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Electronics
THE MAPLIN MAGAZINE

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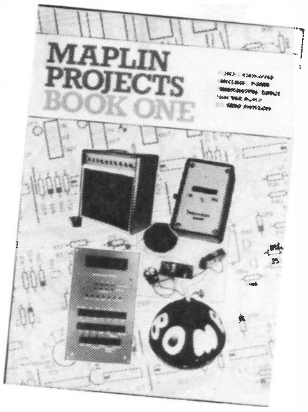

Copies of issue 1 are now sold out, but a reprint of the projects from issue 1 is available and contains:

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.

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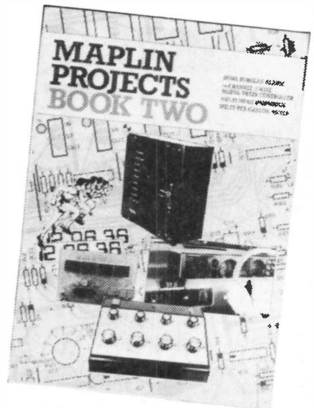
Plus six easy to build projects on Veroboard: Car Battery Monitor — Colour Snap Game — CMOS Logic Probe — Peak Level Indicator — Games Timer — Multi-Colour Pendant.

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



Copes of issue 2 are now sold out, but a reprint of the projects from issue 2 is available and contains:

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.
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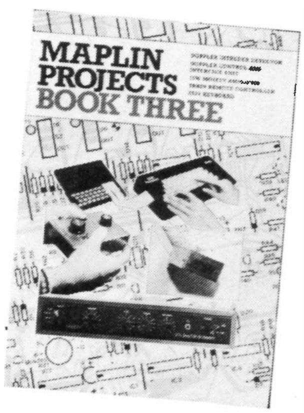

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ZX81 Keyboard. A full size, full travel 43-key keyboard with the electronics to make graphic symbols, function mode and shift lock, single key selections. The two-colour legend for the keys is the same as the ZX81 keyboard. The keyboard plugs directly 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.

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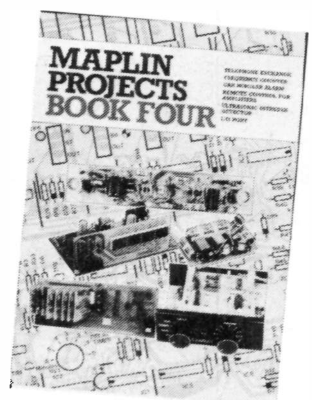

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Telephone Exchange. A complete telephone exchange with up to 32 extensions on 2-wire lines. Ideal for the home, office, or small factory. Save £££'s on rental charges. Full construction details for up to 16 lines in this book.

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 6000MHz 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*

TWO NEW SHOPS THIS AUTUMN

Coinciding with the publication of this issue of "Electronics" is the opening of our first new store this year. Doors open at 9 a.m. on Tuesday, 16th August, at 8 Oxford Road, Manchester (Tel. 061-236-0281), and we'll be open from 9 to 5.30 Tuesdays to Saturdays from then on.

We're easy to find too; right opposite the BBC between Piccadilly and the University complex, just a few steps from Manchester's Oxford Road Station and about five minutes walk from the city centre. There is excellent parking on meters in the adjacent side roads and we're about five minutes drive straight in from junction 10 on the M63 at the start of the M56.

The big difference with this store is that part of the sales area will be self-service, where you can browse around and choose the parts you want. Counter service will be available as well and upstairs you'll find our computer demonstration area along with hundreds and hundreds of different software packages for Atari, BBC, Commodore 64, Dragon, Sord M5, Spectrum and VIC20.

Our second new store this year takes us to the other end of the country. On November 1st we'll be opening in Southampton, to give us a base in the South of the country. You'll find us at 46-48 Bevois Valley Road (Tel. 0703 25831). The shop has sold electronic components for many years and will start to stock the Maplin range from mid-August, but the full range will not be available until November.

As always, of course, the big event of the year for us is the publication of our new catalogue, and this year it's a massive 480 page book with tons of additional data and pictures. The new catalogue will be on sale at the Electronic Hobbies Fair for just £1, so make sure you get along there as it promises to be a super show. In the pleasant, relaxed atmosphere of the Alexandra Pavilion from October 27th to 30th, we'll be demonstrating lots of our projects and kits and you can see some of the large range of Heathkit products, including the incredible microprocessor controlled robot, Hero 1. We look forward to meeting you there.

The one major difference in the new catalogue is that now you will find everything with its price on the page. And that means in the next issue of this magazine we'll have an extra eleven pages of projects and features. See you then!

Cover illustration by Tony Worsfold

Electronics
THE MAPLIN MAGAZINE

September to November 1983 Vol. 2 No. 8

CONTENTS

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★ Complements the Syntom and Synwave projects.
★ Makes a metallic chiming sound, similar to bells, gongs etc.
★ Delay variable from 50ms to 5s.

by Robert Penfold

The popular Maplin "Syntom" and "Synwave" projects are capable of synthesising a wide range of percussive sounds, such as drum and hand-clap sounds. The only obvious gap in their "repertoire" is metallic chiming sounds similar to bells, gongs, etc. The "Synchime" unit has been designed to fill this gap, and it has also been designed to match the "Syntom" and "Synwave" units. It can be triggered by tapping the case (or striking a drum on which the unit is mounted) or using a 5 volt positive trigger signal. The envelope shaper has a fast attack time and a decay time which can be varied from about 50 milliseconds to approximately 5 seconds. The other three controls are a straight forward combined volume and on/off type, plus separate frequency controls for the two oscillators. The latter give a wide operating range of about 100Hz to 7kHz so that a wide range of effects can be obtained. The output signal level is up to about 5 volts peak to peak from a low impedance source, which is more than adequate to drive any normal power amplifier.

Block Diagram

A ring modulator and two audio oscillators are used to generate the basic sound signal, as can be seen from the block diagram of Figure 1. A ring modulator is a form of mixer, but it is more like the mixer circuits used in superhet radio receivers than a normal audio mixer. In other words, it heterodynes the two sets of input frequencies to produce sum and difference frequencies at the output. For example, a 1kHz signal at one input would combine with a 5kHz signal at the other input to give output frequancies of 4kHz (5kHz — 1kHz) and 6kHz (5kHz + 1kHz).

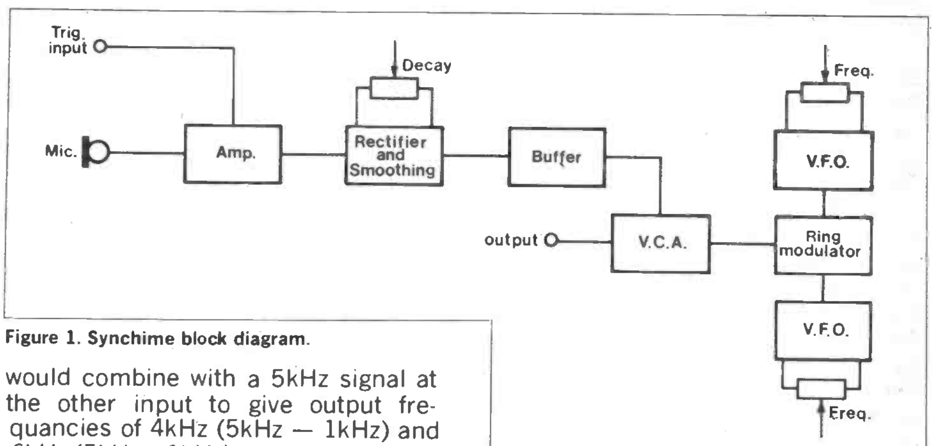


Figure 1. Synchime block diagram.

A ring modulator is a double balanced mixer, which simply means that both of the input signals are balanced or phased out at the output so that only the sum and difference frequencies appear at the output. In practice there is some breakthrough of the input signals at the output, but this is not really of any great significance. The important thing is that the new frequencies generated by the mixing action should be the dominant part of the output signal.

With most instruments the pitch of the sound produced is determined largely by a single dimension, such as the length of a string or a tube. This gives an output spectrum which consists of a fundamental signal plus harmonics of this signal. Instruments which use metal resonators are often two dimensional (plate-like) or three dimensional (bell-like) objects which consequently have more than one fundamental frequency, and mechanically produce a sort of heterodyne effect. A ring modulator fed by two oscillators therefore gives a good electrical analogy of a metallic instrument, and this system generates the desired types of sound.

In order to obtain a realistic percussive sound it is essential to have suitable envelope shaping. A simple fast attack, plus relatively slow decay time is adequate, and this is obtained using an amplifier driving a rectifier and smoothing circuit. When the amplifier receives either a trigger pulse or pulses from the microphone, due to its low output impedance it rapidly charges the capacitor in the smoothing circuit. The discharge rate is controlled by a variable resistor, and this has a value which enables a very long discharge time to be achieved if desired. The output of smoothing circuit is fed to the control input of a V.C.A. which is used to process the output of the ring modulator before it is fed to the output socket.

The Circuit

Figure 2 shows the complete circuit diagram of the "Synchime" unit.

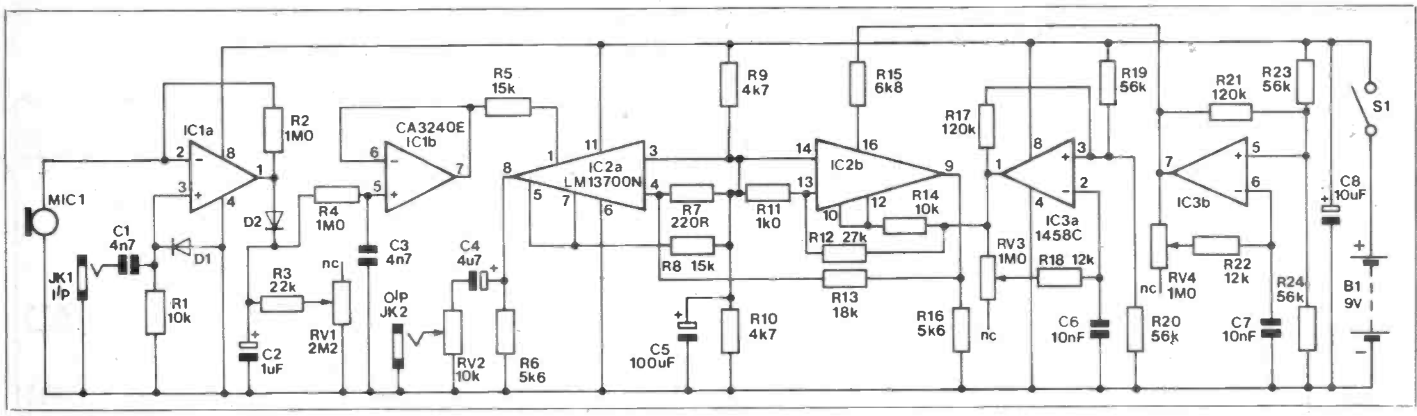
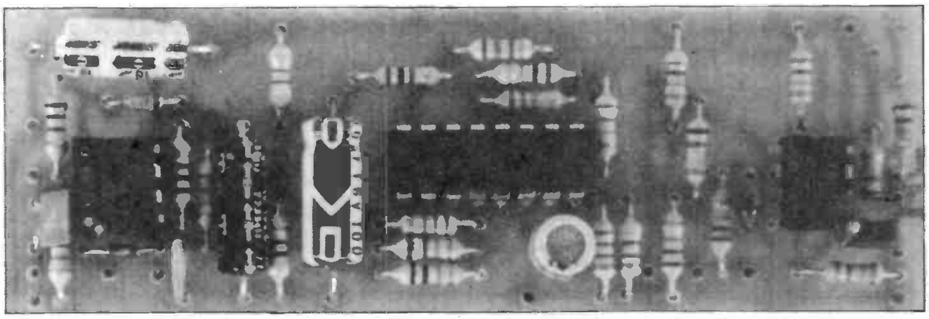


Figure 2. Synchime circuit diagram.



The two audio oscillators are based on the two sections of IC3, and a well known oscillator configuration is used here. The output is a roughly square waveform, and this seems to give good results in the present application due to the strong harmonics which produce a complex signal at the output of the ring modulator.

IC2b is one section of an LM13700N dual transconductance amplifier, and this is the main component of the ring modulator. The output of IC3b is coupled to the amplifier bias input of IC2b via R15. The latter is needed because it is the bias current fed to IC2b that determines its gain, and not the control voltage. Adding R15 in series with the amplifier bias input gives a bias current that is roughly proportional to the applied voltage, and gives the required voltage controlled operation.

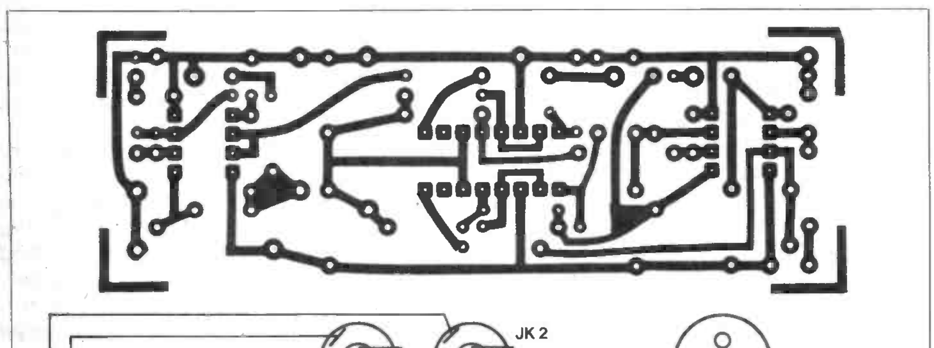


Figure 3. PCB layout.

The output of IC3a is fed to the non-inverting input of IC2b, and it is amplitude modulated by the signal from IC3b to give the heterodyne action and generate the new frequencies at the output. There is little breakthrough of the signal fed to the amplifier bias input and there is no need to add any components to phase out this signal. The same is not true of the signal fed to the inverting input of the modulator, and this does need to be balanced out. This is achieved by including R14 which feeds some of the input signal to the output of the transconductance amplifier. As the signal is inverted through the amplifier this gives the required cancelling, and the value of R14 is chosen to give a high degree of attenuation with the input to R15 at its average level.

Of course, the signal from 1C3a is not totally blocked from the output. When the signal to the amplifier bias input is higher than its average level the gain of the transconductance amplifier increases and its output impedance reduces. This increases the signal from the amplifier and decreases the signal obtained via R14 so that the circuit is unbalanced. Similarly, if the signal to the amplifier bias input falls below its average level, the gain of the amplifier reduces, its output impedance rises and the signal obtained by way of R14 increases so that the circuit is again unbalanced. This provides a proper ring modulator action with a signal applied to just one input producing no significant output, but the mixed signal being produced if both inputs are fed with a signal.

R16 is the discrete load resistor for the emitter follower buffer stage at the output of IC2b. From here the signal is coupled by R13 to the input of the V.C.A. This uses the other section of IC2 as a straight forward V.C.A. which has its

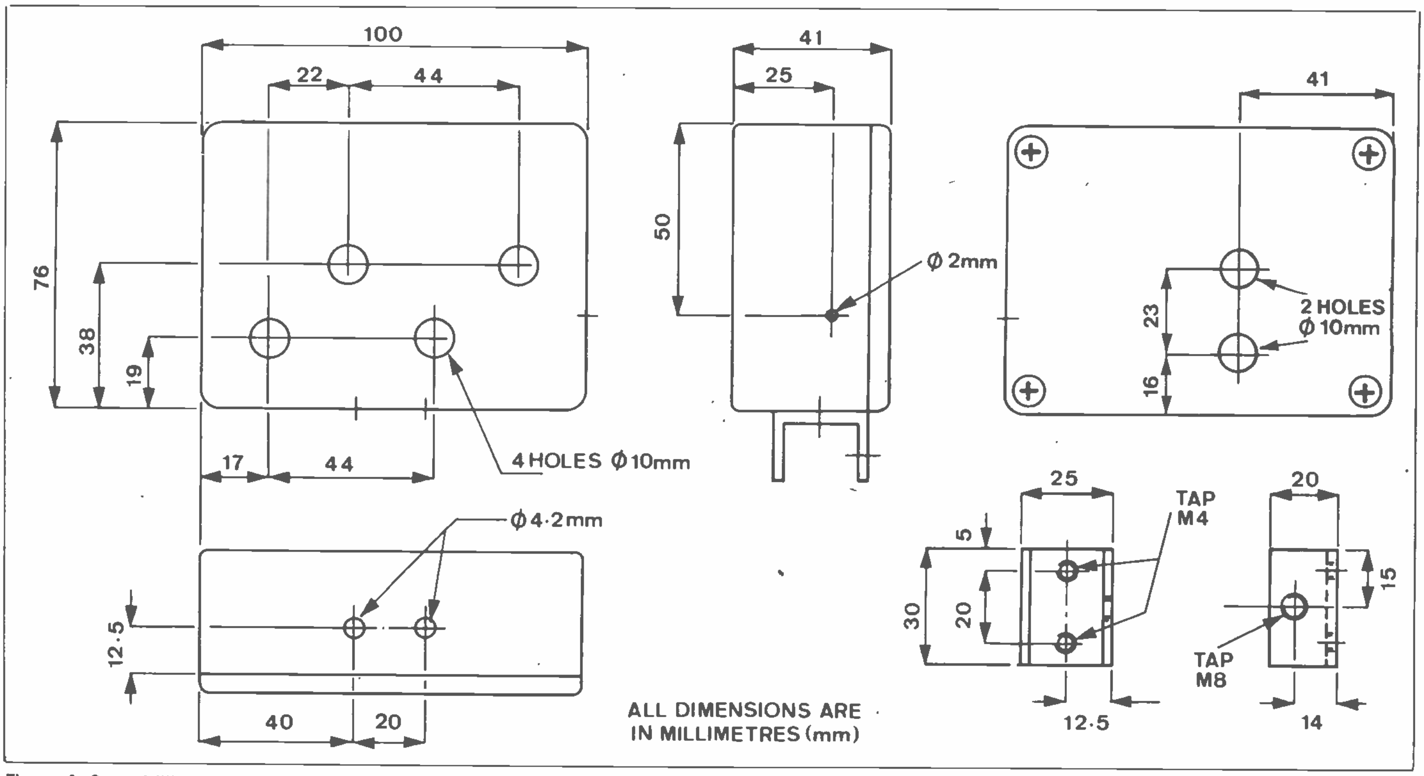


Figure 4. Case drilling details.

output coupled to output socket SK2 through volume control RV2.

IC1a is used as the input amplifier and it has Mic1 directly coupled to its inverting input. This is acceptable as the microphone is a crystal type, and it is actually a crystal earphone which is inexpensive but adequate for this application. R2 has been made quite high in value to give good sensitivity, but if necessary the value of this component could be changed to match the sensitivity of the unit to that of a Syntom or Synwave unit.

R1 biases the non-inverting input of IC1a to the negative supply rail so that the output also assumes this level under quiescent conditions. Negative input half cycles from the microphone drive the output of IC1a positive, but negative half cycles have no effect. The trigger signal is applied to the non-inverting input via C1, and a positive input pulse therefore gives the required positive output from IC1a. C1 is included so that long input pulses are effectively shortened and do not hold the envelope shaper "open".

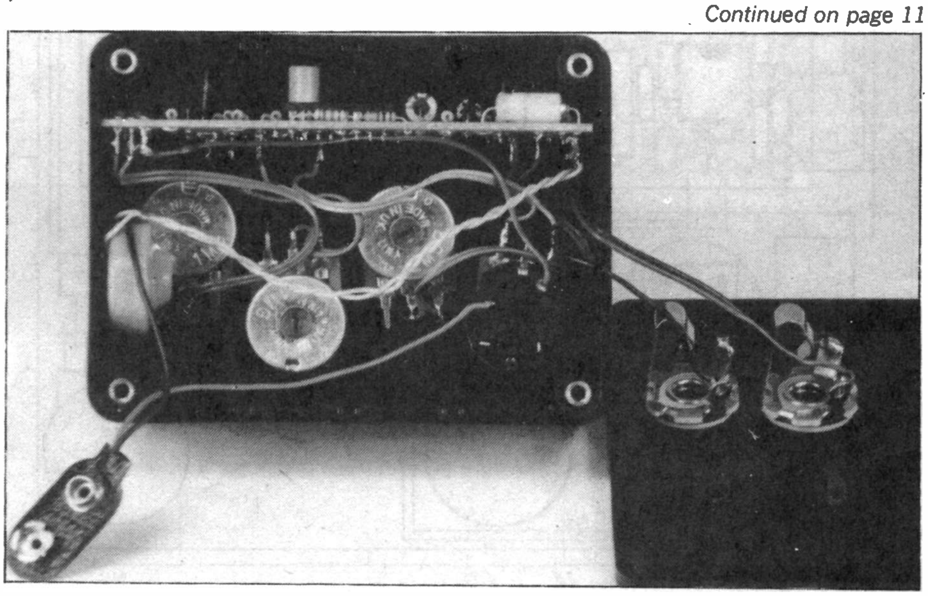
D2 enables IC1A to charge smoothing capacitor C2, but prevents C2 from discharging into IC1a. It can only discharge through R3 and RV1, and RV1 therefore controls the discharge (decay) time of the circuit. R4 and C3 prevent the circuit from having an excessively fast attack time which would cause a loud "click" each time the unit was triggered. IC1b is the buffer amplifier which ensures that the smoothing circuit feeds into a suitably high input impedance. Note that the CA3240E device used in the IC1 position has a class A output stage which enables its output to go within a few millivolts of the negative supply rail so that the V.C.A. is cut off under quiescent conditions. Other dual operational amplifiers such as the 1458C and LF353 cannot produce a low enough output voltage and will not operate properly in this circuit.

Construction

Details of the printed circuit and wiring are shown in Figure 3. The layout of the board is such that crowding of the components occurs in several places, but this is inevitable given the number of components and the size of the board. However, construction of the board is not difficult provided the specified types of capacitor are used and the small components are fitted into place first. IC1 has a PMOS input stage and it should therefore be fitted in an 8 pin DIL socket. The normal MOS handling precautions should be observed when dealing with this device. Veropins are fitted to the board at points where connections to the microphone, battery, and other off-board components will be made. When the board is installed in the case there is insufficient room to take wires over or under the board, and connections from the off-board components have to be made to the underside of the board. Either double sided pins must be used, or single sided pins inserted from the component side of the board must be fitted.

There is only just enough space for all the components inside the case, and the layout is very critical. Figure 4 shows the correct positions for the controls, sockets, and microphone, and it is advisable to follow this as closely and accurately as possible. The microphone, as explained earlier, is actually a crystal earphone. The transparent section of this is unscrewed from the main section and discarded. The screw at the rear of the unit is removed together with the rear cover which will come away with this screw. This screw is then used

Continued on page 11

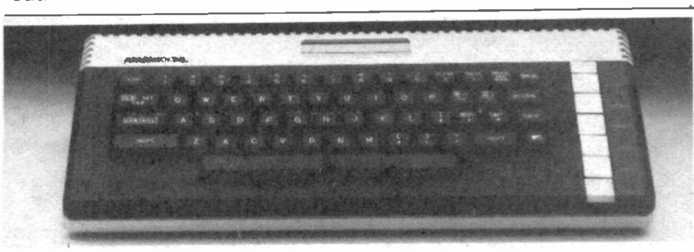


THE NEXT GENERATION

A superb new range of high quality computers from Atari at very competitive prices. The range comprises three new computers similar to the existing 400 and 800, but with the following additional features:

- 24K ROM operating system and BASIC either or both of which may be software switched out.
- Help key to give background information on selected programs.
- 4 special function keys.
- International character set.
- Software compatible with almost all existing software for Atari.
- 11 graphics modes.
- 5 text modes.
- External processor bus for future peripherals including a Z80 CP/M module running CP/M2.2 with its own 64K RAM.
- 256 colours — up to 128 displayable at one time.

Just to set to rest once and for all the popular misconception that Atari computers are just games machines, an expander box will be available in the new year with two RS232C interfaces, a parallel Centronics interface and slots for eight expansion boards. These will include an IBM interface, Z80 interface, 128K RAM disk, Winchester disk controller, modem, 80-column card, real-time clock, voice recognition card and several others. Now let's take a look at this world-beating new range, line by line.



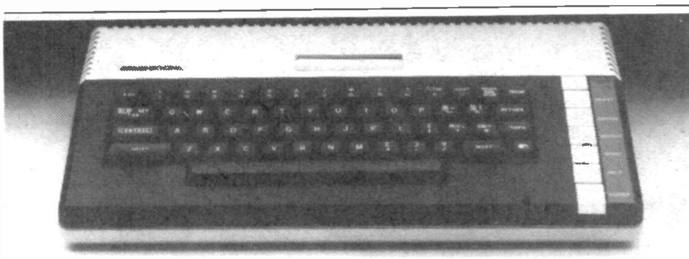
The Atari 600XL Home Computer

Simply — more features for your money.

This stylish new computer replaces the Atari 400, yet features a typewriter-style keyboard like the old 800 model. The single cartridge slot is centrally placed above the keyboard, so program cartridges can be inserted or removed while the computer is on, without disrupting its operation. The computer is supplied with 16K RAM fitted, but a further 48K RAM is also available which simply plugs into the parallel interface port on the computer's back panel to bring the total up to 64K and exactly match the spec of the 800XL. Unlike the American version, the British version is supplied with a socket for a monitor as well as TV. And the price for all that is just amazing.

***†Order As AF77J (Atari 600XL) Price £159.95**

***†Order As AF79L (48K RAM FOR 600XL) Price £99.95**



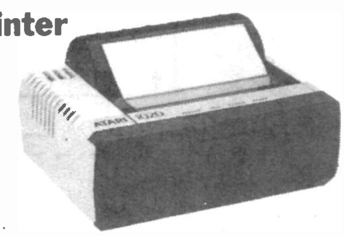
The Atari 800XL Home Computer

Complete with a full complement of 64K RAM.

In a slightly deeper case than the 600XL, the 800XL is a natural replacement for the Atari 800, maintaining all the old features and adding all the new ones described above, yet at a far lower price!

***††Order As AF78K (Atari 800XL) Price £249.95**

Atari 1020 Colour Printer



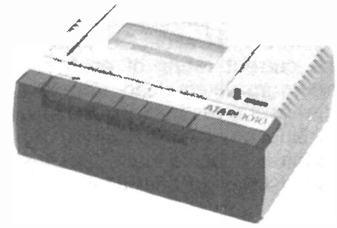
A new plain paper printer to replace the old 822 thermal model. The printer can produce four-colour graphics and text. It can create graphs, charts, artistic designs and comes complete with programs that let you draw on the screen and plot on paper directly, using a joystick and any Atari computer. In standard format mode the printer prints 10 characters per inch at a speed of 10 characters per second. The four-colour print head prints and plots vertically and horizontally and 2 sets of colour pens (red, blue, green and black) are provided.

***†Order As AF83E (1020 Colour Printer) Price £199.95**

****†BK80B (Paper for 1020) Price TBA**

****†BK81C (Rainbow Pen Pack) Price TBA**

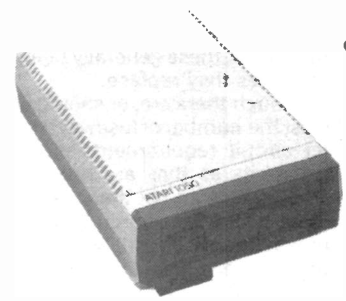
Atari 1010 Program Recorder



Replacing the Atari 410 is the newly styled 1010. It maintains the dual format of the previous recorder, permitting data on one stereo track and audio on the other. An automatic volume control assures perfect record and playback levels and the top-mounted control buttons have a positive touch. Data transmission rate is 600 bits per second giving a capacity of about 100K bytes on a C60 cassette.

***Order As AF80B (Atari 1010 Recorder) Price £49.95**

Atari 1050 Disk Drive



This is the new replacement for the 810, and has an improved positive-feel loading mechanism. All new 1050 drives will be supplied with DOS III which permits a higher data packing density so that you can store up to 127K bytes on each side of a disk. You can of course still call a single-density mode which is fully compatible with disks recorded or pre-programmed for the 810, or convert single-density data to the new format. In addition you can of course plug up to 4 of these drives directly onto any Atari computer giving you over half a Megabyte of on-line storage! The attractively designed, sleek new model is about half the height of the 810.

***†Order As AF81C (Atari 1050 Disk Drive) Price £299.95**

Atari 1027 Letter-Quality Printer

This new printer represents a low-cost technological breakthrough in letter-quality printers. It contains a five-wheel printhead that creates fully-formed characters like a daisy-wheel, but at a fraction of the cost. It's ideal for use with a word processor like Atariwriter for example. It prints 12 characters per inch in Prestige Elite 12 face at a speed of 20 characters per second. The printer accepts single sheets of paper and features bi-directional printing and 80 column. There is also an underlining facility.

***†Order As AF82D (1027 Letter Printer) Price £299.95**

****†BK82D (Replacement Ink Roller For 1027) Price TBA**

More New Products

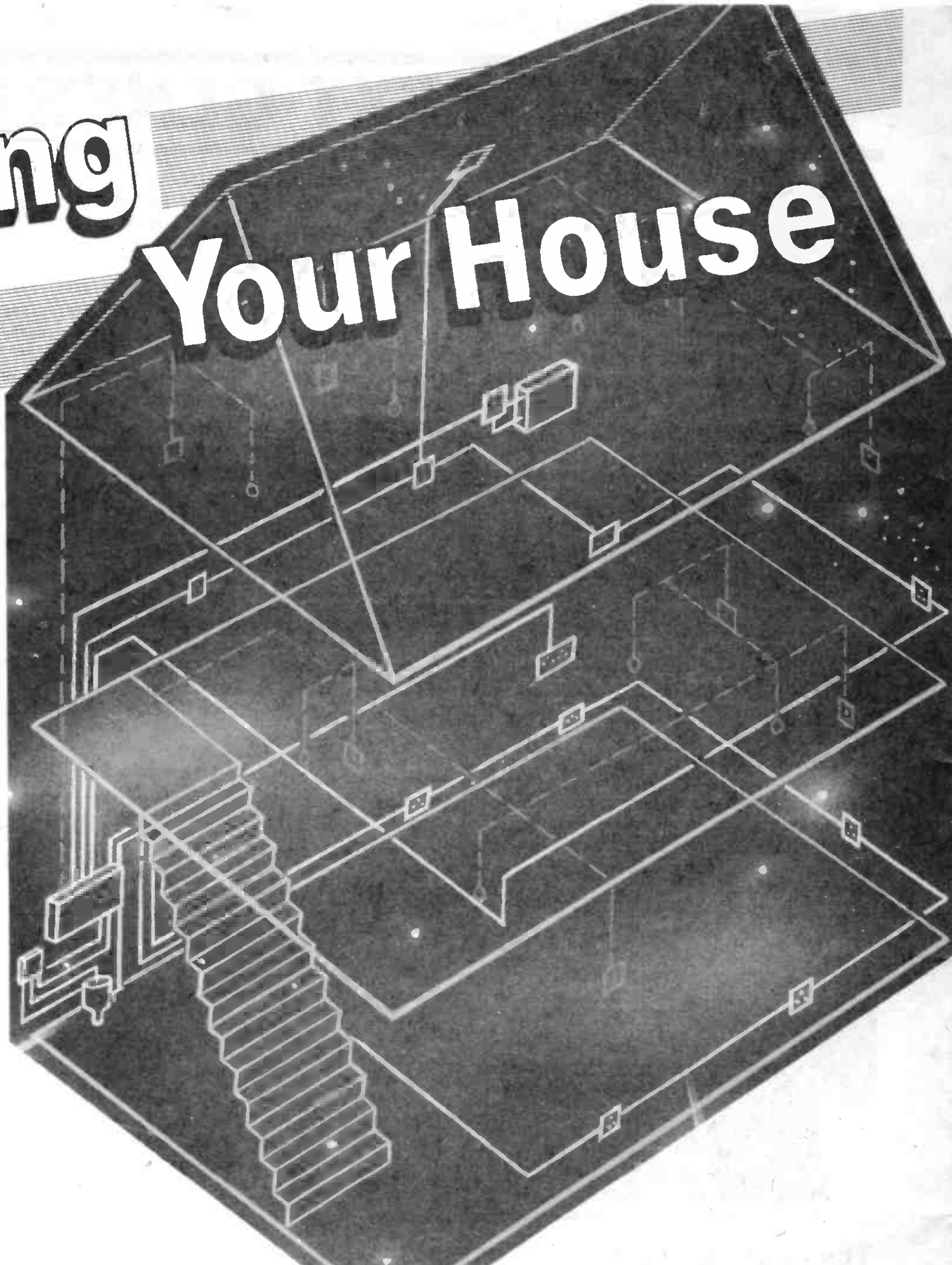
The new Atari product line is swelled by a whole range of new products due for release in November '83 and January '84. They include Atari's new flagship computer, the 1450XLD which in addition to all the features on the 800XL includes 4 programmable keys with 12 preprogrammed functions, and a double-sided dual-density disk drive offering 254K bytes capacity. The price should be under £500!

Also coming soon are a Light Pen, a Graphics Tablet, a new Joystick, an 80-column matrix Printer and a super new Trak-Ball controller that may sell for as little as £30! In addition to all this is the Expansion Box and its range of plug-in cards and the CP/M module described above. We'll have all the latest details in our next issue or for a more detailed specification of this brilliant new range get a copy of our new 1984 catalogue on sale from October 30th.

* Prices are tentative, please check with us before ordering.
** Prices not known at time of going to press.
† Available from mid-September 1983.
†† Available from mid-October 1983.

Please note: The above represents the very latest information from Atari (UK) at the time of going to press, but please check any specific point with us before ordering.

Rewiring Your House



by Geoffrey Burdett

The modern home electrical installation consists of a number of circuits of various current ratings to meet the required total expected load in kilowatts. The current rating of each circuit is the maximum likely load demand which in aggregate gives the total maximum current demand on the installation. Most circuits originate at a combined mainswitch and fuse distribution board, termed a consumer unit.

The fuse distribution section of the consumer unit comprises a number of fuseways, one for each circuit. Although traditionally termed fuseways, in many instances miniature circuit breakers (mcb's) are fitted into the fuseways instead of fuse units, these generally being superior to the fuses they replace.

Although there are, or should be initially, at least the number of fuseways in the unit to meet circuit requirements plus others to add circuits as they are needed over the years this is often not the case.

Where only one circuit is added, it is common practice to fit what is termed a mainswitch and fuse unit, or switchfuse unit which is really a one-way consumer unit.

Such practice lacks foresight, and although only one circuit is added at the time it is better to allow for at least another circuit which means fitting a multi-way consumer unit. Whether a switchfuse unit or a multi-way consumer unit, this, with the existing consumer unit, is connected separately to the mains by the electricity board, usually via a service connector box.

Some installations have yet another consumer unit, for off-peak storage heating and water heating, time controlled by a time switch so that the circuits and appliances are energised only during the off peak period eg. about 7 hours overnight when electricity is supplied at about half price. See tariffs.

Circuit cables

Most houses are now wired in pvc flat sheathed cable. The cable termed twin and earth has two insulated current carrying conductors, one red, the other black, and an uninsulated copper earth conductor now called the circuit protective conductor (cpc) and formerly the earth continuity conductor (ecc), because it is electrically continuous throughout the installation and terminated at the central earthing point, the earth electrode. In some parts of an installation 3-core plus earth flat pvc sheathed cable is used, usually in switching circuits containing more than one switch for the one light or for different lights in the same area. eg 2-gang, 3-gang assembly etc.

The core colours of 3-core and earth cable are red, yellow, and blue respectively plus the uninsulated earth conductor. The colours have no significance in home wiring but represent the three colours of the phases of a 3-phase electricity supply system. When used on single phase circuits

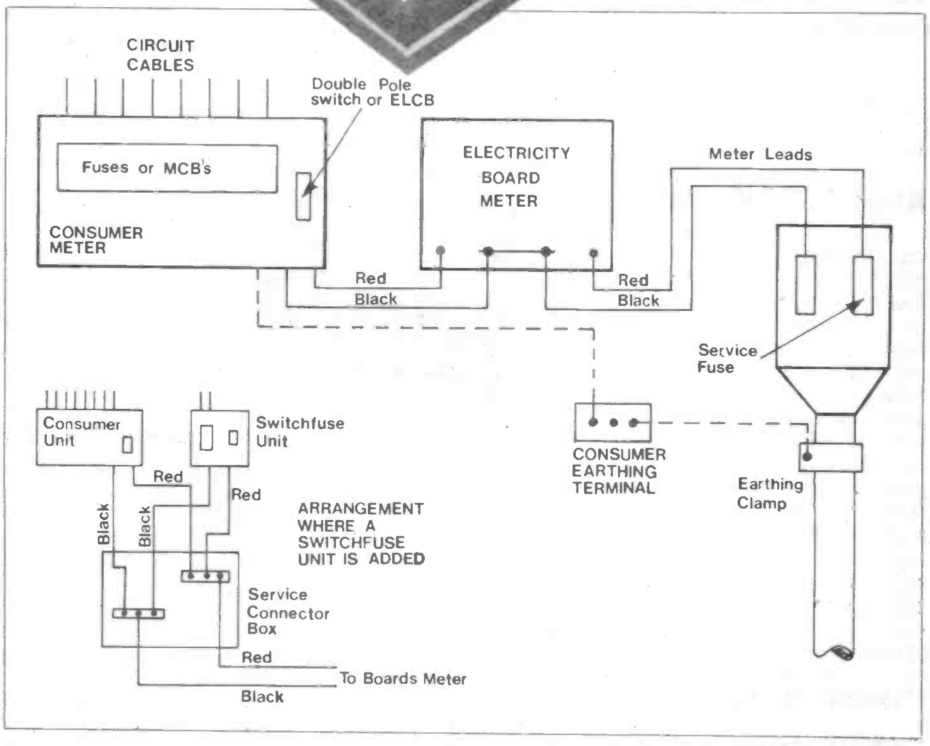


Figure 1. Arrangement at mains supply.

in the home for single pole switching the conductor ends should be enclosed in red sleeving or insulation tape as they are all live conductors.

Circuit cables are sold normally in 50m and 100m reels though they can be bought in shorter cut lengths where a limited amount only is required, this usually being the case with 3-core and earth cable and all the larger sizes of cables used in the home installation. Some homes are wired throughout in plastic conduit using non-sheathed pvc insulated cables in various colours. The cables are single-core and the colours are red, black and green/yellow striped, respectively.

The red is used for the live conductors, the black mainly for the neutral but is sometimes used as a live, suitably identified with red sleeving. The green/yellow conductor is the earth conductor.

Plastic conduit is also used in some twin & earth and 3-core & earth wiring, but as the cables are sheathed the conduit does not have to be continuous. It is used at switch drops and other vertical drops as well as in horizontal cable runs. Another form of enclosure for sheathed cables is plastic mini-trunking run vertically or horizontally on walls and ceilings.

Sizes of cables

The size of a cable is given as the cross section area in mm² of its current carrying conductor, the earth conductor in such composite cables usually being smaller since it carries current only to clear a fault. Earth conductors run independently are sized according to their cross section area in mm².

Circuit cables each have a specific size of current carrying conductor, the size determining the maximum current it is designed to carry without further rise in temperature. Possible voltage drop on long runs is also a factor considered when choosing a cable. The cable sizes used in home wiring circuits range from 1mm² to 10mm², with larger sizes for the connection of the consumer unit to the meter, these being termed meter leads or meter bights.

The 1.0mm² cable is used for lighting circuits, the 10mm² cable for cooker circuit cables. The intermediate sizes of cables for other circuits. See table 1 for the current ratings.

Circuit wiring accessories

In addition to the cables there are various components used in circuit wiring. The mounting box is among the most important wiring accessories, though often omitted. It is used for mounting socket outlets switches, fused connection units and a host of other accessories, these having open backs. The function of the box, in addition to being a ready mount for the accessory, is to enclose the unsheathed ends of cables, flex and connectors where used, in a non-combustible chamber.

There are two principal types of mounting box: moulded plastic and metal. The moulded plastic box is for mounting the accessory on surfaces and the metal box is for flush mounting the accessory, the box being sunk into the plaster or wall.

The boxes are of various sizes and depths. The most used box is the one-gang for mounting a single one-gang accessory. It is square in shape, approximately 87 x 87mm, the faceplate of the switch or other accessory being the same size. The metal box is slightly smaller at 86 x 86mm so that the accessory faceplate overlaps the box and covers the gap in the plaster.

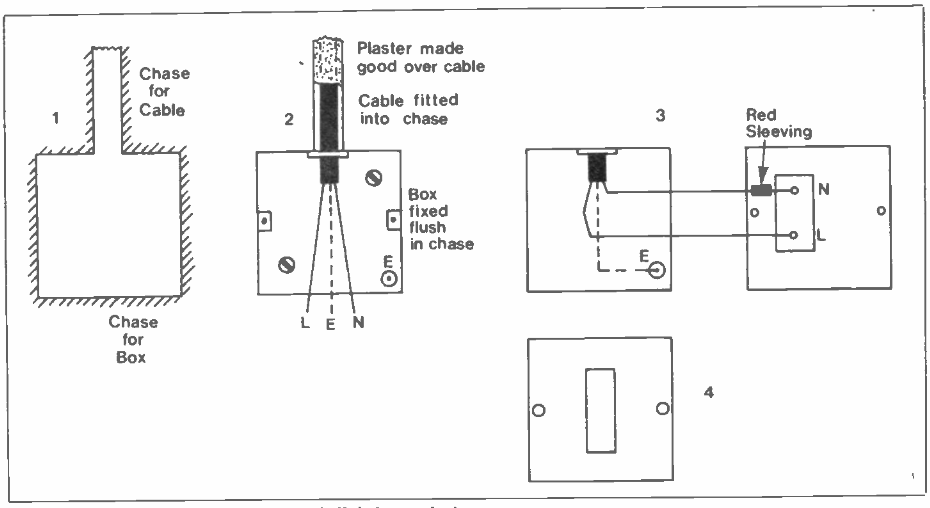


Figure 2. Sequence in fixing a flush lighting switch.

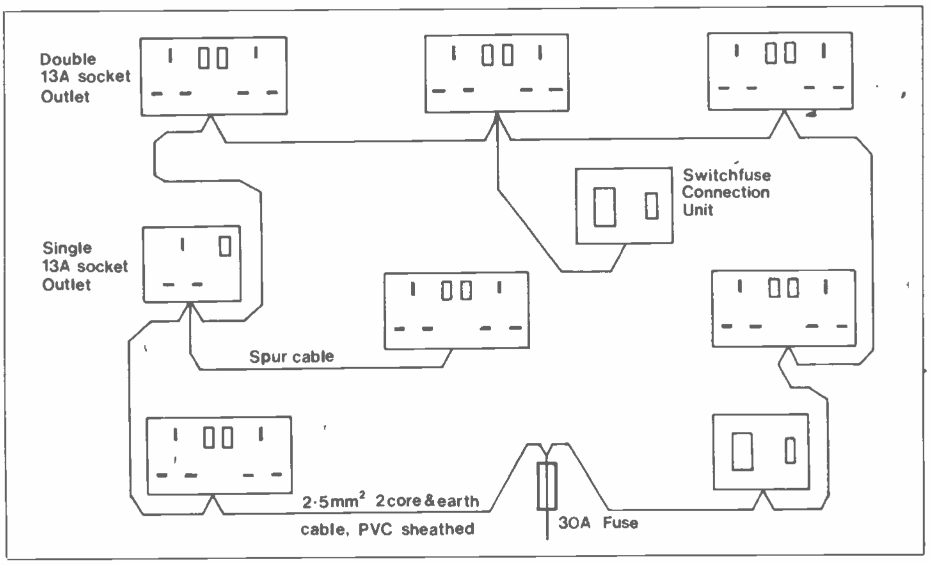


Figure 3. Ring circuit.

Depth of boxes

The boxes for lighting switches are plaster depth 16mm deep, and the plastic box 17mm.

For socket outlets the standard box has a depth of 25mm and deeper boxes where needed depending upon the accessory and the room needed in the box for cable connections. All have two or more screwed lugs for fixing the accessory, these being tapped M3.5 metric. Some lugs are adjustable for levelling the accessory after the box is fixed.

Socket outlets and plateswitches are actually flush fitting components, although surface mounted or flush mounted according to the type of box. Surface sockets are entirely different. They are self contained, and usually have an enclosed back for direct mounting on a suitable surface, the sheathed cable passing right into the accessory. Some versions are, however, mounted on a slim pattress block. There are also surface type switches, these usually being metalclad and sold complete with metal surface boxes. Whatever the type of box or accessory it is essential that the pvc

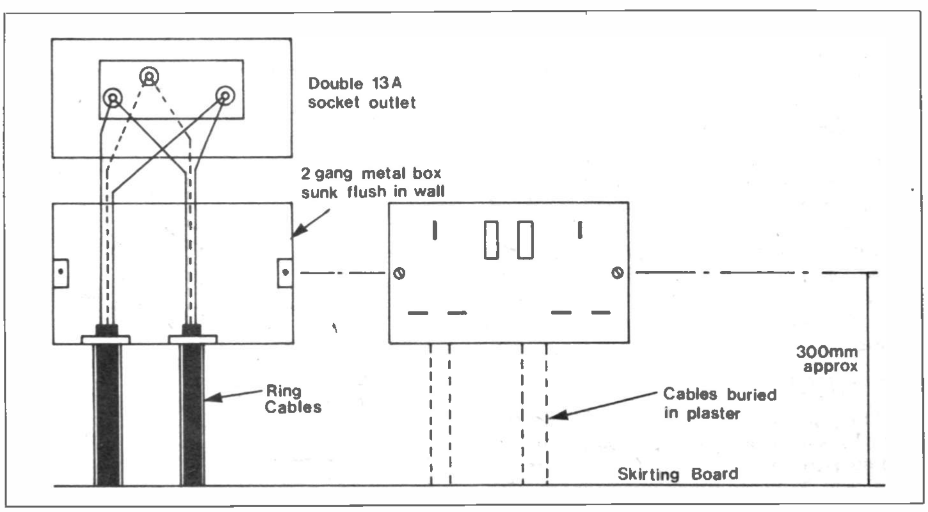


Figure 4. Fixing and connecting a ring socket outlet on the wall above a skirting board.

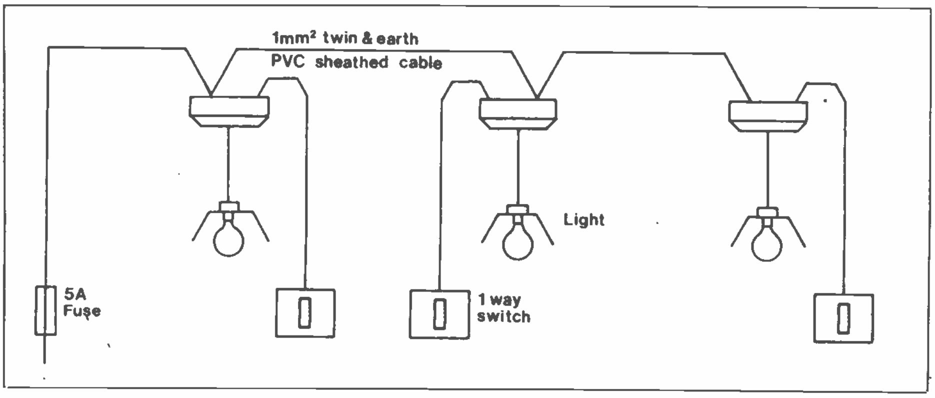


Figure 5. Lighting circuit wired on the loop-in system.

cable sheathing terminates within the accessory or its box.

The modern ceiling rose has no box and does not need one. It has an integral backplate, enabling it to be fixed direct to the surface of the ceiling. Thin plastic sections are knocked out of the backplate into which the sheathed cables are passed. Some batten lampholders and other ceiling fittings have an integral backplate, and need no box. However, most of the special pendant fittings do require a mounting box. This is a circular conduit box termed a BESA box, having a back outlet and fitted flush into the ceiling to support the ceiling plate and the fitting. Two screwed lugs are M4 metric. The box can be plastic, but where it is to support a fitting in excess of 3kg a metal box is necessary. The box is fixed to timber between joists, with a hole drilled to take the box outlet.

Most wall lights, as well as spotlights, also need to be mounted on boxes, to join the circuit wires to the flex wires and to contain the cable connector.

Lighting switches

The modern lighting switches are termed plate switches because of their faceplate, usually moulded plastic but sometimes metal. Most fit a one-gang slim or plaster depth box. The switch assembly can be a single switch, either 1-way, 2-way or intermediate, or it can comprise two or three switches in the one gang, these would all be 2-way switches which can be used for either one-way or two-way. Where four, five or six switches are required in the one position, a 2-gang faceplate and a 2-gang box are used.

Other switches

There is a whole range of switches used for other circuits including 20A double-pole, these requiring a deeper box. Cord operated switches used in the bathroom and bedroom are also made in one-way, two-way and double pole versions with and without neon indicator.

Socket outlets

The modern socket outlet used in the home installation is the 13A with fused plug having square pins, and has largely replaced the old round-pin 2- and 3-pin plugs and sockets of 15A, 5A and 2A current rating. As already explained, most sockets are of the flush type, either switched or non-switched, with or without neon indicator, in single and double versions.

Junction boxes

Junction or joint boxes used in home wiring systems are plastic, usually circular and have three or four terminals or banks of terminals. They are made in current ratings of 5A, 20A and 30A.

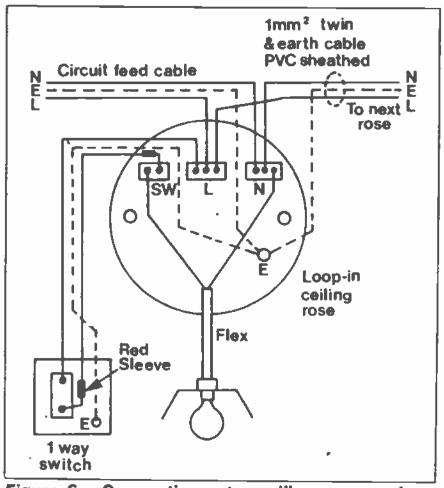


Figure 6. Connections at a ceiling rose on the loop-in system.

The ring circuit

A ring circuit, or ring final circuit to give it its official title, consists of a pvc flat sheathed cable starting at a 30A fuseway or mcb in the consumer unit, and runs throughout the various rooms, finally returning to the same fuseway terminals, forming a complete loop or ring, the connections being made at either the terminals of a ring socket or at a joint box.

Why a ring?

The ring circuit was designed in 1943/44 as a post war measure to enable dwellings to be equipped with an ample supply of socket outlets with the minimum of cable, when copper was in short supply. Before the advent of the ring a 15A socket outlet had to be supplied from a separate circuit, which meant 6 circuits for 6 15A socket outlets. However, abuse of the system over the years meant that sockets had been added to the original circuits, with subsequent danger from overload on the old wiring.

Therefore a circuit was designed to allow a number of power sockets to be supplied from a single circuit, which would save cable and require only one fuseway in the consumer unit, or fuseboard. The alternative was a radial circuit, which to supply a number of 13A socket outlets would mean a very heavy and costly cable. The cable would have to be of 30A current rating and its conductors would be too large for looping in and out of terminals of socket outlets. Ultimately the circuit in the form of a ring was devised using cable half the current rating at 15Amps. For about the same cost the cable supplying the ring would be nearly twice the length, cover a wider area, and be able to supply more socket outlets than a single run of cable.

Since each socket outlet connected to the ring cable would in effect be supplied by two cables (outgoing and incoming), this gave the circuit a current rating of 30A to match the circuit fuse or mcb. The size of the circuit cable was 7/.029 imperial which had a current rating of 15 amps, but was uprated to 21 amps, as is its metric equivalent 2.5mm² now used to wire ring circuits.

Local fusing at each outlet was made necessary because the circuit fuse is 30A and requires anything up to 60 amps to blow. The local fuse is in the plug, so that it protects the appliance and flex connected to it against short circuit current. The current rating (maximum) of a plug fuse is 13A which is the equivalent of a little over 3000 watts. The rectangular shape of the plug pins was chosen so that it could not be plugged into any other existing socket nor could any other plug be plugged into the 13A socket outlet.

The number of 13A outlets (sockets and fused connection units) which may be supplied from any one ring circuit is unlimited but the area in which the outlets are fixed must nox exceed 100m². The logic is that adding sockets within a given area does not itself increase the load or current demand but to increase the area is likely to, so far as space heaters are concerned.

Spurs

As mentioned, a spur is a cable branching off the ring cable at a convenient point, which can be the terminals of a ring socket or a 30A joint box inserted into the ring cable. Its principal purpose is to supply a socket outlet or a fixed appliance via a fused connection unit off the main route of the ring cable. This arrangement saves cable, but as it is a single length of 2.5mm² having a current rating of only 21 amps it may supply only one outlet. This can be either a single or a double socket or a fused connection unit. The number of spurs on a ring circuit must

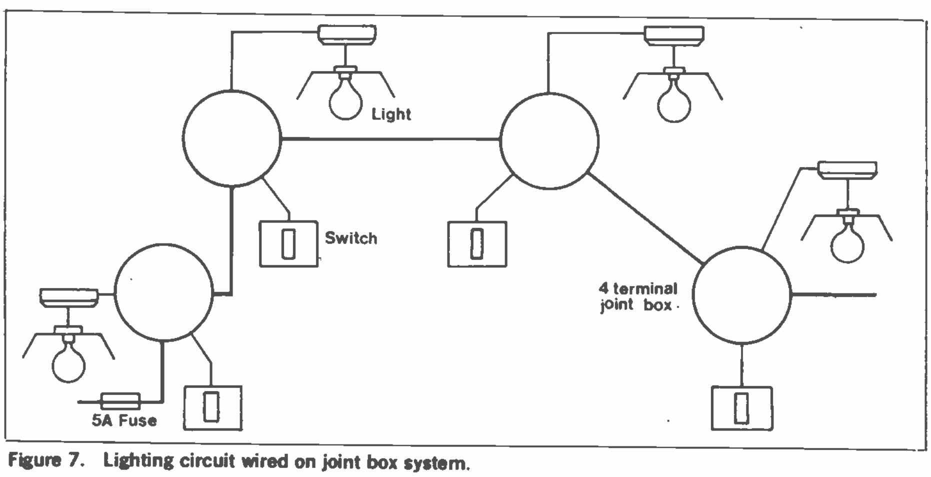


Figure 7. Lighting circuit wired on joint box system.

not exceed the number of socket outlets connected to the ring cable. Chiefly, spurs should be limited mainly for future extensions rather than to install initially, except where significant saving in cable can result.

Lighting circuits

A lighting circuit is a radial circuit, which means that the circuit cable terminates at the last light on the circuit and does not return to the fuseway to form a ring.

A ring is not necessary, since the cable is smaller, and can extend throughout the house if necessary, and the number of lighting points will still be consistent with the current rating of the circuit fuse or mcb.

There are two principal methods of wiring lighting circuits, or rather lighting points, and either or both methods can be used on any one circuit. These are the loop-in and the joint box methods.

Loop-in method

With the loop-in method the lighting circuit cable is run from a 5A fuseway in the consumer unit to each of the lighting points, starting at the nearest, looping out to the next, and so on until the last on the circuit, where the cable terminates.

Then, from each lighting point, a length of the same cable is run to the respective switch position, usually on the wall of the same room or area, eg hall or landing, and in some instances, such as in the bathroom, to a ceiling switch next to the access door. All the cable joints are made in the ceiling rose which also serves as a joint box with ready access in the same room.

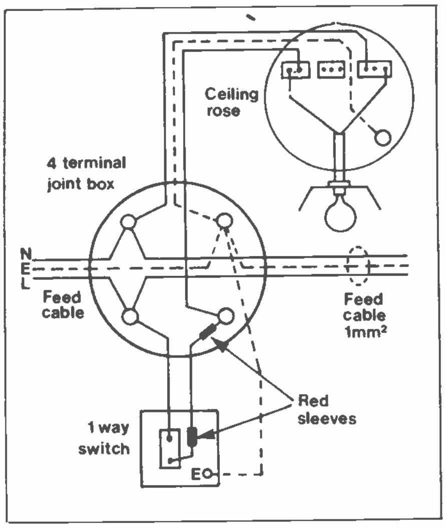


Figure 8. Joint box system.

Joint box method

With the joint box method the lighting circuit cable is run from the 5A fuseway to a series of 4-terminal 15A joint boxes, one for each light, and its switch situated in a convenient position between each light and its switch.

Then from a joint box two additional cables are run, one to the light the other to the switch, making a total of four cables, two feed cables plus the light and switch cables, except at the last joint box where there is only one feed cable. All joints are made in the joint boxes, which being situated in the ceiling voids or roof space are comparatively inaccessible, which is the main disadvantage of the joint box method. The main advantage is that less cable is normally used.

Mixed method

Although there are two methods, both

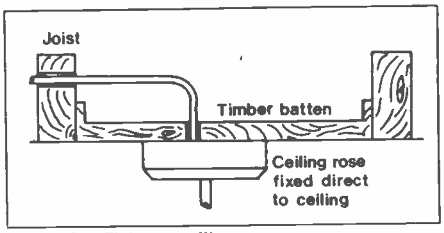


Figure 9. Fixing a ceiling rose.

can be applied to any one circuit, some lights being wired on the loop-in system, usually where ceiling roses are used. On other lights with no loop-in facilities, such as wall lights and some ceiling fittings and pendants, the joint box system is used with only one cable going to the light.

In rewiring the loop-in system is usually employed, since the new cables are run under the floorboards with the minimum disturbance and there is no need to allow for the fixing of joint boxes. Where the circuit cables are run in the roof space for the upstairs lighting the joint box method is often used, with the joint boxes fixed between joists.

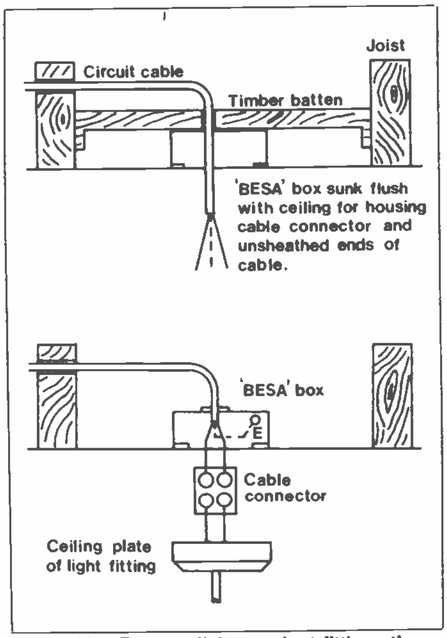


Figure 10. Fixing a light pendant fitting other than a ceiling rose.

Number of lights per circuit

A lighting circuit of 5A is on a 240V electricity supply equal to 1200 watts. This is the maximum which should be connected to the circuit. However regulations stipulate that a light containing a tungsten filament bulb is assessed at 100 Watts for any bulb, up to and including 100 Watts. Bulbs of higher wattage are assessed at the actual wattage. 12 bulbs at 100 watts each total 1200 watts, which is the maximum permitted. This means that the circuit may serve twelve lampholders, provided none contain bulbs of higher wattage than 100W. Where there are higher wattage bulbs the number of lampholders are reduced proportionately. With one or more 2- and 3-light fittings plus higher wattage bulbs the number of lights on a circuit should definitely not exceed eight, and preferably no more than six, so that the area affected by a fuse blowing is limited; this also allows for future additions of one or more lights on a circuit. A house of 3- or 4-bedrooms usually requires two lighting circuits but where wall lights and spotlights are included the number will be more.

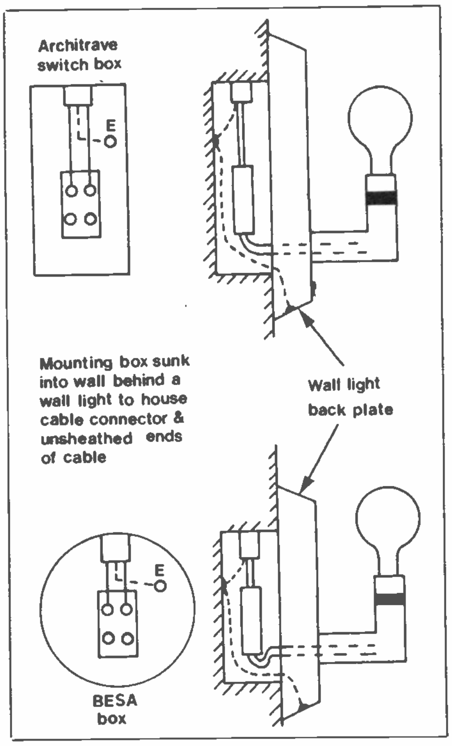


Figure 11. Mounting wall lights.

Fixed lighting, especially spotlights, can be supplied from a ring circuit via a fused connection unit fitted with a 3A fuse. Cable used for a lighting circuit is, as already explained, 1.0mm² twin & earth pvc sheathed with some sections wired in 3-core and earth pvc sheathed cable.

Installing lighting fittings

The simplest lighting fitting is the plain pendant comprising ceiling rose, flex and pendant lampholder. The ceiling rose of the wired pendant is connected to the circuit cables and fitted direct to the ceiling, with wood fixing between the joists to support it. See figure 9 for connections. Batten lampholders and some enclosed lighting fittings are similarly connected, but as already explained a special pendant having a ceiling plate is connected to a circular box fixed flush with the ceiling. The circuit wires are connected to the flex using cable connectors housed in the box. See figure 10.

Wall lights are fixed either to a round box or are mounted over an architrave switch box and fixed direct to the wall. See figure 11.

Fixing switches

A wall switch is fixed to a box mounted on the wall at a height of about 1.4m above floor level. For surface mounting a plastic box is used. This is fixed to the wall by two No.8 wood screws in holes drilled and plugged in the wall. A section of thin plastic is knocked out of the edge of the box and the cable threaded through. The end of the sheathing within the box is stripped off, and about 10mm of insulation from the end of each of the two insulated conductors. A piece of red sleeving or red pvc insulation tape is fitted over the end of the black wire, and the two conductors are connected to the two terminals of the one-way switch. The bared end of the earth conductor is enclosed in green yellow striped pvc sleeving and the conductor is connected to the earth terminal of the box. If a 2-way switch is used one conductor is connected to the common terminal of the switch, the other to the L2 terminal, and the switch fixed to the box with the Top on the faceplate at the top so that the rocker will be down to switch the light on.

For flush mounting the plastic box is fitted into a plaster depth chase cut into the plaster and, using No.8 wood screws, fixed to the wall in the two drilled and plugged fixing holes. For a cord operated ceiling switch the cable is passed through a removed section of thin plastic in the backplate, the ends prepared and the black conductor with red sleeving connected to the switch terminals and the sleeved earth terminal connected to the earth terminal on the backplate.

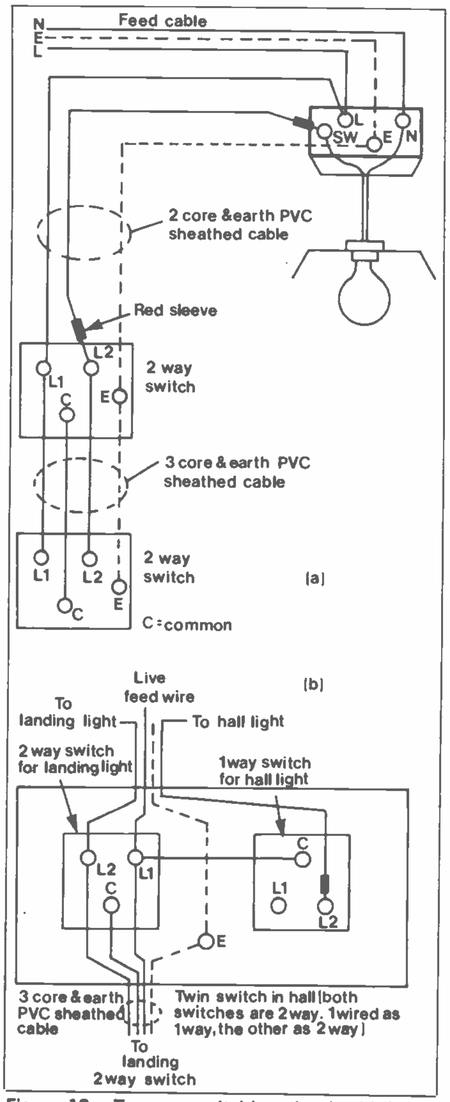


Figure 12. Two way switching circuit with hall and landing wiring.

Two-way switching

Where a light is to be controlled by two switches in different positions a 3-core and earth cable is run from the first switch position to the second switch position and a 2-way switch fixed at each. The connections at each switch are shown in figure 12.

Intermediate switching

Where a light is to be controlled by three or more switches in different positions intermediate switching is used. This is a 2-way switching circuit with a 2-way switch at each end and one or more switches fixed in intermediate positions between the two 2-way switches. One intermediate switch is needed for each extra switch position. An intermediate switch is an ordinary plate switch of the rocker type, but has four terminals instead of the two of a 1-way switch and three of a 2-way switch.

The 3-core and earth cable running

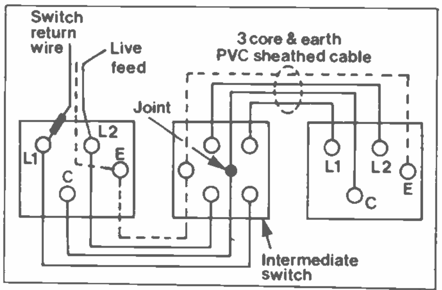


Figure 13. Intermediate switching.

between the two 2-way switches is cut at each intermediate switch and the yellow and blue wires connected to the terminals as shown in figure 13. The red wire running from the common terminal of one 2-way switch to the common terminal of the other 2-way switch is not connected to an intermediate switch, but because the cable is cut the conductor is jointed in the mounting box of the intermediate switch so that it is continuous from one 2-way switch to the other.

Dimmer switches

Where a light is to be controlled by a dimmer switch instead of a rocker switch the dimmer switch replaces the rocker switch without any need for modification in the wiring. Most dimmer switches fit the shallow or plaster depth switch. They are made in one and two-gang assemblies, to fit a one-gang box and control more than one light.

Where the light is fluorescent a dimmer switch cannot be used,though there are special dimmers and fluorescent fittings that can be used, but an extra switch wire has to be run from the switch to the fluorescent lighting fitting.

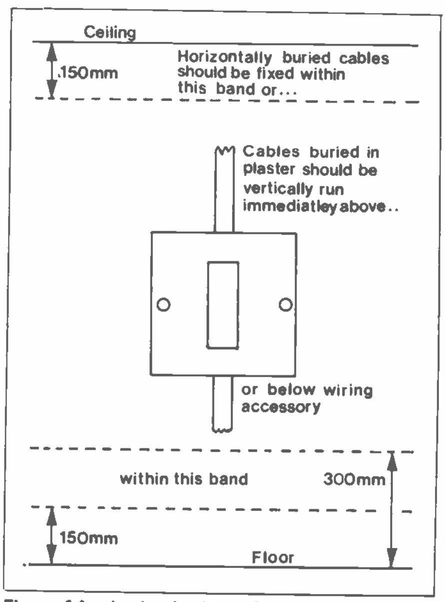


Figure 14. Laying horizontal cables.

In a roof space where polystyrene granules are used for heat insulation pvc sheathed cables must be situated where they do not come into contact with them, as the pvc is adversely affected by it. If it is not possible to avoid the insulation the cables should be enclosed in plastic conduit. Generally cables in the roof space should be situated away from walkways and the cold water storage cistern where they are likely to be disturbed.

Running circuit cables

The various circuit cables are normally run in the void between the ceiling and floorboards above the ground floor of a 2-storey house. These cables serve the lighting points and switches in the room below. Ring circuit cables supply socket outlets in the first floor rooms, and cables to an immersion heater and other apparatus are also run in this void. In the roof space are mainly lighting cables feeding the lights and switches in the rooms below, though the cable to the shower in the bathroom is sometimes run in the roofspace to a ceiling switch in the bathroom.

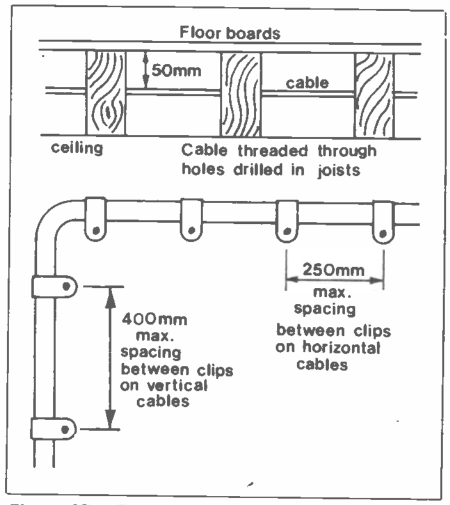


Figure 15. Fixing cables.

On the ground floor cables are run in the void below the floorboards where it is a suspension floor, but if the floor is solid cables may be run in conduits before the screed is laid, otherwise they are run behind skirting boards. PVC sheathed cable may in fact be run anywhere along the house structure, fixed to the surface or buried in the plaster without the need for protection from the risk of mechanical damage.

Cables clipped to the surface must have fixings not more than 250mm apart for horizontal runs and not more than 400mm apart for vertical runs. Where cables are buried in the wall they should as far as practicable be run vertically exactly above or below the switch or socket outlet they feed so that anyone later fixing shelves will know where to expect them. Where horizontal buried cables cannot be avoided they should be run in a band 150mm from the ceiling or between 150mm and 300mm above floor level. Where cables are run under floors and cross joists they must be threaded through holes drilled in the joists not less than 50mm below the tops of the joists.

It is neither necessary nor desirable to enclose pvc sheathed cables in conduit where buried in the wall since they are unaffected by plaster, and the extra chopping away can damage the wall structure. In houses under construction it is usual to enclose them so they stay in place and are not damaged by the plasterer's float during plastering.

Permission to wire

No permission is required in Britain to carry out home electrical installation work, though where the house is rented permission may be necessary from the owner. Neither electricity boards nor local authorities or any other official body has any jurisdiction in respect of wiring. The work should however conform to the IEE Wiring Regulations published by the Institution of Electrical Engineers and recognised as a code of good wiring practice by all official bodies, including electricity boards and government departments. The regulations, contrary to popular belief, are not statutory, and an electricity board has no powers to refuse connection to its mains of an installation, or parts of it, which do not strictly conform to the current IEE wiring regulations, but a board can and will refuse connection to its mains of any installation which is dangerous and as such does not conform to the Electricity Supply Regulations. These are statutory and are quoted in the application form signed by a consumer when requiring a supply of electricity.

An installation conforming to IEE Wiring Regulations is deemed to satisfy the requirements of the Electricity Supply Regulations and the electricity board must connect it to the mains. In these circumstances the board must connect the installation, whether carried out by a recognised contractor or by the householder himself.

From a contractor the board requires a test certificate, and may waive its own test and inspection. The householder who is unable to complete a test certificate can expect the board to test the installation through they are not obliged to do so. The test is at the option of the electricity board and is mainly to satisfy them that the installation will not adversely affect the supply to other consumers. It is important to note that good workmanship using correct material is necessary to conform to the regulations.

Electricity tariffs

A tariff is the means by which an electricity board calculate the amount to charge a consumer for electricity and the service provided. Basically, all tariffs consist of a fixed quarterly charge plus a charge for each unit of electricity consumed. Most domestic tariffs are of this type, though where a lot of electricity is consumed during off-peak times the charge for the electricity may be reduced, or even halved. A popular off-peak domestic tariff is the Economy 7 which provides electricity over a 7-hour night period at a cheaper rate.

Electricity consumed is registered on a 2-rate meter, and all electricity consumed during the 7-hour period is cheaper, whereas in some former off-peak tariffs only the electricity consumed by storage heaters qualified for the cheaper rate.

Even though the cheap rate now applies to all electricity consumed during the off peak period it is not usually financially beneficial to adopt the tariff, because the day time rate is higher than the standard rate per unit on the ordinary tariff. It is therefore advisable to have the tariff temporarily for at least two quarters (one summer the other winter) so that a comparison may be made.

*These current ratings apply where the cables are clipped direct to the surface. Ratings are lower for enclosed cables and some other situations, but are all suitable for the circuits specified.

Circuits	Fuses	Colours
Lighting	5A	White
Ring	30A	Red
Immersion heater	15A	Blue
Storage heater and 20A Radial Circuit	20A	Yellow

Current ratings of house wiring cables

The various cables used in house wiring with their sizes, current ratings, and the principal circuits in which they are used are as follows:

Cable size mm^2	Current rating* amps	circuits
1.0	16	lighting
1.5	20	lighting and 15A single socket circuits
2.5	28	ring circuits and 20A radial circuits
4.0	36	radial circuits (30A)
6.0	46	cooker circuits, shower unit circuits
10	64	cooker circuits
16	85	meter leads
25	108	meter leads

SYNCHIME *Continued from page 4*

to mount the microphone inside the case.

The printed circuit board fits into the top set of horizontal mounting rails in the case with the component side facing upwards. it will probably be necessary to angle C7 slightly inwards so that it fits under one of the corner mounting pillars of the case. Before finally fitting the board in place complete all the point-to-point style wiring. There is space for the PP3 size battery to fit between the sockets and the microphone, and a piece of foam material can be used to wedge this firmly in place.

Testing

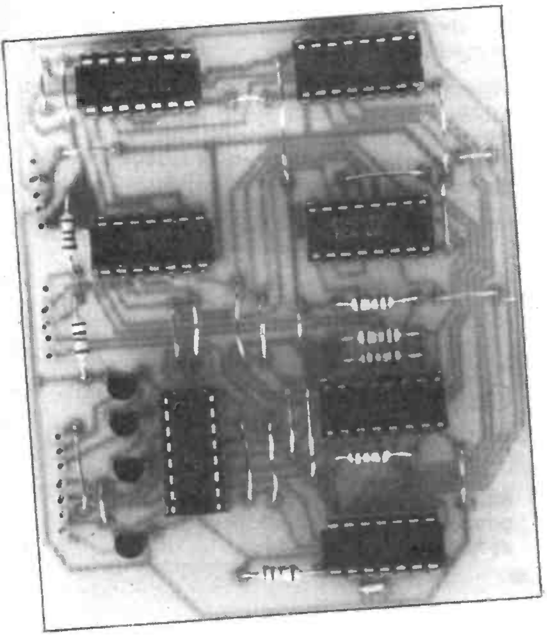
With SK2 coupled to an amplifier and the volume control advanced, tapping the unit should give an output, and using RV1 it should be possible to control the duration of each burst of output signal. The two pitch controls can be a little confusing at first, and it has to be remembered that the main output signals are the sum and difference signals produced by the fundamental frequencies of the two oscillators. The fundamental frequencies themselves appear at the output at a very low level, and might not be apparent at all.

In practice this means that quite a low pitch can be obtained if both pitch controls are set for a high output frequency, since the difference frequency might then be just a few tens of Hertz. With a little experimentation you should soon discover the types of sound that are produced at various control settings. At most settings of the pitch controls the output sounds quite discordant, but with the two oscillators set some musical interval apart, normal chime type sounds will be obtained. Good effects can be obtained with the two oscillators just fractionally off-tune, so that a low frequency beat not is obtained. At most settings of the frequency controls the output signal contains a wide range of frequencies, and filtering the output signal can expand the range of effects that can be obtained.

