple bridge assumes that the capacitor measured has negligible resistance. It may not give a particularly accurate result on electrolytics therefore. What is needed is to insert a variable resistor in series with the standard capacitor Cs. There are now two adjustments to make to get a balance and these should be made alternately until the best null is found. The capacitance should be measured with an appropriate value of d.c. applied, so a variable d.c. supply should be included. To measure leakage current, include a milliammeter in series with the voltage source but wire a normally-closed push-button in parallel with it to protect it against the initial charging current. To provide a d.c. path the indicator can be coupled via a small transformer. After all this you may not think it worthwhile but if you have bought a job lot of electrolytics, it may be worth the effort of making a temporary 'hook-up' at least. See Figure 7.

Finally, there is the question of measuring inductance. This is a very thorny problem indeed. If we divide inductors into two classes these may comprise large values, usually iron-cored, for power and audio frequencies, and small values, air-cored or iron dust-cored for radio frequencies. The problem with large value inductors is that the inductance isn't constant. It varies with the amplitude of a.c. and d.c. applied. At the other end of the scale, radio-frequency inductors contain significant self-capacitance. As you may appreciate, this is a very complex subject and I could fill quite a few pages of this magazine just discussing the whys and wherefores of it. However, what I am going to do is present two methods, one for each category of inductor.

Figure 8 shows a method of comparison with a known capacitor C. This method was devised by one, H.M. Turner, many years ago. Its main snag is that it assumes the availability of a decade capacitor box with a range from about 10nF to $1\mu F$. This may be a reasonable assumption in a professional laboratory but is less likely in an amateur or hobby context. However, if we make the proviso that what we are looking for is a good estimate of inductance, then we can probably achieve this by using a selection of discrete capacitors; the resulting value may well be within 10 - 20% of that possible with a decade box. The method is simplicity itself. The capacitor C is varied until the indicator (an E.V.M. or C.R.O.) reads the same whether the switch S is closed or not. Then, at 50Hz, Lx = 5/C approximately, where C is expressed in microfarads. Before the measurement is made, the variable d.c. supply is adjusted so that the milliammeter reads an appropriate value of d.c.

The method for small value inductors is shown in Figure 9. This is the Maxwell Bridge. Again this has two controls, C and R, which have to be adjusted alternately to get a balance. Obviously we have the same problem with a suitable variable capacitor as before and a decade box would be the best bet. It is possible to buy air-spaced variable capacitors with values up to 500pF but to use one of these would limit the range of inductance which could be conveniently measured. The formulæ for the unknown inductance Lx and its resistance Rx are given in Figure 9. These both involve P and Q which can therefore be chosen to suit values of Lx and Rx to be measured. Space doesn't really allow a full discussion of the design, but the following example may help.

Suppose that when the balance is found, C reads 10nF and R reads 10k. Assume also that P and Q are each 1k in value, then:

$$Lx = PQC = 10^3 \times 10^3 \times 10^{-8} = 10^{-2}H = 10mH$$
$$\text{and } Rx = PQ/R = (10^3 \times 10^3)/10^4 = 100\Omega$$

As this issue's constructional project, I offer a double feature – a 1kHz sine-wave oscillator and a simple a.c. electronic voltmeter. Although these obviously have a number of applications, they can be used as the basis for a de Sauty Bridge. They are both shown in Figure 10.

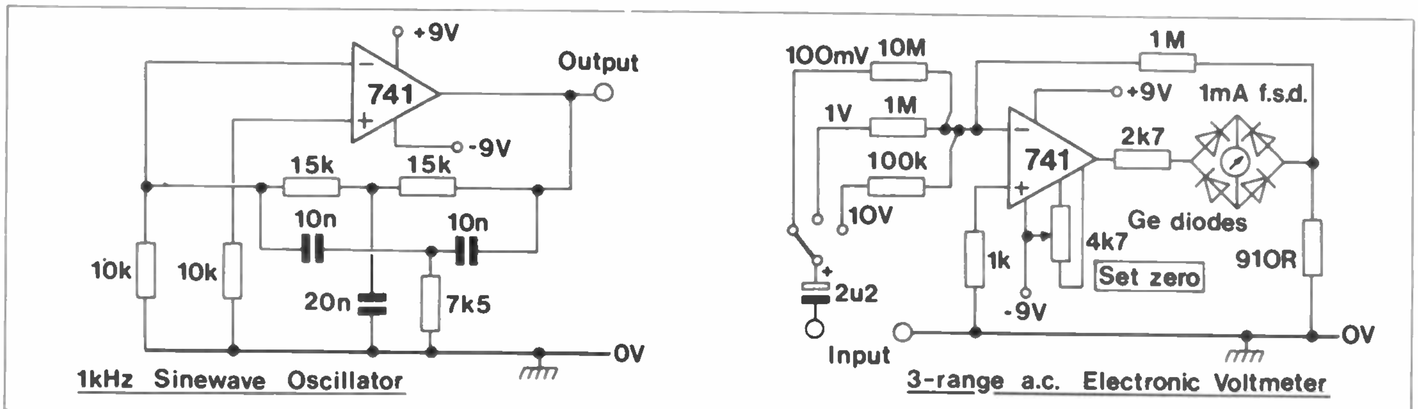
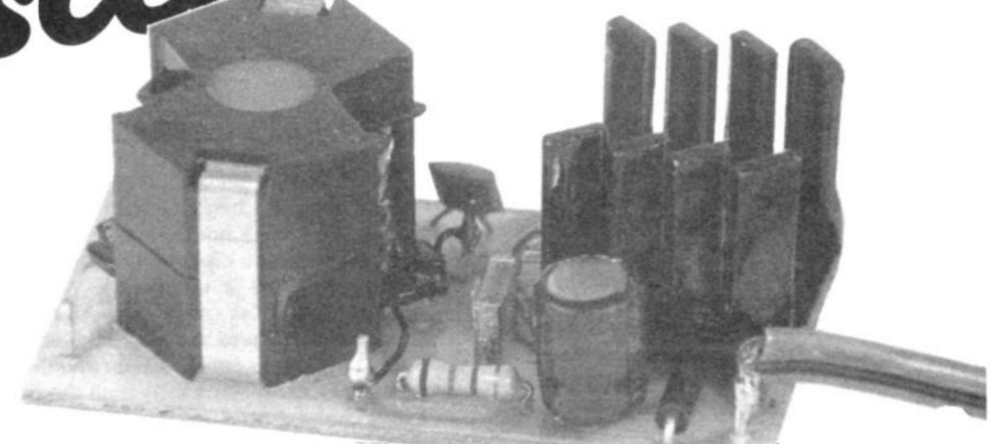


Figure 10. A test oscillator and electronic a.c. voltmeter

8 Watt 12 Volts Fluorescent Tube Driver



By Dave Goodman

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

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

Circuit Description

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

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

Transformer Construction

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

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

Wind L3 first on the bobbin (Figure 2a) by tinning the E/C wire and soldering it to

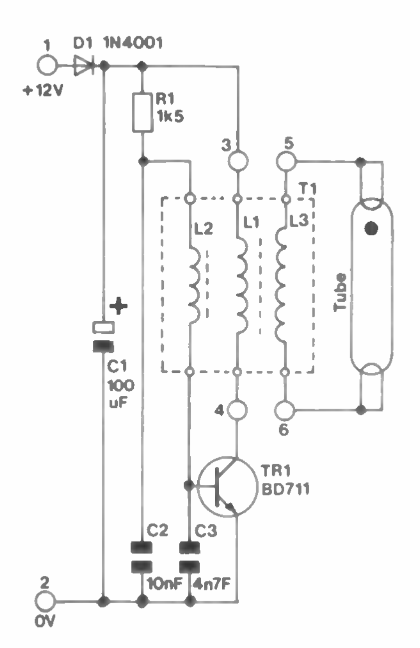


Figure 1. Circuit diagram

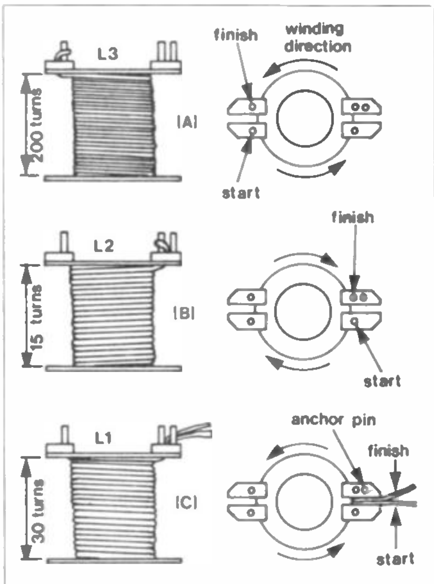


Figure 2. Construction of T1

the terminal L3 start. Wrap each turn close to the previous one and build up in layers. Approximately 30 to 32 turns can be made across the former, so six layers should be built up as neatly as possible. Terminate L3 finish as before and insulate the windings with a single layer of PVC insulating tape wrapped tightly around the coil. Next wind L2 (Figure 2b) starting and terminating on the opposite two bobbin pins (3rd one not used). Again, spread all 15 turns tightly across the previous coil L3 — eight turns across and 7 turns back. Finally, wind L1 straight on top of L2 (Figure 2c). Leaving two inches of spare wire, wind two layers, 15 across and 15 back again leaving two inches of spare wire. Wrap three turns of PVC tape tightly around L1 to prevent it from unwinding and drop into one section of T1. Fit the remaining section over the bobbin and secure both halves with metal clips clamped over each end. Before fitting onto the pcb make sure the windings of L2 and L3 have been soldered correctly to their bobbin pins and remove any excess solder which may prevent insertion into the board.

PCB Construction

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

Using the Module

Connect an ammeter in series with pin number 1 and +12 volt supply; supply common or −ve goes to pin 2. Set the ammeter scale to allow a reading of 1 amp or more and apply power. A high pitch whistling may be heard, with a current reading of 0.4 to 0.5A. If the reading is 1A or more, switch off and reverse L1 connections to pins 3 and 4

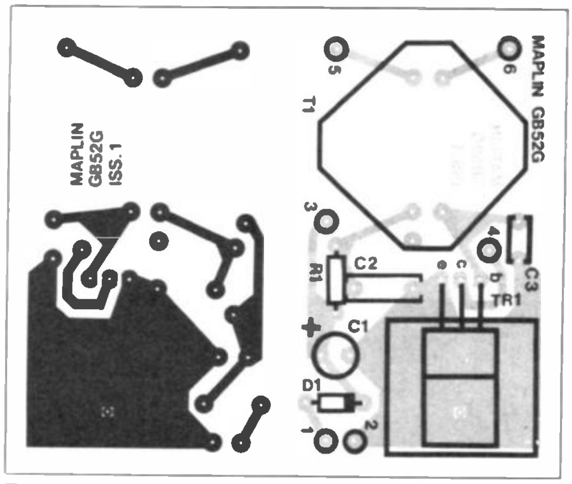


Figure 3. PCB legend

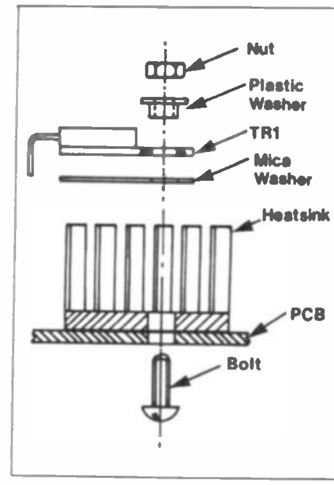


Figure 4. Mounting the transformer and heatsink

and check again. Remove power and connect an 8W 12 inch fluorescent tube across pins 5 and 6. The tube will probably have two starter terminals at each end (four altogether). Join each pair together before connection to the pcb. Keep all connections short and insulate bare terminals to prevent the risk of shock. Remember high voltages are present here and could be dangerous, even with limited current availability!

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

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

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

TUBE DRIVER PARTS LIST

RESISTORS:– ½W 5% Carbon Film			
R1	1k5 (See text)		(S1K5)
CAPACITORS			
C1	100uF 25V PC Electrolytic		(FF11M)
C2	10nF Carbonate		(WW29G)
C3	4n7F Ceramic		(WX76H)
SEMICONDUCTORS			
D1	1N4001		(QL73Q)
TR1	BD711		(WH15R)
MISCELLANEOUS			
L1	30 Turns x 24swg E.C.W.		
L2	15 Turns x 34swg E.C.W.		
L3	200 Turns x 34swg E.C.W.		
T1	Ferrite Pot Core Type 3		(HX09K)
	Bobbin Type 3		(HX10L)
	Clip Type 3	2	(HX11M)
	24swg Enamelled Copper Wire	1 reel	(BL28F)
	34swg Enamelled Copper Wire	1 reel	(BL42V)
	Mounting Kit		(WR23A)
	Heatsink		(FL58N)
	Veropin 2145	1 pkt	(FL24B)
	Tube Driver P.C.B.		(GB52G)
	6BA x ½in Bolt	1 pkt	(BF06G)
	6BA Nut	1 pkt	(BF18U)
	12V 8W Fluorescent Tube		(LQ11M)

A complete kit of parts is available.
Order As LK35Q (Tube Driver Kit) Price £7.75

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Please check the Catalogue Price Change List in this magazine as some lines are already out of stock, and though we've still got plenty of stock left of many lines, at the time of writing it's going fast. So hurry, or you could miss out on a real bargain!

An introduction to CAR ELECTRICS

Part 1

by Graham Bishop

1. Introduction

This article describes the operation of the basic car electrical systems and in particular, the *ignition, battery charging, lighting circuits,* and *indicator* and *accessory* circuits.

The modern motor vehicle is a precision-built highly-tuned machine. High speed performance, low fuel consumption and quiet smooth-running engine all rely on efficient ignition, battery charging and general electrical systems throughout the car.

The electrical system is very complex. One only has to look behind a dashboard to see the hundreds of wires of all sizes and colours, interconnecting the instruments, high voltage and high current circuits. Also, the electrical system is very prone to breakdown, whether this is a blown lamp bulb, a faulty dynamo or badly adjusted contact breaker points.

No two models of cars have identical electrical circuits. The electrical circuits are, however, similar and fall into categories such as conventional ignition or electrical ignition, dynamo or alternator, positive or negative earth.

This article describes the basic systems: it is left to the individual car owner to interpret the descriptions and diagrams to suit their particular vehicle.

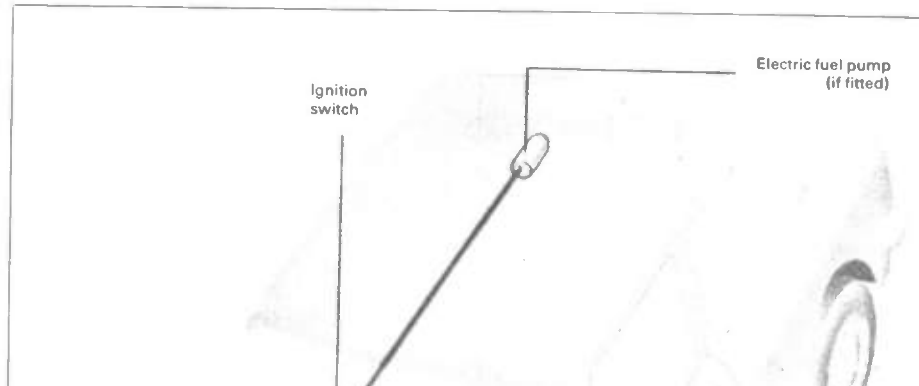


Figure 1.1. The ignition circuit

One word of warning. Car electric circuits can cause damage to either the car or to the user if tampered with. For instance a short circuit across the battery can generate 100's of amperes and a lot of heat, even a fire: the ignition circuit generates very high voltages indeed: tampering with the instrument circuits, can cause misleading readings and a possible safety hazard to the driver. Before embarking on any changes to the car electrics, make every effort to understand how the circuit works. In this way fault finding should be greatly simplified.

The Ignition Circuit Figure 1.1.

The purpose of the ignition circuit is to supply the high voltage required to operate the spark plugs in the correct sequence and so ignite the air/petrol mixture in each cylinder. The explosions generated push the pistons and so turn the engine, causing motion. The circuit comprises the car battery, an ignition coil, the distributor and four (or six) spark plugs. The principle of operation is described in sections 2 and 3.

Battery Charging Figure 1.2.

All electrical systems draw their power from the 12 volt battery. If the battery was not continually charged it would become exhausted very quickly, particularly if the lights, wipers and starter motor were in constant use. The turning of the engine charges the battery by connecting it to a dynamo, via the fan belt. A pully network at the front of the engine constantly turns the dynamo which generates enough power to charge up the battery. A control box controls the charging rate and informs the driver via the ignition light if the battery is not charging. Some cars use an alternator in preference to a dynamo. These are more efficient but generate ac rather than dc and so require rectification of the ac output. Battery charging is described in section 5.

Lighting Figure 1.3.

The lighting circuits are the simplest of all these, comprising a simple connection of the 12 volt lamp to the battery via the instrument panel switches. These circuits are completely independent of the ignition and charging circuits, the one connection to each lamp being taken via a single wire and respective switch to the battery; the other connection uses the car chassis. Section 6 describes the lighting circuits in more detail.

Indicators and Accessories Figure 1.4.

Contained within this circuit is the starter motor which draws hundreds of amperes from the battery to turn the

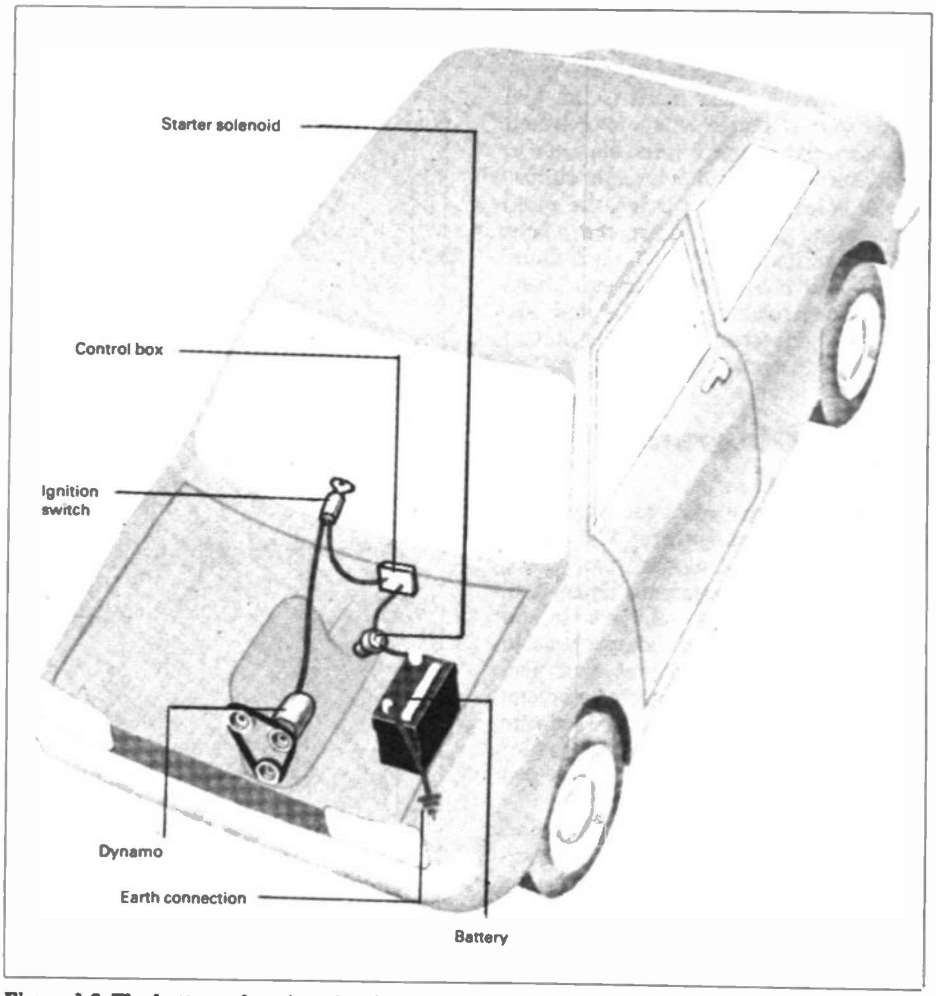


Figure 1.2. The battery charging circuit

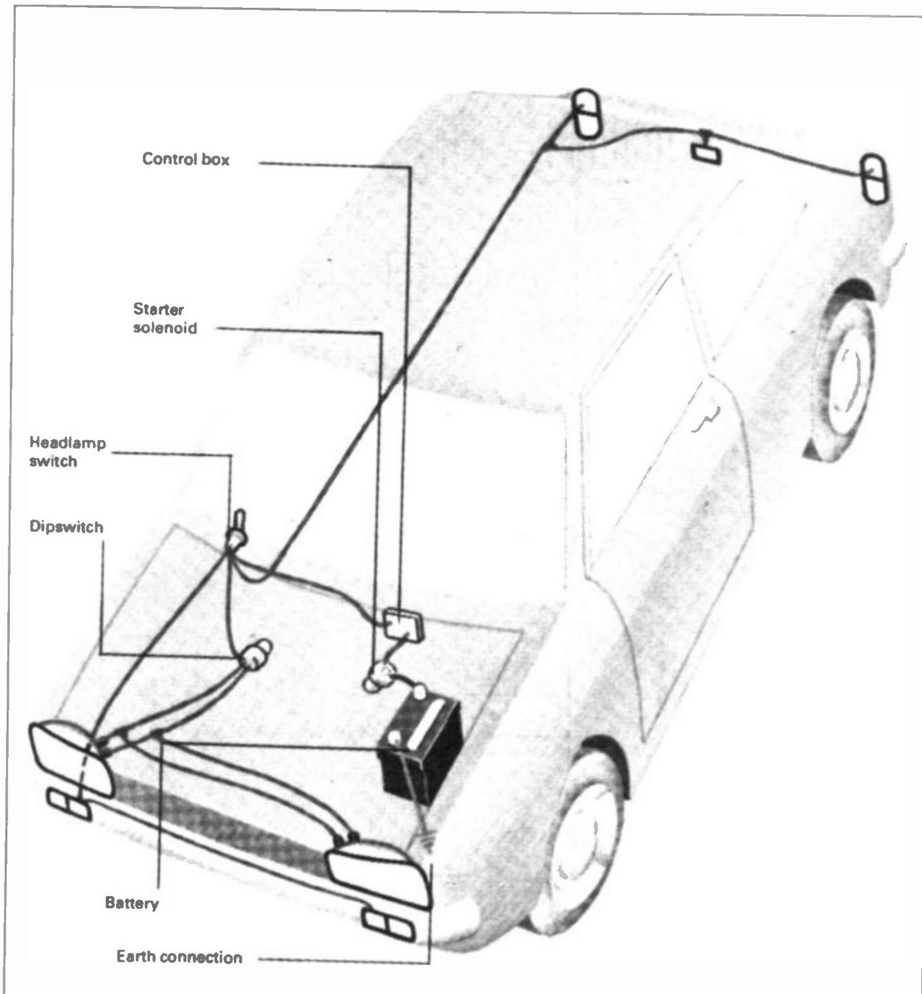


Figure 1.3. The lighting circuit

engine until it fires. Heavy duty cable and a heavy duty solenoid carry out this operation, which is prone to trouble for various reasons. Also there is the fuel pump which is a small solenoid operated device to pump petrol from the tank to the carburettor, the indicator light circuitry with hazard warning lights, the radio and cassette player circuits, the heater and wiper motors, horns, instrument gauges, and heated rear screen. These circuits are relatively simple and are described together with fault-finding techniques in section 7.

Wiring Diagrams Figure 1.5.

Car wiring diagrams are often very difficult to read and interpret. The reason for this is that, in a modern car with a large number of instruments, lights, accessories and motors, all are to be interconnected on one comprehensive diagram. Fuses and switches must also be shown, together with the colours of the wires and cables; many manufacturers use an international colour code for easier identification of the respective circuit cables.

Some of the more popular symbols used in car wiring diagrams are illustrated in Figure 1.5. The cables are often coded *and* coloured for identification and a shorthand method of simplifying the diagram often groups all in one bundle (called a cable-form) as a single line. To

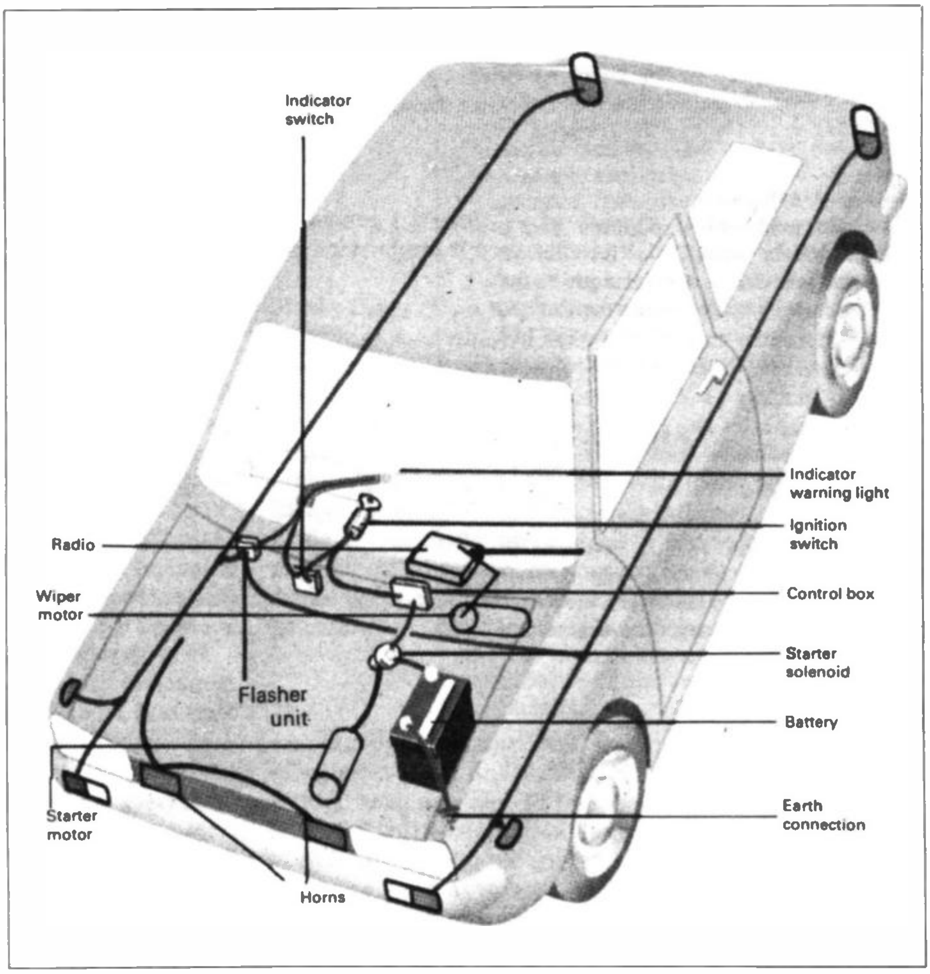


Figure 1.4. The indicator and accessories circuit

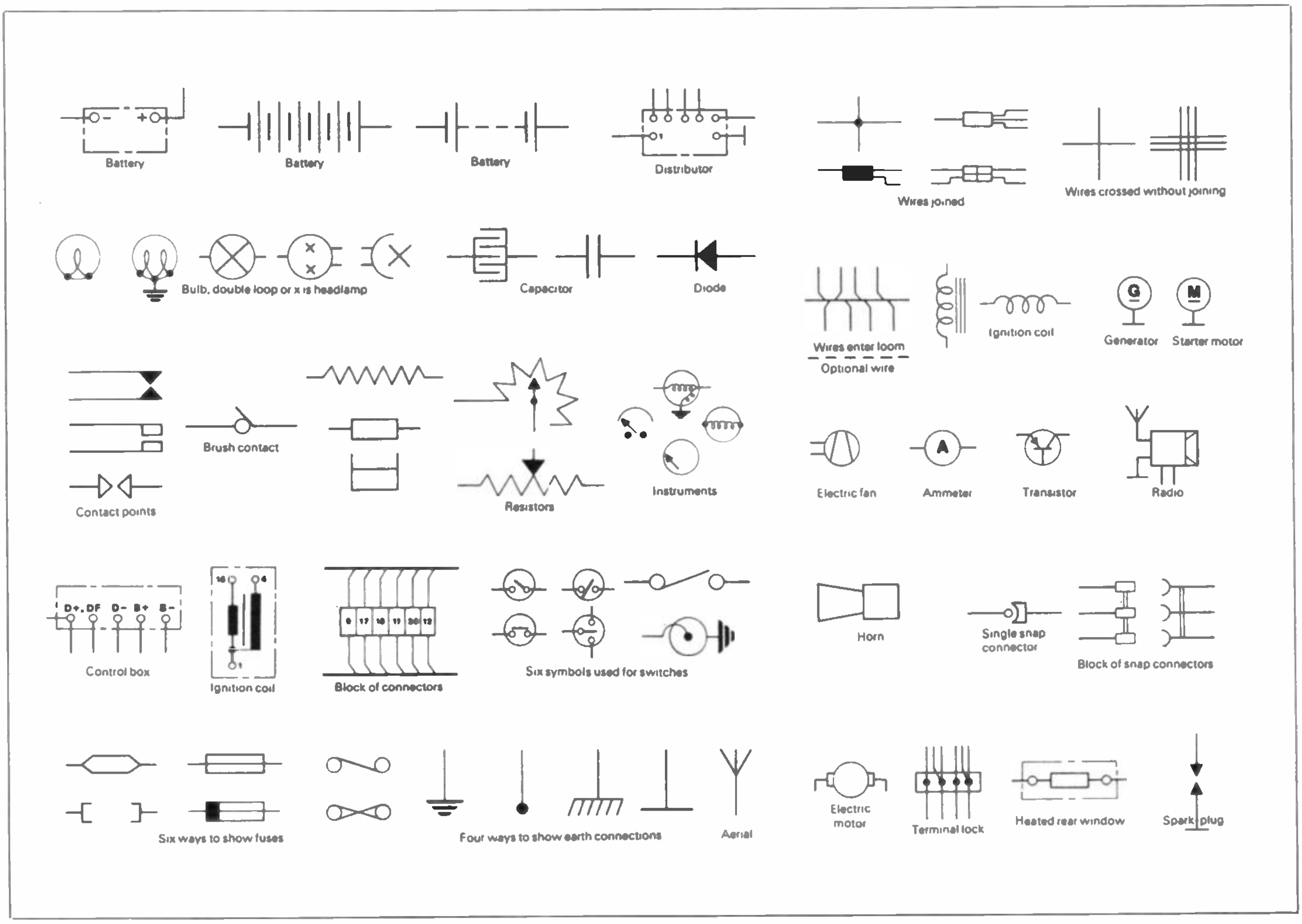


Figure 1.5. Common symbols used in car wiring diagrams

trace the start and finish of one cable involves microscopic analysis of all connections, searching for the required code and colour.

Electronic devices such as electronic ignition or the dashboard microprocessor are shown as simple blocks. Fault finding within these devices must be left to the specialist dealer.

2. The Engine

The most common small to medium car engine is the 4-cylinder petrol internal combustion engine. More powerful engines have six cylinders, some have eight; motor cycles and mopeds have one or two. The arrangement of cylinders varies, some being overhead cam shaft, some pushrod and rocker, and others with cylinders in the shape of a 'V'.

This brief description of the 4-cylinder engine, highlights the importance of accurate timing so as to maximise power and performance. Figure 2.1 shows the arrangement of cylinders and the four strokes, illustrated separately in Figure 2.2:

1. induction — the petrol/air mixture is sucked into the cylinder
2. compression — the piston compresses the mixture
3. power — the spark plug ignites the mixture causing an explosion which pushes the piston down
4. exhaust — the piston pushes the burnt gases out of the cylinder.

