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No 44

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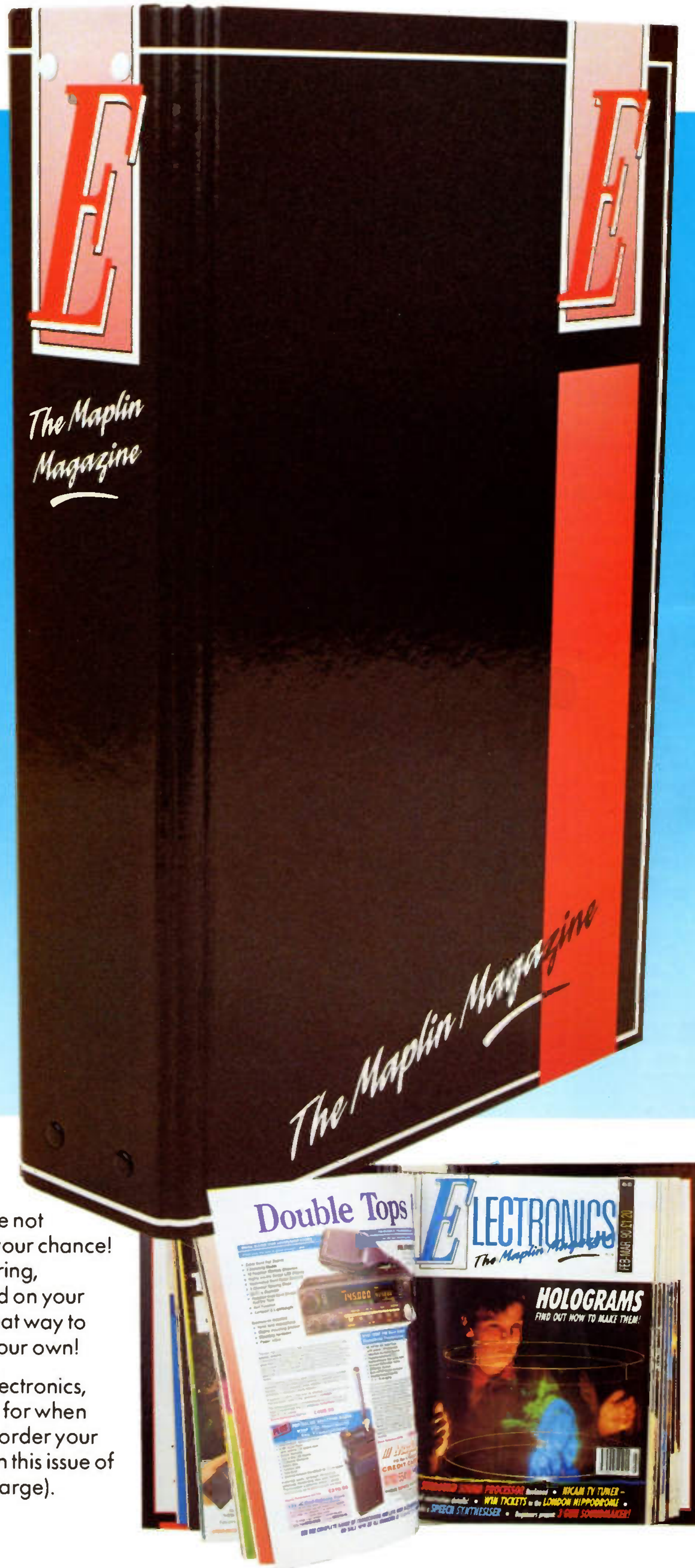

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JUNE TO JULY 1991 VOL.10 No.44

EDITORIAL

This issue of 'Electronics' represents a first for Maplin, the introduction of a Data File based around a surface mounted IC. The introduction of these miniature components, which are 'glued and soldered' onto the surface of the circuit board, instead of the conventional insert and solder technique, has revolutionised production techniques. Due to the small size of components, storage of SMDs is more convenient in terms of space, but component handling and identification present their own problems. The main advantage of SMT is the reduction in the size of the ciruit board employed to carry the components. Products can be smaller, lighter and cheaper – which benefits both the manufacturer and the customer. Until fairly recently, SMT has not had a large impact on the small volume user and the home hobbyist, but gradually the technology is making an inroad into these fields. Indeed the MSM6322 IC used in this issue's Data File is only available in an SMD package so there was no other option but to use SMT. Well, that's it from me, so read on and enjoy!

R. T. Smith

ABC 33,837

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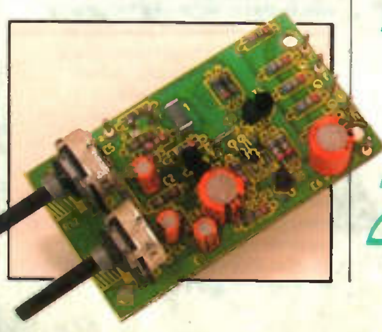
PROJECTS



FEATURES

REGULARS

CORRIGENDA

February to March 1991 Vol. 10 No. 42
Fundamentals
Page 30, middle column, after the formula $C = Q/V$ the following lines of text were omitted: where C is the capacitance in Farads. In terms of the physical configuration of the capacitor, the capacitance is given by: $C = (\varepsilon \times A)/D$

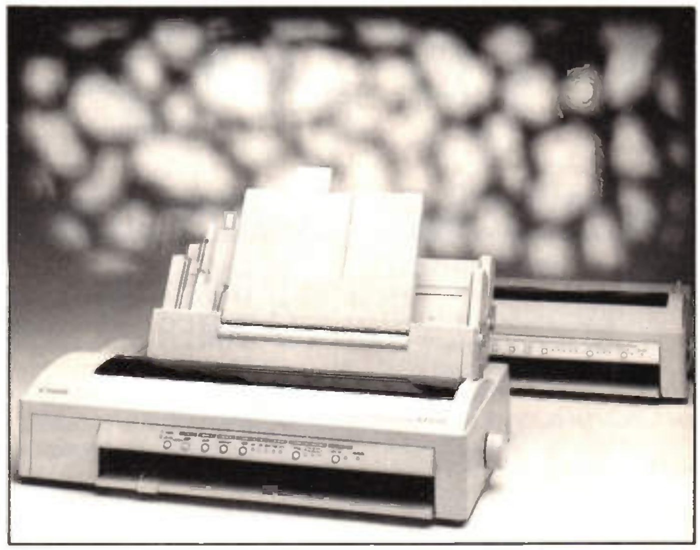
April to May 1991 Vol. 10 No. 43
Temperature Controller
Page 11 (circuit diagram), and page 23 (parts list): R7 and R10 have now been reduced in value to 56Ω, to ensure reliable triggering of OP1 and OP2.
Ranger 150m Receiver
Page 50: circuit diagram Figure 2, shows the value of C10 as 6p8F; this is an error, and should actually read 68pF as shown correctly in the parts list.
Practical Robotics
Page 61: parts list shows resistor order codes with 'E' prefixes (these are bulk packs of 1000 resistors!), the correct prefix is M, i.e. E330R should read M330R.

NEWS Report

Bursting the Bubblejet Price Barrier

Since its development and introduction by Canon, bubblejet technology has produced printers capable of high definition printing and graphics reproduction. Bubblejet technology is very simple – each print head contains 64 nozzles, each finer than a human hair. The ink in these nozzles is instantly heated by applying an electrical impulse to each nozzle to produce a vapour bubble, which ejects a small amount of ink onto the paper. As the pulse ends, the bubble contracts and more ink is drawn into the nozzle for the next command.

The new Canon BJ300 is seen as a direct competitor to the dot matrix and ink-jet printers currently on the market. At under £600, the new machine is set to burst many pricing bubbles. Also announced is the larger, all-new Canon BJ330. Operating at a near silent 45db, the new printers function at speeds of up to 300 cps with a resolution of 360 dpi. Details: Canon UK 081-773 3173.



Dispatches from the Front

One victor – the Allies and the CNN News Network apart – of the Kuwait hostilities war was British Telecom whose video-conferencing services have risen by 60%. It seems that cosy desktop video sessions are replacing those seminars and corporate meetings in Paradise Island, Acapulco or Bali. With travel budgets slashed, video-conference networks are in overdrive top. Assisting the cause are the falling tariff and video equipment costs. BT are also scoring on the use of audio conferencing. As a result, BT has made more lines and facilities available. If you are interested, UK video-conferencing links cost £100 per hour or £1400 for a transatlantic link, while a UK tele-conferencing line charge would be about half that rate.

Way Ahead Seen for Low Cost Videophones

In our last issue, mention of the video telephone systems created a lot of interest. One phone call even interrupted the editor's lunch break. According to the Guardian, videophones which allow people to see as well as hear callers could be on sale for less than £100, thanks to a UK breakthrough. An electronic video camera has been built with a tiny plastic lens, sensor and processing circuits on a single silicon chip the size of a 5p piece. What's more the Toshiba UK project, which is being sponsored by public funds and grants, will have a host of applications – such as seeing toys. In the future, zapping a batmobile will be even more difficult.

Fire the Computer

Zapping your home computer however is not legal. A US enthusiast was arrested after he got angry with his computer and fired 8 shots from his ·44-Magnum automatic. Damage was considerable – the monitor screen and electronic circuits did not withstand the barrage of dum-dum bullets used.

Sky News Wars

While the undoubted winner of the media news carriers was CNN, the SKY 24 hour News Station reported a massive audience surge for their Gulf reports. With over 25m homes in Europe equipped to receive the programme, SKY believes it reaches viewers other stations cannot reach. No facts as yet on how many viewers are making use of the recently introduced Maplin Satellite TV receiver System.

Fax IT

Bound for the record books is the latest fax from Ricoh. Billed as the smallest fax in the world, the PF1 portable fax weighs less than 2·5 kilos and is smaller than A4 size – although it transmits and receives in full A4 size. The unit uses a 12 volt power supply, operating either from its own rechargeable power pack or from a car battery. If it is of any comfort, the unit is designed to cope with severe environmental conditions and will withstand 2 G's of gravitational force. The price is just under £1,000, but with price cutting rampant, try an offer. Details: Ricoh 0932 784357.

Still in the record breaking mode, Samsung have come up with the UK's first personal fax transceiver to retail below £300. The company which entered the UK fax market less than a year ago, are already in sixth position in terms of market share. Details: Samsung 081-391 0168.

Olympic Skills

A new independent body, UK Skills is being set up to co-ordinate the selection and preparation of the 1991 International Youth Skill Olympic team. Held every two years, the event features competitors aged 22 or under, against their contemporaries from some 24 countries in 34 separate skill categories. To date, the response from the UK consumer electronics firms has not been great. Potential competitors should contact: Jonathan Freeman 071-278 2468.

Film Favourites

With the successful launch of a second Astra satellite, BSkyB will be launching two more television channels for Britain – The Movie Channel and The Sports Channel. The co-location of the two satellites in space will allow Astra dish owners to tune into channels from both 16-channel satellites on one dish. Meanwhile, Sky Movies have announced the results of their Viewers 'Film Favourites'. 'Who Framed Roger Rabbit' won the best comedy film; 'Beaches' the best drama film, with Mel Gibson and Bette Midler the best actor and Actress. Overall best film was 'Die Hard'.

Don't Get Your Wires in a Twist

No, it's not a new slant on those Karaoke Parties. Videotwist is in fact an interactive system for the distribution of video services around a building using twisted pair copper cable. The French development is being handled in the UK by JBM. Details: JBM 0494 471133.

Quote, unquote – from John Redwood, Minister for Telecommunications: 'Growth and technological development in the 1980s was exciting for UK telecommunications. In the 1990s it is set to be explosive'. Whether the Minister also met Elvis Presley in his local supermarket is not recorded.

There is No Escape

A new satellite television channel Sportscast, aimed at the licensed trade has started operations. Being marketed as the best in pub entertainment, it is already installed in some 300 licensed premises. Apart from the broadcasting of key sports, quiz programmes are transmitted simultaneously to all sites. Details: British Aerospace 061-683 5977.

BT Revamp Image

BT

So what do you make of the proposed new logo for British Telecommunications – or BT as the company now prefer to be known – a red and blue figure of Pan blowing a trumpet? Or come to that, the £50 million the company is said to be spending on a total revamp. For once the Industry watch-dog OFTEL has been dumb struck. But not so many customers who feel the sum could have been better spent – perhaps to reduce the imposition of directory charges?

OFTEL however has welcomed BT's decision to introduce a free call-barring facility that will allow customers to stop calls to premium rate services, including chatlines, being made on their lines. The new service which is only available on lines connected to BT's modern digital local exchanges, will affect all premium services on codes 0898, 08364, 0839, 0881, 0066 and 0077.

More accolades for BT come from 'Which?' magazine. The BT 'React 320 Plus' *(? – ed)* at £60 was given the 'best buy' accolade as the best high-end phone. Other BT phones selected as 'best buys' were the React 220, Vanguard 10 and Minstrel Plus.

MPS SETS THE PACE Same Day (Same Hour) Motorcycle Courier Service

Maplin Professional Supplies is revving-up the electronic component and product delivery pace with the announcement of a new, pioneering motorcycle courier service, made at a major industry initiative launch at the Nepcon/Electronics International Show at the NEC, Birmingham during March this year.

Using the nation-wide network of Maplin stores, each of which will have a trade counter tended by specialist staff, orders placed will be on their way within moments. In many cases, trade customers could actually receive their orders within the hour, depending on their proximity to their local Maplin store.

The new MPS initiative has resulted from the need of many customers to source their components or product requirements in the shortest possible timescale. MPS is continuing its commitment to total customer satisfaction by offering the additional benefit of a fast and dependable delivery service.

MPS chose Nepcon International as the ideal platform to launch the service, which is an industry first. With a dozen stores already in place and a further *five* scheduled to open this year, MPS can truly operate a nation-wide service. Users of the new courier service will be charged a very competitive dispatch rate for delivery of a few miles radius, with longer distances charged in proportion to the mileage. For further information, please contact: Nick Fogg on 0702 554155.