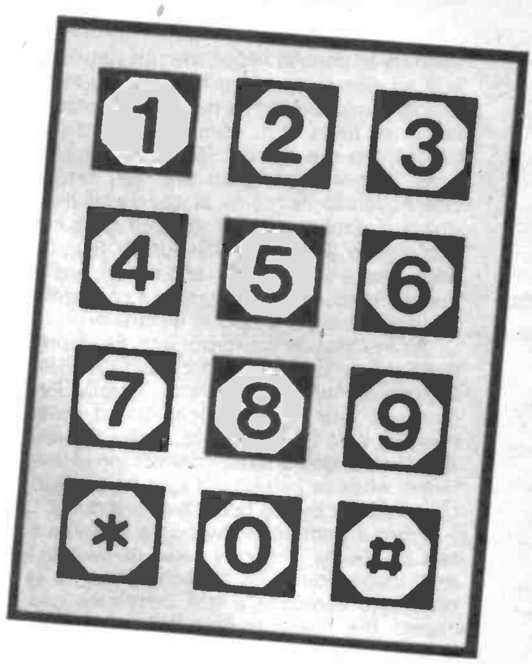
SYNCHIME PARTS LIST

Resistors — All 0.4W 1% Metal Film			
R1,14	10k	2 off	(M10K)
R2,4	1M	2 off	(M1M)
R3	22k		(M22K)
R5,8	15k	2 off	(M15K)
R6,16	5k6	2 off	(M5K6)
R7	220R		(M220R)
R9,10	4k7	2 off	(M4K7)
R11	1k		(M1K)
R12	27k		(M27K)
R13	18k		(M18K)
R15	6k8		(M6K8)
R17,21	120k	2 off	(M120K)
R18,22	12k	2 off	(M12K)
R19,20	56k	2 off	(M56K)
RV1	2M2 lin pot		(FW09K)
RV2	10k switched log pot		(FW63T)
RV3,4	1M lin pot	2 off	(FW08J)
Capacitors			
C1,3	4n7 ceramic	2 off	(WX76H)
C2	1uF 63V axial elect		(FB12N)
C4	4u7 63V P.C. elect		(FF03D)
C5	100uF 10V axial elect		(FB48C)
C6,7	10nF mylar	2 off	(WW18U)
C8	10uF 25V axial elect		(FB22Y)
Semiconductors			
IC1	CA3240E		(WQ21X)
IC2	LM13700N		(YH64U)
IC3	1458C		(QH46A)
D1,2	1N4148	2 off	(QL80B)
Miscellaneous			
JK1,2	Std Open Jacks	2 off	(HF91Y)
S1	Part of RV2		
B1	9 volt PP3 size		
Mic 1	Crystal earpiece		(LB25C)
	Case type MB2		(LH21X)
	Synchime PCB		(GB38R)
	8 pin DIL socket		(BL17T)
	Control knobs	4 off	(YG40T)
	Blue cap		(QY01B)
	Green cap		(QY02C)
	Red cap		(QY04E)
	Yellow cap		(QY06G)
	Battery connector		(HF28F)
	Wire	1 Pkt	(BL00A)
	Synchime Front Panel		(BK77J)

A complete kit of all parts is available.
Order As LK15R (Synchime Kit) **Price £10.90**



CODE LOCK



by Nigel Fawcett

★Fully programmable
★Will work with Maplin Home Security System
★Has a wide range of applications

With the current accent on home security, there have been many designs appearing recently for circuits to protect electrically operated doors or to add to the security of an existing alarm system, by using a code, known only to the owner, that will only disable the associated circuitry when correctly entered on an appropriate keyboard.

Fully programmable units have rarely been included due to their tendency to be costly, consequently extensive use of dummy switches, to fool the unauthorised persons, has been made. This normally means that a soldering iron is the only means of changing the code should it be required (and it frequently is).

The system shown here is fully programmable. A four digit code is used which can be stored and changed at any time simply by switching between read and write mode. (All the external components, plus the PCB but excluding the keypad, should be mounted in a case that is also protected by this device, to prevent access to the read/write switch or any other part of the unit that could render it inoperative).

Circuit Description

The keypad is anotated in exactly the same way as a push-button telephone, with digits 0-9, a hash key and an asterisk key. The hash key is used to arm the system, i.e. take the active high output 'high' and the active low output 'low'. The asterisk key is used to reset the system. This causes the memory address pointer and the number of correct entries counter to be reset to zero. (This also happens on every fourth keystroke). The keys 0-9 are used to enter the code. The four transistors TR1-TR4 are included to allow the use of an SPST type keypad. When a key is pressed, the encoder chip IC2 converts the row/column matrix into a binary code. If either the hash or asterisk symbols are pressed then the system performs a reset or an arm function respectively. If a number key is pressed then operation depends on the state of S1. In write mode, the code is written into the current memory location of the 4*4 bit register chip IC3. The address pointer is stepped onto the next location.

In read mode, the code is sent to the 4063 4-bit comparator IC4, this is then compared with the contents of the current memory location of IC3. If both codes match, then the number of correct entries counter is incremented. In either place the memory pointer is stepped on. If after four consecutive entries bit 2 of the counter is set, then the system will be disarmed, otherwise a reset is performed. Half of IC5 is used as the memory pointer, the other half being the output counter. Half of IC1 is wired as an astable multivibrator to generate the 16kHz clock for IC2, whilst half of IC7 is configured as a flip-flop to provide the active high and active low outputs. The remaining gates are used to decode the arm and reset conditions and to provide the correct polarity for certain data signals.

Construction

Insert all the wire links and resistors. Mount the four transistors and all the IC sockets. The three PCB mounted edge sockets should now be fitted and S1 wired to the appropriate plug. When the PCB has been thoroughly checked for bad joints or short circuits the IC's can be inserted into their sockets.

There are no special setting up procedures.

A five volt power supply is required and the connections for this as well as the wiring to the circuit being protected, are made to SK3. The keypad and S1 should now be connected to SK1 and SK2.

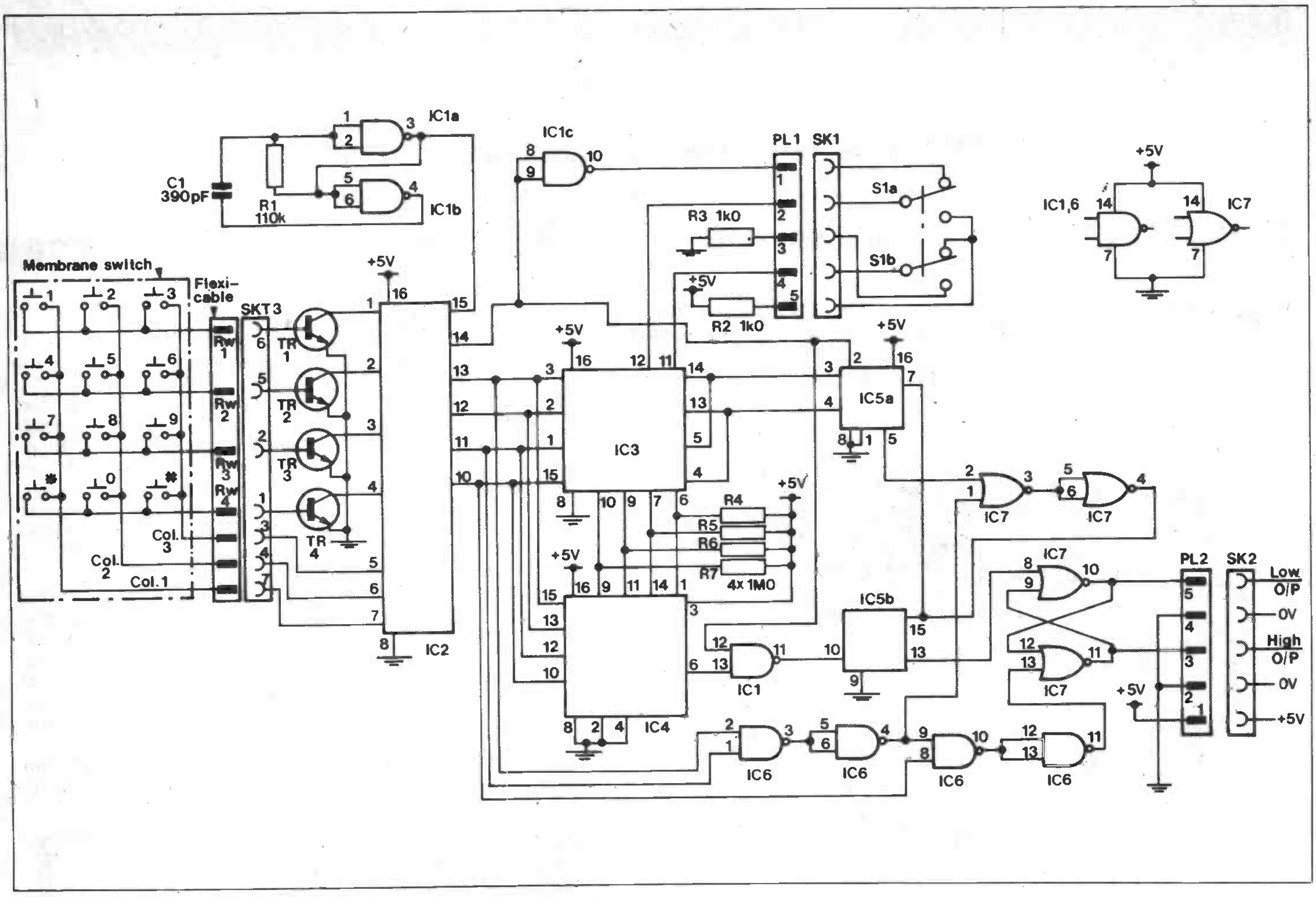


Figure 1. Codelock circuit diagram.

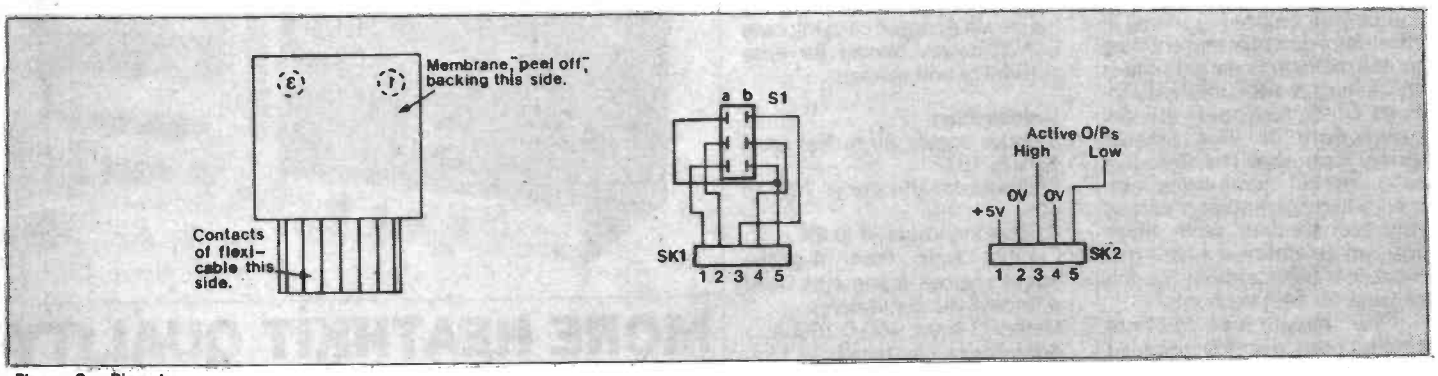


Figure 2. Pinouts.

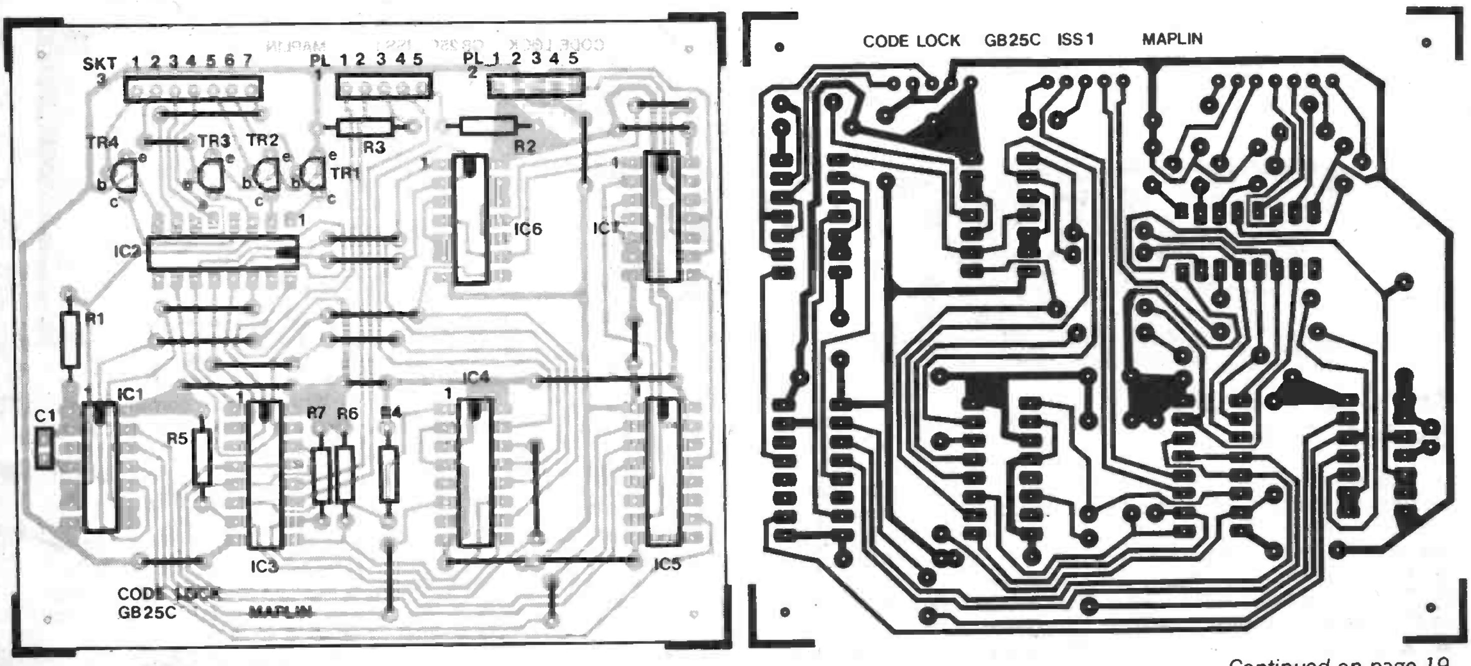


Figure 3. PCB layout.

Continued on page 19

Heathkit

This month: Car projects, more training courses, more test gear.

FASCINATING CAR PROJECTS

Exhaust Gas Analyser

Possibly the best way to guarantee your engine is running at maximum potential and emitting as few pollutants as possible is by testing it with this easy-to-build kit. By measuring thermal conductivity of your exhaust gases, it can show the air-to-fuel ratio, overall combustion efficiency and percentage of carbon mnoxide present. From these you can determine if a car's fuel mixture is unnecessarily too rich or weak for best economy.

The easy-to-read 114mm colour-coded meter is designed to hang on a partly open window or stand upright without marring paint finishes. The removable sensor/probe assembly uses a flexible stainless steel tube for safe conduction of all gaseous material. The instrument is housed in a rugged carrying case with foldaway handle for easy portability and storage.

Specification

3 meter scales: Air to fuel ratio: 11.5 to 15.0.
Combustion efficiency: 70% to 90%.
Carbon monoxide: 0 to 8%.
Exhaust type: From 4-stroke petrol engines (cannot be used with catalytic converters).
Meter: 114mm, 100-0-100uA.
Accessories supplied: 2.13m battery cord; 6.4m sensor cord; 762mm exhaust flexible tube.
Power requirement: 6V or 12V car battery at 150mA.

Order As HK31J (Exhaust Analyser) Price £119.95

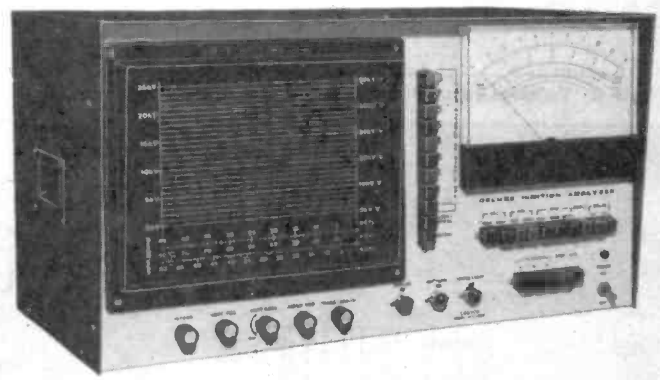
Professional Ignition Analyser

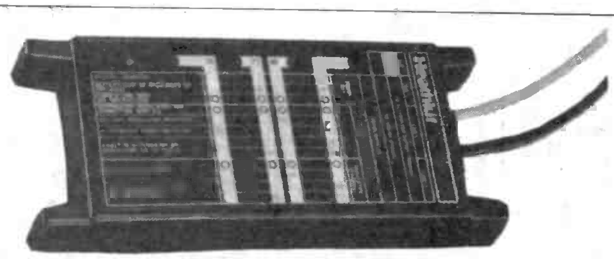
Designed for the hobbyist yet perfect for the professional garage, this superb kit assures you of a precision tune-up every time. Rock steady parade patterns are made possible by the latest design in inductive pickup circuitry and switch selection of 4, 6 or 8 cylinders. Dwell measurements are indicated on the big 200mm (8in.) meter.

The unit has two voltage ranges, 0 to 2V for corroded connections and points measurements and 0 to 20V for battery condition and general distribution checks. Cylinder selection buttons can be pushed in multiple numbers so that banks of cylinders can be shorted for carburettor balance and for display of one or more cylinders. Both parade and superimposed displays of primary or secondary waveforms with 10:1 and 2:1 trace expansion are available on the 305mm (12in.) display.

Rugged high-temperature oil and petrol resistant neoprene cables provide easy, positive connections to engine. For use with 4, 6 or 8 cylinder 4-stroke or 2-rotor Wankel engines and standard, transistorised or CD ignition systems.

Order As HK30H (Prof Ignition Analyser) Price £549.95





Low-Cost Charging System Tester

This easy-to-use, lightweight, portable instrument will check-out your car's charging system components with three quick tests. The tester will show you if the battery has sufficient charge to start the engine, if the battery is being charged by the alternator, if the voltage regulator is faulty and if the alternator stator windings and rectifier diodes are functioning properly. The tester may be used with cars with a negative chassis, 12V charging system that has an alternator or any 12V, negative ground charging system that employs a 3-phase alternator using six rectifier diodes. Size 140 x 64 x 19mm.

Order As HK29G (Charge System Tester) Price £24.95

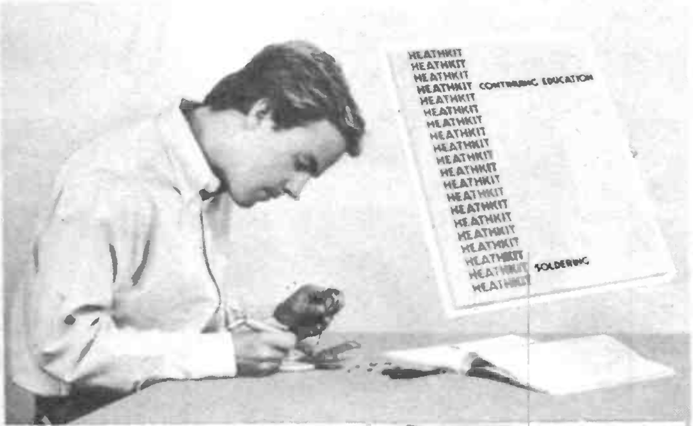
MORE HEATHKIT QUALITY TRAINING COURSES

BASIC ELECTRICITY COURSE

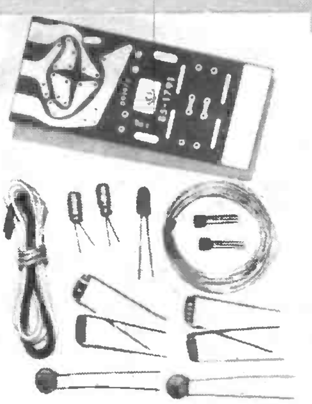
No technical background is required for this course which uses audio-visual teaching methods to introduce you to electricity. A programmed-instruction text, enhanced by clear visuals and two audio cassettes, teaches you each concept in an easy to follow sequence to build a solid foundation. A specially written workbook reinforces the learning process.

When you complete the course you will know the basics: Ohm's law, series and parallel circuits, electromagnetism, direct and alternating current, generators, motors and basic meter operation. This course serves as a valuable introduction to the Heathkit Basic Electronics series (described in our last issue).

Order As HK32K (Basic Electricity) Price £34.95



Soldering Course



With 95% of all returned kits found to be faulty due t poor soldering, here's a course that could benefit many hobbyists. Using the proven programmed instruction format, the step-by-step text begins with mechanical connection and progresses through tinning, temperature control, different types of solder etc. A practice kit complete with circuit board, components and solder is provided for construction of a two transistor light oscillator. Soldering iron and tools are not included.

Order As HK33L (Soldering Course) Price £19.95

An Introduction To Microprocessors EC6800

This course requires no previous knowledge and shows you how microprocessors operate, number systems and codes and computer arithmetic and microprocessor programming. The course is divided into six concise self-instruction units with detailed illustrations.

A typical microprocessor is described in the final units and programming experiments placed throughout the text assist your understanding.

Order As HK36P (Intro To Micros) Price £34.95

Trainer For Intro to Micros Course

For use with the course described above, this trainer, a mini digital computer has an 8-bit parallel NMOS bus-orientated central processing unit. You can access memory locations, enter programs, single-step through programs and alter memory.

Order As HK37S (Trainer For EC6800) Price £99.95

TWO SUPERB TEST GEAR KITS

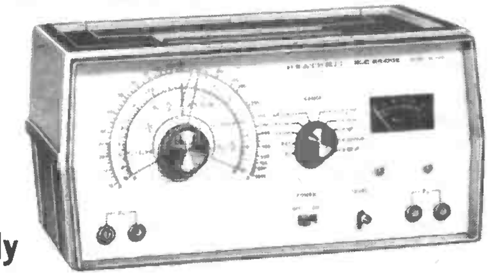
RCL Bridge

A very useful power source for the test-bench. The unit has a continuously variable output voltage from 1V to 15V DC at up to 500mA and features 500mV line and 50mV load regulation. The "floating ground" system enables the supply to furnish positive or negative output voltages.

The programming terminals on the rear of the cabinet enable you to use an AC or DC voltage from another source to control the output voltage of this power supply. The unit has fully adjustable current limiting. Size 146 x 140 x 110mm.

Order As HK35Q (15V Regulated Supply) Price £49.95

1V to 15V Regulated Power Supply



This quality kit allows you to measure capacitance from 10pF to 10uF, inductance from 10uH to 10H and resistance from 10 to 10M . Oscillator frequencies of 1kHz, 10kHz and 100kHz (or external source) are provided. Provided with a rugged moulded cabinet and component clips. Require two 9V batteries.

Order As HK34M (RCL Bridge) Price £54.95

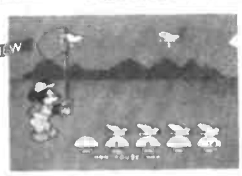
NEW SOFTWARE FROM ATARI

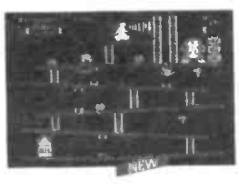
Available now:

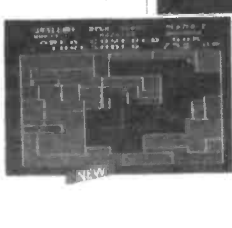
KF16S Qix (16K Cart) **£29.95**
KF19V E.T. Phone Home (16K Cart) **£29.95**
KT22Y Donkey Kong (16K Cart) **£29.95**
KF18U Atariwriter (16K Cart) **£59.95**
KT23A Biorhythm (8K Cass) **£14.95**
KT24B Timewise (32K Disk) **£22.95**
KF10L Defender (16K Cart) **£29.95**
KF11M Galaxian (16K Cart) **£29.95**
KF52G Home Filing Manager (16K Disk) **£34.95**

Due for release in August:

KT25C Eastern Front - 1941 (16K Cart) **£29.95**
KF47B Juggles Rainbow (16K Cass) **£22.95**
KF48C Juggles Rainbow (16K Disk) **£22.95**
KF49D Juggles House (16K Cass) **£22.95**
KF50E Juggles House (16K Disk) **£22.95**
KF51F Speed Reading (16K Cass) **£59.95**
KT26D Mickey In The Great Outdoors (16K Cass) **£22.95**
KT27E Mickey In The Great Outdoors (32K Disk) **£22.95**
KT28F Ms. Pac-Man (16K Cart) **£29.95**
KT29G Tennis (16K Cart) **£29.95**
KT30H Logo (16K Cart) **£59.95**
KT31J Family Finances (32K Disk) **£TBA**







Due for release in September:

KT32K Microsoft BASIC II (16K Cart) **£TBA**
KT33L Donkey Kong Jr. (16K Cart) **£29.95**
KT34M Pengo (16K Cart) **£29.95**
KT35Q Pole Position (16K Cart) **£29.95**
KT36P Robotron (16K Cart) **£29.95**
KT37S Peter Pan (16K Cass) **£22.95**
KT38R Peter Pan (32K Disk) **£22.95**
KT39N Atari Music I (16K Cass) **£TBA**
KT40T Atari Music I (32K Disk) **£TBA**

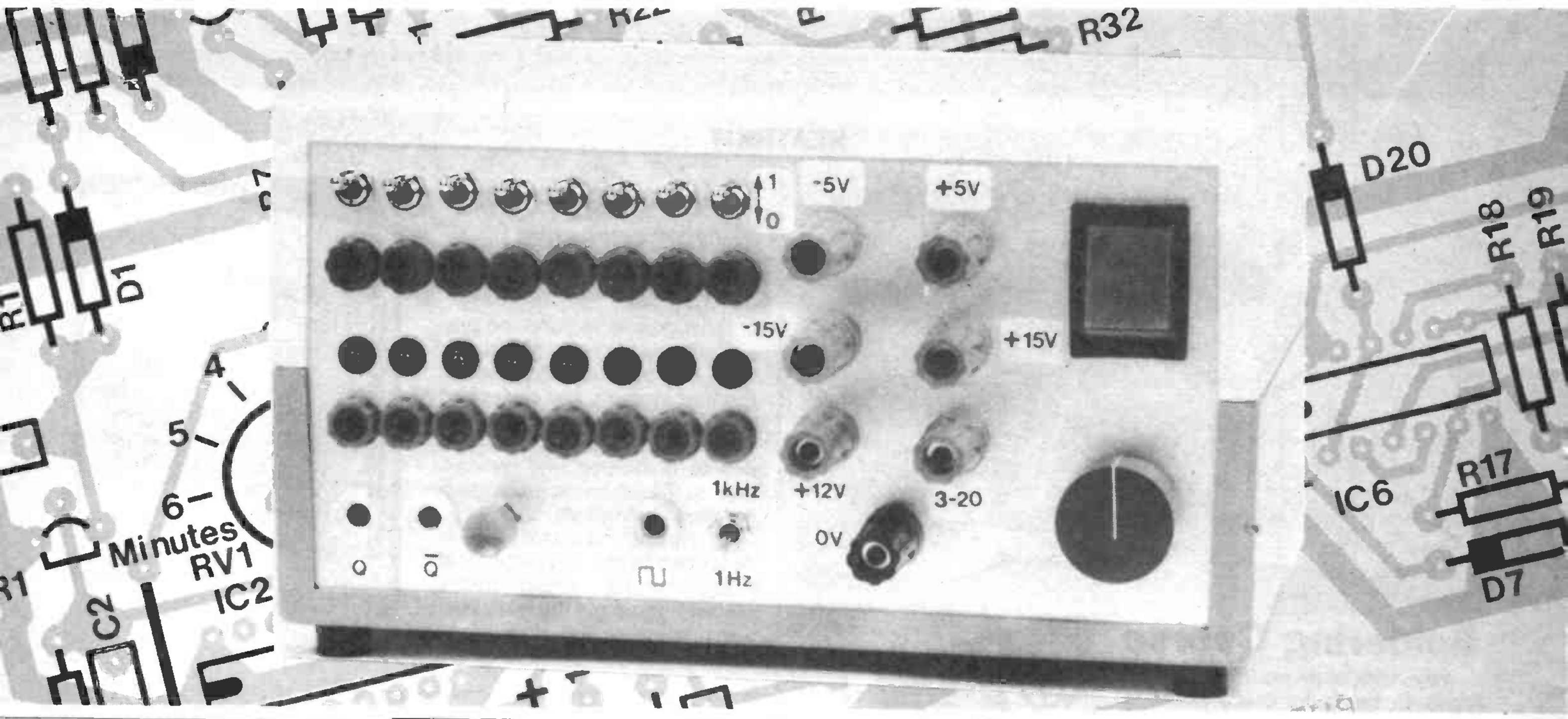
Due for release in October:

KT41U Atari Music II (16K Cass) **£TBA**
KT42V Atari Music II (32K Disk) **£TBA**
KT43W Joust (16K Cart) **£29.95**
KT44X The Learning Co. (48K Disk) **£TBA**
KT45Y Alice In Wonderland (16K Cass) **£22.95**
KT46A Alice in Wonderland (32K Disk) **£22.95**

Due for release in November:

KT47B Soccer (16K Cart) **£29.95**
KT48C Millipede (16K Cart) **£29.95**

Please note that the above represents the best information we have available from Atari (UK) Ltd. at the time of going to press, but delivery dates and prices may change, so please check with us before ordering.



The Maplin MINILAB

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

Introduction

The idea for 'Minilab' developed from the need, or desire, to test and experiment with a wide range of digital and linear circuits. This usually necessitates a variety of different supply voltages. For example, when experimenting with op-amps, a dual 15V supply is needed; TTL digital circuits require a +5V supply and some other digital circuits need +12V and -5V e.g. microprocessors and related chips. An infinite variety of linear circuits exist that need unspecified voltages, but usually they are in the range 0 to +20V. The fixed voltages mentioned need to be held within close limits while the same is true of the variable supply once it has been set to a given value; in other words, regulated supplies are essential.

Before the advent of 'chip regulators' such a design to meet all of the foregoing requirements simultaneously would have been rather complex. The general availability of chip regulators that cover a wide range of voltages and current ratings e.g. 7805 (+5V, 1A) or 79L05 (-5V, 100mA) make design and construction simple — there are few external components. The L200 variable voltage regulator is a boon since a very simple variable voltage stabilised supply with current limit facility can now be built at very low cost. In this design the variable voltage supply can deliver a nominal +3 to +20V at 0.45A, though you may well get up to 24V out, and if you want more current, the regulator can give you up to 2A; however, you will have to reduce R4 to about 0.25 ohms and this will also assume that the other outputs are not loaded at the same time, since the

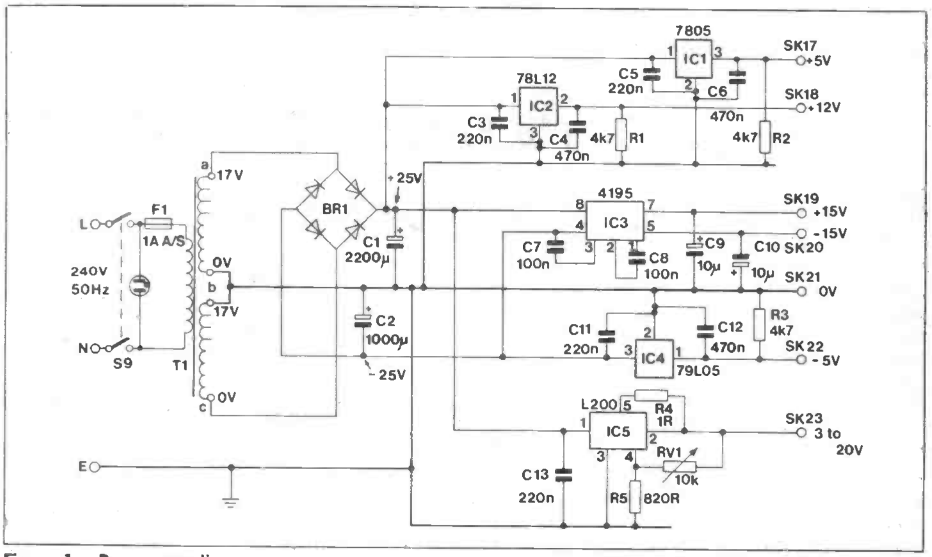


Figure 1. Power supplies.

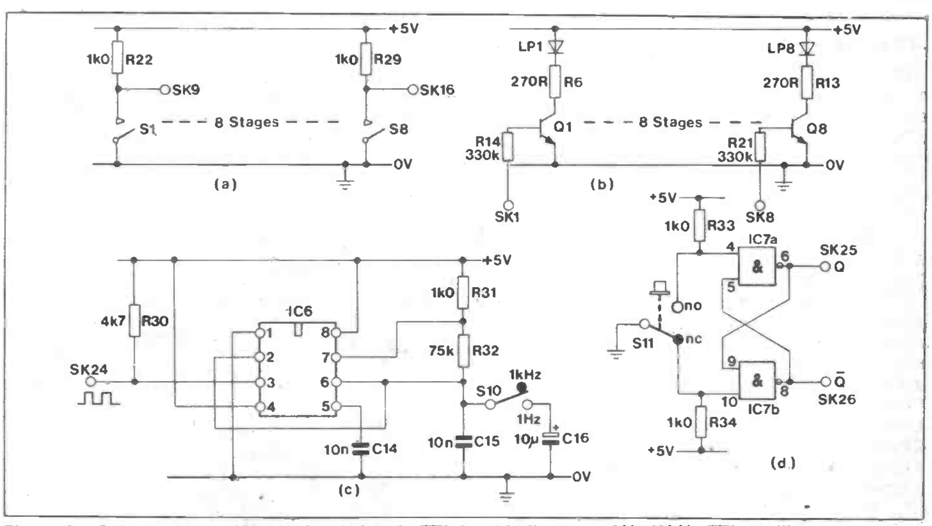


Figure 2. TTL circuits a. TTL level switches b. TTL level indicator c. 1Hz/1kHz TTL oscillator d. de-bounced TTL switch.

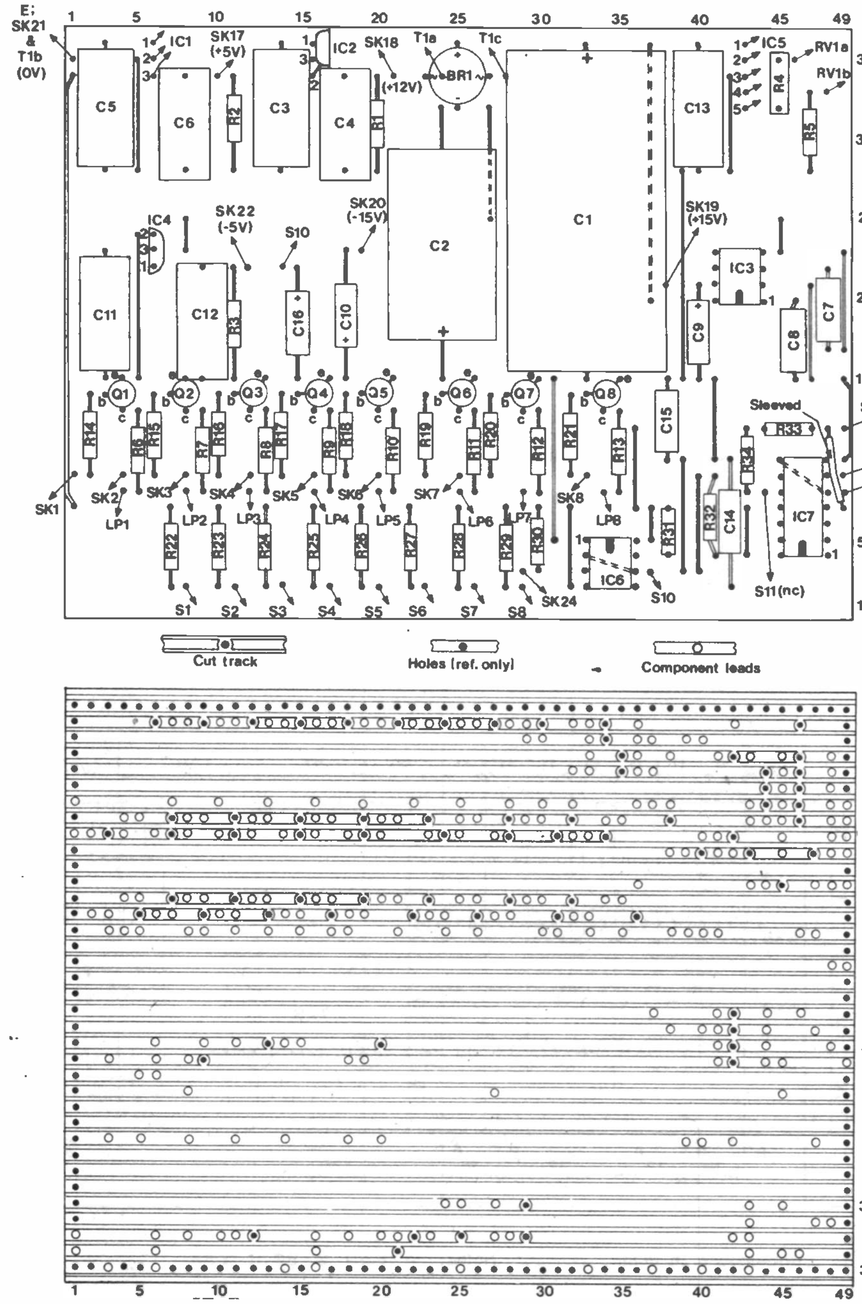
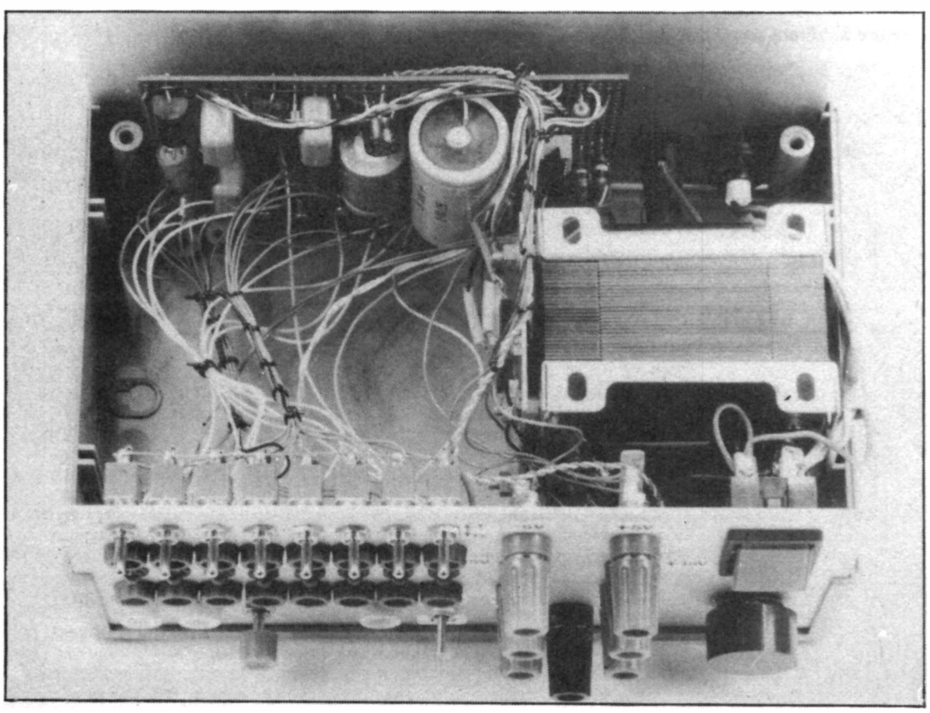


Figure 3. Circuit board details.



limiting factor is the transformer and rectifier, both of which have a rating of 2A.

While a multichannel power supply is useful in its own right, I thought it a good idea to incorporate a few extra, useful but simply provided facilities at the same time.

As a start, there is a set of switches and related sockets that allow the setting-up of eight independent logic levels as inputs to any circuit or system e.g. as variables A, B, C . . . X, Y, Z to a logic gate circuit; or as an 8-bit input to the input/output port of a microcomputer.

Along similar lines is the set of LEDs and associated sockets that will monitor logic levels, whether in a TTL gate circuit, at the outputs of a counter or shift register, or at a microcomputer's input/output port.

In order to study counter or shift register operation a TTL clock input is required. A 1Hz/1kHz square-wave generator provides this facility but there is also a 'debounced' switch so that the operation of such circuits can be observed 'pulse at a time'.

All of the above facilities are shown on the circuits of Figures 1 and 2.

Construction and Testing

As good a starting point as any is the circuit board, which is 0.1" pitch Veroboard, the actual matrix being 49 holes by 36 holes. Use the lower diagram of Figure 3 to identify the 'cut holes' and deal with these first. Then, returning to the face of the board, identify the position of all wire links; fit these (use 22 s.w.g. or 24 s.w.g. T.C.W.), not forgetting those short links beneath the sockets of IC6 and IC7; also noting the sleeved link adjacent to IC7. After this the component order is not too important; a suggested one is: IC sockets, resistors, capacitors, bridge rectifier, transistors and, for the moment, nothing else. Stop now and check that what you have done is correct. What you do next depends upon your level of self-confidence. If you wish to proceed with caution you could, for example, follow the following plan.

First, wire the two transformer secondaries in series (link shown as T1b in Figure 1). Then connect the other two secondary connections (T1a and T1c) to the bridge rectifier (Figure 3) and fit a temporary mains lead and plug. Observing due precautions with regard to personal safety, plug in and check with a DC voltmeter that you have 25V across each of the reservoir capacitors C1 and C2, noting the polarities of these voltages. If these measure correctly then at least the transformer, rectifier and smoothing circuit is alright. Now disconnect from the mains and hook up the connections to IC1 (the heatsink doesn't matter at the moment). Plug in again and check that you have +5V where you should have on the board. Repeat this procedure for IC2-IC5 in turn until you have all the supplies working; for IC5 you will have to hook up temporary connections to the 10k pot. If all is well you can test the transistor switches Q1 to Q8 by temporarily fitting an LED from each of R6-13 to +5V in turn and each time, using an insulated wire link, touching +5V onto the socket side of each of the base resistors to check whether the LED lights or not.

Concerning the hardware, a standard Verobox is suggested in which there is ample room for the transformer, heatsink and circuit board. The transformer is mounted at the extreme right hand end of the box, long axis vertical and with the mains tappings adjacent to the mains switch. The heatsink (Figure 4) is mounted vertically on the free end of the transformer with four screws, nuts and washers. The heatsink must be spaced off from the transformer frame to prevent the screws which mount IC1 and IC5 from touching the transformer laminations; this is easily done with a small tubular spacer or simply an extra nut behind the heatsink. These two ICs must be mounted on the heatsink by means of a TO220 mounting kit for each (mica washer and plastic bush) to insulate them from each other and from the heatsink itself (N.B. these mounting kits are termed 'TO66 plastic' in the Maplin catalogue and the appropriate part number is given in the parts list). The circuit board can be mounted at the rear of the box using a small angle bracket at each end. The redundant holes in ROW 1 can be opened up where required and there should be no risk of short circuits to any components on ROW 2 if the brackets are fitted right at the ends of the board. If the components face forward the board can sit quite close to the back panel and wiring from the board to the front panel can be carried out without any undue difficulty. Naturally these wires (all identified in Figure 3) are connected to the circuit board before it is mounted in place; estimate a little more for the length of

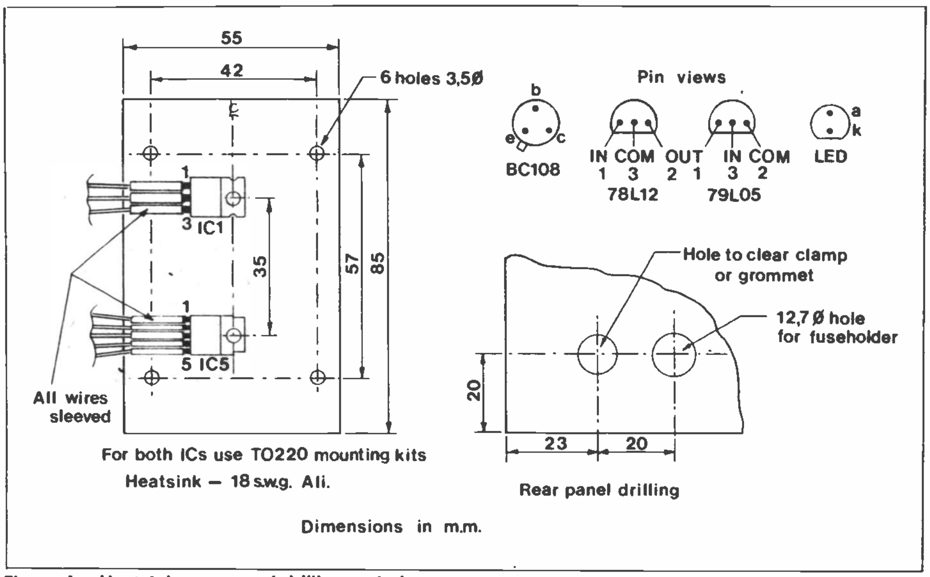


Figure 4. Heatsink, rear panel drilling and pin-outs.

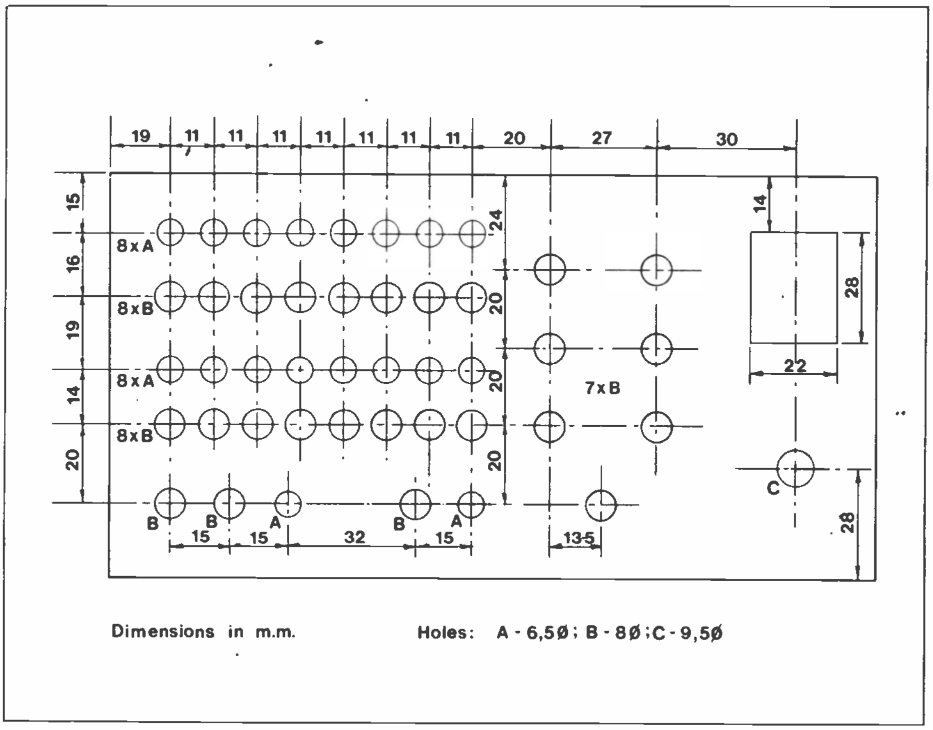


Figure 5. Front panel drilling.

PARTS LIST FOR MINILAB

Resistors — All ½W 5% carbon unless specified			
R1,2,3,30	4k7	4 off	(S4K7)
R4 (3W wirewound)	1R		(W1R)
R5	820R		(S820R)
R6-13	270R	8 off	(S270R)
R14-21	330k	8 off	(S330K)
R22-29,31,33,34	1k0	11 off	(S1K)
R32 (metal film 0.4W)	75k		(M75K)
RV1	10k linear pot.		(FW02C)
Capacitors			
C1	2200uF 40V elect.		(FB91Y)
C2	1000uF 25V elect.		(FB83E)
C3,5,11,13	220nF polyester	4 off	(BX78K)
C4,6,12	470nF polyester	3 off	(BX80B)
C7,8	100nF polyester	2 off	(BX76H)
C9,10,16	10uF 25V elect.	3 off	(FB22Y)
C14,15	10nF polyester	2 off	(BX70M)
Semiconductors			
Q1-Q8	BC108	8 off	(QB32K)
IC1	7805		(QL31J)
IC2	78L12		(WQ77J)
IC3	4195		(XX02C)
IC4	79L05		(WQ85J)
IC5	L200		(YY74R)
IC6	555		(QH66W)
IC7	7400		(QX37S)
BR1	W01		(QL38R)
LP1-8	LED	8 off	(WL27E)
—	Clip for above	8 off	(YY40T)
Miscellaneous			
T1	Transformer 0-17V; 0-17V @ 2A		(WB22Y)
—	Case (Verobox)		(LL07H)
S1-8,10	Sub. min. toggle switch	9 off	(FH00A)
S9	Mains switch DPST (with neon)		(YR70M)
S11	Min. push-button switch SPDT		(BK68Y)
	10mm cap green		(BK71N)
SK1-8	4mm socket — green	8 off	(HF72P)
SK9-16	4 mm socket — brown	8 off	(HF71N)
SK17,18,19,23	4mm terminal — red	4 off	(HF07H)
SK20,22	4mm terminal — blue	2 off	(HF03D)
SK21	4mm terminal — black		(HF02C)
SK24	4mm socket — yellow		(HF75S)
SK25,26	4mm socket — white	2 off	(HF74R)
	DIL socket 8-pin	2 off	(BL17T)
	DIL socket 14-pin		(BL18U)
	Mounting kit TO220	2 off	(WR23A)
F1	Fuseholder 20mm		(RX96E)
	1A antisurge fuse		(WR19V)
	Veroboard 10347		(FL09K)

A complete kit of all parts, excluding the case, is available for this project.
Order As LK09K (Minilab kit). Price £32.50.

each wire than is actually needed. As a tip to make life that bit easier, the two wires to the pot. are best wired to the pot. first and then to the circuit board, since the pot. tends to be obscured by the transformer once the front panel has been dropped into place.

There is little comment to make on the front panel wiring except to point out the bus-bars used to common the anodes of the LEDs (and taken to the +5V terminal SK17) and a similar bus-bar on switches S1-S8, which is taken to the 0V terminal SK21. Figure 6 shows all of these details and identifies the position of all front panel components. The front panel drilling details appear on Figure 5.

The rear panel has only two holes (details in Figure 4), which are for the mains cable clamp or grommet and the fuseholder. This is best drilled and put aside until all else is finished. This simply means wiring from the circuit board to the front panel, dropping the rear panel into place, completing the mains wiring via fuse F1 and testing the complete 'Minilab' to see that the following facilities exist:

+5V @ 1A	Eight TTL outputs
±5V @ 100mA	Eight TTL inputs
+12V @ 100mA	1Hz/1kHz TTL oscillator
+15V @ 50mA	One bounce-free, TTL pair of complementary outputs (Q and $\bar{Q}$)
+3V to +20V @ 450mA	

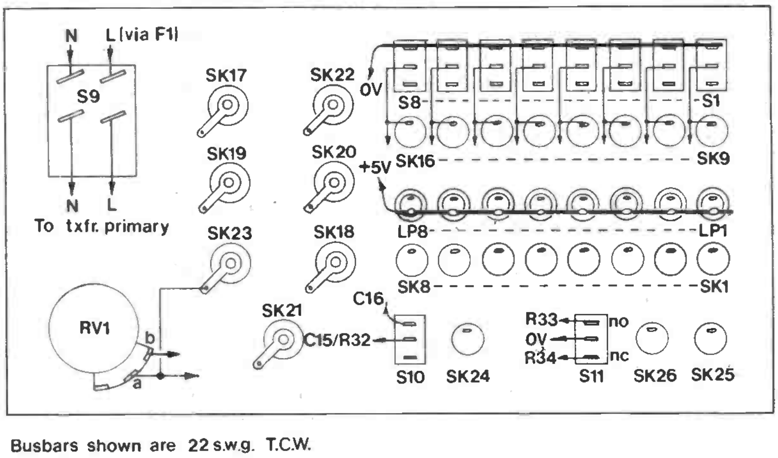
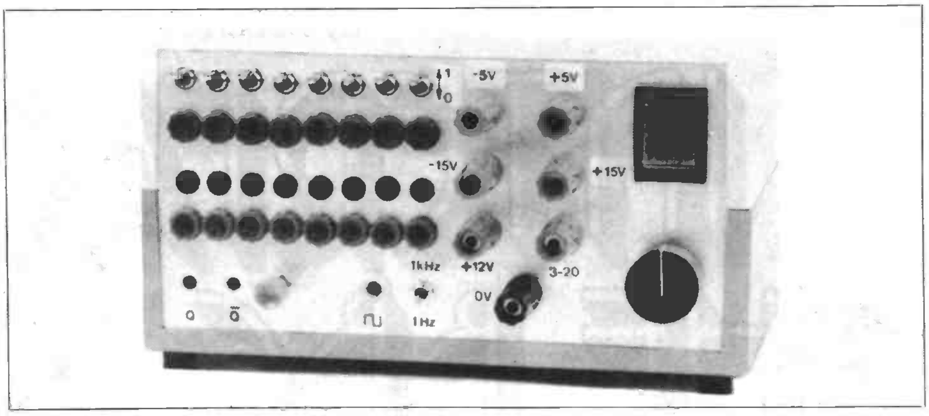


Figure 6. Front panel rear view — component identification.



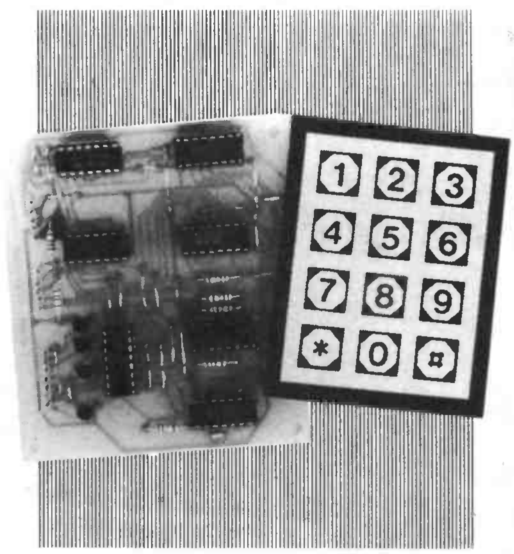
CODELOCK *Continued from page 13*

Application

The applications for a circuit such as this are many and varied, making it difficult to list all of the possibilities, however here are some suggestions.

First and foremost, any form of burglar alarm is an obvious candidate. Here the usual key that would be used to Arm or Disarm the system could be replaced by a Codelock, or as an even more security conscious suggestion, it could be inserted in parallel with the keyswitch, which would mean that both the key and the secret code would be required before the alarm could be deactivated.

The second most obvious application would be to use the Codelock in conjunction with a commercially available electric door lock. This would give tremendous security to, say a computer room, photographic darkroom, office or any number of places where unwelcome visitors would rather be kept out.



Lastly, any device that is normally operated by means of an ordinary switch, could have a Codelock to replace the said switch, barring the devices use from those other than yourself or those to whom you have disclosed the code. In this, and indeed most applications, the output from the Codelock would have to drive a relay or some form of servo or triac to act as the mechanical part of the switch. It is because of the number of different ways in which the Codelock could be utilised, that no final drive circuitry has been included, as this would depend on how it is to be used.

PARTS LIST CODE LOCK

Resistors: All resistors 0.4W 1% metal film unless specified.			
R1	110k		(M110K)
R2,3	1k0	2 off	(M1K0)
R4-7	1M0	4 off	(M1M0)
Capacitors:			
C1	390pF ceramic		(WX63T)
Semiconductors			
TR 1-4	BC 548	4 off	(QB73Q)
IC1,6	4011BE	2 off	(QX05F)
IC2	MC14419		(QY55K)
IC3	74LS170		(YF72P)
IC4	4063BE		(QW41U)
IC5	4518BE		(QX32K)
IC7	4001BE		(QX01B)
Miscellaneous			
SW1	Switch sub. min. slide		(FH35Q)
	Membrane Switch		(BK72P)
SK3	Flat Flex Connector		(BK73Q)
PL1,2	Minicon plug 5 way	2 off	(FY93B)
SK1,2	Minicon latch housing 5 way	2 off	(BH66W)
	Minicon terminal	10 off	(YW25C)
	PC Board		(GB25C)

A complete kit of all parts is available.
Order As LK14Q (Code Lock kit) Price £19.98.

INTERFACING THE BBC MICRO

by Robert Penfold

The BBC model B microcomputer seems to be popular with those who are interested in using a computer for control or measurement applications, and it is well suited to this type of use. It seems to have more input and output sockets than any other microcomputer currently available, including a four channel 12 bit analogue to digital converter, serial and parallel printer interfaces, an 8 bit (plus handshaking lines) user port, and the 1MHz Bus which enables additional input and output ports to be easily added. It also has a fast version of BASIC plus a built-in assembler which makes it relatively easy to use machine code when very high speed operation is essential.

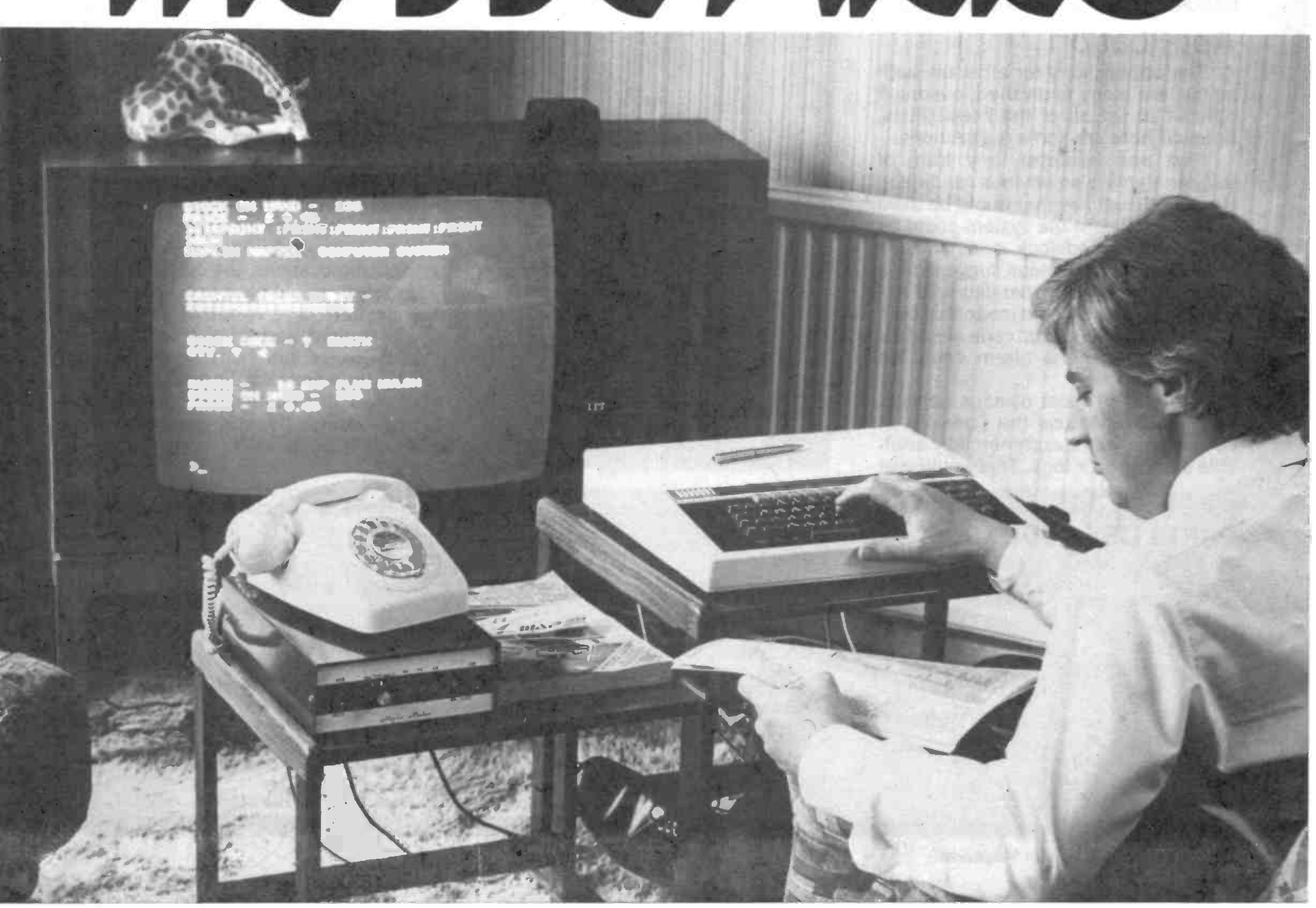
A certain amount of information about interfacing the BBC micro is given in the "User Guide" provided with the machine, but some of this can be a little difficult to understand unless you are already familiar with the techniques and interface devices used. In this article topics such as programming the user port, using the handshaking lines, and adding extra ports to the 1MHz Bus will be covered, filling in some of the detail which is absent from the "User Guide."

User Port

Both the parallel printer and user ports are provided by a 6522 VIA (Versatile Interface Adaptor) device, and this is also used to provide the machine with its Basic "TIME" function. The two timer/counters of the 6522 are available to the user, but these can only be used in machine code programs and would not normally be used directly. In most applications the Basic "Time" command is adequate, and the direct use of the timer/counters will not therefore be considered here.

The two 8 bit ports of the 6522 (called the "A" and "B" ports) are very similar, and each bit of both ports is individually programmable as an input or an output. However, an important point to bear in mind is that the "A" port is used to drive the parallel print output via a 74LS244 buffer. This is a tri-state buffer, but it is permanently enabled so that it operates as a straightforward TTL buffer. The printer port can therefore be used in much the same way as the user port, but only if output lines are required. The data lines of the parallel printer port cannot be used as inputs.

Writing to the appropriate register of the 6522 determines whether each data line of the "B" port is designated as an input or an output. This is called the "data direction register" and is at hex address FE62. Writing a 1 in a bit of this register causes the corresponding data line to operate as an output, and a 0 causes the corresponding data line to act as an input. For example, sending 15 (00001111 in binary) to the data direction register sets the four higher data



lines (PB4 to PB7) as inputs, and the four lower lines (PB0 to PB3) as outputs.

With BBC BASIC the usual PEEK and commands are replaced by a question mark (?) which denotes that the number which follows is an address. Thus, in order to write 15 to hex address FE62 the program line would read:-

?&FE62 = 15

The "&" before the address is needed to inform the computer that the address number is in hex and not in decimal.

It is important to note that address &FE62 is the location of the data direction register and this is not the address used when reading from or writing to the user port. The relevant address for this is &FE60. As a safety measure the data direction register is set to zero at switch on so that there can be no problems if a peripheral device is feeding an input signal to the user port. If you type:-

PRINT ?&FE&0 RETURN

into the computer, 255 should be printed on the screen, since pull-up resistors take the user port inputs to logic 1 if they are simply left floating. Wiring some of the lines to 0V pins of the port should give a suitably modified result if the command is retyped.

If you remove the shorting wires and try typing:-

?&FE62 = 255 RETURN
?&FE60 = 15 RETURN

the data lines of the user port are all set as outputs by the first line, and the second sets PB0 to PB3 high and PB4 to PB7 low. The outputs latch, and the appropriate output states can be confirmed using a logic probe or multimeter.

In some applications it is necessary to read just one bit of the user port, or to read several bits one at a time. Strictly speaking this is not possible, but using the logic AND function it is possible to mask all but one bit. For example, suppose we wish to know if PB4 is low or high. If it is at logic 1 this line adds 16 to the number returned from the user port, and it is therefore ANDed with the number 16. For the sake of this example we will assume that the number returned from the user port is 255. The two numbers are logic ANDed bit by bit, as shown below, giving a logic 1 in the binary result only if that particular column has a 1 in both the figures being ANDed (i.e. in both the first number AND the second).

255	11111111	user port
16	00010000	number used to mask all but PB4
16	00010000	answer

If PB4 was low and the number returned from the user port was (say) 239 this would give the following result:-

239	11101111	user port
16	00010000	number used to mask all but PB4
0	00000000	answer

If you try typing into the computer:-

PRINT ?&FE60 AND 16 RETURN

the number returned should be 16. Taking PB4 and any of the other input lines to 0V should return to 0 if the command is repeated.

By using the appropriate mask number it is possible to effectively read any one bit or selected bits of the user port.

Handshake Lines

When a computer is sending data to or receiving data from a peripheral device it is often necessary to have some form of synchronisation so that data transfers are only attempted when both pieces of equipable to deal with them. It is for this purpose that handshaking lines CB1 and CB2 are

provided on the user port. CB2 can be used as an input or an output, but CB1 can only be used as an input.

Some of the ways in which these lines are used are quite complex and go beyond the scope of this article, but there are some relatively simple but useful ways in which they can be used. CB1 and CB2 are made to operate in the required manner by writing the appropriate number to the Peripheral Control Register which is at address &FE6C. An input from one of these lines gives a change in one bit of the Interrupt Flag Register which is located at address &FE6D. When CB1 is activated it sets bit 4 of the Interrupt Flag Register high, and when used as an input CB2 sets bit 3 of this register high. In other words the number returned from ?&FE6D is raised by 16 and 8 (in decimal) respectively.

CB1 is the more simple of the two handshaking lines since it only has two modes of operation, and it is controlled by one bit of the Peripheral Control Register (bit 4). CB2 has four input modes and four output modes and is controlled by three bits of this register (bits 5 to 7). The table given below summarizes the modes of CB1 and CB2.

Binary/ Decimal No.	Mode of Operation
0/0	CB1 high to low handshake input
1/16	CB1 low to high handshake input
000/0	CB2 high to low handshake input
001/32	CB2 high to low independent input
010/64	CB2 low to high handshake input
011/96	CB2 low to high independent input
100/128	CB2 high to low handshake output
101/160	CB2 high to low pulse output
110/192	CB2 constant low output
111/224	CB2 constant high output

When dealing with CB1 it is simply a matter of selecting a high to low or low to high transition to set the interrupt flag. With CB2 there are the same two options, plus the two independent modes. When using the handshake modes the relevant bits of the Interrupt Flag Register can be reset by reading from or writing to the user port, or by writing a 1 to the appropriate bit or bits of the Interrupt Flag Register (i.e. use ?&FE6D = 16 to reset the CB1 flag, ?&FE6D = 8 to reset the CB2 flag, or ?&RE6D = 24 to reset either of them). With the independent modes this second method is the only way of resetting the flags.

The simple program given below can be used to try out the CB1 and CB2 inputs.

```
10 ?&FE6C = 0
20 CLS
30 PRINT ?&FE6D
40 ?&FE6D = 24
50 TIME = 0
60 REPEAT UNTIL TIME = 100
70 GOTO 20
```

This simply prints the value of ?&FE6D and updates the reading at roughly one second intervals (the delay time set by line's 50 and 60). Line 10 sets all the control registers at zero so that both CB1 and CB2 set their respective interrupt flag registers during a transition from the high state to the low one, and they are both used in the handshake mode. By taking CB1 and (or) CB2 low the initial reading of 0 should change to 8, 16, or 24, as appropriate. However, line 40 resets the interrupt flags and the reading should soon return to zero. As the handshake mode is used, reading from the user port (by putting X = ?&FE60 at line 40, for example) should also reset the flags. By changing the number at line 10 the other input modes can be tried using this program.

The CB2 output modes are quite straight forward. In the two constant modes CB2 is set high or low as required, and is independent of the other user port lines. In the pulse mode it provides a 1us negative pulse each time data is sent to the user port, and in the handshake mode it goes low when data is sent to the user port. It can then only be reset to the high state by an active transition on CB1.

The lower four bits of the Peripheral Control Register function in the same way as bits 4 to 7, but they control lines CA1 and CA2 of the printer port. The printer port is at ?&FE61 and its Data Direction Register is at ?&FE63. The interrupt flags for CA1 and CA2 are bits 1 and 0 respectively of ?&FE6D.

1MHz Bus

An 8 bit user port is obviously very useful, but you may well find that more inputs or outputs are required. The most simple solution to the problem is to use the parallel printer port, but this only provides another 8 lines plus handshaking lines and the 8 data lines (as explained earlier) can only be used as outputs. The 1MHz Bus offers great scope for expansion, and some simple hardware is all that is needed to provide one or two extra input or output ports.

The circuit diagram on page 503 of the "User Guide" shows the various inputs/outputs available on the 1MHz Bus, and this includes the data bus (D0 to D7) and the lower 8 address bus lines (D0 to D7). Only the lower 8 address lines are needed as the upper 8 lines are decoded and provided in the form of lines NPGFC and NPGFD. The former pulses negative when any address in page FC is addressed, and the latter similarly pulses low for any page FD address. This gives a generous quota of 512 addresses for user hardware from ?&FC00 to ?&FDFF, although Acorn only recommend ?&FCC0 to ?&FCFE for user applications. The other addresses are allocated to such things as an extra 64k of memory, a Teletext Unit, and a Prestel Unit. However, if you do not intend to add equipment of this type to the 1MHz Bus, and just require a simple input or output port, it is very easy to make these additions.

Figure 1 shows how an 8 bit input port can be added. This circuit is based on a 74LS244 octal tri-state buffer, and this must be enabled (by taking pins 1 and 19 low) each time there is a read operation to the port. The most simple way of achieving this is to simply connect these pins to NPGFC or NPGFD, but a drawback of this system is that an accidental write operation to the port would result in the MPU and the port simultaneously placing an output on to the data bus. This possibility can be eliminated by gating the read/write line and NPGFC or NPGFD so that IC1 can only be enabled during read operations (when the read/write line is high). In this circuit the necessary gating is provided by three of the 2 input NOR gates of IC2.

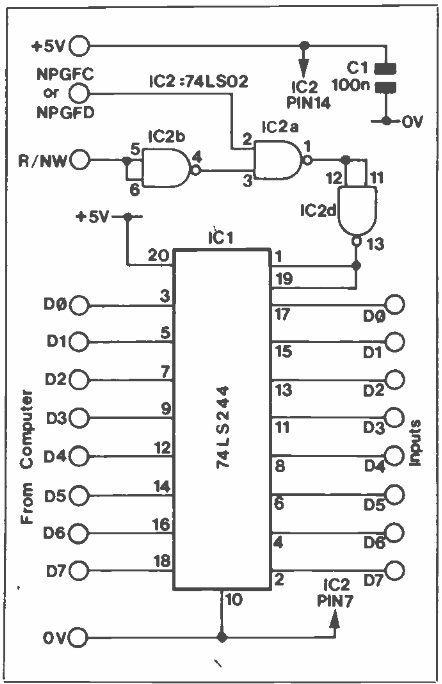


Figure 1. Adding an input port to the 1MHz Bus.

A simple output port can be added using the circuit of Figure 2. This is just a 74LS273 octal D type flip/flop which is fed from the data lines and is latched by the negative pulse from the NPGFC or NPGFD line each time a write operation is performed. As the port cannot place an output onto the data bus there is no need to gate the read/write line with the NPGFC or NPGFD line.

With both of these circuits the port will respond to any address from &FCOO to &FCFF if the NPGFC line is used, or from &FDOO to &FDFF if the NPGFD line is used. This permits only one piece of hardware per line to be used, and it is therefore better to use a more sophisticated system if further expansion is contemplated. Another limitation of these simple circuits is that they do not provide handshake lines, and there is just a negative pulse from the NPGFC or NPGFD line each time a port is written to or read from.

6821 PIA

A more elegant solution to additional input/output ports is to use a 6821 PIA (Peripheral Interface Adaptor) plus full decoding of A0 to A7 address lines, as shown

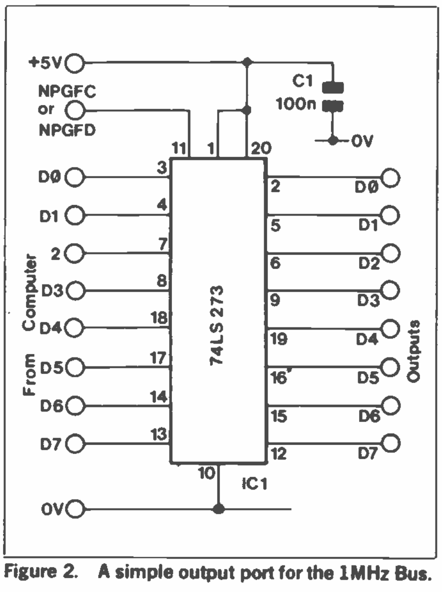


Figure 2. A simple output port for the 1MHz Bus.

in the circuit of Figure 3. This gives two 8 bit ports with each line individually programmable as an input or output. There are also two handshake lines per port.

IC1 is a 74154 (or 74LS154) 4 to 16 line decoder, and this has 16 outputs, one of which will be in the low state if the device is enabled. Which output this is depends on the binary number fed to the four address inputs of the device (A0 to A3). These inputs are fed with the A4 to A7 lines of the 1MHz Bus, and output 12 (C in hex) of IC1 is the only one which is used in this case.

IC1 has two enable inputs which must be taken low in order to permit normal operation of the device, and these are fed from the A2 and A3 lines of the 1MHz Bus. The remaining two address lines (A0 and A1) are fed to the Register Select inputs of IC2 and determine the operating mode of this device.

D1, D2, and R1 form a simple gate which gives a negative signal to the negative chip select input of IC2 when the NPGFC line is activated, and the A2 to A7 lines of the 1MHz Bus are at the correct states to operate IC1. This places IC2 at the four addresses from &FCC0 to &FCC3, which is within the range of addresses that Acorn recommend for user applications. This leaves all the other 508 addresses in pages &FD and &FC available for use.

The reset input of IC2 is fed from the NRST line so that the device is reset at switch-on or when the BREAK key is operated. The read/write input of IC2 is fed from the corresponding line of the 1MHz Bus so that IC2 is automatically set to the appropriate mode. The enable (E) input of the 6821 has a slightly misleading name, and this must be fed with the clock signal so that the computer and the PIA are correctly synchronised. Although the BBC micro has a 2MHz clock, this is divided by 2 to give a 1MHz clock frequency for peripheral devices, including the internal 6522 VIA, incidentally. Thus a standard 6821 can be used for IC2, and it is not necessary to employ the faster 68B21. The two interrupt request outputs of IC2 have open drain driver transistors so that they can be wired together to give an OR function. They can be connected to the interrupt request line of the 1MHz Bus, but it is only worthwhile doing this if you fully understand the use of interrupts, and actually intend to use them. Otherwise it is better to leave these outputs unconnected, so that the possibility of producing an unintentional interrupt and "crashing" the computer is eliminated.

Using the Ports

There are six registers in the 6821; the data direction register (DDR) for port A, the port A peripheral register, the port A control register, and the equivalent three registers for port B. With the circuit only occupying four addresses it is obviously not possible to gain direct access to all six of these. It is only possible to directly access the port A and port B control registers at ?&FCC1 and ?&FCC3 respectively. These registers control access to the other four registers, control the handshake lines of their respective ports, and receive inputs from these lines.

In order to gain access to a DDR, bit 2 of the corresponding control register must be set to zero. As all the registers are reset to zero at switch-on this initially gives direct access to the port A and port B DDRs at ?&FCCO and ?&FCC2 respectively. Use of the DDRs is much the same as for the 6522, with bits being set at 0 or 1 to set the corresponding port data lines and inputs or outputs. The reset at switch on sets all the

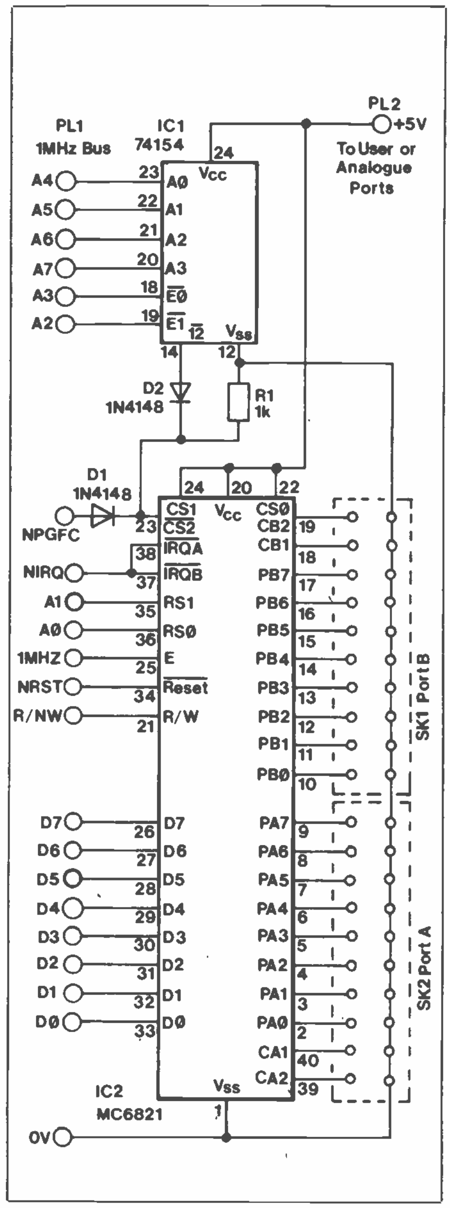


Figure 3. Two 8-bit in/out ports using a 6821 PIA.

data lines as inputs initially.