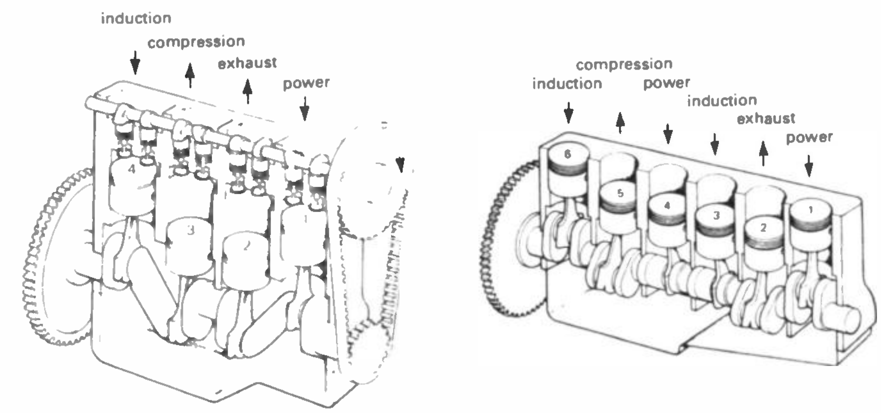
The four cylinders operate in series so that, at any one time, one is being powered. The crank shaft positions the pistons in the correct sequence, two complete revolutions (720°) comprising the complete four-stroke cycle. The electrical circuits have the job of supplying each spark plug with a high voltage pulse to power the piston in the correct sequence, and at the time when the piston is at the top of its stroke (top dead centre). The distributor ensures that the pulses travel in sequence to the four spark plugs and, at the same time, time the pulse to top dead centre.

3. Basic Ignition

The main components of the ignition circuit are the ignition coil — a cylindrical transformer with two connections SW and CB and a high tension cable going to the distributor (see Figure 3.2) — and the distributor — a mechanical device coupled to the engine via skew gears. This acts as a four-way switch to route the high tension to the spark plugs, and as a means of generating the high tension voltage.

Figure 3.1 shows the basic high voltage generating circuit. The operation is as follows, assuming the contact breaker points are initially closed (see Figure 3.3):

1(a) the piston in one cylinder (say number 1) rises to top dead centre, compressing the petrol/air mixture
1(b) the rotor arm in the distributor cap points to the appropriate high tension connection to spark plug number 1 and
1(c) the contact breaker points open.



Crank position (degrees)	Cylinder no. 1	Cylinder no. 2	Cylinder no. 3	Cylinder no. 4
0–180	Power	Exhaust	Compression	Induction
180–360	Exhaust	Induction	Power	Compression
360–540	Induction	Compression	Exhaust	Power
540–720	Compression	Power	Induction	Exhaust

Figure 2.1. 4-cylinder and 6-cylinder engines

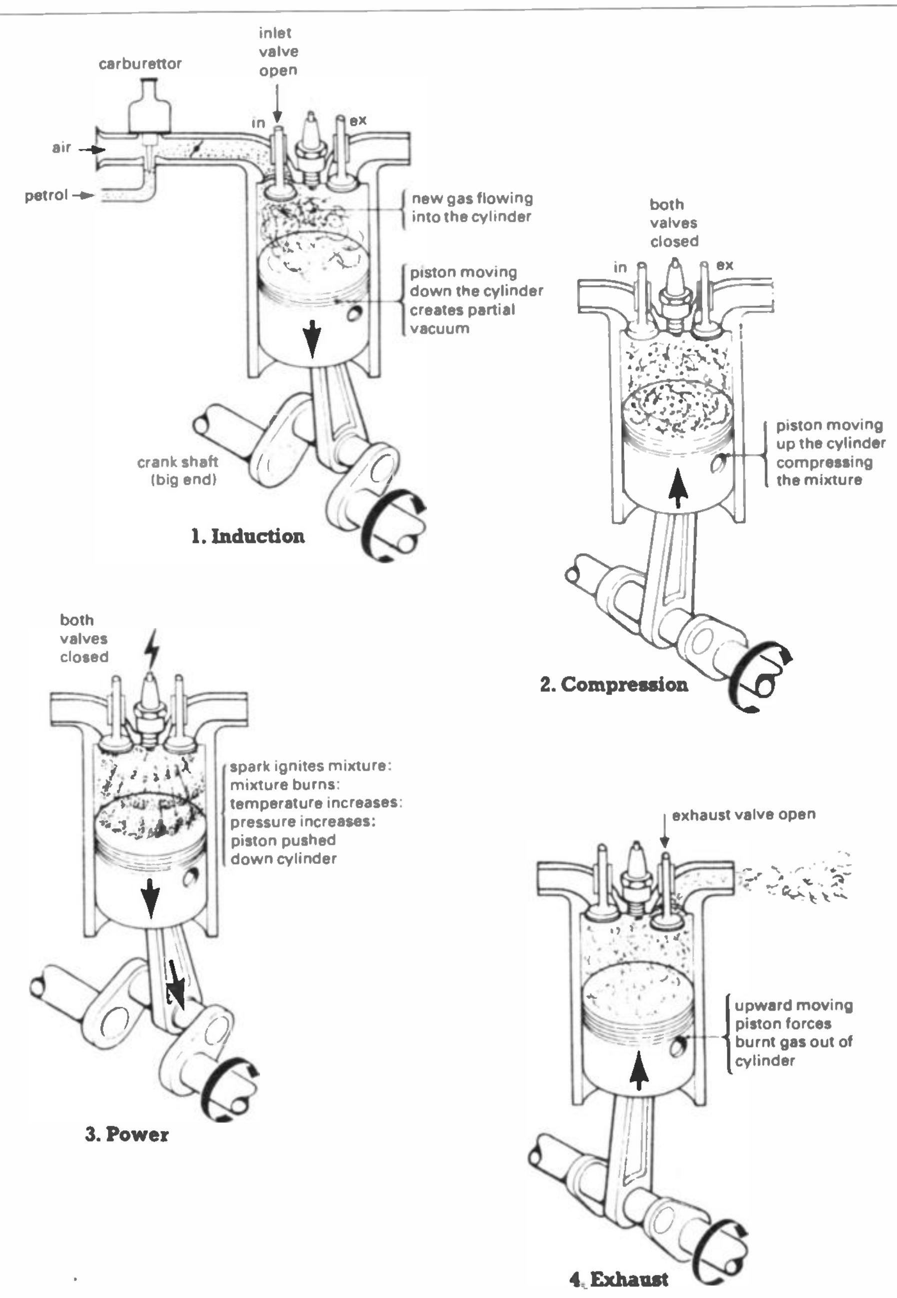


Figure 2.2. The four stages of combustion

2. The magnetic field in the primary of the ignition coil quickly collapses. The turns ratio of the transformer of about 10,000 to 1 transforms this collapse into a voltage of about 20,000 volts across the secondary
3. The high tension pulse ignites the petrol/air mixture in cylinder 1 causing the engine to rotate.
4. The distributor shaft rotates to again close the contact breaker points. The capacitor across the points suppresses the high voltage pulse generated by this closure.
5. The distributor shaft turns the rotor arm to the next cylinder and the procedure repeats.

The timing of the opening of the points is critical. The distributor shaft cam opens the gap as in figure 3.5, the positioning of the contact breaker points assembly is critical together with the gap width. The points, after a period of wear, tend to corrode and pitting occurs; a

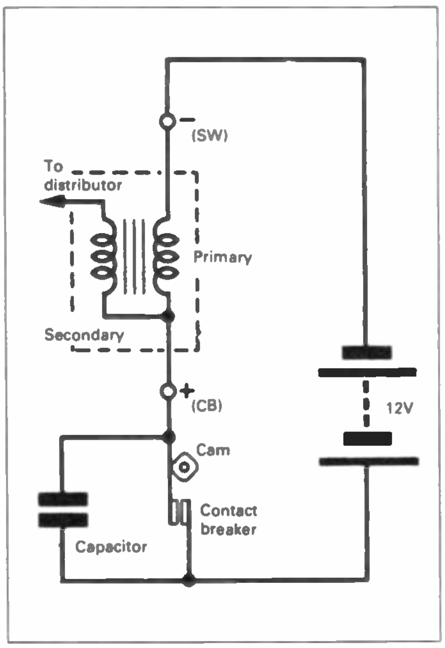


Figure 3.1. Basic high voltage generating circuit

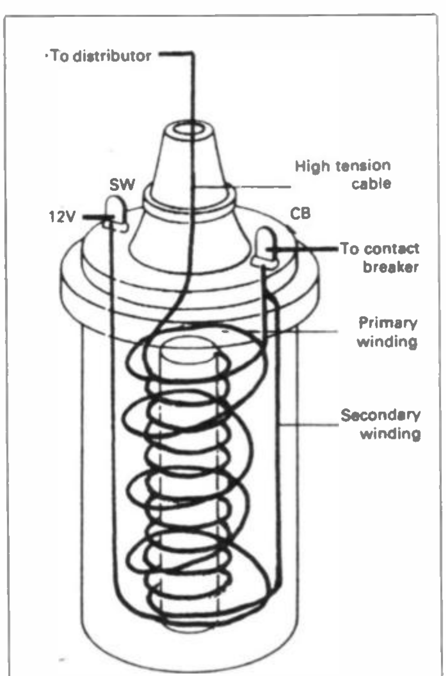


Figure 3.2. The ignition coil

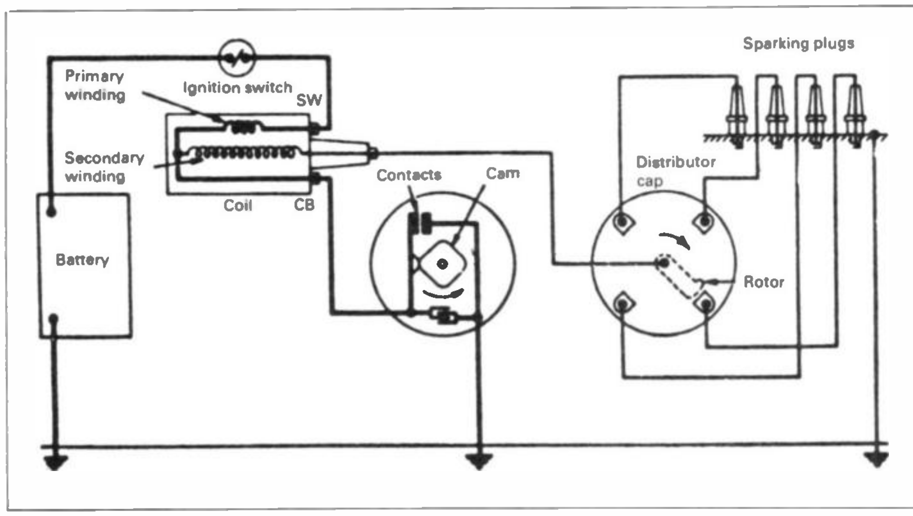


Figure 3.3. Sparking plugs firing circuit

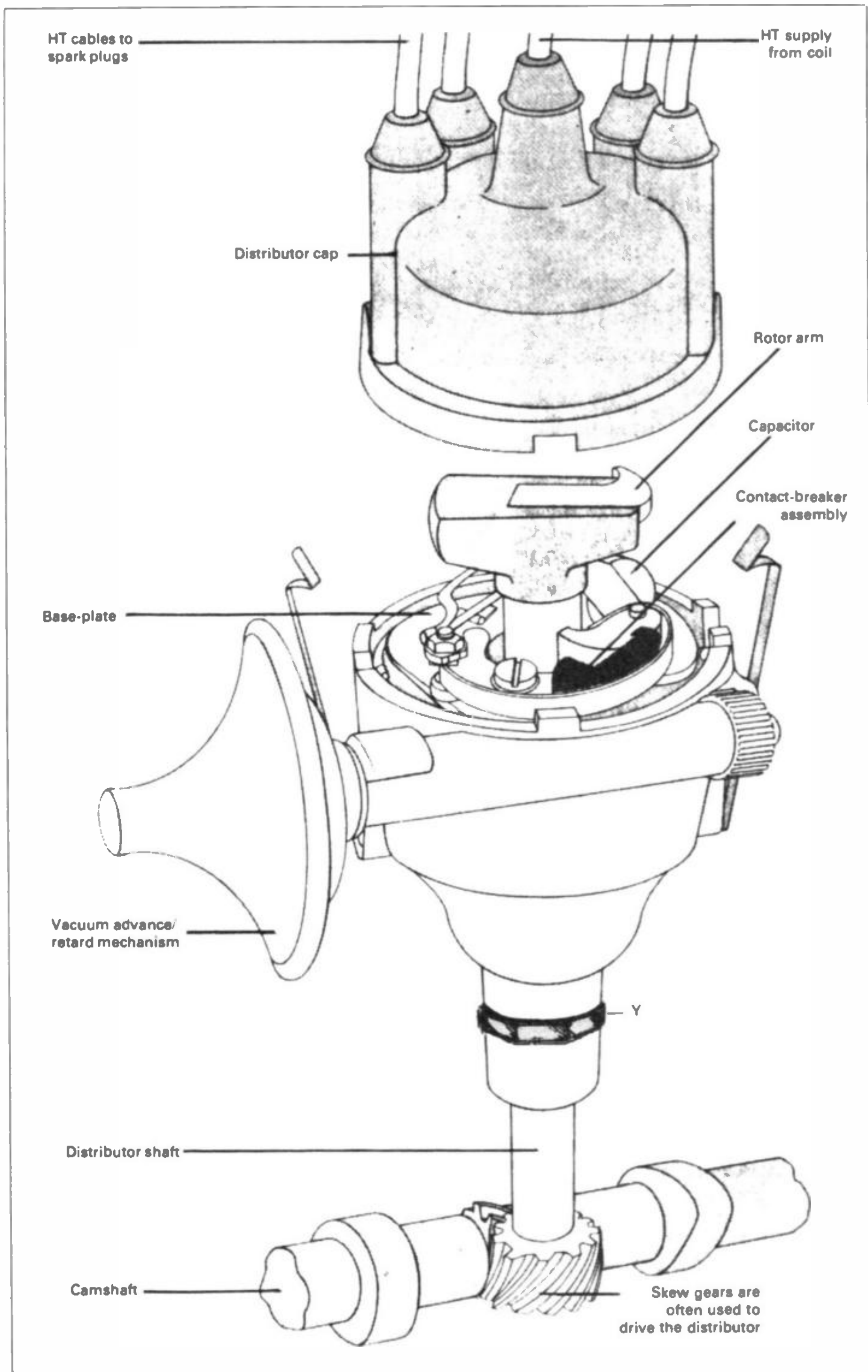


Figure 3.4. The distributor

deposit which builds up and reduces the effective gap. The gap usually about 25 thou wide, opens and closes some ten million times every 1000 miles. One other adjustment to optimise the timing is the dwell angle. This is the number of degrees that the points remain closed; refer to the maker's manual for the recommended value.

Ignition timing is carried out in the following sequence:

1. Choose cylinder number 1 — consult the manual.
2. Locate the timing marks on the fan belt pulley (see Figure 3.6)
3. Turn the engine crank shaft until the marks align at top dead centre (tdc). The engine can be turned by placing the car on level ground, take out all the spark plugs, place in top gear, release the brakes and move the car to and fro.
4. Ensure that the distributor rotor arm points to the high tension lead to cylinder no. 1. If not, turn the engine through a further 360°.
5. Connect a 12V lamp between the contact breaker spring (see point X in Figure 3.5) and a good earth point.
6. Rotate the engine by about 20° then inch it slowly backwards until the lamp just lights.
7. If the tdc reading is incorrect, align the tdc mark, then loosen the distributor clamping nut (point Y in Figure 3.4) and turn the entire distributor anticlockwise until the light just goes out. Then turn clockwise until it just lights. Clamp the nut.
8. Check the tdc setting once again.
9. Replace the plugs, put on the brakes and take out of gear! A faster method uses a stroboscope with the engine running, a Xenon tube flashing as the points open and close.

4. Electronic Timing

The system so far described sometimes fails because of pitting of the points and wear and tear of the moving parts of the distributor. Two types of electronic system are found:
(a) Transistorised ignition or capacitor discharge ignition — see Figure 4.1. and
(b) contactless (optical or magnetic) ignition.

Transistor ignition uses a power dc-dc converter, a two transistor push-pull oscillator, to generate 400V or so, to feed to the ignition coil and produce a higher voltage and healthier spark. At the same time, the contact breakers no longer switch the full 12 volt battery current: they merely switch a 12 volt low current signal to the dc-dc connector. The points therefore last far longer and the system is virtually maintenance-free.

Contactless ignition uses a moving magnet or infra-red ray to replace the cumbersome contact breakers, a transistorised dc-dc converter circuit being used as before to deliver the high tension pulses to the plugs. Both systems can be installed into an existing circuit in a very small time, a number of modern cars having such systems built in when new.

To be continued.

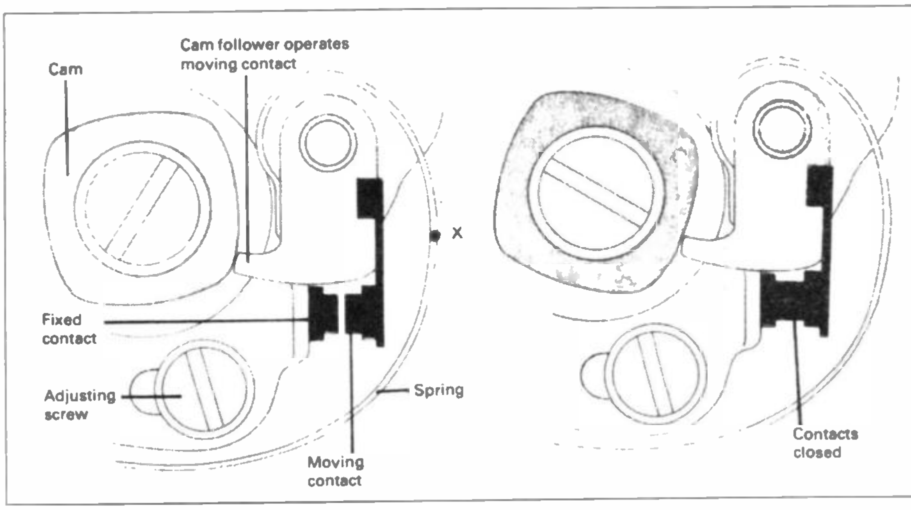


Figure 3.5. Contact breaker assembly

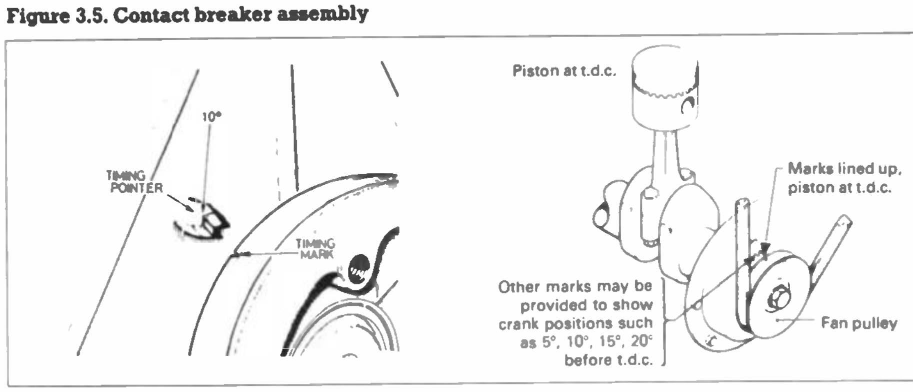


Figure 3.6. Timing marks on fan belt pulley

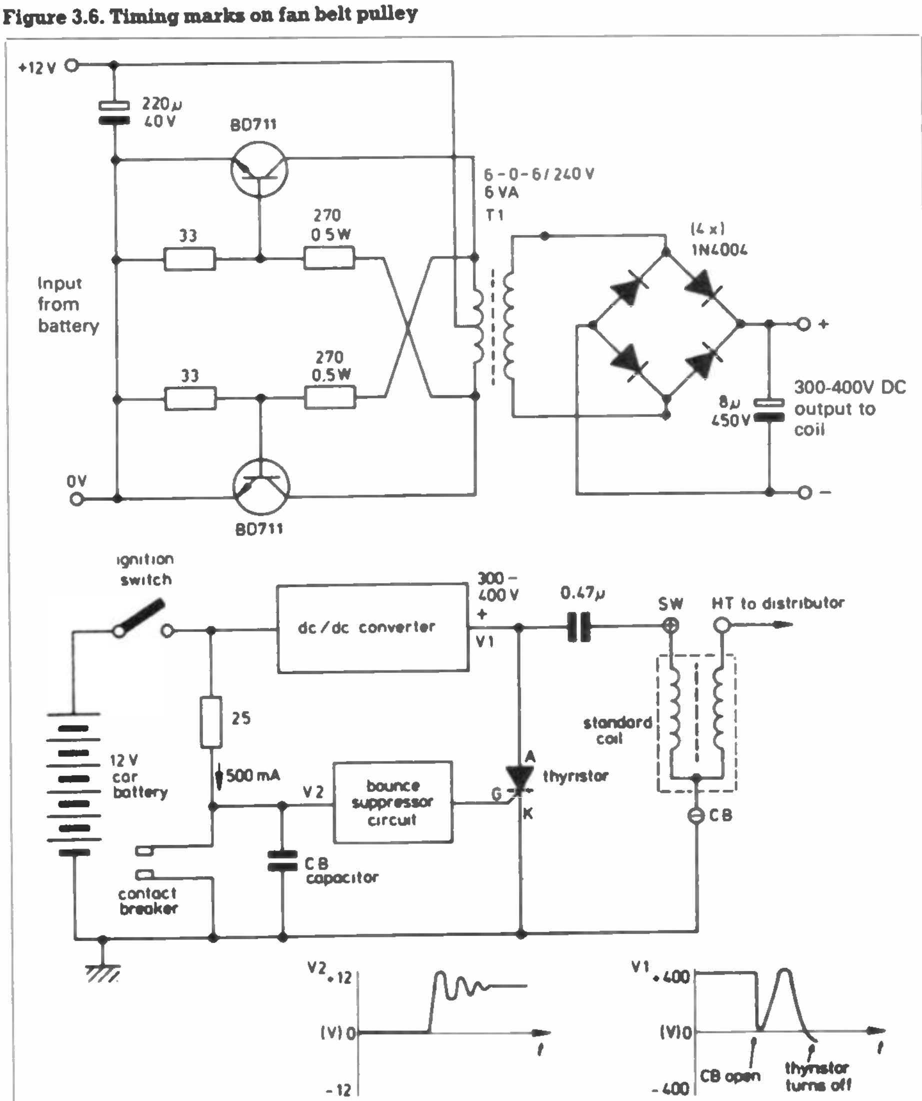


Figure 4.1. Transistorised and capacitor-discharge ignition circuits

MACHINE CODE PROGRAMMING WITH THE 6502

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

Input/Output Introduction

There would be little point in moving data around in the computer and operating on it if there wasn't, ultimately, to be some end product. A user of a microcomputer is, of course, making some use of input/output functions already, whenever he inputs anything through the keyboard or accepts an output via a V.D.U. or printer. To transfer data between the microcomputer and these peripherals requires some form of 'interface adaptor' e.g. a Peripheral Interface Adaptor (P.I.A.) such as the 8154 or a Versatile Interface Adaptor (V.I.A.) such as the 6522. I am not going to show how to interface either keyboard or display specifically to the computer; that isn't necessary unless we are designing a computer from scratch and that isn't the object of the exercise. What I intend to show is how to program your existing micro in order to produce 'useful' signals at the port lines, also how to configure the ports to meet particular requirements and then to receive signals from them.

The General Idea of an Interface Adaptor

Since the data bus is 8 bits wide, the port lines are generally arranged in multiples of this number e.g. two groups of eight lines, each group forming a complete port, known as Port A or Port B. The idea is shown in Figure 1. Each of these port lines can be thought of as an entry or exit point to the computer. This then brings us to a logical question. How do we know whether a line is an input or an output? The answer is simplicity itself. We decide the direction of any line by programming it to be what we want it to be. Thus, the configuration of the ports is entirely under software control and is not fixed by hardware considerations at all. It is possible to have an interface adaptor where the lines are dedicated to one function or the other, but it is generally the case (and certainly is in the case of the 6522) that all lines are programmable completely independently of each other.

The question then is how is this achieved? Figure 1 shows that associated with each port is a pair of registers known as the Data Register and the Data Direction Register. Thus, for Port A there is Data Register A (DRA) and Data Direction Register A (DDRA) and similarly for Port B. The function of the Data Registers and their physical relation to the ports is fairly obvious – they act as short-term stores for data entering or leaving the computer via the port lines. The physical relation of the Data Direction Register to its corresponding Data Register is less easy to show diagrammatically but quite easy to explain and appreciate nonetheless. The function of the Data Direction Register is to establish which port lines act as inputs and which as outputs. This is achieved by the data loaded into it, the rule being as follows:

'A 0-bit loaded into a DDR configures the corresponding port line as an input, while a 1-bit loaded into a DDR makes the corresponding port line an output'.

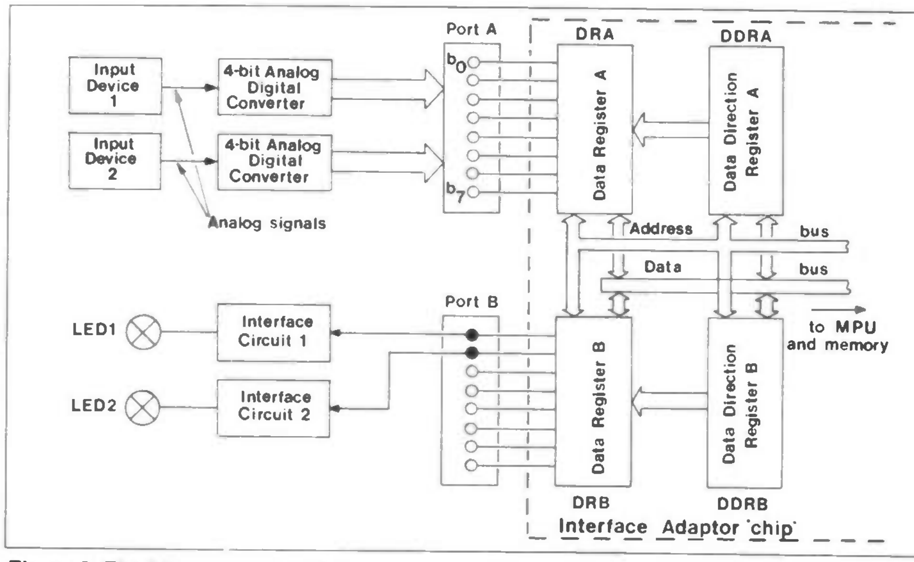


Figure 1. The Microcomputer as a Control Centre.

What is meant by corresponding port lines can be explained as follows:

1) All registers are eight bits wide
2) The b_0 bit of DDRA controls the b_0 bit of DRA
   The b_1 bit of DDRA controls the b_1 bit of DRA and so on until
   The b_7 bit of DDRA controls the b_7 bit of DRA and so on for all bits of Port B.

Thus, there is an easy one-to-one relationship between the bits in the DDR's and in the DR's.

To illustrate this point, suppose that we wish to use Port A in such a way that the four least significant bits are inputs and the four most significant bits are outputs (Figure 2). This means that in the Data Register A, bits $b_0 - b_3$ inc. are input lines while bits $b_4 - b_7$ are output lines. Therefore, in Data Direction Register A, $b_0 - b_3$ will be 0's while $b_4 - b_7$ will be 1's This gives the binary number 11110000 and this is the number that must be loaded into Data Direction Register A.

In hexadecimal notation this number is F0. Since the Data Registers and the

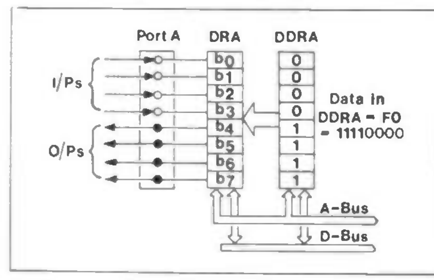


Figure 2. Configuring a Port for Input/Output Functions.

Data Direction Registers are memory-mapped i.e. have specific addresses assigned to them, placing data in these registers or reading data out of the Data Registers is no different from doing the same thing in any area of RAM. It is, therefore, essential to know what the register addresses are for one's own computer, a dive into the manual for the micro hopefully producing the required values. Having found them, they can then be included in your machine-code programs and the computer is turned into a control device with a great deal of potential.

Reading and Writing to Input/Output

Suppose that two input devices are connected to Port A and two LEDs to Port B, as shown in Figure 1. The signals on the input lines are digital, of course, but may well have been derived from a linear device e.g. a potentiometer, temperature sensor, d.c. bridge, etc. They will have then been 'digitised' by an analog-digital converter (A.D.C). To accept these signals into the computer all that is necessary is to include in the program an instruction to load the accumulator (LDA) from the appropriate port address. Having twice mentioned port addresses now, it would be as well to assign some real addresses to our hypothetical computer to use as examples. Obviously it is most unlikely that these addresses would be the same as on any given machine but they will serve their purpose. They could, therefore, be assigned as follows:

Port B Data Register (DRB) – 0910
Port A Data Register (DRA) – 0911
Port B Data Direction Register (DDRB) – 0912
Port A Data Direction Register (DDRA) – 0913

Therefore, they are all on Page 9 of the memory map. A program segment in Assembly Code to configure the ports and then to read the input data from the devices could look like this.

```
LDA  #00    Configures all Port A lines
STA  DDRA     as inputs
LDA  #FF    Configures all Port B lines
STA  DDRB     as outputs
LDA  DRA    Accepts data from Port A
 |
 |
 |
 |
STA  DRB    Sends data to Port B
```

Between the load and store operations for DRA and DRB there would, of course, be a number of instructions to perform the required operations on the input data – not a lot of point inputting it otherwise! However, the exact nature of such instructions is irrelevant at the moment.

As it happens, this simple program doesn't quite do what is intended. In this case it arises because the input signals each occupy less than the whole width of the input port. Port A, as we have seen, is allocated to two 4-bit digital inputs, one on b_0 – b_3 inc., the other on b_4 – b_7 inc. The net result of this is that, loading from Port A puts two separate input signals into the accumulator at the same time, where they appear to be just a single 8-bit value. What is needed is some way of separating one signal from the other, so that each can be assessed separately.

Masking and Shifting, the AND and LSR Instructions

The selection of individual bits or groups of bits in a data byte can be carried out by masking, using the AND instruction. Suppose, for a start we consider selecting the bits b_0 – b_3 first, then a program segment that could do it looks like this:

```
LDA  #00    Initialise Port A, all lines
STA  DDRA       as inputs
LDA  DRA    Load accumulator with ALL
                bits from Port A
AND  #0F    Mask off bits b4 – b7
```

The effect of the AND instruction is to perform the logical AND operation, bit for bit, between the accumulator contents and some specified number, which in this case was 0F. Since 0F = 00001111 in binary, this means that the top four bits of the accumulator are each ANDed with a zero, which of course makes the result for each of these bits also zero – ANYTHING ANDed with zero = zero. A 1 can only be produced by the AND operation when two 1s are ANDed. If this isn't exactly clear, the following example may help.

Accumulator contents (input from Port A)	10111001
ANDed with 0F (the mask)	+ 00001111
gives the result (new accumulator contents)	= 00001001

So that, effectively, the data in the accumulator is now merely the lowest four bits of the Port A Data Register.

The situation for the highest four bits, b_4 — b_7, is slightly different. The mask for the AND operation is now F0 i.e.

Accumulator contents (input from Port A)	10111001
ANDed with F0 (the mask)	+ 11110000
gives the result (new accumulator contents)	= 10110000

The lowest four bits have obviously been masked out but the contents of the accumulator do not now represent the 4-bit number 1011 which is the input from the Input Device 2 (Figure 1); instead the value is an 8-bit word in which the lowest four bits are zeros, not the same thing at all. What is needed is to shift the top four bits down into the lowest four bit positions and, at the same time, shift the four zeros into the highest bit positions. This is done by four consecutive 'logical shift right' (LSR) operations. The accumulator then contains the correct value i.e. 00001011. The LSR operations are shown in more detail in Figure 3. The contents of the carry flag always end up in bit b_7 of the accumulator after each shift operation so it is important that this flag is cleared initially. Subsequently its function is to move the zeros from the low bit positions into the high bit positions.