If You Can't Teach

The government is making a determined drive to promote the teaching of technology to school children. 'Technology teachers will have to be flexible and adaptable individuals who can work collaboratively with young people. They will also require the ability to promote the image of engineering and technology amongst their pupils, which will serve to raise the status of engineering in order to ensure the much needed supply of engineers for the future', says school minister Michael Fallon.

New Breed of Mice

According to 'Computergram', Logitech plans to introduce a line of 'technologically advanced computer mice'. They will break the traditional barriers of style, functionality and commodity production standards. Memo to Dept. of Education. Good recruitment breeding potential here.

Hi-Tech Developments

Those IBM back-room boys have been at it again. Their scientists have developed a way to build as many as 20,000 tiny lasers – each only a fraction of an inch long – on a round semiconductor wafer just two inches across. This is the first time that scientists have been able to both mass produce and test the so-called 'semi-conductor lasers' on a complete wafer.

Yet another diligent team of IBM scientists have built the world's fastest high-capacity memory chip. The experimental chip can send or receive eight billion bits of information per second, the fastest 'data rate' of any chip yet recorded. This exciting development promises to maximise the speed of future high-performance workstations, supercomputers and mainframe computers.

Another memory breakthrough has been announced by Hitachi who have developed technology which would allow the manufacture of a memory-chip only 10-microns wide capable of storing one billion data bits.

Still in the Guinness Book of Records categories, AT&T have developed a monolithic semiconductor that generates the most pulses per second, within the briefest duration yet achieved. According to 'Computergram' the colliding-pulse node-locked laser generates 350,000m pulses a second, each lasting under one nanosecond. It will have considerable use in laser wiring technologies.

Meanwhile, Hitachi has developed a technology that makes it possible to detach individual atoms from the surface of a solid. In one experiment, researchers formed characters of record-breaking smallness on a crystal by selectively removing atoms from its surface.

Lies, Damned Lies and Statistics

The market-place may not be exactly buoyant, but that has not affected the output of the survey takers. According to Context Market Research, the going is tough for PC suppliers with sales showing little increase over the previous year. The same survey shows IBM and Compaq accounting for over half of all PC sales by value. Next in line comes Apple, Toshiba, Tandon, Apricot and Amstrad. Even so, Michael Naughton of IT consultancy points out that there are already some 50m PCs in use world-wide with a further 15m being sold this year.

UNIX Bandwagon Starts to Roll – At Last

According to an exhaustive study by OTR-Pedder, Unix runs on just 21% of all UK-installed systems costing £15,000 and above. The obstacle to faster Unix penetration says the report, is the entrenched position of proprietary operating systems such as Digital's VAX/VMS and IBM's MVS and VM.

Meanwhile, one bandwagon which most users hope will not roll, is that of the level of virus infection within business computing systems. According to Bill Murray of the NCC, the virus problem may be greater than the security experts have previously estimated. As a result of their survey, the NCC will be undertaking a major industry awareness campaign in association with the Department of Trade and Industry.

Take a Further Note

Overall PC sales may be down, but not those of portable or notebook computers. IDC is forecasting that the market for notebook computers will rise by some 40% this year. Leaders include Toshiba whose portable PCs have doubled their sales in the past twelve months. One day, says the company, every PC will be a portable. Details: Toshiba 071-229 4400.

If PC sales are declining, so too is the size of the telephone. Fujitsu are claiming that their latest product, the Pocket Commander is the lightest and smallest portable cellular phone in the world. It weighs a mere 10·2 ounces and comes with such add-on features as a 100-number memory, and an alphabetic directory.

The cellular market-place itself is also in a slow ahead mode. Either the novelty of cellular phones has worn off, or most prospective users are already users. Cellnet in fact are suggesting that phone sales could be down 33% on expectations.

But looking somewhat further ahead, a leading consultancy is suggesting that by the year 2000, the number of cellular, mobile radio, paging and cordless users in Europe could reach a staggering 29 million. Truly it will be a case of 'you are never alone with a phone'.

For '999' Read '112'

Back in February 1991, we assured you that BT had no intentions to change the UK's emergency number '999'. That may still be the case, but the EC have other ideas. The decision has been made to introduce the number 112 as the EC-wide emergency telephone line. Member States have until 31st December 1991 to implement the new number. However, derogations will be permitted until 31st December 1996 – at the latest.

All of which reminds the editor of that christmas cracker joke. 'What do you get if you dial 666? Three upside down policemen'.

STOP PRESS! STOP PRESS! Open Competition for UK Telecomms

The Government has opened the doors to what in effect is a free for all for UK telecomms operations. Everyone it seems will be a winner. Suppliers, especially the cable companies, will be able to provide telephone services – as will such organisations as British Rail, and the water and electricity companies.

The existing carriers, BT and Mercury are happy with the outcome of the duopoly review with BT's chairman, Iain Vallance saying the proposals are good for BT and the industry. Also happy will be most telephone users who are being promised lower call and rental charges.

However, whether the UK can really support a host of telecom suppliers is a matter ignored by the authorities. Speaking on behalf of the communications industry, Michael Naughton of IT consultancy Applied Network Research, comments that even the States with a vastly larger market, manages to make do with just three national carriers.

News Report will examine the situation more closely in the next issue of "Electronics – The Maplin Magazine".

PICTURE CAPTION CHALLENGE

Owls That?

A flighty picture caption challenge this issue. Is it:

British Telecom updating the concept of pigeon post.

BT launching its latest very local area token ring area nestwork.

The latest BT project guaranteed to create a flap at Mercury Towers.

BT enlisting a spotter bird to pin-point any remaining out of order call boxes.

Well no. It is not even a BT engineer earning a feather in his hard hat to help stave off redundancy. Apparently British Telecom engineers have put up special 'owl poles' – telephone poles with wooden boxes on top, seen here in Kent – so that Barn owls can rest and nest in safety. The initiative comes from the Breed and Release Scheme for Owls in collaboration with Tonbridge Wells Borough Council and BT. The species is in danger of losing their traditional shelters as old barns become popular conversions to new homes. The photo shows a 10 month old Barn Owl, raised from the egg, being introduced to the modern, detached residence near Pembury, Kent.

HEARING, DEAFNESS and ELECTRONIC TECHNOLOGY

Part Three – Overcoming Barriers
by David Holroyd

Foreword

The following article, which is the third in a series on Hearing, Deafness and Electronic Technology, takes a look at some of the commercially available devices designed to help deaf people overcome communication barriers; both in the high street and at home. It is hoped that it will encourage people to accept deafness as a part of life, and encourage positive thinking and action to help deaf people to integrate with society as a whole. Every person, whether deaf or hearing, has a vital role in today's world, each with their own, totally unique, contribution.

Introduction

It is in the area of public acceptance of deafness and communication with profoundly deaf people that the most recent advances have been made. Audio Frequency Induction Loop systems are now starting to appear in more and more public places, whereas in the past the majority of these systems were only to be found in Churches, Theatres and Cinemas.

Deaf people often find that glass partitioned counters, such as the types often found in Banks, Building Societies, Railway Stations, Post Offices, Booking Offices, etc, are virtual no-go areas when it comes to communication. The glass partition effectively serves to provide security to the counter staff, but also succeeds in severely attenuating the level of speech carried to the customer. It is not uncommon for people with normal hearing to experience problems with such counters, let alone people with hearing problems! Deaf people in these instances are almost entirely reliant on lip-reading skills. The result of this communication barrier is often an embarrassment for deaf people and frustrating for both the customer and counter staff, consequently many deaf people choose not to tackle such situations, thus leading to a feeling of isolation.

Market leader Connevans of Reigate, produce a complete system for use in public places, known as an 'Across the Counter Communication Aid'. This is designed to work through a glass partition to assist hearing aid users. The component parts of the basic system are shown in Photo 1 and Figure 1, these are: a small microphone, which is attached to the glass partition; an induction loop amplifier, which is placed underneath the counter; and a compact induction loop, which is concealed behind the front of the counter as near as possible to the customer. The system can be

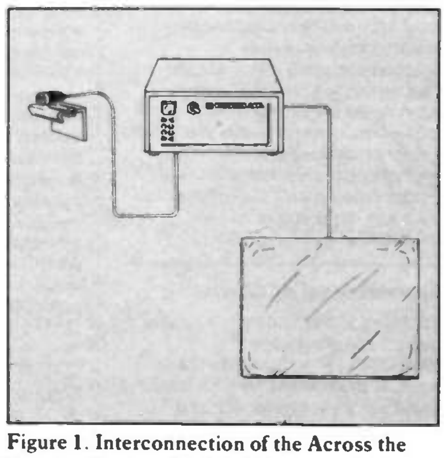


Figure 1. Interconnection of the Across the Counter Communication Aid components.

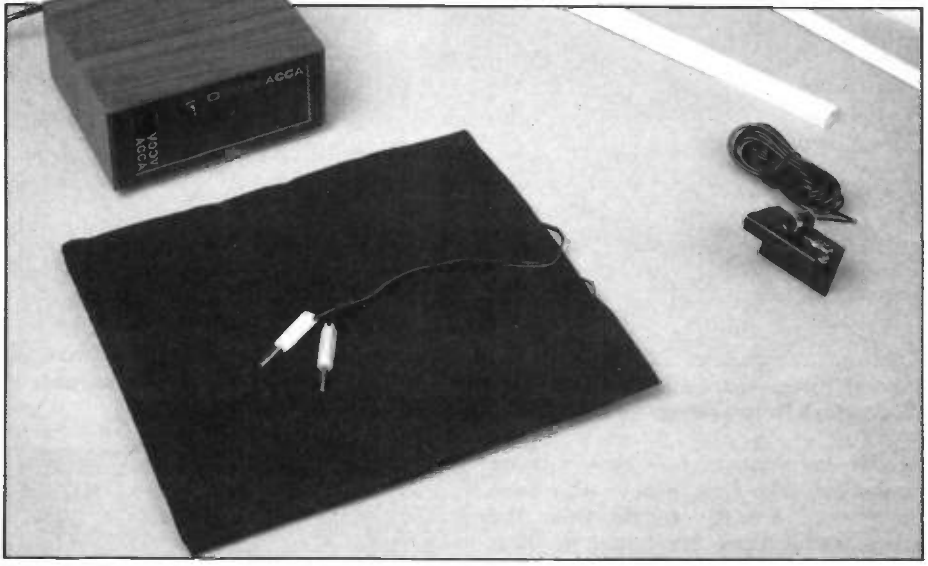


Photo 1. The component parts of the Across the Counter Communication Aid.

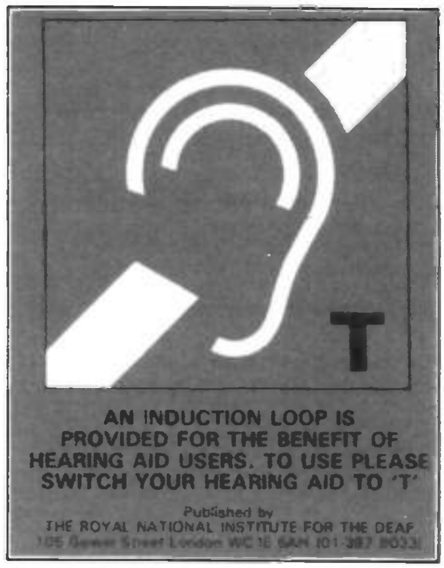


Photo 2. The R.N.I.D. Induction Loop Sign.

switched on the whole time as it does not interfere with normal counter service. Induction loop availability is denoted by displaying the R.N.I.D. Induction Loop sign, see Photo 2. Operation of the system is illustrated in Figures 2a and 2b, the hearing aid user is alerted to the across the counter communication aid by the induction loop sign, and switches their hearing aid to the 'Telecoil' (T) position. From then on the system is 'transparent' in operation to both the customer and counter staff. After completing the enquiry or transaction, the hearing aid user simply switches their hearing back to the normal 'Microphone' (M) position.

Induction loops are also available to improve clarity of speech and provide full communication facilities within either the home or office environment. Such devices can be connected (directly or indirectly) to a TV for example, so that the hard of hearing person may hear the television sound via an induction loop. This has the advantage that the sound is free from extraneous sounds in the room, or the street outside. As a secondary benefit to other occupants of the house and neighbours, the level of sound from the TV's speaker need not be excessively loud!

Induction Loop Theory

The theory and practice of audio frequency induction loop systems has been covered in great detail in a five-part series of articles by J. M. Woodgate, published in Issues 39 to 43 of 'Electronics – The Maplin Magazine'. It is recommended that the reader seeking in-depth information on this subject refer to this series. The issues can be ordered in the normal way, see page 39 for Order Form; Order As XA39N, XA40T, XA41U, XA42V, XA43W (Issues 39 to 43 respectively) issues are priced at £1.45 except issue 39 which is £1.20. However, the following is a short summary of the principle of operation of audio frequency induction loops.

An Induction loop works on the principle of transmitting an audio frequency signal, such as speech, to a listener by means of a magnetic field. The elimination of a direct sound path helps to reduce the interfering effects of distance and background noise. This is something hearing aid users have often found a problem, given that their equipment amplifies rather than receives from a direct sound path. Magnetic induction works as a result of a current creating a magnetic field around a wire and the wire then acting like a transmitting 'aerial'. The magnetic field can then be received by a small coil mounted in a hearing aid or other suitable receiver. Such receivers are significantly cheaper than privately dispensed Hearing Aids and this also means that it is not necessary to own or use a Hearing Aid to benefit from them.