Read and write operations to the ports are performed via the peripheral registers, and bit 2 of the correct control register is set at 1 (e.g. ?&FCC1 or ?&FCC3 = 4) to give access to the A and B peripheral registers at ?&FCCO and ?&FCC2 respectively. In other words there is both a peripheral register and a DDR at each of these addresses, and whichever of these is required is selected by setting bit 2 of the appropriate control register at 1 or 0. For example, to send the value 65 to port A the following program could be used:-

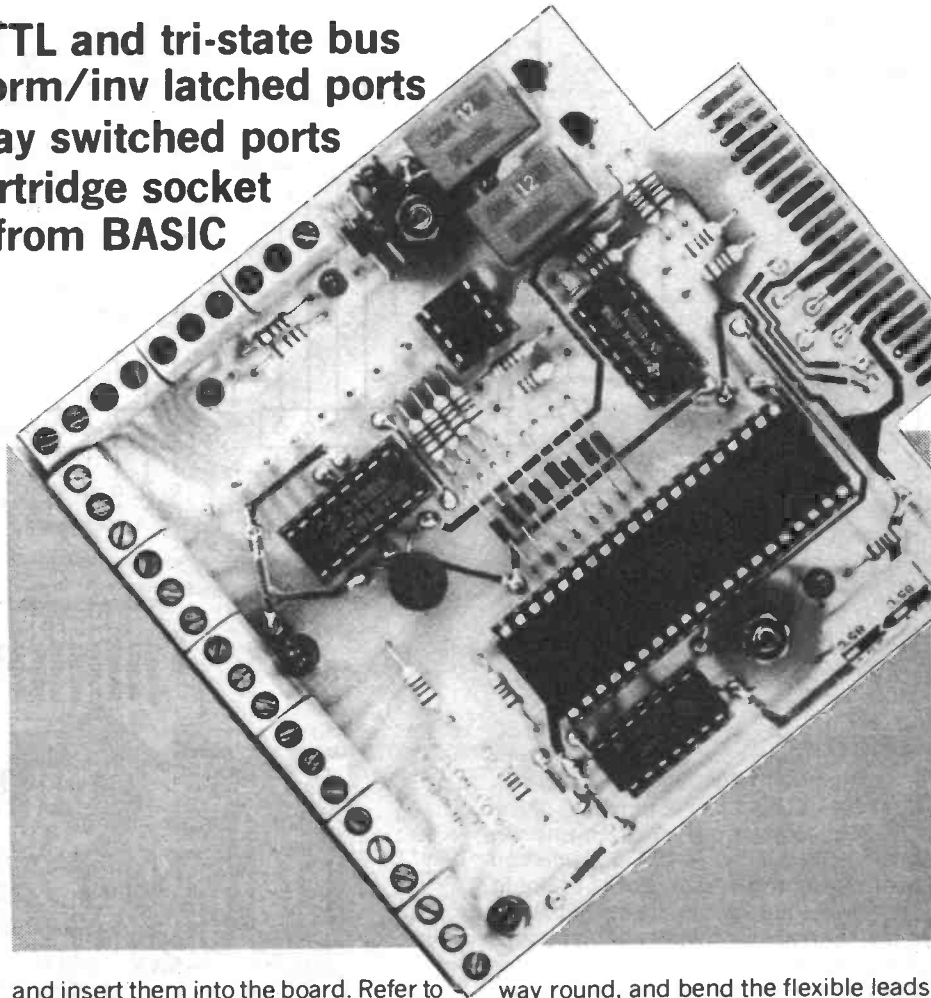
```
10 ?&FCC1 = 0   (if required, gives access
                 to DDRA)
20 ?&FCCO = 255(Sets port A lines as
                 outputs)
30 ?&FCC1 = 4   (gives access to periphe-
                 ral register A)
40 ?&FCCO = 65  (writes 65 to port A)
```

The table shown in Figure 4 should be helpful when writing programs which use the two 6821 ports. Port A and port B are slightly different, and port A, for instance, has pull-up resistors when it acts as an input, whereas port B does not. In practice there is unlikely to be any problem in using either port with TTL ICs to drive transistor switches, etc., but if in doubt the 6821 data sheet gives a substantial amount of information about the output drive capability and input requirements.

Continued on page 26

Dragon 32 Input/Output Ports

★ **Two 8 bit ports with TTL and tri-state bus compatibility ★ Four norm/inv latched ports**
★ **Two opto and two relay switched ports**
★ **Module plugs into cartridge socket**
★ **Fully programmable from BASIC using PEEK and POKE**



by Dave Goodman

Our port interface module allows the Dragon 32 to communicate with external devices such as micros, domestic electrical systems, i.e. central heating and security control, or peripheral control of the computer.

Input/Output ports consist of eight terminals, each of which can access the computer data bus. Information is passed along the bus, to or from the Central Processing Unit (CPU), by enabling the port with appropriate control signals. POKEing data in decimal form (Ø to 255) will result in an eight bit binary code being written to the port, whilst PEEKing will read presented information and take action according to program requirements.

Circuit Description

The four address codes 49152 to 49155 are used to control IC2, using R2 enable signals. Port B, PBØ to PB7 are TTL compatible with normally low outputs, while port A, PAØ to PA7 are tri-state bus compatible outputs. Port C is selected, along with port B, by enabling IC3 with IC1c. Input or output signals present at port B will operate RLA, RLB via IC3 A,B; the dual opto isolator IC5 via IC3c,d, and enable the four bit latch IC4.

PC4 to PC7 Q outputs are normally high, and $\overline{Q}$ are normally low (OV). D1 to D8 buffer port C from port B, making it write only and accessible either from the CPU or externally with +5V to 0V signal levels.

Construction

Insert 32 track pins from side two, through the holes marked with a circle. Solder these to both sides of the PCB. Bend all the leads of the 18 resistors, and insert them into the board. Refer to the parts list for values, and if using 5 band 1% resistors note that colour coding begins at the end opposite to that of the solitary brown band. Fit D1 to D8. These diodes are usually blue in colour, with a black band at one end. This band must be aligned with the white band legend on the PCB. Fit diodes D9 and D10. Although they are larger in size and black in colour the band rule still applies. Capacitors C1 to C4 may now be inserted. C1 and 2 are tantalum types with a + sign printed on the body. Fit the lead closest to this through the hole marked + on the PCB. C4 has a - sign, not a + sign. Take this into consideration before you fit it. All 5 IC sockets can now be fitted, along with TR1 and TR2.

It is advisable, at this stage, to solder all fitted components and remove excess leads before continuing further. Insert both relays. They will only fit one way round, and bend the flexible leads over each pad to secure. LEDs 1 and 2 are the larger LEDs, and 3 and 4 the smaller ones. These can all now be fitted. Each cathode (k) is recognised either by the shorter of the leads, or by a flat section on the body skirting.

Place 6 of the three way terminals in positions PAØ to PA7 and PBØ to PB7. The remaining 2 three way terminals to relay port PCØ and PC1. The four way terminal is fitted to PC2,3 position. Check each terminal faces the outside edge of the PCB before soldering, then insert the 8 vero pins in positions PC4 to PC7. Solder, trim, and inspect your work, then fit all 5 ICs.

Two rubber feet, bolts and nuts can be fitted to side 1 of the PCB, through the 4BA holes drilled for this purpose. They have been included to prevent wobble and excess strain on the edge connector, which could result in lost data or worse. Provided that all instruc-

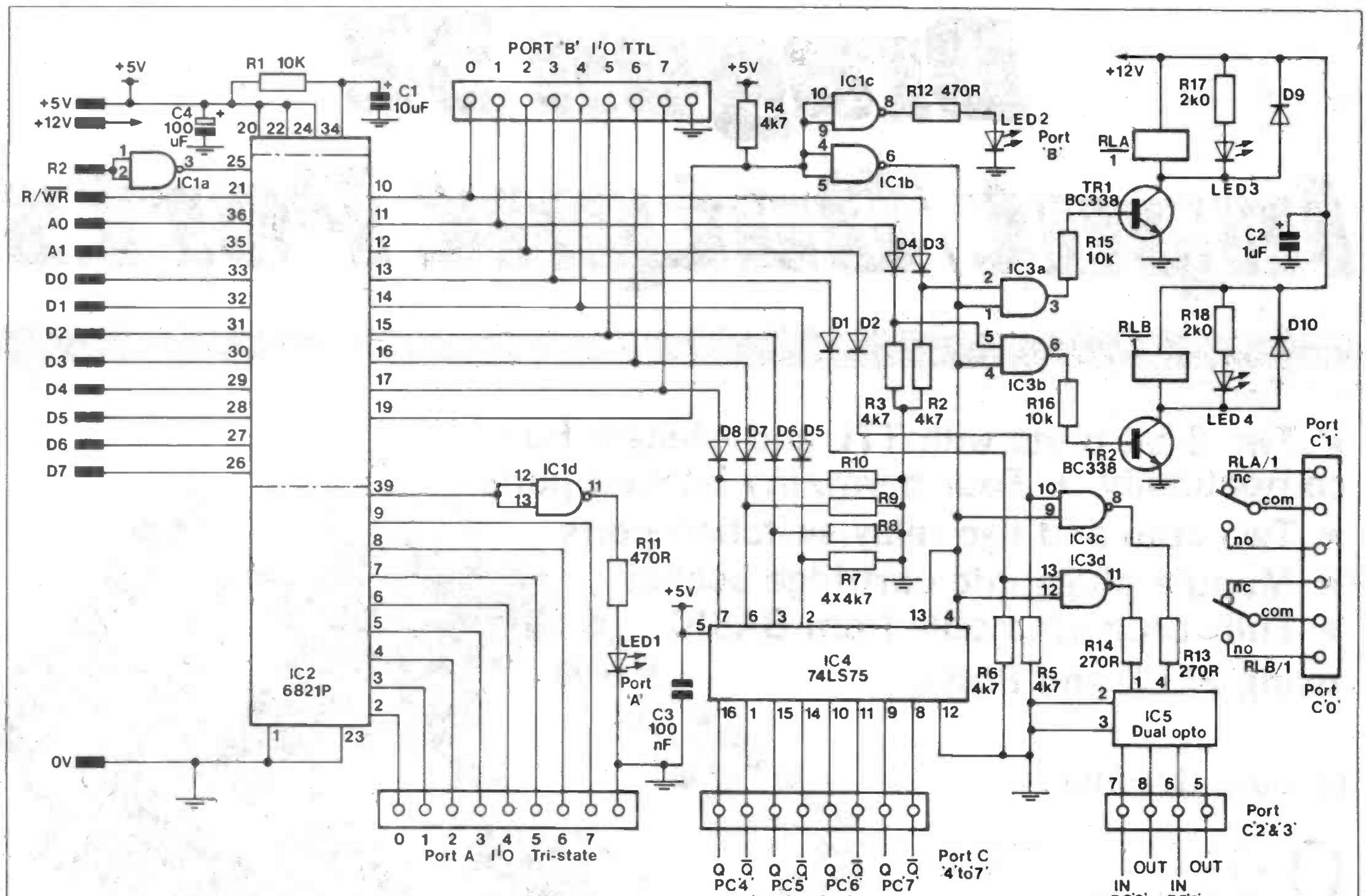


Figure 1. Circuit diagram.

tions have been carefully followed and the module has been correctly built, plug it into the cartridge socket, with component side 2 upwards.

Testing

With a voltmeter set to read 5V DC, connect the negative lead to one of the 0V terminals on port A or B, and the positive lead to pin 14 of IC1. Switch on the Dragon, and a reading of +5V should show that the supplies are correct. Wait a few seconds for the display to appear and confirm that all is well so far. If this does not happen, switch off immediately and remove the module, check that the computer is functioning correctly.

Type POKE 49155, 48 ENTER and LED 2 will operate. Type POKE 49153, 32 ENTER and LED 1 will operate. POKE either of these addresses with Ø to extinguish the LEDs. With all four LEDs off, type POKE 49155,52:POKE49154,1 ENTER. LEDs 2 and 3 will operate, along with RLA.

Type POKE 49154,2 ENTER. LED 3 will go out and LED 4 will operate, RLA release and RLB operate. To check that both relays are working, use a meter set to ohms x 1 between COMM and NO or NC on port C, PCØ and PC1. RLA contacts are at PCØ and RLB contacts at PC1.

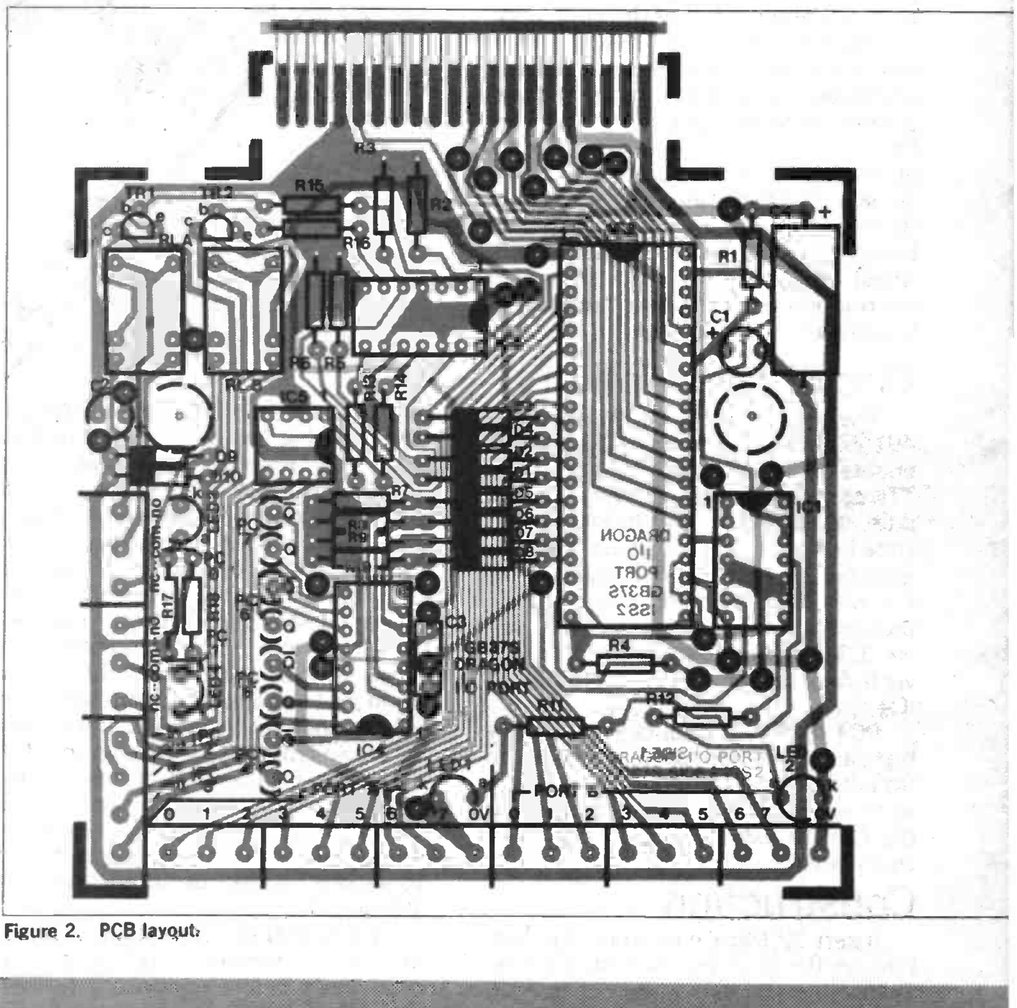


Figure 2. PCB layout.

TABLE 1. PORT C

DATA CODE	PC0 RLA	PC1 RLB	PC2 OPT	PC3 OPT	PC4 Q	PC4 Q1	PC5 Q	PC5 Q1	PC6 Q	PC6 Q1	PC7 Q	PC7 Q1
0	0	0	0	0	1	0	1	0	1	0	1	0
1	1	0	0	0	1	0	1	0	1	0	1	0
2	0	1	0	0	1	0	1	0	1	0	1	0
4	0	0	1	0	1	0	1	0	1	0	1	0
8	0	0	0	1	1	0	1	0	1	0	1	0
16	0	0	0	0	0	1	1	0	1	0	1	0
32	0	0	0	0	1	0	0	1	1	0	1	0
64	0	0	0	0	1	0	1	0	0	1	1	0
128	0	0	0	0	1	0	1	0	1	0	0	1

1=+5V OR 'ON', 0=0V OR 'OFF'

PROGRAM 1.

```
1 CLS
2 PRINT@5,"DRAGON I/O PORT TEST":PRINT
3 INPUT"ENTER PORT (A,B OR C)";P$
4 IFP$<"A"OR P$>"C"THEN3
5 INPUT"ENTER MODE(IN OR OUT)";M$
6 IFM$="IN"AND P$="C"THEN5
7 IFM$="IN"OR M$="OUT"THEN8 ELSE5
8 CLS0:PRINT"PORT-";P$;"-";M$;"PUT"
9 REM PORT CODES
10 IFP$="A"THENP=49153:N=36
11 IFP$="B"THENP=49155:N=4
12 IFP$="C"THENP=49155:N=52
13 IFM$="IN"THEN20
14 REM PORT A-C O/P
15 POKE P,0:POKE P-1,255:POKE P,N
16 GOSUB27
17 PRINT@32,"":INPUT"ENTER DATA(0-255)";D$
18 IFD$="P"THEN POKE P-1,0:POKE P,0:GOTO1
19 D=VAL(D$):POKE P-1,D:GOTO17
20 REM PORT A,B I/P
21 POKE P,0:POKE P-1,0
22 POKE P,4:POKE P-1,0
23 PRINT@20,"DATA="
24 GOSUB27
25 GOSUB28
26 GOTO1
27 PRINT@448,"**** ENTER P TO RE-SELECT ****":RETURN
28 A$=INKEY$:IFA$=""THEN  PRINT@25,PEEK(P-1):GOTO28
29 RETURN
```

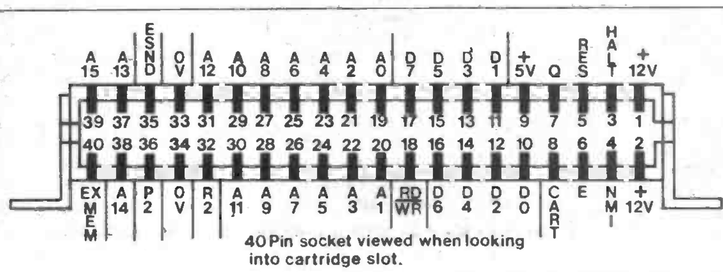
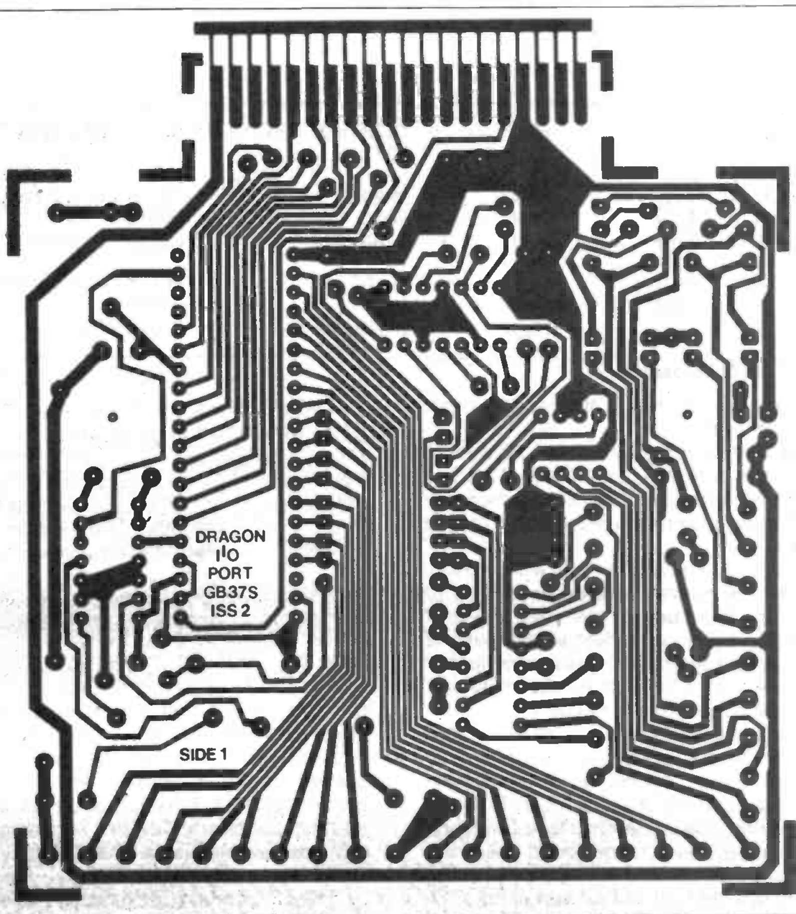


Figure 3. Dragon cartridge socket pinouts.



Opto ports PC2 and PC3 are checked by connecting an ohmmeter across the In/Out terminals of PC2 and typing POKE 49154,4. The In terminal is the positive input to the opto isolator, so connect the negative lead of your ohmmeter to this terminal and the positive lead to the Out terminal. This may appear to be contradictory, but is necessary because on most multimeter ohm ranges the internal battery positive appears at the negative terminal, due to switching arrangements. Full on resistance is about 200ohms. Type POKE 49154,8 to turn PC2 off and PC3 on. Repeat the meter check to PC3. Maximum off resistance is extremely high, and may be considered to be open circuit. POKE 49154 with 0 to turn off PC0-3.

When using opto-isolators, note that they function as a low current switch and can only handle up to 20V at 8ma. Higher currents, up to 25mA at 5V can be switched providing that the load does not exceed 150mW.

Both relays can switch up to 1A at 100V or 24V DC, but will not handle mains voltages.

Port C, PC4 to PC7, when enabled will follow PB4-7 on the Q outputs and their inverse on the $\overline{Q}$ outputs. If port C is disabled the outputs will remain latched until reaccessed. Outputs are TTL levels, 0V to 4V approximately.

Table 1 lists the various options available at port C and the data codes (0 to 255) used for operating them.

To keep the operation of IC2 as simple as possible a list of routines used for accessing each port appears at the end of this article. For further information, comprehensive data sheets for the 6821 are available, but are really only for technically minded constructors.

Type in Program 1 to continue testing the port, RUN and ENTER. The program asks for a port to be entered, so enter A. Enter OUT mode. Connect the voltmeter to PAØ and OV, then enter 1. This should give a reading of +4.5V. Repeat this on pins PA1 to 7, entering data codes 2,4, 8, 16, 32, 64, and 128. Only one PA output should be high, the others should be at OV. Obviously, any decimal code from Ø to 255 could be entered, and the binary coded output calculated, then checked with the meter on port A.

Enter the program again, this time selecting port A,IN. The display is slightly different and input data is required, to be read and printed after

```
     ACCESS ROUTINES
   PORT A
  ---------
POKE 49153,0      (CONTROL REGISTER)
POKE 49152,N      (DATA DIRECTION REGISTER)
POKE 49153,4      (ACCESS OUTPUT REGISTER
POKE 49152,DATA (0-255 WRITE)
 OR PEEK(49152) (0-255 READ)

   PORT B
  ---------
POKE 49155,0      (CONTROL REGISTER)
POKE 49154,N      (DATA DIRECTION REGISTER)
POKE 49155,4      (ACCESS OUTPUT REGISTER)
POKE 49154,DATA (0-255 WRITE)
 OR PEEK(49153) (0-255 READ)

   PORT C(AND B)
  ----------------
POKE 49155,0
POKE 49154,255  (OUTPUT MODE)
POKE 49155,52   (ENABLE PORT C)
POKE 49154,DATA (0-255)

N=BITS 1 TO 8 ON(1) FOR OUTPUT MODE
OR BITS 1 TO 8 OFF(0) FOR INPUT MODE

   LED 1 (PORT A)
  -----------------
POKE 49153,32

   LED 2 (PORT B/C)
  ------------------
POKE 49155,48
```

DATA=. Because port A is tri-state, a no input reading of 255 (PAØ-7 = high) is shown. Connect PAØ to 0V and data will be 254, or 255 - 1. Remove 0V from PAØ and reconnect to PA1. This time DATA= 253 or 255-2. Repeat tests on PA2 to PA7 in turn and check DATA=251,247, 239, 223, 191 and 127.

Type P, followed by B,IN and ENTER. Unlike port A, these inputs are normally low so connect PBØ to +5V for DATA=1. Repeat on PB1 to 7 for DATA= 2,4,6,8,16,32,64 and 128, or try different combinations as before.

By now, the module should be working correctly and be ready for use. If not, there may be edge connector problems, or the PCB may require further support. Fault-finding may be performed with the aid of a voltmeter and the access routines.

PARTS LIST DRAGON I/O PORT

Resistors — All 0.4W 1% metal film unless specified.

R1,15,16	10k	3 off	(M10K)
R2-10	4k7	9 off	(M4K7)
R11,12	470R	2 off	(M470R)
R13,14	270R	2 off	(M270R)
R17,18	2k0	2 off	(M2K0)
Capacitors			
C1	10uF 16V Tantalum		(WW68Y)
C2	1uF 35V Tantalum		(WW60Q)
C3	100nF Disc		(BX03D)
C4	100uF 25V axial electrolytic		(FB49D)
Semiconductors			
D1-8	1N4148	8 off	(QL80B)
D9,10	1N4001	2 off	(QL73Q)
TR1,2	BC338	2 off	(QB69A)
IC1	74LS00		(YF00A)
IC2	6821P		(WQ46A)
IC3	74LS08		(YF06G)
IC4	74LS75		(YF32K)
IC5	Dual opto		(YY62S)
LEd1,2	Red LED	2 off	(WL27E)
LED3,4	Mini Red LED	2 off	(WL32K)
Miscellaneous			
	P.C. board		(GB37S)
RL A,B	Relay ultra min SPDT	2 off	(YX94C)
	3-way P.C. terminal	8 off	(RK72P)
	4-way P.C. terminal		(RK73Q)
	D.I.L. socket 40 pin		(HQ38R)
	D.I.L. socket 16 pin		(BL19V)
	D.I.L. socket 14 pin	2 off	(BL18U)
	D.I.L. socket 8 pin		(BL17T)
	Trackpin	1 pkt	(FL82D)
	Veropin 2145	1 pkt	(FL24B)
	Feet cab	1 pkt	(FW19V)
	Bolt 4BA ¼"	1 pkt	(BF02C)
	Nut 4BA	1 pkt	(BF17T)

A complete kit of all parts is available. Order As LK18U Price £13.95.

Interfacing the BBC Micro *Continued from Page 22*

Handshake Lines

The two handshake lines of each port provide similar facilities to those of the user port, but there is no independent input mode, and there are differences in the way in which they are set up and used. As inputs, the handshake lines can either set their respective interrupt outputs low on an active transition, or they can be used with these outputs disabled. We will only consider the A port, but the B port is used in the same way. CA1 is controlled by bits 0 and 1 of control register A, and its output is at bit 7 of this register. CA2 is controlled by bits 3 to 5 and gives an output at bit 6. The logic AND facility of the computer can be used in the way described earlier to test the state of the just bit 6 or bit 7 of the control register. Table 1

Binary/ Decimal No.	Mode Of Operation
00/0	CA1 high to low, interrupt disabled
01/1	CA1 high to low, interrupt enabled
10/2	CA1 low to high, interrupt disabled
11/3	CA1 low to high, interrupt enabled
000/0	CA2 high to low, interrupt disabled
001/8	CA2 high to low, interrupt enabled
010/16	CA2 low to high, interrupt enabled
011/24	CA2 low to high, interrupt enabled

Table 1

ADDRESS	RS1	RS0	CONTROL REGISTER BIT 2	REGISTER SELECTED
&FCC0	Low	Low	High	Peripheral Register A
&FCC0	Low	Low	Low	DDRA
&FCC1	Low	High	Irrelevant	Control Register A
&FCC2	High	Low	High	Peripheral Register B
&FCC2	High	Low	Low	DDRB
&FCC3	High	High	Irrelevant	Control Register B

Figure 4. 6821 addresses.

details the way in which the various input modes are obtained.

Note that CB2 is different to CA2 when it is used as an output in that in the first mode it is reset by a write operation, and in the pulse mode the pulse is produced when writing to the port.

Often both handshake lines will be used, and then the number written to ?&FCC1 or ?&FCC3 is the sum of the two decimal numbers in the above tables which give the desired operating modes. Remember to add a further 4 to this figure if access to the port (rather than the DDR) is needed.

In this article it has been assumed that the input and output devices will be directly addressed, but Acorn recommend the alternative method of using OSBYTE calls. This is simply because directly addressing peripheral devices will not work if one of the second processors is added to the Tube. It is possible to write to an output port using a *FX command (*FX151,96,255 writes 255 to the user port DDR for example), but it is not possible to send a numeric variable in this way, or to read from a peripheral device. It is

Table 2 shows the various ways in which CA2 can be used as an output.

Binary/ Decimal No.	Mode of Operation
100/32	set high by activating CA1, low by read operation
101/40	high to low pulse during read operation
110/48	constant low output
111/56	constant high output

Table 2

possible to read from an input port using a machine code routine, as described in the "User Manual" (but note that this stores the answer in the Y register and not in the accumulator). It is much easier to directly address peripheral devices, and is probably not worthwhile using the OSBYTE calls unless it is essential to do so.

The 12 bit analogue to digital converter of the BBC micro is very useful for application where a fast sampling rate is not needed. It is quite simple to use and is fully described in the "User Guide".

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FEB	Out of stock, new stock expected in month shown
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Page35

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Page36

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Page37

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WA53H Book BP110 £2.15 NV
+RH17T Book BP23 95p NV
RQ28F Book BP48 £1.92 NV
+WA34M Book BP92 £1.75 NV
RQ29G Book BP49 £1.99 NV
XW67X Book BP80 £2.25 NV
WG86T Book BP98 £2.25 NV
WA35Q Book BP99 £1.95 NV
WA36P Book BP103 £1.95 NV
WG57M Book FT1300 £17.21 NV
+WG28F Book BP83 £2.15 NV

Page38

RB21X Book BP221 DIS
RH29G Book BP36 DIS
RR19V Book NB864 DIS
RF08J Book BP39 DIS
RH30H Book BP37 £1.92 NV
RL05F Book NB074 £6.68 NV
+XW17T Book HD760 £7.64 NV
RL36P Book NB345 DIS
RL41U Book NB354 DIS
RH25C Book BP32 £1.95 NV
WA37S Book BP105 £1.95 NV
XW52G Book BP76 £2.05 NV
WG72P Book BP93 £2.10 NV

Page39

WG50E Book NB500 £4.56 NV
WG18U Book HD748 £8.32 NV
WG35Q Book HD893 £7.36 NV
WG94C Book FT1349 £11.69 NV
WA49D Book BP104 NOV
WG91Y Book FT1261 £7.20 NV
RH18U Book BP24 £1.35 NV
RL30H Book NB153 £6.82 NV
WA50E Book BP106 £2.15 NV
LY04E Book BP44 £2.10 NV
XW38R Book NB480 £6.75 NV
+RQ27E Book BP50 £1.60 NV

Page40

RB23A Book BP223 DIS
+WA30H Book BP97 £1.95 NV
XW20W Book BP65 £1.75 NV
RL01B Book NB058 £6.78 NV
RH28F Book BP35 OOP
WG29G Book BP84 £2.15 NV
RB24B Book BP224 £1.55 NV
RQ66W Book BP59 £1.75 NV
RR07H Book NB216 £6.92 NV
RL44X Book BP58 £1.72 NV
WA62S Book NB769 £6.48 NV
RL43W Book BP56 £1.95 NV
WG54J Book NB535 £4.56 NV

Page41

RB10L Book NB269 £5.63 NV
RF20W Book HD734 £6.80 NV
XW30H Book MM700 £2.39 NV
XW44X Book BP71 £1.90 NV
+RL42V Book NB346 £4.05 NV
WG51F Book NB501 DIS
XW10L Book NB383 £4.54 NV
XW08J Book BP60 £1.65 NV
WG46A Book BP90 £2.15 NV
XW46A Book MM513 £2.90 NV
RL40T Book NB338 £4.34 NV

Page42

+RH52G Book BP220 £1.05 NV
RH22Y Book BP29 DIS
XW37S Book BP69 £1.85 NV
+XW11M Book NB379 £4.10 NV
RH51F Book BP219 DIS
·XW47B Book MM396 £2.19 NV
WG53H Book NB529 £4.56 NV
XW51F Book BP75 £2.00 NV
RH50E Book BP218 DIS
XW07H Book BP57 £2.15 NV
RQ30H Book NB353 £6.94 NV
WG60Q Book BP95 £2.15 NV

Page43

RQ80B Book FT926 £6.60 NV
WG00A Book FT1021 £6.64 NV
XW39N Book BP73 £2.25 NV
XW66W Book BP79 £2.05 NV
·XW06G Book FT1071 £8.20 NV
RL46A Book HD681 £10.99 NV
XW28F Book FT841 £6.55 NV
XW73Q Book FT1241 £8.88 NV
WG92A Book FT1341 £11.96 NV
WG65V Book JW928 DIS
WG61R Book HD192 £14.62 NV
WG47B Book FT1191 £9.64 NV

Page44

WA60Q Book FT1076 £6.40 NV
WA59P Book FT1391 £9.84 NV
RL04E Book NB071 DIS
RR00A Book NB195 £10.20 NV
XW86T Book AG471 OOP
WG34M Book NB472 £5.32 NV
WA90X Book NB112 £4.99 NV
XW54J Book NB439 £3.54 NV
WG59P Book BP91 £2.15 NV
XW92A Book WDXG £5.74 NV
XW27E Book NB402 £6.94 NV

Page45

XW99H Book FT1054 £6.75 NV
RB22Y Book BP222 £1.45 NV
RB26D Book BP226 £2.15 NV
RF18U Book BP43 £1.99 NV
WG52G Book NB502 £4.52 NV
WG95D Book FT1305 £9.72 NV
WG93B Book FT1235 £11.62 NV
WG80B Book FT1185 £6.94 NV
RQ58N Book BP55 £2.00 NV
XW43W Book NB467 £5.64 NV
XW91Y Book WRTV £12.10 NV

Page46

WA97F Book NB156 £7.12 NV
RQ33L Book BP52 £2.25 NV
WA61R Book FT1409 £9.15 NV
+XW96E Book FT933 £2.05 NV
+WG20W Book AG652 £5.76 NV
WG97F Book KN035 £4.17 NV
WG70M Book KN400 £4.32 NV
WG73Q Book BP96 £2.10 NV
RH59P Book NB016 £5.49 NV
RH66W Book NB054 DIS
RQ31J Book NB268 DIS
LW28F Book BP46 DIS

Page47

RH57M Book NB001 £11.20 NV
RL24B Book NB144 DIS
WG89W Book NB132 £8.86 NV
XW88V Book AG569 £3.70 NV
XW32K Book BP70 60p NV
·RQ59P Book NB367 £2.75 NV
RQ77J Book FT732 DIS
XW84F Book AG353 £6.99 NV
RL10L Book NB084 £5.46 NV
RL14Q Book NB101 £5.39 NV
RR24B Book NB970 £6.32 NV

Page48

RH58N Book NB014 £3.34 NV
WA89W Book NB444 £9.18 NV
XW29G Book NB378 £7.96 NV
RH62S Book NB033 £10.61 NV
RL12N Book NB089 DIS
RL21X Book NB134 DIS
RF17T Book NB240 £13.85 NV
RL23A Book NB137 £11.94 NV
RH27E Book BP34 £1.96 NV
WA94C Book NB577 £4.96 NV

Page49

+WA57M Book BP100 £2.15 NV
+WA96E Book NB166 £6.23 NV
WA95D Book NB506 £12.67 NV
WG77J Book NB553 £3.44 NV
WG02C Book NB475 DIS
RF14Q Book NB274 DIS
XW26D Book NB336 £11.20 NV
LW29G Book BP47 DIS
WG69A Book AG602 £8.75 NV
XW85G Book AG510 £6.96 NV
RR14Q Book NB238 DIS
RF13P Book NB2441 £5.70 NV
XW83E Book AG512 £6.17 NV

Page50

RF15R Book NB252 £13.61 NV
RF16S Book NB253 £13.66 NV
RQ36P Book BP51 £1.98 NV
RR16S Book NB262 £4.97 NV
RQ79L Book FT546 DIS
WG09K Book JW266 £13.98 NV
WG40T Book HD753 £27.99 NV
XW55K Book AG695 £5.15 NV
XW68Y Book BP81 £2.06 NV
XW09K Book NB391 £4.46 NV
XW40T Book BP74 £2.05 NV
RH38R Book BP205 £1.15 NV

Page51

RR01B Book NB196 £14.87 NV
RQ34M Book NB369 £5.54 NV
WG82D Book FT1364 £8.00 NV
+RH26D Book BP33 £1.75 NV
RF07H Book BP38 DIS
RQ37S Book BP54 DIS
WA23A Undrstdng Calc Maths £4.99 NV
+WA00A Computers For People £5.55 NV
+WG06G Book HD116 £8.69 NV
XW41U Book ITN1 £8.45 NV
+RQ00A Book Sybex C200 £8.45 NV
+WG76H Book NB555 £2.75 NV

Page52

WG96E Book C400 £11.70 NV
+RQ40T Book HD678 £10.68 NV
XW14Q Book MM604 £6.95 NV
+RQ38R Book NB359 £4.92 NV
+XW33L Book BP66 £2.05 NV
WG68Y Book AG601 £6.46 NV
+WA22Y Undrstdng Micros £5.22 NV
RQ01B Book Sybex C201 £13.18 NV
WA87U Book NB579 £4.99 NV
+RQ12N Book Sybex M1 £7.99 NV
RQ13P Book Sybex M11 £12.33 NV
+WG79L Book NB580 £5.99 NV

Page53

+WA25C Undrstdng Comp Scnce £5.20 NV
XW45Y Book BP72 DIS
+XW25C Book NB414 £4.82 NV
WG78K Book NB496 £5.93 NV
WA17T TI Microsystems £5.30 NV
WG17T Book HD897 £13.95 NV
WG24B Book HD165 £10.63 NV
XW65V Book BP78 DIS
XW15R Book HD813 £4.68 NV
WA58N Book FT1200 £9.25 NV

XW98G Book FT1070 £8.20 NV
RQ02C Book Sybex C207 £14.64 NV

Page54

WA92A Book NB129 £6.64 NV
WA41U Advanced 6502 I/Face £12.18 NV
WA02C Book MM495 £9.98 NV
XW57M Book HD177 £8.87 NV
WG81C Book FT1330 £8.10 NV
XW19V Book HD166 £10.98 NV
XW80B Book C202 £11.72 NV
XW81C Book D302 £11.39 NV
WA05F 6502 Assembly Subs £13.95 NV
WA45Y Beyond Games DIS

Page55

WG63T Book HD183 £7.20 NV
XW70M Book M3 £12.95 NV
RQ06G Book Sybex L2 £9.24 NV
WG88V Book BP102 £1.95 NV
WA04E 68000 Assembly Prog £15.64 NV
XW69A Book M2 £13.25 NV
RQ15R Book Sybex M13 DIS
WG66W Book JW009 £9.40 NV
WG21X Book HD167 £11.32 NV
WA54J Book BP112 £2.75
RL39N Book Sybex L8 DIS
XW71N Book M4 £13.75 NV

Page56

XW72P Book C280 £14.13 NV
RQ17T Book Sybex M15 DIS
XW78K Book C281 DIS
XW58N Book NB415 £6.91 NV
WA88V Book NB120 £4.95 NV
WG16S Book JW331 £9.62 NV
WA74R Instant Basic Book £9.28 NV
WA93B Book BP86 £2.15 NV
WA93B Book NB184 £4.99 NV
+WG12N Book JW500 £8.64 NV
XW49D Book MM304 £4.74 NV

Page57

XW50E Book MM286 £6.66 NV
RL45Y Book HD106 £11.33 NV
RQ42V Book HD585 £11.24 NV
+WG13P Book JW204 £7.18 NV
WA69A Microsoft Basic Book £11.68 NV
XW04E Book FT1055 DIS
+WG98G Book HD534 £10.20 NV
+WG31J Book B250 £10.94 NV
WG39N Book JW412 £8.45 NV
WG84F Book JW415 £6.95 NV
WA16S TI Sftwre Dvlpment £15.43 NV
RQ41U Book NB528 DIS
WG67X Book JW729 DIS

Page58

+WG37S Book HD138 £11.55 NV
XW42V Book HD115 £5.46 NV
WA70M Little BASIC Style £7.76 NV
WA72P Book JW932 £8.12 NV
WA64U Pascal for Humans £4.67 NV
WG03D Book P310 £13.34 NV
WG26D Book JW180 £8.92 NV
WG32K Book P320 £16.24 NV
+XW24B Book HD124 £10.42 NV
RQ43W Book HD682 £10.84 NV
WA68Y Discover FORTH £12.62 NV
WG25C Book JW609 £8.11 NV

Page59

XW79L Book C300 £12.99 NV
WG15R Book JW011 £12.96 NV
+XW59P Book HD154 £10.87 NV
WG90X Book FT1369 £10.71 NV
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WG38R Book JW410 £6.21 NV
WG08J Book JW341 DIS
WG48C Book HD162 £14.47 NV
WA71N BASIC for Scientists £13.54 NV
XW60Q Book HD762 £12.84 NV

Page60

XW94C Book FT1095 £4.78 NV
+RL48C Book HD112 £10.13 NV
RQ21X Book Sybex R4 £7.18 NV
XW48C Book R6 £7.17 NV
+RL47B Book HD109 £9.66 NV
WG49D Book B245 £12.98 NV
+XW18U Book HD170 £5.48 NV
+WG27E Book HD476 £14.11 NV
+WG07H Book HD181 £8.60 NV
XW05F Book FT1085 DIS
+XW75S Book FT1062 £6.25 NV
XW23A Book HD155 £17.82 NV

Page61

XW82D Book G402 DIS
WA77J Visicalc Companion £14.32 NV
WA67X Word Processing £12.95 NV
WG41U Book M46 £13.95 NV
WA65V Book FT1394 £9.11 NV
WG45Y Book FT1275 £7.36 NV
WG14Q Book JW466 £9.72 NV
WA73Q Book JW644 £8.98 NV
+WG64U Book HD182 £8.54 NV
+WA01B Book HD496 £8.25 NV
WG05F Book JW496 £8.18 NV

Page62

WG55K Atari Basic – Rowley £6.24 NV
WA47B Games For The Atari £4.45 NV
WA39N Book JW593 £9.36 NV
WA40T Your Atari Computer £13.72 NV
XH57M Master Memory Map £4.00 NV
WA46A Op–Sys Users Manual £16.95 NV
WG56L De Re Atari £16.95 NV
WA63T Get Acquainted Atom £7.40 NV
WA76H 39 Programs for Atom £5.87 NV

Page63

WA43W Book JW414 £7.12 NV
WK04E BBC Micro Book £4.37 NV
WA66W Let BBC Micro Teach £6.12 NV
WA31J Learn Prog VIC £2.50 NV
WA33L VIC Prog Ref Guide £9.95 NV
WA99H Gtg Acq wth VIC 20 £6.44 NV
WA32K VIC Revealed £10.00 NV
WA75S VIC20 Symphony £6.44 NV
+WG33L Book NB017 £4.99 NV

Page64

WG74R Book NB178 £5.95 NV

WA81C Making Most of ZX81 £8.15 NV
WG83E Book JW413 £6.19 NV
WA91Y Book NB223 £6.64 NV
WA83E Get Acquainted ZX81 £5.61 NV
WA85G 34 ZX81 Games £4.57 NV
WA79L Explosive Games ZX81 £5.58 NV
WA80B 20 ZX81 Projects £5.98 NV
WA42V 30–Hour BASIC £7.50 NV
WA38R Book BP109 £1.95 NV
WA56L Book BP114 £2.70 NV
WG99H Book MM973 £7.63 NV

Page65

WA84F ZX81 Companion £5.62 NV
WA03D Peek,Poke,Byte & RAM £6.13 NV
WG75S ZX81 ROM by Logan £10.12 NV
WA82D ZX81 Machine Code £7.10 NV
WA86T Sinclair Machine Cde £10.19 NV
WK01B Spectrum Sinclair £6.83 NV
WK00A Prog Your Spectrum £6.81 NV
WK02C Spectrum Programmer £6.89 NV
WK03D Spectrum Games Book £6.83 NV
WA78K 20 Prog For Spectrum £8.13 NV
WA98G 60 Games Spectrum £4.57 NV

BOXES

Page66

LH56L Potting Box Min 16p (G)
LH57M Potting Box Small 28p (G)
LH58N Potting Box Medium DIS
LH59P Potting Box Large 34p (F)
LF01B Box PB1 White £1.45 (D)
LH14Q Box PB1 Black £1.45
BK00A Box PB1 Grey NYA
·YK48C Snap Box B1 £1.10 (D)
·YK49D Snap Box B2 £1.40 (D)
·YK50E Snap Box B3 £1.99 (D)
·YK51F Snap Box B4 £2.30 (C)
LH20W ABS Box MB1 £1.10 (D)
LH21X ABS Box MB2 £1.26 (D)
LH22Y ABS Box MB3 £1.49 (D)
LH23A ABS Box MB4 £3.25 (C)
WY03D ABS Box 2002 £1.36 (D)
LH60Q ABS Box 2004 £1.68 (D)
LH61R ABS Box 2005 £1.98 (D)
LH62S ABS Box 2006 £3.42 (C)
LH63T ABS Console M1005 £2.64 (C)
LH64U ABS Console M1006 £4.25 (C)
YK24B Calc–Style Verobox £4.94 (C)

Page67

LH65V ABS Console M6005 £2.96 (C)
LH66W ABS Console M6006 £3.82 (C)
LH67X ABS Console M6007 £5.20 (B)
LH68Y ABS Console M8005 £4.55 (C)
LH69A ABS Console M8007 £6.94 (B)
YR72P Pcb Guide Adaptor 6p (H)
WY00A Metal Panel Bx M4003 £1.62 (D)
WY01B Metal Panel Bx M4004 £1.98 (D)
WY02C Metal Panel Bx M4005 £2.88 (C)
+LH09K Foot Sw Box £3.95 (C)
YK26D Pedal Switch Box £5.99 (B)
LF03D Box PB301 £1.85 (D)
HY25C Display Box £1.25 (D)

Page69

HQ47B Tilt Leg Large £1.68 (D)
LH00A Verobox 101 £4.36 (C)
LH01B Verobox 102 £4.92 (C)
LL00A Verobox 103 £6.84 (B)
·LL01B Verobox 104 £14.95 (A)
LL02C Verobox 105 DIS
LL03D Verobox 106 £3.64 (C)
LL04E Verobox 107 £3.96 (C)
LL05F Verobox 201 £6.64 (B)
LL06G Verobox 202 £7.24 (B)
LL07H Verobox 203 £9.64 (A)
LL08J Verobox 211 £4.69 (C)
LL09K Verobox 212 £4.95 (C)
LL10L Verobox 213 £5.94 (B)
LQ07H Verobox 214 £5.68 (B)
LQ08J Verobox 215 £6.24 (B)
LQ09K Verobox 216 £6.93 (B)
LL11M Verobox 217 £6.64 (B)
LH24B Verobox 221 DIS
LH25C Verobox 222 DIS
+LH26D Verobox 223 £5.40 (B)
LL12N Verobox 301 76p (E)
LL13P Verobox 302 DIS
LH50E Verobox 303 £1.48 (D)
LH51F Verobox 305 £2.62 (C)
LL14Q Verobox 401 99p (D)
+XB88V Verocase 501 £16.24 (A)
XB89W Verocase 502 DIS
+XY15R Verobox 503 £16.20 (A)
LQ03D Flip–Top Box 601 Blk £3.72 (C)
LQ05F Flip–Top Box 602 Blk £5.25 (B)
LH27E Verobox 701 £6.24 (B)
LH28F Verobox 702 DIS
LH30H Verobox 705 £8.42 (B)

Page70

LF08J Box AB7 £1.25 (D)
LF09K Box AB8 DIS
LF10L Box AB9 £1.15 (D)
LF11M Box AB10 £1.35 (D)
LF12N Box AB11 £1.25 (D)
LF13P Box AB12 90p (E)
LF14Q Box AB13 £1.65 (D)
XB71N Box AB15 £3.25 (C)
LF15R Box AB23 £1.65 (D)
LF16S Box AB24 £1.75 (D)
LH10L Box AB28 £1.50 (D)
XB69A Box AB31 £2.25 (C)
XB56L Chassis AC64 £2.10 (C)
XB68Y Chassis AC86 £3.25 (C)
LF02C Case WB1 Vinyl £1.99 (D)
LH37S Case WB2 Vinyl £3.06 (C)
LH38R Case WB3 Vinyl £3.64 (C)
LH39N Case WB4 Vinyl £4.64 (C)
LH40T Case WB5 Vinyl £6.20 (B)
LH41U Case WB6 Vinyl £6.82 (B)
LH42V Case WB7 Vinyl £7.85 (B)
+LH43W Case TP1 Teak £2.20 (C)
+LH44X Case TP2 Teak £3.24 (C)
LH45Y Case TP3 Teak DIS
LH46A Case TP4 Teak DIS
LH47B Case TP5 Teak DIS
+LH48C Case TP6 Teak £7.22 (B)
LH70M Box DCM5002 £2.62 (C)
LH71N Box DCM5004 £3.54 (C)
LH72P Box DCM5007 £4.64 (C)
LH73Q Box DCM5005 £4.64 (C)
LH74R Box DCM5006 £6.36 (B)
+XQ08J G–Range 2A £11.94 (A)
XQ09K G–Range 2B £17.20 (A)
XQ10L G–Range 4B £22.60 (A)

Page71

YK41U Instrument Case NM1 £10.50 (A)
YK42V Instrument Case NM2 £11.95 (A)
YK43W Instrument Case NM3 £12.90 (A)
YK44X Instrument Case NM4 £14.50 (A)
YK45Y Instrument Case NM5 £14.90 (A)
YK46A Instrument Case NM6 £10.90 (A)
YK47B Instrument Case NM7 £13.50 (A)
XY59P Console 103 £10.95 (A)
XY60Q Console 108 £16.45 (A)
XB73Q Blue Case 227 £4.55 (C)
XY40T Blue Case 230 DIS
XY41U Blue Case 235 £5.40 (B)
XY42V Blue Case 209 £4.65 (C)
XY43W Blue Case 212 £5.35 (B)
XY44X Blue Case 231 £5.95 (B)
XB67X Blue Case 236 £6.45 (B)
XY45Y Blue Case 222 £5.85 (B)
XY46A Blue Case 226 £6.85 (B)
+XB70M Blue Case 232 £6.99 (B)
XY47B Blue Case 237 £7.90 (B)
XY48C Blue Case 233 £7.70 (B)
XY49D Blue Case 238 £9.80 (B)
+XY52G Wood–End Case 645 £12.30 (A)
XY56L Wood–End Case 1426 DIS
XY57M Wood–End Case 1437 £19.92 (A)
XY58N Wood–End Case 1449 £24.20 (A)

Page72

FW19V Feet Cab 8p (H)
FW38R Stick–on Feet 20p (G)
FW39N HD Feet 12p (G)
HH23A Recess Plate 10p (H)
YR54J Eurocard Guide 32p (F)
YR55K Mod Inl Card Guide 25p (G)
YR53H PCB Brackets 56p (E)
FX96E Castors £2.98 (C)
+FX05F Castor Cup 49p (F)
XY31J Piano Legs £29.56 (A)
FX06G Cool Grille 39p (F)
FX03D Inst Handle PLastic DIS
BK29G HD Strap + Recess £2.95 (C)
FW81C Handle 82p (E)
FX00A Inst Handle Small £2.68 (C)
FX01B Inst Handle Large £3.20 (C)
FX02C Ferrule 34p (F)

Page73

FW82D HD Strap Handle £1.55 (D)
LH08J Recess Handle 43p (F)
LH11M Heavy Duty Handle £2.94 (C)
YL05F Flip Handle £4.95 (C)
YX00A Cab Corners Small 24p (G)
FX04E Cab Corner Large 16p (G)
FX94C Corner Two–Side 29p (F)
FX95D Corner Three–Side 36p (F)
BK25C Cab Corner/Foot Lge 69p (E)
BK26D Cab Corner/Foot Sm 40p (F)
+HB20W Flexihinge 8p (H)
YL24B Small Hinge £1.55 (D)
YL04E Lift off Hinge £1.72 (D)
YL25C Lockable Catch 99p (D)
YL06G Butterfly Catch £4.22 (C)

Page74

XY17T Laminate Japan Teak £3.75 (C)
XY18U Laminate Penang W/Nu £3.75 (C)
XY19V Laminate Alum Small £1.59 (D)
·XY20W Laminate Alum Large £2.62 (C)
RY06G Acoustic Wadding 65p (E)
RY00A Black Tygan 45in £1.96 (D)
RY01B Black Tygan 22.1/2in 98p (E)
RY02C Brown Tygan 45in £1.96 (D)
RY03D Brown Tygan 22.1/2in 98p (E)
RY04E Covering Cloth 50in £1.06 (D)
RY05F Covering Cloth 25in 53p (E)

CABLES

Page75

BL77J Wire–Wrap Black £1.85 (G)
BL82D Wire–Wrap Red £1.85 (G)
BL83E Wire–Wrap White £1.85 (G)
BL85G Bell Wire Black 45p (H)
BL86T Bell Wire Blue 45p (H)
BL87U Bell Wire Brown 45p (H)
BL88V Bell Wire Green 45p (H)
BL89W Bell Wire Grey DIS
BL90X Bell Wire Orange 45p (H)
+BL91Y Bell Wire Pink 45p (H)
BL92A Bell Wire Red 45p (H)
+BL93B Bell Wire Violet 45p (H)
BL94C Bell Wire White 45p (H)
BL95D Bell Wire Yellow 45p (H)
BL46A L/C Wire Black £1.25 (H)
BL47B L/C Wire Blue £1.25 (H)
BL48C L/C Wire Brown £1.25 (H)
BL49D L/C Wire Green £1.25 (H)
BL50E L/C Wire Grey £1.25 (H)
BL51F L/C Wire Orange £1.25 (H)
BL52G L/C Wire Pink £1.25 (H)
BL53H L/C Wire Red £1.25 (H)
BL54J L/C Wire Violet £1.25 (H)
BL55K L/C Wire White £1.25 (H)
BL56L L/C Wire Yellow £1.25 (H)
BL00A Wire 10M Black 35p (H)
BL01B Wire 10M Blue 35p (H)
BL02C Wire 10M Brown 35p (H)
BL03D Wire 10M Green 35p (H)
BL04E Wire 10M Grey 35p (H)
BL05F Wire 10M Orange 35p (H)
BL06G Wire 10M Pink 35p (H)
BL07H Wire 10M Red 35p (H)
BL08J Wire 10M Violet 35p (H)
BL09K Wire 10M White 35p (H)
BL10L Wire 10M Yellow 35p (H)
XL10L Wire 11C £3.99
+YR00A Bicol Green/Red 34p (H)
YR01B Bicol Green/Yellow DIS
+YR04E Bicol Orange/Black 34p (H)
+YR05F Bicol Orange/Red 34p (H)
YR06G Bicol Pink/Black DIS
+YR07H Bicol Purple/Red 34p (H)
+YR08J Bicol Red/Black 34p (H)
YR09K Bicol Red/Blue DIS
+YR12N Bicol White/Black 34p (H)
YR14Q Bicol Yellow/Black DIS
YR16S Bicol Yellow/Red DIS
XR32K Wire 3202 Black 17p (G)
XR33L Wire 3202 Blue 17p (G)
XR34M Wire 3202 Brown 17p (G)
XR35Q Wire 3202 Green 17p (G)
XR36P Wire 3202 Red 17p (G)
XR37S Wire 3202 White 17p (G)
XR38R Wire 3202 Grn/Yllw 17p (G)

Page76

XR57M HC Wire Black 38p (G)
XR58N HC Wire Green 38p (G)
XR59P HC Wire Red 38p (G)
XR40T Extra Flex Black 20p (G)
XR41U Extra Flex Blue 20p (G)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum trade quantity. For details please see page 27

1983 Catalogue Page No.		VAT inclusive PRICE
XR43W	Extra Flex Green	20p (G)
XR44X	Extra Flex Red	20p (G)
+XR45Y	Extra Flex Yellow	20p (G)
XR68Y	Min Extra Flex Black	15p (G)
XR69A	Min Extra Flex Red	15p (G)
XR22Y	EHT Wire	32p (G)
BL11M	Strappg Wire 16swg	82p (E)
BL12N	Strappg Wire 18swg	87p (E)
BL13P	Strappg Wire 20swg	95p (E)
BL14Q	Strappg Wire 22swg	94p (E)
BL15R	Strappg Wire 24swg	96p (E)
BL16S	EC Wire.14 swg	70p (E)
BL24B	EC Wire 16 swg	79p (E)
BL25C	EC Wire 18 swg	88p (E)
BL26D	EC Wire 20 swg	89p (E)
BL27E	EC Wire 22 swg	93p (E)
BL28F	EC Wire 24 swg	£1.05 (D)
BL29G	EC Wire 26 swg	£1.07 (D)
BL39N	EC Wire 28 swg	£1.07 (D)
BL40T	EC Wire 30 swg	£1.10 (D)
BL41U	EC Wire 32 swg	£1.12 (D)
BL42V	EC Wire 34 swg	£1.16 (D)
BL43W	EC Wire 36 swg	£1.25 (D)
BL44X	EC Wire 38 swg	£1.25 (D)
BL60Q	EC Wire 40 swg	£1.50 (D)
BL61R	EC Wire 42 swg	£1.68 (D)
BL62S	EC Wire 44 swg	£2.20 (C)
BL63T	EC Wire 48 swg	£5.34 (C)
XR39N	Zip Wire	14p (G)
XR60Q	HD Loudspeaker Cable	37p (G)
YG08J	Litz Speaker Leads	£6.84 (B)
XR06G	Ribbn Cable 10-Way	60p
XR07H	Ribbn Cable 20-Way	£1.20
XR67X	Ribbon Cable 30 Way	£1.80 (D)
Page77		
XR65V	IDC Cable 12-Way	£2.28
RK30H	Flexicable 7-way	54p (G)
RK31J	Flexicable 10-way	65p
XR47B	Twn Mains DS Black	28p (G)
XR00A	Twn Mains DS White	20p (G)
XR61R	Twin 6A Mains Orange	49p (E)
XR62S	Twin 6A Mains White	49p (E)
XR01B	Min Mains Black	35p (E)
XR02C	Min Mains White	36p (E)
XR03D	C6A Mains Black	56p (E)
XR04E	C6A Mains White	56p (E)
XR05F	C6A Mains Orange	70p (E)
XR09K	HD Mains Black	99p (E)
XR10L	HD Mains White	80p (E)
XR11M	HD Mains Orange	99p (E)
XR24B	Cotton Mains	94p (E)
BL71N	Stretchflex 1A	£1.05 (D)
BL72P	Stretchflex 6A	£4.95 (C)
Page78		
XR48C	4-Core Mains	£1.28 (E)
XR49D	1.0mm TE Cable	43p (E)
XR50E	1.5mm TE Cable	48p (E)
XR51F	2.5mm TE Cable	65p (E)
XR52G	6mm TE Cable	£1.75 (E)
XR53H	1mm Trpl & ECC Cbl	74p (E)
XR15R	Min Screened	17p (G)
XR12N	Cable Single Black	19p (G)
XR13P	Cable Single Grey	19p (G)
XR14Q	Cable Single White	19p (G)
Page79		
XR16S	Single Mic Cable	42p (G)
XR18U	Low Noise Scnd	42p (G)
XR19V	Low C Cable	55p (G)
XR63T	UR67 RF Cable	£2.20 (D)
XR08J	Twin Mic Cable	84p (E)
XR20W	Lapped Pair	21p (G)
XR21X	Cable Twin	31p (G)
XR23A	Cable Quad	72p (G)
Page80		
XR25C	Multi-Core 4-Way	60p (E)
XR26D	Multi-Core 6-Way	65p (E)
XR27E	Multi-Core 9-Way	86p (E)
XR28F	Multi-Core 15-Way	£1.25 (E)
XR46A	Multi-Core 25-Way	£1.74 (E)
XR54J	Multi-Core 36-Way	£2.31 (E)
XR66W	4-Wire Phone Cable	21p (F)
XR55K	7-Core Trailer Cable	£1.19 (E)
BH30H	Scr Strtchflx Blck	£1.80
BH31J	Scr Strtchflx Blue	£1.80 (D)
BH34M	Scr Stretchflex Red	£1.80 (D)
HQ49D	Twin Stretchflex	£2.40 (C)
XR30H	Standard Co-Ax	52p (G)
XR29G	Low Loss Co-Ax	50p (G)
Page81		
XR31J	Bal Feeder	19p (G)
YR19V	Marker A0	14p (G)
YR20W	Marker A1	14p (G)
YR21X	Marker A2	14p (G)
YR22Y	Marker A3	14p (G)
YR23A	Marker A4	14p (G)
YR24B	Marker A5	14p (G)
YR25C	Marker A6	14p (G)
YR26D	Marker A7	14p (G)
YR27E	Marker A8	14p (G)
YR28F	Marker A9	14p (G)
+YR29G	Marker B0	14p (G)
+YR30H	Marker B1	14p (G)
+YR31J	Marker B2	14p (G)
YR32K	Marker B3	DIS
YR33L	Marker B4	DIS
+YR34M	Marker B5	14p (G)
YR35Q	Marker B6	DIS
YR36P	Marker B7	DIS
YR37S	Marker B8	DIS
+YR38R	Marker B9	14p (G)
YR39N	Marker C0	14p (G)
YR40T	Marker C1	14p (G)
YR41U	Marker C2	14p (G)
YR42V	Marker C3	14p (G)
YR43W	Marker C4	14p (G)
YR44X	Marker C5	14p (G)
YR45Y	Marker C6	14p (G)
YR46A	Marker C7	14p (G)
YR47B	Marker C8	14p (G)
YR48C	Marker C9	14p (G)
BF86T	Heat Shrink CP 16	55p (E)
BF87U	Heat Shrink CP 24	65p (E)
BF88V	Heat Shrink CP 32	30p (F)
BF89W	Heat Shrink CP 48	32p (F)
BF90X	Heat Shrink CP 64	34p (F)
YR17T	Heat Shrink CP95	50p (E)
YR18U	Heat Shrink CP127	£1.10 (D)
BL66W	Ht-Resist Sleeve Blk	12p (G)
BL69A	Ht-Resist Sleeve Grn	12p (G)
BL70M	Ht-Resist Sleeve Red	12p (G)
BH00A	Systoflex 1mm Black	6p (H)
BH01B	Systoflex 1mm Blue	DIS
BH02C	Systoflex 1mm Green	6p (H)
BH03D	Systoflex 1mm Red	6p (H)
BH04E	Systoflex 1mm White	8p (H)
BH05F	Systoflex 1mm Yellow	DIS
BH06G	Systoflex 2mm Black	10p (H)
+BH07H	Systoflex 2mm Blue	10p (H)
BH08J	Systoflex 2mm Green	10p (H)
BH09K	Systoflex 2mm Red	10p (H)
BH10L	Systoflex 2mm White	10p (H)
BH11M	Systoflex 2mm Yellow	10p (H)
BH12N	Systoflex 4mm Black	15p (H)
BH13P	Systoflex 4mm Blue	DIS
BH14Q	Systoflex 4mm Green	15p (H)
BH15R	Systoflex 4mm Red	15p (H)
+BH16S	Systoflex 4mm White	24p (H)
BH17T	Systoflex 4mm Yellow	24p (H)
BH42V	Systoflex 6mm Black	17p (H)
BH43W	Systoflex 10mm Black	24p (H)
BL65V	Lacing Cord	£1.10 (H)
BL57M	Spirawrap 1/8in.	18p (G)
BL58N	Spirawrap 1/4in.	21p (F)
BL59P	Spirawrap 1/2in.	46p (F)
Page82		
BF91Y	Tie-Wrap 92	2p (H)
BF92A	Tie-Wrap 140	3p (H)
BF93B	Tie-Wrap 186	4p (H)
BF94C	Cable Tie Base	19p (G)
RK59P	Re-Usable Cable Tie	2p (H)
BH26D	Safix 4	12p (G)
BH27E	Safix 8	13p (G)
BH28F	Safix 12	14p (G)
LR44X	Cable P Clip 3/16in.	3p (H)
LR45Y	Cable P Clip 1/4in.	3p (H)
LR46A	Cable P Clip 5/16in.	3p (H)
LR04E	Cable P Clip 3/8in.	3p (H)
BH18U	Hiatt Rd 2.3/4mm	25p (G)
BH19V	Hiatt Rd 3.1/2mm	36p (F)
BH20W	Hiatt Rd 4mm	29p (F)
BH21X	Hiatt Rd 5mm	29p (F)
BH22Y	Hiatt Rd 6mm	32p (F)
BH23A	Hiatt Rd 7mm	32p (F)
BH24B	Hiatt Rd 8mm	34p (F)
BH36P	Hiatt Rd 9mm	37p (F)
BH25C	Hiatt Flat 4mm	32p (G)
BH37S	Hiatt Flat 5mm	32p (F)
BH38R	Hiatt Flat 7mm	36p (F)
BH39N	Hiatt Flat 9mm	32p (F)
BH40T	Hiatt Flat 10mm	38p (F)
BH41U	Hiatt Flat 14mm	45p (F)
CAPACITORS		
Page86		
WX35Q	Ceramic 1.8	8p (H)
WX36P	Ceramic 2.2	8p (H)
WX37S	Ceramic 2.7	8p (H)
WX38R	Ceramic 3.3	8p (H)
WX39N	Ceramic 3.9	8p (H)
WX40T	Ceramic 4.7	8p (H)
WX41U	Ceramic 5.6	8p (E)
WX42V	Ceramic 6.8	8p (H)
WX43W	Ceramic 8.2	8p (H)
WX44X	Ceramic 10	8p (H)
WX45Y	Ceramic 12	8p (H)
WX46A	Ceramic 15	8p (H)
WX47B	Ceramic 18	8p (H)
WX48C	Ceramic 22	8p (H)
WX49D	Ceramic 27	8p (H)
WX50E	Ceramic 33	8p (H)
WX51F	Ceramic 39	8p (H)
WX52G	Ceramic 47	8p (H)
WX53H	Ceramic 56	8p (H)
WX54J	Ceramic 68	8p (H)
WX55K	Ceramic 82	8p (H)
WX56L	Ceramic 100	8p (H)
WX57M	Ceramic 120	8p (H)
WX58N	Ceramic 150	8p (H)
WX59P	Ceramic 180	8p (H)
WX60Q	Ceramic 220	8p (H)
WX61R	Ceramic 270	8p (H)
WX62S	Ceramic 330	8p (H)
WX63T	Ceramic 390	8p (H)
WX64U	Ceramic 470	8p (H)
WX65V	Ceramic 560	8p (H)
WX66W	Ceramic 680	8p (H)
WX67X	Ceramic 820	8p (H)
WX68Y	Ceramic 1000	8p (H)
WX69A	Ceramic 1200	8p (H)
WX70M	Ceramic 1500	8p (H)
WX71N	Ceramic 1800	8p (H)
WX72P	Ceramic 2200	8p (H)
WX73Q	Ceramic 2700	8p (H)
WX74R	Ceramic 3300	8p (H)
WX75S	Ceramic 3900	8p (H)
WX76H	Ceramic 4700	8p (H)
WX77J	Ceramic 10,000	8p (H)
WX78K	Ceramic 22,000	8p (H)
YY24B	Monocap 0.001uF	28p (F)
YY25C	Monocap 0.0022uF	28p (F)
YY07H	Monocap 0.0047uF	28p (F)
YY08J	Monocap 0.01uF	28p (F)
YY09K	Monocap 0.022uF	34p (F)
YY10L	Monocap 0.047uF	36p (F)
YY11M	Monocap 0.1uF	43p (F)
YR73Q	Minidisc 0.01uF	5p (H)
YR74R	Minidisc 0.047uF	5p (H)
YR75S	Minidisc 0.1uF	7p (H)
YR76H	Minidisc 0.47uF	15p (G)
BX00A	Disc 0.01uF	5p (G)
BX01B	Disc 0.022uF	5p (G)
BX02C	Disc 0.047uF	8p (G)
BX03D	Disc 0.1uF	8p (G)
Page87		
BX05F	HV Disc 10	10p (G)
BX06G	HV Disc 47	15p (G)
BX07H	HV Disc 100	15p (G)
BX10L	HV Disc 470	15p (G)
BX12N	HV Disc 1000	11p (G)
BX13P	HV Disc 2200	11p (G)
BX14Q	HV Disc 4700	22p (G)
BX15R	HV Disc 10,000	19p (G)
HY18U	1000V Disc 4700pF	19p (F)
BX16S	Feed Thro Cap	8p (H)
WX02C	Mica 5pF	21p (F)
WX03D	Mica 10pF	21p (F)
WX05F	Mica 22pF	21p (F)
WX07H	Mica 33pF	22p (F)
WX09K	Mica 47pF	22p (F)
WX11M	Mica 68pF	22p (F)
WX12N	Mica 82pF	22p (F)
WX13P	Mica 100pF	22p (F)
WX14Q	Mica 120pF	22p (F)
WX15R	Mica 150pF	22p (F)
WX16S	Mica 180pF	22p (F)
WX17T	Mica 220pF	28p (F)
WX19V	Mica 330pF	29p (F)
WX21X	Mica 470pF	29p (F)
WX23A	Mica 680pF	32p (E)
WX25C	Mica 1000pF	43p (E)
WX31J	Mica 4700pF	£1.25 (D)
BX24B	Polystyrene 22	13p (G)
BX25C	Polystyrene 33	8p (H)
BX26D	Polystyrene 47	8p (H)
BX27E	Polystyrene 68	8p (H)
BX28F	Polystyrene 100	8p (H)
BX29G	Polystyrene 150	8p (H)
BX30H	Polystyrene 220	8p (H)
BX31J	Polystyrene 330	8p (H)
BX32K	Polystyrene 470	8p (H)
BX33L	Polystyrene 560	8p (H)
BX34M	Polystyrene 680	8p (H)
BX35Q	Polystyrene 1000	8p (H)
BX36P	Polystyrene 1500	8p (H)
BX37S	Polystyrene 2200	8p (H)
BX38R	Polystyrene 3300	8p (H)
BX39N	Polystyrene 4700	8p (H)
BX40T	Polystyrene 5600	10p (G)
BX41U	Polystyrene 6800	10p (G)
BX92A	Polystyrene 10,000	14p (G)
BX93B	Polystyrene 22,000	19p (G)
BX94C	Polystyrene 47,000	25p (F)
BX95D	Polystyrene 100,000	49p (F)
Page88		
BX46A	1% Polysty 100	25p (F)
BX47B	1% Polysty 150	25p (F)
BX49D	1% Polysty 220	25p (F)
BX50E	1% Polysty 270	28p (F)
BX51F	1% Polysty 330	28p (F)
BX52G	1% Polysty 390	29p (F)
BX53H	1% Polysty 470	29p (F)
BX54J	1% Polysty 560	28p (F)
BX55K	1% Polysty 750	28p (F)
BX56L	1% Polysty 1000	25p (F)
BX57M	1% Polysty 1200	25p (F)
BX58N	1% Polysty 1500	25p (F)
BX59P	1% Polysty 1800	28p (F)
BX60Q	1% Polysty 2200	28p (F)
BX61R	1% Polysty 2700	28p (F)
BX62S	1% Polysty 3300	28p (F)
BX63T	1% Polysty 3900	28p (F)
BX64U	1% Polysty 4700	32p (F)
BX65V	1% Polysty 5600	32p (F)
BX66W	1% Polysty 6800	32p (F)
BX85G	1% Polysty 8200	32p (F)
BX86T	1% Polysty 10,000	35p (F)
BX87U	1% Polysty 22,000	39p (F)
WW22Y	Carbonate 0.001	9p (H)
WW23A	Carbonate 0.0015	9p (H)
WW24B	Carbonate 0.0022	9p (H)
WW25C	Carbonate 0.0033	9p (H)
WW26D	Carbonate 0.0047	9p (H)
WW27E	Carbonate 0.0068	9p (H)
WW28F	Carbonate 0.0082	9p (H)
WW29G	Carbonate 0.01	9p (H)
WW30H	Carbonate 0.012	9p (H)
WW31J	Carbonate 0.015	9p (H)
WW32K	Carbonate 0.018	9p (H)
WW33L	Carbonate 0.022	9p (G)
WW34M	Carbonate 0.027	11p (G)
WW35Q	Carbonate 0.033	11p (G)
WW36P	Carbonate 0.039	11p (G)
WW37S	Carbonate 0.047	11p (G)
WW38R	Carbonate 0.056	11p (G)
WW39N	Carbonate 0.068	12p (G)
WW40T	Carbonate 0.082	DIS
WW41U	Carbonate 0.1	11p (G)
WW42V	Carbonate 0.12	11p (G)
WW43W	Carbonate 0.15	20p (G)
WW44X	Carbonate 0.18	20p (G)
WW45Y	Carbonate 0.22	20p (G)
WW46A	Carbonate 0.27	20p (G)
WW47B	Carbonate 0.33	22p (G)
WW48C	Carbonate 0.39	22p (G)
WW49D	Carbonate 0.47	25p (F)
WW50E	Carbonate 0.56	27p (F)
WW51F	Carbonate 0.68	27p (F)
WW52G	Carbonate 0.82	27p (F)
WW53H	Carbonate 1	27p (F)
BX70M	Polyester 0.01uF	8p (H)
BX71N	Polyester 0.015uF	8p (H)
BX72P	Polyester 0.022uF	8p (H)
BX73Q	Polyester 0.033uF	9p (H)
BX74R	Polyester 0.047uF	9p (H)
BX75S	Polyester 0.068uF	9p (H)
BX76H	Polyester 0.1uF	9p (H)
BX77J	Polyester 0.15uF	15p (G)
BX78K	Polyester 0.22uF	11p (G)
BX79L	Polyester 0.33uF	16p (G)
BX80B	Polyester 0.47uF	16p (G)
BX81C	Polyester 0.68uF	27p (F)
BX82D	Polyester 1uF	27p (F)
BX83E	Polyester 1.5uF	45p (E)
BX84F	Polyester 2.2uF	49p (E)
Page89		
WW15R	Mylar 0.001	5p (H)
WW16S	Mylar 0.0022	5p (H)
WW17T	Mylar 0.0047	5p (H)
WW18U	Mylar 0.01	6p (H)
WW19V	Mylar 0.022	6p (H)
WW20W	Mylar 0.047	8p (H)
WW21X	Mylar 0.1	10p (G)
WW63E	Mylar 0.22	16p (G)
FF53H	IS Cap 0.01uF	24p (G)
FF54J	IS Cap 0.022uF	25p (F)
FF55K	IS Cap 0.047uF	28p (F)
FF56L	IS Cap 0.1uF	45p (F)
FF57M	IS Cap 0.22uF	45p (F)
FF58N	IS Cap 0.47uF	78p (E)
YY29G	Minelect 0.1uF 50V	13p (G)
YY30H	Minelect 0.47uF 50V	13p (G)
YY31J	Minelect 1uF 50V	14p (G)
YY32K	Minelect 2.2uF 50V	15p (G)
YY33L	Minelect 4.7uF 35V	21p (G)
YY34M	Minelect 10uF 16V	13p (G)
YY35Q	Minelect 10uF 40V	16p (G)
YY36P	Minelect 22uF 16V	18p (G)
YY37S	Minelect 47uF 16V	22p (G)
RK50E	Minelect 100uF 6.3V	22p (G)
WW54J	Tant 0.1uF 35V	13p (G)
WW55K	Tant 0.15uF 35V	13p (G)
WW56L	Tant 0.22uF 35V	16p (G)
WW57M	Tant 0.33uF 35V	18p (G)
WW58N	Tant 0.47uF 35V	17p (G)
WW59P	Tant 0.68uF 35V	17p (G)
WW60Q	Tant 1.0uF 35V	18p (G)
WW61R	Tant 1.5uF 35V	18p (G)
WW62S	Tant 2.2uF 35V	23p (G)
WW63T	Tant 3.3uF 35V	19p (G)
WW64U	Tant 4.7uF 16V	18p (G)
WW65V	Tant 4.7uF 35V	19p (G)
WW66W	Tant 6.8uF 16V	21p (G)
WW67X	Tant 6.8uF 35V	24p (F)
WW68Y	Tant 10uF 16V	25p (F)
WW69A	Tant 10uF 25V	28p (F)
WW70M	Tant 10uF 35V	36p (F)
WW72P	Tant 22uF 16V	39p (F)
WW73Q	Tant 22uF 25V	65p (E)
WW74R	Tant 33uF 10V	35p (F)
WW75S	Tant 47uF 10V	57p (E)
WW76H	Tant 47uF 16V	75p (E)
WW78K	Tant 100uF 3V	35p (F)
WW79L	Tant 100uF 10V	£1.25 (D)
Page90		
FF00A	PC Elect 0.47uF 100V	8p (G)
FF01B	PC Elect 1uF 100V	8p (G)
FF02C	PC Elect 2.2uF 63V	8p (G)
FF03D	PC Elect 4.7uF 63V	8p (G)
FF04E	PC Elect 10uF 35V	8p (G)
FF05F	PC Elect 10uF 63V	9p (G)
FF06G	PC Elect 22uF 16V	8p (G)
FF07H	PC Elect 22uF 63V	9p (G)
FF08J	PC Elect 47uF 25V	9p (G)
FF09K	PC Elect 47uF 63V	10p (G)
FF10L	PC Elect 100uF 10V	10p (G)
FF11M	PC Elect 100uF 25V	9p (G)
FF12N	PC Elect 100uF 63V	18p (G)
FF13P	PC Elect 220uF 16V	10p (G)
FF14Q	PC Elect 220uF 63V	24p (F)
FF15R	PC Elect 470uF 16V	18p (G)
FF16S	PC Elect 470uF 25V	23p (F)
FF59P	PC Elect 470uF 63V	32p (E)
FF17T	PC Elect 1000uF 16V	24p (F)
FF18U	PC Elect 1000uF 25V	28p (F)
FF60Q	PC Elect 2200uF 16V	28p (F)
FB11M	Axial 0.47uF 250V	18p (G)
FB12N	Axial 1uF 63V	9p (H)
FB13P	Axial 1uF 450V	25p (F)
FB14Q	Axial 1.5uF 63V	10p (G)
FB15R	Axial 2.2uF 63V	9p (G)
FB16S	Axial 2.2uF 450V	30p (F)
FB17T	Axial 3.3uF 63V	9p (G)
FB18U	Axial 4.7uF 63V	9p (G)
FB19V	Axial 4.7uF 450V	33p (F)
FB20W	Axial 6.8uF 40V	12p (G)
FB21X	Axial 6.8uF 63V	18p (G)
FB22Y	Axial 10uF 25V	9p (H)
FB23A	Axial 10uF 63V	11p (G)
FB24B	Axial 10uF 100V	17p (G)
FB25C	Axial 10uF 450V	45p (F)
FB26D	Axial 15uF 16V	9p (H)
FB27E	Axial 15uF 40V	11p (G)
FB28F	Axial 15uF 63V	16p (G)
FB30H	Axial 22uF 25V	11p (G)
FB31J	Axial 22uF 63V	16p (G)
FB32K	AXial 22uF 100V	17p (F)
FB33L	Axial 22uF 450V	55p (E)
FB34M	Axial 33uF 6.3V	10p (G)
FB35Q	Axial 33uF 16V	11p (G)
FB36P	Axial 33uF 40V	12p (G)
FB38R	Axial 47uF 10V	10p (G)
FB39N	Axial 47uF 25V	13p (G)
FB41U	Axial 47uF 63V	17p (G)
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FB68Y	Axial 330uF 25V	20p (G)
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Page106