A program segment to input data from, say, Port A, to act upon it by examining its value and sending an output to Port B will now be developed. First consider the problem in general form. A decision based on the value of data input to the computer from external devices need not be of the GO/NO GO variety. After all, even a 4-bit number has $2^4 = 16$ possible values. It is obviously possible to decide whether the input number lies above or below a certain

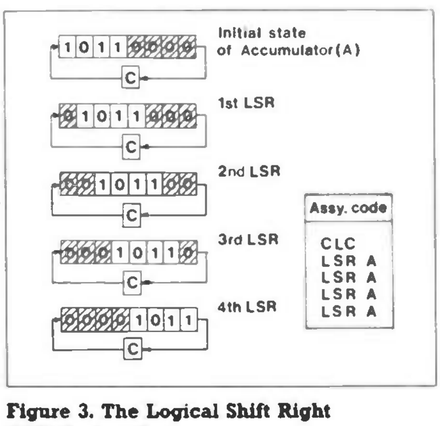


Figure 3. The Logical Shift Right (LSR) Instruction.

datum value. This datum could represent a specific temperature, air pressure, angular or linear displacement, such as could be produced by a potentiometer shaft position. Fairly obviously some sort of comparison has to be made. Once this has been done, branches can be used to implement the decisions based upon the results of the comparison test.

CMP, CPX, CPY and the Branches

The comparison is effected by a subtraction which is implicit in each of the three comparison instructions. The number with which the comparison is made is specified in some way as the operand of the instruction and is subtracted from the accumulator contents (CMP), the X Register contents (CPX) or the Y Register contents (CPY). This subtraction does not actually change the value of the contents of A, X or Y; it merely conditions the appropriate flag in the Processor Status Register. Obviously there are three possible results of the comparison.

Result POSITIVE:	input greater than datum - sign bit clear
Result NEGATIVE:	input less than datum - sign bit set
Result ZERO:	input equals datum - zero bit set

The result in each case leads to the use of the appropriate branch instruction.

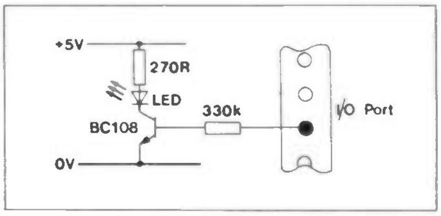


Figure 4. LED Driver Circuit.

Suppose, for example, there is a situation in which two alternative courses of action have to be taken if the input is above or below the datum, but nothing is to happen if the values are equal. Obvious branches are BPL (Branch on result PLUS) or BMI (Branch on result MINUS). What the branch actually achieves depends upon the nature of the controlled device. What we may be looking for are just single-bit outputs on lines of Port B, say to switch on LED's. To carry this out, all we have to do is use the branches to access store instructions which are used to put logic 1's on the correct Port B output lines. A simple driver is the only interface that is necessary (Figure 4). For example, if the two least significant lines of Port B are to be outputs (as in Figure 1), then one STA instruction will have 01 as its operand (putting $b_0 = 1$) while the other STA instruction will have 02 as its operand (putting $b_1 = 1$). We are now in a position to write a complete program that will test the input data on bits b_0 - b_3 of Port A and switch on LED's on bits b_0 or b_1 of Port B when the input is above or below some specified value, say 7. The program will be presented in Assembly Code at first and then encoded into Machine Code.

The programmer is advised to set out the two versions side by side, as on the programming sheet suggested in Part Two, but in this instance, purely for convenience, they will be laid out one after the other.

Assembly Code Program

```
      LDA #00   Initialise Port A
      STA DDRA    as inputs
      LDA #FF   Initialise Port B
      STA DDRB    as outputs
      LDA DRA   Input all Port A data
      AND #0F   Mask off upper 4 bits
      CMP #07   Compare input data
                  from Port A with
                  'datum' (07)
      BPL OUT1  Go to 1st store
                  instruction
      BMI OUT2  Go to 2nd store
                  instruction
OUT1  LDA #01   Load accumulator with
                  required bit pattern
      STA DRB   Make b0 of Port B = 1
OUT2  LDA #02   Load accumulator with
                  alternative bit
                  pattern
      STA DRB   Make b1 of Port B = 1
```

Machine Code Program

```
0020  A9  00
0022  8D  13  09
0025  A9  FF
0027  8D  12  09
002A  AD  11  09
002D  29  0F
002F  C9  07
0031  10  0D
0033  30  11

0040  A9  01
0042  8D  10  09
0045  A9  02
0047  8D  10  09
```

This program in machine code should be checked line by line against the tables of op-codes given previously. Also check the branch lengths (0D and 11) to ensure that you understand how they are calculated. If unsure, refer back to Part Two for the method.

Waveform Generation with the Micro

It is possible to use one's micro as a waveform generator; a variety of waveforms may be produced under control of the program. It is just a matter of loading the right data at the right time into the port Data Register and transmitting it through a port which is configured as an output. For example, a square-wave, (Figure 5) is seen to consist of two separate time periods. For one of these the wave is at the logic 1 level and for the other it is at logic 0. So, in order to generate it, it is only necessary to load successive 'ones' and 'zeros' into any convenient bit of a port, these values being held for the required length of time in order to produce a wave of specific frequency and mark/space ratio. For example, if b_0 was to be the output line carrying the square-wave, then the data loaded into the port Data Register would be alternately 00, 01, 00, 01, etc. This would give a high-frequency square-wave of, theoretically, unity mark/space ratio. The frequency would be determined by the time taken to carry out the instructions. This brings us to the idea of 'micro-cycles' i.e. the number of machine cycles taken to carry out a given instruction. With a 6502 and a 1MHz clock, the length of a micro-cycle is exactly one micro-second. All we then need to know is the number of micro-cycles for each of the instructions in our program. Consider now the program for square-wave generation in Assembly Code form.

```
       LDA #01   Initialise b0 of Port
       STA DDRA    A as output
START  LDA #00
       STA DRA
       LDA #01   Generate continuous
       STA DRA     square-wave
       JMP START
```

If you now look at Figure 5, you will notice that the time interval that each instruction occupies, in micro-cycles, has been written underneath the waveform. Start at point X and assume that the program has already gone through several cycles of the square-wave. At this instant it is at logic 0. The load and store

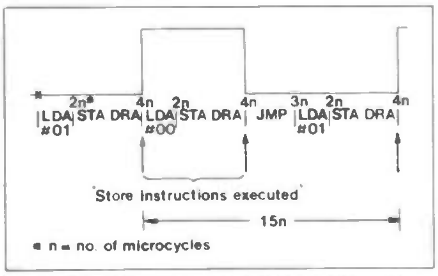


Figure 5. A Programmed Square Wave.

instructions to return it to the logic 1 level are executed during the period following X, taking just 6 mirco-cycles; the voltage then rises to logic 1 and immediately the load and store instructions to return it to the logic 0 level are encountered and executed, also taking just 6 micro-cycles. And at this point we encounter a slight snag. Unless we are going to write an endless list of load and store instructions (quite impractical as is obvious) we must jump back to the start of the sequence each time in order to keep on repeating it. The problem is that the jump (JMP) instructions itself takes 3 micro-cycles and this lengthens one half-cycle of the square-wave. However, let us leave this worry for the moment and press on to calculate the maximum frequency of such a waveform.

One complete cycle of the square-wave takes 15 micro-cycles i.e. is 15 microseconds long. The frequency is the reciprocal of this i.e. is equal to 10^6/15Hz which is approximately 66kHz. When this program was run on a 6502-based micro it was found to give this figure precisely though the leading edge of the wave did show a slight exponential rise rather than a true step. However, the waveform is very much better than this at lower frequencies and it is in this region that use is more likely to be made of this facility anyway. Therefore, all we really need to bother about is how to slow the program down so as to generate much slower waves.

Delay Loops and Index Registers

Obviously what is needed is a predetermined delay between the transitions of level. This can be achieved quite readily by loading one of the Index Registers with data, decrementing it and testing for zero contents repeatedly. Using a branch instruction one then exits the loop. The data loaded originally into the Index Register determines the time spent in the loop. By having two separate loops, one for each half-cycle, the mark/space ratio and frequency are both controlled by the software. The program is shown in Table 1.

Once again one half-cycle has the JMP instruction in it but this time it doesn't matter. If the frequency is low enough a difference of 3 microseconds between half-cycles is neither here nor there. In any case it can be allowed for by loading slightly different values of data into the X register for the two half-cycles. By having both time intervals under software control in this way, a very wide range of mark/space ratio can be obtained. As far as frequency is concerned, the lowest frequency is obtained when the X register is loaded with the largest possible number on both half-cycles. This value is, of course, FF. The resulting frequency is 180Hz. It is possible to have very much lower frequencies. This can be achieved in two ways. Either by 'nesting' one delay loop within another (which means using both X and Y registers) or by using the timer facility in the 6522 chip if this is the interface chip in your machine. But that is another story. More on input/output next time.

	LDA	#01	Set b_0 of Port A as output	0020	A9	01	
	STA	DDRA		22	8D	13	09
LOOP	LDX	#T1	Set time interval T1	25	A2	FF	
JACK	LDA	#00	Set logic level to zero	27	A9	00	
	STA	DRA		29	8D	11	09
	DEX		Decrement X register	2C	CA		
	BNE	JACK	Test for X = 0	2D	D0	F8	
	LDX	#T2	Set time interval T2	2F	A2	FF	
JILL	LDA	#01	Set logic level to one	31	A9	01	
	STA	DRA		33	8D	11	09
	DEX		Decrement X register	36	CA		
	BNE	JILL	Test for X = 0	37	D0	F8	
	JMP	LOOP	Repeat sequence	39	4C	25	00

Table 1. Delay loop program in assembler and machine code

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- BK03D Vertisocket Type 1 £1.26 (D)
- BK04E Vertisocket Type 2 £2.62 (C)

Page 245
- YY66W Infra-Red Sensor 89p (F)

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- HQ61R MEL 12 98p (F)
- HQ63T Lens £2.98 (C)
- HQ64U Lensholder £1.98 (D)

ORGAN COMPONENTS

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- XB13P KB Mounting Strip 54p (F)

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- XB94C Contact Block 1WG 32p (F)

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- XY28F Remote Foot Control £11.80 (A)

PANEL METERS

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- RK12N Quick-Fit Meter 50mA DIS

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- RW94C 2in Pan Meter 1mA £6.98 (B)
- RW95D 2in Pan Meter 5mA £6.98 (B)
- RW96E 2in Pan Meter 10mA £6.98 (B)
- RX33L 2in Pan Meter 100mA £6.64 (B)
- RX36P 2in Pan Meter 50V DIS
- RX53H 2in Pan Meter 'VU' £7.32 (B)

PCB EQUIPMENT

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- FL06G Vero 14354 29p (F)
- FL07H Vero 10345 £1.29 (D)
- FL08J Vero 10346 £1.05 (E)
- FL09K Vero 10347 £1.42 (D)
- FL10L Vero 10348 £1.28 (D)
- HQ48C Vero V-Q Board £2.38 (C)
- FL25C Tool 2022 £1.74 (D)
- FL26D Tool 2150 £2.52 (C)
- FL20W Pin 2140 69p (E)
- FL21X Pin 2141 68p (E)

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- HY16S Verowire Pen £4.68 (B)
- ★HY17T Verowire Spool £1.05 (E)
- HQ84F Verobloc Bracket 78p (E)

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- XB43W Seno Etch System £8.80 (B)

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- HX00A PCB SRBP Smll Single 52p (F)

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- XB90X Fourcuit £9.80 (B)

PROJECTS

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- BH64U Minicon Pl 17way 73p (F)

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- BB43W Synth Trns Gen 1 PCB £3.46 (C)
- BY81C Synth Trns Rept PCB £1.52 (D)
- BB38R Synth Oscillator PCB £5.20 (C)
- BB48C Synth Ext I/P's PCB £1.64 (D)
- BB65V 3800 VCF PCB £2.62 (C)
- BF96D Joylever PCB £1.10 (E)
- LW53H 5600S Synth Kit £649.95 (A)

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- BB47B Synth Otpt Stge PCB £6.86 (B)

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- LW66W Sequencer Kit £99.95 (A)

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- LW85G Hexadrum Kit £19.95 (A)
- LW86T Syntom Kit £11.95 (A)

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- LW87U Synwave Kit £10.95 (A)
- LK15R Synchime Kit £11.96 (A)

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- LW91Y Harmony Gen Kit £17.95 (A)
- LW92A Combo-Amp Kit £99.95 (A)

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- LW71N 25W Stereo Amp Kit £59.96 (A)

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- LW77J Amp Remote Cntrl Kit £28.86 (A)

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- †XH48C MES33 40p NV
- LR13P HQ Mixer PCB No.2 £1.98 (D)

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- LR16S HQ Mixer PCB No 5 £1.29 (D)
- LR35Q HQ Mixer PCB No 25 £1.98 (D)
- LR22Y HQ Mixer PCB No 7 £1.98 (D)

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- LR23A HQ Mixer PCB No 8 £1.72 (D)
- LR24B HQ Mixer PCB No 9 £1.98 (D)
- LR26D HQ Mixer PCB No.14 £2.20 (D)

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- YQ19V LM380 Amp PCB £2.49 (C)
- BY73Q 8W Amp PCB 72p (E)

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- YQ43W 15W Amp Kit £5.75 (B)
- YQ20W 20W Amp PCB £2.20 (D)

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- LW35Q 50W Amp Kit £15.95 (A)
- LW51F 75W MOSFET Amp Kit £12.95 (A)

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- LW32K 150W Power Amp Kit £19.95 (A)

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- XB75S 10-Chl Eqlsr Wwrk £9.98 (B)

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- XY26D Heatsink Mtg Plate £4.20 (C)
- BB19V Disco PSU PCB £2.10 (D)
- BB20W 150W Amp Board £2.42 (C)
- BB27E Light Mod Bd £5.98 (B)
- BB24B Disco Fader Bd £2.32 (C)
- XB37S Sound To Light Case £14.20 (A)

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- LW93B Partylite Kit £9.45 (B)
- YQ21X Snd/Light Conv PCB £2.98 (C)

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- LW94C Universal Timer Kit £44.95 (A)

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- GB04E E L C.Board £5.98 (C)
- LW82D Digi-Tel Main Kit £99.95 (A)
- GA45Y Burglr Alrm Main PCB £7.20 (B)
- LW57M Burglar Alarm Kit £49.95 (A)
- LW59P Break Contact Kit £2.85 (C)
- LW58N Ext Horn Kit £37.50 (A)

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- LW73Q RTX3 Doppler Kit £42.95 (A)
- LW74R Radar Ch/PSU Module £14.95 (A)
- LW83E Usonic Xceiver Kit £10.95 (A)
- LW84F Usonic Interface Kit £2.75 (C)

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- LW97F Panic Button Kit £3.50 (C)
- LW98G Progrmble Timer Kit £7.95 (B)

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- YQ45Y Magnum 2 PCB £3.32 (C)

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- LW61R Train Common/PSU Kit £29.95 (A)
- LW62S Train Control Kit £7.50 (B)
- LW99H Modem Kit £44.95 (A)

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- LK00A VIC 20 Talkback Kit £22.95 (A)

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- LW72P ZX81 Keyboard Kit £23.95 (A)
- XG22Y ZX81 Keyboard £32.50 (A)
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- LK01B ZX81 Talkback Kit £16.95 (A)

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- BB31J RC Interface PCB £1.69 (D)
- BB35Q RC Servo Amp PCB £1.08 (E)
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- LK05F D'Xars Processor Kit £9.85 (A)
- LK07H Enlarger Timer Kit £34.95 (A)

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- LW67X MPG Meter Kit £49.95 (A)

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- GB03D Freq Ctr Display PCB £2.20 (D)

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- LK10L CMOS Xtal Clbrtr Kit £18.95 (A)
- LK06G Sweep Osc Kit £21.95 (A)

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- LK09K Minilab Kit £34.95 (A)

PROTECTION

Page 314
- RX97F Safuseholder 1 1/4in £1.98 (D)

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- BK23A Thermal Breaker 5A £2.10 (D)
- HW06G RF Supp Choke 3A 44p (F)

Page 316
- XY33L Smoke Detectr Type 1 DIS

RECORD & TAPE

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- LB75S Drive Wheel BSR £2.20 (D)

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- HR16S Ctrdg Goldring G800 £9.80 (B)
- FQ41U Cdg Tenorel T2001ED £9.62 (A)

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- YX28F Stylus Sony ND128 DIS

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- FG74R Head + Capstan Kit £1.84

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- FQ63T GF Cassette Head £9.82 (A)
- FQ66W Cassette Erase Head £1.98 (C)

RESISTORS

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

READERSHIP SURVEY

Here's your chance to tell us where we've been going wrong all these years or give us a big cuddle! Tell us what you think about this magazine and Maplin and win £50 ... ... Just like that!

Answer the questions below as carefully as possible, then fold up the form as indicated and pop it in a post box. We will pay the postage of course. Ensure that you post it in time to reach us by June 8th 1984. On June 15th, we will hold the prize draw. The sender of the first form picked will receive £50 in cash and the senders of the second and third forms picked will receive £10 each.

The details of the draw and the results of the survey will be published in issue 12 of this magazine.

We are sure that many of you will be worried about confidentiality. Let us assure you that we require your name and address only for the prize draw; the answers to questions 1, 2 and 3 will not be entered on our computer. So we will be able to tell, for example, how many of our male customers aged between 36 and 50 earn between £9000 and £13,000, but there is absolutely no way we will be able to tell who those customers actually are. The Managing Director of Maplin Electronic Supplies Ltd. personally guarantees that all returned forms will be destroyed immediately after the prize draw.

Please use BLOCK CAPITALS throughout.
Appropriate boxes should be marked ☐

General

1. Customer number (if known) ....

2. Name ....

3. Address ....
....

4. Male ☐1 Female ☐2

5. Age Under 16 ☐1 16 - 21 ☐2 22 - 35 ☐3 36 - 50 ☐4 51 - 65 ☐5 Over 65 ☐6

6. Occupation ....

7. Please state any qualifications you have that are relevant to electronics —
....

The Magazine

8. Which areas of electronics are of most interest to you?
Computing ☐1 Music ☐2 Audio ☐3 Radio ☐4 Car ☐5 Home ☐6 Video ☐7
Other ....

9. Would you like to see more or less pages devoted to:

	More	Less	About right
Computer-related projects	☐1	☐2	☐3
All other types of projects	☐1	☐2	☐3
Beginners features like First Base	☐1	☐2	☐3
Computer-related articles	☐1	☐2	☐3
Educational articles	☐1	☐2	☐3
Equipment reviews	☐1	☐2	☐3

10. Name any particular projects that you would like to see in the magazine ....
....

11. Name any particular subjects you would like to know more about ....
....

12. On average, how many projects do you build a year? ....
How many are Maplin projects? ....

13. In your experience, do Maplin projects:-
Work first time ☐1 Work after fault finding ☐2 Never work ☐3

14. How would you rate Maplin projects in comparison with other projects you have built?
Maplin projects are:- Far better ☐1 Better ☐2 About the same ☐3 Worse ☐4 Rubbish ☐5
Don't know ☐6

15. How thoroughly do you read 'Electronics'?
Very thoroughly ☐1 About half the articles ☐2 One or two items ☐3 Just glance through ☐4

16. How do you buy 'Electronics'?
On subscription ☐1 On order with newsagent ☐2 From newsagent if it's on the rack ☐3
Borrow a copy ☐4

17. How many people read your copy other than yourself? ....

18. Do you keep old copies once you've read them? Yes ☐1 No ☐2

19. What other electronics magazines do you read regularly? And whether you read them regularly or not, give each magazine you know, a rating from 1 to 10, if on the same scale 'Electronics' was rated 5.

Practical Electronics ☐ ....
Electronics Today International ☐ ....
Everyday Electronics ☐ ....
Hobby Electronics ☐ ....
Elektor ☐ ....
Practical Wireless ☐ ....
Wireless World ☐ ....
Electronics and Computing ☐ ....
Sinclair Projects ☐ ....
Electronics and Music Maker ☐ ....
Television ☐ ....
Other ....

Financial

20. What is your current annual wage?
Student ☐1 Under £4000 ☐2 £4000 - £6000 ☐3 £6000 - £9000 ☐4 £9000 - £13,000 ☐5
£13,000 - £18000 ☐6 Over £18,000 ☐7

21. Roughly how much did you spend last year on:-
Electronic components, kits etc. £.........
Computer hardware £.........
Computer software £.........

22. Roughly how much did you spend last year with Maplin? £.........

Maplin

23. What items would you like to see added to the Maplin range if any?

24. In what ways do you think Maplin could improve its service to you?

25. What other electronic component companies do you buy from, and if Maplin were rated 5 on a scale from 1 to 10, how would you rate these companies in comparison?

26. How could the Maplin catalogue be improved in your opinion?

27. Where would you like to see the next Maplin shop opened?

28. Please write here any other comments you wish to make.

Thank you for completing this survey. It will help us to improve our service to you and make this magazine more accurately reflect what you would like to see.

★ £70 PRIZE DRAW

Here are the rules for the prize draw.

1. Only forms which have the majority of questions answered sensibly, will be entered.
2. Employees of Maplin Electronic Supplies Ltd., their printers, distributors and agents; and their families will be disqualified.
3. Only forms in our hands by June 8th 1984 will be entered.
4. The draw will be held on June 15th 1984 and winners notified immediately. The results will be published in issue 12 of this magazine.
5. There will be three prizes. The first drawn will win £50, the second will win £10, and the third £10.
6. Payment will be cash and sent by registered post.
7. The decision of the editor is final.

1st Fold

Flap B. Tuck Flap A inside here.

3rd Fold

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2nd Fold

Flap A

1984 Catalogue Page No.		VAT Inclusive Price

Page 328
V HV Res 1M-33M 14p (G)
YY12N Resnet 100R 89p (E)
YY15R Resnet 1k 89p (E)
YY20W Resnet 47k 79p (E)

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WR81C Hor Skeleton 1k 28p (F)
WR82D Hor Skeleton 2k2 28p (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 28p (F)
WR88V Hor Skeleton 220k 28p (F)
WR89W Hor Skeleton 470k 28p (F)
WR90X Hor Skeleton 1M 28p (F)
WR91Y Hor Skeleton 2M2 28p (F)
WR92A Hor Skeleton 4M7 28p (F)
WW00A Vrt Skeleton 100R 31p (F)
WW01B Vrt Skeleton 220R 31p (F)
WW02C Vert Skeleton 470R 31p (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 31p (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)

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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 (E)
FX42V Thermistor VA1066S 68p (F)

SEMICONDUCTORS

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WQ19V AY-5-2376 DIS
QF17T BF258 34p (F)

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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)
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QF57M BZX61C15 17p (G)
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QF60Q BZX61C20 17p (G)
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QF66W BZX61C36 17p (G)
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QF68Y BZX61C43 17p (G)
QF69A BZX61C47 17p (G)
QF70M BZX61C51 17p (G)
QF71N BZX61C56 17p (G)
QF72P BZX61C62 17p (G)
YH58N CA3080E 74p (E)
QH28F CA3130E 89p (D)
QH30H C106D 44p (F)
WQ23A C126D 98p (D)
QQ01B DAC0801LCN £3 20 (C)
YY75S ICL7660CPA £2 89 (C)
YY93B ICM7045IPI £17 95 (A)
YY94C ICM7216DIPI £21 95 (A)
YY74R L200 £1 82 (C)
WQ29G LF347 £1.62 (D)
WQ30H LF351 49p (E)
QY28F LF412CN £1 62 (D)
QY29G LF441CN 98p (E)
QY30H LF442CN £1.54 (D)
YY89A LF13741 62p (E)
YY73Q LM335Z £1.32 (D)
QH40T LM380 99p (E)
QH41U LM381 £1 80 (C)
WQ34M LM384 £1.72 (D)
QY19V LM1035 £5 30 (C)
QY33L LM1037N £2 30 (C)
YY99H LM1830 £1.96 (C)
YY71N LM1871 £2.24 (B)
WQ38R LM2917 £1 99 (C)
WQ41U LM3914 £2.98 (C)
YY96E LM3915 £2 98 (C)
YY97F LM3916 £2.98 (C)

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QH47B MC1496 98p (E)
WQ46A MC6821P £2.20 (D)
WQ48C MC6850P £2.60 (C)
WQ49D MC6852P DIS
QY35Q MF10CN £5 20 (C)
QH54J MJE340 45p (E)
QH60Q MPSA14 21p (F)
YY68Y NE5534A £2 48 (C)
QH92A OC171 DIS

WQ58N PW06 £1.20 (D)
QL05F SC140D £1 42 (D)
QL07H SG3402 £4 98 (C)
QY50E SP0256 £9 95 (A)
YH91Y TEA1058 £3 64 (C)
QH55K TIP2955 75p (E)
QL29G uA78M12UC 64p (E)
QL32K uA7812UC 68p (E)
WQ80B uA78H05KC £7 86 (B)
WQ81C uA78H12KC £7 45 (B)
WQ84F uA78P05SC £9.36 (B)
WQ86T uA79L12AWC 53p (E)

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QL36P uA7915UC 78p (E)
WQ95D uA79HGKC DIS
QY43W XR2211CP £3 64 (C)
QW00A Z80-CPU £3 98 (B)
QL74R 1N4002 5p (H)
QL82D 1N5401 13p (G)
QR10L 2N1893 72p (F)
QR11M 2N2219 37p (F)
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QR28F 2N3704 11p (H)
QY11M 2SC2547E 39p (F)
QW12N 2114 450ns £1 99 (D)
QQ07H 2716 450ns £4 62 (C)
QX00A 4000BE 32p (F)
QX01B 4001BE 32p (F)
QL03D 4001UBE 32p (G)
QX02C 4002BE 32p (G)
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QX04E 4007UBE 32p (G)
QW14Q 4008BE 72p (F)
QX05F 4011BE 32p (G)
QL04E 4011UBE 32p (G)
QX06G 4012BE 32p (G)
QX07H 4013BE 41p (F)
QW15R 4014BE 68p (F)
QW16S 4015BE 68p (F)
QX08J 4016BE 41p (G)
QX09K 4017BE 63p (F)
QX10L 4018BE 65p (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)
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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 85p (F)
QW27E 4040BE 69p (E)
QW28F 4041UBE 89p (F)
QX19V 4042BE 56p (E)
QW29G 4043BE 72p (E)
QW30H 4044BE 83p (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 57p (E)
QW38R 4056BE DIS
QW39N 4066BE 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 98p (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
QW93B 4116 250ns £2 20 (D)
QW81C 4502BE 59p (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)
QQ44X 4528BE 98p (E)
QW89W 4532BE 78p (E)
QW90X 4555BE 47p (E)
QW91Y 4556BE 47p (E)
QX37S 7400 22p (G)
YF00A 74LS00 22p (G)
YF02C 74LS02 22p (G)
QX74R 7403 22p (G)
YF03D 74LS03 22p (G)
QY24B 74S03 22p (F)
QX40T 7404 22p (G)
YF04E 74LS04 43p (G)
YF05F 74LS05 22p (G)
QX75S 7406 32p (F)
QX42V 7408 22p (G)
YF08J 74LS10 22p (F)
YF08K 74LS11 22p (G)
QX46A 7414 45p (F)
YF12N 74LS14 42p (F)
YF13P 74LS15 22p (G)
QX78K 7416 25p (F)
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YF14Q 74LS20 22p (G)
YF15R 74LS21 22p (G)
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YF18U 74LS27 22p (F)
YF20W 74LS30 22p (G)

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YF21X 74LS32 22p (G)
QX82D 7438 33p (F)
QX53H 7440 22p (F)
YF26D 74LS42 35p (F)
QQ52G 74LS47 54p (E)
YF27E 74LS51 22p (G)
YF28F 74LS54 22p (F)
QX58N 7473 29p (F)
YY83E 74ALS74 76p (E)
QX63T 7485 52p (E)
YF35Q 74LS85 48p (E)
YF36P 74LS86 26p (F)
QX65V 7489 £2 82 (C)
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QX68Y 7493 32p (F)
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QX70M 7495 32p (F)
YF41U 74LS95 86p (D)
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YF69A 74LS166 £1 36 (D)
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YF79L 74LS191 65p (E)
QX90X 74193 68p (D)
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YF89W 74LS242 DIS
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QQ56L 74LS244 79p (E)
YF91Y 74LS245 £1 20 (D)
YF92A 74LS251 59p (E)
YF95D 74LS257 48p (E)
YF97F 74LS259 75p (E)
YH00A 74LS273 £1 38 (D)
YH01B 74LS279 38p (F)
YH02C 74LS283 52p (E)
YH03D 74LS290 78p (D)
QY39N 74LS292 £12 98 (A)
YH04E 74LS293 DIS
YH11M 74LS365 38p (F)
YH12N 74LS366 43p (F)
YH13P 74LS367 43p (E)
YH14Q 74LS368 38p (F)
YH15R 74LS373 86p (E)
YH18U 74LS377 £1 24 (D)
YH19V 74LS378 79p (D)
YH22Y 74LS393 79p (D)
WH02C 74LS629 = 74LS124 £1 96 (D)
YH30H 74C917 £9 60 (B)
YH38R 8038 CCPD £4 98 (C)
YH43W 8211 CPA £2 60 (C)

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YY68Y NE5534A £2 48 (C)

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QH28F CA3130E 89p (D)
YY89A LF13741 82p (E)
WQ30H LF351 49p (E)
WQ29G LF347 £1 62 (D)
QY28F LF412CN £1.62 (D)
QY29G LF441CN 98p (E)
QY30H LF442CN £1 54 (D)

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YH58N CA3080E 74p (E)

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QH40T LM380 99p (E)
WQ34M LM384 £1 72 (D)

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QH41U LM381 £1.80 (C)

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QY19V LM1035 £5 30 (C)

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QY33L LM1037N £2 30 (C)

Page 374
QY35Q MF10CN £5 20 (C)

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QY50E SP0256 £9 95 (A)

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QH47B MC1496 98p (E)

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QL07H SG3402 £4 98 (C)

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YY71N LM1871 £2.24 (B)

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YY99H LM1830 £1 96 (C)
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YY96E LM3915 £2.98 (C)
YY97F LM3916 £2 98 (C)

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YH30H 74C917 £9 60 (B)
YY93B ICM7045IPI £17 95 (A)

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YY94C ICM7216DIPI £21 95 (A)

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YH43W 8211 CPA £2.60 (C)

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YY75S ICL7660CPA £2 89 (C)
YY74R L200 £1.82 (C)

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WQ46A MC6821P £2 20 (D)
WQ48C MC6850P £2 60 (C)
WQ49D MC6852P DIS

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QW00A Z80-CPU £3.98 (B)

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WQ19V AY-5-2376 DIS

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QW93B 4116 250ns £2.20 (D)

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QQ07H 2716 450ns £4.62 (C)

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YH38R 8038 CCPD £4.98 (C)

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QY43W XR2211CP £3 64 (C)
QQ01B DAC0801LCN £3.20 (C)

Page 413
WQ38R LM2917 £1.99 (C)

Page 415
WR29G Transkt 3-Lead TO18 22p (G)

Page 416
HQ77J DIL Socket 20-pin 18p (G)
BL20W DIL Socket 24-pin 20p (G)
HQ38R DIL Socket 40-pin 30p (F)

Page 417
FG52G Clip on TO220 31p (F)
FG55K Powerfin plastic 56p (F)

Page 418
FG60Q Heatsink TO220HP 88p (E)
FG64U Coverslide 6W 38p (B)

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FL42V Flat Heatsink £3 98 (C)
FL54J Heatsink 10DN £2.48 (C)
FG65V Coverslide 4 Y 38p (D)

SPEAKERS

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HY12N Ultrasonic Transducr £3.98 (B)

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YK58N Large Dome Bell £17 20 (A)
YB25C Baby Siren DIS
LH98G Hawaii Five-O Siren DIS

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LH84F Stereophone M110B DIS

Page 425
YW54J 15W Cone Tweeter £3.20 (C)

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XG34M Bullet Tweeter £22 60 (A)
YK71N 10in Speaker Grille £2 98 (C)
YK72P 12in Speaker Grille £3 45 (C)
WF48C Hvy Duty Car Spkr £6.98 (B)

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WF23A Elliptcal Spkr CM852 £5 98 (B)
XQ77J Fane 50 4R DIS

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YK54J Wallclamps Duo 220 £16 20 (A)

SWITCHES

Page 430
FH00A Sub-Min Toggle A 73p (E)
FF72P Sub-Min Toggle L £2.24 (C)

Page 431
XX26F DIL Switch SPDT Sgl 98p (E)