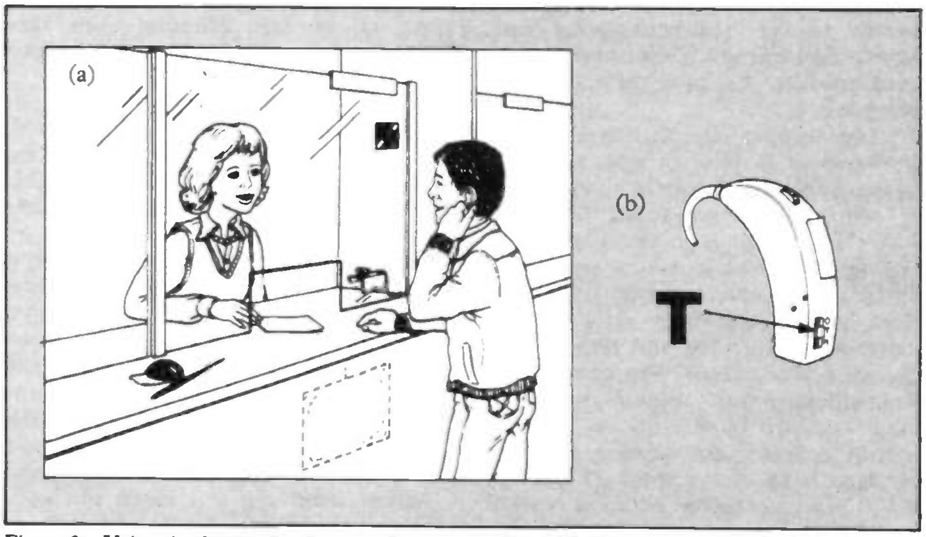


Figure 2a. Using the Across the Counter Communication Aid. Figure 2b. Operation of the M/T switch on a standard hearing aid.

Photo 3. The Minicom Supertel Unit.

An induction loop can be a valuable addition to the home; whilst poor hearing may not be a personal disability, it is of great value to have such a system available when deaf friends or relatives come to visit or stay. Local Social Services Departments may install domestic loops where there is a needy cause, but as with all public provision resources, their funds are stretched and the demand means that waiting lists may well be long.

Help for the Profoundly Deaf

The induction loop has transformed speech communication for people who are hard of hearing. However the basis for using any of the amplification systems, such as shouting, ear trumpet, hearing aid, or hearing aid/induction loop has to be some degree of hearing capability. The profoundly deaf have no hearing capability (or so little to be of no practical benefit) at all, for them it is a totally silent world. The cochlear implant system has been able to offer help to a limited number of profoundly deaf people. This technique was described in part two of the series, briefly, the system can restore a degree of hearing by using implanted electronics to bypass damaged parts of the hearing mechanism. However it is necessary for the patient to have had some memory of sound and speech, i.e. they were born hearing and were then deafened sometime later. For the person who was profoundly deaf at birth, other approaches are adopted to improve communication. The person will have to rely upon information conveyed by their other senses, primarily that of sight. A number of modern means have been developed over the years. These include the greater use of Teletext, signing and subtitles. An area which has always needed some assistance has been the use of the telephone.

One solution offered, that has been developed as an offshoot from the telegraph, computer and radio industry, works by conversing in typed and displayed words. This system is known as Minicom. Minicom is a simple to use person-to-person communication system. It is telephone based, and both sides of the conversation are typed and read, rather than spoken and heard. The two stations communicate using a lap-top typewriter sized keyboard unit with an in-built acoustic coupler, into which a standard telephone hand-set may be placed. TeleTec of Milton Keynes market a number of such systems and the one shown in Photo 3 is the Minicom Supertel version. The unit has an integral printer and QWERTY keyboard, plus 2K of on-board memory which enables messages to be composed, stored and sent. A parallel interface enables larger display units or other printers to be used with the unit.

The Minicom system has liberated the telephone for the profoundly deaf. It enables deaf people to work in the office and other environments, and communicate by telephone with others who also have a Minicom unit. Minicom is also ideally suited to home use, and because of its portability it can be taken and used in any place where a telephone is available. In common with Facsimile, the system benefits from a separate telephone line, although this is not an absolute requirement. The Telecom Approved Supertel Minicom uses CCITT V.21 – 300 Baud or Baudot/Weitbrecht 45·5/50 Baud telecommunications protocols. For those familiar with telecomms technology it can be seen that these protocols are also used by computer users for 300 Baud data communications via modem and radio amateurs for radio-teletype (RTTY) use at 45·5/50 Baud. Therefore it is possible for enthusiasts in these areas to offer help to deaf friends and relatives with their existing equipment. For deaf people who have never been able to benefit from the telecommunications revolution it now means they can experience every word – a major opportunity to participate in the mainstream of society. When businesses and offices have Minicom units they become accessible to hearing impaired customers.

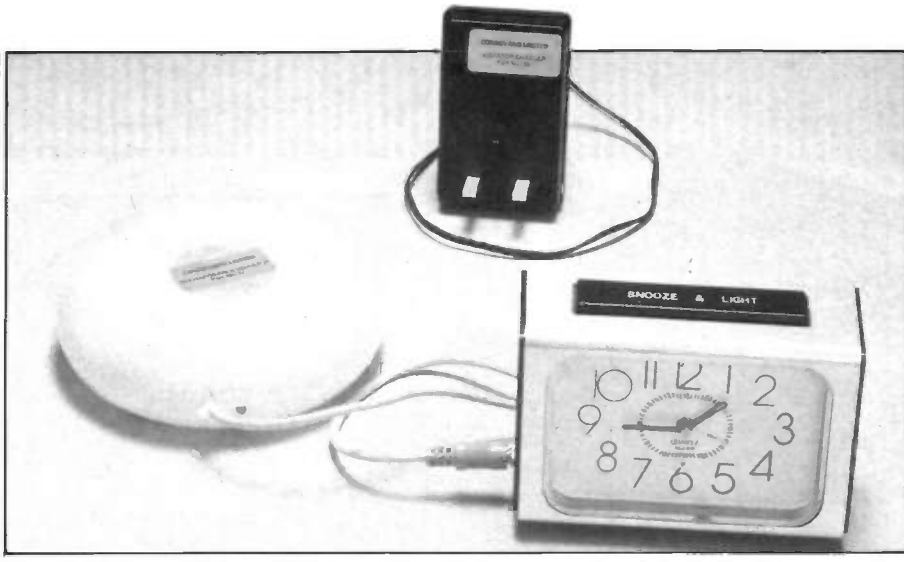


Photo 4. (Foreground) A modified quartz alarm clock connected to a 'silent' vibrating alarm pad. (Background) Battery charger for the vibrating alarm pad.

Attracting Attention

Another means of electronic help for deaf people is the vibrating and/or visible alarm. Photo 4 shows a conventional quartz alarm clock that has been modified by Connevans such that the audible alarm is replaced or supplemented by a vibrating pad. The pad is powered by an integral rechargeable battery pack and is placed under the bottom bed-sheet directly below the pillow. When the preset alarm time is reached, the pad is triggered and the vibration produced is sufficient to wake the deaf person. If required, the normal audible alarm can also sound so that a hearing partner may also be awakened.

Obviously the vibrating pad lends itself to be used in conjunction with other alarm systems, such as a fire alarm, where a deaf person needs to be alerted to because of impending danger. The vibrating alarm can be supplemented by a flashing visual alarm to differentiate between, say, the alarm clock and the fire alarm.

A visual alarm system is ideal for alerting the deaf person to the doorbell, telephone (used in conjunction with a Minicom terminal or hearing aid), crying baby, etc. Such a unit is illustrated in Photo 5, this system illustrated uses a control unit and up to two remote microphones. These are activated by sound, and that activation sets the light flashing.

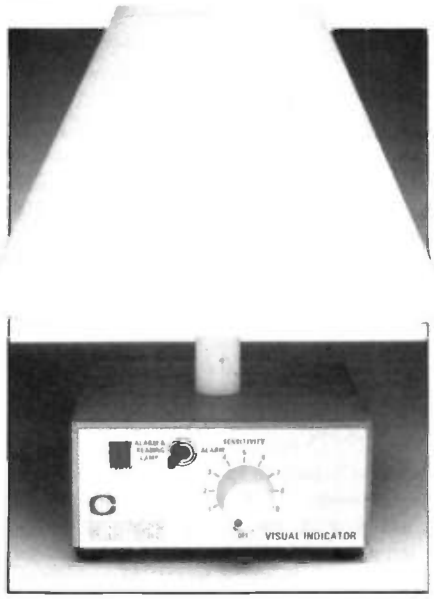


Photo 5. A visual alarm unit.

Education

Many people with hearing difficulties, especially children, experience problems in educational environments. This applies to schools, colleges, evening classes and universities. Children often fare badly because of unkind comments or attitude problems from pupils or uninformed staff. This can lead to children having educational difficulties – there is an unfortunate misconceived idea that 'deafness means stupid' – a very cruel presumption. However a lot can be achieved by the early detection of hearing problems and appropriate action taken, for example the prescribing of a hearing aid, regular audiometry tests to monitor changes in hearing. The group educational environment is often a difficult one because of the distance of the teacher/lecturer from the student and because of extraneous noise and reverberation. One answer is the use of a radio microphone, which allows the speech from the intended person to be relayed directly to the hearing impaired student. Such a system is marketed by Connevans and is shown in Photo 6. The transmitter and microphone is worn by the speaker and the receiver by the student. In fact the home office have allocated twenty radio frequency bands, five of which are specifically for the hearing impaired, the others are used by wideband radio microphones, which may also be used by the hearing impaired. The receiver 're-transmits' the sound to the student's existing hearing-aid by means of an induction loop or alternatively by direct audio input to hearing-aids capable of direct connection; this has the advantage of providing a flatter frequency response. The induction loop is in the form of a body or neck worn loop that radiates a magnetic field that can be picked up by the telecoil within the hearing aid.

A lower cost alternative to the radio microphone system is an infra-red link, this is shown in Photo 7, the versatility of such a system is not as great, but is ideal for use in the home or office environment. As with the radio microphone system the receiver 're-transmits' the sound to the wearer by means of an induction loop, direct audio connection or headphones.

Concluding

The needs of disabled people are varied and complex. Deafness has had its share of neglect. These new moves and developments mean that electronics is starting to show it can respond to these different needs. With so much emphasis upon noise and its intrusion into our often busy lives, a silent telephone alarm or door bell has a number of attractions both for the hearing, and the hearing impaired person. The latest technology advances include the video-phone, which would enable deaf people to 'sign' and possibly lip-read over the 'phone.

References

Audio Frequency Induction Loop Systems, by J. M. Woodgate, Electronics – The Maplin Magazine.

Installation Guidelines for Induction Loops in Public Places – The R.N.I.D.

Acknowledgements

John Poppleston, General Manager, Connevans Ltd. Judith Tingley, TeleTec Ltd.

Additional Information

Additional information on hearing and deafness may be obtained from the E.N.T. department of your local hospital (see telephone directory for address), the Royal National Institute for the Deaf, and the British Deaf Association whose addresses are given below:

The Royal National Institute for the Deaf,
105 Gower Street,
London. WC1E 6AH.

The British Deaf Association,
38 Victoria Place,
Carlisle. CA1 1HU.

Specific information on the commercial products mentioned in this article may be obtained from the companies whose addresses are given below. Please do not contact the R.N.I.D., your hospital, or Maplin for information about these products.

Connevans Ltd.,
54 Albert Road North, Reigate,
Surrey. RH2 9YR.
(0737) 243134 Minicom;
(0737) 247571 Voice.

TeleTec Ltd.,
Premier Suites, Exchange House,
494 Midsummer Boulevard,
Central Milton Keynes. MK9 2EA.
(0908) 691404 Minicom;
(0908) 692355 Voice.

Photo 6. A Radio microphone and receiver system designed for the hearing impaired.

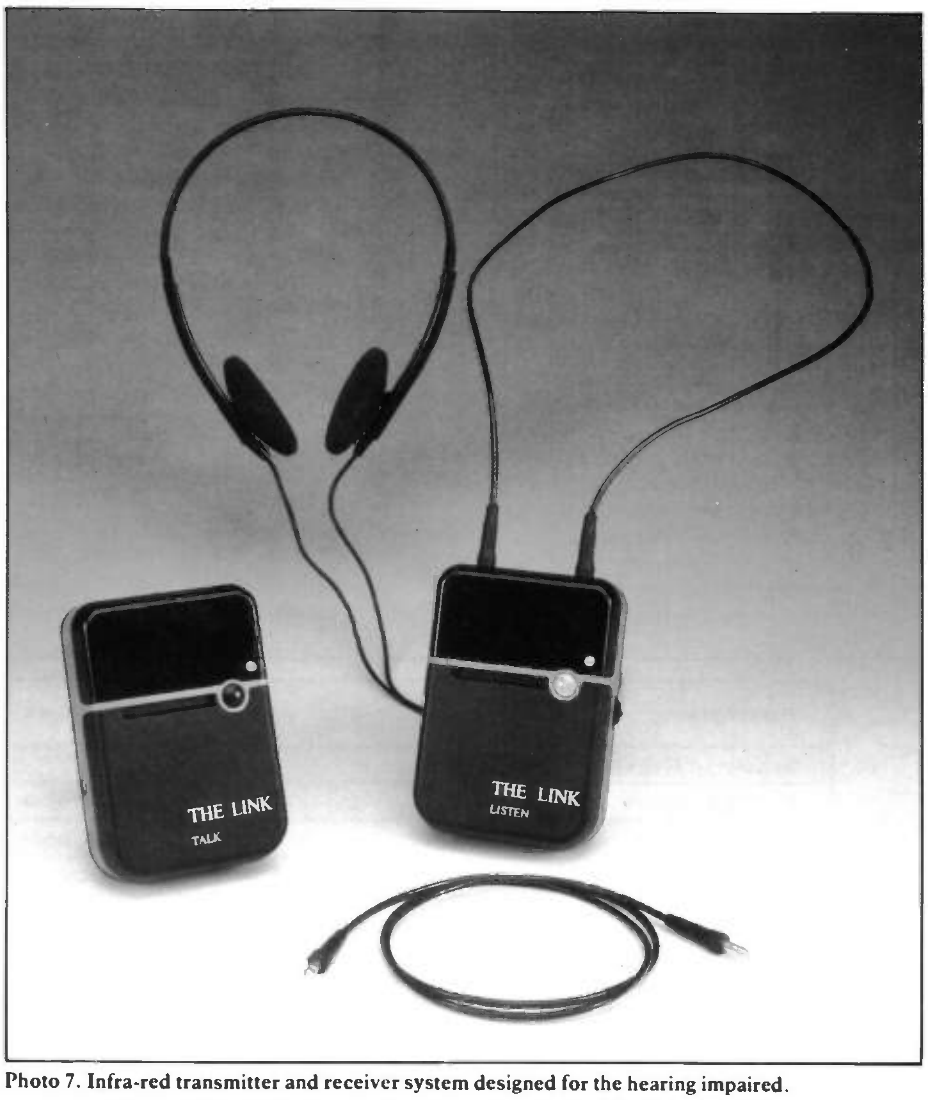


Photo 7. Infra-red transmitter and receiver system designed for the hearing impaired.