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Page107

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Page108

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Page109

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Page110

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Page111

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Page112

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Page113

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Page114

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Page115

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Page116

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Page117

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Page118

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Page119

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Page120

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Page121

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Page122

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Page123

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Page124

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Page125

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AF49D	VIC20 Printer	£230.00
AF50E	VIC20 Disk Drive	£229.99
AF51F	VIC 3K RAM	£19.95
AF52G	VIC 8K RAM	£29.95
AF53H	VIC 16K RAM	£39.95
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AC56L	Machine Code Mon	£34.95

Page126

AC57M	Intro To Basic Part1	£14.95
AC58N	Intro To Basic Part2	£14.95
AC59P	VIC Avenger	£19.95
AC60Q	VIC Star Battle	£11.95
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Page127

AC79L	VIC Panic	£7.00
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AC66W	VIC Rat Race	£11.95
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AC81C	Vicgammon	£7.00
AC83E	VIC Asteroids	£7.00
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Page128

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BC48C	VIC Strategic Advnc	£4.99
AC92A	Simplicalc Disk	£24.95
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AC99H	VIC Maths 1	£9.99
BC00A	VIC Maths 2	£9.99
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Page129

BC01B	VIC Biology	£9.99
BC03D	VIC Physics	£9.99
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Page130

XG28F	MENTA	£115.00 (A)
AF38R	Epson RX80	£339.95 (A)
AF40T	Epson FX80	£447.35 (A)
YX87U	Mini Floppy Disc	£2.50 (C)

Page131

AC00A	Vid Gme Cnsl	£99.95
AC01B	Air Sea Battle Game	£18.95
AC02C	Space War Game	£14.95

Page132

AC03D	Outlaw Game	£14.95
AC04E	Video Olympics Game	£14.95
AC05F	Breakout Game	DIS
AC06G	Basketball Game	£14.95
AC07H	Surround Game	£14.94

Page133

AC09K	Basic Maths	£14.95
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AC12N	Miniature Golf	£14.95
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AC15R	Bowling	£18.95

Page134

AC16S	Brain Games	£24.95
AC18U	Golf	£18.95
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AC21X	Superman	£24.95
AC22Y	Adventure Game	£18.95
AC24B	Indy 500	£29.95
AC25C	Backgammon	£18.95 (A)

Page135

AC26D	Space Invaders	£24.95
AC27E	Programming	DIS
+AC28F	Chess	£18.95

Page136

AC20W	Circus Atari Game	£24.95 (A)
AC17T	Human Cannonball	£14.95
AC23A	Casino Game	£18.95
AC31J	Night Driver Game	£24.95 (A)
AC32K	Dodge Em	£18.95 (A)
AC33L	Pele Soccer Game	£24.95
AC34M	Hangman	£14.95

Page137

AC35Q	Video Checkers	£18.95 (A)
AC36P	Maze Craze	£24.95 (A)
AC41U	Othello Game	£18.95
AC42V	Video Pinball	£24.95 (A)

Page138

AC43W	Asteroids	£29.95 (A)
AC44X	Warlords	£29.95
AC46A	Missile Command	£29.95 (A)
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Page139

AC52G	Dragster	£19.95 (A)
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AC70M	Demons To Diamonds	£18.95
AC72P	Berzerk	£29.95
AC74R	Adventure I	DIS
AC75S	Adventure II	DIS
AC76H	Raiders Of Lost Ark	£29.95
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CONNECTORS

Page140

HF25C	Croc Clips	10p (G)
HF23A	Alligator Clip Black	14p (G)
HF24B	Alligator Clip Red	16p (G)
HF26D	Charger Clip	25p (F)
BW69A	Croc Lead Kit	£1.64 (D)
HF10L	Push-On Receptacle	33p (F)
HF11M	Push-On Blade	33p (F)
HF12N	Push-On Covers	64p (E)
YX47B	Comcon Block 5-way	45p (F)
YX48C	Comcon Terminal	5p (H)
HF02C	Terminal Post Black	42p (F)
HF03D	Terminal Post Blue	39p (F)
HF04E	Terminal Post Brown	42p (F)
HF05F	Terminal Post Green	42p (F)
HF06G	Terminal Post Grey	DIS
HF07H	Terminal Post Red	42p (F)
+HF08J	Terminal Post White	42p (F)
HF09K	Terminal Post Yellow	42p (F)
HF13P	Press Terminal Black	28p (F)
HF15R	Press Terminal Green	28p (F)
HF16S	Press Terminal Red	28p (F)
+HF17T	Press Terminal White	30p (F)
HF18U	Press Terminal Yellw	28p (F)
HF14Q	Press Terminal Blue	DIS
BW72P	Quickterm Type A	49p (F)
YR92A	Quickterm Type B	62p (E)
BW71N	Quickterm Push	62p (E)

Page141

WL57M	1mm Plug Black	20p (G)
WL58N	1mm Plug Red	20p (G)
WL59P	1mm Socket Black	15p (G)
WL60Q	1mm Socket Red	15p (G)
HF38R	2mm Plug Black	17p (G)
HF39N	2mm Plug Blue	DIS
HF40T	2mm Plug Green	DIS
HF41U	2mm Plug Red	17p (G)
HF42V	2mm Plug White	DIS
HF43W	2mm Plug Yellow	18p (G)
HF44X	2mm Socket Black	15p (G)
+HF45Y	2mm Socket Blue	15p (G)
+HF46A	2mm Socket Green	15p (G)
HF47B	2mm Socket Red	15p (G)
+HF48C	2mm Socket White	15p (G)
HF49D	2mm Socket Yellow	15p (G)
HF50E	Wander Plug Black	17p (G)
HF51F	Wander Plug Blue	DIS
HF52G	Wander Plug Green	17p (G)
HF53H	Wander Plug Red	17p (G)
+HF54J	Wander Plug White	17p (G)
+HF55K	Wander Plug Yellow	17p (G)
HF56L	Wander Socket Black	14p (G)
+HF57M	Wander Socket Blue	14p (G)
HF58N	Wander Socket Green	14p (G)
HF59P	Wander Socket Red	14p (G)
HF60Q	Wander Socket White	DIS
+HF61R	Wander Socket Yellow	14p (G)
HF62S	4mm Plug Black	15p (G)
HF63T	4mm Plug Blue	15p (G)
HF64U	4mm Plug Brown	15p (G)
HF65V	4mm Plug Green	15p (G)
HF66W	4mm Plug Red	15p (G)
HF67X	4mm Plug White	15p (G)
HF68Y	4mm Plug Yellow	15p (G)
HF69A	4mm Socket Black	15p (G)
HF70M	4mm Socket Blue	16p (G)
HF71N	4mm Socket Brown	16p (G)
HF72P	4mm Socket Green	16p (G)
HF73Q	4mm Socket Red	16p (G)
HF74R	4mm Socket White	16p (G)
HF75S	4mm Socket Yellow	16p (G)
HF34M	4mm Patch Cord	£1.98 (D)

HQ54J	Screw-Cap Phono Blk	12p (G)
HQ55K	Screw Cap Phono Blue	12p (G)
HQ58N	Screw Cap Phono Red	12p (G)
HQ59P	Screw Cap Phono Whte	12p (G)
HQ60Q	Screw Cap Phono Yell	12p (G)
HH01B	Scr Phono	17p (G)
YW06G	Threaded Phono Skt	15p (G)
HH02C	Phono Socket Single	12p (G)
HH03D	Phono Socket Twin	16p (G)
BW74R	Phono Socket Quad	35p (F)
BW75S	Phono Socket 5-way	DIS
BW76H	Phono Socket 6-way	55p (E)

Page142

HH04E	Line Phono	20p (G)
HH05F	Phono Conn	21p (G)
HF76H	2.5 Plug Plas	16p (G)
HF77J	2.5 Plug Scr	26p (G)
HF78K	2 5 Jack Socket	13p (G)
HF79L	2.5 Line Socket	30p (F)
HF80B	Plug Plas 3.5	13p (G)
HF98G	Stereo Plas 3.5 Plug	25p (F)
HF81C	Plug Scr 3.5	24p (G)
HF82D	Jack Socket 3.5	14p (G)
HF83E	Line Socket Plas 3.5	15p (G)
RK51F	Stereo Plas 3.5 Skt	25p
HF84F	Line Socket Scr 3.5	24p (G)
HF85G	Jack Plug Plas	21p (G)
HF86T	Side Jack Plas	26p (F)
HF87U	Jack Plug Scr	43p (F)
YW07H	SR Jack Plug	52p (F)
YL03D	Side Jack Screened	29p (F)
HF88V	Jack Pl Sto Plas	32p (F)
HF89W	Jack Pl Sto Scr	52p (F)
HF90X	Jack Skt Brk	21p (G)
BW78K	Chro Mono Jack Skt	39p (F)

Page143

HF91Y	Jack Skt Open	19p (G)
HF92A	Jack Skt Sto	25p (F)
BW79L	Chro Stereo Jack Skt	35p (F)
HF93B	Stereo Open Skt	35p (F)
BW80B	DPDT Jack Socket	52p (E)
HH19V	Line Jack Plas	24p (F)
HH20W	Scr Line Jack	50p (F)
HH21X	Stereo Line Skt	30p (F)
HH22Y	Scr Stereo Line Skt	58p (E)
RK80B	Mono 0.25in Jk Cplr	58p (F)
HH07H	Co-ax Plug Aly	24p (F)
HH06G	Co-ax Plug Plas	DIS
YW08J	Co-ax Plug Imp	15p (G)
HH08J	Co-ax Socket Pan	29p (F)
HH09K	Co-ax Socket Flush	25p (F)
YW09K	Co-ax Line Skt	43p (F)
HH11M	Co-ax Conn	15p (G)
HH13P	Skeleton Car Plug	14p (G)
HH12N	Car Plug Plas	DIS
HH14Q	Chassis Car Socket	24p (F)

Page144

HH16S	FM Aerial Plug	17p (G)
HH17T	BNC Plug	98p (E)
HH18U	BNC Socket	98p (E)
YW00A	BNC Square Socket	98p (E)
QY22Y	BNC Earth Tag	20p
YW01B	BNC Line Socket	£1.10 (D)
YW02C	BNC Straight Adaptor	£1.37 (D)
YW03D	BNC T Adaptor	£2.95 (C)
BW81C	Plug PL259	51p (E)
BW82D	UHF Reducer Small	17p (G)
BW83E	UHF Reducer Large	17p (G)
HL95D	RA PL259 Plug	85p (E)
HL96E	Quick-Connect PL259	99p (E)
BW84F	UHF Socket Round	49p (F)
BW85G	Socket SO239	53p (E)
BW86T	UHF Elbow Adaptor	£1.32 (D)
BW87U	UHF Straight Adaptor	59p (E)
BW88V	UHF T Adaptor	£1.55 (D)

Page145

RK00A	UHF Female T Adaptor	£1.75 (D)
RK01B	UHF Adaptor FFLA	£1.65 (D)
RK02C	UHF Adaptor FMLA	£1.75 (D)
YW04E	Adaptor 239	£1.35 (D)
YW05F	Adaptor 259	£1.40 (D)
YX51F	Audio Conn 2-way	£1.15 (D)
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YX53H	Audio Conn 4-way	£1.36 (D)
YX54J	Audio Conn 5-way	£1.55 (D)
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RK52G	10 Way Line Skt	£2.85 (C)
RK53H	10 Way Line Plug	£2.75
RK54J	10 Way Chassis Skt	£1.95
BW89W	XLR Line Plug	£1.82 (D)
BW90X	XLR Chassis Socket	£3.28 (C)
BW91Y	XLR Line Socket	£2.35 (C)
BW92A	XLR Chassis Plug	£1.54 (D)
+RK76H	Mic Con with S R	55p (E)
RK79L	Min Mic SR Connector	DIS

Page146

RK77J	Mic Jck Plug Adaptor	42p (F)
RK78K	Mic Jck Skt Adaptor	DIS
BW94C	Dinlatch 5-pin A Plg	£1.73 (D)
BW98G	Dinltch Sckt 5-pin A	76p (E)
HH24B	DIN L/S Plug	10p (G)
HH25C	DIN Plug 3-pin	16p (G)
HH26D	DIN Plug 4-pin	34p (F)
HH27E	DIN Plug 5-pin A	14p (G)
HH28F	DIN Plug 5-pin B	20p (G)
RK64U	DIN Plug 5-pin C	28p (F)
HH29G	DIN Plug 6-pin	39p (F)
HH30H	DIN Plug 7-pin	19p (G)
HH31J	DIN L/S Socket	9p (H)
HH32K	DIN Socket 3-pin	17p (G)
HH33L	DIN Socket 4-pin	16p (G)
HH34M	DIN Socket 5-pin A	14p (G)
HH35Q	DIN Socket 5-pin B	18p (G)
HH36P	DIN Socket 6-pin	21p (G)
HH37S	DIN Socket 7-pin	21p (G)
HH40T	DIN Line Skt 2-pin	15p (G)
+HH41U	DIN Line Scket 3-pin	16p (G)
HH43W	DIN Line Skt 5-pin A	29p (F)
HH44X	DIN Line Skt 5-pin B	DIS
HH45Y	DIN Line Scket 6-pin	21p (G)
YX90X	PC DIN Skt 2-pin	25p (F)
YX91Y	PC DIN Skt 5-pin A	25p (F)

Page147

RK60Q	D-Range 9 Way Plug	79p (E)
BK58N	D-Range 15-Way Plug	£1.45
YQ48C	D-Range 25-Way Plug	£1.49 (C)
RK61R	D-Range 9 Way Skt	£1.20 (D)
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WQ16S PCB Conns Horizontal 7p (H)
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Page148

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FL84F Edge Conn 116 £1.06 (D)
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YX39N Multicon Skt 2–way 18p (G)
YX40T Multicon Skt 4–way 22p (G)
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YX43W Multicon Skt 24–way 68p (E)
YX44X Multicon Skt 36–way 68p (E)
YX45Y Multicon Plug Pin 3p (H)
YX46A Multicon Skt Pin 3p (H)

Page149

HL01B Octal Ch Plug 89p (E)
HL00A Octal Ch Skt 50p (E)
HL02C 8–way Plug 98p (E)
HL03D 8–way Socket 99p (E)
RK65V Minicon Latch Pl 2w 15p (G)
BX96E Minicon Latch Pl 3w 23p (G)
YW11M Minicon Latch Pl 4w 22p (G)
FY93B Minicon Latch Pl 5w 29p (F)
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YW13P Minicon Latch Pl 8w 29p (F)
RK66W Minicon Latch Pl 10w 32p (E)
YW14Q Minicon Latch Pl 12w 55p (F)
BH61R Minicon Latch Pl 17w 78p (E)
FY92A RA Lch Minicn Pl 2w 26p (F)
YW15R RA Lch Minicn Pl 3w 31p (F)
FY91Y RA Lch Minicn Pl 4w 33p (F)
RK67X RA Lch Minicn Pl 5w 29p (F)
FB99H RA Lch Minicn Pl 6w 40p (F)
YW18U RA Lch Minicn Pl 8w 52p (E)
RK68Y RA Lch Minicn Pl 10w 45p (F)
YW19V RA Lch Minicn Pl 12w 74p (E)
HB59P Mncn Ltch Hsg 2way 9p (H)
BX97F Mncn Ltch Hsg 3–way 11p (G)
HB58N Mncn Ltch Hsg 4way 11p (G)
BH66W Mncn Ltch Hsng 5–way 12p (G)
BH65V Mncn Ltch Hsng 6–way 13p (G)
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YW24B Mncn Ltch Hsng 12way 17p (G)
RK69A Mncn Ltch Hsng 17way 25p (F)
YW26D Minicon Skt 3–way 24p (F)
YW27E Minicon Skt 4–way 30p (F)
YW28F Minicon Skt 6–way 36p (F)
YW29G Minicon Skt 8–way 50p (E)
YW30H Minicon Skt 12–way 65p (E)
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YW96E IDC Con 4–way 28p (F)
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YW98G IDC Con 8–way 68p (E)
YW99H IDC Con 12–way 88p (E)
YX49D IDC Insertion Tool £2.45 (D)

Page150

HL04E Watercon Plug 3–pin 12p (G)
HL05F Watercon Plug 4–pin 14p (G)
HL06G Watercon Plug 6–pin 19p (G)
HL07H Watercon Plug 8–pin 19p (G)
HL08J Watercon Plug 12–pin 29p (F)
HL09K Watercon Skt 3–way 11p (G)
HL10L Watercon Skt 4–way 10p (G)
HL11M Watercon Skt 6–way 17p (G)
HL12N Watercon Skt 8–way 17p (G)
HL13P Watercon Skt 12–way 25p (F)
HL14Q Watercon Terminal 3p (H)
YW32K Polarcon 0.2in 9p (H)
RK72P 3 way PC Terminal 34p (F)
RK73Q 4 way PC Terminal 37p (F)
RK38R 8–Way PC Terminal 58p (E)
RK74R 12 way PC Terminal 98p (E)
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YY23A CB Pin Red 38p (F)
YY26D CT Pin White £1.46 (D)
YY27E AT Pin Black £1.46 (D)
YB08J Large Patchboard £159.60 (A)

Page151

WQ10L Large Patch Plug 37p (F)
HH39N Multi–position Plug 67p (E)
HH38R Universal Plug 85p (E)
HH60Q Std Power Plug 2.1 14p (G)
HH61R Long Pwr Plug 2.1 16p (G)
HH62S Std Power Plug 2.5 15p (G)
HH63T Long Pwr Plug 2.5 15p (G)
HH85G Power Skt 2.1 20p (G)
HH86T Power Skt 2.5 22p (G)
RK37S PC Mtg Power Socket 28p (F)
HH87U Cassette Skt Nivico 45p (F)
HH88V Cassette Skt Paros 46p (F)
HL17T USA Mains Plug 29p (G)
HL18U Flat Pin M/S 19p (F)
HL19V Flat Pin Conn 38p (F)

Page152

HL16S Eurosocket 69p (E)
HL15R Europlug 48p (F)
HL42V Euro Facility Outlet 89p (E)
HL43W Euro Facility Plug 94p (D)
BW99H Euroconn Lead £1.75 (D)
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RW59P Cas Lead Nivico 60p (E)
RW60Q Cas Lead Otake–Orion DIS
RW61R Cas Lead Paros 65p (E)
RW62S Cas Lead Philips DIS
+RW63T Cas Lead Sanyo 60p (E)
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WY17T Euroboard 6–way £6 32 (A)
HL20W Mains Plug P429 71p (E)
HL44X Mains Socket P646 £1.64 (D)

Page153

HL23A Mains Socket P430SE £1 25 (D)
HL45Y Mains Plug P649 £1.34 (D)
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HL47B Mains Plug SA2403 £1.56 (D)
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HL37S Mains Socket P636 £1.29 (D)
HL39N Mains Plug P551 £2.97 (C)

Page154

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RK71N Video Kopy Kit £11 95 (A)
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HL52G Boot 8878 38p (F)
RK84F Video Lead 1 £2.94 (E)
RK85G Video Lead 2 £2.16 (D)
RK70M Video Lead 3 £2.64 (C)
RK86T Video Lead 4 £1.32 (D)
RK87U Video Lead 5 £2 15 (C)
+RK88V Video Lead 6 £1.92 (D)

Page155

RW04E Adaptor E 45p (F)
RW01B Adaptor B 39p (F)
+RW38R Adaptor W 59p (E)
YW39N Adaptor X 72p (E)
+RW07H Adaptor H 38p (F)
+RW03D Adaptor D 40p (F)
RW11M Adaptor M DIS
RW06G Adaptor G 46p (F)
RW08J Adaptor J 37p (F)
RW00A Adaptor A 38p (F)
YW34M Adaptor S 55p (E)
YW35Q Adaptor T £1.25 (D)
RW05F Adaptor F 40p (F)
+RW09K Adaptor K 40p (F)
RW02C Adaptor C 45p (F)
YW37S Adaptor V £1 55 (D)
RW12N Adaptor N 38p (F)
YW33L Adaptor R £1.28 (D)
HL53H Adaptor P £1.30 (D)
+YW36P Adaptor U 99p (E)
RK55K Adaptor Y 48p (F)
RK56L Adaptor Z 49p (F)
RW27E Dinpak P 62p (E)
+RW26D Dinpak N £1.20 (D)
RW45Y Dinpak 273 £1.45 (D)
RW44X Dinpak 262 75p (E)
RW47B Dinpak 275 95p (E)
RW25C Dinpak M £1.55 (D)
+RW46A Dinpak 274 £1.50 (D)
RW15R Dinpak B £1.55 (D)
RW14Q Dinpak A £1.10 (D)
RW43W Dinpak 254 £1 10 (D)
RW16S Dinpak C £1.24 (D)
RW22Y Dinpak J 69p (E)

Page156

RW23A Dinpak K 68p (E)
RW24B Dinpak L 96p (E)
RW18U Dinpak E 82p (E)
RW19V Dinpak F 98p (E)
RW17T Dinpak D £1.42 (D)
RW20W Dinpak G £1.34 (D)
+RW49D Dinpak 280 £1.55 (D)
RW48C Plugpak 279 89p (E)
RW50E Plugpak 282 96p (E)
RW51F Plugpak 283 £1.85 (D)
RW28F Plugpak Q 65p (E)
RW31J Plugpak T £2.25 (C)
RW34M Plugpak X £2 48 (C)
RW35Q Plugpak HD Guitar £4.86 (C)
RK58N Plugpak Y £1.55 (D)
RK27E Plugpak Z 96p (E)
RK57M Plugpak W £1.45 (D)

ELECTRICAL

Page157

HF01B Terminal Block 5A 35p (F)
HL54J Terminal Block 15A 69p (E)
HL55K Terminal Block 30A £1.10 (D)
HL56L Terminal Block Conn £1.47 (D)
HL57M 5 Amp Plug Nylon 59p (E)
RW67X 13 Amp Plug Nylon 75p (E)
HL58N Rubber 13A Plug £1.10 (E)
HL59P 15A Plug Nylon DIS
HL60Q Kettle Connector £1.62 (D)
HL61R Flex Connector £1.40 (D)
HL62S Mains Adaptor 2–way £2.20 (C)
HL63T Mains Adaptor 3–way £3.32 (C)
HL64U Shaver Adaptor £1.15 (D)

Page158

HL65V Junction Box Small 54p (D)
HL66W Junction Box Lge £1.35 (E)
HL67X Junction Box RM £1.65 (D)
HL68Y Single Skt Unswitched £2.14 (D)
HL69A Dble Skt Unswitched £3.99 (C)
HL71N Single Sw Socket £2.72 (C)
HL72P Double Sw Socket £5.20 (B)
HL73Q Trailing Skt Single £1.75 (D)
HL74R Trailing Dble Skt £3.75 (C)
RW68Y Dis Board 4–way £9.98 (B)
HL76H Cooker Switch £8 45 (B)
HL78K Shaver Skt Isolated £18.75 (A)
HL79L Shaver Socket DIS
+HL82D Flex Outlet Unswchd £3.95 (C)

Page159

HL83E Switched Flex Outlet £4.38 (C)
HL86T Blanking Plate 85p (E)
HL87U 20A Plateswitch £3.36 (C)
HL88V 20A Water Htr Switch £4.95 (C)
HL89W Light Swch ST Single £1.28 (D)
HL90X Light Swch DT Single £1 49 (D)
HL91Y Light Swch Dual £2.72 (C)
HL92A Light Switch Triple £3.84 (C)
FQ10L 250W Rotary Dimmer £7.30 (B)
FQ12N 250W Push Dmr Sngl £10.64 (B)
XX35Q Remote Control Dmmr £29.95 (A)

XX36P Dmmr Control Box £15.75 (A)
FQ15R Security Dimmer £16.95 (A)
FQ16S Auto Security Switch £16.50 (A)
YB09K Fl Pattress 16mm Sgl 96p (E)

Page160

YB10L Fl Pattress 25mm Sgl 73p (E)
YB11M Fl Pattress 25mm Dbl £1.20 (D)
+YB12N Fl Pattress 35mm Dbl £1.34 (D)
YB13P Steel Pattress 47mm DIS
YB14Q Sur Patt 20mm Sngl 78p (E)
YB15R Sur Patt 29mm Sngl 98p (E)
YB16S Sur Patt 29mm Dble £1.72 (D)
YB17T Sur Patt 47mm Dble £3.68 (C)
YB18U Conversion Pattress £2.62 (C)
FQ00A Ceiling Switch 1–way £2.84 (C)
FQ02C Lampholder 702 79p (E)
FQ04E Lampholder 252 1/2in DIS
LB63T Bayonet L/Hldr 78p (E)
FQ05F Ceiling Rose £1 24 (D)
FQ07H Starter 80W 25p (F)
YB19V Time Switch £19.20 (A)
WY23A Timetouch £24.80 (A)

Page161

YB20W Room Thermostat £8.90 (B)
XY08J Extn Lead 5A £10 50 (A)
XY09K Extn Lead 13A £17.25 (A)

HARDWARE

Page162

BF00A Bolt 2BA 1/2in 33p (F)
BF01B Bolt 2BA 1in 85p (E)
BF02C Bolt 4BA 1/4in 25p (F)
BF03D Bolt 4BA 1/2in 28p (F)
BF04E Bolt 4BA 1in 30p (F)
LR52G Bolt 4BA 1.1/2in 33p (F)
BF05F Bolt 6BA 1/4in 12p (G)
BF06G Bolt 6BA 1/2in 14p (G)
BF07H Bolt 6BA 1in 43p (F)
LR53H Bolt 6BA 1.1/2in 63p (E)
BF08J Bolt 8BA 1/4in 28p (F)
BF09K Bolt 8BA 1/2in 38p (F)
LR54J C/S Screw 2BA 1/2in 14p (G)
LR55K C/S Screw 4BA 1/4in 14p (G)
BF10L C/S Screw 4BA 1/2in 17p (G)
BF11M C/S Screw 4BA 1in 32p (F)
LR56L C/S Screw 6BA 1/4in 9p (H)
BF12N C/S Screw 6BA 1/2in 19p (G)
BF13P C/S Screw 6BA 1in 35p (F)
LR00A C/S Screw 8BA 1/2in 29p (F)
BF14Q Panel Screw 3p (H)
LR75S C/S Panel Screw 5p (H)
BF16S Nut 2BA 19p (G)
BF17T Nut 4BA 19p (G)
BF18U Nut 6BA 12p (G)
BF19V Nut 8BA 12p (G)
BF20W Washer 2BA 12p (G)
BF21X Washer 4BA 9p (H)
BF22Y Washer 6BA 9p (H)
BF23A Washer 8BA 9p (H)
LR76H Cup Washer 2p (H)
BF24B Shake 2BA 9p (H)
BF25C Shake 4BA 9p (H)
BF26D Shake 6BA 9p (H)
LR01B Shake 8BA 11p (H)
BF27E Tag 2BA 12p (G)
BF28F Tag 4BA 9p (H)
BF29G Tag 6BA 13p (G)
LR02C Tag 8BA 11p (G)
BF30H Pozi Screw M5 6mm 30p (G)
BF31J Pozi Screw M5 12mm 33p (F)
BF32K Pozi Screw M5 25mm 54p (F)
BF33L Pozi Screw M4 6mm 25p (F)
BF34M Pozi Screw M4 12mm 32p (F)
BF35Q Pozi Screw M4 25mm 27p (F)
BF36P Pozi Screw M3 6mm 20p (G)
LR57M Pozi Screw M3 9mm 13p (G)
BF37S Pozi Screw M3 12mm 20p (G)
BF38R Pozi Screw M3 25mm 27p (F)
LR58N Pozi Screw M3 40mm 33p (F)
BF39N Pozi Screw M2.5 6mm 15p (G)
BF40T Pozi Screw M2.5 12mm 18p (G)
BF41U Pozi Screw M2 6mm 29p (F)
BF46A Isobolt M5 12mm 55p (E)
BF48C Isobolt M4 6mm 30p (F)
BF49D Isobolt M4 12mm 33p (F)
BF50E Isobolt M4 25mm 57p (E)
BF51F Isobolt M3 6mm 20p (G)
HY30H Isobolt M3 9mm 12p (G)
BF52G Isobolt M3 12mm 26p (F)
BF53H Isobolt M3 25mm 35p (F)
BF54J Isobolt M2.5 6mm 19p (G)
BF55K Isobolt M2.5 12mm 24p (F)
BF56L Isonut M5 20p (G)
BF57M Isonut M4 20p (G)
BF58N Isonut M3 15p (G)
BF59P Isonut M2.5 14p (G)
LR59P Isonut M2 10p (G)
BF60Q Isowasher M5 15p (G)
BF61R Isowasher M4 9p (H)
BF62S Isowasher M3 9p (H)
BF63T Isowasher M2.5 9p (H)
LR60Q Isowasher M2 7p (H)
BF42V Isoshake M5 12p (G)
BF43W Isoshake M4 9p (H)
BF44X Isoshake M3 9p (H)
BF45Y Isoshake M2.5 9p (H)
LR61R Isoshake M2 9p (H)

Page163

LR62S Isotag M5 18p (G)
LR63T Isotag M4 20p (G)
LR64U Isotag M3 12p (G)
LR65V Isotag M2.5 12p (G)
LR66W Isotag M2 9p (H)
BF68Y Stl–Tpr No.8 x 3/8in 22p (G)
BF69A Stl–Tpr No.8 x 1/2in 25p (F)
LR67X Stl–Tpr No.6 x 3/8in 20p (G)
BF67X Stl–Tpr No.6 x 1/2in 22p (G)
BF65V Stl–Tpr No.4 x 3/8in 15p (G)
BF66W Stl–Tpr No.4 x 1/2in 16p (G)
BF64U Stl–Tpr No.2 x 3/16" 12p (G)
LR68Y Stl–Tpr No.2 x 3/8in 14p (G)
BF70M Nyl 2BA 1/2in 86p (E)
BF71N Nyl 2BA 1in 95p (E)
BF72P Nyl 4BA 1/2in 42p (F)
BF73Q Nyl 4BA 1in 74p (E)
BF74R Nyl 4BA 1.1/2in £1.55 (D)
BF75S Nyl 6BA 1/2in 50p (E)
BF76H Nyl 6BA 1in 60p (E)
BF77J Nyl 8BA 1/2in 60p (E)
BF78K Nyl Nut 2BA 94p (E)
BF79L Nyl Nut 4BA 94p (E)
BF80B Nyl Nut 6BA 94p (E)
BF81C Nyl Nut 8BA 55p (E)
BF82D Nyl Washer 2BA 18p (G)
BF83E Nyl Washer 4BA 18p (G)
BF84F Nyl Washer 6BA 18p (G)

BF85G Nyl Washer 8BA 32p (F)
WH18U Nyl C/S Scw M3 x12mm 6p (H)
WH19V Nylon Nut M3 4p (H)
BF15R Spring Clip 4p (H)
YW94C Batten Clip 4p (H)
LB99H Blk Wdscrw No 4 1/2" 15p (G)
BH44X Plas Fixing 12p (G)
YL23A Hand Wheel Bolt 35p (F)
FW10L Spade 2BA 28p (F)
FW11M Spade 4BA 24p (G)
FW13P Studding 2BA 32p (F)
FW14Q Studding 4BA 34p (F)
FW15R Studding 6BA 38p (F)
FW30H 4BA Spacer 1/8in 38p (F)
FW31J 4BA Spacer 1/4in 48p (F)
FW32K 4BA Spacer 1/2in 59p (E)
FW33L 6BA Spacer 1/8in 35p (F)
FW34M 6BA Spacer 1/4in 38p (F)
FW35Q 6BA Spacer 1/2in 49p (F)
LR69A 8BA Spacer 1/8in 32p (F)
LR70M 8BA Spacer 1/4in 36p (F)
LR71N Thrded Spcr 4BA 89p (E)
LR72P Thrded Spcr 6BA 64p (E)

Page164

FW16S Standoff Short 8p (H)
FW17T Standoff Medium 8p (H)
FW18U Standoff Long 8p (H)
LR03D Terry Clip 1/2in 10p (G)
LR73Q Terry Clip 1 1/2in 29p (F)
FW59P Grommet Small 2p (H)
FW60Q Grommet Large 2p (H)
LR47B SR Grommet 3P–4 6p (H)
LR48C SR Grommet 5M–3 7p (H)
LR49D SR Grommet 6W–1 10p (G)
LR50E SR Grommet 7K–2 26p (F)
LR51F Sealing Grommet 8p (H)
BL74R Flexigrommet A 28p (F)
BL75S Flexigrommet B 30p (F)
BL76H Flexigrommet C 32p (F)
FW36P Hole Plug 1/4in 10p (G)
FW37S Hole Plug 3/8in 12p (G)
HB22Y Quickstick Pads 9p (H)
HB21X Velcromounts 15p (G)
LO12N Sealing Strip 79p (E)

Page165

LH12N Aly Sheet 18 swg £1.59 (D)
LH13P Aly Sheet 16 swg £3.85 (C)
WH48C Mains Warning Label 15p (G)
XX31J PCB Guides 28p (F)
YX88V P7 Paper Roll 46p (F)
YX89W P7 Ink Cassette £2.75 (C)
XH39N Transfer 1/8in Black £1.56 (D)
XH40T Transfer 1/8in Red £1.56 (D)
XH41U Transfer 1/8in White £1.56 (D)
XH42V Transfer 1/4in Black £1 56 (D)
XH43W Transfer 1/4in Red £1.45 (D)
XH44X Transfer 1/4in White £1 45 (D)
XH45Y Panel Transfer Black £1.56 (D)
XH46A Panel Transfer Red £1.56 (D)
XH47B Panel Transfer White £1.56 (D)

KNOBS

Page166

RW75S Knob BK12 19p (G)
RX99H Knob RN92 33p (F)
RW87U Knob KB4 22p (G)
RW86T Knob KB3 45p (F)
+RX09K Knob R78 58p (E)
HB23A Knob K1 36p (F)
HB24B Knob K2 39p (F)
+HB19V Knob RK401 95p (E)
HB57M Knob RK403 £1.55 (D)
RW88V Knob M1 29p (F)
RW89W Knob M2 29p (F)
RW90X Knob M3 28p (F)
RX00A Knob M4 45p (F)
RX10L Knob R81 DIS
+RX11M Knob 82 55p (E)

Page167

RW78K Knob F10 35p (F)
HB26D Knob F11 35p (F)
RX01B Knob NK2 45p (F)
RX02C Knob PK2 49p (F)
YX01B Knob K7A 28p (F)
YX02C Knob K7B 28p (F)
YX03D Knob K7C 34p (F)
YX04E Knob K7D 58p (F)
HB28F Knob R51 52p (E)
HB29G Knob R52 53p (E)
RX07H Knob R76 55p (E)
RX08J Knob R77 64p (E)
HB30H Knob R53 69p (E)
HB31J Knob R54 96p (E)
YR64U Knob K8A 43p (F)
YR65V Knob K8B 68p (E)
YR66W Knob K8C 72p (E)
RK89W Knob K10A 45p (F)
RK90X Knob K10B 59p (E)
RK91Y Knob K10C 86p (E)
HB34M Knob K105L 95p (E)
HB35Q Knob K106L £1.74 (D)
HB32K Knob K105 59p (E)
HB33L Knob K106 £1.42 (E)
HB36P Knob K15 48p (E)
HB38R Knob K30 78p (E)

Page168

HB39N Knob K44 69p (E)
HB40T Knob K45 79p (E)
HB41U Knob K46 £1.15 (D)
RX16S Collet Knob Black 41p (F)
WL45Y 15mm Collet Cap Blk 5p (H)
WL46A 15mm Collet Cap Blue 5p (H)
WL47B 15mm Collet Cap Grn 5p (H)
WL48C 15mm Collet Cap Grey 5p (H)
WL49D 15mm Collet Cap Red 5p (H)
WL50E 15mm Collet Cap Yllw 5p (H)
WL51F 15mm Collet Pntr Blk 5p (H)
+WL52G 15mm Collet Pntr Blu 5p (H)
+WL53H 15mm Collet Pntr Grn 5p (H)
+WL54J 15mm Collet Pntr Gry 5p (H)
WL55K 15mm Collet Pntr Red 5p (H)
WL56L 15mm Collet Pntr Ylw 5p (H)
RX18U 15mm Collet Nut Cvr 15p (G)
RX19V 15mm Collet Indctr 20p (G)
RX20W 15mm Collet Skirt 24p (G)
RX21X 15mm Collet Stator 24p (F)
WL43W 3/8in Nut 16p (G)
WL44X 10mm Nut 21p (G)
YG40T Low–Cost Collet Knob 31p (F)
QY00A LC Cap Black 7p (H)
QY01B LC Cap Blue 7p (H)
QY02C LC Cap Green 7p (H)
QY03D LC Cap Grey 7p (H)
QY04E LC Cap Red 7p (H)

QY05F LC Cap White 7p (H)
QY06G LC Cap Yellow 7p (H)
RX22Y Slide Knob A 18p (G)
YG09K Slide Knob B 18p (G)
YG10L Slide Knob C Black 20p (G)
YG11M Slide Knob C Chrome 29p (F)
RX24B Slide Knob F Blk 17p (G)
RX25C Slide Knob F Blue 17p (G)
RX26D Slide Knob F Green 17p (G)
RX27E Slide Knob F Grey 17p (G)
RX28F Slide Knob F Red 17p (G)

Page169

RX29G Spindle Coupler 89p (E)
RX30H Ext Spindle £1.15 (E)
RX38R Nylon Rod 15p (G)
RX46A Cord Drive Steel £1.68 (D)
RX31J Brass Bush 29p (E)
BL73Q Drive Cord 8p (H)
RX43W Cord Drum Small 92p (D)
RX94C Cord Drum Large £1.21 (D)
RX44X Flywheel £3.68 (C)
HB45Y Aluminium Dial £6.60 (B)
RX42V Ball Drive £2.71 (C)
HB42V Mini Ball Drive £1.95 (D)
RX39N Vernier Dial Small £2.35 (C)
RX40T Vernier Dial Medium £2.95 (C)
RX41U Vernier Dial Large £3.84 (C)
HB46A White Pointer 38p (F)
HB47B Ball Drive Pointer 62p (E)
HB48C Spring Short 9p (H)
HB49D Spring Medium 9p (H)
HB50E Spring Long 9p (H)
RX95D Pulley 1/2in 14p (G)

MICROPHONES

Page170

LB92A Phone Coil 98p (E)
LB93B Crystal Mic In Plas 50p (E)
HY33L Crystal Mic In Metal 84p (E)
LB68Y Lapel Mic £1.39 (D)
YB31J Cassette Mic Jacks £1.95 (D)
YB32K Cassette Mic DIN £2.75 (C)
YB33L Electret Cssette Mic £2.95 (C)
WF35Q Dynamic Ball Mic £10.60 (B)
LH87U Dynamic Stereo Mics £10.98 (A)
WF05F Communications Mic £6.82 (B)

Page171

YW70M Diff Comm Mic £8.25 (B)
RK03D Power Mic DM313P £12.60 (A)
YW77J Mic Hldr Screw–Fix 28p (F)
YW78K Mic Hldr Adhesive 49p (F)
YW79L Mic Hldr Magnetic 69p (E)
RK04E Power Mic DM311P £14.20 (A)
XY72P Base Station Mic £32.80 (A)

Page172

XG11M Base Stn Mic DX357 DIS
XG12N Base Stn Mic BSA610A £34.40 (A)
LB69A Tie–Clip Mic £6.79 (B)
YW71N UM Tie–Clip Mic £13.84 (A)
YB35Q Eletret Mic EM507 £11.98 (A)

Page173

WF34M Electret Mic Dual–Z £17.72 (A)
YB36P Unisound Mic EM82D £22.30 (A)
YB37S Unisound Mic EM83D £22.30 (A)
WY06G Super Cardioid Mic £29.80 (A)
WY07H Stereo Electret Mic £26.20 (A)
YB38R Unisnd Dyn DM–31011 £37.90 (A)

Page174

LB94C Screen S15 £6.58 (B)
LB95D Mic Unit U15 £10.75 (A)
BK01B FM Mic £24.20 (A)
BK02C FM Mic Adaptor £22.80 (A)
LB35Q Mic Windshield 45p (F)
RK92A Universal Mic Holder £1.85 (D)
RK93B Tapered Mic Holder £1.49 (D)
YW72P Gsneck Mic Stand 8in £2.21 (D)
LH88V Gsneck Mic Stnd 13in £2.95 (C)
WF36P Gsneck Mic Stnd 19in £3.72 (C)
YW73Q Plastic Gsneck Base DIS
YW74R Metal Gsneck Base £3.25 (C)
WF37S Bkt For Gsnk Stand £1.95 (D)
YW75S Casl Base Mic Stand £3.85 (C)
YW76H Extra Hgt Mic Stand £7.84 (B)

Page175

LB96E Table–Top Mic Stand £2.25 (C)
XB45Y 5–Foot Mic Stand £13.45 (A)
XB46A Boom Arm £12.65 (A)

MUSIC & EFFECTS

Page176

LB97F Pre–Amp EQ2S £3.98 (C)
YB39N Pre–Amp CS5 £8.43 (B)
XB30H Mono Mic Mixer £8.65 (B)
YK55K Stereo Mixer MM2 £10.75 (A)
XB29G Stereo Mixer £23.90 (A)

Page177

AF60Q Graphic Eqlizr GE206 £62.81 (A)
+AF27E GE1305 Equaliser £84.20 (A)
AF59P Graphic Eq. GE909 £128.98 (A)
LB66W Mini–Phaser £24.20 (A)
YB30H Fuzz Box DIS

Page178

XB41U Fuzz–Wah Pedal TEMP
XB34M Vibra Chorus £57.30 (A)
YB88V Mini Compressor £21.20 (A)
XB33L Echo Chamber £69.60 (A)
LB67X Echo Chamber Tape £5.72 (C)
XY80B BBD Echo Machine £76.40 (A)

Page179

YB40T Cry Guitar Pick–Up £3.93 (C)
YB42V Steel Mag Pick–up £8.98 (B)
YL08J Pickup Transl.AJ21 £27.95 (A)
YL09K Pickup Transl.AJ51 £19.95 (A)
YL07H Pickup Switch £3.24 (C)
LB98G Strap Button 61p (E)
LB60Q Guitar Strings Steel £1.72

OPTO

Page180

RX86T MES Batten Hldr 21p (G)
RX57M Holder MES Amber £1.45 (D)
RX58N Holder MES Blue DIS
RX59P Holder MES Clear £1.45 (D)
RX60Q Holder MES Green £1.45 (D)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum trade quantity. For details please see page 27.

1983 Catalogue Page No.		VAT inclusive PRICE
RX61R	Holder MES Red	£1.45 (D)
RX76H	Dmd LES Lhldr Blue	35p (F)
RX77J	Dmd LES Lhldr Green	35p (F)
RX78K	Dmd LES Lhldr Red	35p (F)
RX79L	Dmd LES Lhldr White	35p (F)
RX80B	Dmd LES Lhldr Yellow	35p (F)
RX67X	Flt-Tp LES Lhldr Blu	35p (F)
RX68Y	Flt-Tp LES Lhldr Grn	35p (F)
RX69A	Flt-Tp LES Lhldr Red	39p (F)
FF66W	Fluted Lhldr Amber	30p (F)
FF67X	Fluted Lhldr Clear	30p (F)
FF68Y	Fluted Lhldr Green	30p (F)
FF69A	Fluted Lhldr Red	30p (F)
YY00A	LES Cover Amber	8p (H)
YY01B	LES Cover Blue	9p (H)
YY02C	LES Cover Green	9p (H)
YY03D	LES Cover Purple	8p (H)
YY04E	LES Cover Red	8p (H)
YY05F	LES Cover White	9p (H)
YY06G	LES Cover Yellow	9p (H)
BK52G	Min Neon Red	38p
BK53H	Min Neon Green	38p
BK54J	Min Neon Amber	38p
RX82D	Pan Neon Amber	31p (F)
RX83E	Pan Neon Red	31p (F)
BK51F	Pan Neon Green	30p
RX81C	Square Neon Red	33p (F)
RX96G	Square Neon Green	36p (F)
BK55K	Chrome Neon Red	59p
BK56L	Chrome Neon Green	72p

Page181

RX70M	Wire Neon	14p (G)
WQ13P	Wire Bulb 12V	30p (F)
WL74R	LES Bulb 6V	19p (G)
WL75S	LES Bulb 12V	15p (G)
RX84F	Neon Bulb	99p (F)
WL76H	Bulb MES 3.5V	35p (F)
WL77J	Bulb MES 6V 0.24W	35p (F)
WL78K	Bulb MES 6V 0.6W	31p (F)
WL79L	Bulb MES 6.5V	27p (F)
WL80B	Bulb MES 12V 1.2W	28p (F)
WL81C	Bulb MES 12V 2.2W	29p (F)
WL82D	Bulb MES 24V	36p (F)
LQ10L	Portable Lamp	£6.95 (B)
XY71N	Caravan Lamp	£10.26 (B)
LQ11M	12V Tube	£1.38 (D)
LL15R	240V Inspection Lamp	£5.60 (B)
HB52G	Pygmy Bulb Blue	90p (E)
HB53H	Pygmy Bulb Green	90p (E)
HB54J	Pygmy Bulb Red	90p (E)
HB55K	Pygmy Bulb White	70p (E)
HB56L	Pygmy Bulb Yellow	90p (E)
WF25C	Spot Lamp Amber	£2.85 (C)
WF26D	Spot Lamp Blue	£2.85 (C)
WF27E	Spot Lamp Clear	£1.84 (C)
WF28F	Spot Lamp Green	£2.85 (C)
WF29G	Spot Lamp Red	£2.85 (C)
WF30H	Spot Lamp Violet	£2.85 (C)
YB29G	Spot Holder	£4.99 (C)
XB31J	BC Clip-On Hdr Sngl	DIS
XB32K	BC Clip-On Hdr Twin	DIS

Page182

WF22Y	Gooseneck Lamp	£5.86 (B)
YK39N	Alarm Beacon	£18.95 (A)
WL32K	Mini LED Red	10p (G)
WL33L	Mini LED Green	19p (G)
WL34M	Mini LED Orange	17p (F)
YY38R	Mini LED Yellow	19p (G)
YY39N	Mini LED Clip	3p (H)
WL27E	LED Red	12p (G)
WL28F	LED Green	19p (G)
WL29G	LED Orange	33p (F)
WL30H	LED Yellow	17p (G)
YY40T	LED Clip	3p (H)
QW96E	Square LED Red	36p (F)
YH60Q	Square LED Green	36p (F)
YH61R	Square LED Yellow	43p (F)
YH62S	Square LED Clip	7p (H)
YY41U	Large LED Red	£1.49 (D)
YY42V	Large LED Clip	21p (G)
YY45Y	Shape LED R1 Red	20p (G)
YY46A	Shape LED R1 Green	25p (F)
YY47B	Shape LED R1 Orange	37p (F)
YY48C	Shape LED R1 Yellow	27p (F)
YY49D	Shape LED S2 Red	20p (G)
YY50E	Shape LED S2 Green	27p (F)
YY51F	Shape LED L3 Red	21p (G)
YY52G	Shape LED L3 Green	26p (F)
YY53H	Shape LED L3 Yellow	26p (F)
YY54J	Shape LED T4 Red	22p (G)
YY55K	Shape LED T4 Green	26p (F)
YY56L	Shape LED T4 Yellow	26p (F)
YY57M	Shape LED A5 Red	23p (G)
YY58N	Shape LED A5 Green	27p (F)

Page183

YH53H	Cliplite Amber	16p (G)
YH54J	Cliplite Clear	16p (G)
YH55K	Cliplite Green	16p (G)
YH56L	Cliplite Red	16p (G)
YH57M	Cliplite Yellow	16p (G)
YY61R	Multicolour LED	TEMP
QR54J	Rect Multicolour LED	75p (E)
YY59P	Chrome LED Small	49p (F)
QY46A	Chrome LED Small Gn	53p
YY60Q	Chrome LED Large Red	59p (E)
QY47B	Chrome LED Large Gn	56p
QY48C	Black Bezel LED Red	38p
QY49D	Black Bezel LED Gn	47p (F)
BY65V	Red Bargraph Dsply	£3.25 (C)
YG33L	Green Bargraph Dsply	£3.22 (C)
YG34M	Ornge Bargraph Dsply	DIS
+YG35Q	Yllow Bargraph Dsply	£3.35 (C)
FR36P	7-Seg Red Type 1	£1.07 (D)
FR38R	7-Seg Red Type 4	£1.25 (D)

Page184

FR39N	"1/2" Display Type 1	99p (E)
FR41U	"1/2" Display Type 4	£1.07 (D)
BK03D	Vertisocket Type 1	£1.15 (D)
BK04E	Vertisocket Type 2	£2.45 (C)
BY66W	DD Display Type A	£1.96 (D)
BY67X	DD Display Type AF	50p (F)
BY68Y	DD Display Type C	£2.20 (D)
XX08J	4-Dig Dspy Cmn Cath	£2.95 (C)
BY70M	4 Dig Dis Cmn Anode	DIS

Page185

HO36P	Mult Cmn Cath Disply	£3.45 (C)
FR32K	Filter Amber	DIS
FR33L	Filter Green	£1.20 (D)
FR34M	Filter Red	85p (E)
FR35Q	Filter Yellow	85p (E)
FY89W	Lqd Crystal Display	£4.82 (C)

Page186

WL35Q	Opto-Isolator	69p (E)
YY62S	Dual Opto-Isolator	£1.48 (D)
YY63T	Quad Opto-Isolator	£2.96 (C)
WQ70M	Darlington Isolator	74p (E)
YY64U	SCR Isolator	£2.12 (C)
QQ10L	Triac Isolator	£1.55 (D)
YY65V	Infra-Red Source	38p (F)
YY66W	Infra-Red Sensor	32p (F)

Page187

RK22Y	Solar Panel 6V	£7.95 (B)
RK23A	Solar Panel 9V	£9.74 (B)
RK24B	Solar Panel 12V	£12.20 (A)
YH70M	IR Emitter TIL38	49p (F)
YH71N	Photodiode TIL100	£1.10 (E)
BL23A	Solar Cell MS4A	£2.95 (C)
QF30H	BPX25	£4.20 (C)

Page188

HQ81R	MEL 12	38p (F)
YQ62S	Xenon Tube	£2.40 (C)
YQ63T	Trigger Transfmr	49p (F)
XR56L	1mm Light Guide	67p (E)
XL11M	Laser Tube	£124.00 (A)
HY19V	5KV Laser PCB	£4.80 (C)
HQ63T	Lens	£2.45 (C)
HQ64U	Lensholder	£1.12 (E)

ORGAN

Page189

QL02C	SAM77	£1.20 (D)

Page190

XB10L	DMO2	£14.82 (A)
XB11M	DMO2T	£15.82 (A)

Page191

XL08J	Short Spring Line	£6.99 (B)
FB98G	Rubber Coupling	78p (E)
XB84F	Long Spring Line	£11.13 (A)
XB85G	MES Driver Module	£6.95 (B)
YL17T	Reverb PSU Module	£4.73 (C)
XB17T	Mid Kbd 49-Note C-C	£26.50 (A)
XB13P	KB Mounting Strip	46p (F)

Page192

XB14Q	Keyboard 48-Note	£23.94 (A)
XB15R	Keyboard 49-Note	£33.20 (A)
XB16S	Keyboard 61-Note	£39.95 (A)
$XY92A	Twin Kbd & Frame	£49.90 (A)
$XY97F	Kbd Separator	£1.95 (D)
BH62S	Spacer Block	4p (H)
BH63T	Keyboard Spacer	2p (H)
XB04C	Contact Block 1WG	29p (F)
XB01B	Contact Block GJ	45p (F)
XB02C	Contact Block GB2	78p (E)
XB03D	Contact Block GC3	DIS
QY07H	Contact Springs	8p (H)
XB00A	Gold Wire	£1.10 (D)

Page193

XB04E	Earth Bar	23p (G)
FL66W	Stop Tab Black	92p (E)
FL67X	Stop Tab Blue	92p (E)
FL68Y	Stop Tab Green	92p (E)
FL69A	Stop Tab Grey	92p (E)
FL70M	Stop Tab Ivory	92p (E)
+FL71N	Stop Tab Maroon	92p (E)
+FL72P	Stop Tab Orange	92p (E)
FL73Q	Stop Tab Red	92p (E)
FL74R	Stop Tab White	92p (E)
FL75S	Stop Tab Yellow	DIS
BR05F	S Tab Acc Del Trem	£1.10 (D)
BR47B	S Tab Bass Guitar	£1.10 (D)
BR67X	S Tab Bourdon 8'	£1.10 (D)
BR06G	S Tab Cello 16'	£1.10 (D)
BR07H	S Tab Clarinet 8'	£1.10 (D)
BR08J	S Tab Clarion 4'	£1.10 (D)
BY00A	S Tab Clavichord	£1.10 (D)
BY01B	S Tab D/B to Rotor	£1.10 (D)
BY02C	S Tab Dly Vbrato Acc	£1.10 (D)
BY03D	S Tab Dly Vbrto Solo	£1.10 (D)
BR09K	S Tab Diapason 8'	£1.10 (D)
BR68Y	S Tab Diapason 16'	£1.10 (D)
BR10L	S Tab Drawbars Acc	£1.10 (D)
BR11M	S Tab Drawbars Solo	£1.10 (D)
BR12N	S Tab Dulciana 8'	£1.10 (D)
BR13P	S Tab Flute 1'	TEMP
BR14Q	S Tab Flute 2'	TEMP
BR15R	S Tab Flute 2.2/3'	£1.10 (D)
BR16S	S Tab Flute 4'	£1.10 (D)
BR17T	S Tab Flute 5.1/3'	£1.10 (D)
BR18U	S Tab Flute 8'	TEMP
BR19V	S Tab Flute 16'	£1.10 (D)
BR20W	S Tab French Horn 8'	£1.10 (D)
BR21X	S Tab Gedeckt 8'	£1.10 (D)
BY05F	S Tab Gedeckt 16'	£1.10 (D)
BY06G	S Tab Honky Tonk	£1.10 (D)
BR22Y	S Tab Horn 8'	£1.10 (D)
BY07H	S Tab Mixture 16'	£1.10 (D)
BR23A	S Tab Oboe 8'	£1.10 (D)
BR24B	S Tab Octave 4'	£1.10 (D)
BR25C	S Tab Pedal Sustain	£1.10 (D)
BY08J	S Tab Piano	£1.10 (D)
BY09K	S Tab Presets Cancel	£1.10 (D)
BY10L	S Tab Prsts to Rotor	£1.10 (D)
BY11M	S Tab Reed 4'	£1.10 (D)
BR26D	S Tab Reverb	£1.10 (D)
BY12N	S Tab Rotor Fast	£1.10 (D)
BY13P	S Tab Rotor To Main	£1.10 (D)
BR27E	S Tab Salicet 4'	£1.10 (D)
BR28F	S Tab Salicional 8'	£1.10 (D)
BR29G	S Tab Saxophone 16'	£1.10 (D)
BR30H	S Tab Solo Del Trem	£1.10 (D)
BR31J	S Tab String 4'	£1.10 (D)
BR32K	S Tab String 8'	£1.10 (D)
BR33L	S Tab Sub Bass 16'	£1.10 (D)
BY14Q	S Tab Sustain Acc	£1.10 (D)
BY15R	S Tab Sustain Solo	£1.10 (D)
BR34M	S Tab Tremulant	£1.10 (D)
BR35Q	S Tab Trumpet 8'	TEMP
BR36P	S Tab Tuba 16'	£1.10 (D)
BY16S	S Tab Vibrato	£1.10 (D)
BR37S	S Tab Vox Angica 8'	£1.10 (D)
BR38R	S Tab Vox Humana 8'	£1.10 (D)
BH49D	Tablet Rocker Grey	96p (E)
BH50E	Tablet Rocker Orange	96p (E)
BH51F	Tablet Rocker Red	96p (E)
+BY17T	Mar Ky Tab Cello 16'	£3.45
BY18U	Mar Key Tab Clar 8'	DIS
BY19V	Mar Key Tab Clrion 4'	DIS
+BY20W	Mar Key Tab Clav	£3.45
+BY21X	Mar Ky Tab D/B to Rtr	£3.45
BY22Y	Mr Ky Tb Dly Vbr Acc	DIS
+BY23A	Mr Ky Tb Dly Vbr Slo	£3.45
BY24B	Mar Key Tab Diap 8'	DIS

Page194

BY25C	Mar Key Tab Diap 16'	DIS
+BY26D	Mar K Tab Dbar Acc	£3.45
+BY27E	Mar K Tab Dbar Solo	£3.45
BY28F	Mar Key Tab Dulc 8'	DIS
+BY29G	Mar Key Tab Flute 1'	£3.45
BY30H	Mar Key Tab Flute 2'	DIS
BY31J	Mr Ky Tb Flte 2.2/3'	DIS
BY32K	Mar Key Tab Flute 4'	DIS
BY33L	Mr Ky Tb Flte 5.1/3'	DIS
BY34M	Mar Key Tab Flute 8'	DIS
BY35Q	Mar Ky Tab Flute 16'	DIS
+BY36P	Mr Ky Tb Frch Hrn 8'	£3.45
+BY37S	Mar Key Tab Gedkt 8'	£3.45
+BY38R	Mr Key Tab Gedkt 16'	£3.45
+BY39N	Mar Key Tab Hnky Tnk	£3.45
BY40T	Mar Key Tab Horn 8'	DIS
BY41U	Mar Key Tab Mix 16'	DIS
+BY42V	Mar Key Tab Oboe 8'	£3.45
BY43W	Mar Key Tab Octve 4'	DIS
+BY44X	Mar Key Tab Pdl Sus	£3.45
+BY45Y	Mar Key Tab Piano	£3.45
+BY46A	Mr Ky Tb Prsts Cncl	£3.45
BY47B	Mr Ky Tb Prsts To Rr	DIS
BY48C	Mar Key Tab Reed 4'	DIS
BY49D	Mar Key Tab Reverb	DIS
+BY50E	Mar Key Tab Rtr Fst	£3.45
+BY51F	Mr Ky Tb Rtr To Main	£3.45
BY52G	Mar Ky Tab Salict 4'	DIS
+BY53H	Mar Key Tab Salic 8'	£3.45
BY54J	Mar Key Tab Sax 16'	DIS
+BY55K	Mar Key Tab Strng 4'	£3.45
BY56L	Mar key Tab Strng 8'	DIS
+BY57M	Mar Ky Tb Sb-Bss 16'	£3.45
+BY58N	Mar Key Tab Sus Acc	£3.45
+BY59P	Mar Key Tab Sus Solo	£3.45
BY60Q	Mar Key Tab Trmpt 8'	DIS
BY61R	Mar Key Tab Tuba 16'	DIS
+BY62S	Mar Key Tab Vibrato	£3.45
+BY63T	Mar K Tab Vox Ang 8'	£3.45
BY64U	Mar K Tab Vox Hum 8'	DIS
FL76H	Key Tab	90p (E)
BR46A	ST Strip	£1.35 (D)
XX13P	KT Strip	£1.50 (D)
BR41U	Drawbar Red	£1.35 (D)
BR42V	Drawbar White	£1.55 (D)
BR98G	Drawbar Blue	£1.55 (D)
BR99H	Drawbar Green	£1.55 (D)
XB18U	Contact Pedal Board	£26.20 (A)

Page195

XB19V	Free-Stdg Pedalboard	£63.00 (A)
XB99H	Pdl Unit Front Panel	£2.95 (C)
XB96E	32-Note Pdlbd	£135.41 (A)
	Carr in UK with XB96	£14.30
XB21X	Piano Pedal	£11.85 (A)
XB20W	Swell Pedal	£11.95 (B)
XY89W	Switched Swell Pedal	£11.45 (A)
XY98G	Swell Pdl Hsg & Trim	£3.75 (C)
XY28F	Remote Foot Control	£12.60 (A)

Page196

XY99H	Roll Top	£19.50 (A)
XG00A	Roll Top Guides (pr)	£2.50 (C)
XG01B	Music Stand	£5.82 (C)
XB95D	Organ Stool	£29.50 (A)

PANEL METERS

Page197

RW74R	Level Meter	DIS
LB80B	Sig Strength Meter	£1.95 (D)
LB79L	Tuning Meter	£1.95 (D)
RW73Q	VU Meter V41	£2.20 (C)
YQ47B	Dual VU Meter	£3.90 (C)
RK21X	Quick Ft Mtr 50-0-50	£2.95 (C)
RK05F	Qck Ft Mtr 100-0-100	£2.95 (C)
RK06G	Quick Fit Meter 50uA	£2.95 (C)
RK07H	Quick Fit Mtr 100uA	£2.95 (C)
RK08J	Quick Fit Mtr 500uA	£2.95 (C)
RK09K	Quick Fit Meter 1mA	£2.95 (C)
RK10L	Quick-Fit Meter 5mA	£2.95 (C)
RK11M	Quick-Fit Meter 10mA	£2.95 (C)
+RK12N	Quick-Fit Meter 50mA	£2.95 (C)
RK13P	Quick-Ft Meter 100mA	£2.95 (C)
RK14Q	Quick-Ft Meter 500mA	£2.95 (C)
RK15R	Quick-Fit Meter 1A	£2.95 (C)
RK16S	Quick-Fit Meter 5A	£2.95 (C)
RK17T	Quick-Fit Meter 25V	£2.95 (C)
RK18U	Quick-Fit Meter 50V	£2.95 (C)
+RK19V	Quick-Fit Meter VU	£2.95 (C)
RK20W	Punch 27.5mm	£6.58 (B)

Page198

RW98G	2inPn Mt 100-0-100uA	£6.65 (B)
RW99H	2inPn Mt 500-0-500uA	£6.65 (B)
RW91Y	2in. Pan Meter 50uA	£6.98 (B)
RW92A	2in. Pan Meter 100uA	£6.98 (B)
RW93B	2in. Pan Meter 500uA	£6.45 (B)
RW94C	2in. Pan Meter 1mA	£6.45 (B)
RW95D	2in. Pan Meter 5mA	£6.45 (B)
RW96E	2in. Pan Meter 10mA	£6.86 (B)
+RX32K	2in. Pan Meter 50mA	£6.65 (B)
RX33L	2in. Pan Meter 100mA	£6.20 (B)
RX34M	2in. Pan Meter 500mA	£5.99 (B)
RX35Q	2in. Pan Meter 1A	£6.96 (B)
RX36P	2in. Pan Meter 50V	£6.65 (B)
RX37S	2in. Pan Meter 300V	£6.95 (B)
+RX52G	2in. Pan Meter 'S'	£6.65 (B)
RX53H	2in. Pan Meter 'VU'	£6.65 (B)
RX54J	Large Panel Meter	£8.56 (B)
RX92A	Meter MI 15V	£7.62 (B)
RX88V	Meter MI 300V	£8.94 (B)
+RX89W	Meter MI 1A	£7.38 (B)
RX90X	Meter MI 5A	£7.24 (B)
RX91Y	Meter MI 15A	£7.65 (B)
RX93B	Meter MI 25A	£7.95 (B)

PCB EQUIPMENT

Page199

FL02C	SRBP 0.1in Type 3	£1.21 (D)
FL06G	Vero 14354	25p (F)
FL07H	Vero 10345	£1.20 (D)
FL08J	Vero 10346	98p (E)
FL09K	Vero 10347	£1.39 (D)
FL10L	Vero 10348	£1.24 (D)
FL53H	Vero 10401	£3.65 (C)
FL17T	Verostrip	£1.39 (D)
FL19V	DIP Board	£4.98 (C)
HQ48C	Vero V-Q Board	£2.30 (D)
FL25C	Tool 2022	£1.64 (D)
FL26D	Tool 2150	£2.32 (D)
FL27E	Tool 2151	£2.23 (D)
FL20W	Pin 2140	68p (E)
FL21X	Pin 2141	65p
FL23A	Pin 2144	65p (E)
FL24B	Pin 2145	69p

Page200

FL80B	Pin 0266 Pk of 100	£2.85 (F)
FL81C	Pin 1657 Pk of 10	38p (F)
*RK94C	Verowire Kit	£5.94 (B)
HY16S	Verowire Pen	£5.32 (C)
*HY17T	Verowire Spool	99p (E)
FY33L	Verowire Comb	8p (H)
FL82D	Track Pin	85p (E)
FL28F	4-Way Tag	12p (G)
FL29G	Mounting Strip	32p (F)
FL11M	Tag Board	98p (E)
YL11M	Vero Plugblock	£4.98 (C)
HQ84F	Verobloc Bracket	72p (E)
BK62S	Engineer Design Sht	69p (F)
BK63T	Verobloc Kit	£5.95 (C)

Page201

YR83E	Eurobreadboard	£6.75 (B)
YR84F	Prof Plugblock	£6.95 (B)
XX42V	MP Urobreadboard	£21.75 (A)
YR85G	Bus-Strip Plugblock	£2.95 (C)
YR86T	Plugblck Contct Strp	28p (F)
YR87U	Plugblock PCB	£1.85 (D)
XB43W	Seno Etch System	£7.96 (B)

Page202

XY10L	UV Exposure Box	£48.20 (A)
BW19V	Photo-Etch PCB	£2.94 (C)
XX12N	Etch Crystals	£1.49 (D)
BW20W	Phot-Etch Drftg Pk	£1.95 (D)
WF10L	Etcher Fluid	£2.52 (C)
HX02C	PCB Pen	£1.35 (D)
HX03D	Resist Remover	£1.21 (E)
HX00A	PCB SRBP Smll Single	48p (F)
WF38R	PCB SRBP Med Single	96p (E)
WF39N	PCB SRBP Lrg Single	£1.25 (D)
HX01B	PCB F.Glass Sm Sngl	85p (E)
WF40T	PCB F.Glass Med Sngl	£1.75 (D)
WF41U	PCB F.Glass Lrg Sngl	£2.75 (C)
WF42V	PCB F.Glass Med Dble	£1.62 (D)

Page203

HX04E	Polish Block	£1.40 (D)
XB90X	Fixircut	£9.52 (B)
XG20W	CM100 PCB Kit	£69.95 (A)
RK40T	Film FPF012	£9.95 (B)
RK41U	Etching Kit CM100E	£5.82 (C)
RK42V	PCB006 Pack	£7.95 (B)
XG21X	Chemicals Kit CM100C	£16.95 (A)
BW21X	Track Tape 31	£1.24 (E)
BW22Y	Track Tape 40	£1.24 (E)
BW23A	Track Tape 50	£1.24 (E)
BW24B	Track Tape 62	£1.39 (D)
BW25C	Track Tape 80	£1.39 (D)
BW26D	Track Tape 100	£1.39 (D)
BW27E	Track Tape 125	£1.96 (D)
BW28F	Track Tape 150	£1.96 (D)
BW29G	Track Tape 200	£1.96 (D)
BW30H	Pad 075	£1.55 (D)
BW31J	Pad 100	£1.55 (D)
BW32K	Pad 125	£1.64 (D)
BW33L	Pad 150	£1.55 (D)
BW34M	Pad 200	£1.64 (D)
BW35Q	Pad 300	£1.50 (D)
BW36P	Pad 400	£2.62 (C)
BW37S	Pad 500	£3.95 (C)
BW38R	Pad 600	£5.64 (B)

Page204

BW40T	IC Pads 200	£5.60 (C)
BW41U	Drafting Template	98p (E)
HX45Y	Transfer Sheet 1	42p (F)
HX46A	Transfer Sheet 2	42p (F)
HX47B	Transfer Sheet 3	42p (F)
HX48C	Transfer Sheet 4	42p (F)
HX49D	Transfer Sheet 5	42p (F)
HX63T	Transfer Sheet 6	42p (F)
HX64U	Transfer Sheet 7	42p (F)
HX65V	Transfer Sheet 8	42p (F)
HX66W	Transfer Sheet 9	42p (F)
HX67X	Transfer Sheet 10	42p (F)
HX68Y	Transfer Sheet 11	42p (F)
HX83E	Transfer Sheet 12	42p (F)
HX84F	Transfer Sheet 13	42p (F)
HX44X	Transfer Kit	£3.75 (C)

PROJECTS

Page208

BH64U	Minicon Pl 17way	46p (F)
BH67X	Rt-Angle Mncn Pl 15W	65p (E)
BX98G	Jumper Cable 17-way	£3.65 (C)
YK06G	Pedalboard Cableform	£2.98 (C)
HY31J	Steel Washer 4BA	11p (G)
$XY94C	Matinee Front Panel	£17.95 (A)
$XY95D	Matinee Mtlwk Kit	£9.50 (B)
XY96E	End Cheek Set	£6.75 (B)
YK04E	Matinee PSU Bkt	£1.60 (D)
YK05F	Pot Mntg Brkt	79p (E)
FH86T	Reset Spring	4p (H)
HB60Q	Latchbrkt 5 way	27p (F)
HY26D	Latch Brkt 16 way	72p (E)
HY27E	Reset Bar 15way	35p (F)
HY28F	Latchbrkt 9way	39p (F)
HY29G	Reset Bar 6way	16p (G)
QY15R	2716/M2	£10.50 (A)
GA18U	Matinee PSU PCB	£2.10 (C)
$XY86T	Matinee Main PCB	£50.00 (A)
XY88V	Matinee Contact pcb	£7.30 (B)
XY91Y	Matinee Organ Kit	£299.95 (A)
	Carriage with XY91Y	£15.00
XY93B	Matinee Cabinet Kit	£99.50 (A)
	Carriage with XY93B	£20.00
XG05F	Matinee Module Kit	£399.95 (A)
	Carr in UK With XG05	£15.00
XX43W	Matinee Dem Cassette	£1.99 (D)
XH55K	Matinee Book	£2.50 NV (C)

Page210

BR45Y	AS314	33p (F)
BR88V	Mk/Space Adptr Kit	£3.95 (C)
YL20W	Mstr Tuning Module	£18.20 (A)
BB00A	Divider Board 'A'	£4.64 (C)
BB01B	Divider Board 'B'	£3.28 (C)
BB02C	Tone Board 'A'	£4.45 (C)
BB03D	Tone Board 'B'	£1.98 (C)
BB07H	Control Board 'A'	£4.25 (C)
BB08J	Control Board 'B'	£2.98 (C)
BB09K	Sawtooth Board 'A'	£4.35 (C)
BB10L	Sawtooth Board 'B'	£5.49 (B)
BB77J	Divider MD & Frq Gen	£4.95 (C)
BB78K	Pedal PCB 'B'	£3.95 (C)
BB79L	32-Note Pedal Voice	£4.82 (C)
BB80B	Pedal Diode PCB	£1.65 (D)
HQ72P	Auto Ogn Gen/Clk PCB	£4.36 (C)
HQ73Q	Auto Ogn Crd Cdr PCB	£4.49 (C)
HQ74R	Auto Ogn Auto St PCB	£6.32 (B)
HQ75S	Auto Ogn PA/PSU PCB	£8.56 (C)
YL00A	Organ Mixer PCB	£3.52 (C)
YL18U	2G05 PSU PCB	£2.60 (D)
YL21X	32 Note Pdl PSU PCB	£3.42 (C)
XX38R	Downbeat Indictr PCB	£2.20 (C)
BB11M	Gate Board	48p (F)
BB04E	Tone Board 'C'	£4.90 (C)
BB05F	Tone Board 'D'	£4.82 (C)
BB06G	Tone Board 'E'	£4.96 (C)
BB12N	Pedal PCB 'A'	£2.20 (C)
BB15R	Mother Board 'A'	£10.30 (A)
BB13P	A/B Switch Board	£1.68 (D)
BB14Q	MES Amp Board 'A'	72p (E)
XH00A	MES51	15p NV
XH02C	MES52	15p NV
XH04E	MES53	35p NV
XH31J	MES54	30p NV
XH33L	MES55	30p NV

Page212

XF11M	Stereo Synth Book	£2.00 NV (C)
BB41U	Synth Mixer PCB	£4.98 (C)
BB44X	Synth VCA PCB	£1.64 (D)
BY87U	Synth Preset Mtg Bd	68p (E)
BY88V	Synth 1979 Kybd Cont	£6.98 (B)
BY89W	Synth Binary Encoder	£8.94 (B)
BB40T	Synth PSU Mk.II PCB	£5.32 (C)
BY90X	Synth Smpl & Nse PCB	£4.20 (C)
BB43W	Synth Trns Gen 1 PCB	£3.20 (C)
BB45Y	Synth Trns Gen 2 PCB	£3.84 (C)
BY81C	Synth Trns Rept PCB	£1.38 (D)
BY82D	Synth Rvrb & Phs PCB	£3.20 (C)
BY83E	Synth VC Pn & AncPCB	£8.36 (B)
BB38R	Synth Oscillator PCB	£4.98 (C)
BB48C	Synth Ext I/P's PCB	£1.54 (D)
BB65V	3600 VCF PCB	£2.20 (C)
BB64U	4600 Hinge	75p (E)
BB63T	Synth Ext I/P's Bkt	64p (E)
BB49D	Synth Osciltr Mtg Bkt	92p (E)
BB52G	Synth Mixer Chassis	£2.10 (C)
BB51F	Synth Pwr Sply Htsnk	£1.30 (D)
BB56L	Synth Mixer Mtg Bkt	16p (G)
BB61R	Synth VCF Mtg Bkt	84p (E)
BB58N	Synth Trns 1/Env Bkt	85p (E)
BB59P	Synth Trns 2 Mtg Bkt	£1.20 (D)
BB60Q	Synth VCA Mtg Bkt	52p (E)
BF95D	Joylever PCB	98p (E)
XQ01B	5600 Front Panel	£15.98 (A)
	Carr in UK with XQ01	£9.00
BY84F	5600 Rear Panel	£4.55 (C)
XQ02C	5600 Cabinet	£55.23 (A)
	Carr in UK with XQ02	£9.00
XB79L	Teak 5600 Cabinet	DIS
	Carr in UK with XB79	£7.00
LW53H	5600S Synth Kit	£599.95 (A)
	Carr in UK with LW53	£20.00

Page214

BY86T	3800 Interface PCB	£2.62 (C)
BB47B	Synth Otpt Stge PCB	£6.34 (B)
XQ03D	3800 Front Panel	£11.98 (B)
BB67X	3600 VCF Mtg Bkt	59p (E)
BF96E	3800 Sp.Ext.I/P.Bkt	55p (E)
BF98G	3800 VCA Bkt	55p (E)
BF99H	3800 Intface Mtg Bkt	55p (E)
BY85G	3800 Rear Panel	£4.56 (C)
XQ04E	3800 Cabinet	£49.60 (A)
	Carr in UK with XQ04	£9.00
LW54J	3800 Synth Kit	£336.75 (A)
	Carr in UK with LW54	£20.00
YQ46A	Synth Demo Tape	£4.50 (A)
XF41U	Synth Guide Book	£2.30 NV (C)
XF42V	5600S Patch Chart	7p NV (H)
XF43W	3800 Patch Chart	7p NV (H)

Page215

QY17T	2716/M3	£14.95 (A)
RK32K	Sequencer Key Print	65p (E)
GA65V	Sequencer PSU PCB	£1.35 (D)
YQ56L	Sequencer Main PCB	£5 54 (C)
YQ57M	Seq Display PCB	£1.65 (D)
YQ58N	Seq Keyboard PCB	£2.35 (C)
YQ59P	Seq Interface PCB	£2.10 (C)
LW66W	Sequencer Kit	£125.00 (A)
XH59P	Sequencer Leaflet	40p NV (F)

Page216

XG08J	Spectrum Front Panel	£14.95 (A)
XX46A	Spectrm Joystk Panel	£2.25 (C)
XY90X	Spectrum Bus Bar Set	£2.20 (C)
GA03D	Spectrum PSU PCB	£2.40 (C)
GA09K	24-Way Contact PCB	£2.98 (C)
GA10L	25-Way Contact PCB	£2.94 (C)
GA36P	Spectrum VCO PCB	£4.75 (C)
GA53H	Spectrum LFO PCB	£2.50 (C)
GA55K	Spectrum Cntrllr PCB	£1.82 (D)
GA57M	Spectrum VCF PCB	£2.64 (C)
GA59P	Spectrum Shaper PCB	£3.26 (C)
LW60Q	Spectrum Synth Kit	£167.50 (A)
XH56L	Spectrum Synth Book	£1.42 NV (D)
XH18U	MES22	25p NV
BY78K	Piano PSU/Voice PCB	£4.45 (C)
BY79L	Piano Top Oct PCB	£5.44 (C)
BY80B	Piano Two-Oct PCB	£6.72 (B)
XQ06G	Piano Cabinet Black	£49.95 (A)

Page217

XH20W	MES25	25p NV
+BB16S	Orgn/Gtar Bass PCB	£12.28 (A)
GA32K	Hexadrum Pcb	£2.60 (C)
LW85G	Hexadrum Kit	£18.95 (A)
GA05F	Syntom PCB	£1.18 (D)
BH60Q	Syntom Front Panel	£1.25 (D)
LW86T	Syntom Kit	£10.90 (A)

Page218

GA35Q	Synwave PCB	£1.10 (D)
BX99H	Synwave Front Panel	£1.25 (D)
LW87U	Synwave Kit	£10.25 (A)
GA54J	Synclock PCB	£1.65 (D)
XX44X	Synclock Front Panel	£1.50 (D)
LW55K	Synclock Kit	£19.75 (A)
LW88V	Volume Pedal Kit	£21.46 (A)

Page219

GA52G	Auto Swell PCB	£1.15 (D)
LW89W	Auto Swell Kit	£10.90 (A)
GA24B	Guitar Tuner PCB	£1.45 (D)
YL26D	Guitar Tuner Frt Pan	£1.10 (D)
LW90X	Guitar Tuner Kit	£10.75 (A)
GA48C	Harmony Gen PCB	£1.96 (C)
LW91Y	Harmony Gen Kit	£15.45 (A)

Page220

GA00A	D.I.Box PCB	£1.10 (D)
GA41U	Combo Amp PCB	£6.24 (B)
XG03D	Combo Amp Frnt Panel	£4.60 (C)
LW92A	Combo-Amp Kit	£92.85 (A)

Page221

RK25C	Stereo Amp Heatsink	£1.25 (D)
XG16S	Stereo Amp Woodwork	£8.95 (B)
XG15R	Stereo Amp Chassis	£6.92 (B)
GA71N	Stereo Amp PCB	£4.92 (C)
GA78K	Stereo Amp Sw PCB	42p (E)
LW71N	25W Stereo Amp Kit	£55.20 (A)
RK36P	Switch Panel	£1.20 (D)
GA97F	Stereo Amp IR Decodr	£2.75 (C)
GA99H	Sto Amp IR Contrller	£1.40 (D)
LW77J	Amp Remote Cntrl Kit	£28.96 (A)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum trade quantity. For details please see page 27.