Page 433
FF79L Long Chrome Slide 27p (G)
FH91Y Motor-Start Press 45p (F)

Page 434
YW44X Square Psh Lck Yllow 84p (E)
FH92A Press Toe Sw Type 1 £2.98 (D)

Page 435
FF90X Click Cap Green DIS
HY34M Click Key Black 26p (F)

Page 436
FL33L Rd Latchbutton Grey DIS

Page 438
YR88V Solenoid 12V £6.82 (B)
BK48C Ult-Mn Rley 6V DPDT £1.20 (D)

Page 439
YX99H 12V 30A Relay £3.24 (C)
FX24B Open Relay 12V £3.98 (C)

Page 441
FX89W Dil Reed Relay 1p12V £1.98 (D)
FX72P Magnet Large 98p (E)

TEST GEAR

Page 444
XB82D Crotech 3030 £195.95 (A)

Page 445
XB83E Crotech 3131 £324.95 (A)
YB82D LCR Bridge £27 50 (A)

Page 446
FL80Q Pocket Multimeter £8.96 (B)

Page 447
YW68Y Multimeter Type 320 £17.98 (A)
YB87U 100K Multitester £46.20 (A)

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YB85G Supertester 680G £36.20
LH80B Clamp Meter £34.20 (A)

Page 449
YK32K Multimeter DD601 £44.80 (A)

TOOLS

Page 453
BR50E Trim TT5 68p (E)

Page 454
BR79L Intrchgbl Scdrvr Set DIS
FY08J Utility Set £4.98 (C)
YX74R Min Screwdriver 11p (G)
BR52G Small Screwdriver 39p (F)

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FY22Y Box JT Side Cutters £8.98 (B)

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BR91Y Electricians Pliers £5.20 (C)

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BR93B Wire Strippers 3A £2.56 (C)
BR96E Stripmaster £17.50 (A)

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FY48D Needle File Flat Wrd £1.86 (D)
★ FY02C Utility Knife £1.69 (D)

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YW84U Snap-Off Blade Knife £1.12 (E)
FY06F Scalpel Handle £2.32 (D)
FY06G Scalpel Bld Type II 42p (E)
LH79L Reliant Kit £24.80 (A)
BW03D Reliant Drill £7.94 (B)

Page 460
BW02C Titan Drill £12.82 (A)
XB12N Drill Stand £17.95 (A)
BR84F Reliant Collar 78p (E)
BR85V Twist Burr 0.8mm 45p (F)
BR86W Twist Burr 1.4mm 44p (F)
BR85G HS Twist Drill 0.8mm 78p (E)
BR86T HS Twist Drill 1mm 78p (E)
BR87U HS Twist Drill 1.4mm 78p (E)
YY28F Long-Life Drill 1mm £1.22 (D)
LH77J 20-Piece Tool Kit £8.98 (B)
LH78K 40-Piece Tool Kit £17.45 (A)
LH76H Wishbone Sharpener £7.42 (B)

Page 461
FR30H Bit 6/1106 £1.20 (E)
FY86V Bit 1101 £1.22 (E)
FY87X Bit 1103 £1.25 (E)
FR01B Element Type CN £2.64 (C)
FR03D Bit 102 £1.20 (E)

Page 462
FR17T Bit No. 51 £1.20 (E)
FR18U Bit No. 52 £1.20 (E)
FR11M Sponge ST3 12p (G)
WY06F Rechargeable Iron £33.80 (A)
YX72P B50 Sponge 35p (F)
FR23A Solder Sucker £3.76 (C)

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FR26D Desolder Tool £8.45 (B)
BK40T Replacement D rings 74p (E)
FR63T Desldr Washer Type 2 52p (F)

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YB76H Foam Cleanser £2.42 (C)
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FL47B PVC Tape Black £42.00 (F)
FL48C PVC Tape Blue 42p (F)
FL50E PVC Tape Green 42p (F)
FL51F PVC Tape Red 42p (F)
FL52G PVC Tape White 42p (F)

WOUND COMPONENTS

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LB40T 9.5 Coil Former DIS
LB18U Former 450 19p (G)
LB41U Dust Core Type 4 14p (G)
LB42V Dust Core Type 6 14p (G)
LB43W Dust Core Type 8 21p (G)
LB36P Screening Can 10 15p (G)
HX05F Small Pot Core £1.76 (D)

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HX57M GE Coil L8 DIS
HX56L GE Coil L7 DIS

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HW27E Choke 10H £2.10 (D)
HX17T Choke 5mH 88p (E)
YG36P Toko KAC8449 DIS

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LB01B IFT 14 £1.86 (D)
LB06F IFT 18 £2.36 (C)
HX82D Min Tr LT44 58p (E)
LB14Q Min Tr LT700 58p (E)
YX84F Z Changer £6.40 (B)

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WB25C Tr 12V 1A £8 36 (B)
YK02C Tr 32-0-32 2A £13.62 (A)

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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 £8.80
YK14Q Toroidal 50VA 9V £8.80
YK15R Toroidal 50VA 12V £8.80
YK16S Toroidal 50VA 15V £8.80
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 £11.87
YK22Y Toroidal 300VA 35V £14.87
YK23A Toroidal 500VA 35V £19.30
WB12N Tr 20V 1A £12.98 (B)
WB17T Tr 28V 1.1/2A £10.98 (A)

PRICE LIST OF NEW ITEMS IN THIS ISSUE

BK97F	2 X 20 Way P.C. Edgecon	£1.60
GB35Q	Digi-Tel Expansion P.C.B.	£25.96
GB51F	Power Controller P.C.B.	£2.38
GB52G	Fluoresc Tube Driver P.CB	£1.96
GB54J	Auto-Waa P.C.B.	£1.99
GB55K	Oric Mpln Modem I/F PCB	£3.25
GB56L	Dragon Extendi-Port PCB	£3.26
GB57M	Spectrum Easyload PCB	£3.62
GB59P	80 Metre Receiver P.C.B.	£2.75
HX77J	Trans Coil 3T Blue	£2.20
HX78K	Trans Coil 3T Red	£2.20
LK34M	2.8kW Power Control Kit	£18.95
LK35Q	Fluoresc Tube Driver Kit	£7.75
LK36P	Auto-Waa Kit	£9.96
LK37S	Digi-Tel Expansion Kit	£129.95
LK39N	Spectrum Easyload Kit	£9.96
LK40T	Oric Mapln Modem I/F Kit	£12.96
LK41U	80 Metre Receiver Kit	£15.95
QY60Q	2716/M5	£10.50
YK86T	Torold Trnsfrmr 24V/24V	£13.96

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 £10.98NV**
WK06G Hart's Dictionary of BASIC by W.A. Hart. **Price £7.25NV**
WK07H The Spectrum Pocketbook by Trevor Toms. **Price £7.95NV**
WK08J The Spectrum Games Companion by Bob Maunder. **Price £5.95NV**
WK09K Mastering CP/M by Alan Miller. **Price £13.52NV**
WK10L Adventures with Digital Electronics by Tom Duncan. **Price £4.25NV**
WK11M Assembly Language Programming for the BBC Micro by Ian Birnbaum. **Price £9.65NV**
WK12N VIC Innovative Computing by Clifford Ramshaw. **Price £7.10NV**
WK13P Understanding Your Spectrum by Dr Ian Logan. **Price £7.95NV**
WK14Q Practical Design of Digital Circuits by Ian Kampel. **Price £12.20NV**
WK15R Programming the BBC Micro by P. Williams. **Price £7.55NV**
WK16S Programming Languages for Micros by G. Marshall. **Price £7.49NV**
WK17T Programming Microcomputers with Pascal by M. Beer. **Price £7.70NV**
WK18U Over the Spectrum. **Price £6.95NV**
WK19V Introducing Spectrum Machine Code by Ian Sinclair. **Price £8.95NV**
WK20W Programming with Graphics by G. Marshall. **Price £6.75NV**
WK21X Machine Intelligent Programs for the 16K ZX81 by Charlton, Harrison & Jones. **Price £5.25NV**
WK22Y Games ZX Computers Play by Tim Hartnell. **Price £3.25NV**
WM38R The Atari Book of Games by James, Gee & Ewbank. **Price £5.95NV**
WM39N Spectrum Adventures by Bridge & Carnell. **Price £7.39NV**
WM40T Master your ZX Microdrive by Andrew Pennell. **Price £8.20NV**
WM41U Commodore 64 Adventures by Mike Grace. **Price £7.53NV**
WM42V The Commodore 64 Games Book by Owen Bishop. **Price £6.88NV**
WM43W Programming for Education on the BBC Computer by Scotiden & Hall. **Price £7.49NV**
WM44X Putting Your BBC Micro to Work by Chris Callender. **Price £5.30NV**
WM46A Advanced Programming Techniques for the BBC Micro by McGregor & Watt. **Price £10.20NV**
WM47B The Oric 1 Companion by Bob Maunder. **Price £7.66NV**
WM48C 40 Educational Games for the Spectrum by Vince Apps. **Price £6.45NV**
WM49D 21 Games for the Electron by James, Gee & Ewbank. **Price £6.35NV**
WM50E The Aquarius and How to Get Most From It by Ian Sinclair. **Price £6.20NV**
WM51F Software 64 (Commodore) by Owen Bishop. **Price £6.30NV**
WM52G Spectrum Interfacing & Projects by Graham Bishop. **Price £7.63NV**

COMPUTERS

YK76H Floppy Disk Album. **Price £4.95**
YK82D Computer Disk Cleaner Kit. **Price £13.95**
YK83E Computer Cassette Cleaner Kit. **Price £11.20**

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BK79L 0.156 inch 2 x 22 Way P.C. Edgcon. **Price £3.50**
BK84F 18 Way R.A. Minicon Plug. **Price 92p**
BK85G 18 Way Latch Minicon Plug. **Price 84p**
BK86T 18 Way Jumper Cable. **Price £4.82**
BK96E 34 Way IDC Socket & Cable. **Price £4.83**

CAPACITORS

FG75S AM/FM Varitune Capacitor. **Price £1.72**

HARDWARE

BK87U Snap Rivet (Pack of 10). **Price 20p**

PROJECTS & MODULES

GB26D TTL/RS232 Converter P.C.B. **Price £1.62**
GB27E ZX81 1K Extendi-RAM P.C.B. **Price £3.20**
GB32K Latchcard P.C.B. **Price £2.20**
GB33L Spectrum ADC P.C.B. **Price £2.80**
GB34M Spectrum DAC P.C.B. **Price £2.84**
GB36P Logic Pulser P.C.B. **Price £1.32**
GB40T Frequency Mtr Adaptor PCB **Price £1.42**
GB41U VIC 20 Extendiboard P.C.B. **Price £5.75**
GB43W ZX81 Hi-Res Graphics PCB. **Price £11.99**
GB44X Personal Stereo DNL PCB. **Price £1.96**
GB45Y Oric Talkback P.C.B. **Price £3.62**
GB47B Spectrum Keyboard P.C.B. **Price £10.72**
GB48C Spectrum Kbd Conn PCB **Price £1.96**
GB50E TDA 7000 Radio P.C.B. **Price £1.82**
LK16S ZX81 1K Extendi-RAM Kit. **Price £8.49**
LK17T TTL/RS232 Converter Kit. **Price £7.98**
LK19V Logic Pulser Kit. **Price £4.99**
LK20W Frequency Mtr Adaptor Kit. **Price £7.95**
LK22Y VIC 20 Extendiboard Kit. **Price £29.95**
LK23A ZX81 High Res Graphics Kit. **Price £19.95**
LK24B Latchcard Kit. **Price £5.55**
LK25C Spectrum DAC Kit. **Price £15.95**
LK26D Spectrum ADC Kit. **Price £27.95**
LK27E Personal Stereo DNL Kit. **Price £8.40**
LK28F Oric Talkback Kit. **Price £22.95**
LK29G Spectrum Keyboard Kit. **Price £28.50**
LK30H Spectrum Kb Adaptor Kit. **Price £6.50**
LK32K TDA 7000 Radio Kit. **Price £11.70**
LK33L Infra-Red Movement Detector Kit. **Price £34.95**
QY58N 2716/M8. **Price £8.50**
XG35Q Spectrum Case. **Price £4.95**
XG36P Spectrum Ready-built Keyboard (including adaptor & case). **Price £44.95**
YK77J Spectrum Keytop Print. **Price 68p**

SEMICONDUCTORS

QY56L 7581 ADC. **Price £19.95**
QY59P 74LS260. **Price 84p**

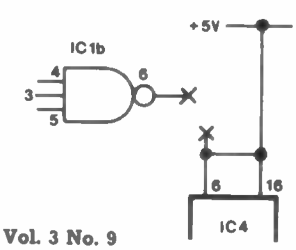
SOUNDERS & SPEAKERS

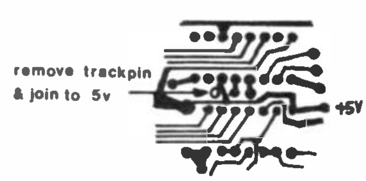
YK84F VDU/Speaker Stand. **Price £15.95**
YK85G 12V DC 6 inch Dome Bell. **Price £9.95**

CORRIGENDA

Vol. 2 No. 8

Page 60. ZX Spectrum RS232/Modem Interface: Although this project functions correctly with issue 2 computers, a small modification must be made for use with the new issue 3 Spectrums. To determine issue 3 computers externally, look into the rear expansion port slot, where an aluminium heatsink bracket can be clearly seen bridging the PCB above 2 IC's. (This heatsink is not visible on earlier issues). A simple modification to the interface PCB requires the removal of a track pin (if previously fitted!) adjacent to IC4 - pin 6 (74LS138) and reconnecting to +5V available on a long track-run from IC2 - pin 14, which lies close to the removed track pin pad, as shown in the diagram. Note that modules fitted with this modification will function equally well on issue 2 Spectrum's.





Vol. 3 No. 9

Page 12. Parts List for Frequency Meter adaptor: the Order Code for C7 should be WW41U.

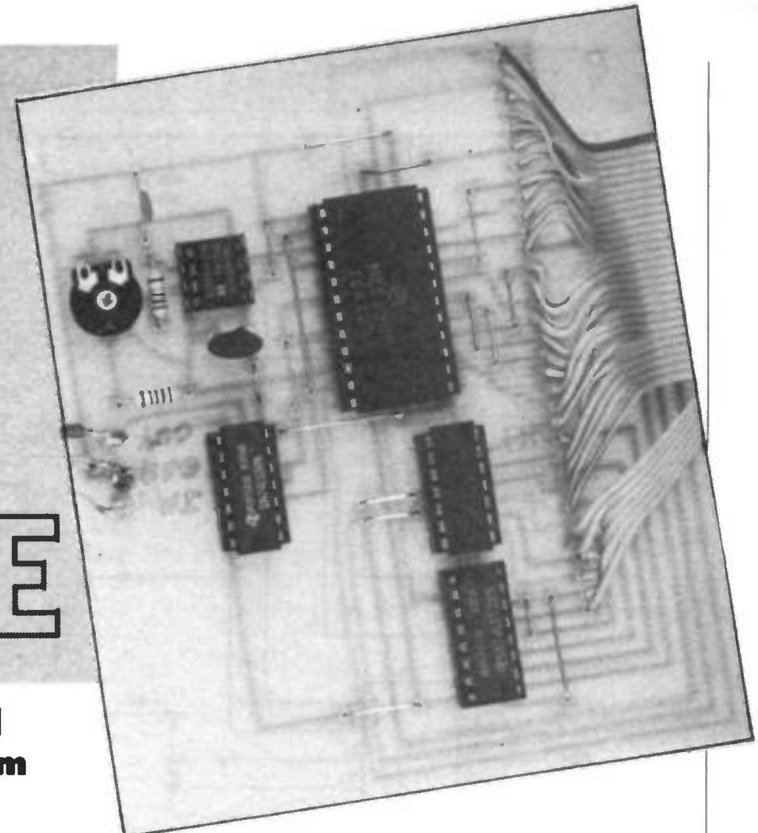
Page 27. Parts List for Oric Talkback: add L1 100μH choke (WH41U).

MAPLIN'S TOP TWENTY BOOKS

1. (–) The Commodore 64 Programmers Reference Guide (WK62S) (cat. P65)
2. (12) International Transistor Equivalents Guide by Adrian Micheals (WG30H) (cat. P36)
3. (9) Power Supply Projects by R. A. Penfold (XW52G) (cat. P41)
4. (2) De Re Atari (WG56L) (cat. P62)
5. (–) Remote Control Projects by Owen Bishop (XW39N) (cat.P45)
6. (6) Cost Effective Projects around the Home by John Watson (XW30H) (cat. P44)
7. (14) Adventures with Micro-Electronics by Tom Duncan (XW63T) (cat. P35)
8. (4) Understanding Telephone Electronics by Geo. Fike and Geo. Friend (WK45Y) (cat. P42)
9. (–) The TTL Data Book (WA14Q) (cat. P37)
10. (8) Master Memory Map (XH57M) (cat. P62)
11. (–) Programming the 6502 by Rodnay Zaks (XW80B) (cat. P56)
12. (11) A Z80 Workshop Manual by E.Parr (WA54J) (cat. P57)
13. (15) How to Use Op-Amps by E.A.Parr (WA29G) (cat. P38)
14. (16) How to Build Your Own Solid State Oscilloscope by F. G. Rayer (XW07H) (cat. P45)
15. (5) IC 555 Projects by E.A.Parr (LY04E) (cat. P42)
16. (–) 52 Projects Using IC 741 by R.& U. Redmer (RH18U) (cat. P42)
17. (–) Z80 IC's Data Sheets (RQ54J) (cat. P38)
18. (–) Build a Personal Earthstation for Worldwide Satellite TV Reception by Robert J. Traister (WA61R) (cat. P48)
19. (–) Radio Control for Beginners by F. G. Rayer (XW66H) (cat. P45)
20. (–) How to Design & Make Your Own PCB's by R. A. Penfold (WK63T) (cat. P40)

These are our top twenty best selling books based on mail order and shop sales during October, November and December 1983. Our own publications and magazines are not included. We stock over 600 different books covering a wide range of electronics and computing, the full selection is shown on pages 33 to 70 of the 1984 catalogue, plus the new books section of this magazine.

ORIC 1 MAPLIN MODEM INTERFACE



★ Build this inexpensive project and use your Oric with the Maplin Modem

by Robert Penfold

For a home–computer in its price range, the Oric 1 has a respectable range of interfaces, but unfortunately it does not have an RS232C or RS423 serial interface, and it cannot be directly linked to the very popular Maplin Modem project. However, the Oric 1 does have an expansion port which provides the full control, data, and address buses, and a relatively simple circuit is all that is needed to interface this to the Maplin Modem.

It is an interface of this type which forms the subject of this article, and the unit is a sort of "stripped down" RS232C interface. The Maplin Modem does not use any of the RS232C handshake lines (clear to send, data terminal ready, etc.), and so none of these are implemented in this interface. Also, the RS232C system uses signal levels of −12 and +12 volts rather than the more usual 0 and 5 volts. The Oric 1 provides only one voltage of +5 volts, and the maximum current available is only about 100 milliamps. In order to provide full RS232C output levels it would therefore be necessary to have a separate mains power supply unit for the interface. Fortunately the Maplin Modem has both standard RS232C and TTL inputs/outputs. Thus there is no difficulty in driving it from this interface which is powered from the Oric 1, and which sends/receives standard TTL logic levels. This simplifies the circuit and avoids the need for a separate power supply, but it should be realised by users of the interface that it is unlikely to operate properly if used with RS232C equipment unless suitable level shifting circuitry is added (such as the Maplin TTL/RS232C Converter project).

The Circuit

Figure 1 shows the full circuit diagram of the Oric 1 Modem Interface. The Oric 1 48K machine has a vacant area of memory between £BF00 and £BFFF, but it is not unused in the normal sense. The Oric 1 48K machine uses 64K RAM chips, and the full 64K address range of its 6502 microprocessor is therefore occupied. The ROM containing the operating system and the BASIC interpreter is used to program part of the RAM, and the remaining 48K (approximately) is available for program storage. The address range from £BF00 to £BFFF is unused in the sense that it is not in the section of the RAM normally used for program storage, and it is not used by the BASIC interpreter or operating system either. There is RAM at this address range though, and it can only be used for input/output devices if the RAM is disabled. This address range is totally unused in the 16K Oric 1 incidentally.

The address decoding is provided by IC1 and IC2. As only a single input/output device is used in the interface, only partial address decoding is required. IC1 is a 3 to 8 line decoder which is used to decode A12 to A15. A12 is connected to the positive chip enable input of IC1, while the other 3 lines are fed to the normal inputs of IC1. IC2 is an eight input NAND gate, and this is used to decode address lines A4 to A11. The output at pin 8 goes low when all the inputs are high. Pin 8 of IC1 is used to drive one of the negative chip enable inputs of IC1. Output 5 of IC1 (pin 10) goes low when A14 is low, but the other 11 decoded address lines are high, and this corresponds to the required address

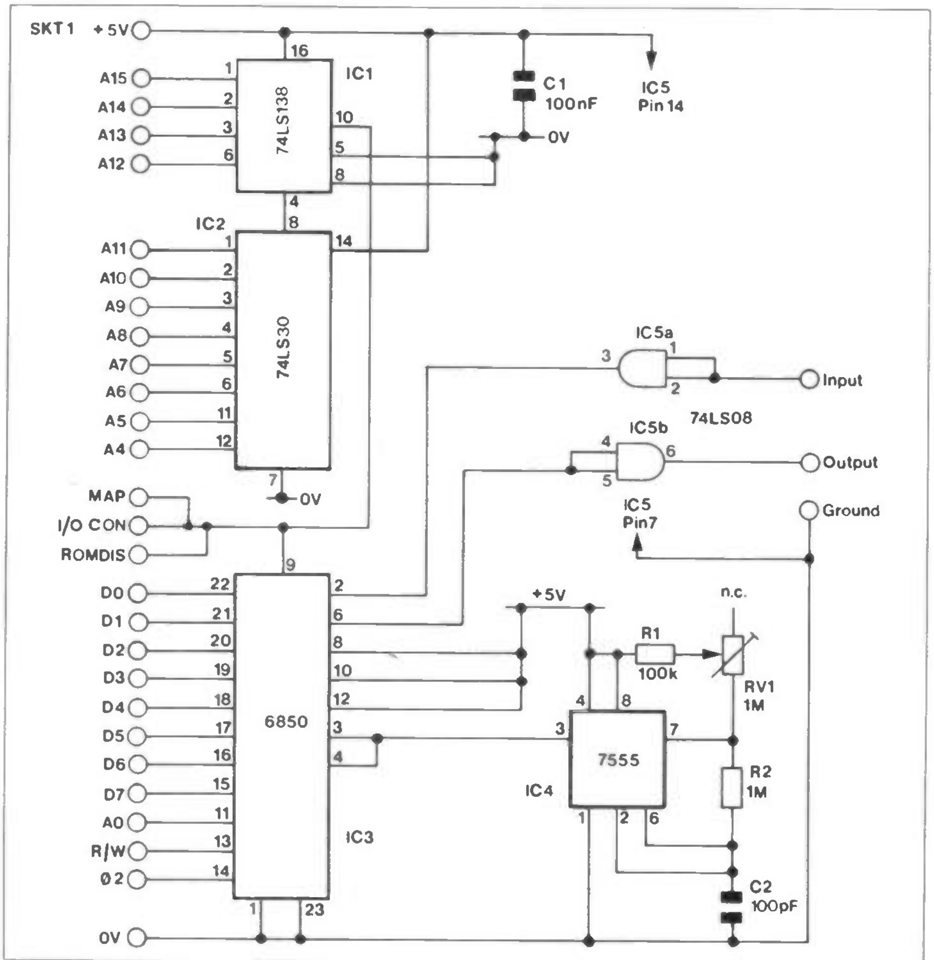


Figure 1. Circuit diagram

range of £BF00 to £BFFF.

The negative output pulse from IC1, when any address in the specified range is accessed, is used to operate the 'MAP', 'ROMDIS', and 'I/O Control' inputs of the Oric 1. The result of this is that internal circuits of the machine, which might otherwise place an output onto the data bus at the same time as the modem interface, are disabled when the interface is being addressed. In particular, the RAM at the relevant address range is effectively eliminated, and the interface is free to place data onto the data bus.

A 6850 ACIA (asynchronous communications interface adaptor) is used to convert the parallel output from the data bus into the correct serial format for the Maplin Modem and CASHTEL. It also converts the serial output of the modem into parallel data which is fed back onto the Oric's data bus. The negative chip select input at pin 9 of the 6850 (IC3) is driven from the output of the address decoder. The data carrier detect input of IC3 is not needed in this application, and is therefore tied to the negative supply rail to permit normal operation of IC3. The 6850 has clear to send and request to send handshake lines at pins 24 and 5 respectively, but as explained earlier, these are not needed for use with the Maplin modem. Accordingly, these pins are left unconnected. The serial data input and output terminals are connected to the input and output of the interface via AND gates of IC5, and these are used to give compatibility with standard TTL input/output levels.

Clock Oscillator

The 6850 has separate transmitter and receiver clock inputs, but in this case the transmission and reception rates are the same at 300 baud, and these two inputs are driven in parallel. The 6850 does not have a built-in divide by n circuit to enable the system clock to be used as the transmit/receive clock. Special baud rate generator chips are available, and these are basically a crystal oscillator and divider circuit. A simple and inexpensive

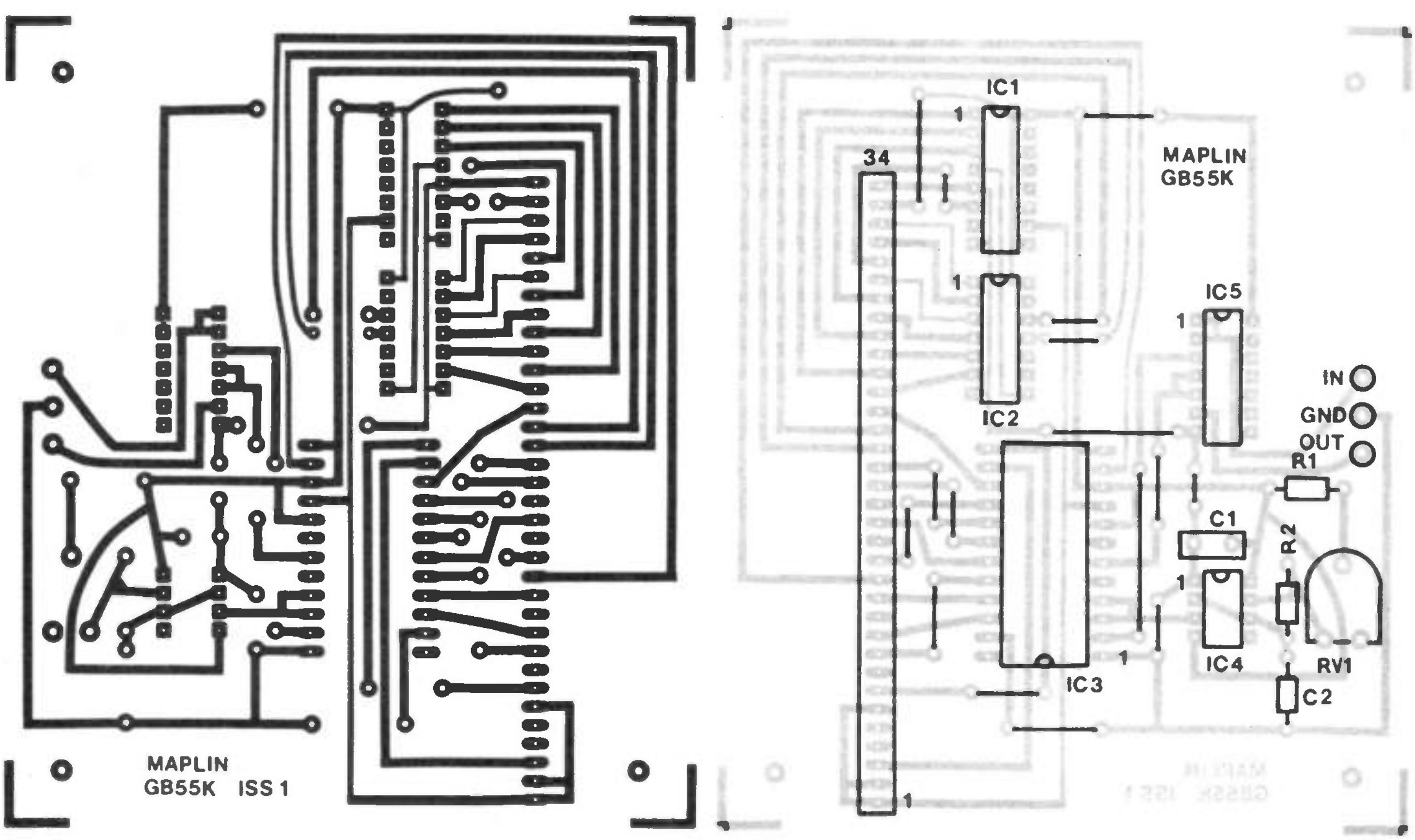


Figure 2. PCB layout and overlay

alternative for an application such as this where only a single, fairly low baud rate is needed, is to use an ordinary C-R oscillator. In this case a straight-forward 7555 astable circuit is utilised, and RV1 is adjusted to give the correct operating frequency. Under software control the 6850 can have a clock frequency at 1, 16, or 64 times the baud rate. In practice it is best to have the clock frequency at 16 or 64 times the baud rate as the clock is then automatically synchronised with incoming data. In this circuit the clock oscillator operates at 4.8kHz and the 6850 is set to the divide by 16 mode to give 300 baud operation.

Although the 6850 has four registers, it has only one register select input (pin 11). This is driven from address line A0, and the port therefore occupies addresses £BF00 (49136 decimal) and £BF01 (49137 decimal). In fact accessing any address from £BF00 to £BFFF will operate one or other of these registers, but the base addresses given are the obvious ones to use. Only two addresses are needed for the four registers as two are read only registers, and the other two are write only types. The table below shows the four registers available and how they are accessed:-

ADDRESS	READ	WRITE
49136	Status Register	Control Register
49137	Receive Register	Transmit Register

Of course, the 6850 is fed from the read/write line of the computer so that the appropriate register at each address is connected through to the data bus. The 6850 needs a timing signal at its 'Enable' input, and this is provided by the Oric's clock signal. Although the Oric 1 uses a high speed version of the 6502 microprocessor, the system clock operates at 1MHz, and a standard 6850 is perfectly adequate for use with this machine.

Construction

Details of the printed circuit board are provided in Figure 2. Start by fitting the resistors, capacitors, and the link wires. The latter are made from about 24 swg tinned copper wire, or pieces of wire trimmed from resistor and capacitor leadouts will do if no suitable wire is to hand. Provided these wires are kept quite taut it is not necessary to add insulation to any of them.

Next the integrated circuits are fitted to the board. Although IC4 is a CMOS device it does not require any special anti–static handling precautions. IC3 is a MOS device, and is a relatively expensive component. It is therefore worthwhile using a (24 pin DIL) IC socket for this device, even if the others are connected directly to the board. Also, do not fit IC3 into its socket until the unit is in other respects complete, and leave it in the anti-static packaging until that time. Note that IC3 has the opposite orientation to the other four integrated circuits.

The board is connected to the Oric's expansion port via a length of 34-way ribbon cable and a 34-way IDC socket. It is advisable to obtain the socket and cable ready connected (they are supplied thus in the kit). The IDC socket fits the expansion port of the Oric 1 and the free end of the cable connects to the board. Be careful to connect the cable to the board the right way round (consult the expansion port connection diagram on page 151 of the Oric 1 manual). Before connecting the cable, strip a small amount of insulation from the end of each lead and tin it with solder. It should then be quite easy to connect the leads to the board, one by one, being careful not to get any leads crossed over. An alternative to direct connection is to use two 17-way Minicon connectors.

In Use

Connect the interface to the Oric's expansion port before switching on the Oric. Once switched on the computer should function normally — switch off at once and recheck the interface if it does not.