PART ONE: THE TIMER CARD

by Tony Bricknell

GALACTIC TIMER UNIT

Features
- ★ 24-hour, 7-day clock
- ★ Four switched outputs interface to relay, triac drives etc.
- ★ 112 Daily switching operations
- ★ 112 Weekly switching operations
- ★ Manual control of any output
- ★ Output status LEDs
- ★ Optional battery back-up

Applications
- ★ Central heating controller
- ★ Immersion heater controller
- ★ Lighting control
- ★ Recording radio transmissions at preset times

Introduction

Way back in the mists of time Maplin created the 'Universal Timer', a very useful project that could switch up to four mains appliances at various times throughout the period of one week.

Unfortunately, this project passed away many years ago and a new, improved timer was needed as a replacement. Enter 'Galactic Timer', a timer that does much more than the old 'Universal Timer', but with a similar name (Galactic, Universal, Cosmic, etc?).

The Galactic Timer is based around the Texas Instruments TMS1601A masked programmed microcontroller, containing a real time 24-hour, 7-day clock and four individually programmable outputs. The full specification for this IC is shown in Table 1.

There are 28 switching times available to each output on a weekly basis and four times on an everyday basis making this project ideal to control central heating, switching on electric blankets, turn lighting on and off when on holiday to give the impression that the house was occupied, etc.

Switching times are entered through a keyboard, stored in battery backed-up memory, and can be of two types :

a) Weekly switching times. i.e. Every Wednesday 13:00 switch 2 turns off and

b) Daily switching times. i.e. Every day at 9:30 switch 3 turns on.

In addition to this, each switch can be manually overridden from the keyboard.

A highly efficient 4-digit 7-segment display gives the time in 24-hour format and 18 LEDs show day of the week, programming information, and switch output status. This display is blanked during battery back-up to reduce power consumption.

Circuit Description

In addition to the circuit shown in Figure 1, a block diagram is detailed in Figure 2. This should assist you when following the circuit description or fault finding on the completed unit.

The mains voltage is stepped down to 12 volts, rectified by BR1 and smoothed by C1. TR1 provides a constant current source of 6mA to charge the 8·4V Ni-Cd battery. TR2 provides a regulated −9V supply to IC1 and IC2, while TR3 supplies a regulated −5V to the logic/display driver ICs.

Parameter	Test Conditions	Min	Typ*	Max	Units
Supply Voltage, V_{DD}		−7.5	−9	−10.5	V
Average supply current	All outputs open		11	17	mA
Average power dissipation	All outputs open		99	178.5	mW
Input current (Column, Data In, 50Hz In)	V_I = 0V	70	180	400	uA
High level output voltage	I_O = −5mA	−1.7			V
Low level output current	V_{OL} = V_{DD}			−10	uA
Internal oscillator frequency		500	575	650	kHz

* All typical values are at V_{DD} = −9V, T_A = 25°C

Table 1. TMS1601A electrical specification.

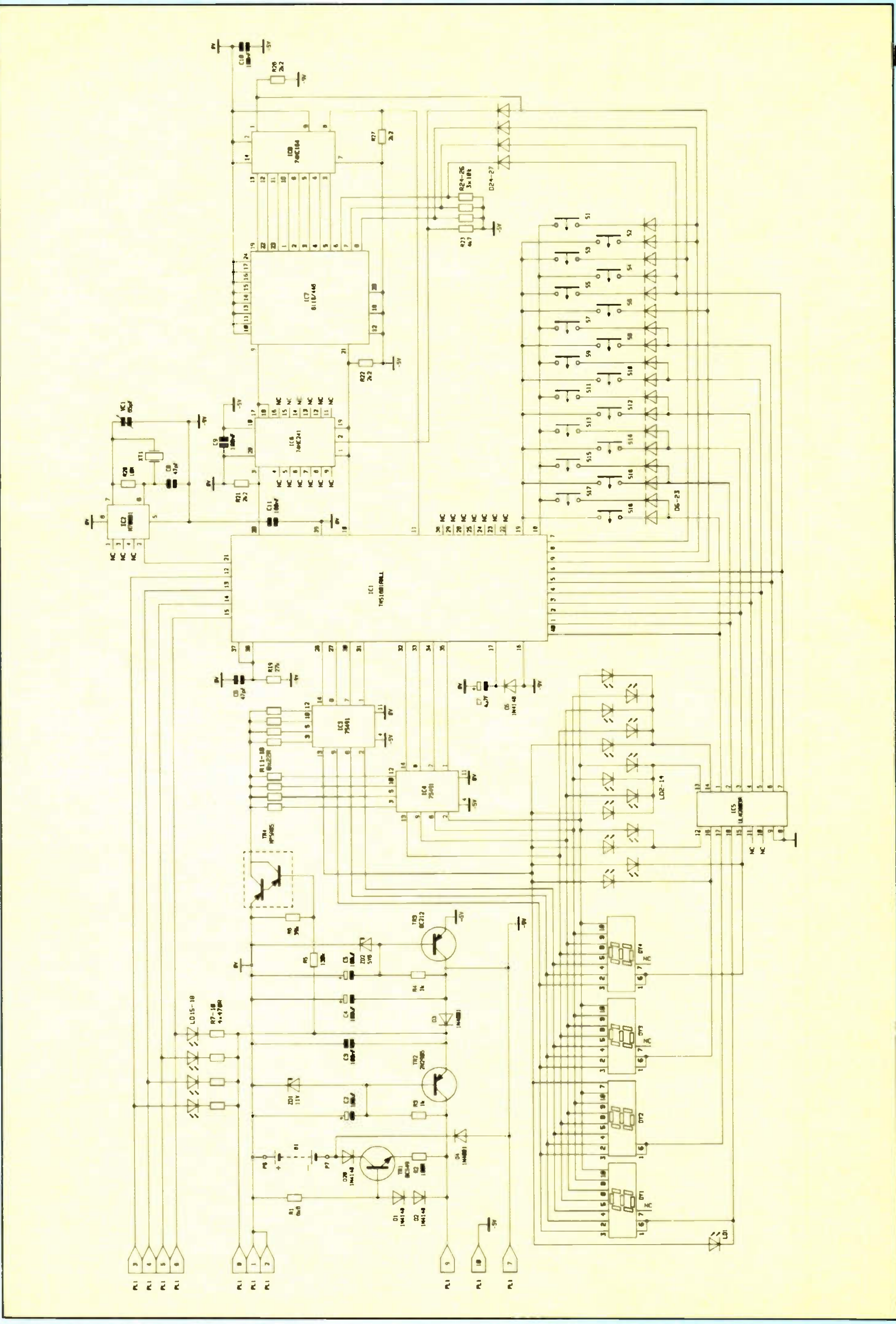
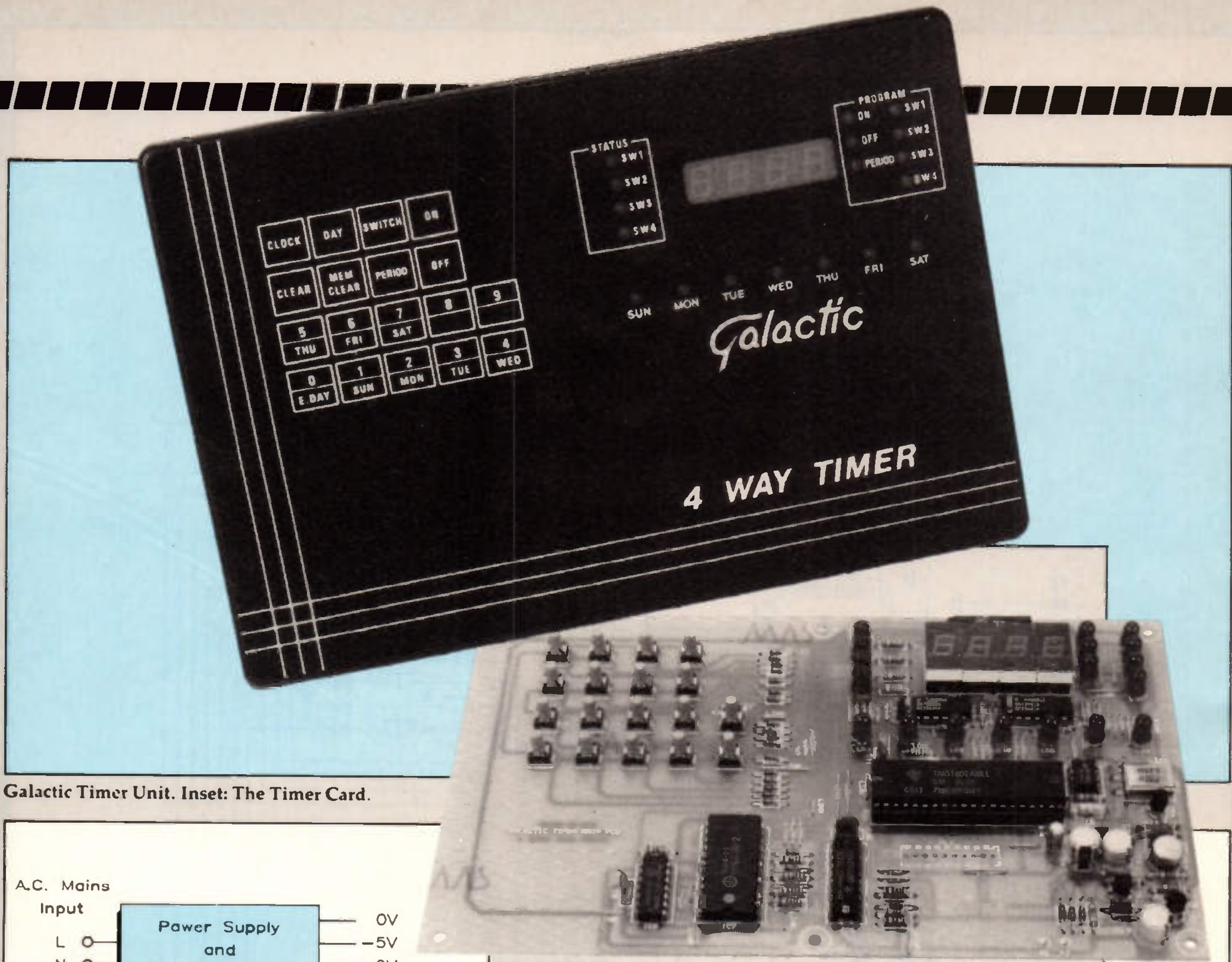


Figure 1. Galactic circuit diagram.



Galactic Timer Unit. Inset: The Timer Card.

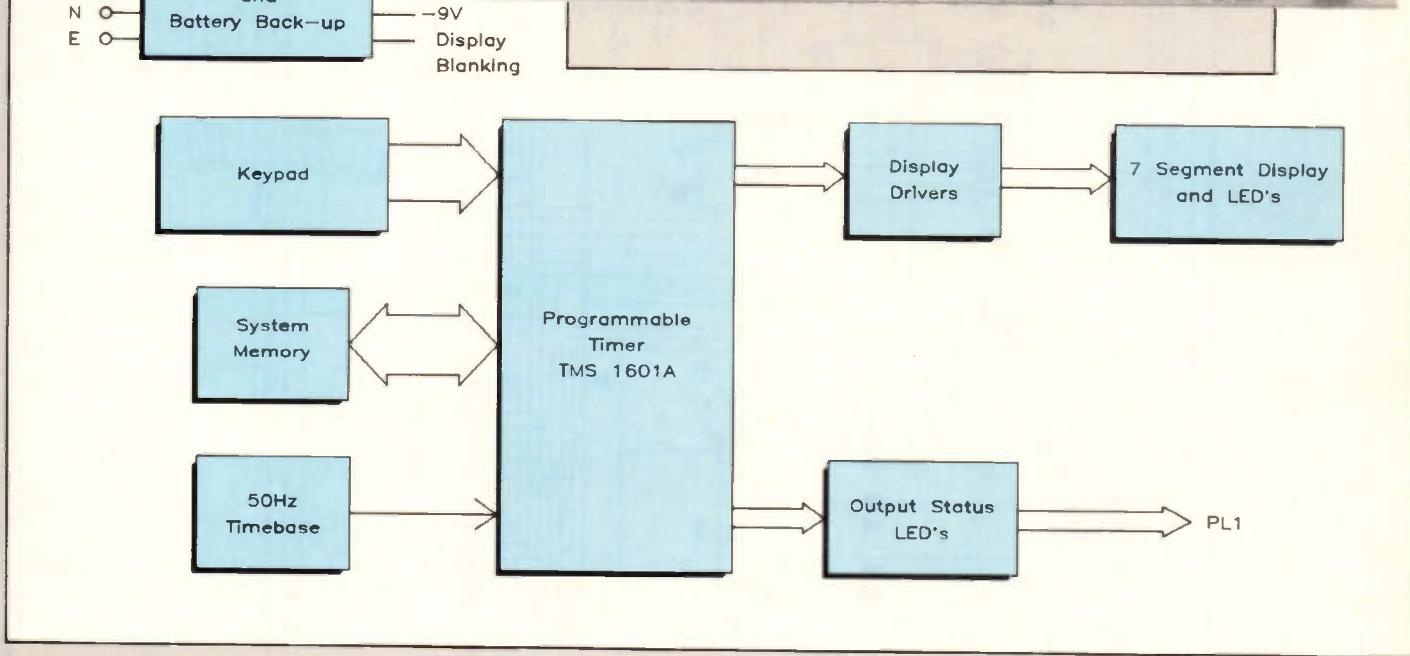


Figure 2. Galactic block diagram.

IC2 divides the 3·2768MHz crystal frequency by 2^{16} to give an extremely accurate 50Hz timebase which is fed to IC1 on pin 21. This is much more accurate than the 50Hz mains frequency and also has the advantage that the clock continues to run during a mains failure! IC1 also has an internal oscillator whose frequency is set by C4 and R19.