1983 Catalogue Page No.		VAT inclusive PRICE
Page222		
XH48C	MES33	40p NV (F)
FL94C	HiFi Amp Sel Mthr PC	£4.20 (C)
FL95D	HiFi Amp Sel PCB	£3.47 (C)
FL96E	HiFi Amp Eql Mthr PC	£3.42 (C)
FL97F	HiFi Amp Eql PCB	£2.20 (D)
FL98G	HiFi Amp Pk Det PCB	£2.46 (D)
FL99H	HiFi Amp PSU PCB	£2.32 (C)
XX32K	H/Phones Skt Brckt	59p (E)
XY21X	HiFi Amp Chassis	£24.20 (A)
XY22Y	HiFi Amp Screen	£2.42 (D)
XY23A	HiFi Amp Frt Panel	£11.98 (B)
XY24B	HiFi Amp Cover Black	£7.96 (B)
Page223		
LR13P	HQ Mixer PCB No.2	£1.96 (D)
LR14Q	HQ Mixer PCB No.3	£1.68 (D)
LR15R	HQ Mixer PCB No.4	£1.62 (D)
LR34M	HQ Mixer PCB No.24	£2.20 (D)
Page224		
LR16S	HQ Mixer PCB No.5	£1.24 (D)
LR35Q	HQ Mixer PCB No.25	£1.92 (D)
LR21X	HQ Mixer PCB No.6	£1.10 (E)
LR22Y	HQ Mixer PCB No.7	£1.75 (D)
LR23A	HQ Mixer PCB No.8	£1.60 (D)
Page225		
LR24B	HQ Mixer PCB No.9	£1.78 (D)
LR42V	HQ Mixer PCB No. 29	£3.24 (C)
LR25C	HQ Mixer PCB No.10	£2.10 (D)
LR26D	HQ Mixer PCB No.14	£1.96 (D)
Page226		
GA68Y	Quadramix PCB	96p (D)
YQ18U	Tone Con PCB	£1.96 (D)
YQ06G	Stereophoner PCB	£1.10 (D)
YQ19V	LM380 Amp PCB	£2.20 (D)
YQ20W	20W Amp PCB	£1.50 (D)
Page227		
HQ68Y	50W Hi-Fi PCB	£3.25 (C)
Page228		
LW35Q	50W Amp Kit	£14.95 (A)
GA29G	MOSFET Amp Mtg Bkt	£1.15 (D)
GA28F	75W MOSFET Amp PCB	£1.80 (D)
LW51F	75W MOSFET Amp Kit	£11.49 (A)
Page229		
LW32K	150W Power Amp Kit	£19.62 (A)
Page230		
GA08J	Woofer PCB	£2.00 (C)
LW40T	Tuner Metalwork Kit	£43.90 (A)
Page231		
LW41U	Tuner PSU Module	£24.96 (A)
LW42V	Tuner Switching Mod	£16.20 (A)
LW45Y	TV Sound Tuner	£45.99 (A)
LW44X	Tuner Head FD811U14	£26.40 (A)
YQ00A	IF Tuner Mono Module	£9.50 (B)
YQ10L	12/30V PSU Module	£6.70 (B)
Page232		
LW43W	Tuner IF Module	£18.98 (A)
LW48C	Stereo Tuner Kit	£161.00 (A)
LW46A	AM Tuner	£17.95 (A)
XF22Y	Tuner Schedule	FREE
Page233		
XH21X	MES37	25p NV (F)
XX03D	10-Channel G.E. PCB	£1.95 (D)
XB74R	10-Chl Eqlsr Mtwrk	£12.20 (A)
XB75S	10-Chl Eqlsr Wwrk	£8.50 (B)
GA30H	Compander PCB	£3.20 (C)
GA31J	Compander PSU PCB	£1.60 (D)
GA43W	Noise Gate Pcb	£1.30 (D)
Page234		
XY32K	Cassette Mechanism	£14.95 (A)
XY34M	Stereo Tape Module	£17.20 (A)
XH51F	MES30	20p NV
YQ30H	Tape Switch Board	42p
YQ33L	Tape Switch Bracket	51p
YQ31J	Tape PSU PCB	39p
XY35Q	Cassette Parts Kit	£11.90 (A)
XY36P	Cassette Recrder Kit	£39.95 (A)
Page235		
XF04E	MES41	40p NV
XB76H	Disco Front Panel	£12.50 (A)
XY26D	Heatsink Mtg Plate	£3.95 (C)
XY27E	Heatsink Cover	£6.45 (B)
BB18U	Heatsink DR2	74p (E)
XB77J	Disco Cabinet	£49.95 (A)
	Carr in UK with XB77	£8.00
BB81C	Disco Pre-Amp Tn PCB	£4.45 (C)
BB19V	Disco PSU PCB	£1.96 (D)
BB20W	150W Amp Board	£2.35 (C)
BB26D	Motor Switch PCB	£1.15 (D)
BB27E	Light Mod Bd	£5.81 (B)
BB22Y	FET-Ceramic PU Bd	£1.95 (D)
BB24B	Disco Fader Bd	£2.20 (C)
BB25C	VUM & HP Amp Bd	£4.24 (C)
XH23A	MES42	25p NV
XB37S	Sound To Light Case	£12.50 (A)
Page236		
GA42V	Partylite Pcb	£2.25 (C)
LW93B	Partylite Kit	£8.45 (B)
YQ21X	Snd/Light Conv PCB	£2.10 (C)
GA25C	Power Control pcb	£1.15 (D)
GA58N	The Bomb PCB	DIS
Page237		
GA04E	Stopwatch PCB	£2.32 (C)
LW65V	Stopwatch Kit	£34.95 (A)
FY84C	Mncn Ltch Hsng 10way	21p (G)
HQ85G	Minicon Plug 10-Way	49p (F)
GA84U	Timer Front Panel	£3.85 (C)
GA61R	Timer Main PCB	£2.80 (C)
GA62S	Timer Switch Board	£3.85 (C)
GA63T	Timer Relay PCB	£1.10 (D)
LW94C	Universal Timer Kit	£39.95 (A)
Page238		
QY25C	2716/M4	£10.50 (A)
GB04E	E.L.C.Board	£4.95 (C)
GB05F	Connect PCB	£3.80 (C)
GB06G	T/E Motherboard	£16.20 (A)
GB07H	T/E PSU PCB	£4.50 (C)
LW80B	Digi-Tel ELC Kit	£25.60 (A)
LW81C	Digi-Tel Connect Kit	£9.95 (B)
LW82D	Digi-Tel Main Kit	£68.50 (A)

1983 Catalogue Page No.		VAT inclusive PRICE
Page239		
XG06G	Burglar Alarm Box	£12.50 (A)
XG07H	Ext Horn Box	£14.50 (A)
GA44X	Burglar Alrm PSU PCB	£2.40 (C)
GA45Y	Burglr Alrm Main PCB	£6.75 (B)
GA46A	Break Contact PCB	£1.82 (D)
GA47B	Ext Horn PCB	£1.60 (D)
LW57M	Burglar Alarm Kit	£44.95 (A)
LW59P	Break Contact Kit	£2.99 (C)
LW58N	Ext Horn Kit	£32.20 (A)
GA81C	Channel/PSU PCB	£1.85 (D)
GA82D	Extra Channel PCB	£1.35 (D)
LW73Q	RTX3 Doppler Kit	£39.95 (A)
LW74R	Radar Ch/PSU Module	£15.40 (A)
LW75S	Radar Extr Ch Module	£4.90 (C)
Page240		
GA00A	Ultrasonic Xvr PCB	£1.60 (D)
GB01B	Ultrasonic IF PCB	£1.60 (D)
LW83E	Usonic Xceiver Kit	£12.65 (A)
LW84F	Usonic Interface Kit	£2.50 (C)
XF44X	Magnum Booklet	59p NV (E)
YQ44X	Magnum 1 PCB	£3.25 (C)
YQ45Y	Magnum 2 PCB	£2.95 (C)
YQ72P	Magnum Mode Chng PCB	£1.65 (D)
GA79L	Multi-circuit Board	£1.35 (D)
Page241		
LW50E	Electronics For All	DIS
XG09K	Train Control Case	£12.50 (A)
XX47B	Train Cnrl Front Pnl	£3.75 (C)
GA72P	Train Common PCB	£2.90 (C)
GA73Q	Train Control PCB	£2.20 (C)
GA74R	Train Receiver 1 PCB	£1.35 (D)
GA75S	Train Receiver 2 PCB	£1.35 (D)
LW61R	Train Common/PSU Kit	£27.50 (A)
LW62S	Train Control Kit	£6.75 (B)
LW63T	Train Rcvr1 ML926Kit	£6.90 (B)
LW64U	Train Rcvr2 ML926Kit	£6.99 (B)
LW68Y	Train Rcvr1 ML927Kit	£6.99 (B)
LW69A	Train Rcvr2 ML927Kit	£6.99 (B)
Page242		
GA84F	Remote Data Ltch PCB	£2.10 (C)
GA85G	Data Encoder PCB	£2.49 (C)
GA86T	Data Decoder PCB	£2.45 (C)
GA87U	IR Tx PCB	£1.25 (D)
GA88V	IR Rx PCB	£1.25 (D)
GA89W	27MHz Tx PCB	98p (E)
XH26D	MES71	30p NV
BB82D	Keyboard PCB	£8.36 (B)
BB83E	VDU Logic PCB	£10.96 (A)
BB96G	VDU PSU PCB	£2.98 (C)
XY12N	VDU Front Panel	£8.48 (B)
XX05F	UHF Mod No 2	£3.49 (C)
Page243		
XH58N	Keytop Prnt ZX81	25p (F)
XG17T	ZX81 Keyboard Case	£4.95 (C)
GA83E	ZX81 Ext Kyboard PCB	£3.36 (C)
LW72P	ZX81 Keyboard Kit	£21.90 (D)
XG22Y	ZX81 Keyboard	£29.95
GA90X	I/O Port PCB	£1.99 (C)
LW76H	ZX81 I/O Port Kit	£9.25 (B)
GB08J	ZX81 Extendiboard	£2.32 (C)
Page244		
XF03D	MES26	£1.28 NV
BB28F	RC Coder PCB	£1.95 (D)
BB29G	RC Xmitter PCB	£2.35 (D)
BB30H	RC Receiver PCB	£1.96 (D)
BB31J	RC Interface PCB	£1.55 (D)
BB32K	RC Decoder PCB	£1.35 (D)
BB33L	RC Relay Drive PCB	99p (E)
BB34M	RC Servo Drive PCB	£1.32 (E)
BB35Q	RC Servo Amp PCB	92p (E)
BB36P	RC Tone Gen PCB	98p (E)
BB37S	RC Tone Decoder PCB	85p (E)
YQ03D	McM Encoder PCB	£1.82 (D)
YQ04E	McM Receiver PCB	£2.73 (D)
YQ05F	McM Rcvr Dcdr PCB	£1.94 (D)
YQ07H	McM Transmitter PCB	£2.67 (D)
YQ08J	McM Elect Ig/Cnv PCB	£1.60 (D)
XH27E	MES16	15p NV
XX40T	Ignition PCB	£1.30 (D)
XX41U	Ign Mtg Plate	£1.28 (D)
GA22Y	Strobe Main pcb	£2.20 (C)
GA23A	Strobe HT pcb	£1.20 (D)
YQ09K	McM Flasher PCB	£1.10 (D)
Page245		
GA26D	Dig Tacho Main PCB	£1.75 (D)
GA27E	Dig Tacho Dsply PCB	£1.25 (D)
GA19V	Batt Mon PCB	£1.20 (D)
GA98G	Car Burglar Alrm PCB	£1.10 (D)
LW78K	Car Burglr Alarm Kit	£6.95 (B)
GA40T	Car Aerial Bster Pcb	£1.35 (D)
Page246		
GA76H	MPG Meter Main PCB	£2.45 (C)
GA77J	MPG Meter Disply PCB	£1.75 (D)
LW67X	MPG Meter Kit	£44.95 (A)
RK39N	Freq Cnt Front Panel	£1.99 (D)
GB02C	Freqency Counter PCB	£4.95 (C)
GB03D	Freq Ctr Display PCB	£1.85 (D)
LW79L	Frequency Countr Kit	£85.00 (A)
GB72P	Sine/Square Gen PCB	£3.12 (C)
GB73Q	Audio Osc Frt Panel	£2.35 (D)
XH24B	MES15	15p NV
Page247		
XF11M	Stereo Synth Book	£2.00 NV(C)
XF13P	MES12B	FREE
XF37S	MES12C	FREE
XH24B	MES15	15p NV
XF14Q	MES15B	FREE
XH27E	MES16	15p NV
XF15R	MES16B	FREE
XH18U	MES22	25p NV
XF18U	MES22B	FREE
XH06G	MES24	FREE
XH20W	MES25	25p NV
XF20W	MES25B	FREE
XF03D	MES26	£1.28 NV
XH13P	MES27	FREE
XH15R	MES30	20p NV
XH48C	MES33	40p NV (F)
XF21X	40W Amp Schedule	FREE
XF22Y	Tuner Schedule	FREE
XF25C	MES35B	FREE
XH21X	MES37	25p NV (F)
XF06G	MES37B	FREE
XF04E	MES41	40p NV
XF05F	Disco Schedule	FREE
XH23A	MES42	25p NV
XF23A	MES42B	FREE
XH00A	MES51	15p NV
XH01B	MES51B	FREE
XH02C	MES52	15p NV
XH03D	MES52B	FREE
XH04E	MES53	35p NV
XH05F	MES53B	FREE
XH31J	MES54	30p NV
XH32K	MES54B	FREE

1983 Catalogue Page No.		VAT inclusive PRICE
XH33L	MES55	30p NV
XH34M	MES55B	FREE
XH26D	MES71	30p NV
XF26D	MES71B	FREE
GA11M	Continuity Testr PCB	£1.32 (D)
XF46A	E&MM April 1981	DIS
XF47B	E&MM May 1981	£1.00 NV
XF48C	E&MM June 1981	£1.00 NV
XF49D	E&MM July 1981	£1.00 NV
XF50E	E&MM August 1981	£1.00 NV
Page248		
XF52G	E&MM October 1981	£1.00 NV
XF53H	E&MM November 1981	£1.00 NV
XF54J	E&MM December 1981	£1.10 NV
XF55K	E&MM January 1982	£1.10 NV
XF56L	E&MM February 1982	£1.10 NV
XF57M	E&MM March 1982	£1.10 NV
XF58N	E&MM April 1982	£1.10 NV
XF59P	E&MM May 1982	£1.10 NV
XF60Q	E&MM June '82	£1.10 NV
XF61R	E&MM July 1982	£1.10 NV
XF62S	E&MM August 1982	£1.10 NV
Page249		
XF63T	E&MM September 1982	£1.10 NV
XF64U	E&MM October 1982	DIS
XH61R	E&MM Projects Vol 1	£1.00 NV (D)
XA00A	Maplin Mag Subscrptn	70p NV
XA01B	Projects Book One	70p NV (E)
XA02C	Projects Book Two	70p NV (E)
XA03D	Projects Book Three	70p NV (E)
XA04E	Projects Book Four	70p NV (E)
PROTECTION		
Page250		
RX96E	Safuseholder 20	45p (F)
RX97F	Safuseholder 1.1/4in	£1.96 (D)
RX49D	Chassis F/H 20mm	11p (G)
RX50E	Chassis F/H 1.1/4 in	17p (G)
WH49D	Fuse Clip	3p (H)
RX51F	F/H Car	10p (G)
WR93R	Fuse 20mm 50mA	6p (H)
WR00A	Fuse 20mm 100mA	9p (H)
WR94C	Fuse 20mm 150mA	6p (H)
WR01B	Fuse 20mm 250mA	9p (H)
WR02C	Fuse 20mm 500mA	9p (H)
WR03D	Fuse 20mm 1A	9p (H)
WR04E	Fuse 20mm 1.5A	9p (H)
WR05F	Fuse 20mm 2A	9p (H)
WR06G	Fuse 20mm 3A	9p (H)
WR07H	Fuse 20mm 5A	9p (H)
WR18U	Fuse A/S 500mA	12p (G)
WR19V	Fuse A/S 1A	12p (G)
WR20W	Fuse A/S 2A	12p (G)
WR95D	Fuse 1.1/4 50mA	5p (H)
WR08J	Fuse 1.1/4 100mA	6p (H)
WR96E	Fuse 1.1/4 150mA	8p (H)
WR09K	Fuse 1.1/4 250mA	7p (H)
WR10L	Fuse 1.1/4 500mA	6p (H)
WR11M	Fuse 1.1/4 1A	8p (H)
WR12N	Fuse 1.1/4 1.5A	8p (H)
WR13P	Fuse 1.1/4 2A	8p (H)
WR14Q	Fuse 1.1/4 3A	8p (H)
WR15R	Fuse 1.1/4 5A	8p (H)
WR16S	Fuse 1.1/4 10A	9p (H)
WR17T	Fuse 1.1/4 15A	12p (G)
HQ31J	Plug Fuse 2A	15p (G)
HQ32K	Plug Fuse 3A	14p (G)
HQ33L	Plug Fuse 5A	15p (G)
HQ34M	Plug Fuse 13A	14p (G)
BK21X	Thermal Breaker 1A	£2.35 (C)
BK22Y	Thermal Breaker 3A	£1.35 (D)
BK23A	Thermal Breaker 5A	£1.64 (D)
BK24B	Thermal Breaker 12A	£1.35 (D)
BK20W	Thermal Breaker 15A	£1.35 (D)
Page251		
HB51F	Fuse Wire	30p (F)
HW04E	RF Supp Choke 1A	29p (F)
HW05F	RF Supp Choke 2A	32p (F)
HW06G	RF Supp Choke 3A	39p (F)
YR90X	R-C Network	£1.39 (D)
HW13P	Mains Trans Supp	65p (E)
HW07H	Delta Cap	97p (E)
YW46A	Door Contact Reed	£1.49 (D)
YW50E	Window Foil	£1.09 (D)
YW51F	Foil Terms	65p (E)
YW49D	BA Junction Box	59p (E)
YW47B	Surface BA Reed	£1.95 (D)
YW48C	Door Loop	£2.24 (D)
YB91Y	Pressure Mat	£3.55 (C)
RECORD & VIDEO		
Page252		
XQ00A	Autochanger	£23.60 (A)
XB23A	Rim Drive Turntable	DIS
XB25C	Belt Drive Turntable	£38.40 (A)
Page253		
FQ17T	Cartridge Slide MP60	£2.68 (C)
FQ18U	Cartridge Slide 710	DIS
FQ19V	Crtridge Slide BDS95	DIS
LB75S	Drive Wheel BSR	£1.94 (D)
YW58N	BSR Drive Belt	£2.20 (C)
LB76H	Dr Wheel Garrard Lrg	£2.55 (C)
FQ30H	Dr Wheel Garrard Sm	£2.85 (C)
FQ31J	Spindle Man Short	DIS
FQ32K	Spindle Man Long	DIS
+FQ33L	Spindle Auto Short	£4.50 (C)
+FQ35Q	CB Weight SP25IV	£4.60 (C)
FQ36P	Garrard Drive Belt	£2.50 (C)
XX34M	Headshell	£3.50 (C)
YX76H	Drive Belt 46mm	98p (E)
YX77J	Drive Belt 57mm	84p (E)
YX78K	Drive Belt 66mm	98p (E)
RK99H	Drive Belt 71mm	98p (D)
YX79L	Drive Belt 76mm	98p (E)
YX80B	Drive Belt 90mm	84p (E)
HR01B	Ctrdg BSR X5M	£3.65 (C)
HR02C	Ctrdg BSR X5H	£3.65 (C)
Page254		
HR04E	Ctrdg BSR SX6M	£4.25 (C)
HR05F	Ctrdg BSR SX6H	£4.49 (C)
HR09K	Ctrdg BSR SC12M	£3.75 (C)
HR10L	Ctrdg BSR SC12H	£3.65 (C)
YX83E	Ctrdge Philips GP215	£4.99 (C)
FY75S	Ctrdg Rigonda 2SB	£5.75 (C)
HR12N	Ctrdg Sono 3509	£4.95 (C)
HR13P	Ctrdg Sono 3549	£5.95 (B)
HR14Q	Ctrdg Sono 3559	£5.25 (B)
HR17T	Ctrdg Sono V100	£6.20 (B)
YX82D	Cartridge QLM36	£21.40 (A)
Page255		
HR15R	Ctrdg Goldring G850	£6.94 (B)
HR16S	Ctrdg Goldring G800	£8.98 (B)
FQ38R	Ctrdg Goldring G800H	£9.49 (B)
FQ39N	Ctrdg Goldring G800E	£11.95 (A)
FQ40T	Ctrdg Tenorel T2001D	£4.85 (C)
FQ41U	Cdg Tenorel T2001ED	£11.29 (A)
RK96G	Tenorel TMC10 Cart	£39.95 (A)
BK64U	TMC10 Replacement	£19.95

1983 Catalogue Page No.		VAT inclusive PRICE
Page256		
HR25C	Stylus GP91SC DD	£1.85 (D)
BK05F	Stylus Sanyo ST26	£5.50
BK07H	Stylus ATN3400	£4.95 (C)
HR31J	Stylus GP104 DD	£1.85 (D)
HR66W	Stylus Acos SM6	£4.95 (C)
*BK08J	Stylus ATN71	£5.50
YX06G	Stylus ADC RSQ30	£6.32 (B)
BK09K	Stylus ATN3710	£4.95
BK10L	Stylus Toshiba N501	£5.50 (B)
+YX09K	Stylus AT70	£4.95 (C)
BK19V	Stylus D5107AL	£4.95 (C)
HR68Y	Stylus VM8	£5.50 (B)
+HR39N	Stylus BSR TC8 D	£1.50 (D)
+HR71N	Stylus BSR ST4 DD	£1.85 (D)
HR42V	Stylus BSR ST10	£1.85 (D)
HR45Y	Stylus BSR ST15	£1.85 (D)
HR47B	Stylus BSR ST17 DD	£1.85 (D)
HR74R	Stylus BSR ST21	£1.85 (D)
BK11M	Stylus Hitachi E100	£5.50 (B)
BK12N	Stylus JVC DT31	£3.50 (B)
YX12N	Stylus Garrard GA150	DIS
HR76H	Stylus D110E	£5.50 (B)
HR77J	Stylus D110H	£2.95 (C)
HR48C	Stylus D110SR	£1.95 (D)
HR49D	Stylus D120SR	£2.45 (C)
HR78K	Stylus Hitachi ST101	£5.40 (C)
HR79L	Stylus Hitachi ST103	£6.75 (B)
+YX13P	Stylus Hitachi ST104	£4.95 (C)
YX14Q	Stylus JVC DT21S	DIS
FQ54J	Stylus JVC DT33	£4.95 (C)
BK14Q	Stylus Trio STY111	£4.95 (C)
HR81C	Stylus LV65977D	£1.50 (D)
HR83E	Stylus NP EPS36	DIS
HR84F	Stylus NP EPS52	£4.95 (C)
YX16S	Stylus NP EPS53	£5.50 (B)
YX17T	Stylus Philip AG3306	DIS
+HR87U	Sty Philips GP200DD	£1.85 (D)
+HR89W	Stylus Philips GP205	£1.25 (D)
YX18U	Stylus Philips GP213	DIS
HR90X	Styl Philips GP400	£5.10 (B)
YX19V	Styl Phlps GP400Mk2	£4.95 (C)
YX20W	Styl Phlps GP401Mk2	£6.75 (B)
BK15R	Stylus EPC207	£5.99 (B)
HR51F	Stylus BF40D	£1.85 (D)
HR96E	Stylus DM500/7	£5.72 (C)
+YX22Y	Stylus Sanyo ST10J	£4.95 (C)
HR95D	Stylus Sansui SN28	£4.95 (C)
+YX23A	Stylus Sansui SN41	£4.95 (C)
YX24B	Stylus Sanyo ST7D	£4.95 (C)
*HR97F	Stylus Sanyo 2611	£4.95 (C)
FQ48C	Stylus Sony ND128	DIS
+YX25C	Stylus Sharp STY101	£4.95 (C)
+HR98G	Stylus Sharp 706	£4.95 (C)
HR99H	Stylus Sharp 717	£4.95 (C)
BK16S	Stylus PN12	£5.50 (B)
HR61R	Stylus Sonotone V100	£4.95 (C)
YX26D	Stylus Sonotone V101	£5.72 (C)
FQ45Y	Stylus 2509	£1.85 (D)
HR60Q	Stylus 9TAHC DD	£1.85 (D)
HR53H	Stylus KS40A DD	£1.85 (D)
BK17T	Stylus Sony ND114	£5.50 (B)
BK18U	Stylus ND200	£6.75 (B)
YX27E	Stylus Sony XL15	£4.35 (C)
+YX28F	Stylus Sony ND126	£4.95 (C)
FQ49D	Stylus Sony ND133	£5.50 (B)
FQ50E	Stylus Sony ND134	£5.50 (B)
FQ51F	Stylus N2001D	£2.95 (C)
FQ52G	Stylus N2001ED	£8.32 (B)
YX30H	Stylus Tetrad 51	DIS
+FQ53H	Stylus Toshiba N3C	£2.20 (C)
YX31J	Stylus Toshiba N55	£4.95 (C)
YX32K	Stylus Toshiba N58	DIS
+YX21X	Stylus Toshiba N550	£4.95 (C)
Page258		
YB47B	Record Care kt C106	£4.95 (C)
LX06G	Cleaning Arm C100	£3.25 (C)
YW81C	Cleaning Cloth C104	78p (E)
FR48C	Dust-Off C101	99p (E)
YW82D	Cleaner C92	£4.65 (C)
YX93B	Stylus Microscope	£2.45 (C)
YW83E	Stylus Brush C103	14p (G)
+FR46A	Stylus Cleaner C95	80p (E)
YB55K	Cleaning Kit C116	£2.42 (C)
FR52G	Anti-Stat Fluid 69S	49p (F)
LX10L	Anti-Stat Mat C119	£2.64 (D)
LX04E	Anti-Stat Gun	£5.25 (B)
FR49D	Stylus Balance PX1	£1.25 (C)
FR50E	Gram Speed Indicator	9p (H)
Page259		
YW86T	Cassette Kit C115	£1.85 (D)
RK95D	Tape Head Care Kit	£2.75 (C)
YB56L	Cassette Kit C107	£4.25 (C)
*BK28F	Deluxe Head Cleaner	£3.25 (C)
+RB04E	Cass Head Clnr C118	£1.49 (D)
YW87U	Cleaning Stick C109	33p (G)
YW88V	Tape Cleaning Fluid	58p (E)
FR54J	Cassette Clnr Tape	55p (E)
YW89W	Cassette Cln & Demag	£2.25 (C)
FR62S	Straight Demagnetizer	£3.64 (C)
FQ62S	Curved Demagnetiser	£3.85 (C)
BK27E	Elec. Head Demag.	£8.95 (B)
YW91Y	Splicing Block	£2.42 (D)
Page260		
YW90X	Cassette Splicer	DIS
LX17T	Splicing Tape	65p (E)
RB03D	Cassette Case	26p (G)
FR60Q	Index Cards	£1.94 (D)
RB01B	Cassette Fast Winder	£2.75 (C)
FR59P	Test Cassette 53	DIS
YG25C	Cassette Tape C60	61p (E)
YG26D	Cassette Tape C90	65p (E)
RB07H	Rota-Rack	£2.45 (C)
LH91Y	Cassettebox	£4.65 (C)
+LH92A	Videocassettebox	£9.68 (B)
RK96E	VHS Head Cleaner	£9.75 (B)
RK97F	Betamax Head Cleaner	£10.95 (A)
Page261		
FQ63T	GF Cassette Head	£13.20 (A)
FQ64U	Mono Cassette Head	£4.62 (C)
FQ66W	Cassette Erase Head	£2.24 (C)
FQ65V	Stereo Cassette Head	£4.48 (B)
FQ69A	Tape hd Four-Trck RP	DIS
FQ70M	Tpe Hd Four Trk Eras	DIS
+FQ71N	2-Head Bracket	£4.65 (C)
FQ72P	3-Head Bracket	DIS
RESISTORS		
Page262		
U	Micro Res	3p (H)
B	Econ Res 1R to 8R2	2p (H)
B	Econ Res 1M2 to 10M	2p (H)
M	M1R to 8R2 (1%)	12p (H)
M	M10R to 1M (1%)	2p (H)
M	M1M2 to M10M (1%)	12p (H)
Page263		
S	Std Res	3p (H)
C	1W Res	8p (H)
XL05F	Colour Wheel	25p (F)

1983 Catalogue Page No.		VAT inclusive PRICE
X	See	M
T	See	M
W	W/W Min 0.22R to 1R	29p
W	W/W Min 1R2 to 22K	19p
Page264		
L	7W W/W	29p (F)
H	10W W/W	35p (F)
P	25 W/W Res	£1.65 (D)
V	HV Res 1M-33M	12p (G)
V	HV Res 47M	25p (F)
BL64U	Constantan 28 swg	£3.35 (C)
YY12N	Resnet 100R	85p (E)
YY13P	Resnet 220R	85p (E)
YY14Q	Resnet 470R	85p (E)
YY15R	Resnet 1k	85p (E)
YY16S	Resnet 2k2	93p (E)
YY17T	Resnet 4k7	85p (E)
YY18U	Resnet 10k	85p (E)
YY19V	Resnet 22k	85p (E)
YY20W	Resnet 47k	85p (E)
YY21X	Resnet 100k	85p (E)
WR52G	Hor S-Min Prest 100R	10p (G)
WR53H	Hor S-Min Prest 220R	10p (G)
WR54J	Hor S-Min Prest 470R	10p (G)
WR55K	Hor S-Min Prest 1k	10p (G)
WR56L	Hor S-Min Prest 2K2	10p (G)
WR57M	Hor S-Min Prest 4k7	10p (G)
WR58N	Hor S-Min Prest 10k	10p (G)
WR59P	Hor S-Min Prest 22K	10p (G)
WR60Q	Hor S-Min Prest 47k	10p (G)
WR61R	Hor S-Min 100k	10p (G)
WR62S	Hor S-Min Prest 220k	10p (G)
WR63T	Hor S-Min Prest 470k	10p (G)
WR64U	Hor S-Min Preset 1M	10p (G)
WR65V	Vrt S-Min Prest 100R	11p (G)
WR66W	Vrt S-Min Prest 220R	11p (G)
WR67X	Vrt S-Min Prest 470R	11p (G)
WR68Y	Vrt S-Min Prest 1k	11p (G)
WR69A	Vrt S-Min Prest 2k2	11p (G)
WR70M	Vrt S-Min Prest 4k7	11p (G)
WR71N	Vrt S-Min Prest 10k	11p (G)
WR72P	Vrt S-Min Prest 22k	11p (G)
WR73Q	Vrt S-Min Prest 47k	11p (G)
WR74R	Vrt S-Min Prest 100k	11p (G)
WR75S	Vrt S-Min Prest 220k	11p (G)
WR76H	Vrt S-Min Prest 470k	11p (G)
WR77J	Vert S-Min Prest 1M	11p (G)
Page265		
WR78K	Hor Skeleton 100R	14p (G)
WR79L	Hor Skeleton 220R	14p (G)
WR80B	Hor Skeleton 470R	26p (F)
WR81C	Hor Skeleton 1k	26p (F)
WR82D	Hor Skeleton 2k2	26p (F)
WR83E	Hor Skeleton 4k7	26p (F)
WR84F	Hor Skelton 10k	26p (F)
WR85G	Hor Skeleton 22k	26p (F)
WR86T	Hor Skeleton 47k	26p (F)
WR87U	Hor Skeleton 100k	27p (F)
WR88V	Hor Skeleton 220k	26p (F)
WR89W	Hor Skeleton 470k	26p (F)
WR90X	Hor Skeleton 1M	26p (F)
WR91Y	Hor Skeleton 2M2	26p (F)
WR92A	Hor Skeleton 4M7	26p (F)
WW00A	Vrt Skeleton 100R	26p (F)
WW01B	Vrt Skeleton 220R	26p (F)
WW02C	Vert Skeleton 470R	26p (F)
WW03D	Vrt Skeleton 1k	26p (F)
WW04E	Vrt Skeleton 2k2	26p (F)
WW05F	Vrt Skeleton 4k7	26p (F)
WW06G	Vrt Skeleton 10k	26p (F)
WW07H	Vrt Skeleton 22k	29p (F)
WW08J	Vrt Skeleton 47k	26p (F)
WW09K	Vrt Skeleton 100k	26p (F)
WW10L	Vrt Skeleton 220k	26p (F)
WW11M	Vrt Skeleton 470k	24p (F)
WW12N	Vrt Skeleton 1M	28p (F)
WW13P	Vrt Skeleton 2M2	28p (F)
WW14Q	Vrt Skeleton 4M7	25p (F)
WR38R	Cermet 100R	98p (E)
WR39N	Cermet 500R	98p (E)
WR40T	Cermet 1k	98p (E)
WR41U	Cermet 5k	98p (E)
WR42V	Cermet 10k	98p (E)
WR43W	Cermet 50k	98p (E)
WR44X	Cermet 100k	98p (E)
WR45Y	Cermet 1M	98p (E)
WR46A	15-Turn Cermet 500R	£1.20 (D)
WR47B	15-Turn Cermet 1k	£1.20 (D)
WR48C	15-Turn Cermet 5k	£1.20 (D)
WR49D	15-Turn Cermet 10k	96p (D)
WR50E	15-Turn Cermet 50k	99p (D)
WR51F	15-Turn Cermet 100k	99p (D)
BW06G	Edge Control Pot	65p (E)
BW07H	Edge Knob Small Blk	8p (H)
BW08J	Edge Knob Small Grey	8p (H)
BW09K	Edge Knob Large Blk	8p (H)
BW10L	Edge Knob Large Grey	8p (H)
FW00A	Pot Lin 1k	43p (F)
FW01B	Pot Lin 4k7	43p (F)
FW02C	Pot Lin 10k	43p (F)
FW03D	Pot Lin 22k	43p (F)
FW04E	Pot Lin 47k	43p (F)
FW05F	Pot Lin 100k	43p (F)
FW06G	Pot Lin 220k	43p (F)
FW07H	Pot Lin 470k	43p (F)
FW08J	Pot Lin 1M	43p (F)
FW09K	Pot Lin 2M2	43p (F)
FW21X	Pot Log 4k7	43p (F)
FW22Y	Pot Log 10k	43p (F)
FW23A	Pot Log 22k	43p (F)
FW24B	Pot Log 47k	43p (F)
FW25C	Pot Log 100k	43p (F)
FW26D	Pot Log 220k	43p (F)
FW27E	Pot Log 470k	43p (F)
FW28F	Pot Log 1M	43p (F)
FW29G	Pot Log 2M2	43p (F)
Page266		
FW41U	Sw Pot Lin 4k7	£1.12 (D)
FW42V	Sw Pot Lin 10k	£1.12 (D)
FW43W	Sw Pot Lin 22k	£1.12 (D)
FW44X	Sw Pot Lin 47k	£1.12 (D)
FW45Y	Sw Pot Lin 100k	£1.12 (D)
FW46A	Sw Pot Lin 220k	£1.12 (D)
FW47B	Sw Pot Lin 470k	£1.12 (D)
FW48C	Sw Pot Lin 1M	£1.12 (D)
FW49D	Sw Pot Lin 2M2	£1.12 (D)
FW62S	Sw Pot Log 4k7	£1.12 (D)
FW63T	Sw Pot Log 10k	£1.12 (D)
FW64U	Sw Pot Log 22k	£1.12 (D)
FW65V	Sw Pot Log 47k	£1.12 (D)
FW66W	Sw Pot Log 100k	£1.12 (D)
FW67X	Sw Pot Log 220k	£1.12 (D)
FW68Y	Sw Pot Log 470k	£1.12 (D)
FW69A	Sw Pot Log 1M	£1.12 (D)
FW70M	Sw Pot Log 2M2	£1.12 (D)
FW50E	W/W Pot 10R	£2.74 (C)
FW51F	W/W Pot 25R	£2.74 (D)
FW52G	W/W Pot 50R	£2.74 (D)
FW71N	W/W Pot 100R	£2.74 (C)
FW72P	W/W Pot 250R	£2.74 (D)
FW73Q	W/W Pot 500R	£2.74 (D)
FW93B	W/W Pot 1k	£2.24 (D)
FW96E	W/W Pot 2K5	DIS
FW94C	W/W Pot 5k	£2.24 (E)
FW95D	W/W Pot 10k	£2.29 (C)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum trade quantity. For details please see page 27.

1983 Catalogue Page No.		VAT inclusive PRICE
FX18U	W/W Pot 50k	£3.24 (C)
FW84F	Dual Pot Lin 4k7	£1.29 (D)
FW85G	Dual Pot Lin 10k	£1.29 (D)
FW86T	Dual Pot Lin 22k	£1.29 (D)
FW87U	Dual Pot Lin 47k	£1.29 (D)
FW88V	Dual Pot Lin 100k	£1.29 (D)
FW89W	Dual Pot Lin 220k	£1.29 (D)
FW90X	Dual Pot Lin 470k	£1.29 (D)
FW91Y	Dual Pot Lin 1M	£1.29 (D)
FW92A	Dual Pot Lin 2M2	£1.29 (D)
FX08J	Dual Pot Log 4k7	£1.29 (D)
FX09K	Dual Pot Log 10k	£1.29 (D)
FX10L	Dual Pot Log 22k	£1.29 (D)
FX11M	Dual Pot Log 47k	£1.29 (D)
FX12N	Dual Pot Log 100k	£1.29 (D)
FX13P	Dual Pot Log 220k	£1.29 (D)
FX14Q	Dual Pot Log 470k	£1.29 (D)
FX15R	Dual Pot Log 1M	£1.29 (D)
FX16S	Dual Pot Log 2M2	£1.29 (D)
FX40T	L/S Control 20R	55p (E)
FX97F	L/S Control 50R	55p (E)
FX98G	L/S Control 100R	55p (E)
FX99H	L/S Control 200R	55p (E)
YG04E	Rheostat 50R	£4.90 (C)
YG05F	Rheostat 100R	£4.90 (C)
YG06G	Rheostat 150R	£4.90 (C)
YG07H	Rheostat 200R	£4.90 (C)

Page267

FX32K	Slide Pot Lin 5k	79p (E)
FX33L	Slide Pot Lin 10k	79p (E)
FX34M	Slide Pot Lin 25k	79p (E)
FX35Q	Slide Pot Lin 50k	79p (E)
FX36P	Slide Pot Lin 100k	79p (E)
FX37S	Slide Pot Lin 250k	79p (E)
FX38R	Slide Pot Lin 500k	79p (E)
FX53H	Slide Pot Log 5k	79p (E)
FX54J	Slide Pot Log 10k	79p (E)
FX55K	Slide Pot Log 25k	79p (E)
FX56L	Slide Pot Log 50k	79p (E)
FX57M	Slide Pot Log 100k	79p (E)
FX58N	Slide Pot Log 250k	79p (E)
FX59P	Slide Pot Log 500k	79p (E)
FX76H	Dual Slide Lin 5k	£1.25 (D)
FX77J	Dual Slide Lin 10k	£1.25 (D)
FX78K	Dual Slide Lin 100k	£1.25 (D)
HB02C	Dual Slide Log 10k	£1.25 (D)
HB04E	Dual Slide Log 50k	£1.25 (D)
HB05F	Dual Slide Log 100k	£1.25 (D)
HB07H	Dual Slide Log 500k	£1.25 (D)
FX07H	Slide Bezel	49p (F)
XB08N	Joystick Pot	£6.38 (B)
HB60E	2-Axis Joystick	£3.25 (C)
XB06G	Joystick Mtg Plate	£1.83 (D)

Page268

FX87U	Thermistor KR152CW	£1.21 (E)
FX21X	Thermistor VA1055S	51p (F)
FX22Y	Thermistor VA1056S	49p (F)
FX42V	Thermistor VA1066S	41p (F)
FX43W	Thermistor VA1067S	48p (F)
FX62S	Thermistor R53	£5.95 (B)
WH23A	Thermistor G16	£5.40 (B)
WH24B	Thermistor G23	£5.82 (B)
HB10L	LDR DRP12	£1.35 (D)
HB11M	LDR ORP60	DIS
HB09K	LDR RPY58A	£1.18 (D)

SEMICONDUCTORS

Page269

QB00A	AA119	11p (G)
QB01B	AC126	36p (F)
QB02C	AC127	38p (F)
QB03D	AC128	38p (F)
QB04E	AC141	39p (F)
QB05F	AC142	42p (F)
QB06G	AC176	34p (F)
QB07H	AC187	35p (F)
QB08J	AC188	37p (F)
QB10L	ACY19	77p (E)
QB11M	ACY20	DIS
BL30H	AD140	£1.55 (D)
BL31J	AD149	£1.35 (D)
BL32K	AD161	61p (E)
BL33L	AD161/2MP	£1.22 (D)
BL34M	AD162	61p (E)
QQ00A	ADC0804LCN	£4.45 (C)
QB19V	AF139	65p (E)
QB20W	AF239	88p (E)
BR45Y	AS314	33p (F)
QB21X	AY-1-0212	DIS
HQ52G	AY-1-1320	£4.99 (C)
HQ51F	AY-1-5050	£1.99 (D)
YY98G	AY-3-1270	£9.30 (B)
YY89W	AY-3-1350	£5.95 (B)
WQ18U	AY-3-1015D	£5.98 (B)
WQ16W	AY-5-2376	£13.99 (B)
QB27E	BA102B	29p (F)
QQ12N	BA243	DIS
QQ13P	BAR28	16p (G)
QB28F	BAX13	12p (H)
QB29G	BAX16	7p (H)
QB31J	BC107B	16p (G)
QB32K	BC108C	16p (G)
QB33L	BC109C	16p (G)
QB34M	BC117	24p (F)
QB35Q	BC119	39p (F)
QB36P	BC136	40p (F)
QB37S	BC140	40p (F)
QB38R	BC141	37p (F)
QB39N	BC142	35p (F)
QB40T	BC143	34p (F)
QB44X	BC154	27p (F)
QB48C	BC160	43p (F)
QB49D	BC161	36p (F)
QB50E	BC168C	11p (G)
QB51F	BC169C	11p (G)
QB52G	BC177	20p (G)
QB53H	BC178	20p (G)
QB54J	BC179	20p (G)
QB55K	BC182L	11p (G)
QB56L	BC183L	11p (G)
QB57M	BC184L	11p (G)
QB58N	BC204	15p (G)
QB59P	BC209C	14p (G)
QB60Q	BC212L	11p (G)
QB61R	BC213L	11p (G)
QB62S	BC214L	10p (G)
QB63T	BC301/5	40p (F)
QB64U	BC301/5/303/5MP	89p (E)
QB65V	BC303/5	36p (F)
QB66W	BC327	15p (G)
QB67X	BC328	15p (G)
QB68Y	BC337	15p (G)
QB69A	BC338	15p (G)
QB70M	BC441	38p (F)
QB71N	BC441/461MP	90p (E)
QB72P	BC461	43p (F)
QQ14Q	BC547	11p (G)
QB73Q	BC548	14p (G)
QQ15R	BC549	12p (G)
QQ16S	BC557	11p (G)
QQ17T	BC558	11p (G)
QQ18U	BC559	11p (G)
QB74R	BC650	29p (F)

1983 Catalogue Page No.		VAT inclusive PRICE
QF00A	BCY70	18p (G)
QF01B	BCY71	18p (G)
QF03D	BD131	49p (F)
QF04E	BD131/2MP	£1.19 (D)
QF05F	BD132	50p (E)
QF06G	BD135	36p (F)
QF75S	BD136	33p (F)
QF07H	BD139	40p (F)
QF08J	BD140	40p (F)
WH15R	BD711	68p (E)
WH16S	BD712	68p (E)
QF09K	BF115	38p (F)
QF10L	BF167	38p (F)
QF11M	BF180	48p (F)
QF15R	BF200	32p (F)
QF16S	BF244	32p (F)
QF17T	BF258	33p (F)
QF18U	BF259	39p (F)
QF19V	BF337	40p (F)
QQ19V	BF494	25p (F)
QQ20W	BF495	25p (F)
QF20W	BFW10	£1.43 (D)
QF21X	BFX29	33p (F)
QF22Y	BFX30	35p (F)
QF23A	BFX84	34p (F)
QF24B	BFX85	31p (F)
QF25C	BFX87	32p (F)
QF26D	BFX88	36p (F)
QF27E	BFY50	30p (F)
QF28F	BFY51	29p (F)
QF29G	BFY52	31p (F)
QF31J	BRY39	48p (F)
QF32K	BSX20	26p (F)
QF33L	BSX21	29p (F)
QF35Q	BT109	£1.94 (D)
QF37S	BU205	£1.95 (D)
QF39N	BU208	£2.99 (C)
QF41U	BY126	21p (G)
QF42V	BY127	16p (G)
QF43W	BY164	76p (E)
QF44X	BY206	25p (F)
QF45Y	BZX61C4V7	16p (G)
QF46A	BZX61C5V1	16p (G)
QF47B	BZX61C5V6	16p (G)
QF48C	BZX61C6V2	16p (G)
QF49D	BZX61C6V8	16p (G)
QF50E	BZX61C7V5	16p (G)
QF51F	BZX61C8V2	16p (G)
QF52G	BZX61C9V1	16p (G)
QF53H	BZX61C10	16p (G)
QF54J	BZX61C11	16p (G)
QF55K	BZX61C12	16p (G)
QF56L	BZX61C13	16p (G)
QF57M	BZX61C15	16p (G)
QF58N	BZX61C16	16p (G)
QF59P	BZX61C18	16p (G)
QF60Q	BZX61C20	16p (G)
QF61R	BZX61C22	16p (G)
QF62S	BZX61C24	16p (G)
QF63T	BZX61C27	16p (G)
QF64U	BZX61C30	16p (G)
QF65V	BZX61C33	16p (G)
QF66W	BZX61C36	16p (G)
QF67X	BZX61C39	16p (G)
QF68Y	BZX61C43	16p (G)
QF69A	BZX61C47	16p (G)
QF70M	BZX61C51	16p (G)
QF71N	BZX61C56	16p (G)
QF72P	BZX61C62	16p (G)
QF73Q	BZX61C68	16p (G)
QF74R	BZX61C75	16p (G)
QH00A	BZY88C2V7	9p (H)
QH01B	BZY88C3V0	9p (H)
QH02C	BZY88C3V3	9p (H)
QH03D	BZY88C3V6	9p (H)
QH04E	BZY88C3V9	9p (H)
QH05F	BZY88C4V3	9p (H)
QH06G	BZY88C4V7	9p (H)
QH07H	BZY88C5V1	9p (H)
QH08J	BZY88C5V6	9p (H)
QH09K	BZY88C6V2	9p (H)
QH10L	BZY88C6V8	9p (H)
QH11M	BZY88C7V5	9p (H)
QH12N	BZY88C8V2	9p (H)
QH13P	BZY88C9V1	9p (H)
QH14Q	BZY88C10	9p (H)
QH15R	BZY88C11	9p (H)
QH16S	BZY88C12	9p (H)
QH17T	BZY88C13	9p (H)
QH18U	BZY88C15	9p (H)
QH19V	BZY88C16	9p (H)
QH20W	BZY88C18	9p (H)
QH21X	BZY88C20	9p (H)
QH22Y	BZY88C22	9p (H)
QH23A	BZY88C24	9p (H)
QH24B	BZY88C27	9p (H)
QH25C	BZY88C30	9p (H)
QH26D	CA3046	72p (E)
YH58N	CA3080E	87p (E)
QH27E	CA3089E	£2.70 (C)
QH28F	CA3130T	£1.26 (D)
QH29G	CA3140T	99p (E)
WQ20W	CA3189E	£1.95 (D)
WQ21X	CA3240E	£1.10 (D)
YG37S	CL8960	£31.26 (A)
QH30H	C106D	42p (F)
WQ22Y	C116D	62p (E)
WQ23A	C126D	£1.63 (D)
WQ24B	C206D	£1.40 (E)
WQ25C	C226D	64p (E)
QL14Q	C246D	£1.29 (D)
QQ01B	DAC0801LCN	£2.45 (C)
QQ21X	DV1202W	£8.35 (B)
QQ22Y	DV1205W	TEMP
QQ23A	DV1210W	£13.63 (A)
QQ24B	DV1220W	£16.88 (A)
QQ25C	DV1230W	£21.30 (A)
QQ26D	DV1240W	TEMP
WQ28F	HSCH1001	55p (E)
YH59P	ICL7109	£19.98 (A)
YY75S	ICL7660CPA	£3.24 (C)
YY93B	ICM7045IPI	£14.20 (A)
YY94C	ICM7216DIPI	£19.95 (A)
+YY95D	ICM7226BIPI	£21.90 (A)
YH63T	ICM 7555	£1.32 (D)
QH33L	1R122D	£2.79 (C)
BH45Y	J005	£1.75 (D)
BL36P	J02	£1.80 (D)
BH46A	J04	£1.95 (D)
BH47B	K01	£3.15 (C)
BH48C	K04	£4.25 (C)
YY74R	L200	£2.24 (C)
WQ29G	LF347	£1.54 (C)
WQ30H	LF351	56p (E)
WQ31J	LF353	82p (E)
QY26D	LF400CN	NYA
QY27E	LF411CN	82p (E)
QY28F	LF412CN	£1.38 (D)
QY29G	LF441CN	72p (E)
QY30H	LF442CN	£1.42 (D)
QY31J	LF444CN	£1.98 (D)
YY69A	LF13741	55p (E)
QH35Q	LH0042C	£4.46 (C)
QH36P	LM301A	27p (F)
QH37S	LM308	72p (E)
QY09K	LM311N	68p (E)
WQ32K	LM334	£1.28 (D)

1983 Catalogue Page No.		VAT inclusive PRICE
YY73Q	LM335Z	£1.62 (D)
QH38R	LM377	£2.25 (C)
QH39N	LM379S	£5.52 (B)
QH40T	LM380	75p (E)
QH41U	LM381	£2.24 (D)
YY84F	LM382	£1.45 (D)
WQ33L	LM383	£1.61 (D)
WQ34M	LM384	£1.99 (D)
WQ35Q	LM387	£1.52 (D)
WQ36P	LM389	£1.49 (D)
QY19V	LM1035	£4.96 (C)
QY33L	LM1037N	£2.72 (C)
QY34M	LM1038N	£2.85 (C)
YY85G	LM1818	£1.95 (D)
YY99H	LM1830	£2.65 (C)
QY36P	LM1851N	£1.46 (D)
YY71N	LM1871	£5.60 (B)
YY72P	LM1872	£4.62 (B)
WQ38R	LM2917	£2.45 (C)
WQ37S	LM1820	£1.98 (D)
QH42V	LM3900	86p (E)
WQ39N	LM3909	98p (E)
WQ40T	LM3911	£1.58 (D)
WQ41U	LM3914	£3.98 (C)
YY96E	LM3915	£3.24 (C)
YY97F	LM3916	£3.48 (C)
YH64U	LM13700N	£1.39 (D)
YY81C	M083	£4.75 (C)
WH22Y	M087	TEMP
YY90X	M108	£18.25 (A)
YY91Y	M147	£6.51 (B)
HQ71N	M251	£12.20 (A)
WH21X	M254	£7.49 (B)
QH43W	MCR102	59p (E)

Page270

QH45Y	MC1310P	£1.86 (C)
QH47B	MC1496	89p (E)
QH48C	MC3302P	80p (E)
QH49D	MC3340P	£2.44 (D)
WQ42V	MCM4027 250ns	£2.40 (D)
WQ43W	MC6800P	£5.10 (B)
WQ44X	MC6802P	£4.72 (C)
WQ45Y	MC6810AP 450ns	£1.86 (D)
WQ46A	MC6821P	£1.99 (D)
QQ03D	MC6845	£7.95 (A)
WQ48C	MC6850P	£2.20 (C)
WQ49D	MC6852P	£2.95 (C)
WQ50E	MC6875L	£6.32 (B)
QY23A	MC10116P	96p (E)
QY35Q	MF10CN	£4.96 (C)
QH54J	MJE340	75p (E)
WQ51F	MJE350	96p (D)
QH55K	MJE2955=TIP2955	99p (D)
QH56L	MJE3055=TIP3055	88p (E)
QH57M	MJ2501	£2.98 (C)
BL38R	MJ2955	£1.10 (D)
QH58N	MJ3001	£2.40 (C)
YY92A	MK50395	£10.50 (A)
YH67X	ML922	£5.25 (B)
QR57M	ML926	£2.45 (C)
QR58N	ML927	£2.45 (C)
YH68Y	ML928	£2.40 (C)
YH69A	ML929	£2.40 (C)
QH59P	MPF102	52p (E)
QH60Q	MPSA14	36p (F)
QH61R	MPSA65	45p (F)
QH62S	MPS3638	19p (G)
QH63T	MPS3638A	18p (G)
WQ53H	MVAM115	£2.62 (C)
WQ54J	NE531	£2.12 (D)
WQ55K	NE 544	£2.18 (C)
QH66W	NE 555	21p (G)
QH67X	NE 556	62p (E)
WQ56L	NE 565	£1.64 (D)
QH68Y	NE 566	£1.58 (D)
QH69A	NE 567	£1.30 (D)
QY10L	NE570	£4.28 (C)
YY87U	NE571	£3.62 (C)
YY68Y	NE5534A	£2.26 (C)
YY67X	NE5539	£7.85 (B)
QH70M	OA47	15p (G)
QH71N	OA90	9p (H)
QH72P	OA91	8p (H)
QH73Q	OA95	8p (H)
QH74R	OA200	9p (H)
QH75S	OA202	13p (G)
QH82D	OC45	47p (F)
QH84F	OC71	25p (F)
QH85G	OC72	42p (F)
QH87U	OC81	42p (F)
QH89W	OC83	45p (F)
QH91Y	OC170	95p (E)
QH92A	OC171	99p (E)
QY37S	Satronics PC1R	£3.62 (C)
QY38R	Satronics PC12R	£6.94 (B)
QH93B	PN3643	30p (F)
WQ57M	PW01	95p (E)
WQ58N	PW06	£1.10 (E)
WQ59P	RO-3-2513	£8.95 (B)
QL00A	R2008B	£2.25 (C)
QL02C	SAM77	£1.20 (D)
QL05F	SC146D	£1.82 (D)
WQ60Q	SFF96364	£9.45 (B)
QL06G	SG1495D	£3.95 (C)
QL07H	SG3402	£4.56 (C)
WQ61R	SH120A	£6.65 (B)
YH66W	SL490	£3.35 (C)
QY18U	SP8680B	£9.82 (A)
QL08J	ST2	25p (F)
QL09K	S005	47p (F)
QL10L	S04	52p (E)
WQ62S	TAA 550	35p (F)
QL11M	TAG1/100	£1.45 (D)
QL12N	TAG1/600	£1.20 (D)
BL35Q	TBA 851	£2.25 (C)
QL13P	TBA810P	95p (E)
WQ63T	TBA820M	70p (E)
YY79L	TCA350Z	£3.95 (C)
WQ64U	TCA4500A	£3.35 (C)
WH20W	TDA1022	£6.75 (B)
YY76H	TDA1024	£1.49 (D)
QY32K	TDA 1102SP	£3.24 (C)
YY70M	TDA2005M	£8.25 (B)
WQ66W	TDA2006	£1.65 (D)
WQ67X	TDA2030	£1.95 (D)
YY86T	TDA3410	£1.90 (D)
QL15R	TIP31A	39p (F)
QL16S	TIP32A	39p (F)
WQ71N	TIP33A	68p (E)
WQ72P	TIP34A	99p (E)
QL17T	TIP41A	45p (F)
QL18U	TIP42A	45p (F)
WQ73Q	TIP122	99p (E)
WQ74R	TIP127	75p (E)
QL19V	TIS43	55p (E)
WQ75S	TL170C	55p (E)
WQ76H	TL172C	76p (E)
YY77J	TL430C	99p (E)
YY78K	TL497A	£1.65 (D)
YY88V	TMS1121	£9.32 (B)
QY14Q	UAA170L	£2.50 (C)
QL20W	uA709C	75p (E)
BL22Y	uA723C T099	85p (E)
QL21X	uA723C 14-pin DIL	55p (E)
QL22Y	uA741C 8-pin DIL	29p (G)

1983 Catalogue Page No.		VAT inclusive PRICE
QL23A	uA741C 14-pin DIL	78p (E)
QL24B	uA747C	75p (E)
QL25C	uA748C	59p (E)
QL26D	uA78L05AWC	32p (F)
WQ77J	uA78L12AWC	34p (F)
QL27E	uA78L15AWC	32p (F)
QL28F	uA78M05UC	79p (E)
QL29G	uA78M12UC	79p (E)
QL30H	uA78M15UC	79p (E)
WQ78K	uA78MGU1C	£1.25 (D)
QL31J	uA7805UC	78p (E)
QL32K	uA7812UC	78p (E)
QL33L	uA7815UC	59p (E)
WQ79L	uA78GU1C	£1.25 (D)
QL34M	uA7805KC	£1.65 (D)
QL35Q	uA7815KC	£1.65 (D)
WQ80B	uA78H05KC	£5.55 (B)
WQ81C	uA78H12KC	£6.49 (B)
WQ83E	uA78HGKC	£6.25 (B)
WQ84F	uA78P05SC	£8.25 (B)
WQ85G	uA79L05AWC	62p (E)
WQ86T	uA79L12AWC	68p (E)
WQ87U	uA79L15AWC	75p (E)
WQ88V	uA79M05UC	89p (E)
WQ89W	uA79M12UC	64p (E)
WQ90X	uA79M15UC	89p (E)
WQ91Y	uA79MGU1C	£1.20 (D)
WQ92A	uA7905UC	74p (D)
WQ93B	uA7912UC	95p (E)
QL36P	uA7915UC	55p (E)
WQ94C	uA79GU1C	£1.64 (D)
WQ95D	uA79HGKC	£8.59 (B)
QQ27E	VK10KM	83p (E)
QQ28F	VK1010	£1.48 (D)
QQ29G	VK1011	£1.35 (D)
WQ96E	VN46AF	£1.10 (D)
WQ97F	VN66AF	£1.55 (D)
WQ98G	VN88AF	£1.76 (D)
QQ11M	VQ1000CJ	£4.30 (C)
QL37S	W005	28p (F)
QL38R	W01	34p (F)
QL39N	W02	38p (F)
QL40T	W04	39p (F)
QL41U	ZN414	£1.25 (D)
QL42V	ZS120	44p (F)
QL43W	ZTX107	22p (G)
QL44X	ZTX108	15p (G)
QL45Y	ZTX109	24p (G)
QL46A	ZTX300	21p (G)
QL47B	ZTX301	20p (G)
QL48C	ZTX302	22p (G)
QL50E	ZTX304	24p (F)
QL54J	ZTX326	98p (E)
QL56L	ZTX330	29p (F)
QL57M	ZTX331	32p (F)
QL60Q	ZTX500	21p (G)
QL62S	ZTX502	19p (G)
QL64U	ZTX504	34p (F)
QL66W	ZTX530	42p (F)
QL67X	ZTX531	33p (F)
QL68Y	ZTX541	31p (F)
QL69A	ZTX542	33p (F)
QL70M	Z5J	£2.84 (C)
QW00A	Z80-CPU	£7.95 (B)
QW01B	Z80-CTC	£4.50 (C)
QW03D	Z80-PIO	£3.99 (C)
QL71N	1N914	4p (H)
QL72P	1N916	5p (H)
QL73Q	1N4001	5p (H)
QL74R	1N4002	4p (H)
QL75S	1N4003	6p (H)
QL76H	1N4004	6p (H)
QL77J	1N4005	6p (H)
QL78K	1N4006	6p (H)
QL79L	1N4007	7p (H)
QL80B	1N4148	4p (H)
QL81C	1N5400	15p (G)
QL82D	1N5401	12p (G)
QL83E	1N5402	16p (G)
QL84F	1N5404	19p (G)
QL85G	1N5406	20p (G)
QL86T	1N5407	21p (G)
QL87U	1N5408	19p (G)
QL88V	1S921	9p (H)
QH46A	1458C	45p (F)
QR00A	2N697	49p (F)
QR01B	2N706	26p (F)
QR03D	2N708	35p (F)
QR09K	2N1711	39p (F)
QR10L	2N1893	32p (F)
QR11M	2N2219	31p (F)
QR12N	2N2369A	22p (G)
QR13P	2N2484	38p (F)
QR14Q	2N2646	62p (E)
QR15R	2N2647	95p (E)
QR16S	2N2904	31p (F)
QR17T	2N2905	31p (F)
QR18U	2N2906	26p (F)
QR19V	2N2907	26p (F)
QR20W	2N2926Or	12p (G)
QR21X	2N2926Ye	12p (G)
QR22Y	2N2926Gn	12p (G)
QR23A	2N3053	32p (F)
QR24B	2N3054	79p (E)
BL45Y	2N3055	75p (E)
QR25C	2N3525	£1.85 (D)
QR26D	2N3702	11p (G)
QR27E	2N3703	11p (G)
QR28F	2N3704	8p (G)
QR29G	2N3705	12p (G)
QR30H	2N3706	14p (G)
QR31J	2N3707	12p (G)
QR32K	2N3708	11p (G)
QR34M	2N3711	11p (G)
QW07H	2N3772	£1.95 (D)
QR35Q	2N3773	£2.94 (C)
QR36P	2N3819	32p (F)
QR37S	2N3823	65p (E)
QR38R	2N3866	£1.10 (D)
QR39N	2N3903	17p (G)
QR40T	2N3904	17p (G)
QR41U	2N3905	15p (G)
QR42V	2N3906	14p (G)
QR43W	2N4058	14p (G)
QR44X	2N4060	12p (G)
QR45Y	2N4061	17p (G)
QR46A	2N4062	12p (G)
QR47B	2N4871	69p (E)
QR49D	2N5458	42p (F)
QR50E	2N5459	36p (F)
QR51F	2N6073	£1.20 (D)
QW08J	2N6609	£3.55 (C)
QR56L	2SA715	45p (F)
QQ30H	2SA872	39p (F)
QY12N	2SA1085E	34p (F)
QQ31J	2SB716	30p (F)
QR59P	2SC1162	45p (F)
QQ32K	2SC1307	£2.54 (C)
QY11M	2SC2547E	38p (F)
QQ33L	2SD756	30p (F)
QQ34M	2SJ48	£3.82 (C)
QQ35Q	2SJ49	£3.95 (C)
QW09K	2SJ50	£4.54 (C)
QQ36P	2SK133	£3.60 (C)
QQ37S	2SK134	£4.18 (C)
QW10L	2SK135	£4.30 (C)
QW11M	2102 450ns	£2.32 (D)

1983 Catalogue Page No.		VAT inclusive PRICE
QW12N	2114 450ns	£1.30 (D)
QW13P	2708 450ns	£3.85 (C)
QQ07H	2716 450ns	£3.65 (C)
QQ08J	2732 450ns	£5.19 (B)
QQ09K	2764 450ns	£9.64 (A)
QR52G	3N140	£1.62 (D)
QR53H	3N141	DIS
QH51F	3403	72p (E)
QX00A	4000BE	24p (F)
QX01B	4001BE	15p (G)
QL03D	4001UBE	17p (G)
QX02C	4002BE	15p (G)
QX03D	4006BE	52p (E)
QX04E	4007UBE	15p (G)
QW14Q	4008BE	42p (E)
QX05F	4011BE	15p (G)
QL04E	4011UBE	16p (F)
QX06G	4012BE	15p (G)
QX07H	4013BE	35p (F)
QW15R	4014BE	46p (E)
QW16S	4015BE	43p (E)
QX08J	4016BE	22p (F)
QX09K	4017BE	42p (F)
QX10L	4018BE	47p (F)
QW17T	4019BE	42p (F)
QX11M	4020BE	46p (E)
QW18U	4021BE	59p (F)
QW19V	4022BE	43p (E)
QX12N	4023BE	15p (G)
QX13P	4024BE	37p (F)
QX14Q	4025BE	15p (G)
QX15R	4026BE	80p (E)
QX16S	4027BE	21p (F)
QX17T	4028BE	40p (E)
QW20W	4029BE	54p (E)
QW21X	4031BE	98p (D)
QW22Y	4032BE	75p (E)
QW23A	4033BE	94p (E)
QW24B	4034BE	£2.45 (C)
QW25C	4035BE	48p (E)
QW26D	4038BE	85p (E)
QW27E	4040BE	44p (E)
QW28F	4041UBE	44p (E)
QX19V	4042BE	41p (F)
QW29G	4043BE	52p (E)
QW30H	4044BE	43p (E)
QW31J	4045BE	99p (D)
QW32K	4046BE	49p (E)
QX20W	4047BE	75p (E)
QW33L	4048BE	38p (E)
QX21X	4049UBE	25p (F)
QX22Y	4050BE	26p (F)
QW34M	4051BE	45p (E)
QW35Q	4052BE	60p (E)
QW36P	4053BE	50p (E)
QW37S	4054BE	95p (E)
QW38R	4055BE	85p (E)
QW39N	4056BE	76p (D)

Page271

QW40T	4060BE	60p (D)
QW41U	4063BE	85p (D)
QX23A	4066BE	25p (F)
QW42V	4067BE	£2.99 (C)
QX24B	4068BE	17p (G)
QX25C	4069UBE	18p (F)
QX26D	4070BE	16p (G)
QW43W	4071BE	16p (G)
QX27E	4072BE	16p (G)
QW44X	4073BE	16p (G)
QW45Y	4075BE	16p (G)
QW46A	4076BE	52p (E)
QW47B	4077BE	16p (G)
QX28F	4078BE	16p (G)
QW48C	4081BE	15p (F)
QW49D	4082BE	16p (G)
QW50E	4085BE	65p (E)
QW51F	4086BE	65p (E)
QW52G	4089BE	£1.40 (D)
QW53H	4093BE	22p (F)
QW54J	4094BE	£1.20 (D)
QW55K	4095BE	75p (E)
QW56L	4097BE	£3.20 (C)
QX29G	4098BE	79p (E)
QW57M	4099BE	79p (E)
QW58N	40100BE	£1.96 (D)
QW59P	40101BE	90p (E)
QW60Q	40102BE	£1.50 (D)
QW61R	40103BE	£1.20 (E)
QW62S	40104BE	85p (E)
QW63T	40105BE	£1.20 (E)
QW64U	40106BE	60p (E)
QW65V	40107BE	60p (E)
QW66W	40108BE	£4.30 (C)
QW67X	40109BE	62p (E)
QW68Y	40110BE	£1.10 (D)
QW69A	40160BE	£1.25 (D)
QW70M	40161BE	92p (E)
QW71N	40162BE	85p (E)
QW72P	40163BE	£1.60 (D)
QW73Q	40174BE	68p (E)
QQ38R	40175BE	DIS
QW74R	40181BE	£2.45 (D)
QW75S	40182BE	85p (E)
QW76H	40192BE	£1.25 (D)
QW77J	40193BE	67p (E)
QW78K	40194BE	85p (E)
QW79L	40257BE	£1.10 (D)
QX34M	40673	£1.62 (D)
QW93B	4116 250ns	£1.45 (D)
QQ05F	4118 250ns	£5.90 (C)
XX01B	4136	75p (E)
QW80B	4151	89p (E)
QQ06G	4164 250ns	£4.90 (B)
XX02C	4195	£1.62 (D)
QX30H	4416BE	£1.92 (D)
QW81C	4502BE	62p (D)
QQ41U	4503BE	42p (E)
QW82D	4508BE	£2.10 (C)
QW83E	4510BE	68p (E)
QX31J	4511BE	52p (E)
QW84F	4512BE	£1.49 (D)
QW85G	4514BE	£1.20 (D)
QW86T	4515BE	£1.20 (D)
QW87U	4516BE	49p (F)
QX32K	4518BE	43p (E)
QX33L	4520BE	52p (E)
QQ42V	4521BE	£3.36 (C)
QQ43W	4522BE	88p (E)
QQ44X	4526BE	95p (E)
QW88V	4527BE	£1.15 (D)
QQ45Y	4529BE	£1.42 (D)
QW89W	4532BE	55p (D)
QW90X	4555BE	50p (E)
QW91Y	4556BE	58p (E)
QQ49D	4568BE	£3.15 (C)
QQ51F	45100BE	£2.92 (C)
QX35Q	5W Zener 5V6	£1.27 (D)
QX36P	5W Zener 8V2	£1.27 (D)
YH31J	5101-L1	£3.48 (C)
QR55K	634SS2	£4.95 (C)
QQ04E	6402	£6.99 (B)
QQ02C	6502	£6.36 (B)
QW94C	7106	£8.15 (B)
QW95D	7107	£7.95 (B)

TRADE QUANTITIES
The letter in brackets after the price indicates the minimum trade quantity. For details please see page 27.