The accompanying program (figure 3) enables the interface to be used with the Maplin modem and CASHTEL. When initially testing the unit try running this program with the input & output of the interface connected together. Characters typed on the keyboard should appear on the screen, but this should not happen if the link from the output to the input of the interface is cut.

```
10 POKE 49136,3
20 POKE 49136,21
30 CLS
40 IF (PEEK(49136)AND1)=1
   THEN PRINT CHR$(PEEK(49137));
50 IN$ = KEY$
60 IF IN$<>""THEN POKE 49137,ASC(IN$)
70 GOTO 40
```

Figure 3. Program listing

The 6850 does not have a reset input, but is instead reset under software control by writing a value of 3 to the control register (i.e. POKE 49136,3). The control register is also used to select the required word format, after a master reset has been performed. There are eight word formats available, as detailed in the table provided below.

VALUE	WORD FORMAT POKED
1	7 bits, 2 stop bits, even parity
5	7 bits, 2 stop bits, odd parity
9	7 bits, 1 stop bit, even parity
13	7 bits, 1 stop bit, odd parity
17	8 bits, 2 stop bits
21	8 bits, 1 stop bit
25	8 bits, 1 stop bit, even parity
29	8 bits, 1 stop bit, odd parity

Deducting one from these values sets the 6850 to the divide by 64 mode, and reduces the baud rate to 75. The CASHTEL system requires 8 data bits and one stop bit, and 21 is the value to be POKEd to the control register. However, when accessing other systems it might be necessary to use a different word format and the corresponding control number.

The ASCII codes of characters to be transmitted are written on the transmit register at address 49137. Bit 1 of the status register can be read to determine if the transmit register is empty, and ready to receive the next character, but this is normally unnecessary if the keyboard is the source of the transmitted characters, due to the relatively slow rate at which characters will be supplied to the interface. The receive data register full flag is at bit 0 of the status register, and it is normally necessary to check this and only read the receive register when a new character has been received. Otherwise multiple readings of each character will occur. The receive register full flag is automatically reset when the receive register is read.

Those who require full information on the 6850 should consult the relevant data sheet (which is available from Maplin price 40p).

Initially RV1 should be set at about half resistance, but it will probably be necessary to trim this component slightly before precisely the right baud rate is obtained and the interface operates properly with the CASHTEL system, etc.

ORIC MAPLIN MODEM INTERFACE PARTS LIST

RESISTORS:- All 0.4W 1% Metal Film

R1	100k		(M100K)
R2	1M		(M1M)
RV1	Hor S-Min Preset 1M		(WR64U)

CAPACITORS

C1	100nF Disc Ceramic		(BX03D)
C2	100pF Ceramic		(WX56L)

SEMICONDUCTORS

IC1	74LS138		(YF53H)
IC2	74LS30		(YF20W)
IC3	MC6850P		(WQ48C)
IC4	ICM7555		(YH63T)
IC5	74LS08		(YF06G)

MISCELLANEOUS

SK1	34-way IDC Socket & Cable		(BK96E)
	Veropins 2145	1 pkt	(FL24B)
	Printed Circuit Board		(GB55K)
	24-way DIL Socket		(BL20W)

A kit of all the above parts is available.
Order As LK40T (Oric Modem I/F Kit) Price £12.95

HERO GOES TO SCHOOL

There was a hushed air of expectation in the school as David Snoad, Maplin's National Sales Manager called for Hero the Robot to bring himself onto the stage. David had just finished explaining to the 400 pupils at Earls Hall Junior School in Southend, how famous Hero is as a result of his personal appearances on BBC TV's "60 Minutes" and "Pebble Mill At One" programmes and on chat shows on Central, Anglia and Tyne Tees television.

"We want Hero!" the children shouted when the robot did not appear and a voice from off-stage said, "Please be quiet, I'm trying to sleep. And anyway, I'm feeling shy."

David became exasperated, "If you don't come out, I'll pull your plug out!"

The children strained forward; the naughty schoolboy image those few words had conjured, had already endeared Hero to them. And when Hero at last propelled himself onto the stage, his diminutive appearance — less than 1 metre high — further reinforced their identification with him.

Hero made a wide tour around the stage until David said, "Come here!" and the robot at once turned, went up to David and stopped. The children were totally convinced that Hero was moving and speaking entirely from decisions made within his own 'brain'. After all there were no wires attached to him and there was no visible aerial for remote control.

It may come as quite a surprise to you to learn that the children were absolutely correct. From the moment Hero came onto the stage, everything he did was as a result of instructions pre-programmed into his microprocessor 'brain' and silicon chip memory. There was no remote control by radio, infra-red or anything else. Throughout the entire 2 hour demonstration Hero did it all, all by himself!

However, Hero did have his own microphone which David placed beside him. The robot then demonstrated the movements he can make, describing each one: "I can move my arm"; "I can turn my head" and so on.

David invited six children onto the stage to make up a panel to ask the robot questions. The children sat on chairs, three on each side and the first question was, "What can you say?"

"Everything that has ever been said, or ever will be said," replied the robot. Hero demonstrated his ability to speak other languages as well then, by saying some French and Spanish phrases.

Spelling Tests

The next questioner asked, "How do you spell coat?"

"K O T E," said Hero.

"That's not right!" said David.

"You asked me how *I* spell coat, not how the dictionary spells it," said Hero. Not a very original joke, but the children enjoyed it. "Anyway, robots don't need coats." And David then explained to the children how vital robots are for working in areas where it would be dangerous or impossible for humans to work due to excessive heat for example.

"Hero will now show you how he can spell his name," said David, and placed in front of the robot, but in the wrong order, the four letters of his name on large pieces of card. Without further intervention, Hero moved the letters around. At one point it looked as though he was going to spell it incorrectly, but when he moved the last letter it was right and the children applauded loudly.

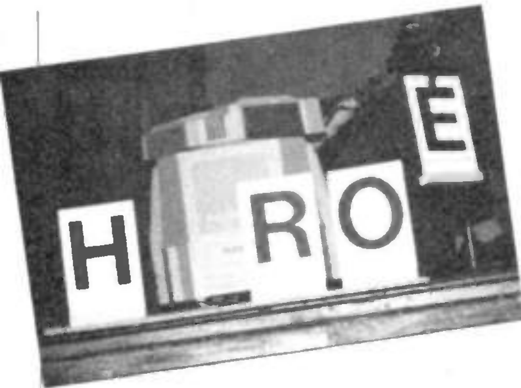
The children on stage began to get fidgety and David asked Hero to tell him if any child moved when his back was turned. When David spoke to one of the two groups on the stage, a boy on the other side slowly raised his leg.

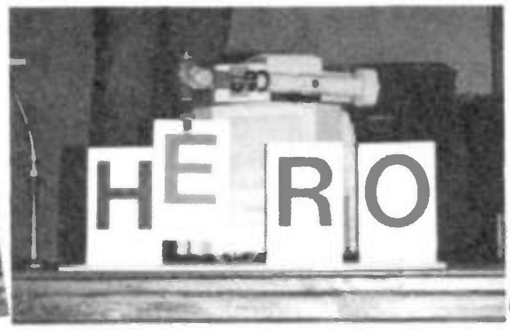
"Something moved!" said Hero to the delight of the audience. This pantomime sequence had all the children rocking with laughter.

When Hero demonstrated his ability to sing, his rendition of Jingle Bells, with which the whole school joined in, earned him a school choir badge which he is still very proud of.

Finally, Hero was asked what he would like for Christmas. "A cuddly toy," he replied.

"You're just an old softy at heart," said David.





And Hero replied, "Robots need love and cuddles too, just like humans."

"What's the time?" asked one of the children. Hero gave the correct time from his internal real-time clock which runs continuously.

The realisation that the presentation had lasted nearly two hours and that it was nearly time for lunch, led to the robot going into his grand finale, a rendition of Old MacDonald Had A Robot — "..with a ready here and a ready there. Here a ready, there a ready, everywhere a ready, ready..."

Letters to Hero

The children clapped loud and long. They had thoroughly enjoyed themselves and learned a lot as well. As they were leaving the hall, one little girl asked David in a very serious tone if Hero had a girlfriend. "He didn't have a girlfriend before today," said David, "but he's made friends with lots of nice little girls this morning."

In the afternoon, the children watched a film about industrial robots which had been kindly loaned to us by the Ford Motor Company. Afterwards, each class, unbeknown to David, wrote him a letter and here are some of the best ones.

Nicola Squibb wrote, "I enjoyed every moment of the show; it was fantastic the way Hero was controlled. I thought the way his arm worked was very unusual. I liked his singing a lot and I thought he was a very clever robot, but the next time he spells coat, he should look it up in a dictionary first."

Mario Lawton of Class 1E wrote, "I liked it when Hero refused to come on and when he spelt his name. His singing is very nice, but mine is better. I hope he likes his choir badge. I hoped that we could touch him. Love Mario."

Rebecca Hindle of Class 2K wrote, "I liked Hero very much because he made me laugh. I liked Hero when he put the letters in the right place. He's very clever. I also liked it when the boy told a joke and he laughed, but Hero wouldn't stop laughing. I think Hero is cute."

The mysterious Andrew W. wrote, "I like the things that Hero can do. I would like to have a robot like Hero. I hope he is being a good boy."

Graham Newell of Class 3J wrote, "Hero was a bit rude at first, but he was just joking. My favourite bit was when he was joking and telling fibs to you when he was asked a question."

But our favourite letter of all came from Sarah Staplton of Class 2B who wrote, "We enjoyed Hero being here and we enjoyed his singing. I think he's very clever to do all he did for us. Do you keep him at home or is he just your friend?"

Continued on page 46.

SPECTRUM EASYLOAD

★ **Connects between Micro and Recorder.**
★ **Battery Powered — No Bus Connections.**
★ **Save and Load Indication.**
★ **Mic Output for Second Recorder.**
★ **Charging From Spectrum P.S.U.**

by Dave Goodman

Much has been written about cassette loading and saving problems associated with Sinclair Micro's, which tend to show that difficulties of one sort or another are being experienced. Many low cost recorders suffer from poor high frequency response which can sometimes be improved by careful re-alignment of the record/playback head. Systems with record level AGC can fluctuate if the signal level is too high producing large low-frequency transients and attenuated harmonics, none of which leads to reliable operation!

The rule, therefore is always to use good quality recorders and data cassettes whenever possible if problems are to be minimised, but even so one particular nuisance still exists. When making a cassette recording, input signals can be 'monitored' from the ear socket. On most recorders, either a small percentage of signal is taken from the mic input directly or via signal processing circuitry, allowing the user to listen in with an ear-piece when recording and is fine for normal use. However, the Spectrum 'ear' and 'mic' ports are effectively coupled together, through internal circuitry, and with both sockets connected to a recorder, a closed loop is generated. The result of this is signal feedback similar to the howl heard when microphones are placed too close to amplifier loud speakers, and data is corrupted or lost altogether. One recommended method to prevent this from happening is to remove the ear lead when saving, or mic lead when loading programs and trust that the appropriate connections are made each time this is done. After a while wear and tear takes its toll; plug leads can pull out and sockets become loose, returning the original reliability problem. An improvement would be to place a changeover switch between recorder and micro which selects either ear or mic leads separately.

Simple Save, Easy Load

Figure 3, block diagram, shows the basic switching method employed in the module with both mic and ear signal paths disconnected via SWA and SWB. When a signal is output from the Spectrum mic socket, SWB operates (Figure 3B) completing a path to the recorder mic socket and preventing SWA from operating. The ear connection is thus isolated between recorder and micro. Similarly signals present at the recorder ear socket (Figure 3C) are detected and SWA operates completing a path to the Spectrum ear socket and preventing SWB from operating. Save or Load monitors detect signal directions and operate switches appropriate to the required route automatically.

Circuit Description

Data output from the Spectrum is high-pass filtered by C1, R1 and R3 to reduce the amplitude of low frequency signals. IC1B imposes AGC on the signal keeping the level constant for good recording quality. At the start of a Spectrum save routine, a short header tone is sent allowing the recorder AGC to stabilise. This tone is of higher frequency than the serial data train and being high impedance, from source, can suffer

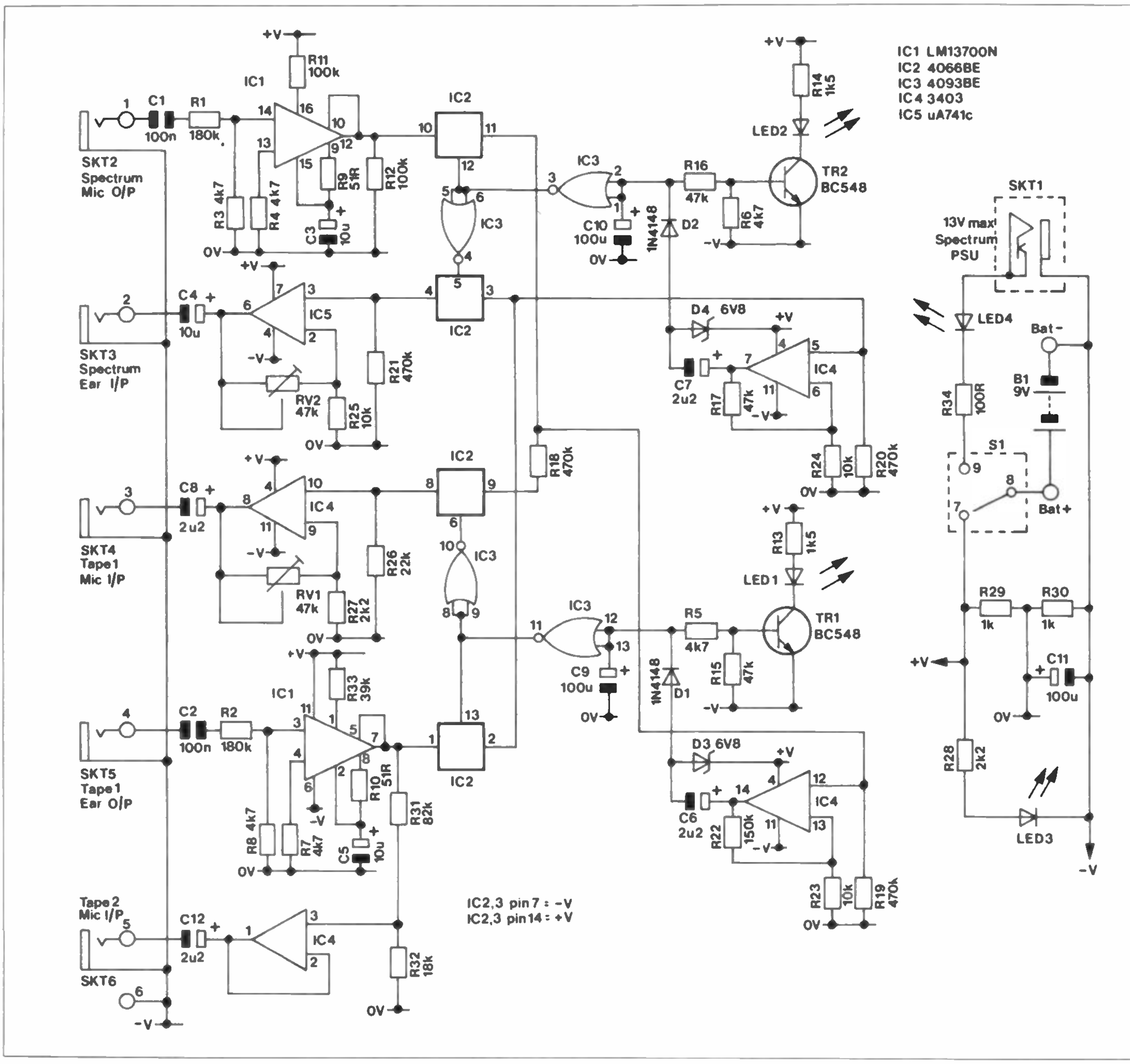
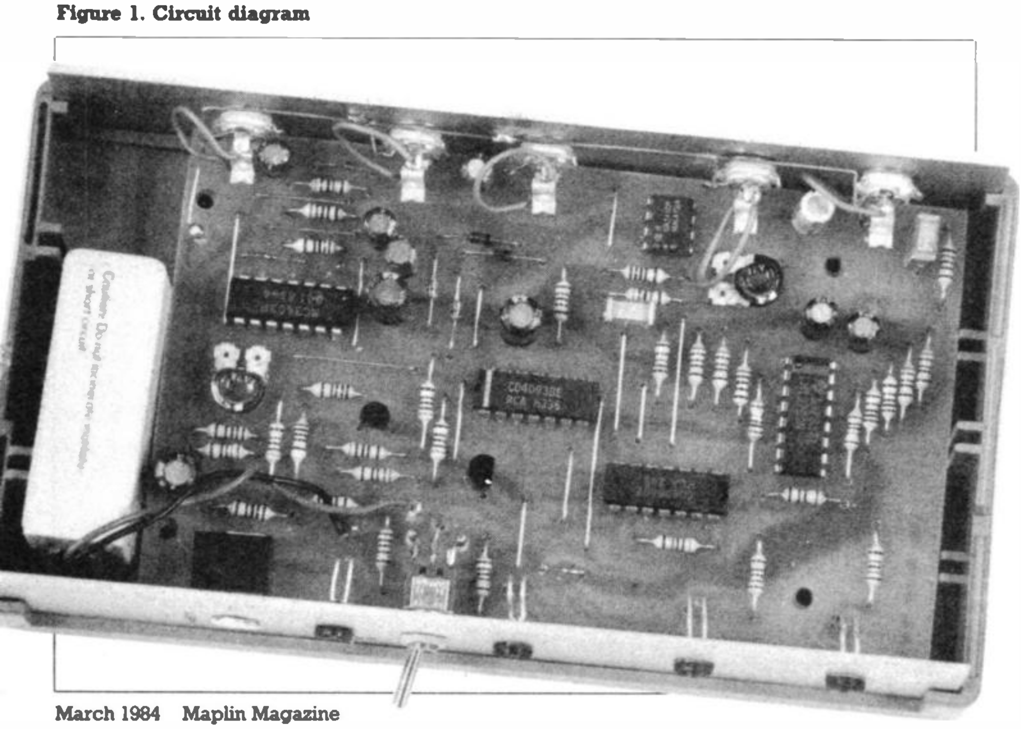


Figure 1. Circuit diagram



attenuation, causing incorrect AGC settings. IC1B therefore maintains a constant amplitude on all composite data signals. IC2D is normally closed (Bilateral switch) and IC4 amplifies the incoming signal for charging C9. TR1 conducts, operating LED1 (indicating that 'save' mode is selected) and IC3D output goes low. IC3C operates switch IC2C and the processed signal is further amplified by IC4C to pass at a low impedance to the recorder mic (input) socket. To prevent the monitor signal from activating IC2B, IC2A is held open while IC2C is closed and the return path is thus disconnected. Providing that the recorder is set to record, data signals are stored on tape until the save routine has completed and no further signals are present; whereby LED1 is extinguished, switch IC2C is opened and IC2A is closed.

When loading from tape, IC1A AGC amplifier determines a suitable signal level for driving the Spectrum ear input. A minimum input level of 0.4V is required from the recorder, which corresponds to

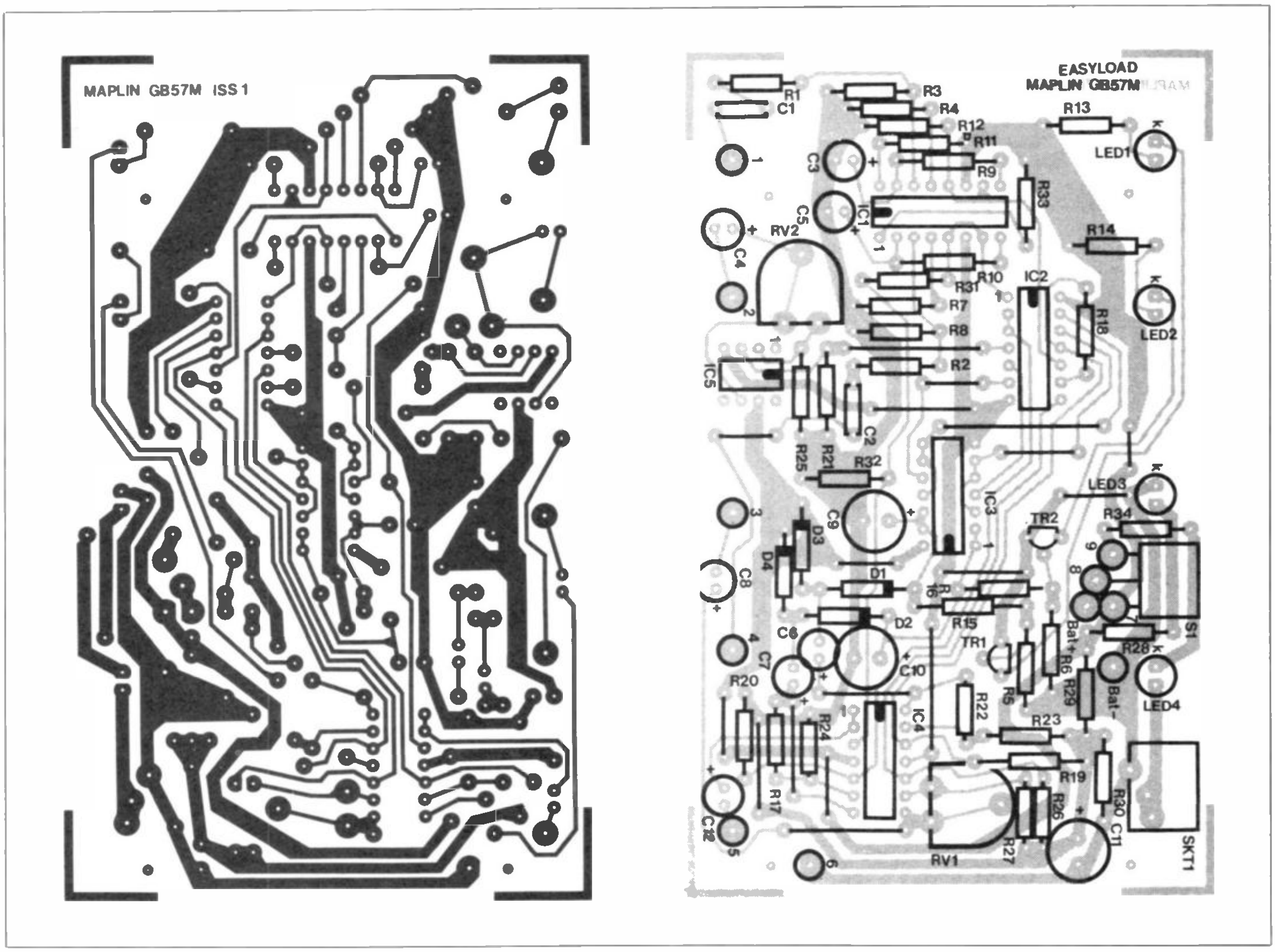


Figure 2. PCB Layout and overlay

a low volume setting, although higher levels up to 3V will make little difference. IC4B amplifies the signal and produces a voltage across C10, TR2 conducts operating LED2 (LOAD mode selected) and IC3A output goes low. IC3B closes switch IC2B whereby the data signal is further amplified to approx. 4V by IC5. RV2 can be used for trimming the amplitude to suit individual Spectrum input requirements. IC2D is held open, while IC2B is closed, thus breaking the loop as before. With loading completed, LED2 extinguishes, IC2B opens and switch IC2D closes. In both save and load modes, capacitors C9 and C10 discharge slowly with the absence of data signals ensuring a small delay before releasing the bilateral switches. Occasionally short gaps appear between data streams, which would cause IC4B or IC4D to break the signal path, resulting in lost data, so a delay is necessary for preventing this action.

P.S.U.

Power is supplied to the module from a PP3 battery which delivers 9V at 10mA. S1 in the 'ON' position connects 9V to LED3 and potential divider R29, R30. Three voltage rails of +4.5V, −4.5V and 0V are generated for supplying the IC's, but only in the 'ON' mode. If a rechargeable type nicad (HW31J) is used, then periodic recharging is available using the Spectrum power supply connected to

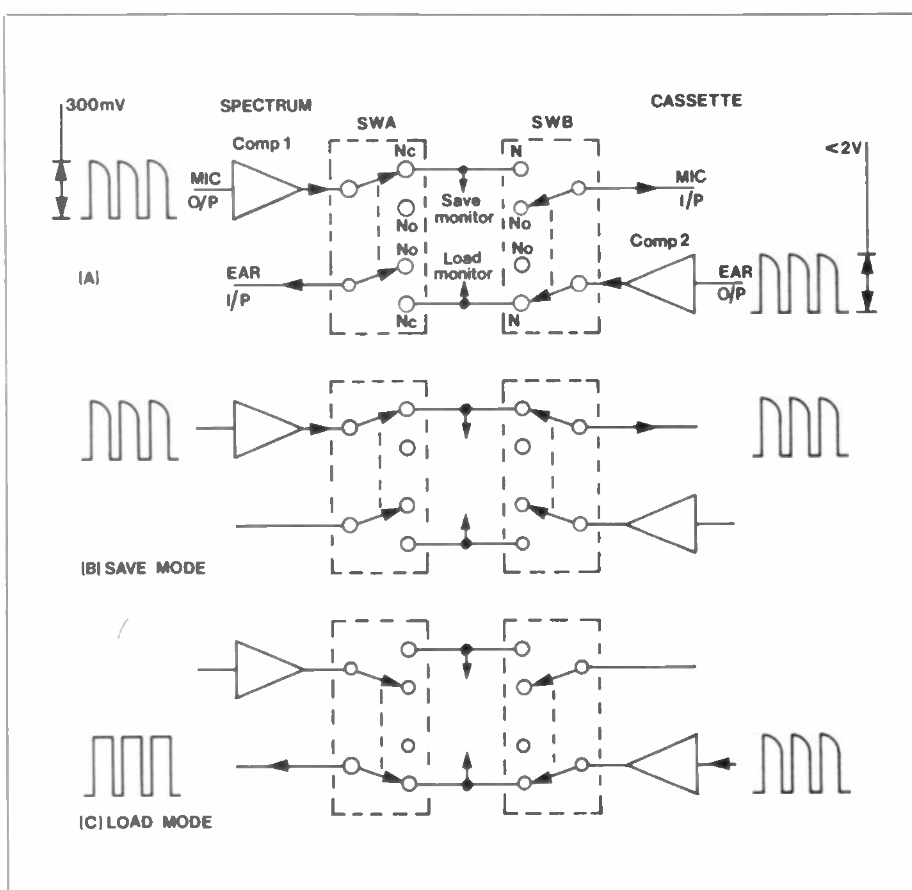


Figure 3. Switching modes

SKT1. LED4, R34 and S1 in the 'charge' position set a 10mA charge rate for the battery and *only* Spectrum power packs should be used for this purpose.

Construction

Use 24 gauge BTC to fabricate 17 links required for insertion into the PCB (see Figure 4). Place each link over a line printed on the legend and push flat down into the PCB. Carefully bend and insert diodes D1 and D2 then Zener diodes D3 and D4. In all cases, position the bar-end printed around one end of the component body, to line up with the bar on the legend, as these components must be fitted correctly. Resistors R1 to R34 can next be bent to shape and fitted into the PCB. Solder all components to the track pads and cut off excess wire ends. Fit IC's 1 to 5, RV1, RV2, and TR1, TR2 (referring to Figure 4). When inserting capacitors C1 and 2 (Polycarb's) treat each connection lead carefully as they are easily broken. If breakage does occur, it is possible to re-solder these leads to the body edge, but is not advisable. Mount PC electrolytics C3 to 12; the longest lead is +V and the shortest lead (minus sign on body) is −V. Note that these components stand vertical with the base flat onto the PCB. Again, solder the remaining components in place, remove excess wires and fit 9 Veropins, pin 1 to 9, from the track side. Press them home with the soldering iron and solder in place. Insert SKT1 and press down onto the board. Solder in position. Finally wire the battery clip with +ve (red lead) to 'BAT+' and −ve (black lead) to 'BAT−'. Terminal pins are not required for these connections so solder direct into the PCB.

Clean the tracks and joints with solvent or thinners and a brush to facilitate inspection. Ensure all joints are sound with no shorts apparent between pads etc, then recheck assembly and components.

Case & Final Assembly

If mounting the project into a box (Verobox LL08J) then Figure 5 shows recommended drilling and mounting arrangements. LEDS 1 to 4 are mounted directly onto the PCB and bent at right angles so they may protrude through the metal side plate. When using holders, push them into each hole from the outside before inserting the LED. Switch S1 also mounts onto this panel and the three terminals are wired directly to each pin immediately behind on the PCB. 3.5mm sockets SKT2 to 6 are mounted on the opposite panel. Snip off the bottom contact (Figure 4) before fitting and wire to each pin as shown. The −ve return connection is commoned to each socket and terminated on pin 6. Pins 1 to 5 are wired to the centre terminals on each socket only. Place S1 in the 'Charge' position which is left when viewed from the front and connect the battery. Just enough room between PCB and box has been allowed to accomodate the PP3 battery or a rechargeable version.

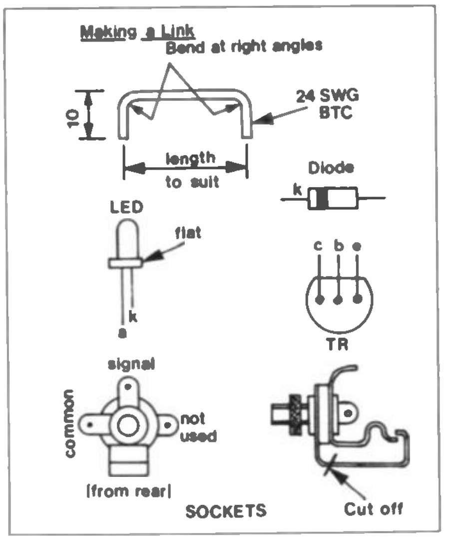


Figure 4. Pinouts

Testing

A multimeter is required for voltage/current checks. The first check requires the meter being connected between battery +V terminal and +ve clip terminal. Set the meter to current range and switch S1 to the ON (right) position. LED 3 illuminates and the supply current should be 10 to 12mA. Now insert a Spectrum PSU into SKT 1 and turn switch S1 from 'ON' to 'Charge'. LED 3 goes out and LED 4 illuminates with a charge current reading between 7 and 10mA. Remove the PSU plug and LED 4 extinguishes with zero current reading. Switch to 'ON' position again, remove meter and reconnect the battery clip.

Set the meter to Volts range and connect the −ve lead to battery −ve. Switch to ON and check quiescent state of Bilateral switches IC2 as follows:– IC2 pin 5 and pin 6 = 0V (low), IC2 pin 12 and pin 13 = 9V (high).

Next check the op-amp supply rails are correct by removing the meter negative lead and reconnecting to 0V. The most convenient place to find the 0V connection is on the link between resistors R17 and R20. Place the meter positive lead on IC5 pin 7 and check for +4.5V. Also check for −4.5V on IC5 pin 4. Note that the exact readings are dependant on the battery voltage and could be between 4.3 and 4.8V.