High-efficiency 7-segment displays and LEDs are driven by buffers IC3, IC4 and IC5. Display blanking during battery back-up is achieved by TR4 interrupting the supply to IC3 and IC4.

Switching times entered via the keyboard matrix SW1 – SW18 are stored in IC7, a 2048 × 8-bit static RAM, through IC6 and IC8.

C5 simply provides a reset pulse to IC1 on initial power up.

The four switched outputs and power supply connections are brought out to a 10-way minicon (see Table 2). In following editions of *'Electronics'* a four channel relay card and four channel 240V AC triac card will be described which link the small power supply PCB (GE51F), through the relay/triac card, to the main PCB's 10-way minicon.

Construction

The Galactic Timer is constructed on two PCBs. Both PCBs are of the single sided fibreglass type, chosen for maximum reliability and electrical stability. Removal of a misplaced component is, however, quite difficult so please double-check each component type, value and polarity where appropriate, before soldering!

For further information on component identification and soldering technique please refer to the constructors' guide included with the kit.

It is best to start construction with the small Power Supply PCB GE51F (see Figure 3). Insert the five veropins P1 – P5, and press them into position using a hot soldering iron. When the pins are heated in this way, very little pressure is required to push them in place. Once the pins are in position they can be soldered. Insert and solder the remaining components, taking care with the orientation of C1, leaving the large transformer T1 and fuse FS1 until last. The assembled Power Supply PCB is shown in Photo 1.

Put this board to one side and now start construction of the main PCB, shown in Figure 4, with printed legend to help you correctly locate each component. The sequence in which the components are fitted is not critical; however, as there are several 'anomalies' in the construction, the following instructions will be of use in making these tasks as simple as possible.

Start by inserting and soldering the two veropins P6 and P7 from the *legend* side of the PCB, with a soldering iron as previously described. Using the length

PL1−1	0 Volts
PL1−2	0 Volts
PL1−3	Switched output 1
PL1−4	Switched output 2
PL1−5	Switched output 3
PL1−6	Switched output 4
PL1−7	−9 Volts¹
PL1−8	−9 Volts²
PL1−9	−12 Volts input
PL1−10	−5 Volts

Note : −9V¹ is battery backed up, whereas −9V² is not

Table 2. Minicon connections.

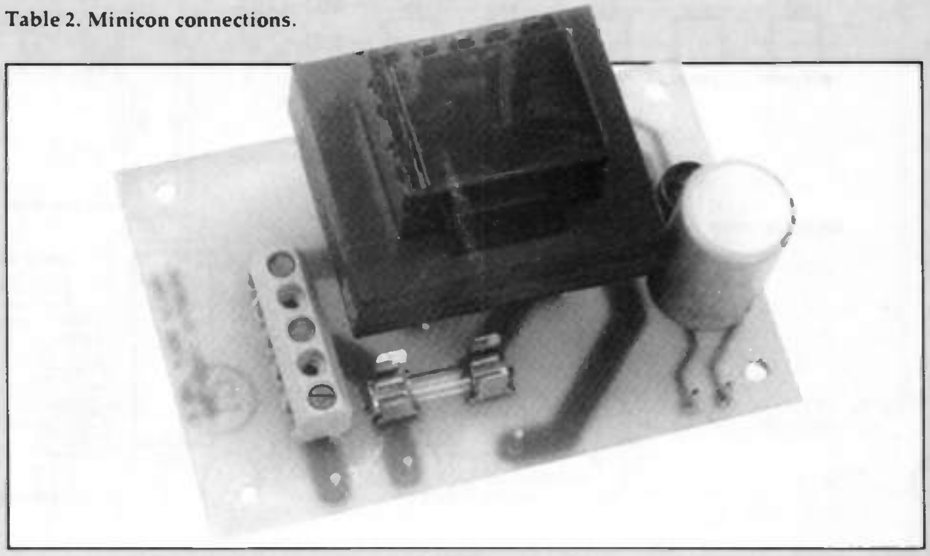


Photo 1. The Assembled Power Supply PCB.

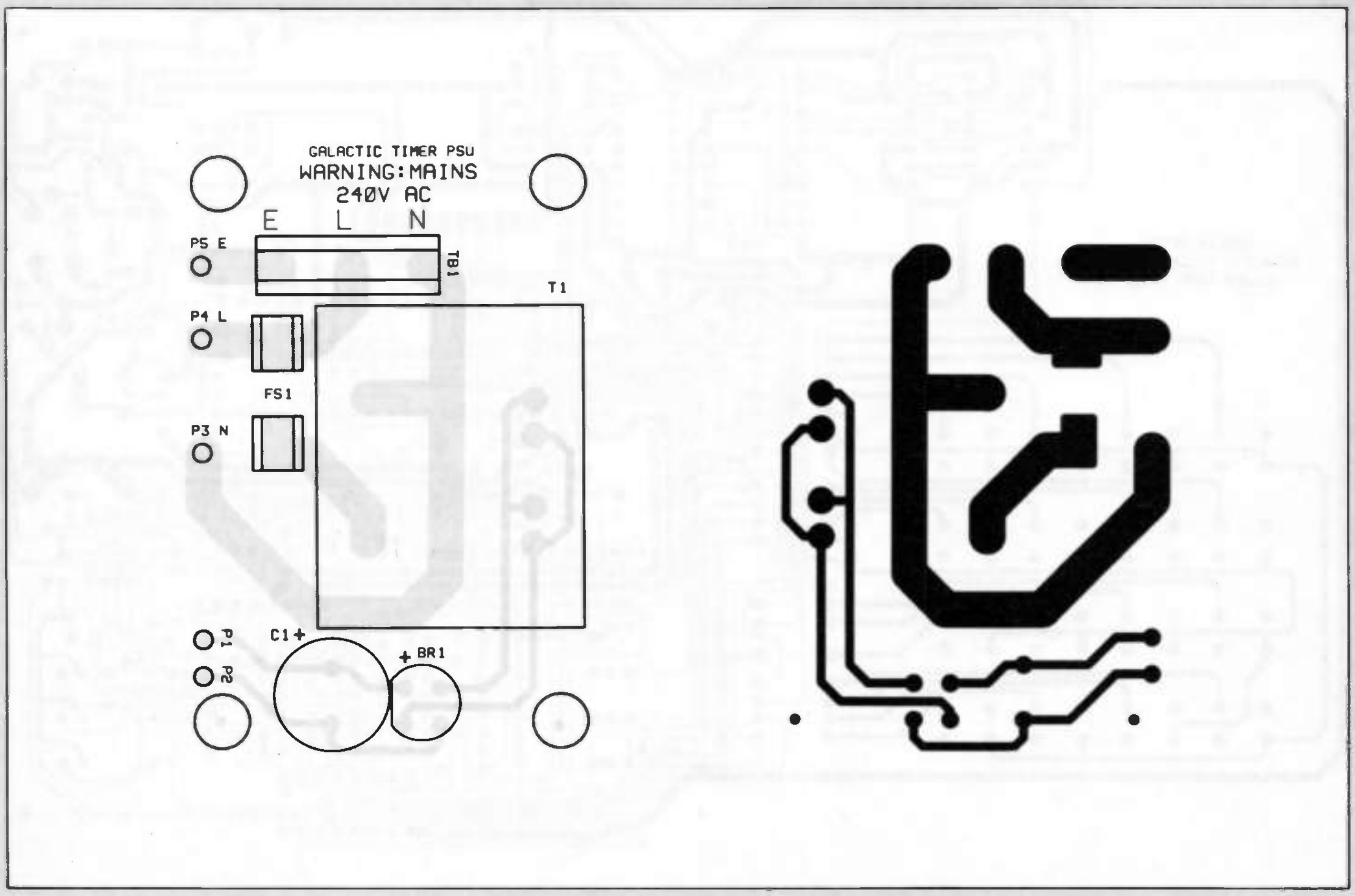
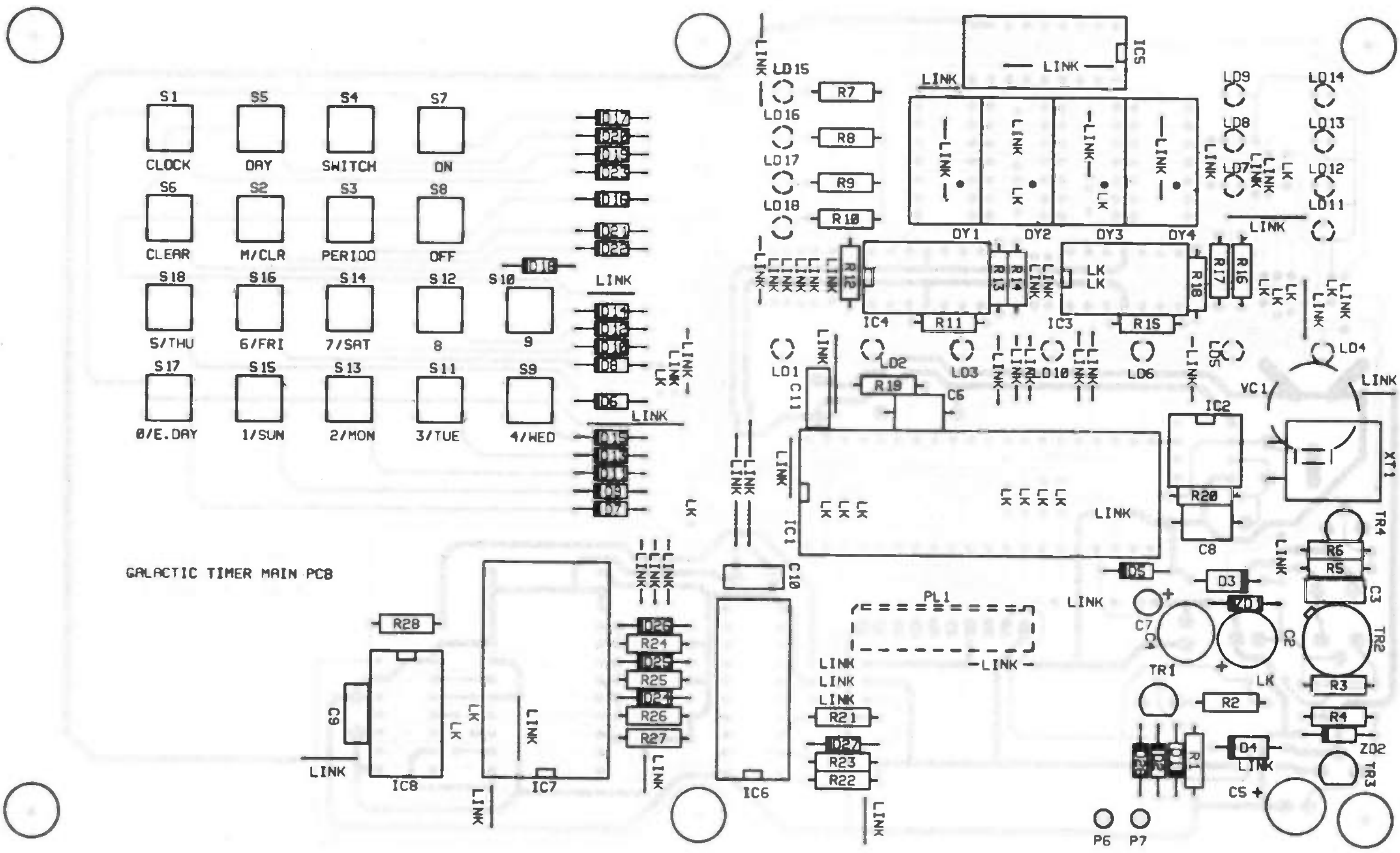


Figure 3. Power supply PCB layout.



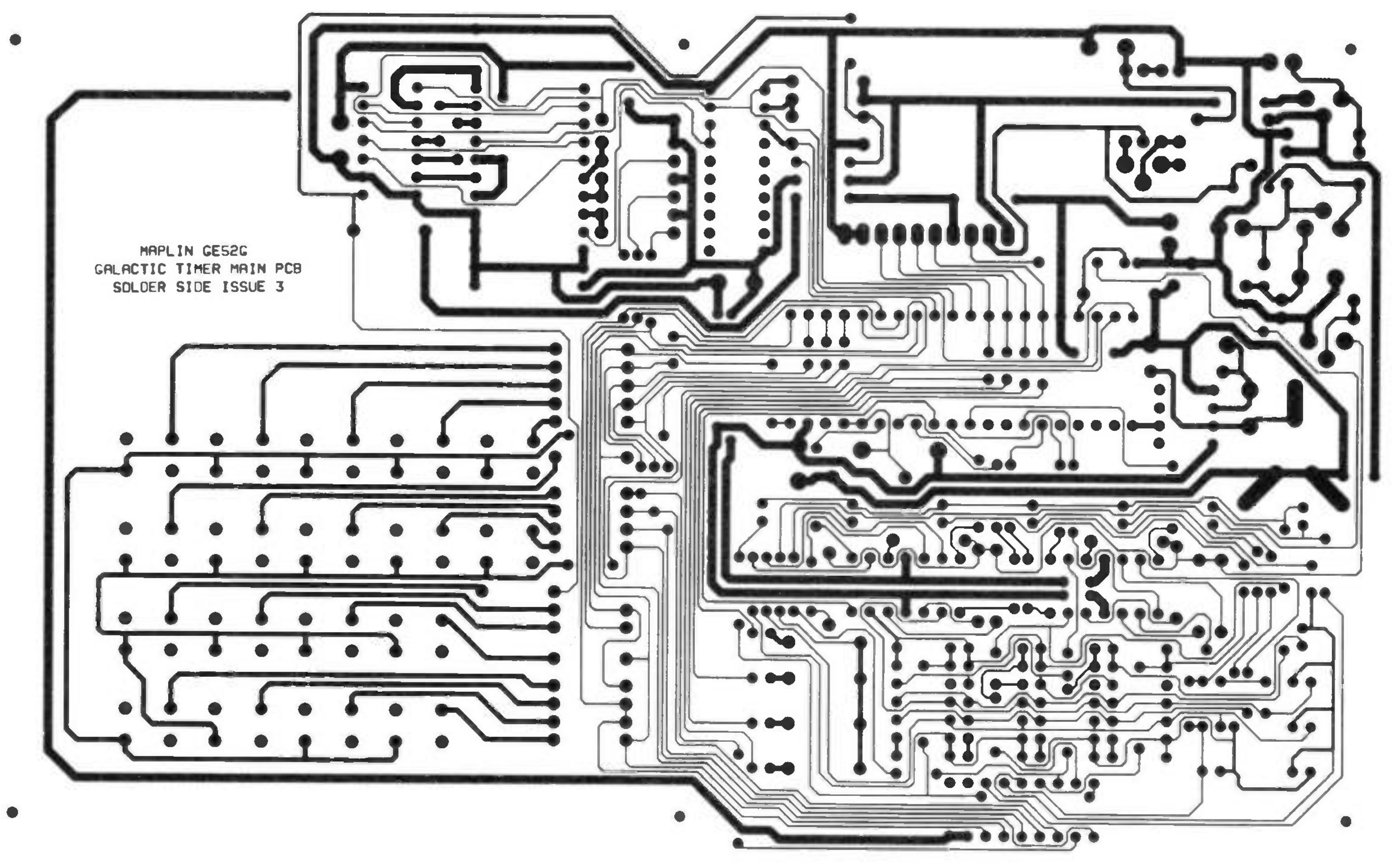


Figure 4. Main PCB layout.

of 22 SWG wire included in the kit, fit the 73 links (yes 73!). It should now be easier to start with the smaller components, such as the resistors, and work upwards in size, until the LEDs and minicon connector are last to be fitted.