1983 Catalogue Page No. — VAT inclusive PRICE

QX37S 7400 17p (G)
YF00A 74LS00 20p (G)
QX38R 7401 17p (G)
YF01B 74LS01 17p (G)
QX39N 7402 22p (G)

YF02C 74LS02 21p (G)
QX74R 7403 20p (G)
YF03D 74LS03 21p (G)
QY24B 74S03 30p (E)
QX40T 7404 21p (G)

YF04E 74LS04 20p (G)
QX41U 7405 21p (G)
YF05F 74LS05 20p (G)
QX75S 7406 29p (F)
QX76H 7407 29p (F)

QX42V 7408 21p (G)
YF06G 74LS08 22p (G)
QX77J 7409 22p (G)
YF07H 74LS09 22p (G)
QX43W 7410 17p (G)

YF08J 74LS10 24p (G)
QX44X 7411 24p (F)
YF09K 74LS11 20p (G)
YF10L 74LS12 17p (G)
QX45Y 7413 38p (F)

YF11M 74LS13 31p (F)
QX46A 7414 42p (F)
YF12N 74LS14 44p (F)
YF13P 74LS15 21p (G)
QX78K 7416 31p (F)

QX79L 7417 30p (F)
QX47B 7420 23p (G)
YF14Q 74LS20 21p (G)
QX48C 7421 40p (F)
YF15R 74LS21 20p (G)

YF16S 74LS22 28p (G)
QX80B 7425 28p (F)
QX81C 7426 22p (G)
YF17T 74LS26 24p (G)
QX49D 7427 29p (F)

YF18U 74LS27 29p (F)
YF19V 74LS28 29p (F)
QX50E 7430 21p (G)
YF20W 74LS30 21p (G)
QX51F 7432 36p (F)

YF21X 74LS32 21p (G)
YF22Y 74LS33 32p (F)
YF23A 74LS37 21p (G)
QX82D 7438 32p (F)
YF24B 74LS38 22p (G)

QX53H 7440 24p (F)
YF25C 74LS40 40p (F)
QX54J 7442 58p (F)
YF26D 74LS42 33p (F)
QX55K 7447A 55p (E)

QQ52G 74LS47 65p (E)
QQ53H 74LS48 46p (E)
QX83E 7451 22p (G)
YF27E 74LS51 21p (G)
YF28F 74LS54 30p (F)

QX56L 7470 36p (F)
QX57M 7472 35p (F)
QX58N 7473 32p (F)
YF30H 74LS73 28p (F)
QX59P 7474 32p (F)

YY83E 74ALS74 90p (E)
YF31J 74LS74 26p (F)
QX60Q 7475 45p (F)
YF32K 74LS75 31p (F)
QX61R 7476 32p (F)

YF33L 74LS76 28p (F)
QX82S 7481 £1.75 (D)
QX85G 7483 50p (E)
QX63T 7485 77p (E)
YF35Q 74LS85 70p (E)

QX64U 7486 28p (F)
YF36P 74LS86 36p (F)
QX65V 7489 £3.10 (C)
QX66W 7490 32p (F)
YF38R 74LS90 36p (F)

QX86T 7491 £1.20 (D)
QX67X 7492 32p (F)
YF39N 74LS92 36p (F)
QX68Y 7493 35p (F)
YF40T 74LS93 36p (F)

QX69A 7494 39p (F)
QX70M 7495 48p (F)
YF41U 74LS95 £1.20 (E)
QX87U 7496 50p (E)
QX71N 74107 26p (F)

YF43W 74LS107 41p (F)
QX88V 74109 53p (E)
YF44X 74LS109 34p (F)
YF45Y 74LS112 32p (E)
YF46A 74LS113 40p (F)

QX72P 74118 £2.30 (C)
QX73Q 74121 33p (F)
WH00A 74122 48p (E)
QQ54J 74LS122 62p (E)
WH01B 74123 42p (F)

YF48C 74LS123 62p (E)
YF49D 74LS125 33p (F)
YF50E 74LS126 33p (F)
WH03D 74132 68p (E)
YF51F 74LS132 45p (F)

YF52G 74LS136 38p (F)
YF53H 74LS138 42p (F)
YF54J 74LS139 44p (F)
WH05E 74141 78p (E)
WH06G 74145 67p (E)

YF55K 74LS145 £1.65 (D)
QX89W 74150 80p (E)
WH07H 74151 65p (E)
YF56L 74LS151 43p (F)
YF57M 74LS153 56p (F)

WH08J 74154 78p (E)
YF58N 74LS154 98p (E)
YF59P 74LS155 37p (F)
YF60Q 74LS156 57p (E)
YF61R 74LS157 35p (F)

YF62S 74LS158 33p (E)
WH09K 74160 67p (E)
YF63T 74LS160 49p (F)
YF64U 74LS161 49p (F)
YF65V 74LS162 53p (E)

YF66W 74LS163 49p (F)
WH10L 74164 79p (E)
YF67X 74LS164 55p (E)
YF68Y 74LS165 £1.10 (D)
YF69A 74LS166 £1.25 (D)

YF70M 74LS168 £1.20 (D)
YF71N 74LS169 99p (E)
YF72P 74LS170 £1.20 (C)
YF73Q 74LS173 58p (E)
WH11M 74174 96p (E)

YF74R 74LS174 44p (E)
YF75S 74LS175 43p (E)
YF76H 74LS181 £2.95 (C)
YF78K 74LS190 58p (E)
YF79L 74LS191 68p (E)

WH12N 74192 70p (E)
YF80B 74LS192 56p (E)
QX90X 74193 £1.75 (E)
YF81C 74LS193 65p (E)
WH13P 74194 65p (E)

YF82D 74LS194 65p (E)
YF83E 74LS195 45p (F)

WH14Q 74196 48p (F)
YF84F 74LS196 59p (E)
YF85G 74LS197 82p (E)

YF86T 74LS221 63p (E)
YF87U 74LS240 79p (E)
YF88V 74LS241 99p (E)
YF89W 74LS242 £1.20 (E)
YF90X 74LS243 89p (E)

QQ56L 74LS244 87p (E)
YF91Y 74LS245 £2.23 (C)
YF92A 74LS251 56p (E)
YF93B 74LS253 98p (E)
YF95D 74LS257 52p (E)

YF96E 74LS258 55p (E)
YF97F 74LS259 68p (E)
YF98G 74LS261 £3.40 (C)
YF99H 74LS266 38p (F)
YH00A 74LS273 £1.32 (D)

YH01B 74LS279 44p (F)
YH02C 74LS283 69p (E)
YH03D 74LS290 £1.30 (D)
QY39N 74LS292 £11.20 (A)
YH04E 74LS293 96p (E)

QY40T 74LS297 £11.20 (A)
YH06G 74LS298 £1.75 (D)
YH07H 74LS299 £4.25 (C)
YH08J 74LS323 £6.75 (B)
YH09K 74LS363 £2.36 (C)

YH11M 74LS365 39p (F)
YH12N 74LS366 45p (F)
YH13P 74LS367 62p (E)
YH14Q 74LS368 43p (F)
YH15R 74LS373 78p (D)

YH16S 74LS374 99p (D)
YH18U 74LS377 £1.10 (D)
YH19V 74LS378 £1.40 (D)
YH20W 74LS379 £2.40 (C)
YH21X 74LS390 £1.11 (D)

YH22Y 74LS393 £1.40 (D)
YH23A 74LS395 £1.35 (D)
YH24B 74LS398 £1.99 (D)
YH25C 74LS399 £2.50 (C)
QQ59P 74LS600 NYA

QY41U 74LS601 £11.72 (A)
QY42V 74LS604 £4.56 (C)
QQ61R 74LS608 NYA
QQ62S 74LS610 NYA
WH02C 74LS629=74LS124 £1.94 (D)

YH29G 74LS670 £3.96 (C)
QQ63T 74LS684 £4.75 (C)
YH30H 74C917 £8.95 (B)
YQ08J 74C925 £5.95 (B)
YH32K 76477 £5.20 (B)

YH33L 76489 £5.64 (B)
YH34M 8T28 £1.99 (C)
YH35Q 8T95 £2.55 (C)
YH38R 8038 CCPD £4.80 (C)
YH39N 8069 DCQ £2.62 (C)

YH40T 8080A £4.95 (C)
YH41U 8085A £5.99 (B)
YH43W 8211 CPA £3.25 (C)
YH44X 8212 £1.95 (D)
YH45Y 8216 £1.95 (D)

YH46A 8224 £2.68 (C)
YH47B 8228 £4.94 (C)
YH48C 8250 £9.95 (B)
YH49D 8251 £3.98 (C)
YH50E 8255A £3.64 (C)

YH51F 8279 £6.46 (B)
YH52G 82S126M1 £2.51 (C)

Page295
QH36P LM301A 27p (F)
QH37S LM308 72p (E)
WQ54J NE531 £2.12 (D)
YY68Y NE5534A £2.26 (C)
YY67X NE5539 £7.85 (B)
QL20W uA709C 75p (E)
QL22Y uA741C 8-pin DIL 29p (G)
QL24B uA747C 73p (E)
QL25C uA748C 59p (E)
QH46A 1458C 45p (F)
QH51F 3403 72p (E)
XX01B 4136 75p (E)

Page296
QH28F CA3130T £1.26 (D)
QH29G CA3140T 99p (E)
WQ21X CA3240E £1.10 (D)
QH35Q LH0042C £4.46 (C)
WQ30H LF351 56p (E)
WQ31J LF353 82p (E)
WQ29G LF347 £1.54 (C)
QY26D LF400CN NYA
QY27E LF411CN 82p (E)
QY28F LF412CN £1.38 (D)
QY29G LF441CN 72p (E)
QY30H LF442CN £1.42 (D)
QY31J LF444CN £1.98 (D)
YY69A LF13741 55p (E)

Page297
YH58N CA3080E 87p (E)
YH64U LM13700N £1.39 (D)
YQ09K LM311N 68p (E)
QH48C MC3302P 80p (E)

Page298
WQ36P LM389 £1.49 (D)
QH38R LM377 £2.25 (C)

Page299
QH40T LM380 75p (E)
WQ34M LM384 £1.99 (D)
QL13P TBA810P 95p (E)
BR02C 5W Amp PCB £1.62 (D)

Page300
WQ33L LM383 £1.61 (D)
BY73Q 8W Amp PCB 69p (E)
LW36P 8W Amp Kit £4.45 (C)
YY70M TDA2005M £8.25 (B)
WQ66W TDA2006 £1.65 (D)

Page301
WQ67X TDA2030 £1.95 (D)
YQ43W 15W Amp Kit £6.45 (B)
YQ35Q 15W Amp PCB £1.39 (D)
YQ36P 15W Amp Bracket 65p (E)
YQ38R 30/2 PSU PCB £1.40 (D)
YQ37S 15W Amp Module £6.49 (B)

Page302
QY32K TDA 1102SP £3.24 (C)
QH41U LM381 £2.24 (D)
BR04E LM381 PCB £1.99 (C)

Page303
YY84F LM382 £1.45 (D)
QY10L NE570 £4.28 (C)
YY87U NE571 £3.62 (C)
YY86T TDA3410 £1.90 (D)
WQ35Q LM387 £1.52 (D)

Page304
QY19V LM1035 £4.96 (C)
QY33L LM1037N £2.72 (C)
QY34M LM1038N £2.85 (C)

Page305
QH49D MC3340P £2.44 (D)
YY85G LM1818 £1.95 (D)
QY35Q MF10CN £4.96 (C)
YY81C M083 £4.75 (C)
WH22Y M087 TEMP

Page306
QB21X AY-1-0212 DIS
HQ53H Piano IC Kit £38.44 (A)
HQ52G AY-1-1320 £4.99 (C)
HQ51F AY-1-5050 £1.99 (D)
HQ71N M251 £12.20 (A)
WH21X M254 £7.49 (B)
YY90X M108 £18.25 (A)

Page307
YY91Y M147 £6.51 (B)
YY89W AY-3-1350 £5.95 (B)
WH20W TDA1022 £6.75 (B)
YH33L 76489 £5.64 (B)

Page308
YY79L TCA350Z £3.95 (C)
YH32K 76477 £5.20 (B)
YQ42V Sound Effects PCB £1.10 (O)

Page310
WQ61R SH120A £6.65 (B)
QH27E CA3089E £2.70 (C)
WQ20W CA3189E £1.95 (D)

Page311
WQ37S LM1820 £1.98 (D)
BL35Q TBA 651 £2.25 (C)
WQ64U TCA4500A £3.35 (C)
QH45Y MC1310P £1.86 (C)
BR03D Decoder PCB £1.96 (D)

Page312
QL41U ZN414 £1.25 (D)
QY23A MC10116P 96p (E)

Page313
QH47B MC1496 89p (E)
QL06G SG1495D £3.95 (C)
QL07H SG3402 £4.56 (C)
QH26D CA3046 72p (E)
QQ11M VQ1000CJ £4.30 (C)
YH66W SL490 £3.35 (C)

Page314
YH67X ML922 £5.25 (B)
QR57M ML926 £2.45 (C)
QR58N ML927 £2.45 (C)

Page315
YH68Y ML928 £2.40 (C)
YH69A ML929 £2.40 (C)
YG37S CL8960 £31.26 (A)
YY71N LM1871 £5.60 (B)
YQ69A LM1871 Xmitter PCB £1.20 (E)
BX11M HV Disc 680 9p (H)

Page316
YY72P LM1872 £4.62 (B)
YQ70M LM1872 Receiver PCB 95p (E)
WQ55K NE 544 £2.18 (C)
YQ71N Servo Driver PCB 85p (E)
WQ76H TL172C 76p (E)

Page317
WQ75S TL170C 55p (E)
QR55K 634SS2 £4.95 (C)
YY99H LM1830 £2.65 (C)
YY73Q LM3352 £1.62 (D)
WQ40T LM3911 £1.58 (D)

Page318
YY98G AY-3-1270 £9.30 (B)
WQ41U LM3914 £3.98 (C)
YY96E LM3915 £3.24 (C)
YY97F LM3916 £3.46 (C)
YQ66W LM3914 PCB 85p (E)

Page319
QY14Q UAA170L £2.50 (C)
YH30H 74C917 £8.95 (B)
FY90X Crystal 6.5536MHz £2.98 (C)
YY93B ICM7045IPI £14.20 (A)

Page320
YY88V TMS1121 £9.32 (B)
QY08J 74C925 £5.95 (B)
YY92A MK50395 £10.50 (A)

Page321
YY94C ICM7216DIPI £19.95 (A)
QY18U SP8680B £9.82 (A)
+YY95D ICM7226BIPI £21.90 (A)
QH67X NE 556 62p (E)
QH66W NE 555 21p (G)

Page322
YH63T ICM 7555 £1.32 (D)
QH68Y NE 566 £1.58 (D)
WQ56L NE 565 £1.64 (D)

Page323
QH69A NE 567 £1.30 (D)
WQ39N LM3909 98p (E)
YY76H TDA1024 £1.49 (D)
QY36P LM1851N £1.46 (D)
YH43W 8211 CPA £3.25 (C)
YH39N 8069 DCQ £2.62 (C)

Page324
WQ32K LM334 £1.28 (D)
YY78K TL497A £1.65 (D)
YY77J TL430C 99p (E)
WQ62S TAA 550 35p (F)
YY75S ICL7660CPA £3.24 (C)
XX02C 4195 £1.62 (D)

Page325
XX04E 15V Supply PCB 75p (E)
YY74R L200 £2.24 (C)
BL22Y uA723C TO99 85p (E)
QL21X uA723C 14-pin DIL 55p (E)

Page326
YQ39N 0.1A Reg PSU PCB £1.24 (D)
YQ40T 0.5/1A Reg +V PS PCB 85p (E)
YQ41U 0.5/1A Reg -V PS PCB 85p (E)
YQ54J 0.5/1A Vareg Pos PCB 92p (E)
YQ55K 0.5/1A Vareg Neg PCB 85p (E)

Page327
QY37S Satronics PC1R £3.62 (C)
QY38R Satronics PC12R £6.94 (B)

Page328
QQ02C 6502 £6.36 (B)
WQ43W MC6800P £5.10 (B)
WQ44X MC6802P £4.72 (C)
WQ46A MC6821P £1.99 (D)
WQ48C MC6850P £2.20 (C)
WQ49D MC6852P £2.95 (C)
WQ50E MC6875L £6.32 (B)
QW00A Z80-CPU £7.95 (B)
QW03D Z80-PIO £3.99 (C)
QW01B Z80-CTC £4.50 (C)
YH40T 8080A £4.95 (C)
YH41U 8085A £5.99 (B)

Page329
YH46A 8224 £2.68 (C)
YH47B 8228 £4.94 (C)
YH50E 8255A £3.64 (C)
YH49D 8251 £3.98 (C)
YH48C 8250 £9.95 (B)
YH51F 8279 £6.46 (B)
YH44X 8212 £1.95 (D)
YH45Y 8216 £1.95 (D)
YH34M 8T28 £1.99 (C)
YH35Q 8T95 £2.55 (C)
WQ19V AY-5-2376 £13.99 (B)
WQ18U AY-3-1015D £5.98 (B)
QQ04E 6402 £6.99 (B)

Page330
WQ60Q SFF96364 £9.45 (B)
QQ03D MC6845 £7.95 (A)
YH31J 5101-L1 £3.48 (C)
QW11M 2102 450ns £2.32 (D)
WQ45Y MC6810AP 450ns £1.86 (D)
QW12N 2114 450ns £1.30 (D)
QQ05F 4118 250ns £5.90 (C)
WQ42V MCM4027 250ns £2.40 (D)
QW93B 4116 250ns £1.45 (D)

Page331
QQ06G 4164 250ns £4.90 (B)
QW13P 2708 450ns £3.85 (C)
QQ07H 2716 450ns £3.65 (C)
•QQ08J 2732 450ns £5.19 (B)
QQ09K 2764 450ns £9.64 (A)

Page332
XY84F Softy 2 System £169.00 (A)
XY83E EPROM Eraser £42.95 (A)
YH52G 82S126M1 £2.51 (C)
WQ59P RO-3-2513 £8.95 (B)
YH38R 8038 CCPD £4.80 (C)

Page333
YQ65V 8038 PCB 92p (E)
QW80B 4151 89p (E)
QQ01B DAC0801LCN £2.45 (C)

Page334
QQ00A ADC0804LCN £4.45 (C)
YH59P ICL7109 £19.98 (A)
WQ38R LM2917 £2.45 (C)
YQ67X LM2917 PCB 85p (E)
QW94C 7106 £8.15 (B)
QW95D 7107 £7.95 (B)

Page335
BY76H 7106/7 PCB £1.62 (D)
WR29G Transkt 3-Lead TO18 16p (G)
WR30H Transkt 4-Lead TO18 35p (F)
WR31J Transkt 3-Lead TO5 19p (G)
WR32K IC Skt 8-Lead 72p (E)

WR33L IC Skt 10-Lead 69p (E)
QY44X Insulator TD3 18p (G)
QY45Y Insulator P 14p (G)
WR24B Kit TO3 11p (H)
WR25C Kit TO66 9p (H)

WR27E Kit SO55 9p (H)
WR26D Kit TO126 5p (H)
WR23A Kit (P) Plas 6p (H)
XX14Q Soldercons 98p

Page336
BL17T DIL Socket 8-pin 9p (H)
BL18U DIL Socket 14-Pin 11p (G)
BL19V DIL Socket 16-pin 12p (G)
HQ76H DIL Socket 18-pin 16p (G)
HQ77J DIL Socket 20-pin 17p (G)

HQ78K DIL Socket 22-pin 20p (G)
BL20W DIL Socket 24-pin 19p (G)
BL21X DIL Socket 28-pin 24p (F)
HQ38R DIL Socket 40-pin 35p (F)
FR25C Insertion Tool 80p (E)

YG27E Header 14-pin 54p (E)
YG28F Header 16-pin 75p (E)
YG29G Header 24-pin £1.10 (D)
YX50E ZIF Socket 24-Way £4.42 (C)
FL56L Transistor Cover 10p (G)

HQ79L Heatsink 92F 19p (G)
HQ80B Heatsink 18F 24p (F)
FL78K Heatsink Clip-On 16p (G)
WR34M TO5 Chassis Heatsink 89p (E)

Page337
FL59P Vaned Heatsink TO3 46p (F)
FL58N Vaned Htsnk Plas Pwr 34p (F)
FL57M Vaned Heatsink IC 72p (E)
HQ70M Heatsink 2E £2.96 (C)
FL41U Heatsink 4Y £2.20 (D)

HQ69A 50W Hi-Fi Heatsink £1.95 (D)
HQ81C 8W Hi-Fi Heatsink £1.17 (D)
FL42V Flat Heatsink £3.71 (C)
FL54J Heatsink 10DN £2.30 (C)
FL55K Heatsink 10DNDR £2.60 (C)

FL77J Heatsink 6W-1 £6.62 (B)

Page338
YB26D Heatsink 60DN £13.95 (A)
FL79L Thermpath £3.60 (C)
HQ00A Silicone Grease Tube 84p (E)
WY08J Standard Fan £15.50 (A)

SPEAKERS

Page339
HY12N Ultrasonic Transducr £6.20 (B)
QY13P Piezo Transducer27mm 30p (F)
QY16S Rubber Disc 27mm 5p (H)
FL39N Buzzer 6V 88p (E)
FL40T Buzzer 12V 88p (E)

FL38R AC Bell £2.24 (D)
FL37S Bell Xformer £5.60 (C)
FQ08J Bell Push DIS
FQ09K Nameplate Bell Push 55p (E)

Page340
YB25C Baby Siren £9.95 (B)
LH96E Plastic Siren £5.95 (B)
LH98G Hawaii Five-O Siren £24.95 (A)
XG14Q Electronic Siren £19.95 (A)
XQ71N Re-entrant Horn Sndr £26.50 (A)

YW52G 2in Piezo Tweeter £2.49 (C)

Page341
WF54J Direct Radiant Piezo £3.95 (C)
WF09K Piezo Horn Flush £6.72 (B)
WF55K Piezo Horn Recessed £6.56 (B)
WF56L Wide Angle Piezo £8.64 (B)
LB23A Mag Earpiece 2.5mm 25p (F)

LB24B Mag Earpiece 3.5mm 25p (F)
LB25C Crystal Earpiece 57p (E)
YW57M Stethoscope 75p (E)
•WF20W Mag Headset £4.95 (C)
LH81C Education Headphone £5.75 (B)

LH82D Boom Mic Headphone £13.90 (A)
LH83E Stereophone OH150P £4.25 (C)

Page342
WF13P Stereophone HP110C £5.40 (B)
WF14Q Stereophone DH207 £7.99 (B)
LH84F Stereophone M110B £8.60 (B)
LH85G Stophone SH590/HS310 £13.40 (A)
YK56L Persnl Stereo Phones £4.95 (C)

LB13P Headphone Adaptor £3.95 (C)
WB04E L/S Lo-Z 388 85p (E)
WB05F L/S Lo-Z 458 89p (E)
WB08J L/S Lo-Z 508 89p (E)
WB09K L/S Lo-Z 568 89p (E)

WB13P L/S Lo-Z 668 89p (E)
WF57M Hi-Z L/S 64R 99p (E)
YW53H L/S Lo-Z 768 99p (E)
WF58N 3 inch Tweeter £1.64 (D)
YW54J 15W Cone Tweeter £2.85 (C)

Page343
WF24B Multi-Cell Tweeter £5.95 (B)
WF33L Free Stand Tweeter £5.95 (B)
WF43W Dome Tweeter £5.45 (B)
WF44X Rectangular Tweeter £5.45 (B)
WF02C Crossover 2-Way £4.20 (C)

WF03D Crossover 3-Way £5.20 (B)
WF46A Controlled Crossover £10.69 (A)
WF47B Low-Cost 4in Spkr £2.94 (C)
BK30H Spkr Fixing Clamp 25p (F)
YW55K Plastic Car Grille £1.10 (E)

Page344
WF48C Hvy Duty Car Spkr £6.92 (B)
WF50E Elliptcal Spkr CM641 £3.47 (C)
WF18U Elliptcal Spkr CM742 £4.45 (C)
WF23A Elliptcal Spkr CM852 £5.20 (B)
WY13P Elliptcal Spkr LT853 £6.45 (B)

WF00A Rd Speaker LT530 £8.84 (B)
WF52G Rd Speaker LT610 £5.75 (B)
WF08J Rd Speaker CM820 £5.95 (B)
WF11M Rd Speaker LT830 £7.30 (B)
WF12N Rd Speaker LT840 £11.45 (A)

WF53H 20W Squawker £3.82 (C)
WY15R 40W Squawker £5.45 (B)
XG02C Loudspeaker 12in 35W £19.75 (A)
XQ77J Fane 50 4R £19.95 (A)
XB26D Fane 50 8R £21.45 (A)

Page345
XQ78K Disco 80 4R £29.45 (A)
XB27E Disco 80 8R £29.45 (A)
XQ79L Forte 1250TC 8R £21.75 (A)
XQ80B Forte 1250TC 16R £21.75 (A)
XQ81C Forte C1285TC 8R £29.64 (A)

XQ82D Forte C1285TC 16R £28.45 (A)
XQ83E C15 Bass 8R £59.60 (A)
+XQ84F C15 Bass 16R £57.80 (A)
XB28F Power L/S Cabinet £49.00 (A)

Page346
AF33L Mini Speaker System £59.95 (A)
AF34M 5W Spkr in Cab DIS
AF7Q 15W Spkr Pair £33.50 (A)
+AF31J 20W Spkr Pair £63.00 (A)
AF32K PA Spkr in Cab £25.60 (A)

XY79L Ceiling Speaker £11.75 (A)
YL15R Bracket Minor 5 £6.50 (B)
YL16S Bracket Bek 100 £16.98 (A)
YK54J Wallclamps Duo 220 £15.95 (A)

SWITCHES RELAYS

Page347
FH97F SPST Ultra Min Tggle 66p (E)
FH98G SPDT Ultra Min Tggle 69p (E)
FH99H DPDT Ultra Min Tggle 75p (E)
FH00A Sub-Min Toggle A 70p (E)
FF70M Sub-Min Toggle J 89p (E)

FH01B Sub-Min Toggle B 89p (E)
FH03D Sub-Min Toggle D £1.06 (D)
FH04E Sub-Min Toggle E 99p (E)
FF71N Sub-Min Toggle K £2.35 (C)
FH05F Sub-Min Toggle F £1.29 (D)

FH07H Sub-Min Toggle H £1.25 (D)
FF72P Sub-Min Toggle L £2.15 (C)
FH08J 4-Pole SM Toggle £2.35 (C)
FH39N Toggle Sw 62p (E)
YL01B Toggle Switch Cover 47p (F)

FH10L Std Toggle SPST 50p (E)
FH11M Std Toggle SPDT 57p (E)
FH12N Std Toggle DPDT 77p (E)
BK32K 10A SPST Toggle 95p (E)
BK33L 10A SPDT Toggle £1.15 (D)

FH17T H/D Toggle Type 4 £2.98 (C)
FH18U H/D Toggle Type 7 £1.95 (D)
FH19V H/D Toggle Type 8 £4.40 (C)
FH20W H/D Toggle Type 9 £3.20 (C)

TRADE QUANTITIES
The letter in brackets after the price indicates the minimum trade quantity. For details please see page 27.

1983 Catalogue Page No. — VAT inclusive PRICE

1983 Catalogue Page No. — VAT inclusive PRICE
1983 Catalogue Page No. — VAT inclusive PRICE
1983 Catalogue Page No. — VAT inclusive PRICE
1983 Catalogue Page No. — VAT inclusive PRICE

Page348

- FH13P Duck Bill Toggle 55p (E)
- YX56L Chrome Bar Toggle TEMP
- YX64U Min Rocker SPST 69p (E)
- YX65V Min Rocker DPDT £1.15 (D)
- FH30H SPST Rocker 39p (F)
- FH31J SPDT Rocker 49p (F)
- YR68Y Rocker Neon 79p (E)
- YR69A Rocker Sw DP 69p (E)
- FH34M DPDT Rocker 98p (E)
- YR70M Dual Rocker Neon 98p (D)
- BH58N Co–ax Switch SD239 DIS
- BH59P Co–ax Switch PL259 DIS
- XX26D DIL Switch SPST Dual 99p (D)
- XX27E DIL Switch SPST Octl £1.65 (D)
- XX28F DIL Switch SPDT Sgl 89p (E)
- XX29G DIL Switch SPDT Quad £2.95 (C)
- FF73Q Rotary SW12B 74p (E)
- FF74R Rotary SW6B 70p (E)
- FF75S Rotary SW4B 79p (E)
- FF76H Rotary SW3B 70p (E)
- FH42V Rotary SW12 85p (E)
- FH43W Rotary SW6 85p (E)
- FH44X Rotary SW4 85p (E)
- FH45Y Rotary SW3 89p (E)
- XX45Y Switchpot 1p 12w 98p (E)

Page349

- FF83E Thumbwheel Decimal £3.32 (C)
- FF84F Thumbwheel BCD £3.78 (C)
- BK49D End Cheeks 78p (F)
- BK50E Dial Stops 35p (F)
- YR77J Push Wheel BCD DIS
- +YR79L Push Whl End Cheeks 99p (E)
- FH40T Key Switch £3.60 (C)
- FH57M Rotary Mains 75p (E)
- FH95D Roller Microswitch £1.15 (D)
- FH46A Maka Shaft £1.10 (D)

Page350

- FH47B Maka Wafer 1p 12w £1.06 (D)
- FH48C Maka Wafer 2p 6w £1.06 (D)
- FF81C Maka Wafer 2p 9w £1.25 (D)
- FH50E Maka Wafer 4p 3w £1.10 (D)
- FH51F Maka Wafer 6p 2w £1.17 (D)
- FH52G Maka Wafer 1p 12w MB 75p (E)
- FH53H Maka Wafer 2p 6w MB £1.05 (D)
- FF82D Maka Wafer 2p 9w MB 29p (F)
- FH55K Maka Screen 5p (H)
- FF87U Click Switch 30p (F)
- FF88V Click Cap Black 21p (G)
- FF89W Click Cap Blue 21p (G)
- +FF90X Click Cap Green 21p (G)
- FF91Y Click Cap Grey 21p (G)
- +FF92A Click Cap Ivory 21p (G)
- FF93B Click Cap Red 21p (G)
- FF94C Click Cap White 21p (G)
- +FF95D Click Cap Yellow 21p (G)
- HY34M Click Key Black 24p (F)
- FF61R Keyboard Switch 23p (G)
- FF62S Keytop 1 Position 18p (G)
- FF63T Keytop 2 Position 29p (F)
- FF64U Keytop 3 Position 39p (E)
- FF65V ASCII Transparency £1.35 (D)
- YR71N Switch Contact Sheet £1.49 (D)

Page351

- FF77J SP Slide 12p (G)
- FH35Q Sub–Min Slide 15p (G)
- FF79L Long Chrome Slide 22p (G)
- FH36P Std Slide Switch 15p (G)
- FH38R 4–Pole Slide 69p (E)
- FH59P Push Switch 17p (G)
- YR67X HQ Push Switch 39p (F)
- FH60Q Break Push 23p (G)
- FH91Y Motor–Start Press 43p (F)
- RK82D Lge Red Push Button 69p (E)
- FF96E Square Push Black 77p (E)
- FF97F Square Push Green 77p (E)
- FF98G Square Push Red 77p (E)
- FF99H Square Push Yellow 77p (E)
- YW41U Square Psh Lck Black 82p (E)
- YW43W Square Psh Lck Red 82p (E)
- YW44X Square Psh Lck Yllow 82p (E)

Page352

- FH41U Pushlock SPCD £1.20 (D)
- FH66W Pushlock DPCD £1.45 (D)
- FH94C Pressil Switch 28p (F)
- FH92A Press Toe Sw Type 1 £1.20 (D)
- BK31J Press Toe SPST 2 £1.39 (D)
- FH93B Press Toe Sw Type 2 £1.95 (D)
- LB64U Foot Switch £4.25 (C)
- FH37S Mains Push £1.10 (D)
- LB91Y Flasher Unit 2–Way £7.89 (B)
- LQ00A Beginners Morse Key £1.98 (D)
- LQ01B Professl Morse Key £5.86 (B)
- HY00A Touch Pads Rect DIS
- HY01B Touch Pads Tri 27p (F)
- YR88V Solenoid 12V £5.96 (C)
- YR89W Solenoid 240V AC £5.98 (C)

Page353

- FH67X Latchswitch 2–pole 46p (F)
- FH68Y Latchswitch 4–pole 59p (E)
- FH69A Latchswitch 6–pole 99p (E)
- FH70M Latchswitch 8–pole £1.45 (D)
- FH71N Latchswitch 10–pole £1.71 (D)
- BW11M Latchsoft 2–pole 60p (E)
- BW12N Latchsoft 4–pole £1.20 (D)
- FH72P Latchdummy 32p (F)
- FH74R Mains Latchswitch £1.59 (D)
- FH75S Latchbracket Single 16p (G)
- FH76H Latchbracket 2–way 38p (F)
- FH78K Latchbracket 4–way 45p (F)
- FH80B Latchbracket 6–way 64p (E)
- FH82D Latchbracket 8–way 64p (E)
- FH84F Latchbracket 10–way 69p (E)

Page354

- FL31J Rd Latchbutton Black 14p (G)
- FL32K Rd Latchbutton Green 14p (G)
- +FL33L Rd Latchbutton Grey 14p (G)
- FL34M Rd Latchbutton Red 14p (G)
- FL36P Rd Latchbutton Chrm 22p (G)
- BW13P Sm Latchbutton Black 11p (G)
- BW14Q Sm Latchbutton Chrm 33p (F)
- FH61R Rct Latchbutton Blk 14p (G)
- FH62S Rct Latchbutton Grey 14p (G)
- FH63T Rct Latchbutton Red 14p (G)
- FH64U Rct Latchbutton Whte 14p (G)
- FH87U Magiclight Bttn Blu DIS
- FH89W Magiclight Bttn Orng 49p (F)
- FH90X Magiclight Bttn Yllw 49p (F)
- BW15R Latchbush Blue 39p (F)
- +BW16S Latchbush Green 45p (F)
- BW17T Latchbush Orange 45p (F)
- BW18U Latchbush Yellow 39p (F)

Page355

- BK47B Micro–Min Relay 94p (E)
- YX94C Ult–Mn Rlay 12V SPDT 98p (E)
- YX95D Ult–Mn Rlay 12V DPDT £1.49 (D)
- BK48C Ult–Mn Rlay 6V DPDT £1.10 (E)
- YX96E 3A Min Relay 99p (E)
- YX97F 10A Mains Relay £1.65 (D)

Page356

- YX98G 5A Mains Relay £1.95 (C)
- YX99H 12V 30A Relay £2.15 (C)
- FX23A Open Relay 6V £3.25 (C)
- FX24B Open Relay 12V £3.88 (C)
- FX26D 2p Sub–Min Relay 6V £3.45 (C)
- FX27E 2p Sub–Min Relay 12V £3.45 (C)
- FX30H 4p Sub–Min Relay 12V £3.99 (C)

Page357

- FX48C Power Relay 12V £3.95 (C)
- FX49D Power Relay 230V AC £4.25 (C)
- +HY20W Relay Flat 12V £1.98 (C)
- FX50E Reed Relay 6 to 9V £1.98 (D)
- FX51F Reed Relay 9 to 12V £2.15 (C)
- FX88V Dil Reed Relay 1p 5V £1.95 (D)
- FX89W Dil Reed Relay 1p12V £1.70 (C)
- FX90X Dil Reed Relay 2p 5V £3.99 (C)
- FX91Y Dil Reed Relay 2p12V £3.85 (C)
- FX93B Dil Rd Rly 1p C/012V £7.60 (B)

Page358

- FX68Y Reed SW Standard 89p (E)
- FX69A Reed SW Compact £2.36 (D)
- FX70M Reed SW Miniature 79p (E)
- FX71N Magnet Small 38p (F)
- FX72P Magnet Large 88p (E)

TEST GEAR

Page359

- HF19V Test Prod Black 45p (F)
- HF20W Test Prod Red 45p (F)
- HF21X Probe Clips 98p (E)
- YX57M Min Probe Black 42p (F)
- YX58N Min Probe Blue DIS
- YX59P Min Probe Green 42p (F)
- YX60Q Min Probe Red 42p (F)
- +YX61R Min Probe Yellow 42p (F)
- HF30H Pistol Probe Black £1.24 (E)
- HF31J Pistol Probe Red £1.24 (E)
- HF22Y Lo–Cost Test Probe 79p (E)
- HF32K Moulded Test Probe 79p (E)
- HF33L 4mm Test Probe 89p (E)
- YR93B Test Lead Kit £2.99 (C)
- FY73Q Logic Probe £9.50 (B)
- +FY88V Continuity Probe 75p (E)

Page360

- FL61R Signal Injector £3.99 (B)
- FY74R IC Test Clip £2.35 (C)
- YB21X Salebloc £7.50 (B)
- BW05F Scope Probe BNC £13.85 (A)
- YR95D Lo–Cost Scope Probe £3.75 (C)
- XB82D Crotech 3030 £167.90 (A)
- Carr in UK with XB82 £8.45

Page361

- XB83E Crotech 3131 £286.00 (A)
- Carr in UK with XB83 £9.45 (B)
- YX38R Low–Cost Counter £49.90 (A)
- LH05F Transistor Testr HFE £15.20 (A)
- YB82D LCR Bridge £25.95 (A)

Page362

- YB81C Seesure Sig Gen. £28.64 (A)
- YX40T Seesure CMOS Tester £34.95 (A)
- YW93B Low Cost Multimeter £5.42 (C)
- FL60Q Pocket Multimeter £8.74 (B)
- YB83E Small Multimeter £16.42 (A)

Page363

- YX35Q Multimeter 2050 £11.95 (A)
- YX37S Range Dblr Multimetr £19.95 (A)
- YW68Y Multimeter Type 320 £17.46 (A)
- LH93B Taut–Band Multimeter £27.95 (A)
- YB87U 100K Multitester £44.00 (A)

Page364

- YB84F Microtest 80 £25.00
- YB85G Supertester 680G £34.50
- YB86T Supertester 680R £42.50

Page365

- LH80B Clamp Meter £31.50 (A)
- YX36P Low Cost DMM £29.95 (A)
- YK32K Multimeter DD601 £42.50 (A)

Page366

- YX34M Auto Range Meter £56.20 (A)
- LH95D DMM 100 £88.61 (A)
- YX01B RF Frequency Meter £69.95 (A)
- YB04E Grid Dip Meter £49.80 (A)

Page367

- XY75S Ham Multimeter DIS
- WY18U SWR Meter 310 DIS
- WY19V SWR Meter 110 £14.75 (A)
- WY21X SWR Meter 178 £24.95 (A)

TOOLS

Page368

- LH15R Hobby Box £3.45 (C)
- FR22Y Storage Drawer 99p (E)
- BR48C Hex Trimmer 24p (F)
- BR51F Trim Tool 45p (F)
- BR49D Preset Trimmer 72p (E)
- BR50E Trim TT5 60p (E)
- BK34M Trim Tool Set £1.38 (D)
- FY07H Min Screwdriver Set 85p (E)
- BR58N Jewllers Scrwdvr Set £2.59 (C)
- BK44X 11 Pce S/Driver Set £6.45 (B)

Page369

- BR79L Intrchgbl Scdrvr Set £1.69 (D)
- +YW60Q Min Tool Set £2.10 (C)
- FY08J Utility Set £4.49 (C)
- YX74R Min Screwdriver 10p (G)
- BR52G Small Screwdriver 34p (F)
- BR53H Large Screwdriver 38p
- FY10L Driver S3 36p (F)
- FY12N Driver S5 64p (E)
- FY13P Driver S6 DIS
- BK35Q Driver S7 £1.25 (D)
- BK36P Driver S8 £2.72 (C)
- FY15R Pozidriver P1 £1.52 (D)
- FY17T Pozidriver P2 £1.60 (E)
- BK37S Pozidriver 3 £1.26 (D)
- BK38R Pozidriver 4 £2.72 (C)
- BR71N Mains Tester 60p (E)

Page370

- LH75S Spiraldriver £4.25 (C)
- YW92A Ratchet Socket Set £5.99 (B)
- WY04E Cushiongrip Drvr Set £5.84 (B)
- FY19V Low Cost Min Cutters £4.25 (C)
- BR75S Ins Min Cutters £7.25 (B)
- BK42V Slant Edge Cutters £6.98 (B)
- FY20W Box–JT End Cutter £6.95 (B)
- FY21X Low–Cost Cutters £2.25 (C)
- +FY76H Large Low Cost Cutts. £2.96 (C)
- BR74R Side Cutters £6.43 (B)
- FY22Y Box JT Side Cutters £7.60 (B)
- BR72P Side Cutters S55 £6.32 (C)
- YW67X Tweezers 26p (G)

Page371

- BK43W Pearl Catcher £2.24 (D)
- FY24B Low Cost Min Pliers £3.90 (C)
- BR78K Ins Min Snipe £5.96 (B)
- BK41U Hooked Pliers £7.98 (B)
- BR77J Bright Pliers £4.99 (C)
- FY25C Low–Cost Pliers £1.95 (D)
- FY26D Box Combined Pliers £4.28 (C)
- BR73Q Long Snipe Pliers £7.49 (B)
- BR90X Box Radio Pliers £6.98 (B)
- FY27E Low–Cost Long Pliers £4.98 (C)
- BR92A Combination Pliers £4.95 (B)
- +FY28F Low–Cost Elec Pliers £2.25 (C)
- FY29G Low–Cost HD Pliers £2.95 (C)

Page372

- BR91Y Electricians Pliers £4.90 (C)
- +FY30H Pincers £3.85 (C)
- FY31J Crimp Tool £2.32 (C)
- BR76H End Action Strippers £6.38 (B)
- BR93B Wire Strippers 3A £2.35 (C)
- BR94C Wire Strippers 8B £1.49 (D)
- BR95D Wire Strippers 9 £3.96 (C)
- BR96E Stripmaster £16.95 (A)
- XX11M Blade L4421 £6.62 (B)
- BR97F Blade L5361 £6.48 (B)
- FY32K Hand Wrap Tool £6.94 (B)
- YX52G Helping Hands £5.95 (B)
- YX53H Helping Hands + Mag £9.62 (B)
- FY34M Allen Keys AF £1.64 (D)
- FY35Q Allen Keys Metric £1.72 (D)

Page373

- +YR82D Min Spanner Set £2.10 (C)
- YW61R Box Spanner Set £2.15 (C)
- FY36P Min Spanner 24 £1.15 (D)
- FY37S Min Spanner 68 £1.15 (D)
- FY38R Ring Spanner 02 £1.99 (D)
- FY39N Ring Spanner 46 £1.79 (D)
- FY45Y Crescent Wrench 160 £3.96 (C)
- FY46A Crescent Wrench 210 £4.38 (C)
- FY40T Box Spanner 2BA £1.25 (D)
- FY41U Box Spanner 4BA £1.25 (D)
- FY42V Box Spanner 6BA £1.25 (D)
- FY43W Box Spanner 8BA £1.25 (D)
- FY47B Adjustable Wrench DIS
- YW63T Needle File Set £7.45 (B)
- FY49D Needle File Flat Wrd £1.75 (D)
- FY50E Needle File Hand £1.75 (D)
- FY51F Needle File Halfrnd £1.96 (D)
- FY52G Needle File Round £2.27 (C)
- BR63T Junior Hacksaw 99p (E)
- BR64U 6in Hacksaw Blades 99p (E)
- FY54J Wire Brush DIS
- FY55K Wet & Dry Fine 20p (G)
- FY56L Wet & Dry Med 20p (G)
- FY57M Wet & Dry Course 28p (F)

Page374

- *FY02C Utility Knife £1.60 (D)
- FY03D Retractable Knife £2.65 (D)
- FY04E Knife Blades 99p (E)
- YW64U Snap–Off Blade Knife 99p (E)
- FY05F Scalpel Handle £1.75 (D)
- FY06G Scalpel Bld Type II 58p
- BR59P Punch 3/8in £4.38 (C)
- BR60Q Punch 7/16in £4.49 (C)
- BR61R Punch 1/2in £4.64 (C)
- BR62S Punch 9/16in £4.86 (C)
- BR80B Punch 5/8in £4.92 (C)
- BR81C Punch 3/4in £4.99 (C)
- BR83E Punch 1in £6.24 (B)
- BW00A Punch 1 1/2in £6.49 (B)
- YK27E Chassis Punch Set £13.89 (A)
- FY53H Mini Vice £3.85 (C)
- LH79L Reliant Kit £22.50 (A)
- BW03D Reliant Drill £6.94 (B)
- BW02C Titan Drill £11.25 (A)

Page375

- YW65V Mini Mains Drill £14.25 (A)
- XB12N Drill Stand £14.95 (A)
- BR84F Reliant Collar 75p (E)
- BW04E Drill Power Supply £13.99 (A)
- BR65V Twist Burr 0 8mm 43p (F)
- BR66W Twist Burr 1 4mm 43p (F)
- BR85G HS Twist Drill 0 8mm 75p (E)
- BR86T HS Twist Drill 1mm 75p (E)
- BR87U HS Twist Drill 1 4mm 75p (E)
- YY28F Long–Life Drill 1mm £1.20 (D)
- LH77J 20–Piece Tool Kit £8.25 (B)
- LH78K 40–Piece Tool Kit £15.46 (A)
- LH76H Wishbone Sharpener £6.85 (B)
- YW66W Pin Drill £4.95 (C)
- HQ02C HS Drill 1/16in 19p (G)
- HQ03D HS Drill 5/64in 23p (G)
- HQ04E HS Drill 3/32in 29p (F)
- HQ05F HS Drill 7/64in 33p (F)
- HQ06G HS Drill 1/8in 36p (F)
- HQ07H HS Drill 9/64in 43p (F)
- HQ08J HS Drill 5/32in 46p (F)
- +HQ09K HS Drill 11/64in 49p (F)
- HQ10L HS Drill 3/16in 56p (E)
- HQ11M HS Drill 13/64in DIS
- HQ12N HS Drill 7/32in 65p (E)
- HQ13P HS Drill 15/64in DIS
- HQ14Q HS Drill 1/4in 82p (E)
- +HQ15R HS Drill 17/64in 95p (E)
- HQ16S HS Drill 9/32in 98p (E)
- HQ17T HS Drill 19/64in DIS
- HQ18U HS Drill 5/16in £1.19 (D)
- +HQ19V HS Drill 21/64in £1.26 (D)
- HQ20W HS Drill 11/32in £1.36 (D)
- +HQ21X HS Drill 23/64in £1.54 (D)
- HQ22Y HS Drill 3/8in £1.54 (D)
- HQ23A HS Drill 25/64in DIS
- HQ24B HS Drill 13/32in DIS
- HQ25C HS Drill 27/64in DIS
- HQ26D HS Drill 7/16in £2.32 (C)
- HQ27E HS Drill 29/64in DIS
- HQ28F HS Drill 15/32in DIS
- HQ29G HS Drill 1/2in £2.99 (C)

Page376

- FY59P Retractable Rule £2.75 (C)
- +FY60Q Feeler Gauge Imp 96p (E)
- FY61R Feeler Gauge Metric DIS
- FY62S Iron CX £6.24 (B)
- FY63T Element CX £2.80 (C)
- FR30H Bit 6/1106 89p (E)
- FY64U Bit 1100 92p (E)
- FY65V Bit 1101 92p (E)
- FR31J Bit 7/1101 £1.19 (D)
- FY66W Bit 1102 93p (E)
- FY67X Bit 1103 92p (E)
- FR01B Element Type CN £2.65 (C)
- FR02C Handle Type CN 99p (E)
- FR03D Bit 102 92p (E)
- FR04E Bit 104 88p (E)
- FR05F Bit 106 84p (E)
- FR06G Bit 820 89p (E)
- FR07H Bit 821 84p (E)
- FR08J Bit 822 84p (E)
- FR12N Iron X25 £6.56 (B)
- FR13P 12V Iron MLX12 £7.62 (B)
- FR14Q Element X25 £2.65 (C)
- FR15R Element MLX12 £2.49 (C)
- FR16S Bit No 50 99p (E)
- FR17T Bit No 51 92p (E)
- FR18U Bit No 52 89p (E)

Page377

- FR20W Stand ST4 £2.46 (C)
- FR11M Sponge ST3 11p (G)
- RK33L Sponge ST4 32p (F)
- FY68Y Kit SK3 £8.92 (B)
- FY69A Kit SK4 £8.99 (B)
- WY05F Rechargeable Iron £32.50 (A)
- YX68Y B50 Bit Angled £3.62 (C)
- YX69A B50 Bit Flattened £3.65 (C)
- YX70M B50 Lamp 85p (E)
- YX71N B50 Holder 68p (E)
- YX72P B50 Sponge 29p (F)
- FR10L Heat Sink Tweezers 38p (G)
- FR23A Solder Sucker £4.50 (C)
- FR24B Sucker Tiplet £1.55 (D)
- FR26D Desolder Tool £7.25 (B)
- BK39N Desolder nozzle 3 85p (E)
- BK40T Replacement O rings 55p (E)
- FR63T Desldr Washer Type 2 24p (F)
- HY13P Desldr Nozzle Type 2 89p (E)
- FR28F Desolder Nozzle £1.55 (D)
- FR29G Solda–Mop 68p (E)

Page378

- FR21X Solder D622 82p (E)
- FY70M 1/2kg Reel Solder £11.98 (A)
- FY71N Aluminium Solder 54p (F)
- FY72P Conductive Paint £5.35 (B)
- LH04E Freeze–it £1.94 (D)
- LH03D Switch Cleaner £1.94 (D)
- YB77J Servisol £1.96 (D)
- LH02C Aero–Klene £1.65 (D)
- YB73Q Aero–Duster £1.75 (D)
- YB74R Silicone Grease £2.24 (D)
- YB75S Plastic Seal £1.62 (D)
- YB76H Foam Cleanser £2.35 (C)
- YB78K Excel Polish £1.78 (D)
- YB79L Anti–Static Spray £1.72 (D)

Page379

- YB80B Fire Extinguisher £5.45 (C)
- FL43W Evostik Impact £1.38 (E)
- FL46A Cyanoacrylate 82p (D)
- LQ02C Potting Compound £3.75 (C)
- FL44X Araldite Rapid £2.25 (C)
- FL45Y Double Bubble Sachet 28p (F)
- FL47B PVC Tape Black 35p (F)
- FL48C PVC Tape Blue 35p (F)
- FL49D PVC Tape Brown DIS
- FL50E PVC Tape Green 35p (F)
- FL51F PVC Tape Red 35p (F)
- FL52G PVC Tape White 35p (F)
- YR99H PVC Tape Yellow 35p (F)

WOUND COMPONENTS

Page380

- +LB40T 9.5 Coil Former 60p (E)
- LB17T Former 351 24p (F)
- LB18U Former 450 16p (G)
- LB19V Former 722/1 16p (G)
- LB20W Former 722/2 18p (G)
- LB21X Former 722/8 21p (G)
- LB22Y Former 722/4 18p (G)
- LB41U Dust Core Type 4 10p (G)
- LB42V Dust Core Type 6 12p (G)
- LB43W Dust Core Type 8 17p (G)
- LB44X Former Base 12p (G)
- LB36P Screening Can 10 10p (G)
- LB39N Screening Can 15 14p
- LB62S A.P Beads 39p
- HX05F Small Pot Core £1.30 (D)
- HX06G Core Type 2 £1.55 (D)

Page381

- HX07H Bobbin Type 2 96p (E)
- HX08J Clips Type 2 6p (H)
- HX09K Type 3 Core £1.85 (D)
- HX10L Type 3 Bobbin 82p (E)
- HX11M Type 3 Clips 6p (H)
- HX12N Large Pot Core 99p (E)
- HX13P Bobbin Type 4 18p (G)
- HX14Q Mtg System Type 4 £1.10 (D)
- HW23A GE Coil L15 £3.98 (D)
- HX58N GE Coil L9 £5.20 (C)
- +HX57M GE Coil L8 £2.36 (C)
- HW24B GE Coil L14 £3.92 (D)
- HX56L GE Coil L7 DIS
- HX55K GE Coil L6 £3.96 (C)
- +HX54J GE Coil L5 £2.36 (C)
- HW25C GE Coil L12 £2.98 (D)
- HW26D GE Coil L11 £2.96 (D)

Page382

- HX24B Choke 0.5H £1.15 (D)
- HX25C Choke 1H £1.15 (D)
- +HX26D Choke 2H £1.15 (D)
- HX27E Choke 4H £1.15 (D)
- LR07H Filter Pot Core £2.15 (C)
- XX30H Equaliser Pot Core £1.99 (D)
- HW27E Choke 10H £1.96 (D)
- HX22Y Choke RFC5 DIS
- HX23A Choke RFC9A DIS
- +HW28F Choke 5uH HC 59p (F)
- HX15R Choke 1.5mH 58p (E)
- HX16S Choke 2.5mH 59p (E)
- HX17T Choke 5mH 66p (E)
- HX19V Choke 10mH 29p (F)
- WH25C Choke 0.22uH 52p (E)
- WH27E Choke 0.47uH 53p (E)
- WH29G Choke 1.0uH 45p (F)
- WH30H Choke 1.5uH 49p (E)
- WH31J Choke 2.2uH 45p (F)
- WH32K Choke 3.3uH 45p (F)
- WH33L Choke 4.7uH 49p (F)
- WH34M Choke 6.8uH 55p (E)
- WH35Q Choke 10.0uH 45p (F)
- WH36P Choke 15.0uH 61p (E)
- WH37S Choke 22.0uH 48p (F)
- WH38R Choke 33.0uH 48p (F)
- WH39N Choke 47.0uH 48p (F)
- WH41U Choke 100uH 54p (E)
- WH45Y Choke 470uH 55p (E)
- WH47B Choke 1mH 75p (E)

Page383

- HX42V Toko YRCS 11098 51p (E)
- YG30H Toko YRCS12374 61p (E)
- HX43W Toko YHCS 11100 52p (E)
- YG31J Toko CSK3464 53p (E)
- YG32K Toko YMCS17104 62p (E)
- HX97F Toko ACS 34342 72p (E)
- HX98G Toko ACS 34343 76p (F)
- +YG39N Toko KAC8448 48p (F)
- YG36P Toko KAC8449 46p (F)
- LB00A IFT 13 £1.62 (D)
- LB01B IFT 14 £1.75 (D)
- LB03D IFT 16 £1.72 (D)
- LB02C IFT 15 £1.81 (D)
- LB05F IFT 18 465kHz £2.19 (C)
- LB06G IFT 18 1.6MHz DIS
- HX28F Toc 1 £1.99 (D)
- HX82D Min Tr LT44 55p (E)
- LB14Q Min Tr LT700 55p (E)
- YR91Y Min Tr LT800 33p (F)
- LR06G Mc Xfm Typ2 200–600R £19.45 (A)
- YX84F Z Changer £8.45 (B)

Page384

- HX81C Pulse Transformer £3.82 (C)
- YX66W Line Transformer £3.35 (C)
- BK57M 600 Ohm Isotran £5.45 (B)
- *WB00A Sub–Min Tr 6V £1.30 (D)
- *WB01B Sub–Min Tr 9V £1.30 (D)
- *WB02C Sub–Min Tr 12V £1.40 (D)
- WB06G Min Tr 6V £3.46 (C)
- WB11M Min Tr 9V £4.25 (C)
- WB10L Min Tr 12V £3.35 (C)
- YK28F Tr 12V 0.5A £4.48 (C)
- LY03D Tr 10VA 15V £4.95 (C)
- WB22Y Tr 34V HP £8.84 (B)
- WB16S Min Tr 20V £3.35 (C)
- WB20W Min Tr 24V £3.56 (C)
- WB07H Tr 34V 1A £7.85 (B)

Page385

- WB25C Tr 12V 1A £6.55 (B)
- WB26D Tr 12V 2A £8.84 (B)
- YK02C Tr 32–0–32 2A £13.45 (A)
- YK07H Tr 32–0–32 4A £22.25 (A)
- YK08J Toroidal 30VA 6V £8.59
- YK09K Toroidal 30VA 9V £8.59
- YK10L Toroidal 30VA 12V £8.59
- YK11M Toroidal 30VA 15V £8.59
- YK12N Toroidal 30VA 18V £8.59
- YK13P Toroidal 50VA 6V £9.96
- YK14Q Toroidal 50VA 9V £9.96
- YK15R Toroidal 50VA 12V £9.96
- YK16S Toroidal 50VA 15V £9.96
- YK17T Toroidal 80VA 18V £10.98
- YK18U Toroidal 80VA 22V £10.98
- YK19V Toroidal 80VA 30V £11.98
- YK20W Toroidal 120VA 30V £11.98
- YK21X Toroidal 160VA 35V £13.98
- YK22Y Toroidal 300VA 35V £15.98
- YK23A Toroidal 500VA 35V £19.98
- WB03D Tr 9V 1.1/2A £6.94 (B)
- WB12N Tr 20V 1A £8.25 (B)
- WB17T Tr 28V 1 1/2A £10.86 (B)
- XB38R TR 32032/6.1/2A £23.25 (A)
- HX59P Trnsformer Mtg Plate 66p (E)
- LW34M 15/22V Power Tran £14.94 (A)
- LW33L Tr 240V Isotran £4.95 (C)

Page386

- YK03D Matinee Transformer £13.75 (A)
- YG12N Min Motor £2.45 (C)
- YG13P Small Motor £1.25 (D)
- YG14Q Servo Mechanism £3.60 (C)

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The letter in brackets after the price indicates the minimum trade quantity. For details please see page 27.

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Atari

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Continued overleaf

MAPLIN NEWS MAPLIN NEWS

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- ★ Personal Stereo Dynamic Noise Limiter
- ★ Syndrum Interface
- ★ Microphone Pre-amp/Limiter
- ★ Pseudo Stereo AM Radio
- ★ NiCad Charger Timer
- ★ Spectrum I/O Port
- ★ TTL/RS232 Converter
- ★ 1K ZX81 RAM Extension
- ★ Part 2 of the Telephone Exchange
- ★ VIC Extendiboard with 3K RAM Pack
- ★ Logic Pulser
- ★ Frequency Meter Adaptor
- ★ An Auto-Waa pedal
- ★ A Spectrum Keyboard
- ★ Part 2 of the House Wiring Article

CORRIGENDA

Vol. 2 No. 5
Modem: R4b should be 12k.

Vol. 2 No. 7
VIC20 RS232 INTERFACE: Since this project was published, a few improvements have been made.

R4,8,12 and 16 are now 4k7.

Four extra resistors (R33-36 inc.) value 4k7, have been added to each of the input lines Sin, DCD, CTS and DSR.

The power supply section of the circuit has been redesigned, see sketch below. C3 is a 100uF Reversolytic, R37 is a 47R ½W Standard resistor and D5 to 7 are IN4001.

Note: The PCB (GB28F) has been modified to accept these new components and the kit (LK11M) has the new parts supplied.

SIMPLE SWEEP OSCILLATOR: Some components in the PARTS LIST have been changed.

C4,6,7,8 are now 100uF 25V P.C. Electrolytics (FF11M).

C11 is 220nF polyester (BX78K).

4 DIL sockets 8 pin (BL17T) are required, and 2 DIL sockets 16 pin (BL19V) are needed.

Note: The Kit (LK06G) contains these parts.

CMOS CRYSTAL CALIBRATOR: In the PARTS LIST, TR2 should be BC108 not EC108.

ENLARGER TIMER: In Figure 4, the pin out designated 2N6073 should be uA 78L12AWC and vice versa.

Price list of new items in this issue

BK68Y	SPCO Nonlock Switch	**£1.99**
BK71N	10mm Cap Green	**6p**
BK72P	Membrane Switch	**£9.64**
BK73Q	Flat Flex Connector 7-way	**62p**
BK77J	Synchime Front Panel	**£1.25**
BK79L	0.156" 2 x 22 Way P.C. Edgecon	**£3.50**
FG23A	2 x 2 8-Way P.C. Edgecon	
B20W	Doorbell P.C.B.	**£1.92**
GB25C	Code Lock P.C.B.	**£2.92**
GB29G	Dragon RS232 Interface P.C.B.	**£3.62**
GB30H	Probe Upper P.C.B.	**98p**
GB31J	Probe Lower P.C.B.	**98p**
GB37S	Dragon I/O Port P.C.B.	**£2.95**
GB38R	Synchime P.C.B.	**£1.20**
GB42V	Spectrum RS232 Interface P.C.B.	**£3.95**
LK09K	Mini-lab Kit	**£32.50**
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LK15R	Synchime Kit	**£10.90**
LK18V	Dragon I/O Port Kit	**£13.95**
LK21X	Spectrum RS232 Interface Kit	**£17.95**
QY54J	Low Current Display	**£2.89**
QY55K	MC 14419	**£3.86**
QY57M	2716/M7	**£8.50**

MAPLIN'S TOP TWENTY BOOKS

1. (3) De Re Atari (WG56L) (cat. P62)
2. (2) Games for the Atari by S. Roberts (WA47B) (cat. P62)
3. (1) Audio Circuits and Projects by Graham Bishop (XW46A) (cat. P41)
4. (4) Cost Effective Projects Around the Home by John Watson (XW30H) (cat P41)
5. (6) Projects for the Car and Garage by Graham Bishop (XW31J) (cat. P30)
6. (11) Remote Control Projects by Owen Bishop (XW39N) (cat. P43)
7. (—) Understanding Telephone Electronics by George L. Fike and George E. Friend (WK45Y) (see note)
8. (5) Master Memory Map (XH57M) (cat. P62)
9. (10) Electronic Security Devices by R. A. Penfold (RL43W) (cat. P40)
10. (8) The 6809 Companion by M. James (WG88V) (cat. P63)
11. (16) The TTL Data Book (WA14Q) (cat. P33))
12. (17) Programming the 6502 by Rodnay Zaks (XW80B) (cat. P54)
13. (7) VIC Programmers Reference Guide (WA33L) (cat. P63)
14. (19) How to Use Op-Amps by E. A. Parr (WA29G) (cat. P35)
15. (13) Atari BASIC Learning by Using by Thomas E. Rowley (WG55K) (cat. P62)
16. (—) Radio and Electronics Colour Codes and Data Chart (RH05F) (cat. P30)
17. (15) Electronic Synthesiser Projects by M. K. Berry (XW68Y) (cat. P50)
18. (12) Power Supply Projects by R. A. Penfold (XW52G) (cat. P38)
19. (9) The BBC Micro — An Expert Guide by Mike James (WK04E) (cat. P63)
20. (—) VIC Revealed by Nick Hampshire (WA32K) (cat. P63)

These are our top twenty best selling books based on mail order and shop sales during April, May and June 1983. Our own publications and magazines are not included. We stock over 500 different books to do with electronics and computing and the full range is shown on pages 29 to 65 of the 1983 catalogue, page 15 of issue 6, pages 60 and 61 of issue 7, and of course the new books section of this magazine.

Note: For full details of WK45Y please see page 60 of issue 7 of this magazine.

NEW ITEMS PRICE LIST *Continued from page 37*

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GA17T MOS-Amp Bridge PCB **Price £1.96**
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GB24B Enlarger Timer PCB **£3.96**
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LK00A VIC20 Talkback Kit **Price £24.95**
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CLASSIFIED

If you would like to place an advertisement in this section then here's your chance to tell Maplin's 180,000 customers what you want to buy or sell, absolutely free of charge. We will publish as many advertisements as we have space for. To give everyone a fair share of the limited space, we will print 30 words free of charge. Thereafter the charge is 10p per word.
Please note that only private individuals will be permitted to advertise. Commercial or trade advertising is strictly prohibited in the Maplin Magazine.
Please print all advertisements in bold capital letters. Box numbers are available at £1.50 each. Please send your advertisement with any payment necessary to: Classifieds, Maplin Mag, P.O. Box 3, Rayleigh, Essex SS6 8LR.
For the next issue your advertisement must be in our hands by 5th October 1983.

VARIOUS

MAPLIN STEREO cassette deck kit (P.234 in catalogue). PCB's assembled, otherwise unbuilt, vgc, including all packing and accessories, cost £40. Sell £25. Tel. Bristol (0272) 772965).

100 ELECTRONICS magazines for sale, consisting 62 Practical Electronics, 31 Practical Wireless, 7 Elektors. Offers invited. Phone Pete (Formby 79388).

A.S.R.33 TELETYPE with papertape, £50 ono, connoisseur BD2 turntable M75ED2, vgc, £30; Lowrey TG1 organ, immaculate, £400. Caterham 47784 after 7 p.m.

SX 200 scanning monitor receiver 12v input, complete with brackets for mobile use, set top antenna, large scale circuit diagrams incl. modification and instruction booklet, £125. 0695 31614.

538A KIKUSUI 5MHz oscilloscope, hardly ever been used, still in box. Interests changed to computing. Swap for 16K Spectrum or offers. M. Swanson, High Street, Spilsby, Lincs.

FOR SALE, Practical Wireless, April 1972 to April 1981, £25 ono. Can deliver locally. Tel. Fence Houses (Durham STD) 854734.

MUSICAL FOR SALE

MIXER FRONT panel, Allen & Heath 16 into 4 into 2 studio mixer, fully punched & legended; £20. Canvey 694900.

MAPLIN S600S synthesiser, professionally built, cash needed so only £100 more than component value. £700 ono. 0264 4850 (Andover).

KORG MS10 synthesiser, as new, with guarantee, £200; swop for BBC A/B micro in good condition, 16K ZX81. Lots of hardware, £100. 36 Sunningdale Avenue, Lowestoft, Suffolk. Tel. (0502) 64729.

MAPLIN 5600 synth. kit, complete order without components and cabinet, PCB's, mounting brackets, front-rear panels, hinges, book, still unpacked. Catalogue price £68. Sell £30. Phone 01-840 4336.

CRUMAR STAGE piano, 60 note, 3 voice, sustain pedal, case and stand, ideal for group, home or studio, £150 ono. Banbury 720056.

FOR SALE electronic organ, Casio 403, plays 25 different instruments, 16 rhythms, plus much more. Still under guarantee. £200 ono. Tel. 01-891 3079.

ALAN DOUGLAS electronic organ (dismantled), 2.6in manuals, all coils, chassis, generators, valves, frame, room wanted, buyer collects, £30. Tel. 061 761 2952.

COMPUTERS FOR SALE

MZ80K 48K 48k, with Basic and Pascal, manuals and software, £300 ono. 15 Stramane Close, Brant Road, Lincoln. Lincoln 42036.

VDU-FERRANTI with green display, ideal as monitor and keyboard. Documentation supplied. Includes high current psu 5v and #12V, £50 ono. Tel. Orpington 71317.

ZX81 #16K with sounder, + Zonix prog. Sound generator + manual/ books/tapes all nearly new, £89. Peter Cunningham, 11 Berwyn Ave., Penyffordd, near Chester. Tel. Caergwrle 760172.

ATARI 400 16K program recorder, basic cartridge, many books, magazines, manuals. Four game cartridges. Lots of extras including joysticks. Cost £450+, sell for £350 ono. Tel. 0375 672077.

NASCOM 2 with NAS-SYS 1, 16K memory, wooden box, two available at £150 each. Foulds, 42 Cotswold Avenue, Ipswich. Tel. 214004.

MAPLIN ZX81 Talk-Back unassembled for sale or exchange with ZX81 or ZX80 assembled or unassembled. Offers. Hamid Reza Tajzadeh, 4th Floor, No. 11 Street, No. 3, Noarmack Tehran 16479, Iran.

CLUB DETAILS

ALWAYS WELCOME, new members to help support free enterprise in space, promote space exploration and oppose the moon treaty. For further information write to Free Space and Space Settlers Society(MM), c/o Christ Forrest, 8 Barton Bridge Close, Raglan, Gwent.

UNIQUE non-commercial scheme helps with the purchase, sale and exchange of Atari VCS cartridges. Pilot scheme by Atari enthusiasts for all Atari users. S.A.E. for details to The Secretary, V.G.E.S., 25 Rona Road, London, NW3 2HY.

WANTED

WANTED URGENTLY manual/circuit any data (or loan for copy and return), postage refunded. For Furzeehill Oscilloscope type 0100 (1956). P. Merriman, 41 Wattleton Road, Beaconsfield, Bucks, HP9 1SD.

WANTED CIRCUIT diagram of a single channel on/off radio control system to operate on any frequency. Mr. D. Corder, Low Weasdale, Newbiggin-on-Lune, Kirkby Stephen, Cumbria.

FIELD TELEPHONES, pair wanted, any type, including handset, bell and hand-generator. Preferably USA type EE8 in leather case. Phone 0234 67729 (Sundays).

TRANSCENDENT 2000 required, must be in good condition, unfinished kits considered. £56. Mr. C. Fyson, 17 Kitchener Road, Hampton Park, Southampton, Hampshire S02 3SF.

WANTED audio pre-amp I.C. (number Nikko G0003) and circuit diagram/ service manual for Nikko TRM 30 amplifier. Would consider complete amplifier.
Contact Andy Bryson 26 South Crescent, Ardrossan, Ayrshire (0294-63829).

WANTED: INFORMATION on I.C. No. A-Y-1224A (Digital Clock), am having very great difficulty in obtaining this particular chip. Contact S. R. Jefferies, 47, Nutfield Road, Coulsdon, Surrey CR33JP. 01-668 2833.

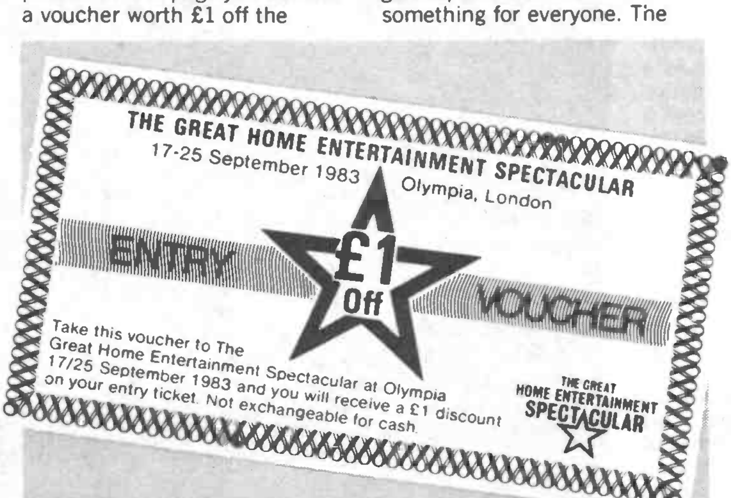
EXHIBITION NEWS

Maplin are pleased to announce that they will be exhibiting at no less than three different shows over the next few months. In addition to all our normal displays of computers and software we will have, on show for the first time, our new robot, Hero 1. Hero can see, speak, detect moving and stationary objects and determine their distance, pick up small objects, move in any direction, and learn from your instructions. He will be meeting the public at selected times throughout the shows, and would be very pleased to make your acquaintance.

The Maplin Modem will also be working, together with a demonstration of Maptel and Cashtel, the Maplin shopping-by-computer system that points the way to the future, allowing you to buy goods and access information 24 hours a day.

A representative of the Atari User Group will be on hand to answer questions at all three shows, and the latest issue of the User Group magazine will be on sale.

The Great Home Entertainment Spectacular is the first of the shows, and printed on this page you will find a voucher worth £1 off the normal price of your entrance ticket. The show organisers have planned a series of competitions and games, treasure hunts, live performances, product demonstration, and computer games, so there should be something for everyone. The show is open from 11.30 am to 9.00 pm every day except Monday, when it will open at 5.00 pm, and it runs from the 17th to the 25th of September at Olympia, London. Tickets are £3 adults, £2 children.



From the 29th of September to the 2nd of October we have the second in our series of shows, the 6th Personal Computer World Show, at the Barbican, London. Opening hours are from 10.00 am to 7.00 pm every day except Sunday, when the show closes at 5.00 pm. Tickets are priced at £3 for adults, £2 for children.

Finally, we have the Electronic Hobbies Fair at Alexandra Palace, London, from October the 27th to the 30th. The show is open from 10.00 am to 6.00 pm every day except Sunday, when closing time is at 5.00 pm. Tickets are priced at £2.00 for adults, £1.00 for children.

We look forward to seeing you.

Say it with SATELLITES

by Mike Wharton

Ups and Downs

It is usually only the more interesting space shots which attract the attention of the news media. This often gives the impression that satellite launches are few and far between, with perhaps the odd Space Shuttle launch now and then. Nothing could be further from the truth, for there are many launches of all manner of craft throughout the year. Most of these are put up by the Big Two, America and Russia, but quite a few launches are made by countries such as Japan, India and, of course, Britain. Some indication of the numbers involved may be obtained from the following; in December of last year the Russians launched seven satellites of various types, and of the total of 121 launches during 1982, 101 were Russian, 18 from the USA, 1 from Japan and 1 from China.

Most of the Soviet satellites were military in nature, ranging from the surveillance devices mentioned in a previous issue to communications satellites. Such activity is not an unusual event, for during January of this year, the Russians launched another four rockets; one of these is particularly interesting, since it carried aloft a batch of no less than eight small military communications satellites.

It should be no surprise to find the Japanese active in the business of satellites, and doubtless they see it as another area to exploit with their usual acumen. The first Japanese satellite launched in 1983 was a communications satellite, launched from the Tanegashima Space Centre near Takazaki on the 4th February. This was followed by an astronomical satellite, Astro-2, launched on the 20th February from the Kagoshima Space Centre. This last satellite will be used for detecting and monitoring celestial X-ray sources.

With all these satellites going up it is not surprising that there are many that come down. Some of these come down of their own accord, due to the decay of a relatively low orbit, whilst some are brought down deliberately. These, of course, are the military surveillance satellites which are recovered in order to retrieve the information they contain without divulging the contents by transmitting it over a radio link. During December 1982 and January and February 1983, fourteen space-craft were recovered or re-entered, most of them of Russian origin.

Amateur Satellites

Many radio Hams will be waiting with anticipation for the launch of the latest amateur satellite, the so-called Phase 3-B, aboard the Arlane launch vehicle. Some readers may recall that the last attempt to use this launcher to put a payload aloft ended with the whole lot splashing down in the Atlantic. This was attributed to a breakdown in the third stage turbo-pump. As a consequence, the launch of the next mission has been put back while this component is rigorously checked over in order ensure that there is no repetition of such an expensive failure. The amateur satellite will again be going as a 'piggy-back' payload, the main satellite in this case being the European communications satellite, ECS-1.

If this launch proves to be successful, and by the time you read this it should have gone, then another satellite will be available for amateur use, which will then be known as OSCAR 10.

The prior satellite to this one, OSCAR 9, is still not completely out of the woods. This 'bird' is rather different from other amateur satellites, in that it carries scientific experiments and no transponders. A transponder is a sort of space repeater, used for retransmitting radio signals over large distances. Unfortunately, complete control has not been regained since it came back on the air, and it must be feared that its orbit will decay beyond the point of no return before it is able to realize its full potential.

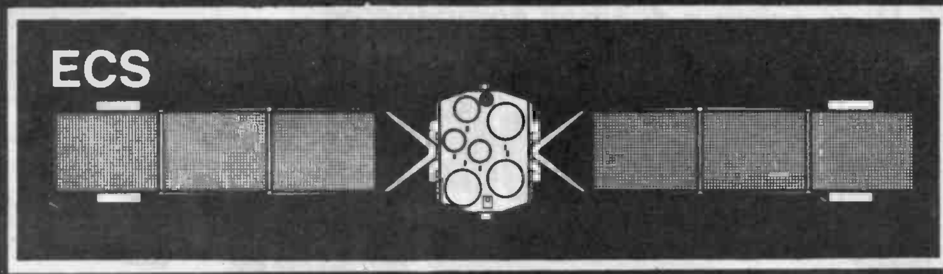
Space Astronomy

The number of satellites dedicated to research from the vantage point of space continues to increase. During May this year a satellite was launched by the European Space Agency, ESA, to study distant X-ray sources. Called EXOSAT, its two-year mission will be to observe some of the most unusual and violent events in the known Universe. For example, it is intended to be used to examine the disappearance of matter into 'black holes' as well as the massive out-pouring of X-rays from some of the remote radio galaxies. One particular feature of this craft is its ability to be pointed at these sources to an accuracy of one thousandth of a degree of arc, which is claimed to be some fifty times better than hitherto achieved.