These general checks give a good indication that all is well so far. If any, or all readings do not correspond to the values given, assume a fault exists and go no further until the problem is cleared. IC's and PC electrolytic capacitors are often inserted wrongly and are worth re-checking. Set both RV1 and RV2 with

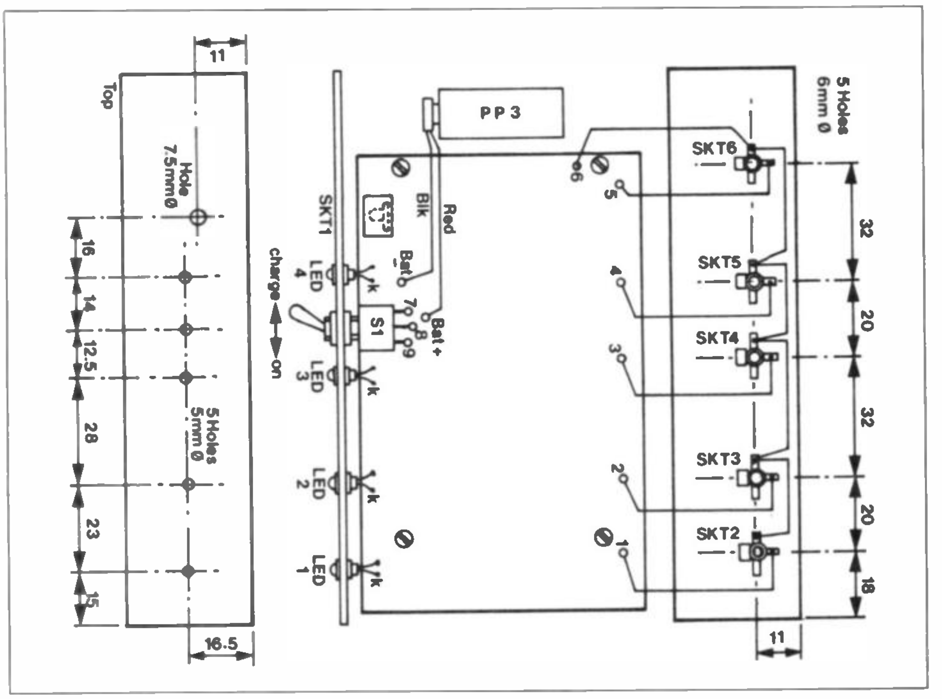
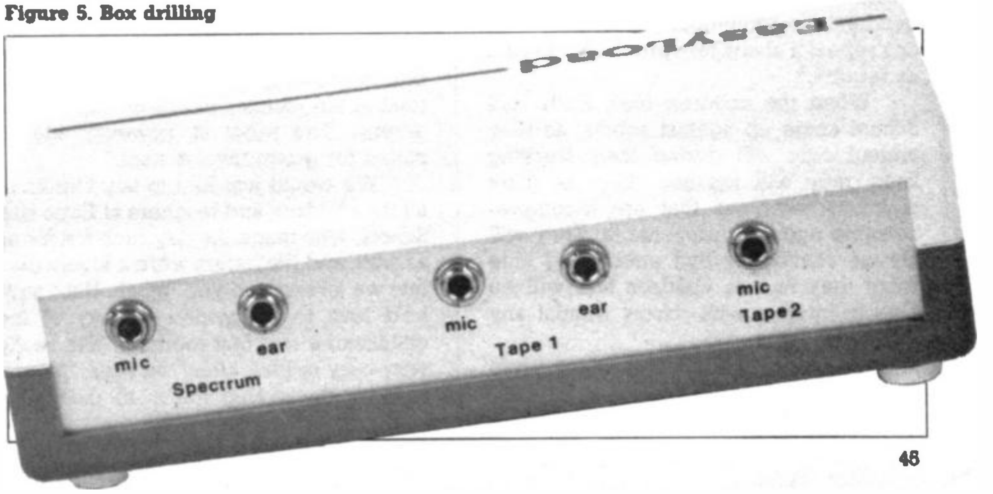


Figure 5. Box drilling



their wipers to halfway position. Connect the cassette recorder ear socket to SKT5, Tape 1 Ear O/P, and switch on the module. Play back a pre-recorded program and adjust the volume control to about ⅓rd travel. LED2 will illuminate until either data disappears or the recorder is turned off. Repeat the test with recorder ear connected to module SKT2, Spectrum mic, and check LED1 only illuminates.

In case of confusion the Spectrum connections are EAR = SKT3 and MIC = SKT2. Recorder connections are EAR = SKT5 and MIC = SKT4. SKT6 presents a processed output from SKT5 for connection to a mic input on a second recorder and may be used for making back up copies of your own programs.

Final testing involves the addition of two connecting cables, terminated both ends with 3.5mm plugs. Connect both mic and ear Spectrum ports to SKT2 and SKT3 on the module. Connect the two new cables (see parts list) from the recorder mic and ear sockets to SKT4 and SKT5 on the module, switch on and try loading a program. Adjust either recorder volume or RV2 as necessary if problems are encountered. When saving programs, RV1 can be adjusted if playback levels are too low or noisy, but the half travel setting should be adequate.

SPECTRUM EASYLOAD PARTS LIST

RESISTORS:– All 0.4W 1% Metal Film			
R1,2	180k	2	(M180K)
R3–8 inc.	4k7	6	(M4K7)
R9,10	51R	2	(M51R)
R11,12	100k	2	(M100K)
R13,14	1k5	2	(M1K5)
R15,16,17	47k	3	(M47K)
R18–21 inc.	470k	4	(M470K)
R22	150k		(M150K)
R23,24,25	10k	3	(M10K)
R26	22k		(M22K)
R27,28	2k2	2	(M2K2)
R29,30	1k	2	(M1K)
R31	82k		(M82K)
R32	18k		(M18K)
R33	39k		(M39K)
R34	100R		(M100R)
RV1,2	47k Hor Sub–min Preset	2	(WR60Q)
CAPACITORS			
C1,2	100nF Polycarbonate	2	(WW41U)
C3,4,5	10uF 35V PC Electrolytic	3	(FF04E)
C6,7,8,12	2u2F 63V PC Electrolytic	4	(FF02C)
C9,10,11	100uF 10V PC Electrolytic	3	(FF10L)
SEMICONDUCTORS			
D1,2	1N4148	2	(QL80B)
D3,4	BZY88C6V8	2	(QH10L)
TR1,2	BC548	2	(QB73Q)
IC1	LM13700N		(YH64U)
IC2	4066BE		(QX23A)
IC3	4093BE		(QW53H)
IC4	3403		(QH51F)
IC5	uA741C(8 pin)		(QL22Y)
MISCELLANEOUS			
LED1–4 inc.	Miniled Red	4	(WL32K)
S1	SPDT Ultra Min Toggle		(FH98G)
SKT1	PC Mtg Power Skt		(RK37S)
SKT2–6 inc.	3.5 Jack Skt	5	(HF82D)
	Minled Clips	4	(YY39N)
	PP3 clip		(HF28F)
	Veropin 2141	1pkt	(FL21X)
	Spectrum Easyload PCB		(GB57M)
OPTIONAL			
	Case		(LL08J)
	Plugpack Q	2	(RW28F)

A Complete Kit of parts (excluding Case and Plugpak Q) is available.
Order As LK39N (Spectrum Easyload Kit) Price £9.95

HERO GOES TO SCHOOL *Continued from page 41.*

So how was it all done. Well the fact is that Shakin' Stevens has got nothing on David Snoad! The trigger needed to make Hero say the next line of his pre-programmed speech was in fact David surreptitiously moving his leg into the detection range of Hero's ultrasonic range-finder. Everything was, of course, carefully rehearsed and the children on the stage only asked the questions they had been told to ask.

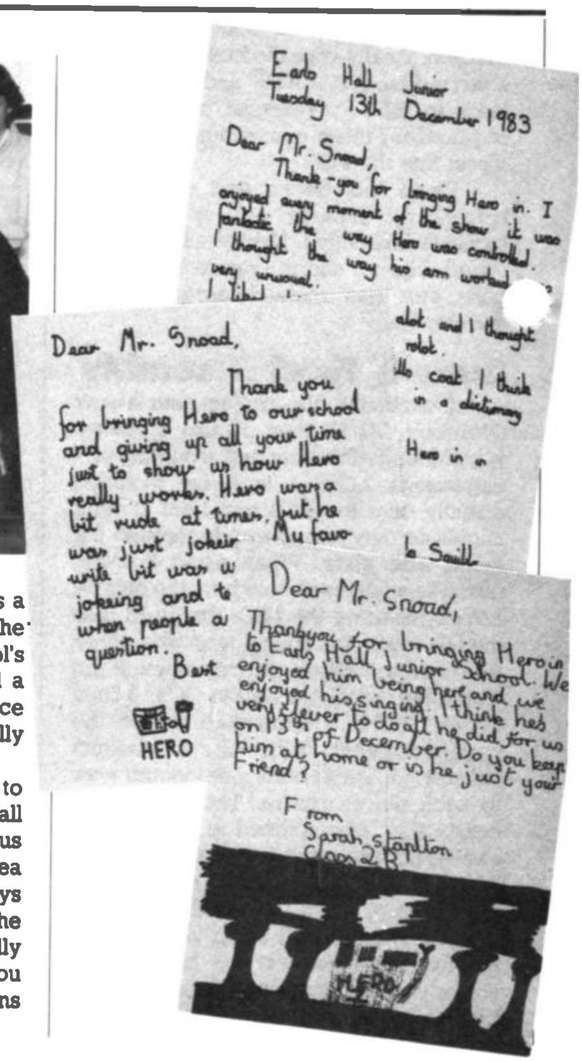
Robots Are Fun

Hero's entrance routine and the part where he spelt his name was achieved by having controlled him directly to make each move before the show. When controlled in this way from his 'teaching pendant', he remembers everything and can repeat it absolutely precisely as often as required.

When the children from Earls Hall School come up against robots, as they undoubtedly will during their working lives, they will not see them as giant daunting machines that are incomprehensible and unapproachable. They will always remember that enchanting little robot they met as children and will be able to interact with robots without any qualms or fears.

As far-sighted headmaster Bob Shaw, who had organised the show said, "Few such demonstrations have commanded such a high level of interest. As a means of demystifying the robot, the event was a great success. The school's one microcomputer allows each pupil a total of ten minutes hands-on experience a term. The robot is, however, ideally suited for group involvement."

We would just like to say thanks to all the children and teachers at Earls Hall School, who made the day such fun for us as well, and the letters were a lovely idea that we all enjoyed very much. Hero says he'd love to be owned by any of the children he met that morning. "I'm really very easy to look after," he says, "all you have to do is plug me in to the mains when I say, 'Low battery'!"



New Books

DIY Robotics and Sensors with the BBC Computer
by Jim Billingsley
This book provides an introduction to Robotics and its application to the BBC Computer. By using practical projects to construct many gadgets from a joystick to a robot and explaining the software required for interfacing; the author provides an excellent grounding in the principles of digital and analogue input and output.
235x155mm, 119 pages, illustrated.
Order As WM53H (BBC DIY Robotics) Price £7.95*NV*

Advanced Sound & Graphics for the Dragon Computer
by Keith & Steven Brain
Covers all major aspects of the sound & graphics capabilities of the Dragon, from first principles to bar charts, maps, 3D, movement, animation, direct drawing, screen saving/printing etc. Sound effects and keyboard synthesis are also examined in detail. The book deals with machine codes as well as BASIC and shows how to develop routines in your Dragon programs.
235x155mm, 250 pages, illustrated.
Order As WM54J (Dragon Advanced Sound & Graphic) Price £6.95*NV*

Writing Strategy Games on Your Atari Computer
by John White
How to write computerised games of strategy, (chess for example) for all Atari computers. The book is aimed at intermediate level and looks at programming theory behind intelligent games, followed by many practical examples including sample games. Atari BASIC & machine code are used.
235x155mm, 127 pages, illustrated.
Order As WM55K (Atari Strategy Games) Price £6.95*NV*

Advanced Programming Techniques on the Commodore 64
by David Lawrence
By setting out to analyse some of the techniques required to write successful applications programs, this book forms a basis for those who want to begin real programming on the Commodore 64. It is packed with advice and examples to help you write faster, clearer and more efficient programs.
235x155mm, 174 pages, illustrated.
Order As WM56L (Commodore 64 Advance Prog) Price £6.95*NV*

Graphic Art on the Commodore 64
by Boris Allan
The book mainly deals with the development of high resolution turtle graphics for the Commodore 64. Topics covered include PEEKS & POKES, VIC ROMAN II and CIA chips, the use of logical operators to produce special effects, the arrangement and relocation of memory and much more. A knowledge of the Commodore 64 User Manual is assumed and numerous appendices explaining specific topics not in that manual are included.
235x155mm, 120 pages, illustrated.
Order As WM57M (Commodore 64 Graphic Art) Price £6.85*NV*

Audio Amplifier Construction
by R.A. Penfold
Circuits of a wide range of preamplifier and power amplifier designs, from low noise microphone & tape head preamps to 100W mosfet amps, are provided in this book. The projects are relatively easy to construct using the pcb or stripboard designs given. Setting up and testing procedures are described, although in most cases no test gear is required.
178x110mm, 99 pages, illustrated.
Order As WM31J (Audio Amp Construction) Price £2.25*NV*

Linear Electronic Circuits & Systems
by Graham Bishop
This book includes all the knowledge to understand and apply linear circuit theory, from basic A.C. circuit theory to advanced analogue computer circuits. Transistor construction, operation and circuit design are fully covered. The second edition, which has been revised and updated, now includes FET & IC manufacture plus analogue - digital circuits, etc.
232x152mm, 220 pages, illustrated.
Order As WM59P (Linear Electronics) Price £8.95*NV*

Mastering Electronics
by John Watson
A comprehensive handbook giving all the essential information required to learn and master the principles of electronics. Arranged as a complete self-contained course, for individual or classroom use, it includes basic theory as well as more advanced subjects including radio & TV, computers etc. Tested projects are featured to provide the reader with pratical experience. This very reasonably priced book is recommended for the beginner in electronics.
215x135mm, 382 pages, illustrated.
Order As WM60Q (Mastering Electronics) Price £4.35*NV*

The Electron Book
by J. McGregor & A. Watts
The complete guide for the Electron owner, featuring sections on BASIC, sound, colour, graphics & animation. Many example programs are used to introduce general ideas, thus making the book more readable. Ten appendices contain more detailed technical information. Recommended for all Electron users.
235x155mm, 322 pages, illustrated.
Order As WM64U (The Electron Book) Price £9.98*NV*

The Electron Programmer
by S.M. Gee & Mike James
A step by step guide from first principles of BASIC to proficient programming, paying special attention to the Electron's remarkable sound and graphics commands. Sample programs are used throughout the book, to demonstrate techniques and provide a starting point for the user. A clear, logical book for all Electron owners.
235x155mm, 183 pages, illustrated.
Order As WM63T (Electron Programmer) Price £6.95*NV*

Assembly Language Programming on the Electron
by John Ferguson & Tony Shaw
Written for the user with some knowledge of BASIC who wishes to start from scratch with assembly language programming. Many practical examples and illustrations help you to master the subject thus speeding the execution of your programs. Assembly language brings you in contact with the heart of your computer and is therefore ideal for graphics & controlling external devices.
235x155mm, 197 pages, illustrated.
Order As WM65V (Electron Assembly Language) Price £9.48*NV*

An Introduction to Programming the Dragon 32
by R.A. & J.W. Penfold
The ideal book for the Dragon 32 owner who wants to master BASIC programming. By using sample commands and short programs a gradual approach to mastering the subject is achieved. A number of demonstration programs are included in this book, which has been designed to complement the Dragon 32 Manual.
178x110mm, 92 pages, illustrated.
Order As WM34M (Dragon 32 Program Intro) Price £1.95*NV*

Introducing Dragon Machine Code
by Ian Sinclair
This book will show you what machine code is, how it works and how to enter, run & save code. Thus you will be able to fully master the Dragon and make maximum use of special effects, graphics modes etc. & enjoy really fast operation of your machine. Some knowledge of BASIC is needed.
235x155mm, 151 pages, illustrated.
Order As WM62S (Dragon Machine Code) Price £8.95*NV*

32-LINE EXPANSION

for the Maplin Digi-Tel Telephone Exchange

- ★ **Expansion board for up to 32 extensions**
- ★ **No call can be interrupted or overheard by another caller**
- ★ **Standard 2-wire connection to all telephones**
- ★ **All phones powered by the 2-wire line**
- ★ **Mains connection required only at the exchange**
- ★ **May be used with standard British Telecom phones**
- ★ **Up to 16 telephones may be in use at any one time**

by Robert Kirsch

Introduction

This article describes the additions to the 16 line Digi-Tel Telephone Exchange (described in the September/November 1982 edition of 'Electronics' and Maplin Project Book Four) to enable a furthur 16 lines to be added thus increasing the total capacity to 32 lines. The expansion board is the same size as the 16 line mother board and may be mounted above or below it; most of the interconnecting wires coming from the left hand side of both boards. There are six additional connections between the two boards, details of which are shown in Figure 3b.

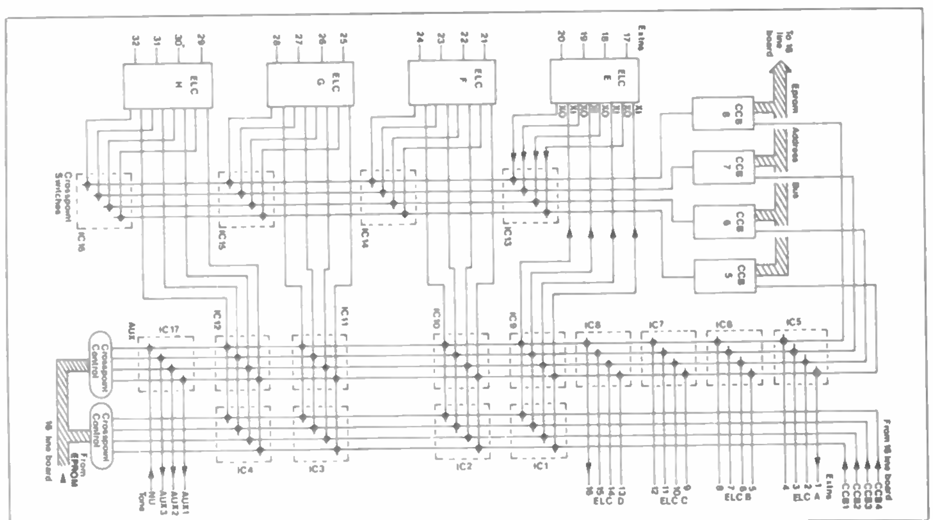
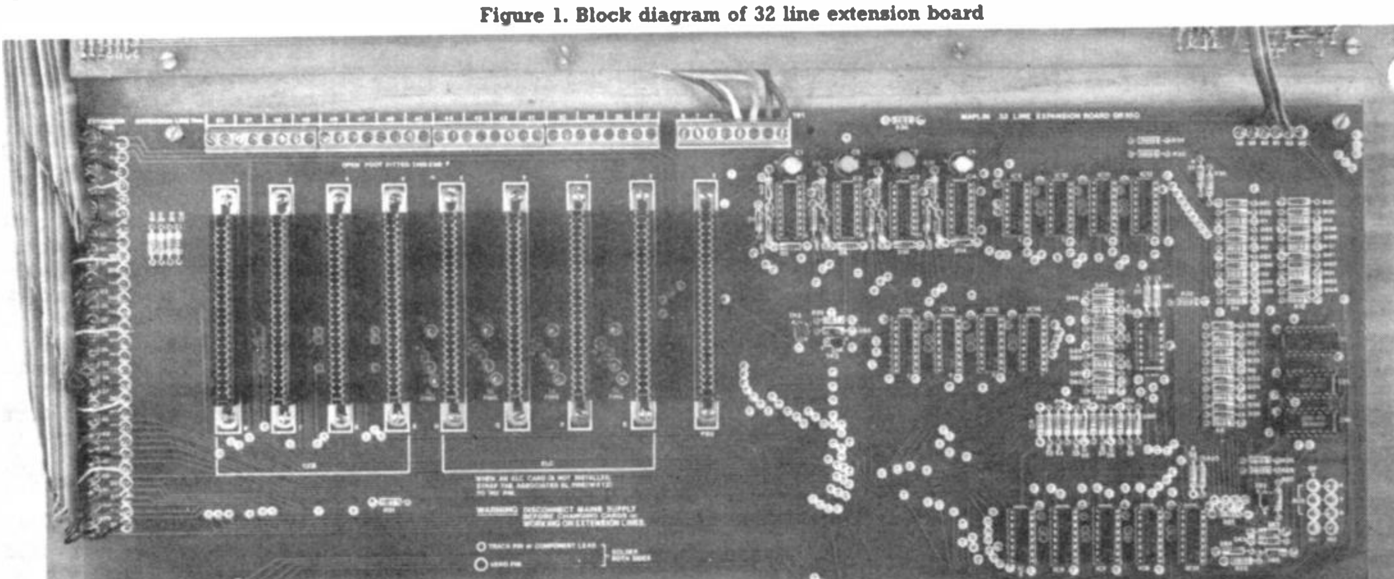
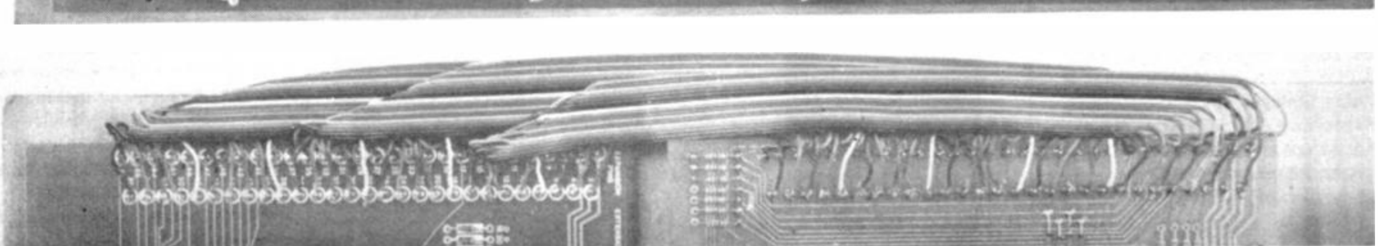


Figure 1. Block diagram of 32 line extension board





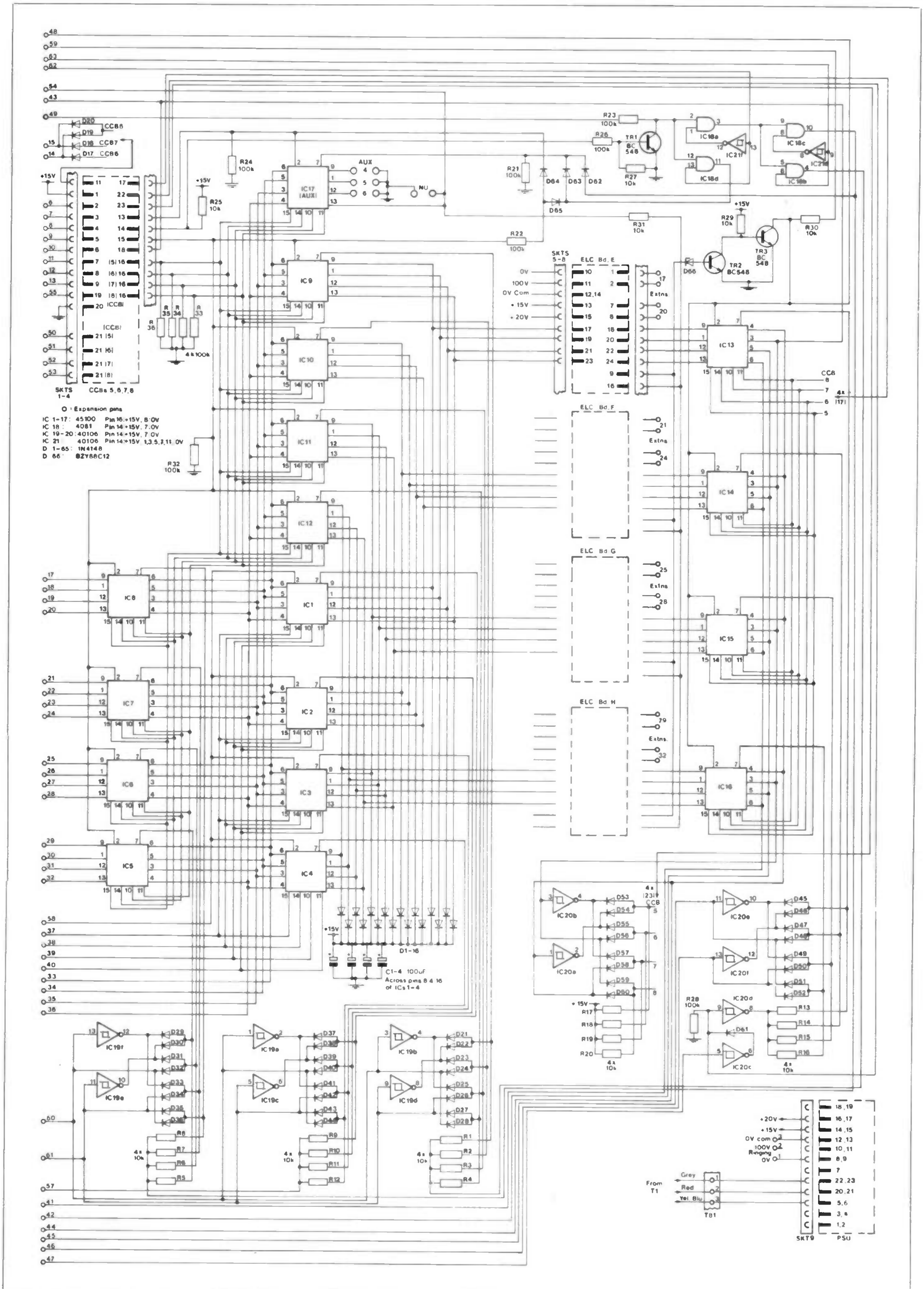


Figure 2. Expansion motherboard circuit

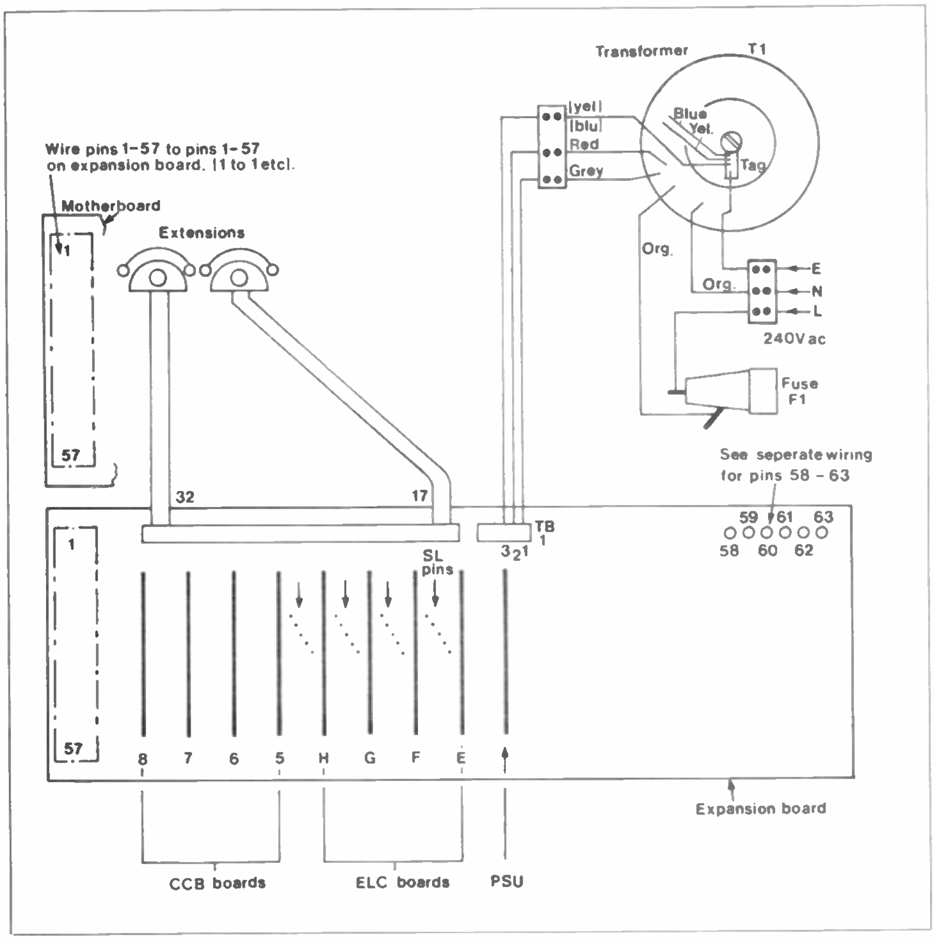


Figure 3a. Wiring diagram

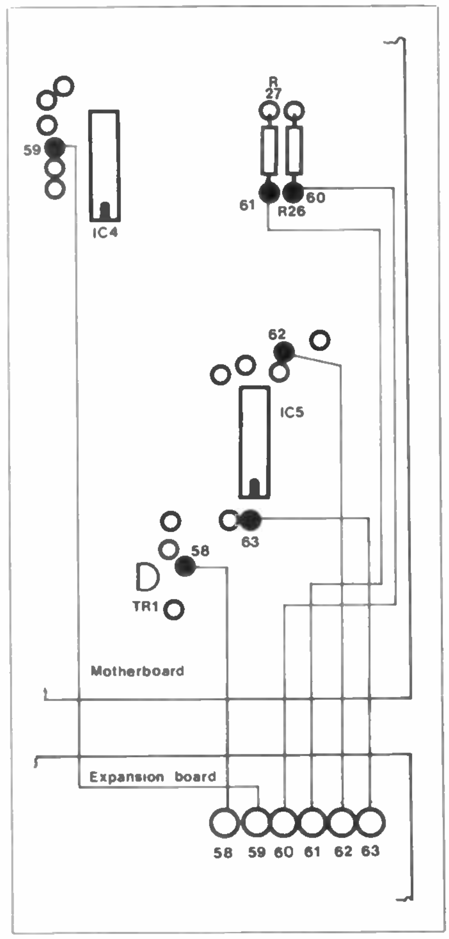


Figure 3b. Additional inter-board wiring

The expansion board can be equipped with up to 4 E.L.C. cards and up to 4 C.C.B. cards, in the same manner as the 16 line exchange, depending on the number of additional extensions required. A modified P.S.U. card is used that does not include the components for the 100V ringing as this is fed, along with all timing pulses etc. from the 16 line board.

Numbering Scheme

The relationship between the extension system number, and the number dialled to obtain that extension is reprinted in figure 3c.

Circuit

See Figures 1,2 & 4. The principle of operation is the same as that described in Part 1 but, as in this case the 4 C.C.B. cards on the 16 line board must have access to the new 16 extensions, 4 additional CP switches (IC's 1-4) are provided. The 4 C.C.B. cards on the expansion board, switch to any of the 32 lines using the 8 CP switches (IC's 5-12). A calling extension is switched to a free C.C.B. card by one of the 4 CP switches (IC's 13-16). All control of output CP switches is accomplished by the EPROM logic on the 16 line board and for this reason both EPROM address and data lines are extended between the two boards.

When extensions 17-32 are dialled on the 16 line Digi-Tel, the EPROM (M4 YELLOW) connects the call to NU tone, therefore a new EPROM (M5 BROWN) is provided in the expansion kit, which has the correct codes for routing to the new

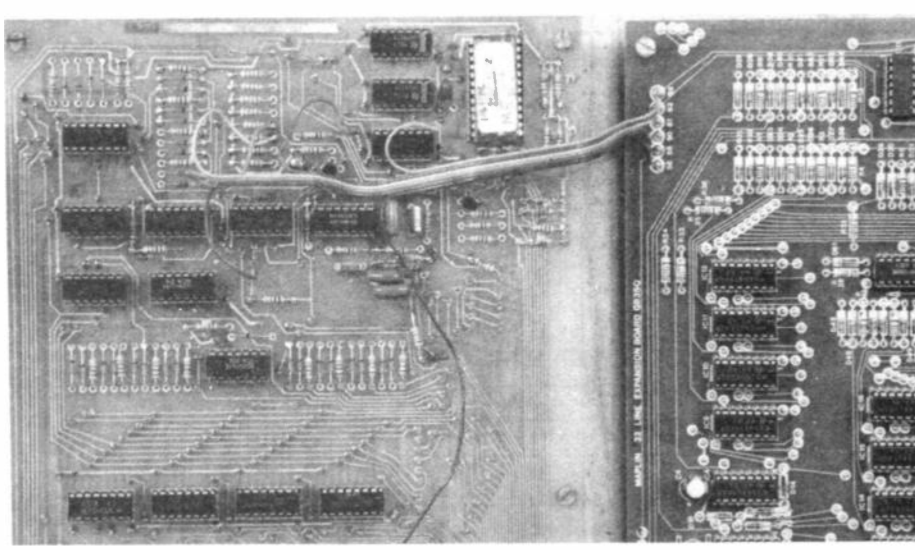
System Extension Number	Number Dialled	System Extension Number	Number Dialled
1	21	19	39
2	22	20	30
3	23	21	41
4	24	22	42
5	25	23	43
6	26	24	44
7	27	25	45
8	28	26	46
9	29	27	47
10	20	28	48
11	31	29	49
12	32	30	40
13	33	31	51
14	34	32	52
15	35	Aux 1	8
16	36	Aux 2	9
17	37	Aux 3	0
18	38		

Figure 3c. Number conversion table

extensions. Both boards have 3 auxiliary outputs. These may be used independently or both sets may be connected in parallel, the busy tone being returned if a second board tries to switch to a circuit already in use.