Semiconductors (diodes and transistors) need special precautions when fitting. In particular, take care not to overheat them during soldering. All the silicon diodes have a band identifying one end, be sure to position these adjacent to the white blocks marked on the legend. The polarity for the electrolytic capacitors is shown by a plus sign (+) matching that on the PCB legend; however, on the actual body of most electrolytic capacitors, the polarity is designated by a full length stripe with a negative symbol (−), in which case the lead nearest *this symbol goes in the hole opposite* to that adjacent to the positive sign on the legend.

When fitting switches SW1 – SW18 do not mount them flush with the PCB, instead solder them in place at a height of approximately 1–2mm above the PCB.

Install the four transistors, matching the shape of each case to its outline on the legend. As shown in Figure 5, the 7 segment displays DY1–DY4 fit centrally in the four 14-pin IC sockets supplied with the kit. Take care that all pins are firmly inserted and no pins are bent under the displays. Fit the 40-pin IC socket, matching the notch in the end of the socket with the white block on the legend. *Do not* install any ICs until they are called for during the test procedure!

With reference to Figure 6, insert LD1 – LD19 at a height of 3mm. The best way to do this is to cut a thin strip of card 3mm wide and place this between the legs of the LEDs and the PCB whilst they are soldered.

The 10-way Minicon connector and variable capacitor VC1 are soldered to the *rear* of the PCB. Bend the legs of VC1 outwards as shown in Figure 7. Place the component centrally on the three 'finger' pads and carefully solder. Take care in the orientation of PL1 (see Photo 2).

If battery back-up is required then solder a PP3 battery clip to P6 (+/red) and P7 (−/black), otherwise short out the two veropins with a length of wire.

The assembled Timer Card PCB is shown in Photo 3.

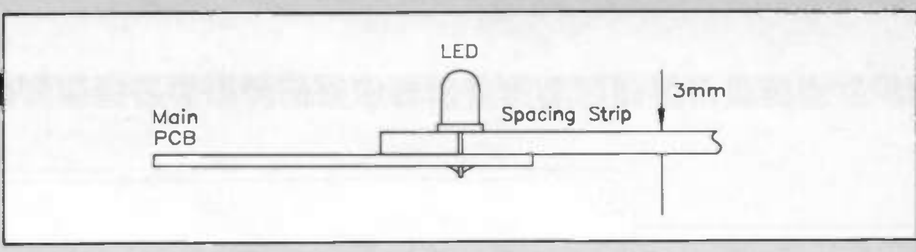


Figure 5. Inserting DY1 – DY4 in the 14-pin DIL sockets.

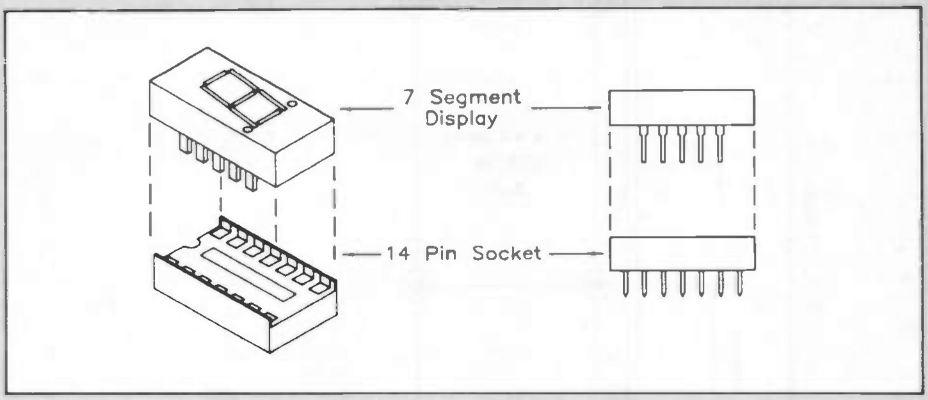


Figure 6. Inserting LD1 – LD19.

Figure 7. Modifying VC1.

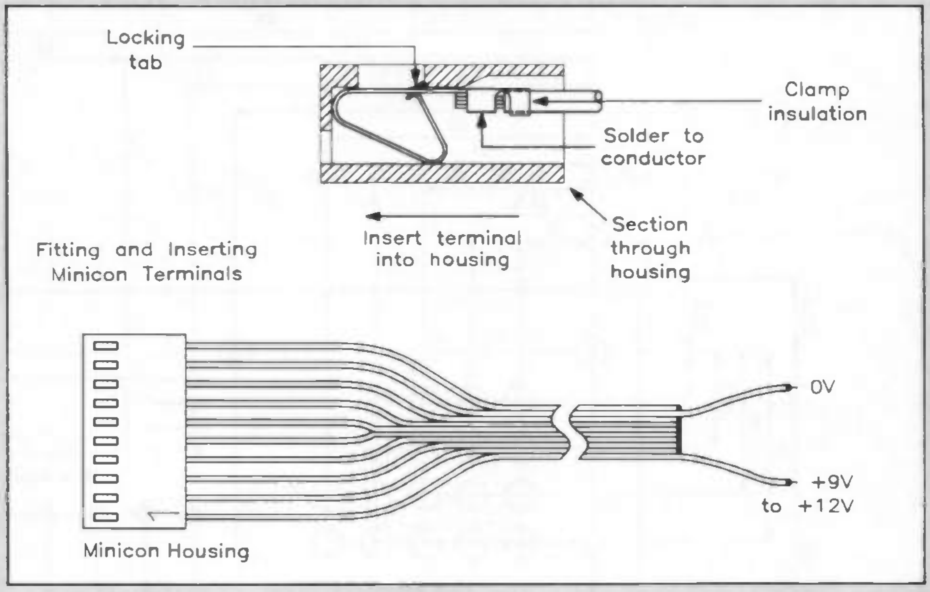


Figure 8. Testing the main PCB.

Testing

Testing the unit can be achieved with the minimum of equipment. You will need a multimeter and a DC supply of between 9 and 12 Volts. The readings were taken from the prototype using a digital multimeter, some of the readings you obtain may vary slightly depending upon the type of meter employed.

Double check your work to make sure that there are no dry joints or short circuits, and that none of the ICs have been fitted into the board.

The first test is to ensure that there are no short circuits. Set your multimeter to read Ohms (Ω) on its resistance range, connect the test probes to PL1-1 and PL1-9. With the probes either way round a reading of greater than 500Ω should be obtained.

Temporarily make up a short connection lead as shown in Figure 8 but *do not* connect the power supply just yet! Connect the optional 9V battery to the PP3 clip. It is *very* important that the 9V battery is installed (or P6 and P7 shorted) *before* power is applied to the PCB otherwise damage could result!

Apply power to the main PCB. With your meter reading DC Volts connect its positive test lead to IC1 socket pin 39 and its negative lead to pin 16. If all is well a reading of approximately +9V should be obtained.

Remove the supply and disconnect the 9V battery (if fitted), then install IC1, making certain that all the pins go into the socket properly and that the pin one marker on the IC package is at the notched end of the socket. Insert the remaining ICs, matching the pin one designator or notch at one end of the package with the white block on the legend. Take great care while soldering the ICs, allowing several seconds between solder joints for the IC to cool down! As a guide, solder the four corners first, ensuring that the IC is flush with the board, then solder the remaining pins.

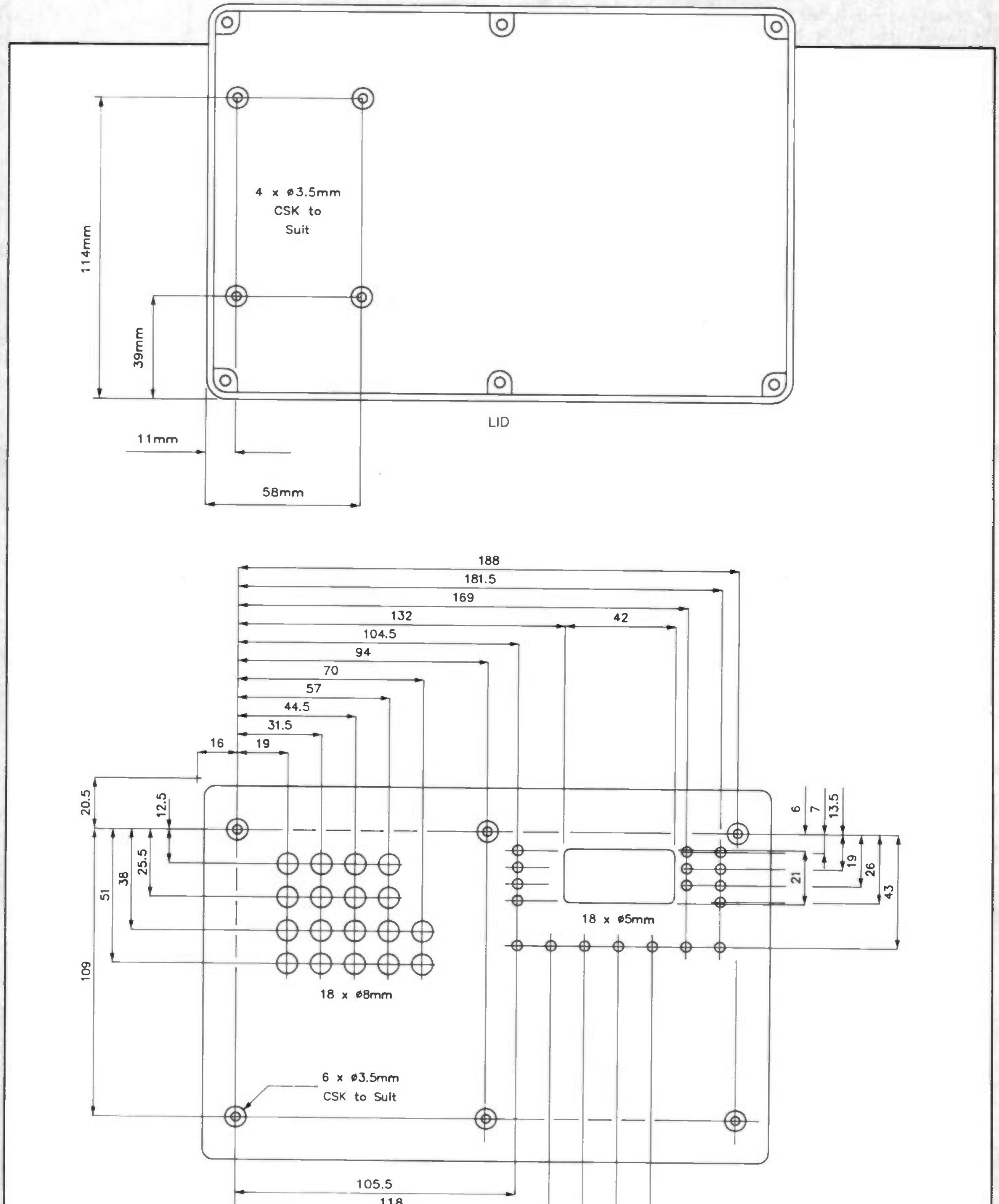


Figure 9. Box drilling dimensions.

Final Assembly

The complete Galactic Timer fits nicely into an ABS Box MB6, stock code YN39N. The lid and tray of this box need to be drilled and filed to the dimensions given in Figure 9. With reference to Figure 10, fix the small power supply PCB to the lid of the box, and the main PCB to the tray of the box using M3 fixings. A self-adhesive membrane front panel is available (stock code JX51F) which should be fixed squarely onto the top of the box.

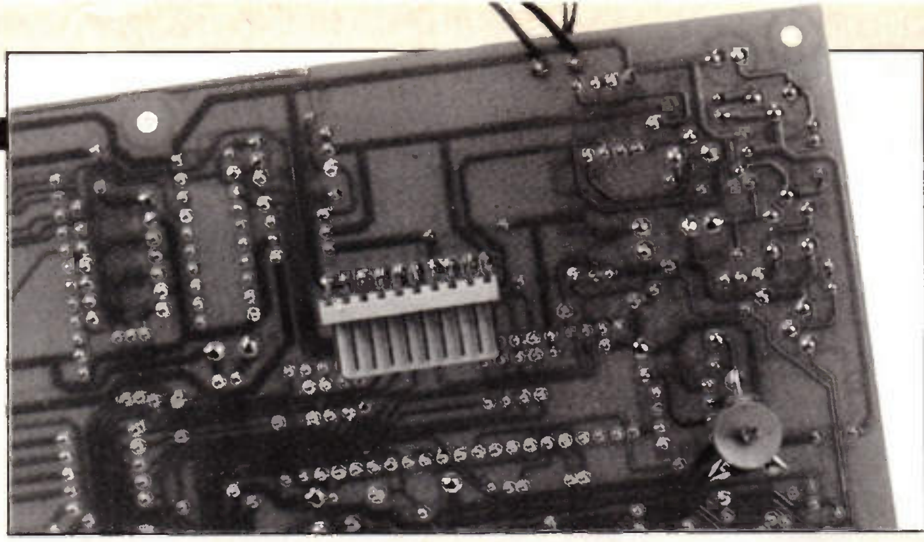


Photo 2. Minicon and VC1 soldered to *rear* of the Timer Card PCB.