Another similar space-craft, but one which is observing a completely different part of the electro-magnetic spectrum, is the Infra Red Astronomical Satellite, IRAS. A recent achievement of this craft was the detection of a comet, which eventually became visible to the naked eye; in recognition of this the comet was named IRAS-Araki-Alcock. This craft was mentioned in a previous article, and the supply of liquid helium used to cool the infra-red sensors seems to be holding up well and it has provided a great deal of information to astronomers on this part of the spectrum.

Space Shuttle

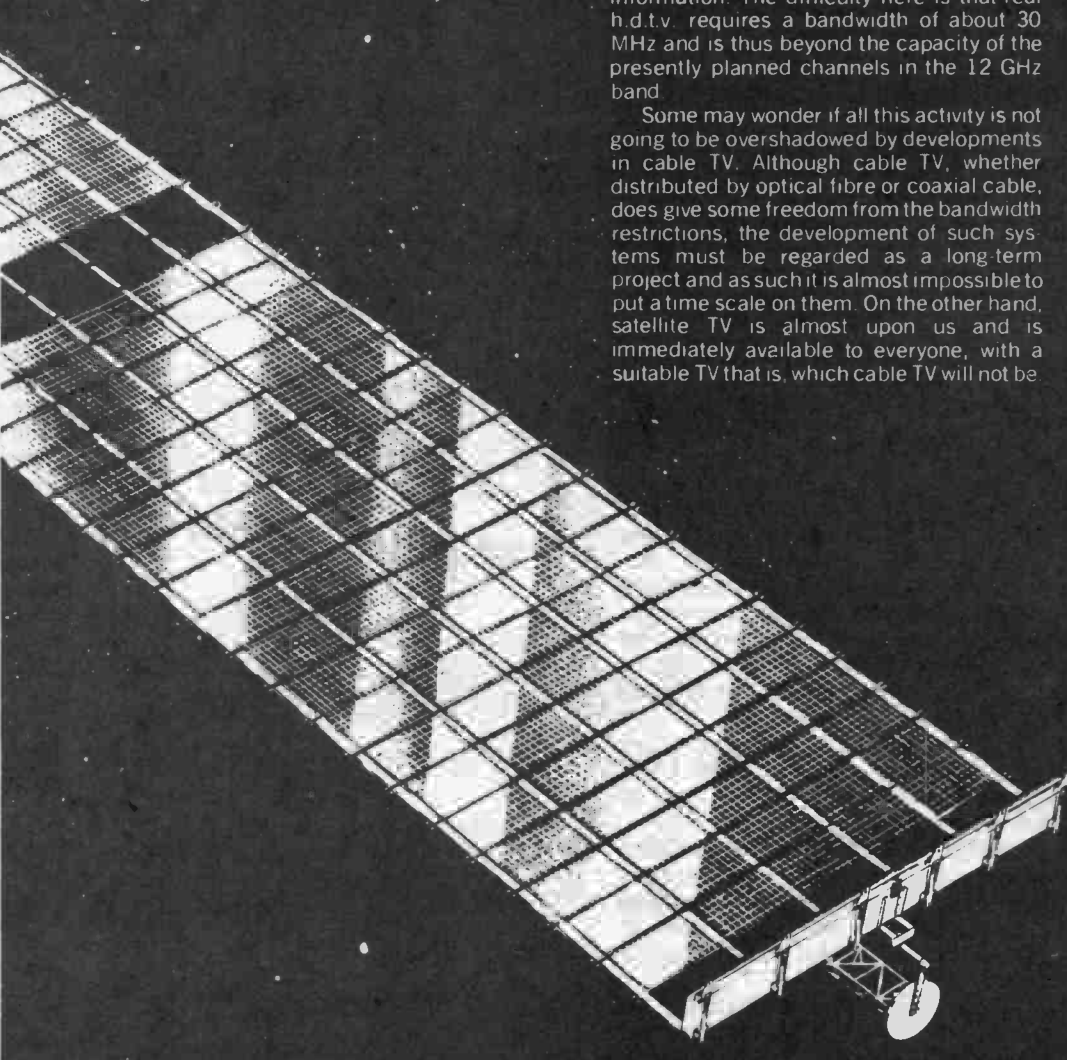
The next scheduled flight of the American Space Shuttle will be in the autumn this year. The primary aim of this flight will be to carry the joint U.S.-European Spacelab aloft. One of the interesting aspects of this flight is that NASA has given the go-ahead for one of the crew, Dr. Owen Garriott, to take an amateur 2-metre band transceiver with him. Thus it will be possible for radio amateurs all over the world to make contact with the call "CQ from W5LFL aboard the Space Shuttle", for W5LFL is Dr. Garriott's amateur call-sign. Exactly how successful this proves to be only time will tell, and certainly one of NASA's stipulations is that any transmissions must not interfere in any way with the planned mission of the Space Shuttle.



DBS–the continuing story

Finally, a few words on the latest developments in Direct Broadcasting by Satellite. This service is the one which is already enjoyed on a somewhat limited basis in some parts of the world, and which is intended to be available in Europe by the end of 1986. The satellite which will carry the TV signals is Olympus (previously L-Sat) presently being built by the British Aerospace Corporation. The U.K. has been allocated five d.b.s. channels in the 12 GHz band and the first two of these will be made available for two new BBC programme services. The three remaining U.K. d.b.s. channels will, no doubt, be allocated in future years. The channel bandwidth available with this system is around 10 MHz, which is appreciably larger than the 5.5 MHz offered by terrestrial transmissions. This has led to suggestions that the extra bandwidth should be used to improve the definition of the system. There are several ways in which this could be done; one method would use the same number of lines and frames as at present, 625 and 50 fields per second, but circuitry in the receiver would store the video information and enable the production of a picture with 1250 lines or 100 fields per second or possibly both. Although there is no more information transmitted, a display with much less line structure and free from flicker could be visually more pleasing. The longer term goal is to transmit true high-definition television (h.d.t.v.), where the picture would actually be generated and transmitted on higher line and field rates, and hence would genuinely contain more information. The difficulty here is that real h.d.t.v. requires a bandwidth of about 30 MHz and is thus beyond the capacity of the presently planned channels in the 12 GHz band.

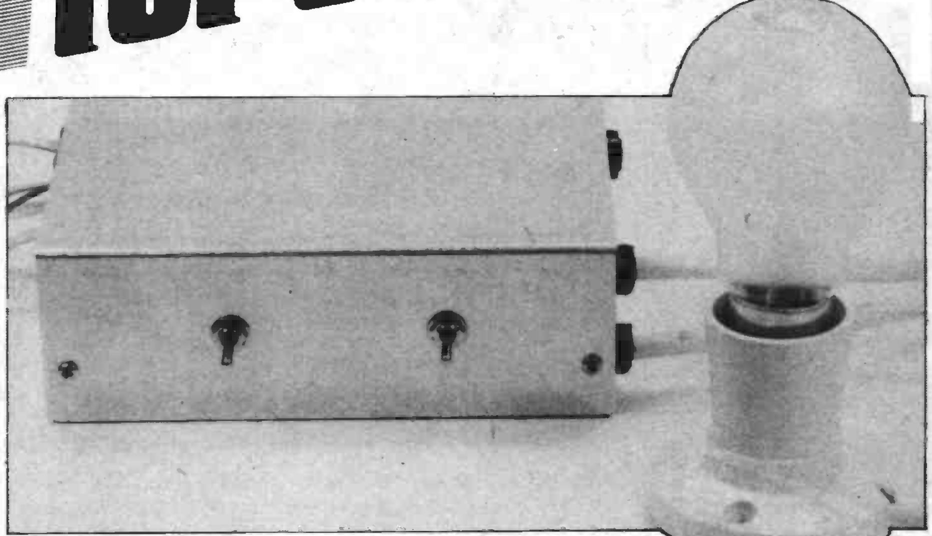
Some may wonder if all this activity is not going to be overshadowed by developments in cable TV. Although cable TV, whether distributed by optical fibre or coaxial cable, does give some freedom from the bandwidth restrictions, the development of such systems must be regarded as a long-term project and as such it is almost impossible to put a time scale on them. On the other hand, satellite TV is almost upon us and is immediately available to everyone, with a suitable TV that is, which cable TV will not be.



★ **Attracts attention with or without noise**
★ **Uses existing doorbell components**
★ **Simple to instal**

Doorbell for the Deaf

by Garfield Dean



For the hard of hearing or the deaf a doorbell is obviously useless. This circuit is an attempt to increase the chance of getting the attention of a deaf person by flashing a light or lights on and off several times in the deaf person's room(s). Also the bell can be made to ring several times for the benefit of anyone who is only hard of hearing and also for the person who pushed the bell switch.

Circuit Description

Figure 1 shows a typical doorbell system. Figure 2 shows the circuit for the doorbell for the deaf which uses all of the existing hardware. There are two 7555 timers, the first of which is in monostable mode with a period of about 2-20 seconds determined by RV1, R2 & C2. When the push switch is pressed, the output of IC1 goes high for 10 seconds and this enables IC2 to work in a stable mode (i.e. oscillate) at a rate of once every two seconds set by C3, R3, R4 & RV2. IC2 turns the relays on and off which in turn switches the bell and lights on and off about 5 or 6 times. A 5A fuse is included in the lighting circuit for safety. S2 disengages the bell relay if, for example, children are sleeping. S1 disengages the light relay if it is necessary that the lights don't flash, e.g. for a photograph. also this allows normal doorbell operation simply by turning S1 off and setting RV1 to give one ring per push. D1 prevents large back EMFs from the relays destroying the rest of the circuit.

Note that the 7555 timer has been used instead of the 555 timer, because of the long time constants involved and for the lower power consumption in standby mode (useful if the circuit is battery operated).

The P.S.U. is the easiest part of the circuit but may need the most careful looking at, depending on the existing doorbell. If you have no doorbell at present or if your doorbell power supply is not suitable (see below) then the circuit for the power supply in figure 3 will work. BR1 rectifies the 8V A.C. and this is then smoothed by C1. IC3, C4 & C5 provide extra smoothing and voltage dropping if required. D2, if fitted, prevents wrong connection by a D.C. supply. With the Maplin transformer the regulator is not used and a wire link is used in the position marked for D2 (Figure 4b).

A suitable supply is:

a) D.C. 9-15V — In this case BR1, C1 and the optional regulator should not be fitted. D2 should be fitted as in figure 4b. Also links should be fitted in place of BR1 as shown in figure 4c. (Note that batteries will run down every 6 months or so, and therefore a transformer may be a better long term solution).

b) A.C. 8-12V — From a Bell Transformer (as this is built for the job). The power supply is built as if using the Maplin transformer; but make sure that

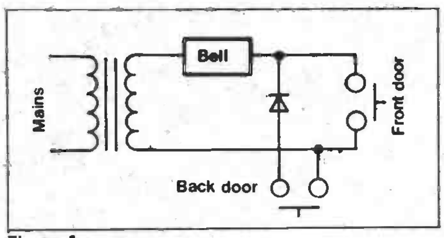


Figure 1

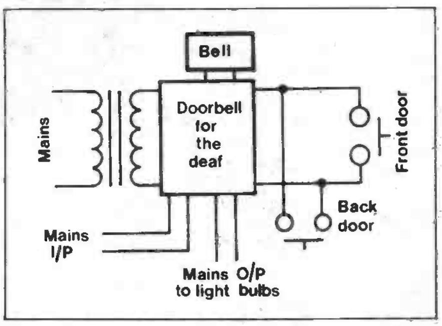


Figure 1a

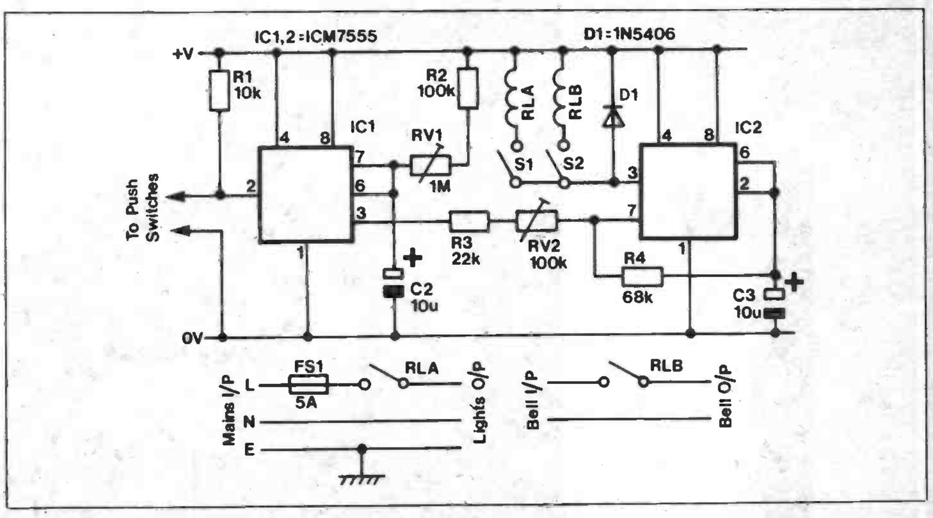


Figure 2. Circuit diagram.

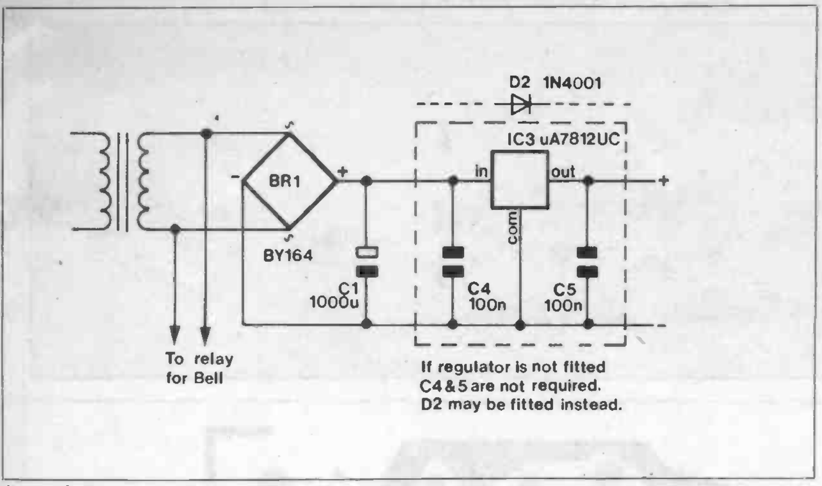


Figure 3. Power supply.

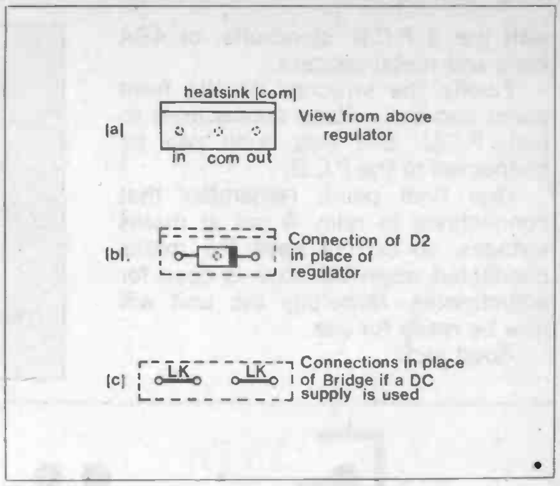


Figure 4.

the connections to the bell (via relay B) come from the pair of transformer windings that the bell was originally connected to.
c) A.C. 12-20V — From a Bell Transformer. The power supply is built as for the Maplin transformer but uses the optional regulator section. Also connections to the bell (via relay B) should come from the pair of transformer tappings that the bell was originally connected to.

Constructional Details

The P.C.B. should be built up as in figure 6 by soldering in components in order of increasing height, inserting veropins into the low voltage output holes. Remember that you will only need to use some of the components listed for your type of power supply.

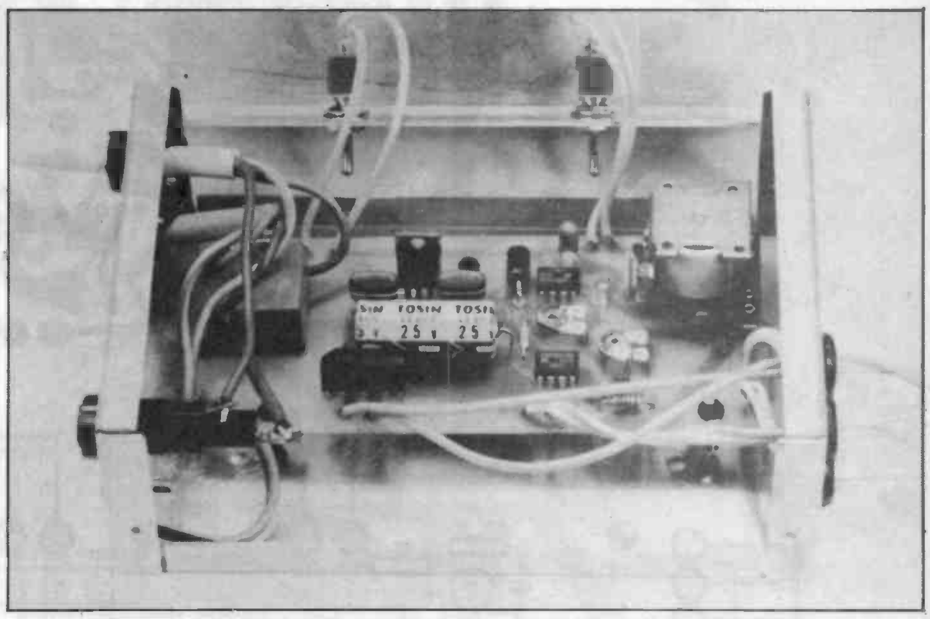
Check the P.C.B. after completion, especially for solder blobs, dry joints and correct polarity of devices; an electrolytic capacitor connected the wrong way round makes a nasty mess when it blows up. The unit is now ready for testing. Temporarily short across each of the two sets of contacts going to the switches S1 and S2.

Put RV1 and RV2 in their mid-positions and temporarily connect the input to the P.S.U. Give a trial push of the doorbell by shorting the two veropins for the bell push together. Both relays should click on and off several times. RV1 adjusts the total length of time the doorbell operates for after a bell push. RV2 adjusts the length of time between individual flashes of the lights (should these need frequent alteration then potentiometers can be used).

If the unit does not work there are 3 main things to check:

1) Is the voltage across IC1 pins 1 and 8 between 9 and 16V? If not then the power supply is at fault.
2) If the output of IC1 does not go high for 2-20 seconds when the bell is pushed, then IC1 or an associated component are at fault.
3) If the output of IC2 does not oscillate between positive and negative supply when IC1 output goes high, then IC2 or an associated component is at fault.

The P.C.B. will now be ready to be fitted into a case. For a functional unit an AB13 case can be used, but for a



more attractive finished product a type 215 Verocase should look better. A suggested set of drilling details for an AB 13 case are shown in figure 5.

When drilling is complete, fit grommets and the fuse holder where marked and insert the mains wires coming from outside the unit.

Solder these wires directly to the P.C.B., along with an extra earth lead, connected to a solder tag which should be attached to the case with a 4BA bolt and shakeproof washer.

Then fix the P.C.B. down to the case

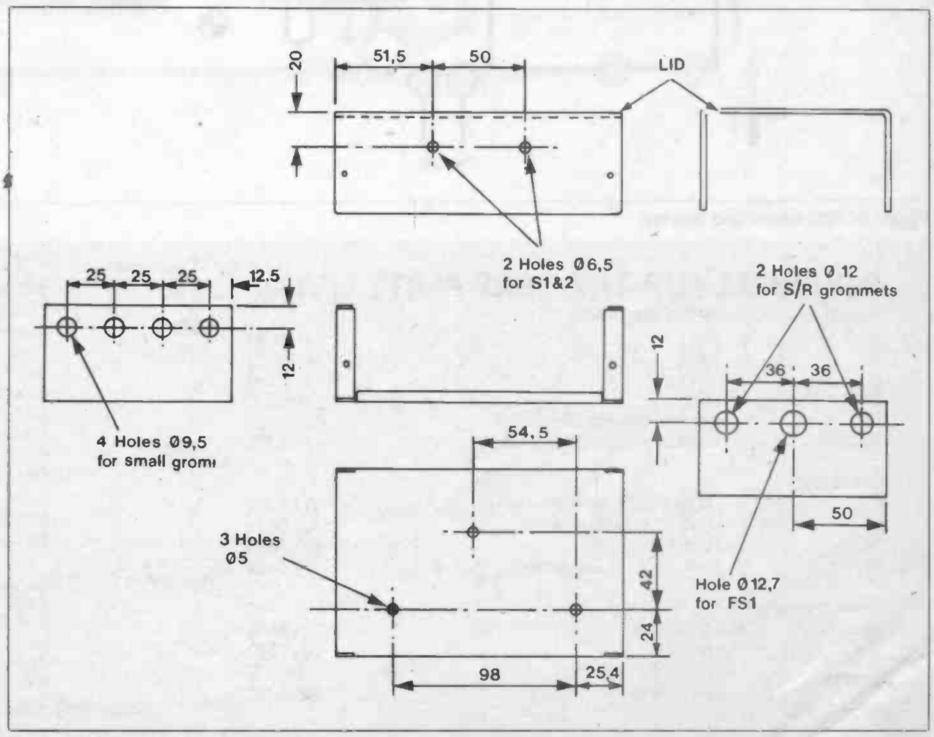


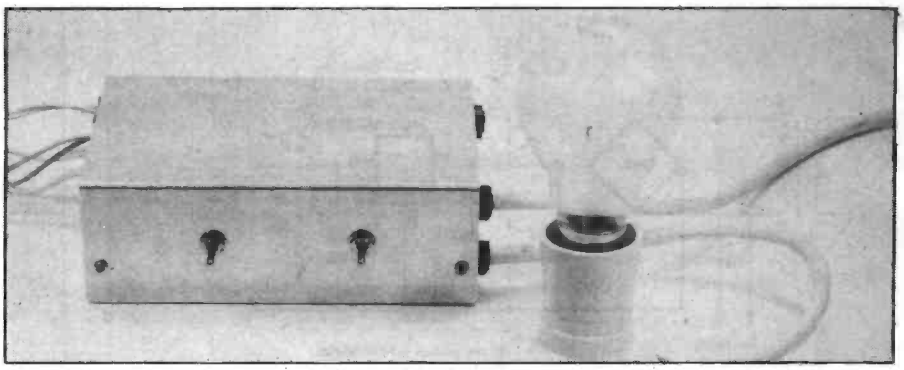
Figure 5. Drilling instructions.

with the 3 P.C.B. stand-offs, or 4BA bolts and metal spacers.

Finally the switches on the front panel and low voltage connections to bell, P.S.U. and bell push can be connected to the P.C.B.

One final point: remember that connections to relay A are at mains voltages, so do not have the mains connected when the case is open for adjustments. Hopefully the unit will now be ready for use.

Good luck!



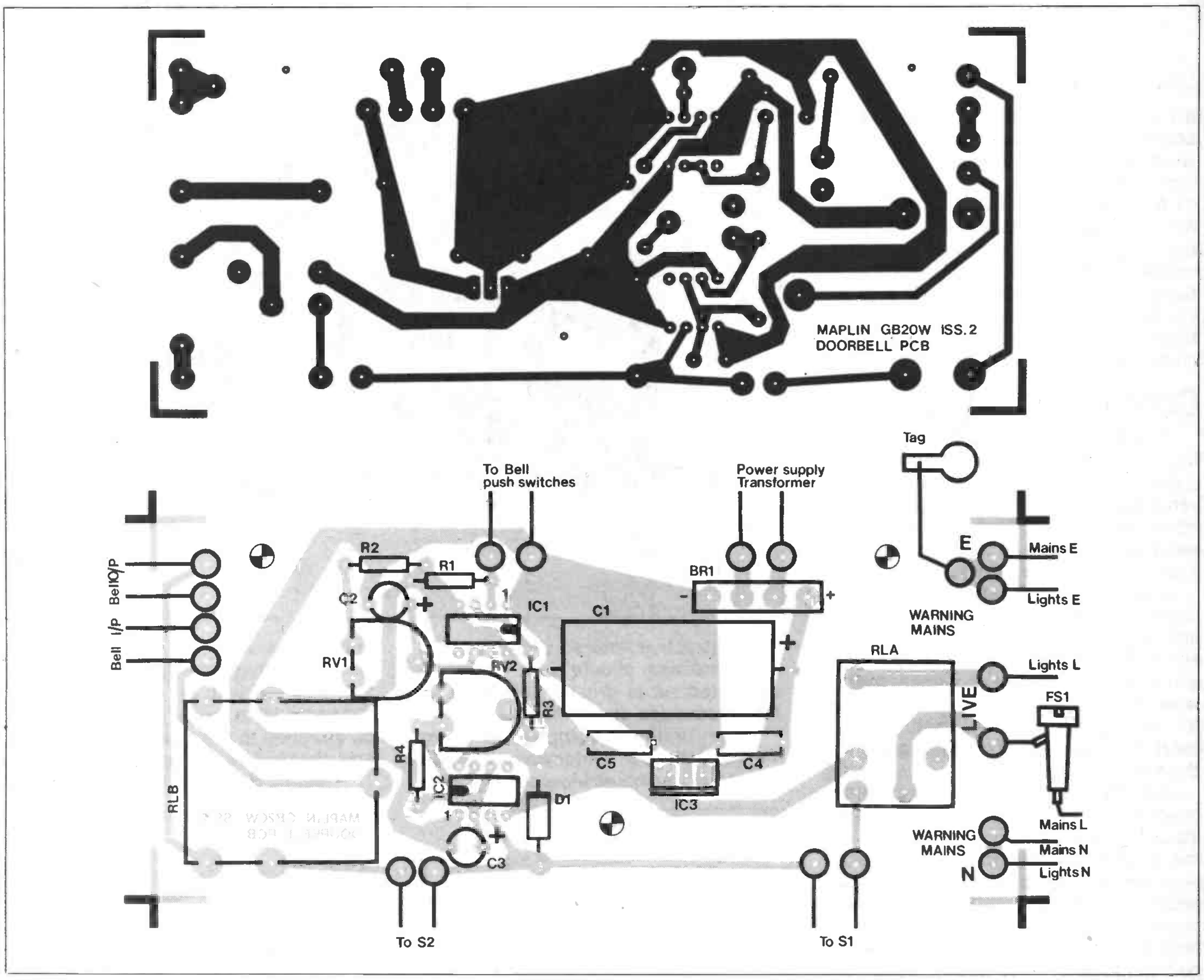


Figure 6. PCB layout and overlay.

DOORBELL FOR THE DEAF PARTS LIST

Resistors — All 0.4W 1% Metal Film

R1	10k		(M10K)
R2	100K		(M100K)
R3	22k		(M22K)
R4	68k		(M68K)
RV1	1M Hor-sub min Preset		(WR64U)
RV2	100K Hor-sub min Preset		(WR61R)

Capacitors

C1	1000uF 25V Axial Electrolytic		(FB83E)
C3	10uF 25V Tantalum		(WW69A)
*C4,5	100nF Polyester	2 off	(BX76H)
C2	22uF 16V PC Electrolytic		(FF06G)

Semiconductors

D1	1N5406		(QL85G)
*D2	1N4001		(QL73Q)
IC1,2	ICM7555	2 off	(YH63T)
*IC3	uA7812UC		(QL32K)

Miscellaneous

S1,2	Sub-min Toggle A	2 off	(FH00A)
RLA	10A Mains Relay		(YX97F)
RLB	Open Relay 6V		(FX23A)
FS1	Fuse 5A 20mm		(WR07H)
	Safefuseholder 20		(RX96E)
	Grommet small	4 off	(FW59P)
	SR Grommet 6W-1	2 off	(LR49D)
	Stand-off Short	3 off	(FW16S)
*BR1	BY164		(QF43W)
	Doorbell PCB		(GB20W)
	Case AB13		(LF14Q)
	Mains Cable	As reqd	(XR03D)
	Veropin 2141	1 pkt	(FL21X)

If there is no existing doorbell, suitable components are:—

Bell	(FL38R)
Bell Transformer	(FL37S)
Bell Push	(FQ08J)
Bell Push + Nameplate	(FQ09K)
Wire to bell push	(XR39N)

Note components marked * may or may not be used, see text.

New Books

Practical Electronic Building Blocks Book 1
by R. A. Penfold
Virtually any circuit will be found to consist of a number of distinct stages when analysed. Some circuits are specialised, but in most cases they are built up from building blocks of standard types. This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects, and gives the circuits and produce their own projects, and gives the circuits for a number of useful building blocks with details of how to change the parameters of each circuit to suit individual requirements where relevant.
1983. 110 pages. 180 x 110mm.
Order As WK51F (Book BP117)
Price £1.95 *NV*

Practical Electronic Building Blocks Book 2
by R. A. Penfold
This is the sequel to Book 1, and follows much the same pattern using different circuits. The two books do not overlap, and have been specifically written to complement each other, Book 1 dealing mainly with circuits to generate signals and Book 2 with circuits that process them.
1983. 94 pages. 180 x 110mm.
Order As WK52G (Book BP118)
Price £1.95*NV*

The Pre-Computer Book
by F. A. Wilson
Aimed at the absolute beginner with no knowledge of computing, this entirely non-technical discussion of computer bits and pieces and programming is written mainly for those who do not possess a microcomputer but intend either to one day own one or simply wish to know something about them. Also highly recommended for the new computer owner who may be beset with uncertainties and, also, the person who cannot understand the jargon and technical terms used by most manufacturers in their sales leaflets.
1983. 78 pages. 180 x 110mm.
Order As WK50E (Book BP 115)
Price £1.95*NV*

Mastering the Colour Genie
by Ian Sinclair
This book covers the BASIC of the Colour Genie, including the use of the colour graphics and sound, as well as the very comprehensive set of data filing/handling instructions. A whole host of programs are illustrated for you to enjoy as you become more proficient and able. You are shown how to write your own programs so that you are soon in command of this powerful machine.
1983. 148 pages. 234 x 155mm.
Order As WK54J (Master the Colour Genie)
Price £6.95*NV*

Assembly Language Assembled for the Sinclair ZX81
by Anthony Woods
The ZX81 does not allow you to enter assembly language programs directly, they have to be translated into machine code before they will run. There is, however, a software solution. One company has produced the ZXAS assembler and ZXDS disassembler programs which can be used to translate assembly language automatically to and from machine code, using standard Zilog mnemonics. This book has been designed especially for use with these programs. At the same time, it is structured in such a way that the reader can learn to program in assembly language just as easily as they learnt BASIC.
1983. 154 pages. 234 x 153mm.
Order As WK60Q (ZX81 Assembly Language)
Price £7.65*NV*

The Complete Spectrum ROM Disassembly
by Dr Ian Logan & Dr Frank O'Hara
Every routine in the ROM has full comments on what its function is and how it relates to the other functions in the ROM. Overall, the 16K ROM program offers an extremely wide range of BASIC functions and commands, and this book makes all the functions and entry points available for use in your own programs or for modifications into special routines.
1983. 232 pages. 214 x 141mm.
Order As WK57M (Spectrum ROM Disassembly)
Price £9.95*NV*

The Dragon 32 Games Master
by Keith & Steven Brain
This book shows you how to write your own top class games, taking you line-by-line from the first principles of writing the simplest games right through to the design, construction and testing od adventure games which can rival commercial software in complexity and presentation.
1983. 200 pages. 239 x 152mm.
Order As WK58N (Dragon, Games Master) Price £7.40*NV*

Lynx Computing
by Ian Sinclair
Aimed at all users, this book starts at the very beginning with how to set up the machine. It then goes on to guide you step-by-step until you become sufficiently expert to write your own programs and start using your machine creatively. Many useful programs are included and you will continue to find the book useful as a handy reference even after you have mastered all the techniques.
1983. 148 pages. 234 x 155mm.
Order As WK55K (Lynx Computing)
Price £7.85*NV*

Discovering BBC Micro Machine Code
by A. P. Stephenson
You can unlock your micro's latent powers with machine code, generate fast-moving graphics, make more effective use of peripherals and ancillary equipment, save precious memory and get to know your machine better. This book will show you how to get started, using many short programs and routines.
1983. 148 pages. 234 x 155mm.
Order As WK56L (BBC Machine Code)
Price £7.85*NV*

Advanced Programming for the 16K ZX81
by Mike Costello
A description of the techniques that can be applied to the ZX81 in order to overcome some of its inherent limitations. This involves some investigation of the ZX81's operating system, discussion of BASIC sub-routines, as well as details of the application of Artificial Intelligence techniques to programming for the ZX81. Later chapters are devoted to the use of assembly language programming techniques, hybrid programming techniques, hybrid programming — mixing BASIC with machine code, and developing utility programs to suit the user's own particular needs.
1983. 126 pages. 234 x 153mm.
Order As WK59P (Advanced 16K ZX81 Programming)
Price £6.55*NV*

BASIC and PASCAL in Parallel
by S. J. Wainwright
This book takes the two languages and develops programs in both simultaneously. Emphasis is placed on structured programming by the systematic use of control structures; and modular program design is used throughout. Example programs are used to illustrate the program structures as they are introduced, and the reader can learn by example. As the title suggests, the book is intended as a bilingual introduction to programming which can be used to learn both languages simultaneously, and to learn programming techniques which are compatible with both languages.
1983. 60 pages. 180 x 110mm.
Order As WK53H (Book BP126)
Price £1.50*NV*

Electronics For Technicians
by G. D. Bishop
A comprehensive basic reference text for the fast-changing world of electronics. The book is designed to cover all the electronics content of the revised T.E.C. Certificate and Diploma programmes, fit a wide range of related courses including C.S.E. and 'O' level electronics, suit first-year degree courses and those fresh to the world of electronics. It includes a number of large clear diagrams supporting the text, together with photos where necessary. The text follows the pattern of the associated T.E.C. unit syllabus, but it has been extended where necessary to create a comprehensive electronics text.
1983. 134 pages. 234 x 202mm.
Order As WK61R (Electronics for Technicians)
Price £5.95*NV*

The Commodore 64 Programmers Reference Guide
This tells you all you need to know about your Commodore 64. The perfect companion to the User Guide, the manual presents detailed information on every thing from graphics and sound to advanced machine language techniques. This book is a must for all CBM 64 owners. Comes complete with circuit diagram.
1983. 486 pages. 216 x 135mm.
Order As WK62S (CMB64 Programmers Ref Guide)
Price £13.25*NV*

How to Design and Make Your Own PCBs
by Robert Penfold
This book should enable you to familiarise yourself with both the simple and more sophisticated methods of producing PCBs. The emphasis is very much on the practical aspects of design and construction, and is highly recommended to all newcomers to electronics.
1983. 66 pages. 177 x 110mm.
Order As WK63T (Book BP121)
Price £1.95*NV*

FIRST BASE

by Mike Wharton

A Beginner's Guide to Logic Design Part 3

Solution to Problem

If you recall, there was a little problem left for you to sort out in the last section. This was to deduce the Truth Table of an array made up of two-input NAND gates, and the result which you should have arrived at is given in Fig. 1. Comparison of this table with published ones will show it to be that of the Exclusive-OR gate, (EX-OR). The common symbol for this gate, also known as the Difference gate, is shown in Fig. 2a. It is called the Difference gate since a look at its Truth Table will reveal that the output is high only when the inputs are different; the complement of this gate is the Exclusive-NOR gate, (EX-NOR), whose symbol is shown in Fig. 2b. This gate is also known as an Equivalence gate, since its output is high when the inputs are the same, and the Truth Table for this gate is shown in Fig. 3.

A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

Figure 1. Derived truth table for 2 input Exclusive OR gate.

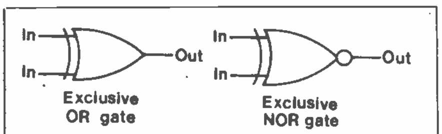


Figure 2. Symbols

A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

Figure 3. Truth table for Exclusive NOR gate

It would be possible to produce an EX-NOR gate by adding an inverter to the output of the previous EX-OR gate made up from NAND gates, thus using a total of five 2-input NAND gates. This would be quite wasteful of gates, and not surprisingly it is possible to obtain both of these devices in a single package. Thus Fig. 4a. shows the pinout of the 7486, a quad 2-input EX-OR gate package, and Fig. 4b. gives the pinout of the 74266, the EX-NOR gate package.

This now completes the list of main logic gates, although there are a few others which

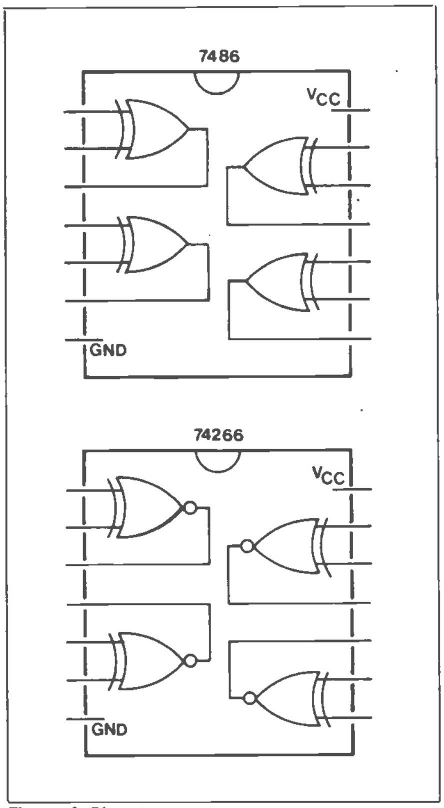


Figure 4. Pinouts

can be obtained, but these really combinations of the above types in order to obtain 'programmable' gates in the one package. An example of this is the 7451 AND-OR-INVERT gate, shown in Fig. 5; here it may be seen that the package contains two AND gates connected to the input of the NOR gate. It is left as an exercise for the reader to derive the Truth Table for this arrangement of gates.

Multi-input gates

So far we have really only concerned ourselves with gates having one or two inputs. Many of the devices available have more than this, as a glance at the relevant pages of the Maplin Catalogue will reveal. For example, the 7430 is an 8-input NAND gate, shown for reference in Fig. 6 along with its Truth Table. Fortunately, this does not make the understanding of these gates that much more difficult. If you look back at the previous Truth Tables, as well as the one for the 8-input NAND gate, you will see that they all have a unique output state. An exception to this rule are the Truth Tables for the EX-OR and EX-NOR gates, which are special cases. The other gates have just one value of logic output for a particular set of inputs; for example, in a 2-input AND gate the output is always low except when both inputs are high. In a 2-input NAND gate, the output is always high, except when both inputs are high, and this follows on for the 8-input NAND gate, where the output is always high except when all the inputs are high.

That this is so can be tested by connecting up a 7430 on a bread-board with a

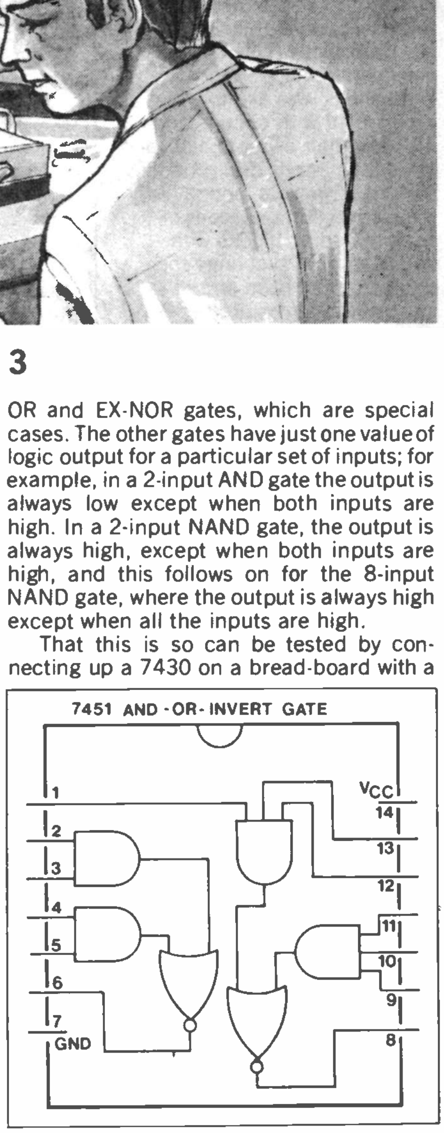
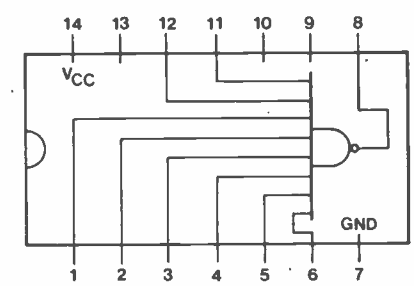


Figure 5. Pinout



7430 8 INPUT NAND GATE

A	B	C	D	E	F	G	H	Q
0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	1
0	1	0	0	0	0	0	0	1
				etc				
0	0	0	0	0	0	0	1	1
1	1	1	1	1	1	1	1	0

Figure 6. Pinout and truth table

LED wired to the output, as shown in the last issue. If each of the inputs is connected to logic 1 then the output will be found to be at logic 0, with the LED extinguished. If one of the inputs is now taken to logic 0, then the LED will light up, and will remain alight while any number of inputs are held at logic 0.

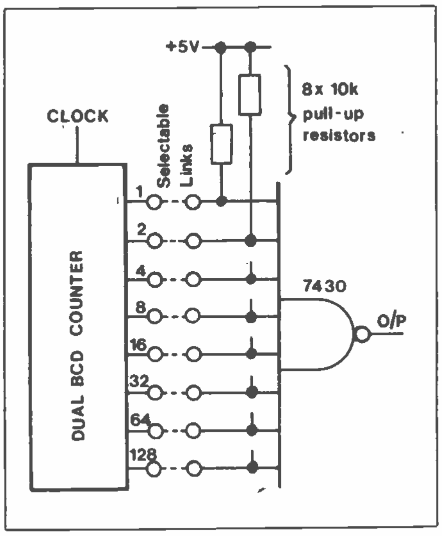


Figure 7. Part of counter/decoder circuit

The use of such a device may be demonstrated by referring to the part of a circuit shown in Fig. 7. The problem here was to produce a signal from the output of the 8-input NAND gate after the counter had counted a selectable number of clock pulses. To achieve this action, each of the inputs is connected to logic 1 by a 'pull-up' resistor, thereby ensuring that the output will be logic 0. The numbers shown by the outputs from the BCD counter are the number of clock pulses which need to be counted before that particular output goes high, assuming a start from zero. Without going into any further detail of how the outputs from the counter would appear, by connecting the appropriate links it is possible to set the circuit to count any value of pulses from 1 to 255. For example, if it were required to count up to 23 clock pulses before a logic 0 appeared at the output of the NAND gate, then the links for 1,2,4 and 16 would be made, since 1+2+4+16=23.

The individual pull-up resistors are needed on the inputs in order to ensure that any unconnected inputs are held at logic 1; the value of these resistors is not all that critical, but it must be remembered that the output of the counter will be required to sink the current through them when it goes low. The BCD counter is a rather different type of animal from the ones we have encountered so far, belonging to the breed of sequential logic devices. This is a whole range of beasties which will be dealt with in a lot more detail in a subsequent article.

Arithmetic Logic Units

Any reader who has perused books or articles on the subject of micro-processors or micro-computers, and these days it's hard to avoid them, may well have come across the term Arithmetic Logic Unit, or ALU. This is the part of the micro-processor which is concerned with 'doing sums' and other logical operations. Needless to say, in a real life processor, this section contains a multitude of functional devices, but it is possible to emulate one of its basic building blocks, the Adder. Side-stepping the old jokes about venomous snakes, the digital adder comes in two types, the half-adder and the full-adder. However, before we delve into the workings of these circuits, it may well be a good idea to brush up on some binary arithmetic.

I am sure everyone reading this is fully conversant with denary arithmetic, that is working in powers of ten. In binary arithmetic the same rules apply, but in this case we are using the number base of two, with the digits 0 and 1. When two denary (or decimal) digits are added together there are two possible situations:

a) a third digit, larger than the other two results, but smaller than the base of the number system, eg,

```
 5     1
+3    +4
 8     5
```

The new digit, 8 or 5 in these examples, is called the SUM.

b) the third digit is equal to or larger than the base of the number system,

```
        5          8
       +6         +7
  1     1     1    5
CARRY  SUM  CARRY  SUM
```

In this case the position of the digits comes into play and the answer consists of two parts, the SUM and the CARRY. The generation of Sum and Carry occurs whatever number base is in use. In binary addition the generation of Carry bits occurs much more often, as there are only two digits.

```
 0      0               1
+0     +1              +1
 0      1        1      0
SUM    SUM     CARRY   SUM
```

These examples cover nearly all the possible combinations of binary addition, the only other one being where the 0 and 1 are reversed in the middle example!

Where binary numbers containing more than one digit are to be added, then the process can be broken down into a series of repeated two-digit additions, until the process is complete. For example:-

```
        10          111
       +01         +010
CARRY   11   SUM   1001
```

In the second example, the addition of the first (right-hand) digits of 0 and 1 gives a Sum of 1, and no Carry; adding the next two digits, 1 and 1, produces a Sum of 0 and a Carry of 1. The next stage is to add together 0, 1 and the Carry; as before 0 and 1 give a Partial Sum of 1, and adding the 1 carried over gives a Sum of 0 and a Carry into the next column. The simple rules of binary addition may be summarised in a Truth Table, shown in Figure 8.

A	B	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Figure 8. Binary addition truth table

Looking at this Table it is possible to see that a Sum OR a Carry is the result of a binary addition, never a Sum AND a Carry. To perform this operation with logic gates, it i only necessary to find ones which have the same Truth Table as that for binary addition. The circuit would require two inputs, A and B and two outputs to correspond to the Sum and Carry. This can, in fact, be achieved in several different ways; if you look back at the Truth Table for the EX-OR gate and the AND gate it is apparent that the Sum part is the same as the EX-OR truth table and the Carry part is the same as the AND gate. Actually, this is not quite a full solution, since no account has been taken of the fact that a Carry bit may have been produced by an earlier stage, and hence this is known as the half-adder.

Half-Adder Circuit

A digital half-adder circuit may be made up, on a bread-board, following the diagram given in Figure 9. Here it can be seen that the two gates which are required are the EX-OR and the AND gates. Possibly the most convenient method of making up this circuit is to use single gates from a 7486 and a 7408, and connect them up as shown. In this case the two bits to be added are applied to inputs A and B to give the Sum and Carry appear at the corresponding outputs. It is also possible, remember, to make up such gates as these from the common NAND gate. We have already seen how the EX-OR gate may be made up from four 2-input NAND gates, and so to complete the picture figure 10 shows how the AND gate may be fashioned. It is left as a further exercise for the reader to make up the half-adder circuit from NAND gates and confirm that it is logically identical to the first design.

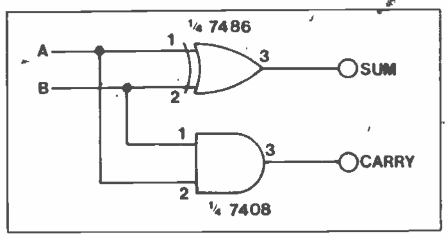


Figure 9. Circuit for half-adder

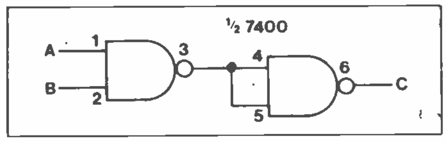


Figure 10. AND gate using NAND gates

Full-Adder Design

The half-adder is incomplete in that no provision is made for a 'carry-in' from a previous stage. In the case of the full-adder, not only is account taken of this, but also a provision is made for the possible generation of a 'carry-out' to subsequent stages. Again, the requirements of the full-adder may best be summarised in the form of a Truth Table; this will need to have three inputs, A,B and Carry In, with two outputs, Sum and Carry Out, as shown in Figure 11.

A	B	CARRY IN	SUM	CARRY OUT
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Figure 11. Truth table for binary full adder

The full-adder is, in essence, two half-adders connected together to take account of the extra bit carried in. The circuit for the full-adder is given in Figure 12. Again, although this is shown made up from discrete gates, it can also be done with NAND gates in the same manner as the half-adder.

If more than two bits are to be summed then the block can be repeated, with the carry out from one stage being connected to the carry in of the next stage. Finally, Figure 13 shows a couple of full-adders being used to add binary 11 and 11, giving 110; ie decimal 3+3=6.

Address Decoding

Still on the micro-processor scene, another important use of TTL combinational logic designs is in the area of address decoding. The essential problem here is to produce a signal in response to a unique pattern of bits on the micro-processor address bus. This pattern of bits is, of course, the address of the device which is being sought in order to send or receive data along the data bus of the system. Typically,

Continued on page 64

Logic Probe

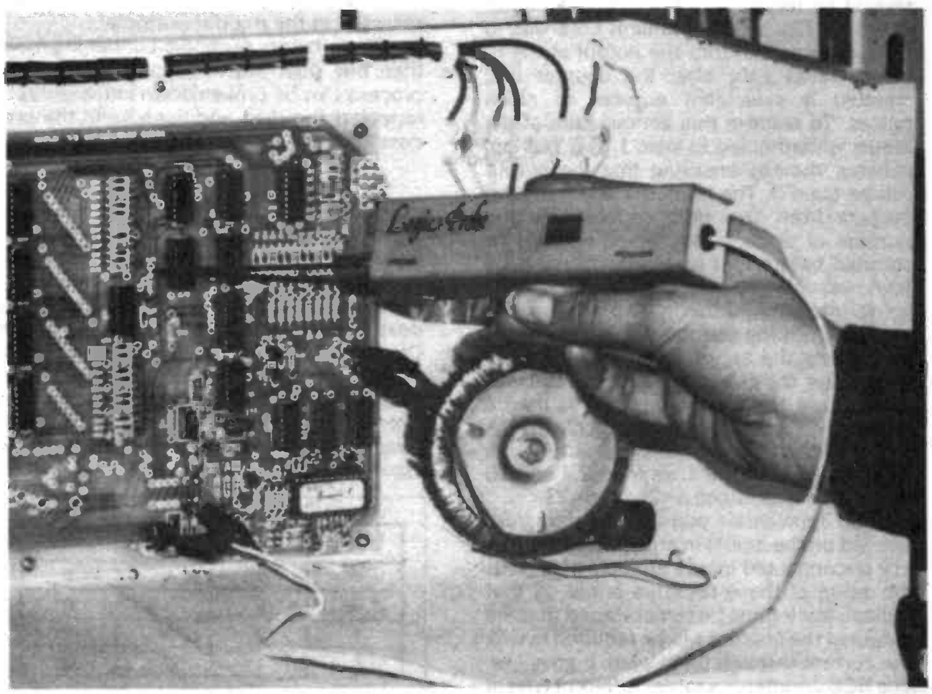
by Graeme Durant

- ★ **Detects pulses from around 1Hz**
- ★ **Instantly recognisable logic states**
- ★ **Low current consumption**
- ★ **Over volts protection**

Over the years, countless designs have appeared in the electronics press for logic probes; ranging from very simple High/Low indicators, to complex pulse stretching probes. The logic probe described here, has a number of features found only on the more complex probes, and as such, lies somewhere between these two extremes. Thus it is perfectly suited to day to day fault diagnosis.

As well as detecting High and Low logic states, open circuit (floating input) and pulsing inputs are displayed. Pulse trains from around 1Hz are detected as a pulsing input, the upper limit is above that attainable in most common C-MOS logic.

The main difference between this logic probe and all others is that the output is shown on a seven segment LED display, as a letter of the alphabet; Hi for High; L for Low; F for Floating; P for Pulsing. In this way, the logic state is instantly recognisable and totally unambiguous, unlike some commercial logic displays. The use of a special high efficiency display means that the total current consumption at a supply voltage of 15v is only 15mA - quite suited to battery operated circuits. In addition, the probe is protected against over-voltage inputs, and reversed supply.



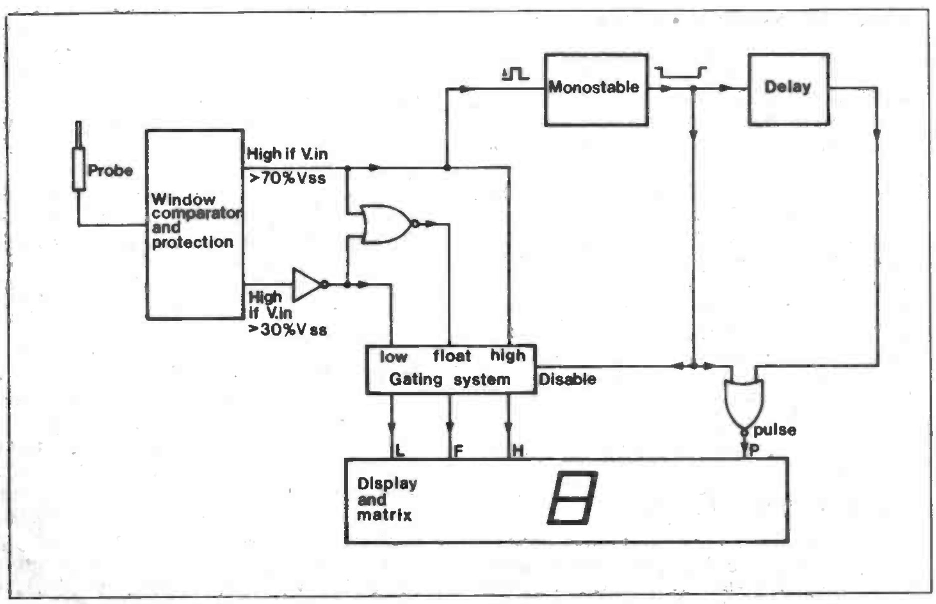


Figure 1. Block diagram.

Block Diagram

The input from the probe goes via a protection network to a window comparator, with switching levels of 70% V_{SS} and 30% V_{SS}; these are the standard CMOS limits. If the upper limit is exceeded, then the probe input is CMOS logic high. Thus, the upper output goes on to the display circuitry for HIGH indication.

If the probe input does not exceed the lower limit, then it is at CMOS logic low. The output of the lower comparator is inverted to give a high level at the display circuitry for LOW indication. If the probe input is between logic levels,

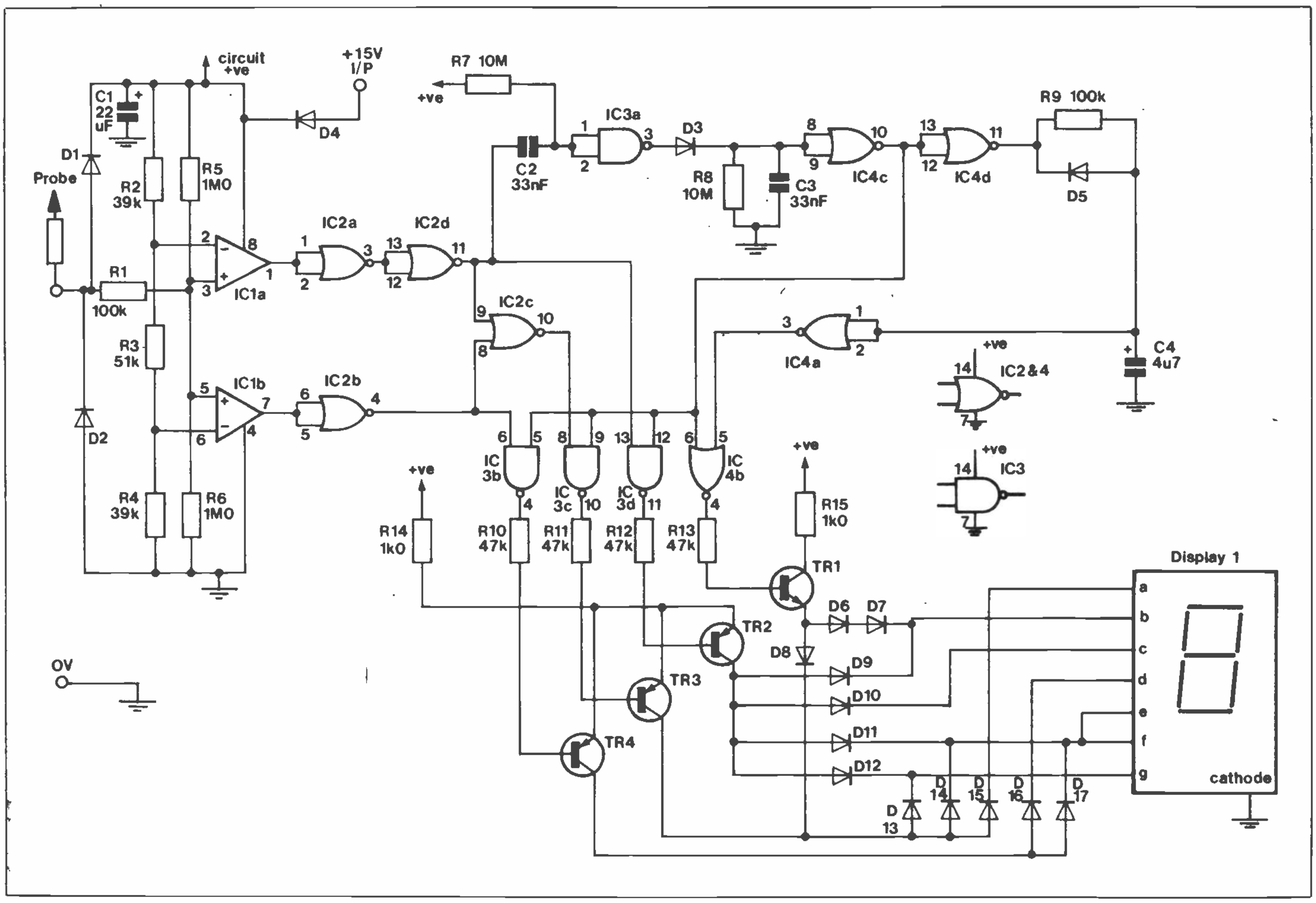
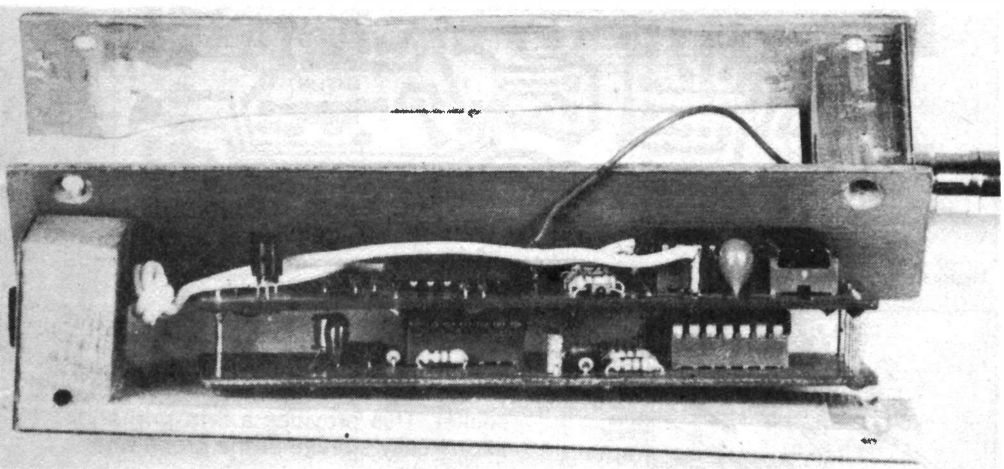


Figure 2. Circuit diagram.



then the upper comparator will be low and the lower comparator high. These two outputs are fed to a NOR gate, which gives a high level to the display circuitry on FLOAT.

The HIGH indication also drives a retriggerable monostable. will produce a continuous low output. If this monostable goes low, the display is disabled via a simple gating system. This is to prevent misleading displays, whilst the circuit decides whether the input is indeed pulsing, or whether a low to high transition has taken place (e.g. the probe has just touched a point at logic high). As soon as a low pulse appears at the monostable output, a delay, slightly

PARTS LIST FOR LOGIC PROBE

Resistors: All 0.4W 1% metal film unless specified

R1,9	100k	2 off	(M100K)
R2,4	39k	2 off	(M39K)
R3	51k		(M51K)
R5,6	1M0	2 off	(M1M0)
R7,8	10M	2 off	(B10M)
R10-13	47k	4 off	(M47K)
R14, 15	1k0	2 off	(M1K0)
Capacitors			
C1	22uF 25V Tantalum		(WW73Q)
C2, 3	33nF polycarbonate	2 off	(WW35Q)
C4	4u7F 35V Tantalum		(WW65V)
Semiconductors			
IC1	CA3240E		(WQ21X)
IC2, 4	4001BE	2 off	(QX01B)
IC3	4011BE		(QX05F)
TR1	BC107B		(QB31J)
TR2, 3,4	BC557	3 off	(QQ16S)
D1, 2	BAR28	2 off	(QQ13P)
D4	1N4001		(QL73Q)
D3, 5-17	1N 4148	14 off	(QL80B)
Disp.1	Low current disp.		(QY54J)
Miscellaneous			
	Printed circuit board (top)		(GB30H)
	Printed circuit board (bottom)		(GB31J)
Additional parts if required			
	8pin DIL skt		(BL17T)
	14pin DIL skt	3 off	(BL18U)
	Screened phono plug		(HH01B)
	Threaded phono skt		(YW06G)
	Croc. clips		(HF25C)
	Zip wire	1 metre	(XR39N)
	Filter red		(FR34M)
	Veropin 2141	1 pkt	(FL21X)

A complete kit of all parts is available. Order As LK13P (Logic Probe Kit). Price £9.95.

longer than the monostable period is initiated. At the end of this time period, if the output of the monostable is still low, i.e. the input is pulsing, the display shows PULSE. Otherwise, the HIGH/FLOAT/LOW display is enabled again.

The display consists of driver transistors, a diode matrix to produce the desired alphabetic displays, and a seven segment LED display.

Circuit Description

The probe input goes via R1 to a simple window comparator formed around IC1. R2, R3 and R4 determine the changeover voltage levels. The circuit input is protected from overvoltage by D1, D2 and R1; the input is biased at half supply by R5 and R6 so that if the input is open circuit, the display shows FLOAT. The upper window comparator output is buffered by IC2a and IC2d, and goes to the display switching transistor for HIGH indication, via IC3d, which allows the HIGH display to be disabled.

The low and float displays are similarly connected, using IC2b and IC3b for LOW, and IC2c and IC2c and IC3c for FLOAT.

A simple CMOS monostable wired around IC3a and IC4c, and having a period of around 0.5 seconds senses a pulsing input. Its output, which is normally high, disables the HIGH/FLOAT/LOW display, and starts a delay, formed around C4 and R9, which is a little over the monostable period. The output of the RC delay is inverted and fed to IC4b, which senses whether the input is still pulsing. If it is, Q1 is switched on, and PULSE is displayed. Otherwise Q2 to 4 are enabled. A diode matrix and seven segment common cathode display decode the signals, so as to give H, F, L and P displays.

'Construction'

Before soldering in any components, solder in wire links on both PCBs, there are eight in all. Fit in all the resistors and capacitors, taking care with polarity on C1 and C4. If you are using IC sockets these may be fitted along with the diodes — again be careful about polarity. Note also, that D4 is fitted vertically on the PCB. Fit the transistors, and finally, the ICs. It is a good idea to use veropins for all the cable to PCB connections, but it is not vital. This only leaves the display, which requires setting at the correct height to fit inside a suitable case.

The PCBs are mounted one on top of the other in the case, with connections between made by solid wire links - cropped component leads are ideal. Solder eleven lengths of wire, about 20mm long, to the underside end connections of the top board, passing the wire through the holes until level with the topside of the PCB. See Figure 5.

Slide on the lower board, until there is a gap of a millimetre or so between the top board and the tallest components

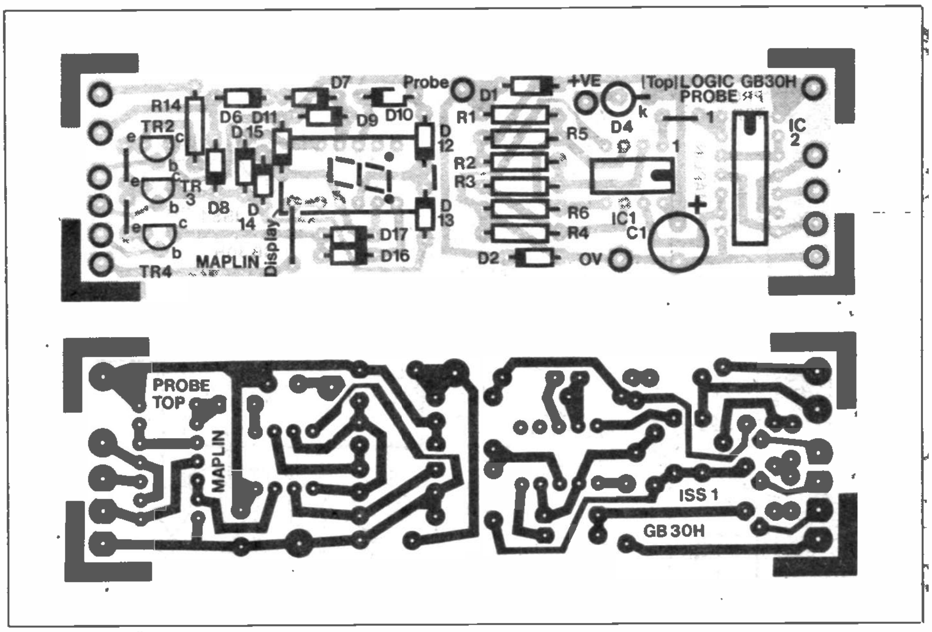


Figure 3. PCB layout.

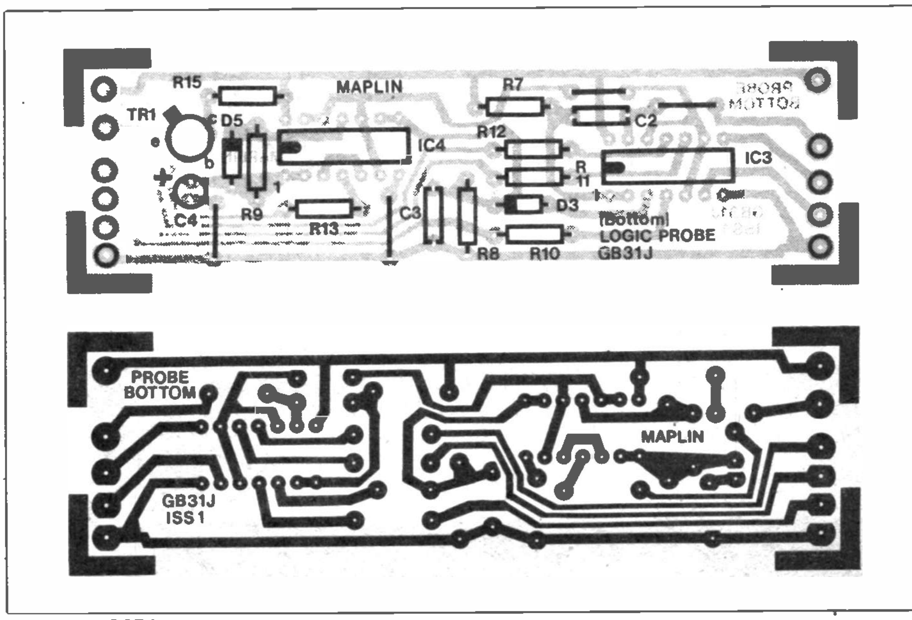


Figure 4. PCB layout.

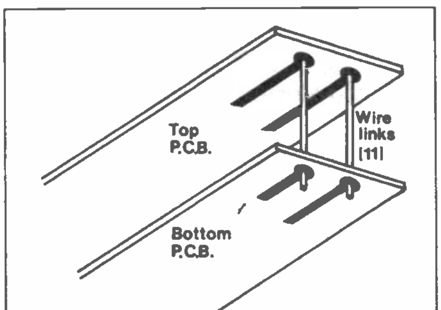


Figure 5.

on the bottom PCB. Solder the wires to the bottom board and crop as normal.

The circuit now may be fitted into the case, insulated from the case bottom by masking tape and held firmly in position by sticking a strip of thin foam rubber in the lid, with a cutout for the display. A small square of red display filter film may be stuck behind the cutout for the display for easier viewing.

The power cable, a piece of Zip wire terminated in crocodile clips must pass through the case via grommet. The probe, made from a sharpened steel rod or knitting needle, is soldered into a Phono plug, and connected to the circuit by a case mounted Phono socket. This provides a firm grip and allows easy storage of the probe when not in use.

Testing and Use

Power the circuit up with a typical CMOS supply voltage. After around half a second, the display should show a letter F. If not, disconnect quickly, and recheck the circuit. If all is well, touch the probe to positive - a letter H should be light after a brief delay. Tap the probe on and off positive a few times a second - a letter P should be displayed after a delay. Then, touch the probe to Ov - a letter L should light immediately. If all this happens, the probe is working perfectly.

The probe is designed for use with CMOS logic circuitry, and may be used to trace faults on any such logic. All that remains now is to find a suitable circuit to test!

MACHINE CODE PROGRAMMING WITH THE 6502

Part Two

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

Memory Addressing

Little progress can be made in writing machine-code programs without a reasonable degree of understanding of the addressing modes available. The better the understanding, the better the programs. In a program written by the user, all of the instructions and data will be entered into the RAM area of memory, and running the program will access these instructions and data sequentially. Questions then naturally arise. Whereabouts in the RAM should the program be located? What are the criteria that determine the choice of locations? Given that there are a variety of ways of loading and storing data, how does one decide which method to use? It is the intention of this article, the second of this series, to answer these questions by showing how some of the 6502 addressing modes work. So that it is possible to 'see the wood in spite of the trees', no attempt will be made at this stage to write anything very ambitious in the way of programs. That can come later. But the first 6502 mnemonics and their corresponding op-codes will be met so that addressing can be seen to be used in a meaningful sense.

The Paging Concept

Memory is organised in 'pages', each 256 bytes long. These are known as 'Page 0', 'Page 1', 'Page 2'... 'Page E', etc. The page number is obtained by writing the memory addresses in numbers of four HEX digits length and examining the two most significant digits.

Thus, Page 0 runs from 0000 to 00FF
Page 1 runs from 0100 to 01FF
Page 2 runs from 0200 to 02FF

Page E runs from 0E00 to 0EFF
etc.

This idea of pages is more important than might be thought. For one thing, it is possible to write a shorter (and hence faster) program on Page 0 than on others - because of a unique addressing mode that will be explained shortly. Secondly, crossing a page 'boundary' in certain operations incurs a loss of speed.

A pictorial method of illustrating memory is the 'memory map', an example of which is shown in Figure 1. This shows both

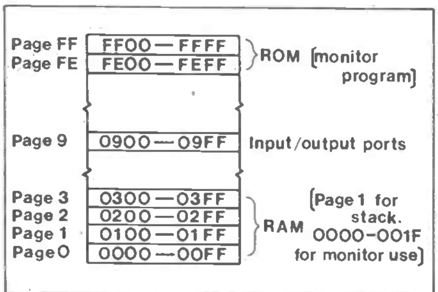


Figure 1. Memory map of a typical small microcomputer.

the pages referred to and also the way in which they are allocated. This memory map may be taken to represent a typical small development microcomputer with just 1K of RAM and 512 bytes of ROM. Whatever computer is concerned, it will be necessary to determine its memory map so as to know (a) which areas of RAM are available for user programs and (b) where the input/output ports are located. The 'stack' is standard on all 6502-based machines, being located on Page 1 - thus this page is not to be used for user programs, except in stack operations. One word of warning - the monitor program, which is stored in ROM and controls the computer operation, may well have a small part of one of the RAM pages (e.g. Page 0) reserved for its own use for what is known as a 'scratch-pad'. User programs should not be written here as strange things will happen!

Assembly Code and Machine Code - the first mnemonics

Assembly and machine codes are both termed 'low-level languages'. Assembly code consists of easily recognisable mnemonics and is the form in which the program is first written. When there is a good chance that the program will work, then it can be put into machine code; this consists of op-codes and data, whose meanings at a glance are much less obvious. It is as well to be disciplined in approching program writing right from the start, since a well laid out program is easier to de-bug than one in which the logical approach is missing. When writing the Assembly Code program space should be left alongside for the related machine-code program; then a direct correspondence between the two can always be seen.

Now for a few instructions and their Assembly Code mnemonics:

SED - Set the Decimal mode (for arithmetic operations)
LDA - Load the Accumulator (with the byte of data specified in some way by what follows next)

The bracketted words actually refer to the addressing mode to be used.

CLC - Clear the Carry (flag): sets the carry flag to zero
ADC - Add with Carry (adds the contents of the accumulator - plus the carry flag - to the data specified by what follows next) This operation was illustrated diagramatically in Part One of this series.
STA - Store the accumulator contents (at a location determined by what follows next)

These mnemonics, as listed, actually form a short program that adds together two numbers and stores the result. The only problem that needs them to be solved is how to address the memory, both to fetch the data, i.e. the numbers to be added, and to

MNEMONIC	OP CODE	OPERATION
BRK	00	Break
CLC	18	0 → C
CLD	D8	0 → D
CLI	58	0 → I
CLV	B8	0 → V
DEX	CA	X-1 → X
DEY	88	Y-1 → Y
INX	E8	X+1 → X
INY	C8	Y+1 → Y
NOP	EA	No operation
PHA	48	A → Stack
PHP	08	P → Stack
PLA	68	Stack → A
PLP	28	Stack → P
RTI	40	Return from interrupt
RTS	60	Return from sub-routine
SEC	38	1 → C
SED	F8	1 → D
SEI	78	1 → I
TAX	AA	A → X
TAY	A8	A → Y
TSX	BA	S → X
TXA	8A	X → A
TXS	9A	X → S
TYA	98	Y → A

Table 1. 6502 instructions using inherent addressing.

store the result of the addition. So now to some 6502 addressing modes.

Inherent Addressing (Implied)

There are two instructions in the above program that use this mode. They are SED and CLC. This is the simplest form of addressing since it is complete as it stands; there is no following data byte/s. This is a 'single-byte' instruction which is performing an operation which is totally self-contained within the MPU chip. The complete list of 6502 instructions that use this mode are given in Table 1.

Zero Page Addressing

This mode provides access to all memory locations on Page 0 i.e. the addresses in the range 000 - 00FF. These are 'two-byte' instructions; the first byte is the instruction itself e.g. LDA; the second byte is the Page 0 address where the data is located. Suppose as an example this address is 0030; using zero page addressing this is specified simply by the HEX number 30. It is a utility of 6502 programming that all Page 0 addresses can be identified by using the low byte of the address only; for all other pages of memory both bytes must in some way be specified. It is for this reason, as mentioned earlier, that programs on Page 0 run faster than those on other pages.

The op-code for LDA on Page 0 is A5 so that the program line in machine code for this operation is:

A5 30

It should now be appreciated that this represents an instruction to the MPU to load its accumulator with whatever number it finds at memory location 0030 - in a language which it can understand i.e. HEX machine code. Actually that is a half-truth since there also has to be a further translation from HEX into binary, but this is not a worry of the programmer; the machine sorts this out itself.