Construction

Refer to P.C.B. legends, parts lists and Figures 3a & 3b. The board is constructed in the same way as the 16 line one, not forgetting to solder on both sides of the board components marked with a ring on the legend. D.I.L. sockets should be used for all CP switch IC's (IC1-17) and these components should not be inserted until the construction has been completed and all P.S.U. voltages have been checked.



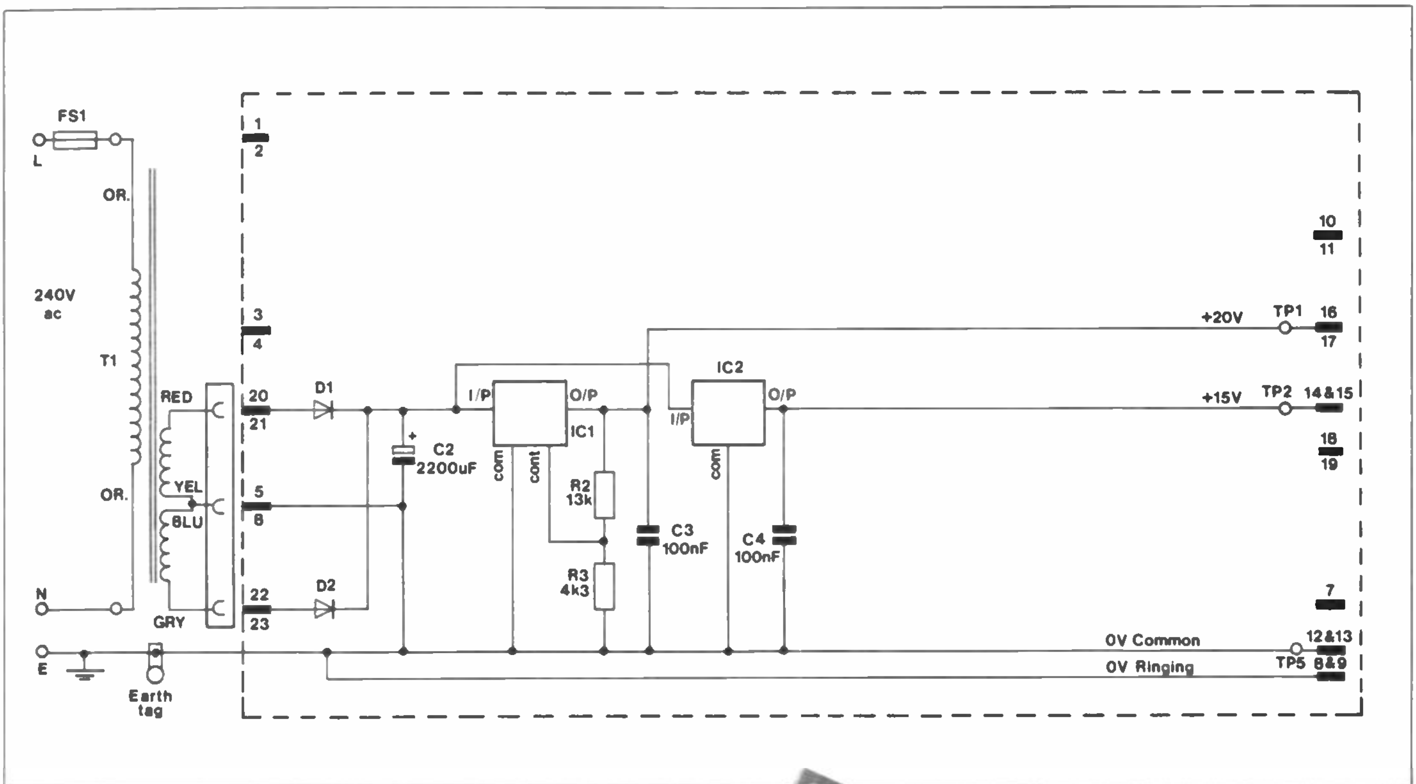
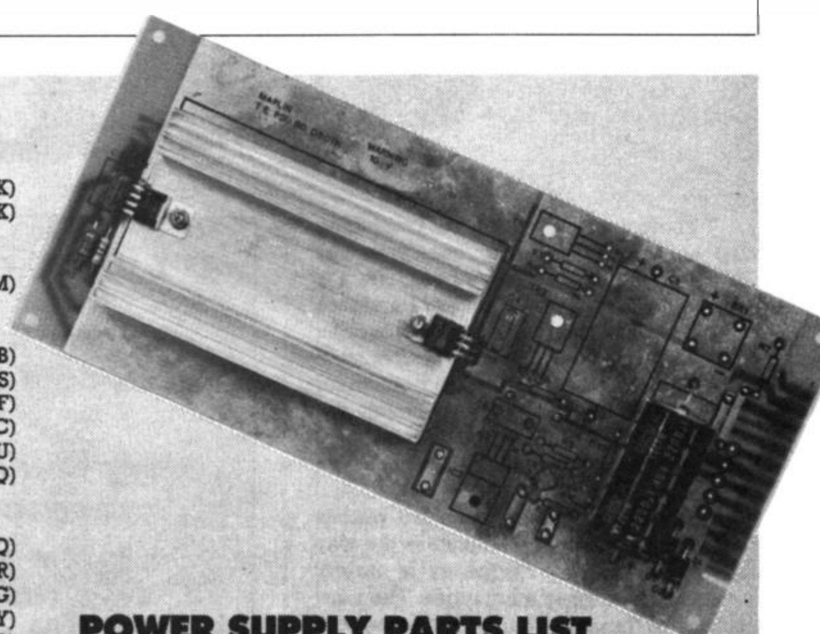


Figure 4. Modified PSU circuit



EXPANSION BOARD PARTS LIST

RESISTORS:- All 0.4W 1% Metal Film			
R1-20,25,27,29-31	10k	25	(M10K)
R21-24,26,28,32-36	100k	11	(M100K)
CAPACITORS			
C1-4	100uF 25V PC Electrolytic	4	(FF11M)
SEMICONDUCTORS			
D1-65	1N4148	65	(QL80B)
D66	BZY88C12V		(QH16S)
IC1-17	45100BE	17	(QQ51F)
IC18	4081BE		(QW48C)
IC19-21	40106BE	3	(QW64U)
TR1-3	BC548	3	(QB73Q)
MISCELLANEOUS			
	P.C. Board		(GB35Q)
	8 way P.C. Terminal	5	(RK38R)
	Edge Connector 124	9	(FL85G)
	Edge Connector Foot G	9	(FL91Y)
	Edge Connector Foot H	9	(FL92A)
	DIL Socket 16 pin	17	(BL19V)
	Track Pin	6 pkts	(FL82D)
	Veropin 2145	1 pkt	(FL24B)
	Bolt 6BA x ½"	2 pkts	(BF06G)
	Nut 6BA	2 pkts	(BF18U)
	Washer 6BA	2 pkts	(BF22Y)

ADDITIONAL PARTS

T1	Toroidal Transformer 24V/24V		(YK86T)
	Safuseholder 20		(RX96E)
F1	Fuse A/S 2A		(WR20W)
	Terminal Block 5A		(HF01B)
	Tag 2BA	1 pkt	(BF27E)
	C6A Mains White	2m	(XR04E)
	Wire 3202 White	2m	(XR37S)
	Ribbon Cable 30 way	2m	(XR67X)
	EPROM 2716/M5		(QY60Q)
OPTIONAL			
	P.B. Telephone	Set of 4	(XG19V)
	P.B. Telephone	As req	(XG18U)
	4-wire Phone Cable	As req	(XR66W)

POWER SUPPLY PARTS LIST

RESISTORS:— All 0.4W 1% Metal Film			
R2	13k		(M13K)
R3	4k3		(M4K3)
CAPACITORS			
C2	2200uF 40V Axial Electrolytic		(FB91Y)
C3,4	100nF Polyester	2	(BX76H)
SEMICONDUCTORS			
D1,2	1N5401	2	(QL82D)
IC1	uA78GU1C		(WQ79L)
IC2	uA7815UC		(QL33L)
MISCELLANEOUS			
	P.C. Board		(GB07H)
	Heatsink 4Y		(FL41U)
	Bolt 6BA x ½"	1 pkt	(BF06G)
	Nut 6BA	1 pkt	(BF18U)
	Washer 6BA	1 pkt	(BF22Y)
	Track Pins	1 pkt	(FL82D)
	Veropin 2145	1 pkt	(FL24B)

A kit is available containing all the parts in the above 3 lists, excluding optional parts.
Order As LK37S (Digi-Tel 32-Line Expansion Kit) Price £129.95

AUTO~WAA EFFECTS UNIT

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

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

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

by Robert Penfold

★

Automatic — no foot pedal needed

★

Very low power consumption

★

Wide range of musical effects

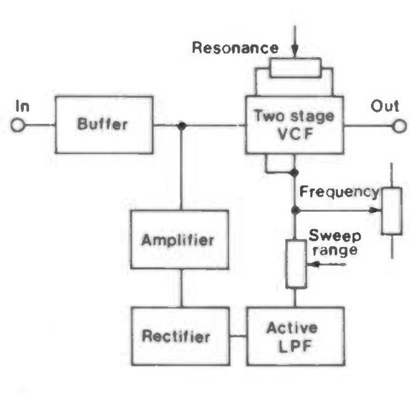


Figure 1. Block diagram

Block Diagram

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

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

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

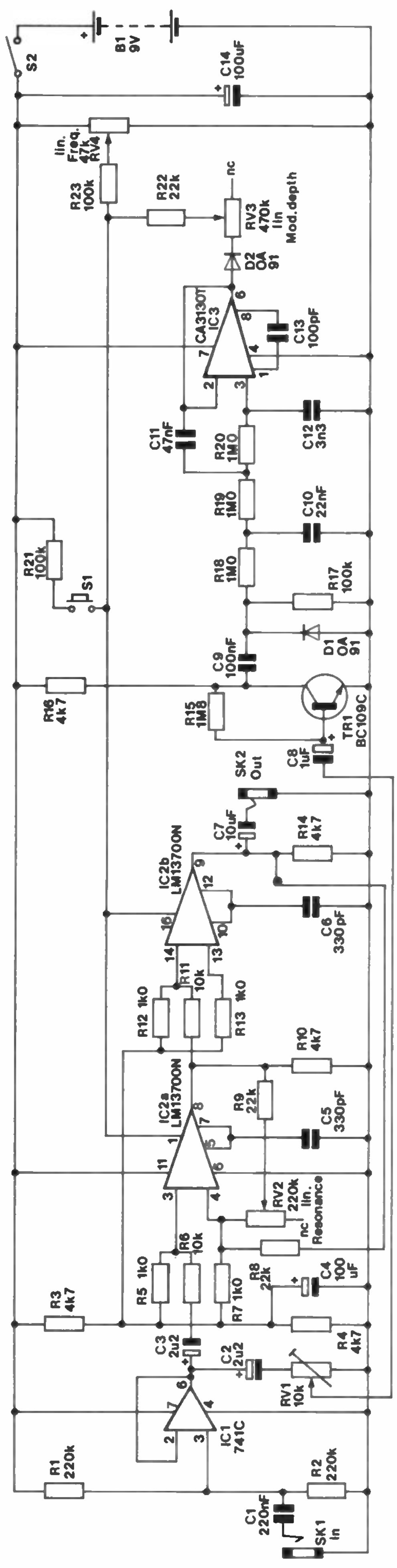
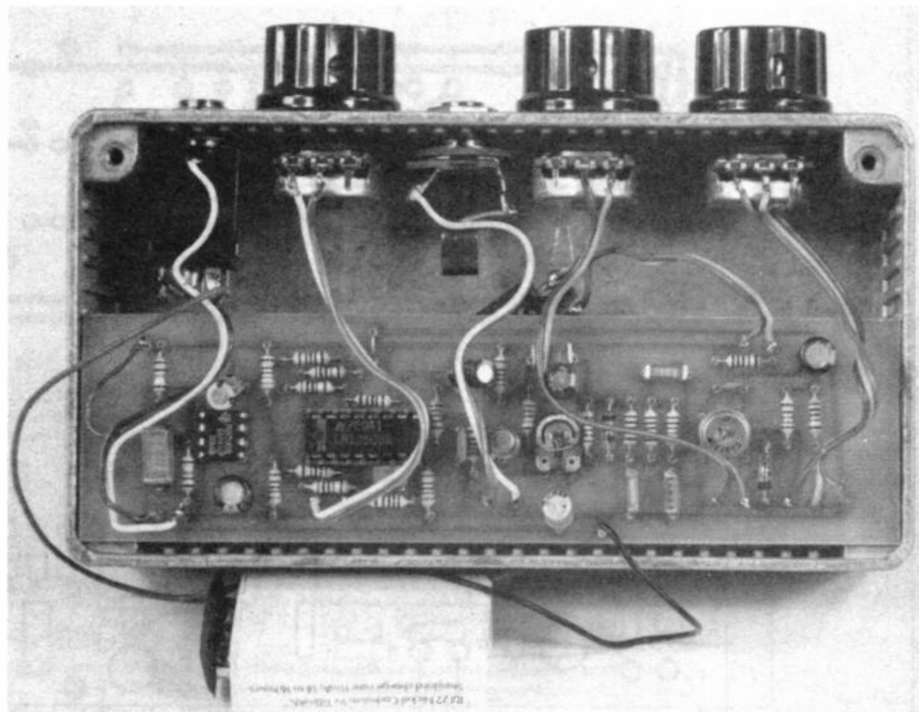


Figure 2. Circuit diagram



The Circuit

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

IC1 is used as the buffer amplifier at the input of the unit, and this provides the circuit with an input impedance of over 100 kilohms. C3 couples some of IC1's output to the VCF which uses both transconductance amplifiers and buffer amplifiers of the LM13700N, IC2.

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

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

A certain amount of the output from IC1 is taken via preset attenuator RV1, and then amplified by TR1 which is used as a straight forward high gain common emitter amplifier. The amplified signal is rectified by D1 and then applied to the input of the active filter which is based on IC3. This is a conventional three stage circuit apart from the fact that R17 biases the input of the filter to earth and the filter only handles positive half cycles. A CA3130T is used in the IC3 position because this has a CMOS output stage which enables its output to go within a few millivolts of the negative supply rail. Most operational amplifiers, such as the standard 741C device, have a minimum output voltage of about 2 or 3 volts which is far too high to give acceptable results in this circuit. Another advantage of the CA3130T is that it has an extremely high input impedance, and due to the high value of filter resistors R18 to R20 this is essential. The filter resistors have been given such a high value in order to enable the low cutoff frequency of about 10 Hertz to be achieved using reasonably low filter

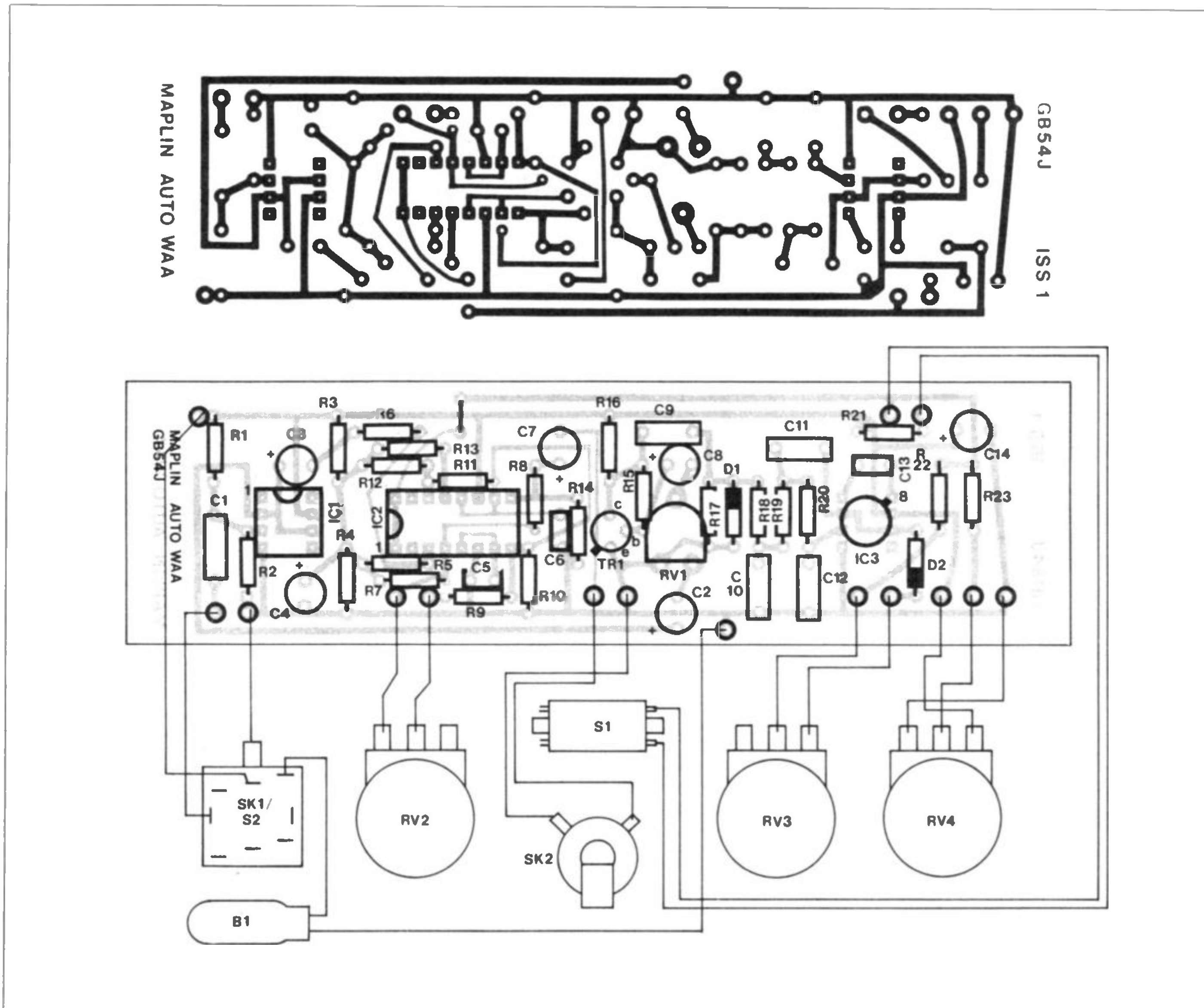


Figure 3. Legend, artwork and wiring diagram

capacitor values. This cutoff frequency gives more than adequate attack and decay times but ensures that there is no sigificant ripple on the DC output signal.

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

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

Construction

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

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

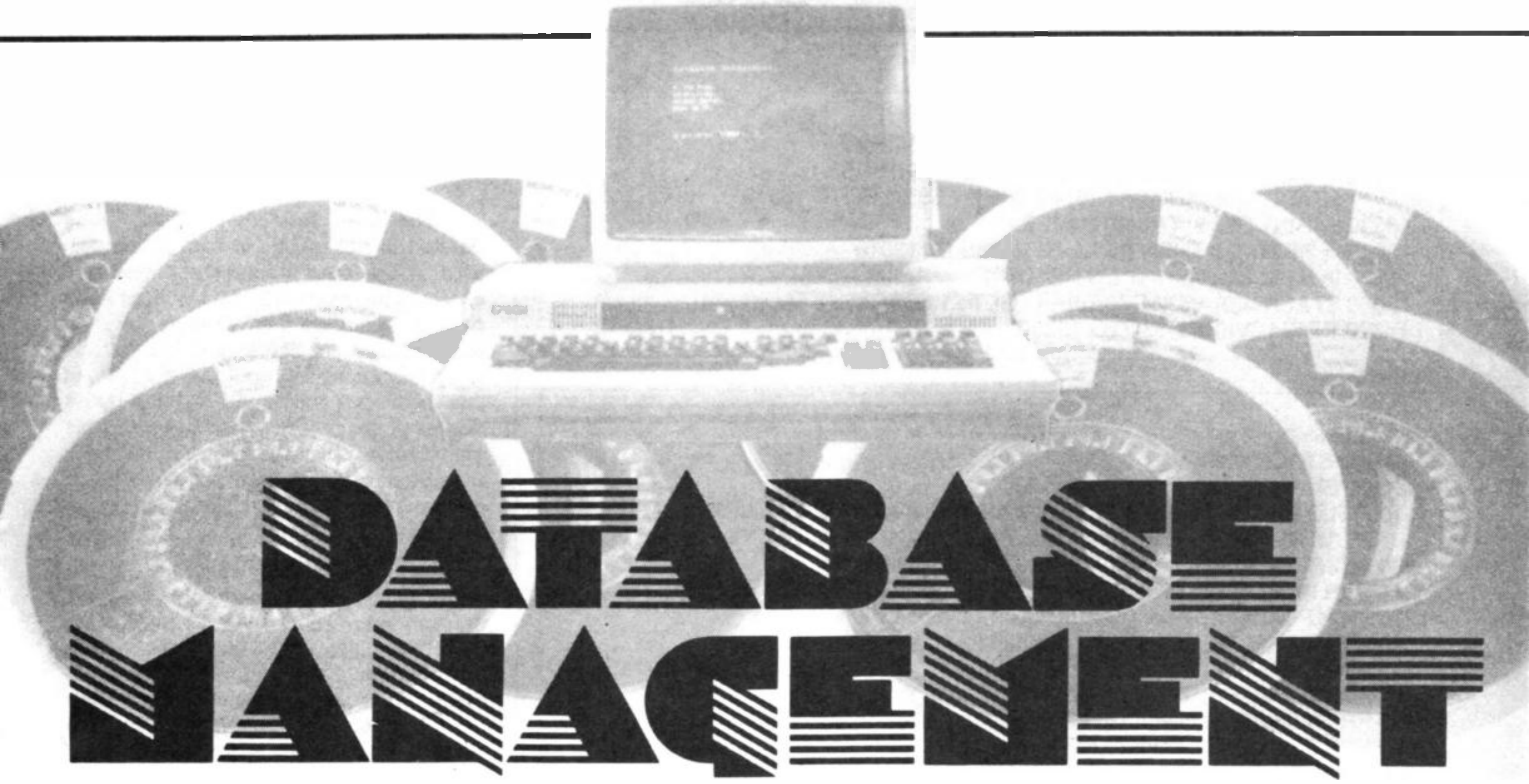
Next the hard-wiring is added, as shown in the wiring diagram of Figure 3. This is all quite straight forward and should not give any problems. Finally, the printed circuit board is fitted into the set of guide rails nearest the rear of the unit with the component side facing forwards. There is plenty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

Adjustment

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

Results are likely to be best with RV2 well backed off, RV4 set for a base fre-uency around the middle of the audio

Continued on page 57.



DATABASE MANAGEMENT

Part 2

by N.L.J. Fawcett

In part one we briefly discussed the theory of linked lists, free lists, and trees, in order to write, understand, and apply the concept of data storage and retrieval structures, that are so vital if the computer user is to realise the full potential of the microcomputer in this branch of data processing and computer science. We were able to turn the principles into a working, practical program, that allowed the fast and efficient addition and interrogation of data records. In this follow up article we will discuss the need to delete and re-use records, and the production of a sorted list from the file.

Record Deletion

Technically, our data file is a form of free list and records are consequently deleted and re-used in the same manner as was described for free lists in part one, however, things have now been complicated by the tree structure of the database. We must now be very careful to ensure that this structuring is left intact, and that no records become severed and without connection.

First the simplest case; the record being deleted is a leaf node and therefore has no siblings. The procedure here is to look at the parent node to determine whether this is a right or a left branch. When this has been determined, the pointer from the parent node can be set to zero, indicating no further branching in that direction, and the record can now be deleted ready for re-use.

The second case; the record being deleted has only one sibling, either left or right. Once again the parent node is examined to determine the branch direction of the record being deleted.

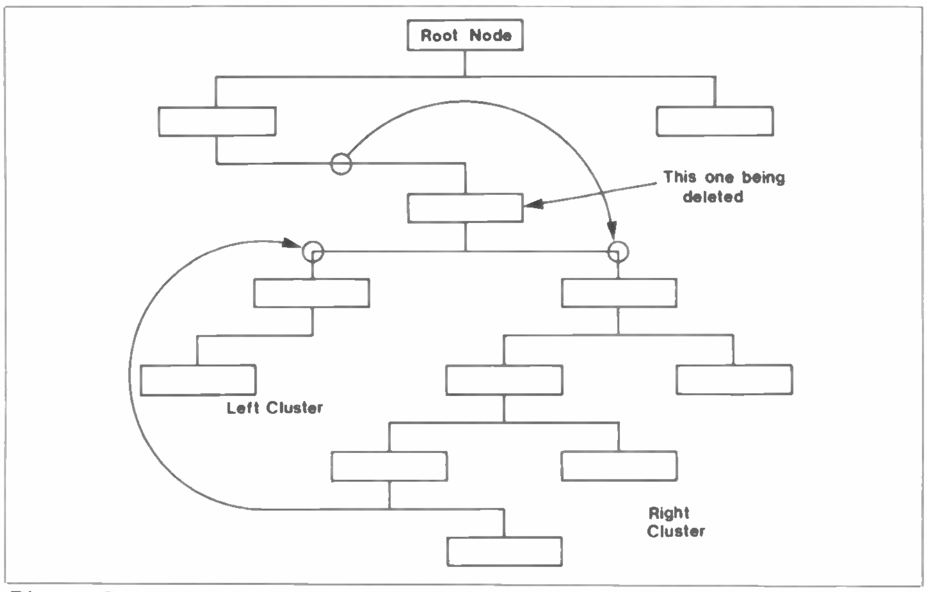


Diagram 1

```
13100 PN%=CVI(PN$) : LB%=CVI(LB$) : RB%=CVI(RB$)
13110 GET £1,1 : NX1%=CVI(LP$) : LSET LP$=MKI$(RE%) : PUT £1,1
13120 GET £1,RE% : LSET REF$=SPACE$(8) : LSET LB$=MKI$(0)
13130 LSET RB$=MKI$(0) : LSET PN$=MKI$(0) : LSET NME$=SPACE$(25)
13140 LSET ROAD$=SPACE$(25) : LSET TOWN$=SPACE$(30)
13150 LSET COUNTY$=SPACE$(32) : LSET LP$=MKI$(NX1%) : PUT £1,RE%
13160 IF LB%<>0 THEN IF RB%<>0 THEN 13230 ELSE 13100 ELSE
      IF RB%<>0 THEN 13100
13170 GET £1,PN% : IF CVI(LB$)=RE% THEN LSET LB$=MKI$(0) ELSE
      LSET RB$=MKI$(0)
13180 PUT £1,PN%
13190 RETURN
13200 GET £1,PN% : IF CVI(LB$)=RE% THEN IF LB%=0 THEN
      LSET LB$=MKI$(RB%) ELSE LSET LB$=MKI$(LB%) ELSE
      IF LB%=0 THEN LSET RB$=MKI$(RB%) ELSE LSET RB$=MKI$(LB%)
13210 PUT £1,PN%
13220 RETURN
13230 NLB%=RB%
13240 GET £1,NLB% : IF CVI(LB$)<>0 THEN NLB%=CVI(LB$) : GOTO 13240
13250 LSET LB$=MKI$(LB%) : PUT £1,NLB%
13260 GET £1,PN% : IF CVI(LB$)=RE% THEN LSET LB$=MKI$(RB%) ELSE
      LSET RB$=MKI$(RB%)
13270 PUT £1,PN%
13280 RETURN
```

Listing 1

```
13300 RE%=1 : STACK%(0)=1
13310 GET £1,RE% : LB%=CVI(LB$) : RB%=CVI(RB$)
13320 IF LB%<>0 THEN STACK%(STACK%(0))=RE%:
      STACK%(0)=STACK%(0)+1 : RE%=LB% : GOTO 13310
13330 LPRINT REF$; TAB(20);NME$
13340 IF RB%<>0 THEN RE%=RB% : GOTO 13310
13350 IF STACK%(0)=1 THEN RETURN
13360 STACK%(0)=STACK%(0)−1 : GET £1,STACK%(STACK%(0))
13370 RB%=CVI(RB$):GOTO 13330
```

Listing 2

```
10 CLS
20 DLE%=0
90 DIM STACK%(63)
100 OPEN "R",£1,"B:DBASE.DAT",128
110 FIELD £1, 8 AS REF$, 2 AS LB$, 2 AS RB$, 2 AS PN$, 2 AS LP$,
    25 AS NME$, 25 AS ROAD$, 30 AS TOWN$, 32 AS COUNTY$
200 PRINT TAB(20); "Name & Address file card system."
210 FOR I%=1 TO 4 : PRINT : NEXT I%
220 PRINT TAB(20); "Add a new record ........ ( 1 )"
230 PRINT TAB(20); "Interrogate a record .... ( 2 )"
240 PRINT TAB(20); "Delete a record ......... ( 3 )"
250 PRINT TAB(20); "Produce ordered list .... ( 4 )"
260 PRINT TAB(20); "Return to BASIC ......... ( 5 )"
300 FOR I%=1 TO 3 : PRINT : NEXT I%
310 PRINT TAB(21); "Please enter option 1-5 ";
320 INPUT OPTN% : IF OPTN%<1 OR OPTN%>5 THEN 310
330 ON OPTN% GOSUB 1000,2000,3000,4000,20000
340 CLS : GOTO 200
1000 CLS
1010 INPUT "Enter REF Name... "; RN$ : IF RN$="END" THEN RETURN
1020 RN$=LEFT$(RN$+SPACE$(8),8)
1030 GOSUB 13000
1040 IF MATCH% THEN PRINT "* Already on file *" : GOTO 1010
1050 IF RN$>REF$ THEN LSET RB$=MKI$(NX%) ELSE LSET LB$=MKI$(NX%)
1060 PUT £1,P% : GET £1,NX% : NX1%=CVI(LP$)
1070 LSET REF$=RN$ : LSET PN$=MKI$(P%)
1080 LSET LP$=MKI$(−1) : GOSUB 1500 : PUT £1,NX%
1090 GET £1,1 : LSET LP$=MKI$(NX1%) : PUT £1,1
1100 GOTO 1000
1500 PRINT
1510 INPUT "Enter Name ....... "; N$
1520 INPUT "Enter Address 1 .. "; A$
1530 INPUT "Enter Town ....... "; T$
1540 INPUT "Enter County/Pcode "; C$
1550 LSET NME$=N$ : LSET ROAD$=A$ : LSET TOWN$=T$ :
     LSET COUNTY$=C$
1560 RETURN
2000 CLS
2010 INPUT "Enter REF NAME... "; RN$ : IF RN$="END" THEN RETURN
2020 RN$=LEFT$(RN$+SPACE$(8),8)
2030 GOSUB 13000
2040 IF MATCH% THEN 2050 ELSE 2500
2050 CLS : FOR I%=1 TO 5 : PRINT : NEXT I%
2060 PRINT RN$ : PRINT NME$ : PRINT ROAD$ : PRINT TOWN$ :
     PRINT COUNTY$
2070 FOR I%=1 TO 5 : PRINT : NEXT I%
2075 IF DLE% THEN RETURN
2080 INPUT "Carriage return to continue... "; DUMMY$
2090 RETURN
2500 CLS : PRINT "***** Not on File. *****" : PRINT
2510 GOTO 2010
3000 DLE%=−1 : GOSUB 2000 : DLE%=0
3010 INPUT "Really delete this record < y/n > "; ANSWER$
3020 IF (ASC(ANSWER$) AND 95)=89 THEN 3030 ELSE RETURN
3030 PRINT "Ok! Deleting ";REF$,NME$
3040 GOSUB 13100
3050 RETURN
4000 CLS
4010 PRINT "Printing all records in REF NAME order ... "
4020 GOSUB 13300
4030 RETURN
13000 GET £1,1 : NX%=CVI(LP$) : P%=1
13010 IF RN$=REF$ THEN MATCH%=−1 : RETURN
13020 IF RN$>REF$ THEN RE%=CVI(RB$) ELSE RE%=CVI(LB$)
13030 IF RE%=0 THEN MATCH%=0 : RETURN
```

Continued

The appropriate pointer is now reset to point to the sibling of the deleted record (and through that sibling to any further dependents i.e. siblings of the sibling).