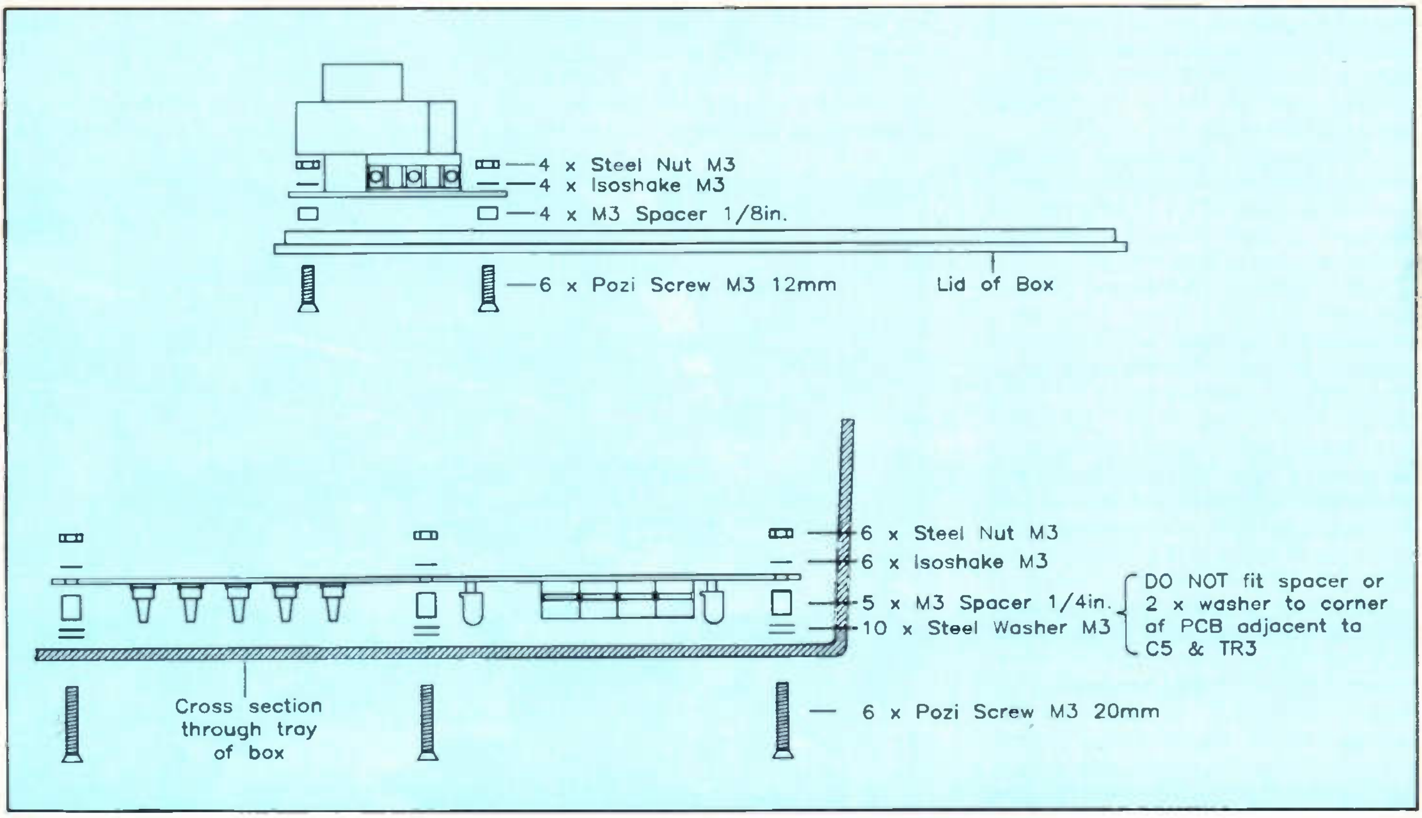


Figure 10. Fixing the two PCB's to the box.

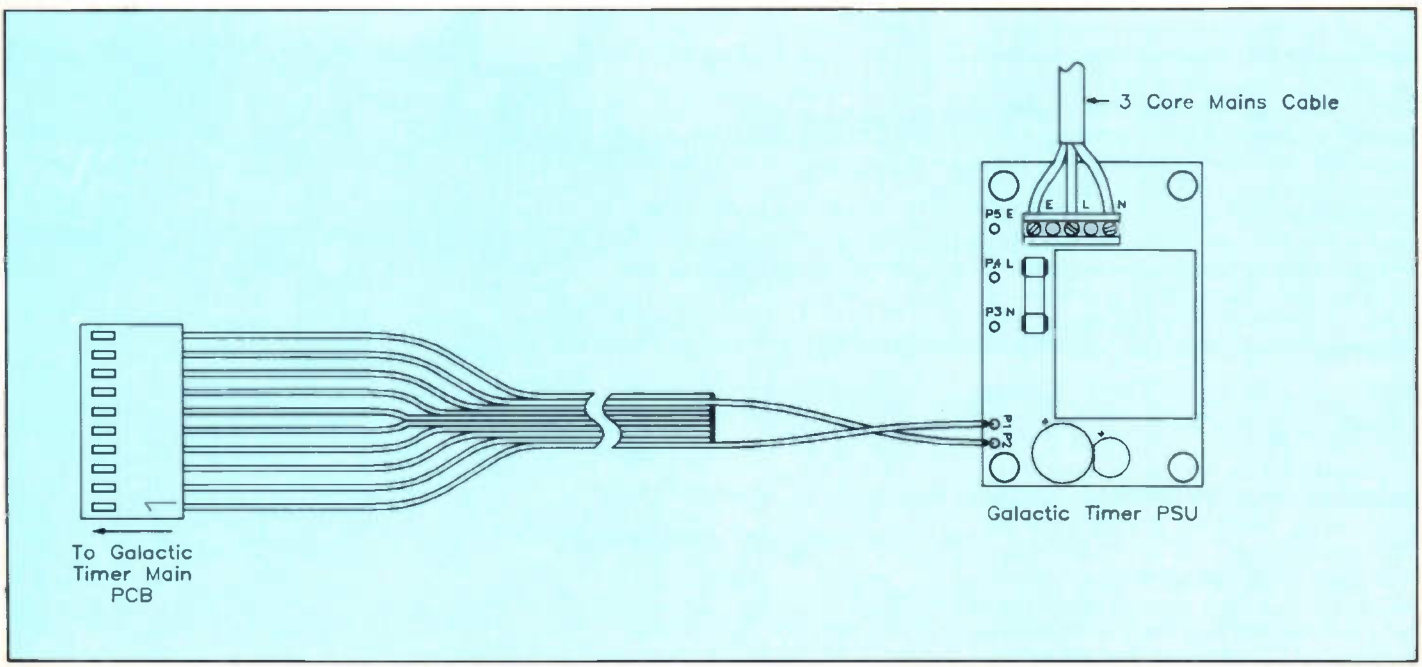


Figure 11. Temporarily connecting the two PCB's.

Continued on page 23.

WHEN DISASTER STRIKES!

by Alan Simpson

If a Disaster Can Happen, it Will...

Early in 1989 Digital Equipment's computer facility at Basingstoke was destroyed by fire, at this time a lot of senior company management must have sat up and taken notice. It was not long before they had to sit up again.

A 'major electrical outrage' – as the Americans call power blackouts – cut power to over 300 data centres in lower Manhattan. Lights went out, elevators halted and air-conditioning systems shut down. Financial transactions ceased zapping around the networks and company PABX systems went down. A week later some of the nation's largest corporations were still having to make use of back-up computer centres. Observers called the blackout one of the worst regional computer-related disasters of all time.

However, this description was disputed by communications managers when, also early last year, AT & T's long distance telephone network 'thought' it was overloaded and began to reject calls.

As consultancy PA reported, back-up computers across the United States were automatically triggered to alleviate the 'problem', only to show the same symptoms. With the network down for some *nine hours*, only half of the 150 million long-distance calls normally routed along the network got through. Hotels and airlines reservation systems crashed and news agencies lost their input – even to the extent of not being able to report on the network disaster news itself! Eventually AT & T traced the problem to a *single* logic failure in the computer programs which route the calls, which occurred in a recent software upgrade. The fault spread rapidly because all the back-up computers had been updated with the same programming error! As PA comment, it appears to have been one of those cases where the new software was not adequately tested.

Closer to home, more management sitting-up took place last November when a fire at BT's main telephone exchange at Scarborough cut off the rest of the country for several days. The blaze consumed MegaStream and KiloStream data cables, as well as nearly 25,000 business and residential lines. Five days after the fire, many large computer sites in the locality were still cut-off. BT, who were criticised by local authorities over the lack of back-up, said that such major disasters were very, very rare. But consideration is now being given to re-appraise the resistance of its exchanges to fires, floods and explosions.

Preparing for the Worst

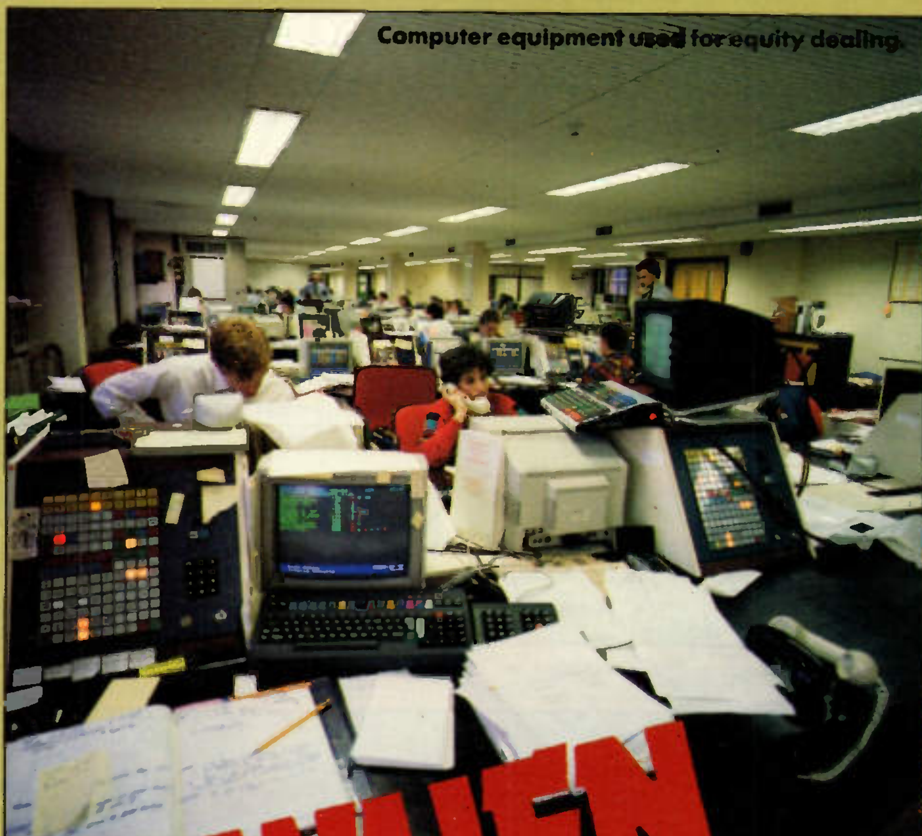
Sometimes, as a research report from Amdahl comments, the potential consequences of a threat to security may be relatively minor. But this is not always the case. Disasters are a form of security threat whose consequences jeopardise activities to such an extent that the organisation's very survival is threatened. It is impossible, certainly impractical, for most companies to try to reduce that risk to zero. But they can go a long way towards making that risk a good deal smaller, by making an investment, in terms of both money and management attention, in preventive measures and contingency planning. Digital Equipment certainly had cause to feel pleased that they at least had followed good housekeeping procedures by taking full back-ups of all disks to magnetic tape which are stored off-site. Also that the VAX architecture could be run on a variety of DEC configurations. In fact one of the biggest problems was the rehousing of the 500 installation staff. Certainly the disaster comes into the 'spectacular' league. It took 100 firemen with 20 appliances from two fire brigades to deal with the fire which broke out at the DEC facility.

Fortunately no one was injured, but computer equipment apart, some sixty staff cars perished. However, it was business as usual for DEC just a matter of days after the disaster. But for most companies, a computer disaster could spell the *end of the company*. Because of this, modern computers are highly reliable.

According to Storm Larkins, who heads the Hardware Environmental Protection Agency, installation protection should clearly be focused on the environment. Several dangers lurk here – the air conditioning, power supplies, cabling and fire and smoke detection systems. HEPA, who prefer to conduct regular site maintenance inspections rather than acting as a 'Red Adair', believes that over 75% of installations are vulnerable in some way or other.

Industry Concern

Disaster awareness – or lack of it – seems to be a well documented matter. A recent Mori poll found that nearly 60% of



Computer equipment used for equity dealing.

computer managers are unconcerned about data security – a figure confirmed by the computer research group Romtec who found that only 40% of computer managers had any contingency strategy or disaster recovery plan in the case of a computer shut down.

"Disaster recovery should be built into IT strategies and planned as an essential item rather than an option," says Keith Windram, managing director of Sherwood Computer Management, one of the UK's leading suppliers of disaster recovery services. "Companies need to provide total protection for their computer resources, not only to safeguard their business, but also to protect customers, shareholders, suppliers and employees."

Instant Solutions

The ultimate disaster protection approach, says Amdahl, is that of integrated back-up. Here two centres are kept running virtually in tandem with files being passed between the two centres as often as required. Should one centre go down, then the other can continue with little or no disruption. There is a major snag however. That of the cost of duplicate configurations, staffing and procedures having to be doubled.