Immediate Addressing

This is also a 'two-byte' addressing mode but with the following important difference. The second byte is not an actual address for the data but is the 'data itself'. To distinguish it from zero page addressing the # (hash) is used in Assembly Code and, of course, the op-code for machine-code is different. This is illustrated by the following example:

Assembly Code	Machine Code	Comments
LDA MEM1	A5 30	Zero page mode

(meaning Load Accumulator with data at address 0030)

LDA #30 A9 30 Immediate mode (meaning Load Accumulator with the number given i.e. 30)

Notice one point of protocol - in the Assembly Code for zero page the memory location is simply referred to as MEM1, whereas in the corresponding machine code the actual address is specified i.e. 30=0030. MEM1 is called a 'label' and is generally used in writing Assembly Code programs so as to preserve a general approach to program writing. It is later, when the program is encoded into machine code, that the actual memory location to be used can be assigned.

Absolute Addressing

Naturally it often happens that access is required to memory locations that are on another page other than Page 0. One way of achieving this is to use the 'three-byte' mode known as absolute addressing. The first byte is the appropriate op-code followed by the full two bytes of the address. Straightforward enough evidently but note that in machine-code the 'low' byte of the address comes 'first', thus; the op-code for LDA in this mode is AD so that, to load the accumulator from the Page 3 memory location 031A, the program line in machine-code would be - AD 1A 03. Obviously a point to remember.

The instructions that can use the Immediate, Zero Page or Absolute addressing modes are listed in Table 2. together with their op-codes.

ASSEMBLY CODE				MACHINE CODE			
LABEL	MNEMONIC	DATA	COMMENTS	PC	OP CODE	DATA/ADDRESS	
					BYTE 1	BYTE 2	BYTE 3

Figure 2. Scheme for headed programming sheet.

	ASSEMBLY CODE				MACHINE CODE			
	LABEL	MNEMONIC	DATA	COMMENTS	PC	OP CODE	DATA/ADDRESS	
						BYTE 1	BYTE 2	BYTE 3
[a]		SED		Sets dec. mode	0020	F8		
		LDA	MEM1	MEM1 ⟶ A	21	A5	30	
		CLC		0 ⟶ C	23	18		
		ADC	MEM2	MEM1+MEM2 ⟶ A	24	65	31	
		STA	MEM3	A ⟶ MEM3	26	85	32	
	MEM1=0030; MEM2=0031; MEM3=0032							
[b]		CLD		Clears dec. mode	0050	D8		
		LDA	MEM4	MEM4 ⟶ A	51	A5	60	
		SEC		1 ⟶ C	53	38		
		SBC	# 10	MEM4 − 10 ⟶ A	54	E9	0A	
		STA	MEM5	A ⟶ MEM5	56	8D	1F	03
	MEM4=0060; MEM5=031F							

N.B. ⟶ means "goes into"

Figure 3. Two simple programs: (a) single-byte addition (b) subtraction.

MNEMONIC	OP CODE			OPERATION
	IMM.	ABS.	0 Page	
ADC	69	6D	65	A+M+C ⟶ A
AND	29	2D	25	A ∧ M ⟶ A
ASL		0E	06	C ← [ ] ← 0
BIT		2C	24	A ∧ M
CMP	C9	CD	C5	A − M
CPX	E0	EC	E4	X − M
CPY	C0	CC	C4	Y − M
DEC		CE	C6	M − 1 ⟶ M
EOR	49	4D	45	A ⊻ M ⟶ A
INC		EE	E6	M + 1 ⟶ M
JMP		4C		Jump to:
JSR		20		Jump sub
LDA	A9	AD	A5	M ⟶ A
LDX	A2	AE	A6	M ⟶ X
LDY	A0	AC	A4	M ⟶ Y
LSR		4E	46	0 → [ ] → C
ORA	09	0D	05	A ∨ M ⟶ A
ROL		2E	26	[ ] ← C ← (rotate left)
ROR		6E	66	C → [ ] → (rotate right)
SBC	E9	ED	E5	A − M − C ⟶ A
STA		8D	85	A ⟶ M
STX		8E	86	X ⟶ M
STY		8C	84	Y ⟶ M

Table 2. 6502 instructions using immediate, zero page or absolute addressing.

Two Simple Machine Code Programs

The list of instructions for a simple 'single-byte' addition program has already been given. This program can now be encoded into machine-code in order to illustrate the way in which a written program may be laid out and to clarify, if needed, some of the instructions.

It will be necessary when writing the machine-code program to assign actual memory locations. As already explained, those addresses available will vary from one machine to another. However, rather than get round the problem by putting in a series of Xs whenever an address is needed, as it is sometimes done, the memory map of Figure 1. will be used. This approach is much more meaningful in terms of learning how to write programs, and it is only necessary for the individual programmer to remember that he may well have to assign different addresses for his own machine.

A headed programming sheet might look something like that shown in Figure 2. The column headed LABEL is only needed for programs containing 'branches' or 'jumps' but, for a general purpose programming sheet it should be included. PC stands for Program Counter, of course, and it is this register that holds all of the program memory locations, in turn, as the program runs.

Figure 3. shows two of the simplest programs possible - single-byte addition, and subtraction. These are included to illustrate the use of the programming sheet as well as the addressing modes that have been discussed so far.

The addition program starts by selecting the 'decimal' mode i.e. all data is handled as Binary Coded Decimal (BCD); the alternative mode is HEX. The accumulator is then loaded with the contents of the location labelled MEM1 (actual address 0030) and the carry flag is cleared prior to the addition. This step is necessary since the state of the carry flag is quite arbitrary at this instant and the 6502 instruction set has only the one addition instruction, which always includes the carry bit. Next the accumulator contents and the data at MEM2 (0031) are added together, the result being retained in the accumulator. This sum is then stored at MEM3 (0032). The whole program has been carried out on Page 0.

MNEMONIC	OP CODE	OPERATION
BCC	90	Branch on C=0
BCS	B0	" " C=1
BEQ	F0	" " Z=1
BMI	30	" " N=1
BNE	D0	" " Z=0
BPL	10	" " N=0
BVC	50	" " V=0
BVS	70	" " V=1

Table 3. 6502 instructions using relative addressing.

The subtraction program could have been written on very similar lines but has been used, instead, as an illustration of the Immediate and Absolute addressing modes.

The program starts by clearing the decimal mode i.e. HEX arithmetic is selected (a choice entirely at the user's whim). The accumulator is loaded with the contents of MEM4 (0060) and the carry flag is 'set'. This must always be done before a subtraction so that 'borrows' can be made as required. The number subtracted from the accumulator contents is the decimal number 10 (immediate mode), which has to be written in HEX for the machine-code program and then becomes OA. The result of this subtraction is retained in the accumulator, which is then stored on Page 3 (at 031F), which requires absolute addressing.

Unless the above is absolutely crystal clear it would be as well to study these two programs carefully alongside Tables 1 and 2 so tht the op-codes used in them can be related to the addressing modes used. A look at the PC column shows that only the address for the first byte on a program line is given; however, the other addresses have been allowed for, as study of the PC column should make clear. For example, in the addition program there are eight bytes corresponding to the eight memory locations 0020 - 0027 respectively. Notice also that the subtracting program is longer at nine bytes because of the absolute mode used for the store operation.

Perhaps it might be as well to make it clear now that these two apparently trivial programs are included principally to illustrate the points made so far and to establish a structured approach towards programming. Obviously one does not need a computer just to add or subtract two numbers, but one might do so as part of a much larger and, hence, more complex program. In fact, such operations may need to be repeated many times during the course of a program run. They would then be called as 'sub-routines' each time required. It is intended to familiarise the reader with the whole of the 6502 instruction set and to show how to write programs to perform useful, mainly control-centred functions.

Relative Addressing

This mode is used only with 'branch' instructions, i.e. where a departure is made from the current address to another part of memory, as the result of a decision. This offers alternative courses of action based on the current state of affairs. For example, taking inputs to the computer from transducers and testing their values may decide the value of the output to some control element, perhaps a relay, lamp, motor, heater, etc. Flowcharts show clearly the action of branches. For example, Figure 4(a) shows the idea of testing an input and taking the appropriate action for a computer-controlled furnace, while Figure 4(b) shows the computer making this same type of decision based on the accumulator status. Table 3 lists all of the 6502 instructions that use relative addressing.

Obviously a change in program direction can be either forward or backward, i.e. a branch can be 'positive' or 'negative'. In relative addressing the 'length' of the branch is added to or subtracted from the current contents of the program counter, thus causing the program to branch suddenly from one area of memory to another. The length of the branch is simply the number of steps that must be made through memory to the required new location.

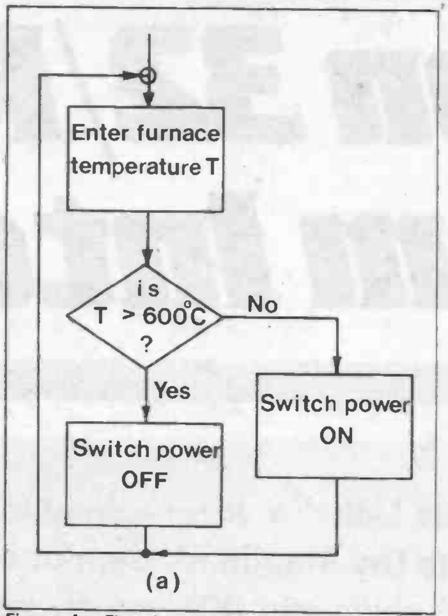
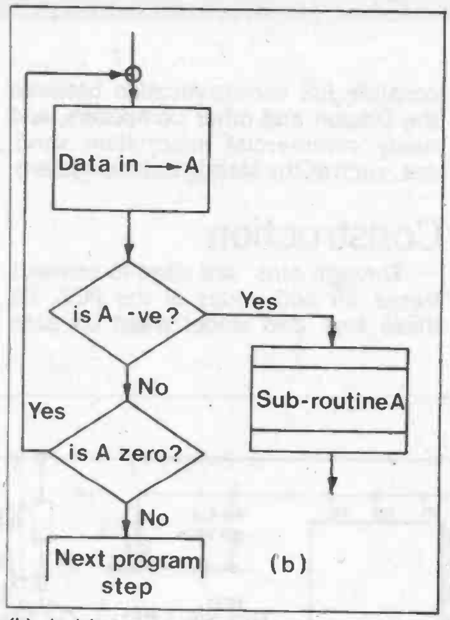


Figure 4. Flowcharts (a) computer-controlled furnace.



(b) decision making based on accumulator status.

Suppose that a positive branch must be made when the accumulator contents are negative and a negative branch is to be made elsewhere if these contents are instead zero, perhaps as the result of a subtraction that has just been performed. Otherwise, if the accumulator contents are positive the program doesn't branch at all but just proceeds to the next step in the program. The program segment might look like this:

```
LOAD  LDA   MEM1    0020  A5 E2
      SEC             22  38
      SBC   #20       23  E9 14
      BNE   OUT       25  D0 OA
      BEQ   LOAD      27  FO F7
             |
             |
             |
OUT   STA   PORT B  003B  8D 00 09
```

The data for the BNE and BEQ instructions are the branch lengths, which are OA and F7 respectively, computed as follows.

(i) Positive branch: BNE to OUT; the memory location for the latter is seen to be 003B. When the program branches to this location it then finds the instruction to store the accumulator contents at the output port B. In this way the decision and action is taken to output data from the computer to some peripheral device. The question now is 'from where does the branch start?' The answer is that a branch always starts from the address immediately following the one at which the branch length is to be found - in this case 0027 (the branch length being at 0026). The reason for this is quite simple. The program counter is stepping sequentially through the program instruction and data bytes, each byte being sent in turn to the 6502's instruction register where it is decoded. While this decoding is taking place, the program counter automatically increments to the next address in the sequence, so it is one step ahead when the branch length is in the instruction register. This instruction register, which has not been mentioned before, is for the decoding mentioned only and is not accessible to the programmer.

The branch length is therefore the number of steps between 0027 and 003B which is 10 in decimal or 0A in HEX. Count them!

(ii) Negative branch: BEQ to LOAD; this time it is necessary to go backwards to 0020. The branch starts at 0029 so, therefore, the branch length is -9 (the - sign indicates a negative branch) and this has to be written as a 'signed HEX number' - not as bad as it sounds.

Method 1.

(i) Write 9 in binary (8 bits)	= 00001001
(ii) Complement it	= 11110110
(iii) Add '1' to it	= 11110111
(iv) Write this as two HEX digits	= F7

Method 2.

Note the following sequence of HEX numbers:

F7	=	-9	
|		|	
|		|	
|		|	
FD	=	-3	Negative numbers
FE	=	-2	
FF	=	-1	
00	=	zero	
01	=	+1	
02	=	+2	Positive numbers
03	=	+3	

Imagine this as a continuous sequence around the surface of a cylinder. Where will the join be between positive and negative numbers? The answer is:

80 = -128 (highest negative number)
7F = +127 (highest positive number)

This is easy enough to grasp especially if the analogy is taken of a mechanical counter, such as the odometer in a car. If it was set at all zeros i.e. 0000, what would it read if it was turned back one notch, then two, etc? Easy enough of course - 9999,9998 and so on. So it is with HEX that going backwards (i.e. negatively) from zero gives the highest HEX digits first, then reducing by one at each step - FF, FE, etc.

A final point worth making now. Using relative addressing, the maximum distance that one can branch out through memory is 127 steps forward or 128 steps backward - or is it? There must be a way of branching as far as one likes, and this, plus more complex addressing modes will be dealt with in the next article. Also, since quite a bit of useful theory has now been covered in the first two articles, the time has come to start developing more useful and ambitious programs.

Dragon 32/RS232 Modem Interface

★ RS232 Data Link ★ Programmable word format
★ Will connect Dragon to the Maplin Modem or other compatible system
★ Module plugs into ROM expansion socket

by Dave Goodman

The first in a series of projects for the Dragon 32 computer is our Serial Communications Interface Adaptor, or SCIA. Although primarily designed for use with the Maplin Modem, the SCIA could connect to any serial RS232 compatible system where data exchange is required. It makes possible full communication between the Dragon and other computers, and many commercial information services, such as the Maplin Cashtel system.

Construction

Through pins are used to connect tracks on both sides of the PCB. Fit these first, and solder them on both sides of the board. Resistors and diodes are fitted next, bending each lead before insertion. On the legend a white bar shows the position for aligning the cathode of each diode, which in turn is recognised by a black band printed on the body. Fit RV1, and all the capacitors. C4, 5, and 6 are polarised, with the negative end marked on the body, while C7 is marked with a positive sign. Make

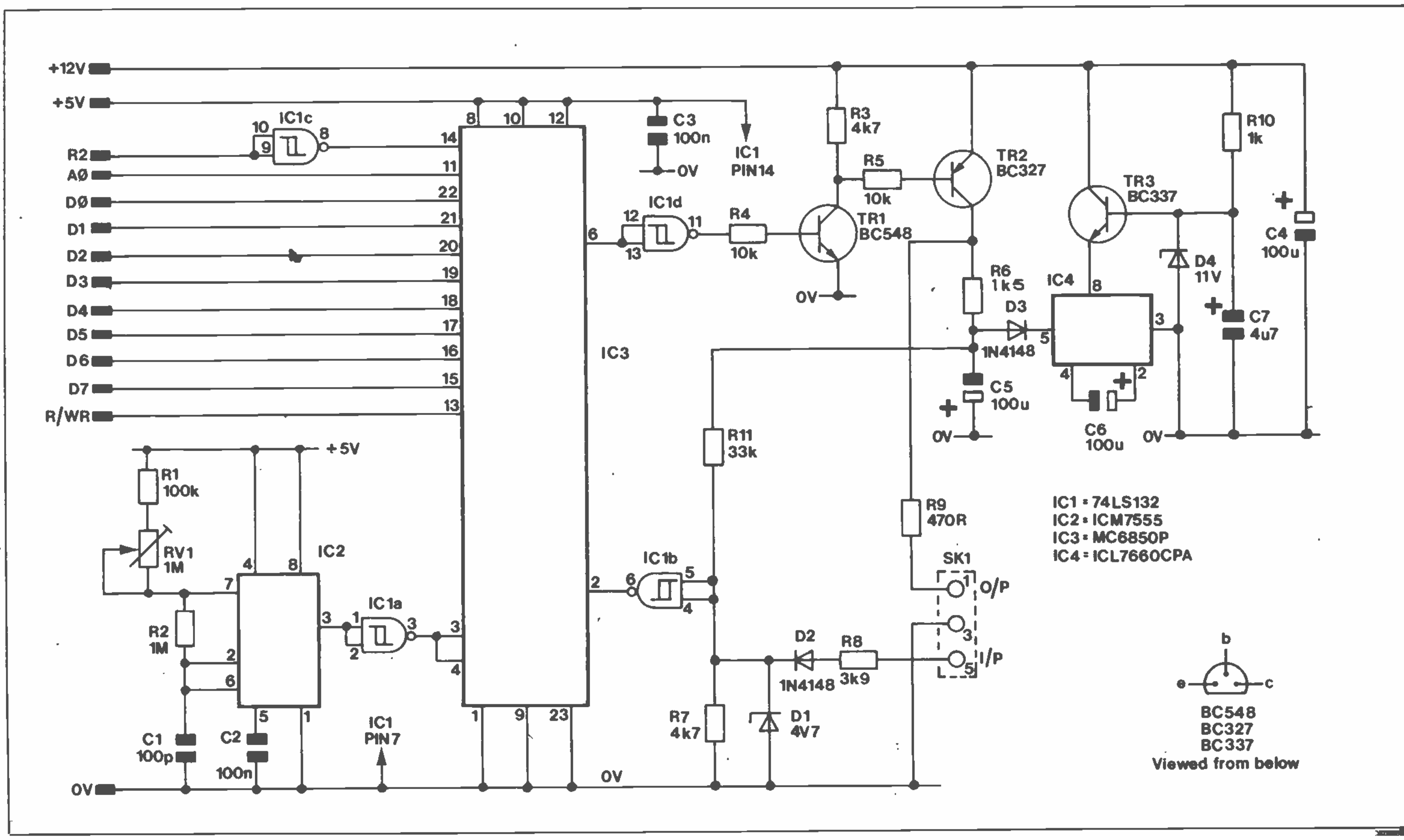
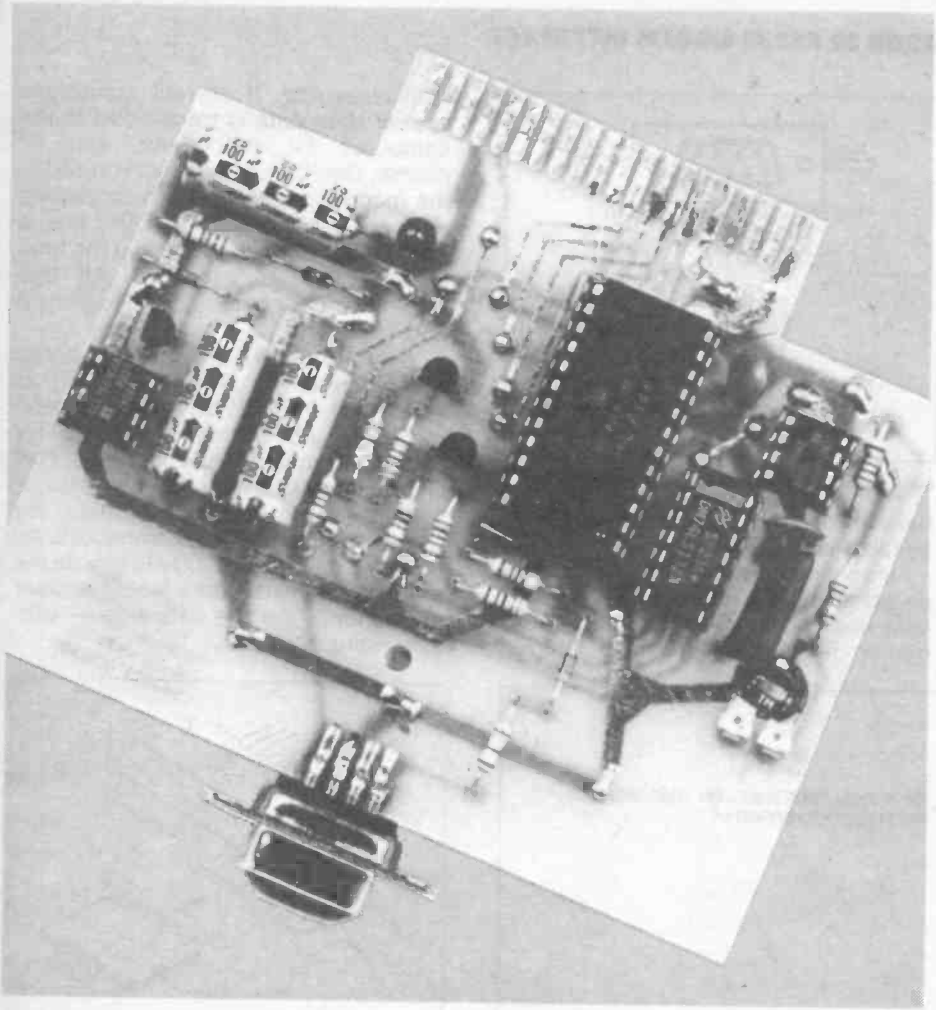


Figure 1. Circuit Diagram



sure they are fitted the correct way round!

Transistors TR1 to TR3 and all four IC sockets should be mounted as shown on the legend. Carefully solder each component in place, remove excess leads, and clean the track. Finally fit and solder SKT1 in place, then insert IC4 only. You should inspect your work before testing, rechecking all components and solder joints for errors.

Circuitry and Testing

Characters are transmitted or received at a particular speed, or Baud rate. The standard telecommunications speed of 300 Baud is used for the SCIA, and, although not critical, RV1 should be set with the centre of its wiper pointing to the arrow on the PCB legend. Insert the module (component side upwards) into the ROM expansion socket on the right hand side of the computer. Switch on the Dragon and wait for the usual display to appear. If vertical lining appears, or nothing at all happens, then switch off immediately and remove the module for inspection.

Using the positive end of C5 as the 0V reference point, place a voltmeter between 0V and IC4 pin 8, and check

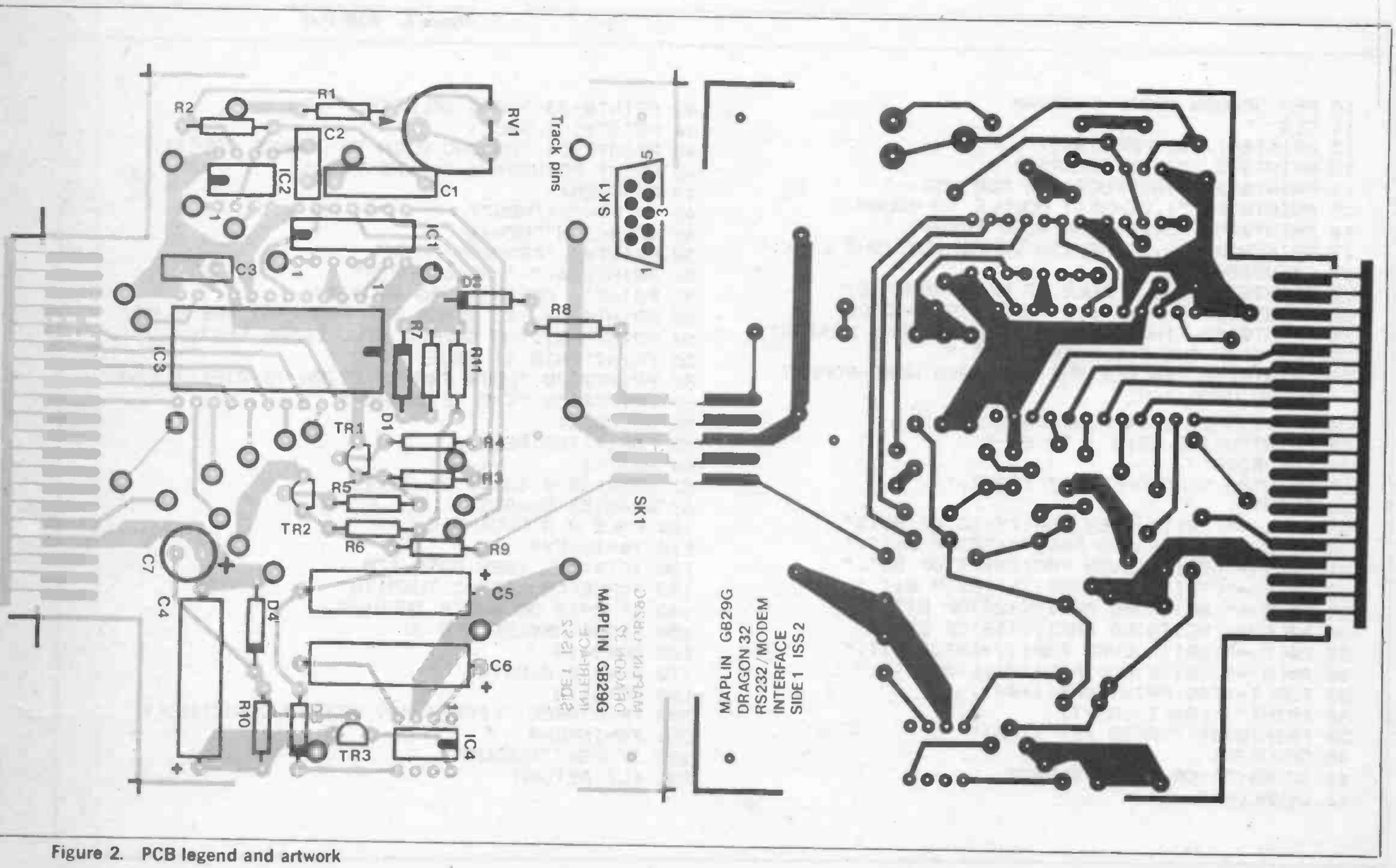


Figure 2. PCB legend and artwork

for approx. +10.3V. Now check for approx. -9.8V between 0V and pin 5 of SKT1. Remove the module, insert the remaining ICs, and re-fit the module into the Dragon.

IC2 is a CMOS 555 timer, and is used for the clock oscillator. IC3 divides the clock signal to determine the Baud speed for character transfer. With a 4.8kHz clock and a programmed divide by 16 code, the Baud rate is 300. Three divide ratios of 1, 16 and 64 are available.

IC4 is a voltage inverter, producing -10V across C5 for a +10V input from TR3. This negative voltage is necessary to produce RS232 compatible levels for signal transmission. Serially coded signals are converted from pin 6 of IC3, IC1, TR1 and TR2 to RS232 +12V, -10V levels at SKT1, pin 5. Input signals on SKT1, pin 1 are chopped and potentially divided by R8, D2 and R7 to a level suitable for TTL use.

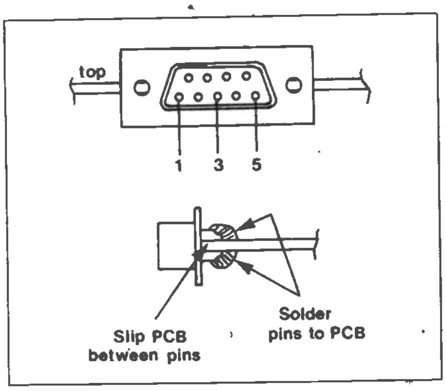


Figure 3. Plug and socket external connections

Incoming serially coded signals are decoded by IC3 into eight bit parallel data bus codes. By reading IC3, information is obtained from an internal status register. If correct conditions appear then data is transferred to the computer for processing, etc. Of course, the IC must be synchronised to the incoming data for such conditions as the number of STOP/START bits, a PARITY bit, ODD or EVEN, and the total number of bits expected. All this information is contained in Program 2 and Table 1.

Two addresses are used as ports: PORT A address is 49152, PORT B address is 49153. Port A may be read for status checks, or written to for setting internal control conditions. Port B is read for received character data, or written to for transmitting data. By using PEEK and POKE commands, an R2 pulse on pin 14 of IC3 will enable the system, otherwise data would appear permanently on the data bus — with interesting results!

```
10 CLS
12 PRINT@40,"'TEST PROGRAM'
14 PRINT@96,"CONNECT BOTH RS.232 (IP/OP)PINS TOGETHER,ON THE MODULE."
16 PRINT"THEN TYPE CHARACTERS DIRECT FROMTHE KEYBOARD!"
18 PRINT@234,"***********"
20 A=49152:B=49153
22 POKEA,3:POKEA,21
24 T$=INKEY$:IFT$=""THEN24
26 POKEB,ASC(T$)
28 IFPEEK(A)<3THEN28
30 PRINTCHR$(PEEK(B));
32 GOTO24
```

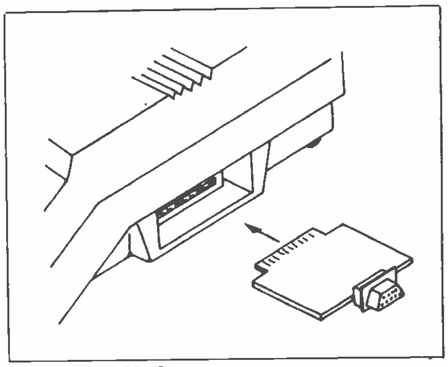


Figure 4. ROM Port

```
10 REM DRAGON MODEM PROGRAM
11 CLS
12 PRINT@41,"***MAPLIN***"
13 PRINT@73,"MODEM PROGRAM"
14 PRINT@128,"INSTRUCTIONS FOR USE:-"
15 PRINT@192,"1.CONNECT MODULE TO MODEM."
16 PRINT@256,"2.PROGRAM WORD FORMAT."
17 PRINT@320,"3.ESTABLISH COMMUNICATIONS LINK."
18 GOSUB200
19 PRINT@34,"THE MODULE IS PROGRAMMED BY"
20 PRINT@66,"ENTERING A'WORD-FORMAT'CODE"
21 PRINT@160,"THERE ARE 8 CODE OPTIONS LISTED"
22 PRINT"ON THE FOLLOWING PAGE."
23 PRINT@256,"SELECT THE REQUIRED WORD-FORMAT
   TO BE USED,";
24 PRINT"THEN ENTER THE CODE"
25 PRINT"USING KEYS 1 TO 8:-"
26 GOSUB200
27 PRINT@6,"'WORD-FORMAT'TABLE."
28 PRINT
29 A$(1)="(7BITS)EVEN PARITY+2STOP BITS"
30 A$(2)="(7BITS)ODD PARITY+2STOP BITS."
31 A$(3)="(7BITS)EVEN PARITY+1STOP BIT."
32 A$(4)="(7BITS)ODD PARITY+1STOP BIT."
33 A$(5)="(8BITS)NO PARITY+2STOP BITS."
34 A$(6)="(8BITS)NO PARITY+1STOP BIT."
35 A$(7)="(8BITS)EVEN PARITY+1STOP BIT."
36 A$(8)="(8BITS)ODD PARITY+1STOP BIT."
37 FOR I=1TO8:PRINTCHR$(I+48);
38 PRINT".";A$(I):NEXTI
39 PRINT@359,"PRESS KEY 1TO8!"
40 GOSUB201
41 IF K$<"1"OR K$>"8"THEN27
42 C=VAL(K$)
43 PRINT@103,"CODE SELECTED=";C
44 PRINT@162,A$(C)
45 PRINT@354,"DO YOU WISH TO CHANGE CODES?"
46 PRINT:PRINT@426,"(TYPE Y/N)"
47 GOSUB201
48 IF K$="Y"THEN27
49 IFK$<>"N"THEN43
50 PRINT@9,"PROGRAM DATA:-"
51 PRINT@64,"-";A$(C):PRINT
52 PRINT"- SPEED @ 300 BAUDS!"
53 PRINT@192,"TO START THE PROGRAM, PRESS ANY"
54 PRINT"KEY.THE SCREEN WILL CLEAR UNTIL"
55 PRINT"DATA IS RECEIVED!"
56 PRINT@320,"DATA TRANSMISSION IS DIRECT FROM"
57 PRINT@352,"THE KEYBOARD."
58 GOSUB201
59 FORI=1TOC:READ C
60 NEXT I
61 DATA1,5,9,13,17,21,25,29
62 A=49152:B=49153
100 POKE A,3:POKE A,C
110 T$=INKEY$
120 IFT$<>"" THEN GOTO 170
130 X=PEEK(A):IFX=2 THEN110
140 IF X=19 OR X=126 THEN100
150 PRINTCHR$(PEEK(B));
160 GOTO110
170 POKE B,ASC(T$)
180 GOTO110
200 PRINT@450,"(PRESS ANY KEY TO CONTINUE!)"
201 K$=INKEY$
202 IF K$=""THEN201
203 CLS:RETURN
```

Type in Program 1 and connect pins 1 and 5 on SKT1 together on the module. The idea is to transmit a character into the receive register and print it on the TV display, thus testing the module.

Line 22 first resets the status register and initialises both the receiver and transmitter using data code three (DØ and D1 = Logic 1), and second, a clock divide ratio of 16 is selected with code 1 (DØ = Logic 1) added to a word format code of 20 (D2 and D4 = Logic 1) or 21.

The keyboard is scanned to see if a key is being pressed, and, if so, an ASCII code value for the key is POKEd into Port B and transmitted, along with all bit information. Port A is scanned to see if correct data has been received, by looking for DØ = Logic 1. D1 will normally be at Logic 1 when the transmit data register is empty, so data code three (DØ and D1 = 1) is required to step the program forward, whereupon Port B is read and data printed on the display.

Run the program and press any key. The character will be printed, showing all is well.

Initial program requirements are for the setting of code 3 (POKE A,3) followed by divide code plus word format code (POKE A + total) 0 to 34.

Generally, code 21 can be used, which breaks down as divide clock by 16 and select word format of 8 bits (no parity) and 1 stop bit. This should suit most user requirements.

The MC6850 has many other control and status conditions associated with it, and a complete article could be written on this IC alone. However, informative data sheets are available from Maplin for those wishing to pursue the subject further. Program 2 gives information for those using the SCIA module and sets up the programming data to your requirements. ASCII coded data may be transmitted or received over a suitable link and printed to the display. If there is no 'echo-back' facility on the equipment connected to the module, then the characters transmitted from the Dragon will not be returned and printed. This facility exists for data clarification, so that you know exactly what you are sending out. Save all programs on tape for future use, and don't forget to dial 'CASHTEL' when ready to use the working module.

Table 1a — Register Contents (Ports A and B)

Data Bus	Port B (Rx)	Port B(Tx)	Port A (write)	Port A (read)
DØ			Clock divide	Rx register full
D1	Receive	Transmit	Clock divide	Tx register empty
D2	Codes 0-127	Codes 0-127	Word Format	(Carrier Detect)
D3	ASCII	ASCII	Word Format	(Clear to Send)
D4	ASCII	ASCII	Word Format	Framing Error
D5	ASCII	ASCII	(Tx Control)	Rx Overrun
D6	ASCII	ASCII	(Tx Control)	Parity Error
D7	ASCII	ASCII	(Rx Int Enable)	(Int Request)

Table 1b (Control Register — Port A) Reset/Divide

Function	DØ	D1	D2	D3	D4	D5	D6	D7	Code
	Data Bus								
Reset	1	1	0	0	0	0	0	0	3
Divide by 64	0	1	0	0	0	0	0	0	2
Divide by 16	1	0	0	0	0	0	0	0	1
Divide by 1	0	0	0	0	0	0	0	0	0

Table 1c. (Control Register — Port A) Word Format

Word Format	D2	D3	D4	D5	D6	D7	Code
7 bits. Even par. + 2 stop bits	0	0	0	0	0	0	0
7 bits. Odd par. + 2 stop bits	1	0	0	0	0	0	4
7 bits. Even par + 1 stop bit	0	1	0	0	0	0	8
7 bits. Odd par. + 1 stop bit	1	1	0	0	0	0	12
8 bits + 2 stop bits	0	0	1	0	0	0	16
8 bits + 1 stop bit	1	0	1	0	0	0	20
8 bits. Even par. + 1 stop bit	0	1	1	0	0	0	24
8 bits. Odd par. + 1 stop bit	1	1	1	0	0	0	28

DØ and D1 — see table 1b.

PARTS LIST FOR DRAGON 32 RS232/MODEM INTERFACE

Resistors — All 0.4W 1% Metal Film

R1	100k		M100k
R2	1M		M1M
R3,7	4k7	2 off	M4K7
R4,5	10k	2 off	M10K
R6	1k5		M1K5
R8	3k9		M3K9
R9	470R		M470R
R10	1k		M1K
R11	33k		M33K
RV1	1M Hor sub-min Preset		WR64U

Capacitors

C1	100pF Silver Mica		WX13P
C2,3	100nF Minidisc	2 off	YR75S
C4,5,6	100uF 25V Axial Electrolytic	3 off	FB49D
C7	4u7F 35V Tantalum		WW65V

Semiconductors

D1	BZY88C4V7		QH06G
D2,3	1N4148	2 off	QL80B
D4	BZY88C11V		QH15R
TR1	BC548		QB73Q
TR2	BC327		QB66W
TR3	BC337		QB68Y
IC1	74LS132		YF51F
IC2	ICM7555		YH63T
IC3	MC6850P		WQ48C
IC4	ICL7660CPA		YY75S

Miscellaneous

SK1	D-Range 9-Way Skt		RK61R
	8 Pin DIL Skt	2 off	BL17T
	14 Pin DIL Skt		BL18U
	24 Pin DIL Skt		BL20W
	P.C.B.		GB29G
	Track Pin	1 Pkt	FL82D

A complete kit of all parts is available for this project.
Order As LK12N (Dragon/RS232 Interface kit). Price £13.75

USING THE COMMODORE 64

by Nigel Fawcett

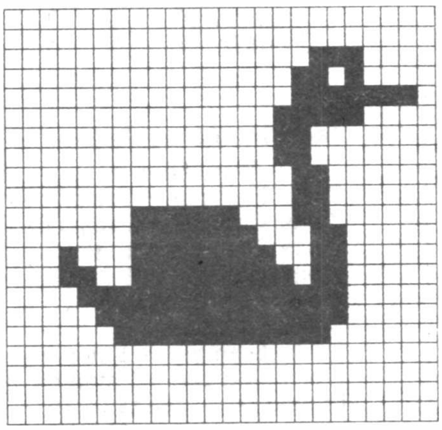
During the course of this and subsequent issues of Electronics I shall be including articles which should be of considerable use to the CBM 64 owner. These articles will cover many of the subjects which are not fully explained, or are merely hinted at in the manual which accompanies the 64. In many instances the 'Programmers Reference Guide' is mentioned and this publication is now available from Maplin, order code WK62S, price £13.25.

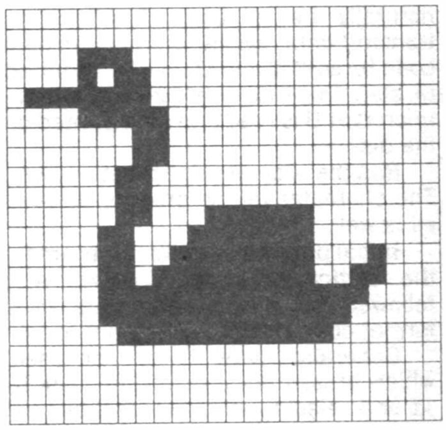
In this issue I shall demonstrate the use of the moveable object blocks or sprites as they have become known.

At the heart of the 64's graphics system lies the video interface chip (6567). This IC is responsible for managing the 40 column by 25 line text display, the 320 by 200 dot high resolution graphics display and the sprites (MOBS). In addition to these functions the 6567 also handles the character sets, split screen, colour modes, scrolling and a host of other graphics related jobs.

When the 64 user wants to write his own games, or even master the theory behind the commercially available arcade type games, it is natural that an understanding of mobs should be attained. The basic concept is that one should be able to define a shape, reasonably recognisable and proportioned for the application, and then be able to place it anywhere on the screen (this also includes those parts of the screen which lie above, below, left or right of the screen edges and which are therefore technically out of sight). In addition they should be able to move smoothly in any direction desired. Witht he 6567 all this is possible. First, graph paper should be used to design the bit pattern for the sprite. Each sprite is mapped on a grid which is 24 bits wide by 21 bits deep. Every bit which is 'on' will be displayed on the screen in the colour chosen for that sprite. In memory the data for the sprite patterns is arranged in 63 consecutive bytes

Continued on page 59





```
100 PRINT CHR$(147)
1000 FOR I=14336 TO 14463
1010 READ A : POKE I,A : NEXT I
1020 VC=53248
1030 POKE 2046,224
1040 POKE VC+21,64
1050 POKE VC+39,64
1060 VC+12,0 : POKE VC+13,100
1070 POKE VC+16,64
1080 FOR I=15360 TO 15400
1090 READ MC : POKE I,MC : NEXT I
1100 SYS 15360 : FOR I=0 TO 31
1110 NEXT I : GOTO 1100
3000 DATA 0,0,0,0,0,0,0,0,112,0,0,208
3010 DATA 0,0,254,0,1,240,0,1,128,0,1
3020 DATA 128,0,0,192,0,0,192,1,248,192
3030 DATA 1,252,96,17,254,96,25,255,96
3040 DATA 15,255,224,7,255,224,3,255
3050 DATA 192,0,0,0,0,0,0,0,0,0,0,0,0
3060 DATA 0,0,0,0,0,0,14,0,0,11,0,0,127
3070 DATA 0,0,15,128,0,1,128,0,1,128,0
3080 DATA 3,0,0,3,0,0,3,31,128,6,63,128
3090 DATA 6,127,136,6,255,152,7,255,240
3100 DATA 7,255,224,3,255,192,0,0,0,0,0
3110 DATA 0,0,0,0,0,0,0,0
3500 DATA 173,254,7,201,224,208,11,173
3510 DATA 12,208,201,36,240,15,238,12
3520 DATA 208,96,173,12,208,201,0,240.
3530 DATA 10,206,12,208,96,169,225,141
3540 DATA 254,7,96,169,224,141,254,7,96
```

MODEM NEWS

USER VIEWS

The Maplin Modem, and the CAShTel and Maptel services have been much more successful than anyone anticipated. Especially useful to us have been the user comments, a selection of which have been printed below. We are always interested in user comments and suggestions on what you would like to see on the system, e.g. User Group pages, bulletin board services. User groups (any machine) are welcome to get in touch with us, with the information they would like displayed, and we will see what we can do.

1. Terminating the isolating transformer with 600 ohms (across D1) enables correct setting of RV3. System now seems to have high immunity from noise. Stewart Hoare.
We agree that 600 ohms should give correct results, but, under practical conditions, the line rarely exhibits a 600 ohm impedance, and therefore the best way of setting up is to make a call to a friend and get them to leave their phone off the hook whilst you adjust RV3 for minimum crosstalk.

2. I have found it very difficult to get onto your system A. Perhaps it would be worth adding a few more ports? Roger Lee.
It is not extra ports that we need, but extra lines. More will be added in the future, according to demand.

3. If you sent Control N at the start of logon, please don't - it means reverse video to me. Andy Michael.
We don't.

4. How do I get rid of the double echo? Ian Atkins.
Either you are running in half duplex instead of full duplex, or there is something in your program which is giving a double echo.

5. It would be nice to have column width selectable. S.R.Vann.
It would, we agree, but there are just too many options, and this makes it impractic-able at present.

6. Why don't you use both upper and lower case? Roderick McLeod.
We do receive both upper and lower case, but we cannot transmit using lower case because of the problems this causes for some micros (notably the Dragon), which will not accept it.

7. A problem occurs with your system not always echoing back my characters. This is only confined to your system and not the others I use. Anon.
Our system should always echo back, and we have not had any other complaints. Any comments from anyone else?

8. When will bulletins become available? J.P. Cowell.
During August.

9. I would like to see a good modem program for the BBC that loads to cassette. R.H. Gregory.
There is one published in this issue.

10. I am using a Transdata 300 printer terminal and I find that there are two characters missing at the beginning of each line, due (I think) to the slow return of the carriage in between lines. Is there any way of delaying the output from your computer? Michael King-Beer.
Please transmit 3-5 DEL characters after 'CR' 'LF' to allow elderly mechanical terminals time. Anon.
There is nothing we can do at present, but we are looking into this one. Please bear with us.

11. At 300 Baud Maptel is fairly slow. Are there any plans for other speeds, e.g. 1200/75 and 600? Mike Harvey.
We are looking into the possibility at the moment, and hope to have something fairly soon.

12. Please let us have a CBM 64 group page. P.A.Friend.
Would you consider making a page available for Maplin Modem users? Dr N.Robinson.
Your wish is our command.

13. Why is there no delete feature on input of messages? Mike Hobbs.
Delete vary too much between different computers. However, we are rethinking this one.

14. I would appreciate it if you would enrol me as a user of your system. I have a Barclaycard number, please advise me of the procedure. Also, I would like to know if the system will eventually be available after 17.30 hours, and if so until what time? P.A.Friend.
You do not need to be 'enrolled' into our system. The only requirement is that you have a customer number, which you can obtain by writing to us, enclosing your name and address, and details will be mailed to you. Alternatively, if you have already placed an order with us, you will have a customer number, and can use that.
The Maptel/Cashtel system is in the process of continuous expansion (as some of you may have noticed!), and we are experimenting with a non-interactive order system outside normal working hours at present. We hope this will provide a viable alternative, but we will consider making the full service available should the demand prove sufficient to justify it.

MODEM BOX

At last! The Maplin Modem has a box available. Custom built for us, the front panel is silk screened with a legend in white on black, and the rest of the box an attractive dark blue. The whole case comes in just two pieces, and will make your modem look completely professional.
All this for the incredibly low price of only £9.95. Order As YK62S (Modem Box).

```
5 REM  BBC VDU PROGRAM  R.J.B.K.83
10  CLS
20 * FX 7,3
30 * FX 8,3
40 * FX 2,2
50 A = INKEY(1): IF A = -1 THEN 100
60 * FX 3,7
70 VDU A
80 * FX 3,0
90 GOTO 40
100 * FX 2,1
110 * FX 3,0
120 A = INKEY(1)
130 IF A > 31 THEN VDU A AND 127
140 IF A = 41 THEN GOSUB 200
150 IF A = 13 OR A = 10 THEN VDU A
160 GOTO 40
200 A = 10 : VDU A
210 A = 13 : VDU A
220 RETURN
```

USING THE COMMODORE 64 *Continued from page 58*

(21 rows of 3 bytes [3 bytes = 24 bits]). The basic manual gives this information in greater detail, so refer to the relevant chapter for a fuller description.

Enough waffle — let's have a demonstration!

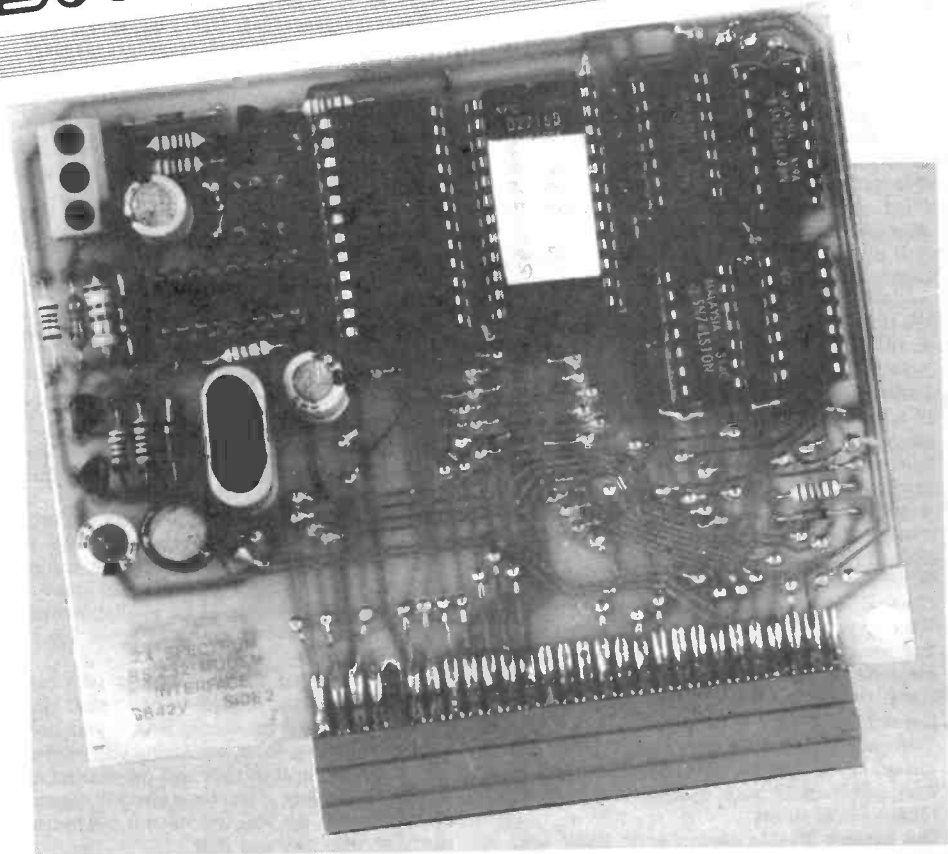
The following program sets up a sprite from basic, and then uses a machine code routine to handle the movement. The routine is continually recalled from basic, allowing you to add to the program which could form the basis for a game. A swan is set up using a sprite and swims backwards and forwards across the right hand side of the screen. This frees the rest of the screen for more action.

You will notice that two images are set up in memory for the swan, one facing right and one facing left. If I had not done this the poor swan would have had to swim backwards!

The assembly language routine is only shown for reference, the actual data for the machine code is included within the basic program.

```
SWAN    LDA  2046
        CMP  229
        BNE  RVSWAN
        LDA  53260
        CMP  46
        BEQ  RSPAT1
        INC  53260
        RTS
RVSWAN  LDA  53260
        CMP  0
        BEQ  RSPAT2
        DEC  53260
        RTS
RSPAT1  LDA  230
        STA  2046
        RTS
RSPAT2  LDA  229
        STA  2046
        RTS
```

ZX SPECTRUM RS232/MODEM INTERFACE



Our series of computer/modem interfaces continues with one for the Spectrum, which can be operated directly from BASIC, without typing or LOADing lengthy program listings. Access to (or exit from) the module may be initiated as required, either directly from switch-on or during a normal program run, without changing any previous contents of memory except the display file, and does not require RAM space to operate.

Interface

For computers to communicate with external sources suitable interfaces must be used. These must have the necessary facilities to enable compatibility with both devices and be under software control.

Transmitted or Received data is formatted as a character containing so many 'bits', and serialised for data transfer in a continuous stream. The speed of transfer is variable, but is usually standardised at 300 Bauds for modem/telephone links; higher Baud rates being required for higher transmission speeds.

Three wire links are used, one for transmitting data, one for receiving data, and a common 0V. Signal levels are to the RS232 standard of +12V amplitude at up to 20mA loads.

Circuit Description

Within the Spectrum ROM, before the character set, lies an unused area of memory between addresses 14446 and 15615. By disabling the ROM at the correct time this area is freed for use by the EPROM IC7 and ASCIA IC6 (A Synchronous Communications Interface Adaptor). ICs 1 to 4 perform the decoding necessary for memory mapping two areas. Addresses 14592 to 15584 are used for printing and operating subroutines, and addresses 15585 to 15615 are reserved for I/O scanning, word formatting, and data transfer. R1 and D1 supply the ROM CS disable pulse from IC3, also enabling IC7 during the correct read only address block. IC6 can be read or written to by the system within the address block determined by A5,6,7 and IC4 pin 11, but only four addresses are used, and these are detailed further on in the article.

IC5 is a fourteen stage ripple counter and clock oscillator running at 2.4576MHz, with C1, R10 and X1 determining the fundamental frequency, and this produces four divider outputs, shown in table 1.

Pin	Frequency	Baud	Link
6	19.2kHz	300	A
4	38.4kHz	600	B
5	76.8kHz	1200	C
7	153.6kHz	2400	D

Table 1.

Serial data output is from IC6 pin 6 and inverter IC2, whose normally low output holds TR2 in the 'off' state. TR1 does not conduct, due to lack of base drive current, and its collector sits at -10V potential, which appears at the RS232 output socket.

Pin 23 of the edge connector is notated -12V (page 160 of the user manual), when in fact it is derived from an internal oscillator, used for generating +12V and -5V supplies for the memory ICs, and takes the form of a 20kHz pulse waveform at approximately 12V. By connecting this signal via DC blocking capacitor C4 and referencing to ground via D4, a level shifted -12V signal is developed. This is rectified and smoothed by D3 and C5 to give approximately -10V DC at R5. TR1 switches between +12V and -10V during data transmission, producing the required RS232 levels to line. Incoming data is kept to a positive potential by D2, for switching TR3 and as a TTL input to pin 2 of IC6.

Module Operation

The EPROM IC6 holds 746 data bytes, most of which are used to display the MENU and WORD FORMAT options necessary for programming ASCIA IC6. Eight options are available for different by Dave Goodman

★ Connects the Spectrum to modems or other computers
★ RS232 compatible — 300/2400 Baud rates
★ Completely self-contained operating system — no programming, LOADing or SAVEing required!
★ Plugs into expansion socket or motherboard

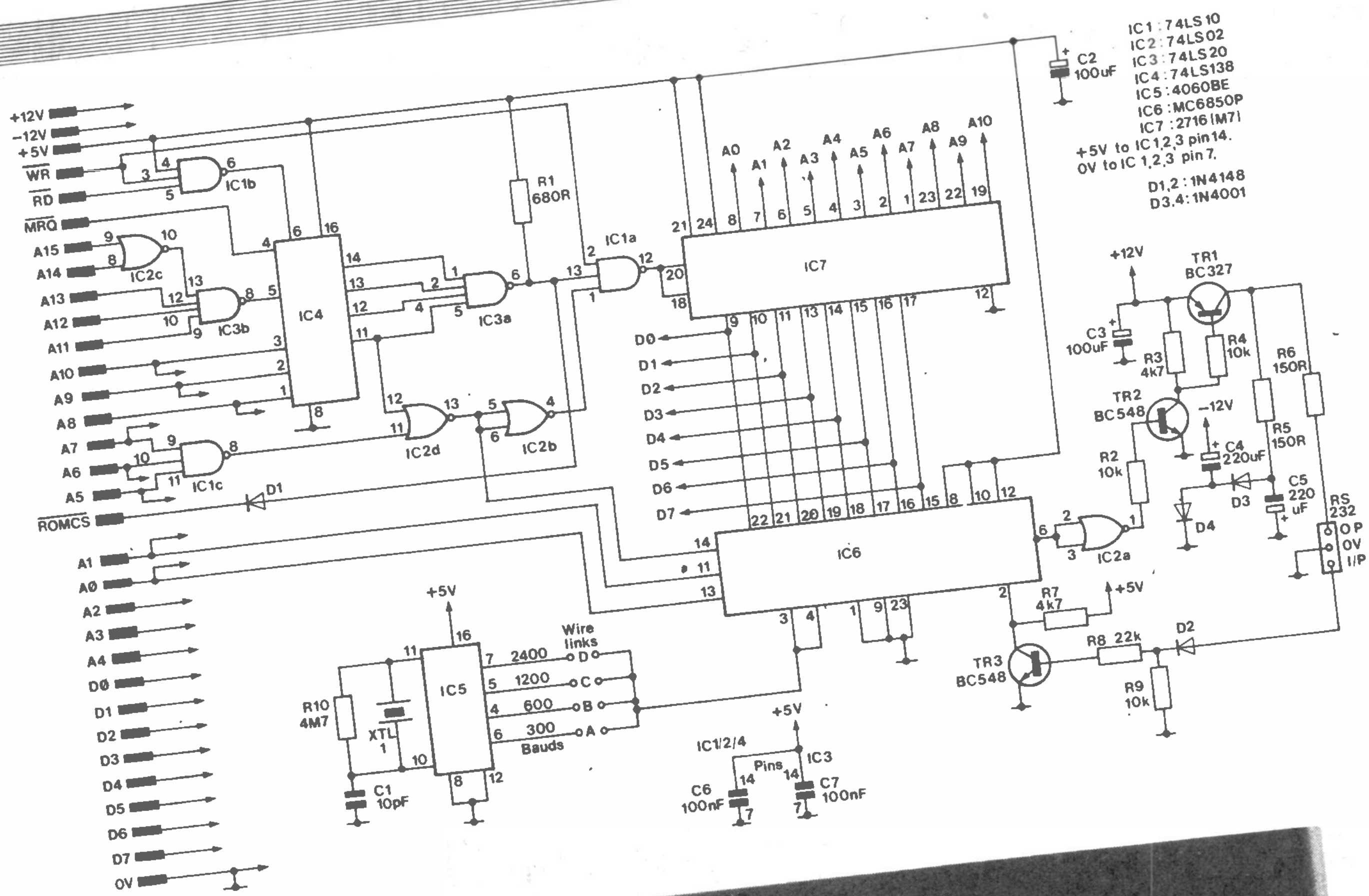
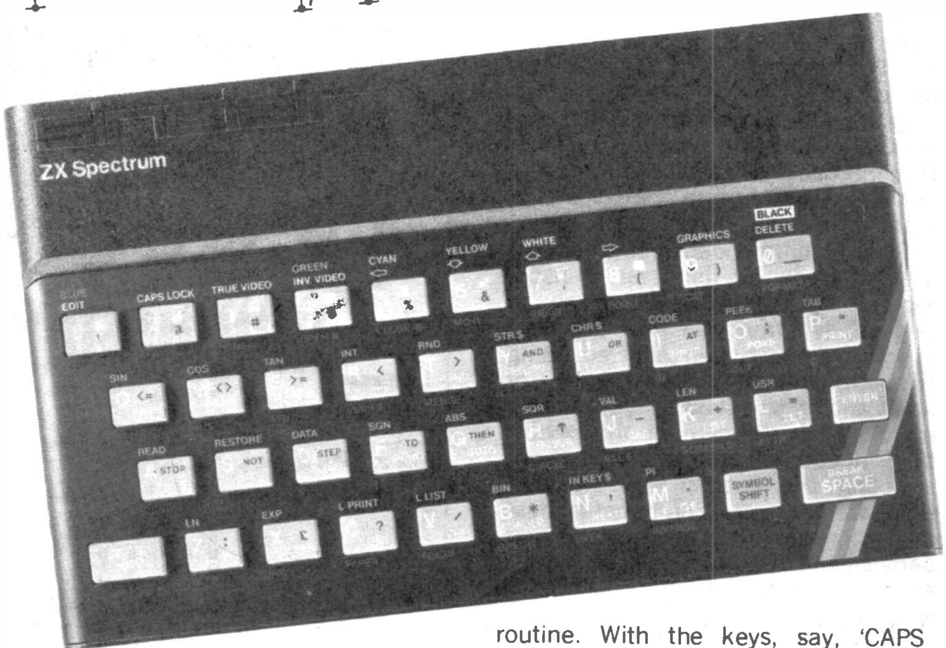


Figure 1. Circuit diagram.



word formats, setting total bits per character, odd, even, or no parity, and 1 or 2 stop bits. Master reset and clock divide ratios are also selected with these codes using data bits DØ to D4.

Within IC6 there are four registers accessible for use. Each register has a specific address and is either read or write in operation. See table 2 for definitions.

After control register has been set, the status register is examined to see if any data has arrived. If not, then the Spectrum keyboard is scanned for a key down. Various routines look for shifted or normal key operations, and also too many keys down before returning to the input status scanning routine. With the keys, say, 'CAPS SHIFT' and 'A', depressed, the formatted ASCII code '65' is transmitted once only, but if the key is held down for more than two seconds the character code will be repeatedly transmitted until released.

During repeat time the STATUS register is being scanned so that re-

	Address	Register	Use
	15612	Control (WR)	Reset, clock, and word format
	15613	status (RD)	inspect incoming data
	15614	Tx data (WR)	send 'Spectrum' codes to line
Table 2.	15615	Rx data (RD)	incoming data for printing

ceived data has priority over transmitted data. This ensures that characters are not lost when 'echo' is utilised. The STATUS register indicates parity error, overrun, frame error, whether the transmit register is empty, or if receive register is full. Control is directed according to these conditions so that when a character is correctly decoded it will be sent to the receive data register and read by the Spectrum CPU for printing, etc.

Specifications for the MC6850 ASCIAs are available from us if further information is required.

Construction

A double-sided PCB is used which requires 86 track through pins to be fitted. Insert these from side 2 into all holes marked with a circle, and carefully solder each pin to both sides of the board. Close track proximity requires very careful use of the soldering iron, otherwise bridging or shorting will occur, which can be difficult to trace and could result in damage being done to the Spectrum, so keep all soldering to a high standard.

This done, refer to the parts list and fit all ten resistors by bending each lead at right angles to the body and inserting in the correct position, flat to the board. Diodes D1 and 2 are fitted in the same way, except that each black band, or cathode, must align with the white band on the legend. Repeat for diodes D3 and D4. These should have a silver band.

Now solder the component leads onto the PCB and cut off the excess wire, before mounting capacitors C1 to 7. Note that C2 to 5 are electrolytic, and must be orientated for correct polarity; the PCB legend has a positive sign, denoting the lead NOT marked with a negative sign on the component body. Finally, insert Xtal 1 and the three way PC terminal, with the terminals facing outwards. Solder these components in place.

It is recommended that a suitable solvent, such as thinners, is used, together with a stiff paint brush, to remove flux from the PCB after the excess spills have been removed. Doing this will facilitate close inspection of joints and help to show up track shorts more clearly. Remember the importance of good workmanship whilst constructing this project, as, although there are only a few components, mistakes can easily be made which can damage the Spectrum, so check your work thoroughly.

Testing

Connect the module either directly into a motherboard if you have one, or solder a 2x28 way 0.1in socket to the edge connector (see parts list) and plug into the rear expansion port. For the moment, fit IC3 only. A voltmeter or oscilloscope will be required for making a few checks around the circuit, and the

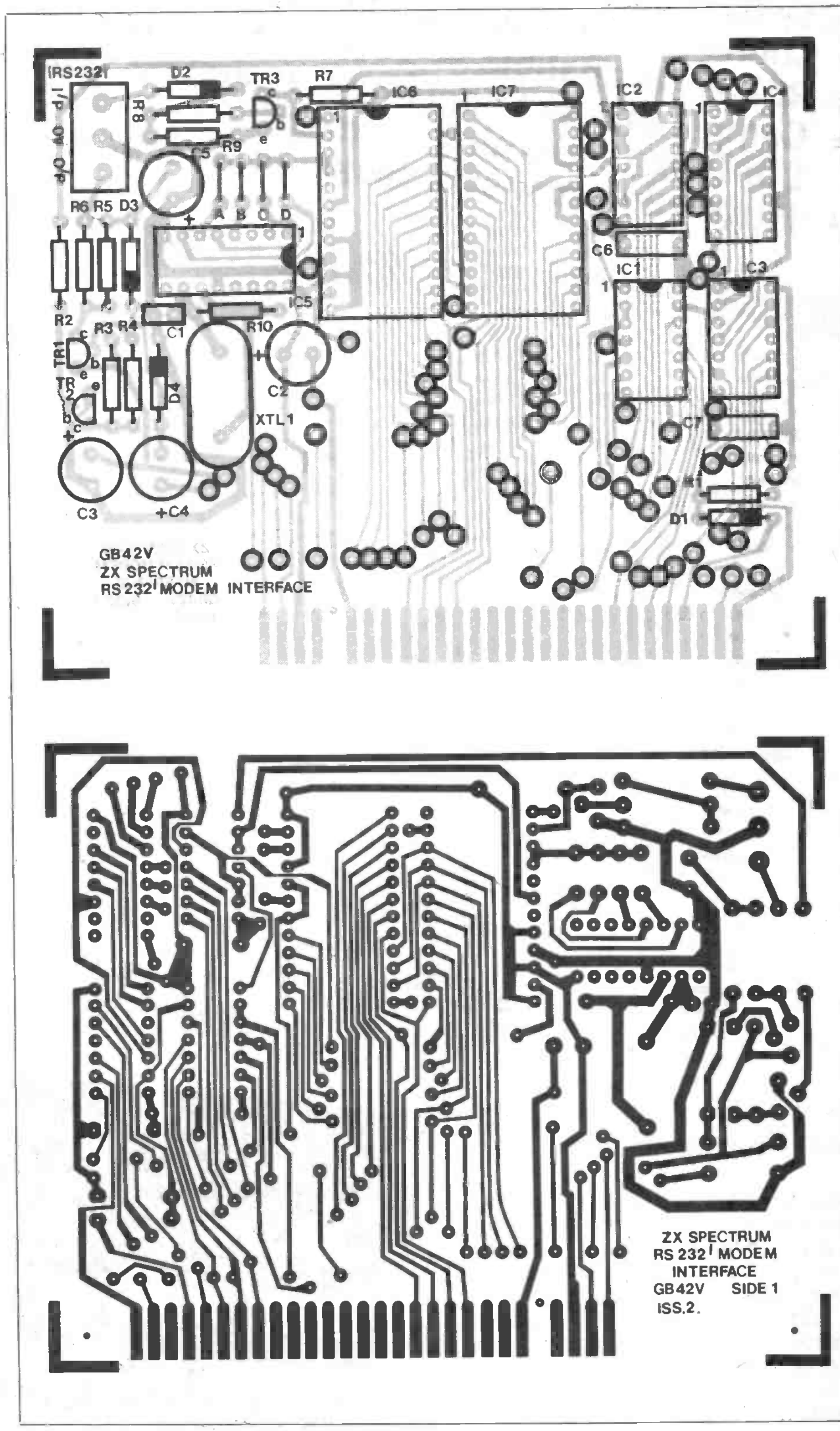


Figure 2. PCB layout.

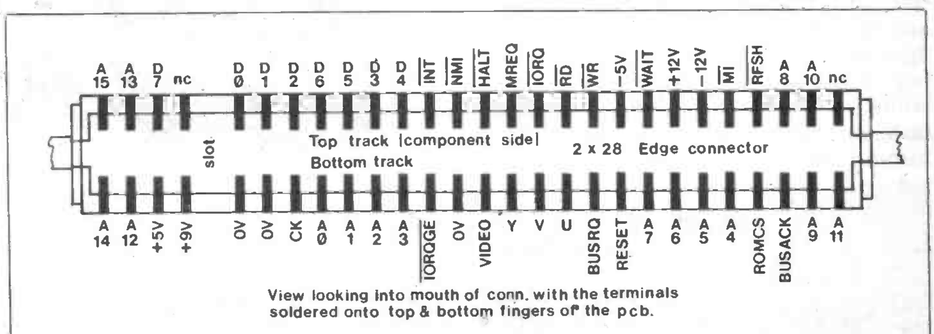


Figure 3. Pin functions.

centre terminal of the RS232 connector socket can be used as an 0V reference point.

With TV and PSU connected, switch on and check for usual display and keyboard operation. Any problem here will appear either as vertical lining or a permanent black display, in which case you should switch off immediately and remove the module. If all is well, you should check for:

1. +4.5V between 0V and IC4 pin 16
2. +0.2V between 0V and the junction of D1 and R1
3. +11 to +12V between 0V and R3/TR1 emitter
4. -11 to -12V between 0V and the RS232 output socket

Switch off, remove the module, and fit link A. The remaining six ICs can now be fitted and the module reinserted. Switch on again, and type:

```
10 POKE 15612,3:POKE 15612,1
20 POKE 15614,85:GOTO 20
```

Recheck the RS232 output for -11V and run the program. Line 20 continually transmits ASCII code 85, or 'U' which has an even mark to space ratio. The average output reading will therefore be halfway between -11V and +11V, i.e. approximately 0V. Break the program and check that the reading returns to -11V again. This test proves that address decoding logic, ASCIA, and output converter stages are functioning correctly.

Remove the voltmeter, connect the RS232 output and input terminals together with a short length of wire and type RAND USR 14592, then ENTER, to access the module. A MENU will be displayed listing word format codes a to h and instructions showing how to return either to BASIC or MENU. All entries are direct from the key concerned, without using ENTER, and, for letters only, normal lower case is transmitted. CAPS SHIFT is used for changing from lower to upper case, but will not function with numbers 1 to 0, so that CAPS LOCK, CURSOR, and DELETE are not available. All red shift symbols can be used with the SYMBOL SHIFT key, as can the ENTER key, remembering that shifted A (stop) will display the MENU. Pressing both CAPS and SYMBOL SHIFT keys allows a return to BASIC, upon which the module is no longer effective until called by the USR instruction.

Press both SHIFT keys to prove that this is so, and the O.K. prompt will appear. Type RAND USR 14592 again for the MENU and select WORD FORMAT code f. You will see that all single keys above H are inoperative and only A to H are recognised. The 'DATA?' prompt is waiting for incoming information for printing, so press the A key. Lower case a will appear at the start of a new line (automatic carriage return), now press CAPS SHIFT and A. Upper case A will be printed adjacent to the last character. Hold the A key down and printing will repeat, filling the line with 32 characters before auto-scrolling. Clear the screen by holding the ENTER (carriage return) key down, then select STOP to return to MENU.

The Module In Use

The most common word format used is f, or 8 bits per character with one stop bit. The format is applicable to our Maptel A and B systems, but other systems could require different format codes. If data is being received before the module is selected the characters may be unsynchronised, and garbage will be printed, so have the module functioning before data arrives, to avoid this occurring. Baud speeds up to 2.4KB are selected by fitting a link in the appropriate position.

Connected for 300 Bauds, which is the CCITT standard for use over telephone lines, it will match Maptel and also our Modem.

In normal use, transmitted data will not be displayed unless peripheral equipment connected to the interface has an 'echo' facility, which sends data back on receipt of incoming data. Shorting both transmit and receive lines to simulate echo may cause problems when using modem systems, and is recommended for test purposes only. Finally, the EPROM IC7 has 256 spare bytes available at the end of the instruction set which have been left high or FF. Additional instructions can be placed here and called as a machine code routine, providing you have the necessary equipment for doing this.

The first spare address is:
Spectrum — 15338
EPROM — 1002

ZX SPECTRUM RS232/MODEM INTERFACE PARTS LIST

Resistors — All 0.4W 1% metal film unless specified.

R1	680R		(M680R)
R2,4,9	10k	3 off	(M10K)
R3,7	4k7	2 off	(M4K7)
R5	150R (½W carbon)		(S150R)
R6	150R		(M150R)
R8	22k		(M22K)
R10	4M7 carbon film ½W 5%		(B4M7)

Capacitors

C1	10pF ceramic		(WX44X)
C2,3	100uF 25V P.C. electrolytic	2 off	(FF11M)
C4,5	220uF 16V P.C. electrolytic	2 off	(FF13P)
C6,7	100nF disc	2 off	(BX03D)

Semiconductors

D1,2	IN4148	2 off	(QL80B)
D3,4	IN4001	2 off	(QL73Q)
TR1	BC327		(QB66W)
TR2,3	BC548	2 off	(QB73Q)
IC1	74LS10		(YF08J)
IC2	74LS02		(YF02C)
IC3	74LS20		(YF14Q)
IC4	74LS138		(YF53H)
IC5	4060BE		(QW40T)
IC6	MC6850P		(WQ48C)
IC7	2716/M7		(QY57M)

Miscellaneous

XTL1	MP crystal 2.4576 MHz		(FY81C)
	P.C. Board		(GB42V)
	3 way P.C. terminal		(RK72P)
	Trackpins	2 pkts	(FL82D)
	D.I.L. socket 24 pin	2 off	(BL20W)
	D.I.L. socket 16 pin	2 off	(BL19V)
	D.I.L. socket 14 pin	3 off	(BL18U)

Optional part

	0.1 in 2 x 28 PC Edgecon		(FG23A)

A complete kit of all parts, excluding FG23A, is available.
Order As LK21X (Spectrum RS232 Kit) Price £17.95

FIRST BASE *Continued from Page 47*

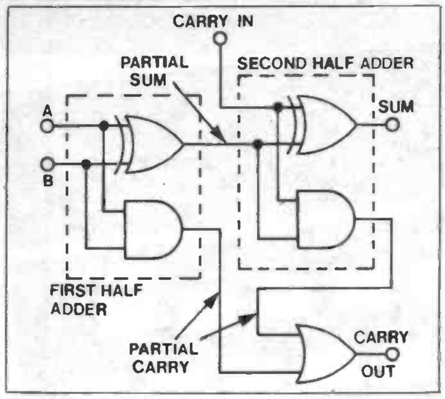


Figure 12. Full adder design

there may be 16 address lines, each of which is set to either 1 or 0 according to the specific address which the micro-processor wishes to access. The address is set in response to the requirements of the controlling program or soft-ware, and the logic must ensure that only one device is enabled if data bus contention is not to arise. With 16 address lines there are 65,536 possible unique addresses, corresponding to the locations in the memory map of the system. There are a number of logic devices which have been specially devised for address decoding, but we will consider a smaller problem using devices already described.

In some systems, the lower eight address lines are used by the micro-processor for a special purpose, that of addressing input or output devices which allow information to be fed between the processor and the 'outside world'. With only eight lines the number of possible addresses is reduced to 256, which helps to bring the problem down to more manageable proportions. What is needed, then, is a logical 'black box' into which may be sent the eight address lines along with

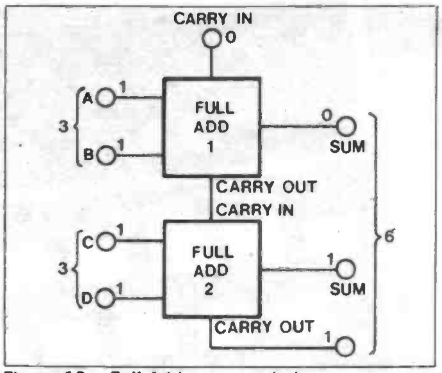


Figure 13. Full-Adders cascaded.

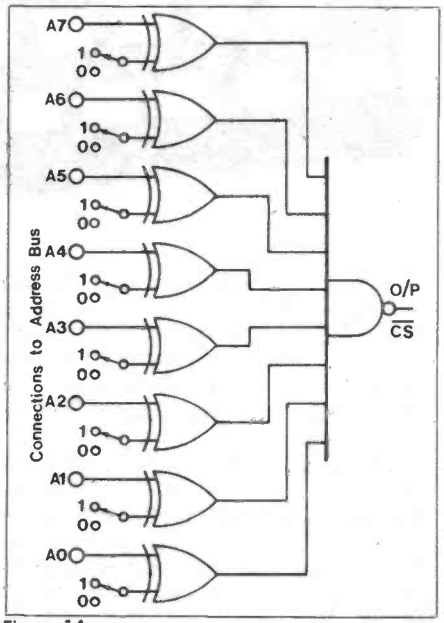


Figure 14.

signals to set a certain address, and from which emerges one line carrying the logic signal to select the particular device being addressed.

One solution to this problem is given in Figure 14 and again this may be bread-boarded to see how it works. One input of the EX-NOR gates is connected to the address bus, and the other used to select the address of the device. The output of each EX-NOR gate is then NANDed, so that the final output goes low when the appropriate address appears on the address bus. This low signal could be connected to the 'chip select', (CS) pin of the chosen device or combined with other control bus signals for further decoding. Suppose the address of the input/output device corresponds to the following bit pattern:-

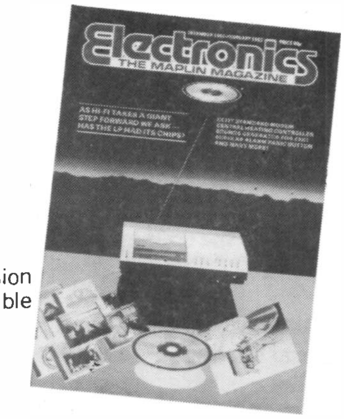
Most Significant Bit Least Significant Bit
(MSB) 1 1 0 1 0 0 1 1 (LSB)

If this pattern is set on the inputs to the EX-NOR gates then all the outputs from them will go high when the two bit patterns coincide. This in turn will set the inputs to the 8-input NAND gate all high, which is the only condition for the output to go low.

The required address may be fixed in a practical application by 'hard-wiring' the selecting inputs to the desired pattern; alternatively, the inputs may be connected via DIP switches, so that the address may be changed by altering the position of the switches.

A more convenient way of describing a bit pattern, such as the one in the above example, is to use the hexadecimal system. We shall be looking at this in more detail next time for any readers who are not familiar with the system. It will also be useful when dealing with the other main group of TTL devices, viz. those concerned with Sequential logic, which we shall also start to have a look at in the next article in the series.

DID YOU MISS THESE ISSUES?



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