The last case; the record being deleted has branches in both directions. This is the most complicated example and is resolved as follows; the right hand path is examined first. Testing the right hand branch for left hand siblings, we keep branching left until the test fails, at this point we 'hook' on the left hand cluster of the record being deleted. This entirely new cluster is now 'hooked' onto the parent of the deleted record, in place of the record being deleted (refer to diagram one).

The reasoning behind these solutions is self-evident in cases one and two, but is not so clear in the third case. Here we are left with two quite independent branches, and only one, single point in the tree, at which both must be adhered. This requires us to replace the deleted record with either the left or the right path, and then to ascertain where in the hierarchy the now floating branch is to fit. I have chosen the right hand path to replace the deleted record, but first I appended the left hand cluster, to the right hand cluster, in its rightful place. How do we determine this rightful place? Well, we know that all the nodes in the left hand cluster are of a lower value than any of the nodes in the right hand cluster, so all we need do is find the lowest value on the right hand side, and 'hook' the entire left hand cluster, intact, onto this lowest value right hand node. The BASIC code in listing one, forms the routine to enable the delete facility in our database project.

The Sorted List

I decided in part one, that another prerequisite was to be able to produce a sorted list of the database. As I have already mentioned, the file is, by its very nature, already in some semblance of order. In fact we know that by commencing at the root node and travelling left until we can go no further, we arrive at the lowest (ASCII) value in the database — and by the same token, travelling all the way right, we arrive at the highest (ASCII) value. So, to print all the records in order, we must first take the left path to its conclusion, thereby finding the lowest value. This we print, and then determine the existence of a right hand path. If one does not exist, then we back up one step, print, and again look for a right hand path. When one is found we again take the left path, if one exists, until we can go no further (the test fails immediately if no left path), print, then start looking for a right path, backing up one if not found. To illustrate this more clearly, the flowchart can be considered like this:-

(1) Start at the Root and initialise the stack, which is used to store the nodes visited but not yet printed.

```
13040 GET £1,RE% : P%=RE% : GOTO 13010
13100 PN%=CVI(PN$) : LB%=CVI(LB$) : RB%=CVI(RB$)
13110 GET £1,1 : NX1%=CVI(LP$) : LSET LP$=MKI$(RE%) : PUT £1,1
13120 GET £1,RE% : LSET REF$=SPACE$(8) : LSET LB$=MKI$(0)
13130 LSET RB$=MKI$(0) : LSET PN$=MKI$(0) : LSET NME$=SPACE$(25)
13140 LSET ROAD$=SPACE$(25) : LSET TOWN$=SPACE$(30)
13150 LSET COUNTY$=SPACE$(32) : LSET LP$=MKI$(NX1%) : PUT £1,RE%
13160 IF LB%<>0 THEN IF RB%<>0 THEN 13230 ELSE 13100 ELSE
      IF RB%<>0 THEN 13100
13170 GET £1,PN% : IF CVI(LB$)=RE% THEN LSET LB$=MKI$(0) ELSE
      LSET RB$=MKI$(0)
13180 PUT £1,PN%
13190 RETURN
13200 GET £1,PN% : IF CVI(LB$)=RE% THEN IF LB%=0 THEN
      LSET LB$=MKI$(RB%) ELSE LSET LB$=MKI$(LB%) ELSE
      IF LB%=0 THEN LSET RB$=MKI$(RB%) ELSE LSET RB$=MKI$(LB%)
13210 PUT £1,PN%
13220 RETURN
13230 NLB%=RB%
13240 GET £1,NLB% : IF CVI(LB$)<>0 THEN NLB%=CVI(LB$) : GOTO 13240
13250 LSET LB$=MKI$(LB%) : PUT £1,NLB%
13260 GET £1,PN% : IF CVI(LB$)=RE% THEN LSET LB$=MKI$(RB%) ELSE
      LSET RB$=MKI$(RB%)
13270 PUT £1,PN%
13280 RETURN
13300 RE%=1 : STACK%(0)=1
13310 GET £1,RE% : LB%=CVI(LB$) : RB%=CVI(RB$)
13320 IF LB%<>0 THEN STACK%(STACK%(0))=RE% :
      STACK%(0)=STACK%(0)+1 : RE%=LB% : GOTO 13310
13330 LPRINT REF$; TAB(20);NME$
13340 IF RB%<>0 THEN RE%=RB% : GOTO 13310
13350 IF STACK%(0)=1 THEN RETURN
13360 STACK%(0)=STACK%(0)-1 : GET £1,STACK%(STACK%(0))
13370 RB%=CVI(RB$) : GOTO 13330
20000 CLOSE
32767 END
```

Listing 3

(2) Can we go left?
Yes. Push this node onto the stack.
Get left node and goto (2).
No. Print this one & fall through to (3).

(3) Can we go right?
Yes. Get right node and goto (2).
No. Is stack empty?
Yes. Sorted list complete.
No. Pop and print top of stack and goto (3).

The complexity of the theory is greatly reduced when viewed in this form, which resolves into eight lines of BASIC code, as given in listing two. This subroutine, together with the delete routine and a few extra lines to tidy up the presentation side if things can now be introduced into the main listing, given in part one, to finish off our database management program. The complete program is shown in listing three.

NB: The sorted list is generated, strictly in the alphabetical order of the Reference names entered into the database when each record was created. If a sort is required on, say, the town or some other field within the record, then the relevant data must be extracted and sorted using one of the many conventional sort algorithms, that can be found in most books on BASIC applications.

AUTO-WAA *Continued from page 54.*

band, and RV3 set for a medium to high modulation depth. However, a little experimentation will soon show what settings give the best effects with a particular instrument. Bear in mind that setting RV4 for a low base frequency could result in fundamental frequencies in the processed signal being substantially boosted as the filter sweeps through them, and with a high level input overloading with attendant distortion could result. There is also a danger of overloading the equipment fed from the output of the unit, and the best effect tends to be obtained with the filter sweeping over medium and high frequencies anyway.

PARTS LIST FOR AUTO-WAA

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

R1,2	220k	2	(M220K)
R3,4,10,14,16	4k7	5	(M4K7)
R5,7,12,13	1k0	4	(M1K)
R6,11	10k	2	(M10K)
R8,9,22	22k	3	(M22K)
R15	1M8 Carbon film ½W 5%		(B1M8)
R17,21,23	100k	3	(M100K)
R18,19,20	1M0	3	(M1M)
RV1	10k Hor Sub-min Preset		(WR58N)
RV2	220k Pot Lin		(FW06G)
RV3	470k Pot Lin		(FW07H)
RV4	47k Pot Lin		(FW04E)

CAPACITORS

C1	220nF Polycarbonate		(WW45Y)
C2,3	2u2 63V PC Electrolytic	2	(FF02C)
C4,14	100uF 10V PC Electrolytic	2	(FF10L)
C5,6	330pF Ceramic	2	(WX62S)
C7	10uF 35V PC Electrolytic		(FF04E)
C8	1uF 100V PC Electrolytic		(FF01B)
C9	100nF Polycarbonate		(WW41U)
C10	22nF Polycarbonate		(WW33L)
C11	47nF Polycarbonate		(WW37S)
C12	3n3 Polycarbonate		(WW26C)
C13	100pF Ceramic		(WX56L)

SEMICONDUCTORS

D1,2	OA91	2	(QH72P)
TR1	BC109C		(QB33L)
IC1	uA 741C (8-pin DIL)		(QL22Y)
IC2	LM13700N		(YH64U)
IC3	CA3130T		(QH28F)

MISCELLANEOUS

SK1	DPDT Jack Socket		(BW80B)
SK2	Jack Socket Open		(HF91Y)
S1	Press Toe Sw 1		(FH92A)
S2	(Part of SK1)		
	Printed Circuit Board		(GB54J)
	Knob K7B	3	(YX02C)
	Wire	1 pkt	(BL00A)
	Battery Clip (PP3 Clip)		(HF28F)
	Veropins 2145	1 pkt	(FL24B)

OPTIONAL

	Battery 9V PP3 Nicad		(HW31J)
	Case		(LH73Q)
	Cabinet Feet	1 pkt	(FW19V)
	16 Pin DIL Socket		(BL19V)
	8 Pin DIL Socket		(BL17T)
	Bolt 4BA ¼"	1 pkt	(BF02C)
	Nut 4BA	1 pkt	(BF17T)

A kit of parts (excluding optional items) is available.
Order As LK36P (Auto Waa Kit) Price £9.95

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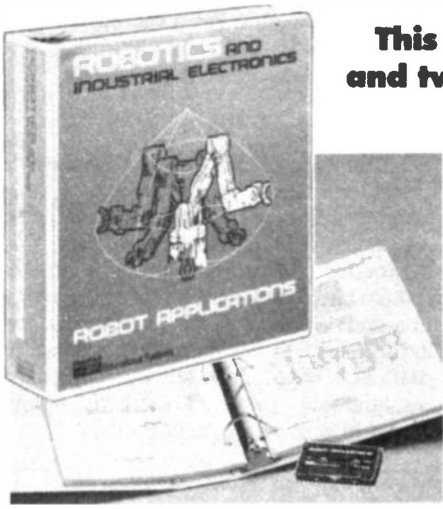

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- ★ Includes cassette with robot programs.
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Objectives
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The possible applications of microprocessors are almost endless and only limited by the imagination. Dedicated computer intelligence in such everyday items as cars, appliances and toys is becoming commonplace — yet it is only a beginning. Because of the microprocessor, just about any electromechanical device is a candidate for computer control. The next few years will see increasingly widespread application of this technology.

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EE-3405 was written to help students bridge the gap between their daily analogue world and the digital world of the microprocessor. The fundamental methods of microprocessor programming and interfacing (presented in EE-3401 and EE-3402) to perform simple I/O tasks, are prerequisite to having a microprocessor actually sense, control

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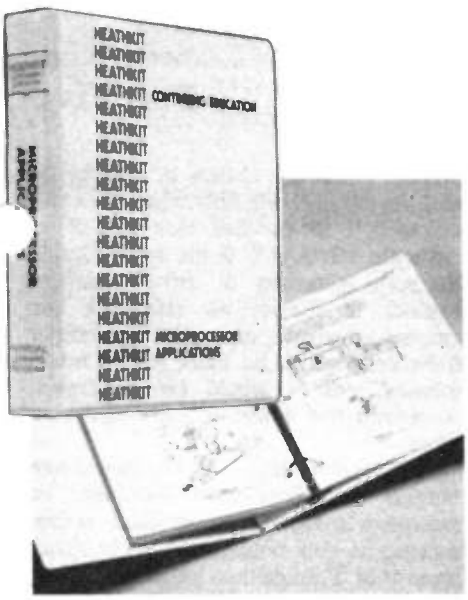

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Test all popular sized batteries and end waste. Be certain a battery is dead before you throw it away. Does more than just give a 'good — ? — bad' reading like other testers. Actually indicates how much useful life remains on a 0 to 5 meter scale. Tests alkaline or carbon-zinc 9V or 1.5V AA, C and D size batteries, plus rechargeable 1.2V ni-cads. Indispensible for households with many independently powered items — tape-recorder/players, radios, cameras, toys, smoke or burglar alarms, flashlights etc.

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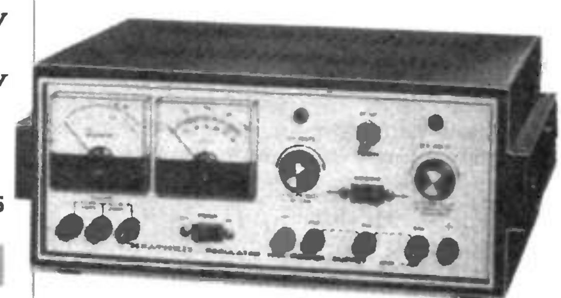
★ Separate 0 to 400V DC at 100mA high voltage output and 0 to −100V DC at 1mA bias voltage output.
★ Separate 6.3V AC and 12.6V AC filament outputs.

The IP-2717A is a compact, convenient source of variable regulated high voltage, variable bias voltage, and filament voltage for workshops and experimenters. The high voltage (B+) output provides 0 to 400V of regulated DC at a continuous 100mA or an intermittent 125mA. The B+ has less than 10mV (rms) ripple and varies less than 1% from a no-load to full load condition. The bias (C−) output provides negative voltages from 0 to −100V DC up to 1mA. All high voltage and bias voltage output binding posts are insulated from the chassis allowing high B+ and C− voltages to be used as either negative or positive voltage sources. Also available are two filament voltages, 6.3V AC and 12.6V AC at 2A, which may be used at the same time as long as the total combined power does not exceed 25VA.



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FIRST BASE

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

We have almost come to the stage where some of the topics covered in previous articles in the series can be brought together in a simple project. This will not be a 'state of the art' design and hence not offered as a complete kit of parts. What is intended is to illustrate how a timer/counter circuit may be made up using several functional integrated circuits, rather than a single VLSI device. In fact, it would make an ideal candidate for construction on a breadboard, as outlined in an earlier article.

Loose Ends

First there are a couple of loose ends which ought to be tied up before we go much further, and the first of these concerns the nature of TTL output stages. As a general rule, one should never connect the outputs from any logic gates together. Indeed, it is one of the common mistakes in wiring up a breadboard circuit which should be particularly looked for. If it is not corrected then this is a very good way of zapping the chip when the power is applied. The reason for this is because of the type of output configuration used in TTL output stages, which is shown diagrammatically in Figure 1. The use of a complementary pair of transistors like this is often called a 'totem pole' output. The effect is to ensure that the voltage swings as close to +5V or 0V (logic 1 or 0) as possible, depending on the state required by the logic. A TTL output is described as being able to sink or source a certain amount of current, for the following reason. In order

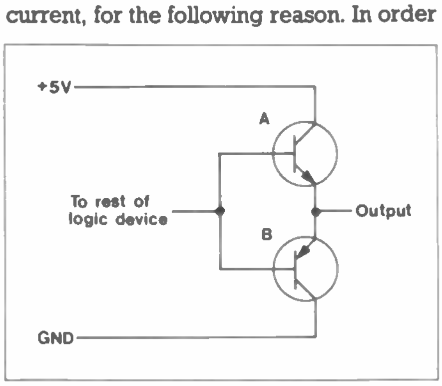

Figure 1. TTL output stage.

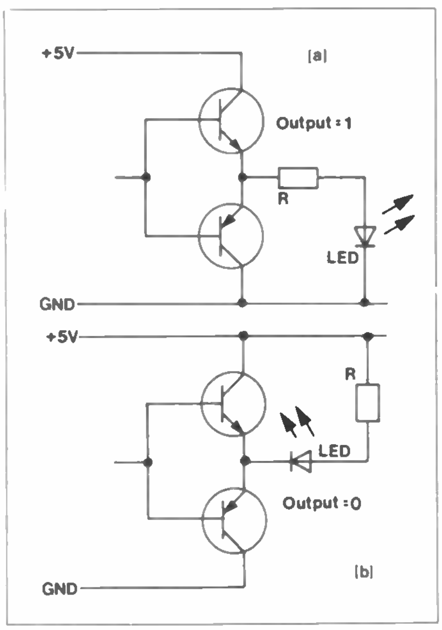

Figure 2. Current source and current sink.

for the logic level of the output of Figure 1 to be '1', then transistor 'A' will be 'ON' and transistor 'B' will be 'OFF'. Thus current can flow through transistor 'A' from the 5V supply to the load and thence to ground. Alternatively, if the logic level of the output is at '0', then transistor 'A' will be 'OFF' and transistor 'B' will now be 'ON'. In this case current can flow into the output stage from a load which has one end connected to the +5V supply. In the first instance the output stage is acting as a current source and in the second instance it is a current sink. Both of these

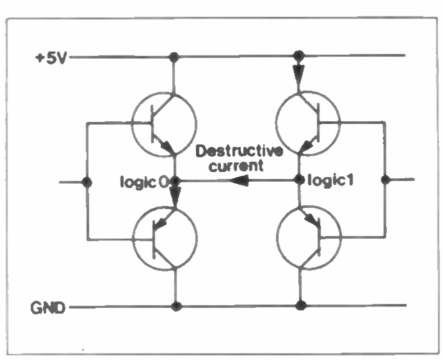

Figure 3. Outputs connected together.

arrangements are shown in Figures 2a and 2b; the LED will light when the logic output is '1' for the first case, and when the logic output is '0' in the second case. In both instances a current limiting resistor is shown, as otherwise the current through one of the output transistors would be more than it could tolerate, and it would be destroyed, rendering the whole of the logic gate useless.

The same thing will happen if two outputs are connected together, as indicated in Figure 3. Everything is fine so long as both outputs remain at either logic '0' or '1', since then the voltage at the output will be the same and no current will flow. However, as soon as the outputs are different, then current can flow through one transistor in each output stage, with one acting as a source and the other as a sink. The current will be limited only by the 'ON' state resistance of each transistor and sooner, rather than later, one or both will burn out. It is a practical result of Murphy's Law which will ensure that the devices are ruined before you can spot the mistake and turn off the power!

Open Collector Outputs

Readers of this series with good memories will probably recall that a circuit diagram was given in Part 3 which showed the very thing just warned about. Actually, there was also an error in the diagram, which showed 2-input EX-OR gates rather than EX-NOR gates. The outputs, however, were correctly shown all connected together. This is possible only if devices are used which have open collector outputs, as they are called.

The arrangement in such an output stage is shown in Figure 4. Here, the output must be connected to an external collector load, usually a resistance of around 1k. In this case, the output voltage will be pulled up to logic 1 by this resistor when the output transistor is 'OFF'. When the transistor is turned 'ON' the output will go to logic 0 as current flows through the collector load resistor. A number of separate output stages may share a

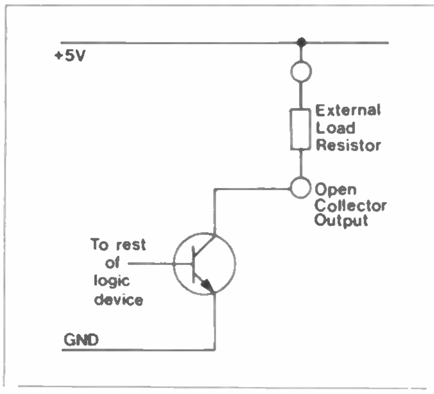

Figure 4. Open collector output stage.

common load resistor without any danger of damage since they can only act as current sinks. If one output is 'OFF' and another is 'ON', no current flows through the 'OFF' transistor; likewise, if several transistors are 'ON' then the current through the load resistance will be more or less shared by each one. This type of output connection is also sometimes called 'wired-OR', since the arrangement is similar to the use of diodes and a resistor to form a simple OR gate.

Synchronous and Asynchronous Counters

The second 'loose end' which needs paying attention to relates to another feature of the output stages of TTL dividers or counters. So far we have considered one particular device, the 7493, or its low-power Schottky counterpart, the 74LS93. If you look up either of these two devices in the catalogue you will see them described as 4-bit binary ripple counters, and this needs a little explanation. Firstly, the reference to 4 bits relates to the number of individual bits available at the output; in this case with four bits the maximum binary value which may be obtained is 1111, or 15 decimal. In some cases this can be a bit of a nuisance (pun not intended!) where decimal values are required, but more on that in due course. More important is the reference to them being ripple counters. This means that the outputs do not change state exactly together, and the use of the word 'ripple' indicates something of the internal working of these devices.

If you refer to the diagram of such devices you may recall that the output from the first stage was fed back to the input to the second and subsequent stages. In operation, as clock pulses are fed into the chain of counting circuits, the output from the first stage acts as the clock for the second stage, the output of the second stage then clocks the third stage, and so on. It can be imagined that each clock pulse passes along the chain of divider stages like a wave, and as the wave passes the outputs change, one after the other. Such a device is then described as being 'asynchronous', since the outputs do not change in step. This can often be a great inconvenience, especially when the outputs are to be connected into a logic array designed to respond to a certain set of output states. The unexpected states appearing at the inputs to such a decoder would produce 'glitches' which would almost certainly prevent the correct operation of the rest of the circuitry.

In order to get round problems such as these, it is necessary to employ a device whose outputs do all change in step, that is a 'synchronous' counter or divider. Here, the outputs will change state exactly in step, either on the leading or trailing edge of the input clock pulse. Since there are no 'illegal' states present at the outputs, they may be used to trigger other events within the circuit without any fear of problems due to glitches. A TTL 4-bit synchronous counter is the 74161 or 74LS161; this is slightly more difficult to make than the asynchronous 7493 device, and the opportunity is taken by the manufacturer to incorporate other features within this package.

Decoders and Displays

The main object of this article is to examine the rest of the circuitry needed to make up a simple counter/timer. We shall also graduate from the use of simple LED's to indicate binary values to 7-segment LED displays for showing decimal numbers.

This then brings us on to the topic of another range of devices called: Decoders. These are used to convert the binary output from a counter to the correct pattern for operating a 7-segment display. As is often the case, there are a variety of devices available for this purpose, but we shall consider only one. Most decoders intended for use with 7-segment displays have output stages which are able to deliver the required current to drive such displays directly, that is without a separate buffer chip. In this case these devices are more correctly termed decoder/drivers. The pin-out of a typical decoder/driver, the 7448, is shown in Figure 5; here the inputs are on the left and the outputs are on the right.

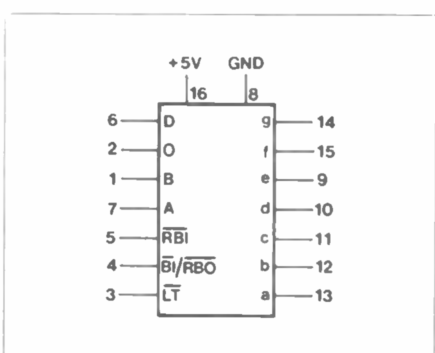

Figure 5. 7448 BCD to 7-segment decoder/driver.

The inputs may be connected directly to the outputs of the counter, such as the 7493, and the outputs to the 7-segment display.

A decoder of this sort may be regarded as a simple Read Only Memory, (or ROM, of which more in a later article). The Truth Table of this device is, of course, fixed and is shown in Figure 6. For each of the 16 possible combinations of the inputs A, B, C and D, the internal logic will set the outputs to that for the corresponding decimal number. The outputs are marked a, b, c, d, e, f and g, and these match the segments of the display, as shown in Figure 7.

Dec No	D	C	B	A	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	0	1	1	0	0	0	0
2	0	0	1	0	1	1	0	1	1	0	1
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	0	1	1	0	0	1	1
5	0	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	1	0	1	1	1	1	1
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	1	0	1	1

Figure 6. Truth table for 7448.

In order to reduce the number of connections to the display, either the cathodes or the anodes of the individual LED's are connected together. In the first instance the display is referred to as a Common Cathode display and in the second as a Common Anode display. Both types are available, as shown on page 243 of the new Maplin catalogue, which also shows the nature of the common connections for each type. Of course, in order to obtain sensible digits, the appropriate type must be used with a particular driver.

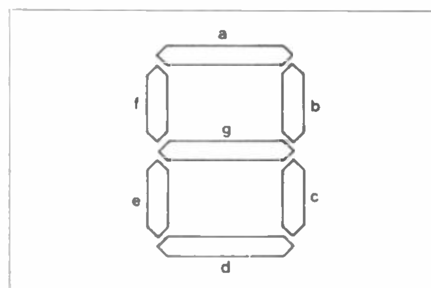

Figure 7. Segment identification.

The 7448 has outputs which are 'high' for the corresponding binary input; this means that an LED display must be used which has all the cathodes connected together and to ground. Thus suitable versions would be Catalogue Nos. FR38R or FR41U, depending on size, or the BY68Y which is a double digit type.

The chosen device, the 7448 (or 74LS48) has the open collector type of output described earlier. The method of connection to the LED display is thus shown in Figure 8; the output from the driver stage is connected directly to the corresponding segment, and each segment has its own pull-up resistor to +5V. The value of resistance will need to be chosen such that the current is limited to around 10mA for each segment. With a 5 volt TTL supply and red LED's having a forward voltage drop, V_f, of 1.6V, the resistance is found from:–

$$\frac{(5 - 1.6)}{10} = 340 \text{ ohms}$$

A preferred value of 330 or even 470 ohms will be satisfactory.

The circuit may be made up as

Continued on page 64.

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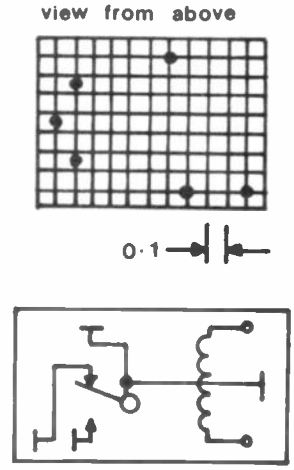
AMENDMENTS TO CATALOGUE *Continued from page 2.*

Page 208, HK84F is the assembled version not the kit.
Page 210, HK14Q is the assembled version not the kit.
Page 211, HK19V is the assembled version not the kit.
Page 211. The picture under the heading Microprocessor Trainer is transposed with the top left picture on page 212.
Page 212. Product ETA-3400, the picture of this item is shown in the right hand column of page 211. The last line above the order codes should show the ready-built version Heathkit No as EWA-3400.
Page 212, HK91Y is the assembled version not the kit.
Page 213, HK88V is the assembled version not the kit.
Page 235, YB39N Is now supplied with 5-pin DIN plug and socket not phono plugs.
Page 262, BW40T DIL IC Clusters. Available in 2:1 size i.e. 0.2" by 0.6" not 0.1" by 0.3" as stated.
Page 296. Toroidal Transformer (0-24V, 0-24V, 0-100V) for Digi-Tel Main Kit, which is included in the kit, is also available separately. Order As YK33L Price £15.75.
Page 315, YW47B Switch is not as stated in the catalogue: there are no fixing screws.
Page 324, BK28F Deluxe Head Cleaner. This item has been erroneously omitted from this edition of catalogue. Price £3.25.
Page 338, QX25C should be 4069UBE and not BE as stated.
Page 339, QQ53H should be 74LS48 and not 74LS38 as stated.
Page 351, Semiconductor Section, 7447A is not the same as 74LS48.
Page 384, YH66W, in the application circuit, the last code (pin 12) should be 111 not 110.
Page 414, the DD Display AF, required for this project is available. Order As BY67X. Price £2.20.
Pages 418 & 419, FG64U and FG65V descriptions should be transposed.
Page 429, XY79L Ceiling Speakers, Wattages are now 0.5, 1, 2 and 4W. Not the stated 1.25, 7 & 15W.
Page 431, Toggle Switch, 10A SPDT is illustrated but no details given. Order As BK33L Price £1.15.
Page 439, YX99H, specification is changed as follows:- Max current: 20A AC, 15A DC (make contact) inductive or resistive. 10A AC, 5A DC (break contact) inductive or resistive. Max voltage: 240V AC/28V DC. Life: 100,000 operations at rated load. Operate time: 15ms, max. Release time: 10ms, max. Coil resistance: 106Ω. Operate voltage range: 9V to 14.4V Dimensions: 30x24x17mm Pin spacing: As shown in diagram.

view from above



view from below

Page 458, FY04E Knife Blades are now supplied in packs of 10. The price is 76p.
Page 469, YX84F Microphone Transformer Type 3. This has been replaced by a different type details thus:- An in-line impedance changer, with high impedance input (50kΩ)and low impedance output (100 to 250Ω). Thus a long lead may be used with a high impedance microphone. The unit has an attractive spun aluminium barrel with standard ¼" mono jack socket input and ¼" mono jack plug output. Adaptors are available to suit other plugs/sockets, see page 186 of catalogue. Order As YX84F (Z Changer) Price £6.40.

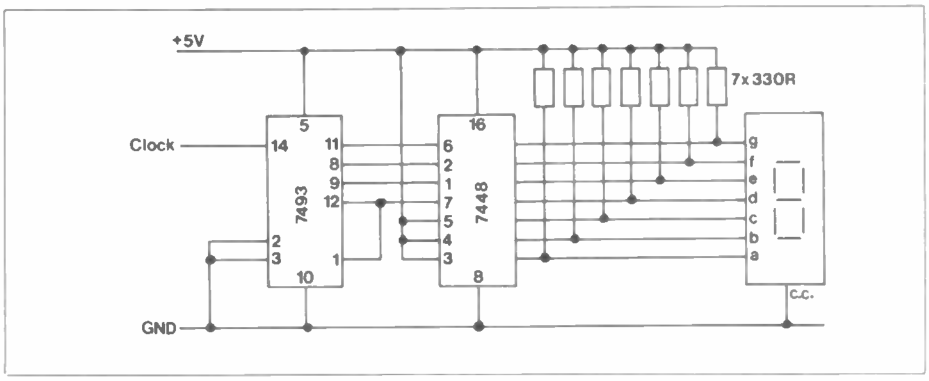


Figure 8. TTL counter with 7-segment display output.

shown in Figure 8, but there are a few remaining details which need to be explained. Looking at the pinout of the 7448 reveals some pins which have not yet been mentioned, i.e. those marked LT, BI/RBO and RBI, each of which has an 'over-bar' indicating that it is an active low input. The first, LT, stands for Lamp Test, and when taken to a logic 0 will cause all the segments to be lit, irrespective of the data inputs. In this application it must be connected to logic 1, +5V. The other two inputs are the Blanking Input/Ripple Blanking Output and the Ripple Blanking Input. These are used when several 7448's are used in cascade in order to blank out leading or trailing zeros in a multi-digit display, which helps to conserve power. In this application these inputs should be connected to logic 1, otherwise the display will be blanked out! However, once the circuit has been made up, don't hesitate to experiment and try to ascertain the effect of different logic levels on these pins. This would be more interesting if, say, two or three digits were used, but more of this in a subsequent article.

The input for the 7493 counter may be obtained from any of the clock sources outlined in the previous article. If a simple push switch is used, then the display will show the decimal number of 'pushes'; however if a 555 timer is used and the component values are chosen to give a period of 1 second, then the display will show elapsed time in seconds. It is not easy to obtain an accurate time-base of one second from such a simple circuit, and for greater accuracy it is usual to employ a crystal controlled oscillator. A typical frequency is 32768 hertz, and a chain of dividers is used to reduce this down to a frequency of 1 hertz, or a period of one second. The number of divide-by-two stages needed would be 15, and although this could be achieved using four 7493's, it would be a very inefficient and cumbersome arrangement. Needless to say, there are devices which can do all this, and more, in a single device.

Finally, the divider referred to throughout this article has been the 7493, which is a 4-bit device. This means that it is able to count up to 15 decimal, whilst the 7448 is only a binary coded decimal, or bcd, device. There will be six outputs, from 10 to 15, which cannot be represented on a single digit, and the 7448 will give a blank display for these inputs. A rather more suitable device for this application is the 7490 (or 74LS90) which is a decade counter. This will count up to decimal 9 and then go to 0 on the next clock pulse. It is pin compatible with the 7493, and may be used as a direct replacement in the above circuits. The only thing which needs to be done is to take account pins 6 and 7, labelled R9(1) and R9(2). These may be used to reset the counter outputs to 1001, i.e. decimal 9, rather than zero. In the above application both pins will need to be connected to logic 0, in order for the counter to operate.

In the next article we shall examine the subject of drivers and displays further and start to look at shift registers of various types.

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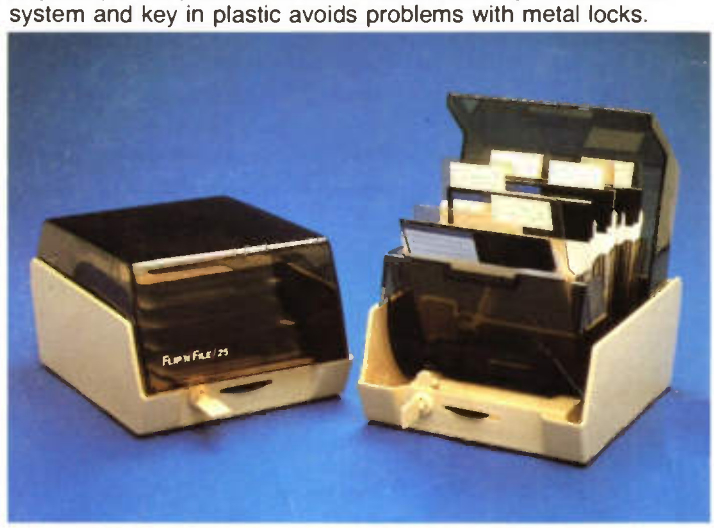

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