Mission Rescue

Somewhat less expensive is the 'rescue on wheels' service. A mobile portable computer centre can be provided following an in-house disaster. In many cases they combine a prefabricated building with reinforced flooring to support the weight of a mainframe computer. Such a portable centre can be set up close by the primary centre, minimising the need to relocate staff and equipment. However, the service does make the assumption that the main computer has not been severely damaged or that a replacement can be obtained in a short space of time. There is also the problems of lack of air conditioning and heating units.

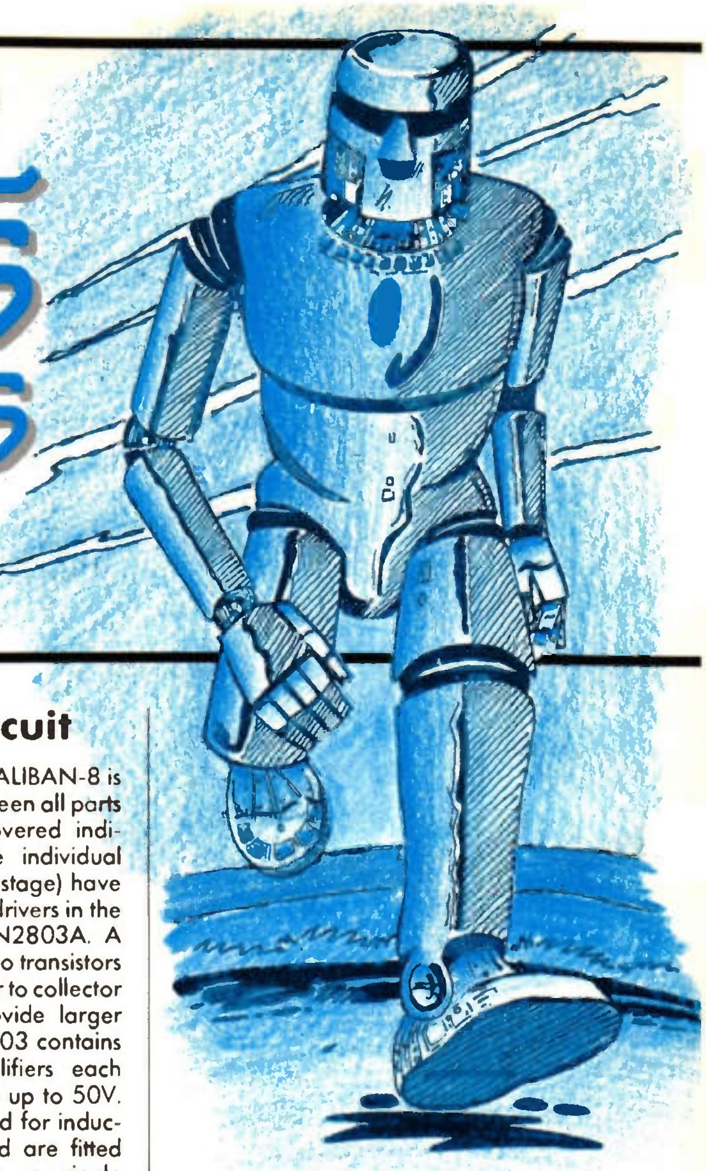
There could also be a problem of space. Accommodating a 40-foot articulated trailer could present some problems as could the £8,000 or so annual fee for the standby service.

Alternative back-up solutions include mutual back-up by two companies whose computer configurations are roughly similar. But, states the Amdahl report, if the two companies are to offer back-up to each other, then each company's essential applications must represent less than 50% load on either system. This means that either further capacity on both machines is required, or that only a limited service will be available for both company operations

Continued on page 31.

The remains of DEC's computer facility after a fire in 1989.

PRACTICAL ROBOTICS TECHNIQUES



Part 3 – Further experiments and a complete 8-bit design

by Alan Pickard

Part 1 of the series dealt with introductory ideas, practical aspects and some simple experiments. Part 2 looked at actual interface circuits for control of one or two motors, LED's and simple switch sensing (inputs). In this final article a complete robot vehicle control circuit will be included, based on the experimental circuits in Part 2. The circuit will make use of all 8 lines of a user port, with 6 lines programmed as outputs and 2 lines as inputs. Later in the article, machine code (assembly language) test programs will be discussed. Machine code programming may be considered as being suitable for more advanced robotic control, but this series would be incomplete without it being covered briefly.

Robot Vehicle Specification

It is customary and useful for a particular robot vehicle design to be designated a name, in order to 'personalise' it or to identify it with a suitable code name or acronym. This particular one I have called 'CALIBAN-8', being the name of a famous Shakespearean monster creation – the '8' denoting the number of control bits. The reader is of course welcome to come up with his or her own profoundly meaningful name!

Assuming that the basic principles on control and the requirements for on-board power supplies are understood and also that the constructor has acquired, modified or constructed a suitable motor/wheel chassis unit, then we can outline the basic requirements of our vehicle. A specification is as follows:

2 D.C. motors	requiring 2 × 2 =	4 output lines
2 LED indicators	requiring	2 output lines
2 collision detect switches	requiring	2 input lines

This fully utilises a typical 8-bit user port where the individual lines may be programmed or set as input or output. A block diagram of the robot vehicle is shown in Figure 1.

Full Control Circuit

A full control circuit for CALIBAN-8 is shown in Figure 2. As can be seen all parts of the circuit have been covered individually in Part 2, but the individual transistors (2 per motor drive stage) have been replaced by darlington drivers in the form of an IC package ULN2803A. A darlington driver consists of two transistors connected in parallel (collector to collector and emitter to base) to provide larger current switching. The ULN2803 contains 8 separate darlington amplifiers each capable of sinking 500mA at up to 50V. Protective diodes are provided for inductive loads such as relays and are fitted internally. Figure 3 shows a single

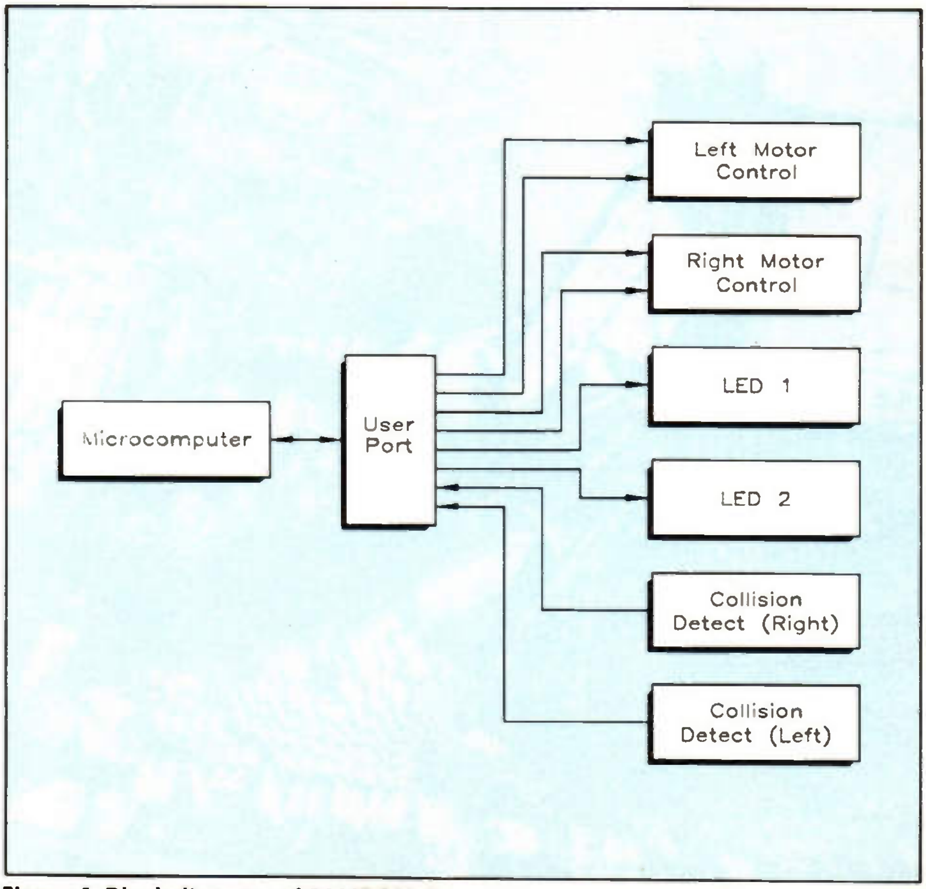


Figure 1. Block diagram of CALIBAN-8.

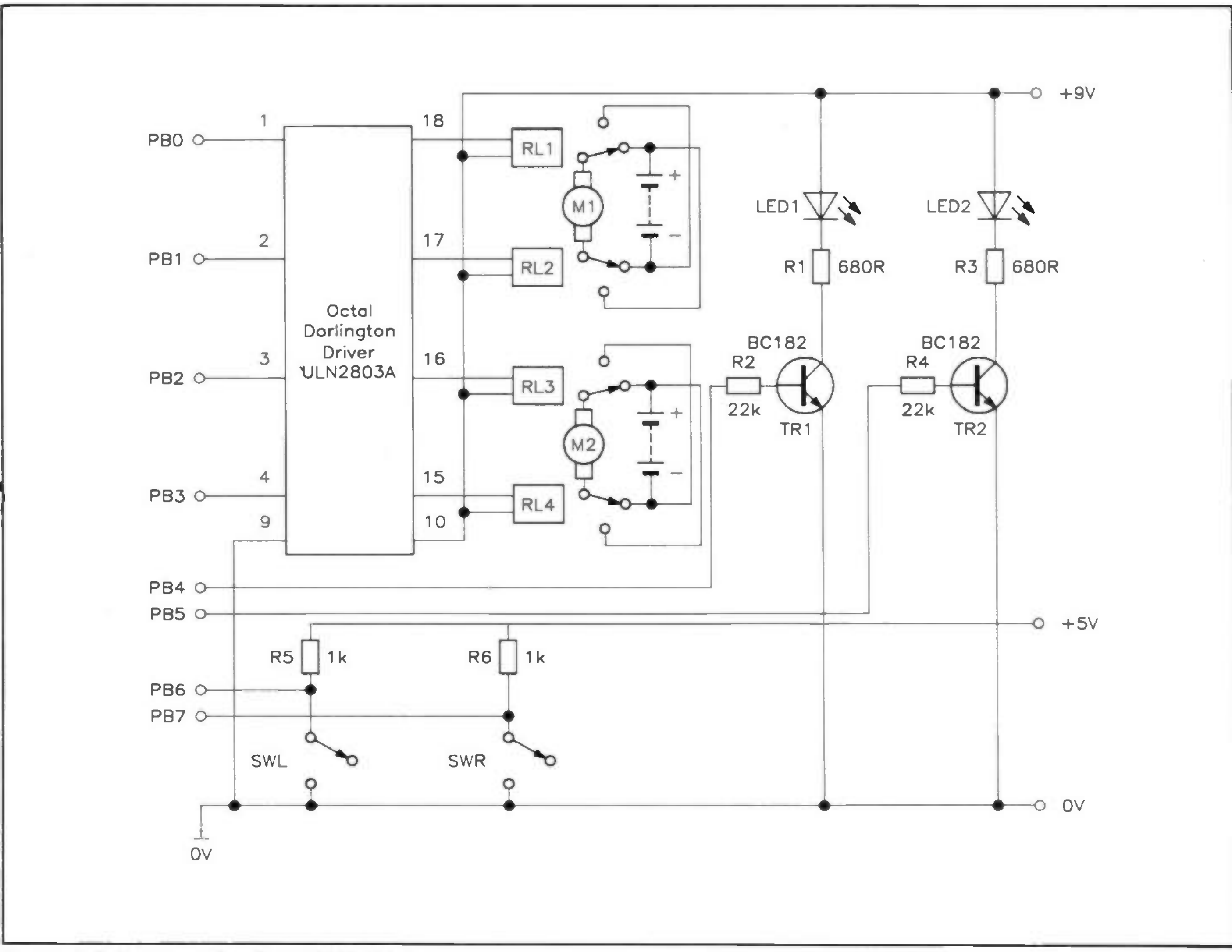


Figure 2. Full control circuit of CALIBAN-8.

darlington stage contained within a ULN2803A package.

Figure 4 shows the pin connections and internal layout of the four darlington stages used to drive the four relays (two for each motor). A summary of the full circuit is as follows:

Two relays are used for each motor, to enable three operational states, i.e. forward motion, reverse motion and stop. Because 2 bits are used, four combinations are possible (i.e. $2^2 = 4$). This means that one code (e.g. binary 10) for stop is redundant, as 01 will do the same job. To control two motors, providing steering of the vehicle, a total of four lines, and four relays are used.

To turn on two LED's individually under software control (enabling flashing, etc.) requires a further two lines.

The remaining 2 lines are used as inputs, the sensors feeding them being simple microswitches. This provides collision detection and by positioning the switches on opposite sides at the front of the vehicle a left or right collision may be distinguished.

Circuit Board Layout

A suggested stripboard layout for the complete control circuit is shown in Figure 5. This 'shape' should be suitable for a vehicle with a rectangular load platform (rather than square or circular) but of course the constructor can produce his own layout or even a PCB form.

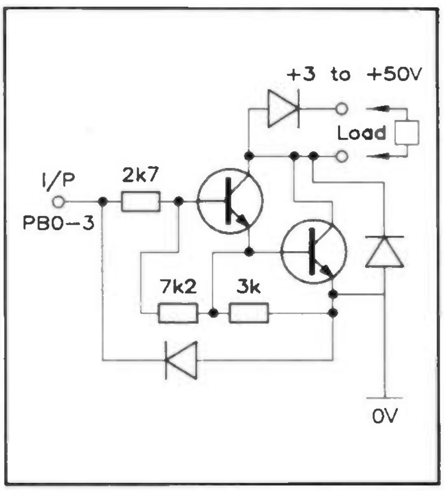


Figure 3. Single darlington stage in ULN2803A package.

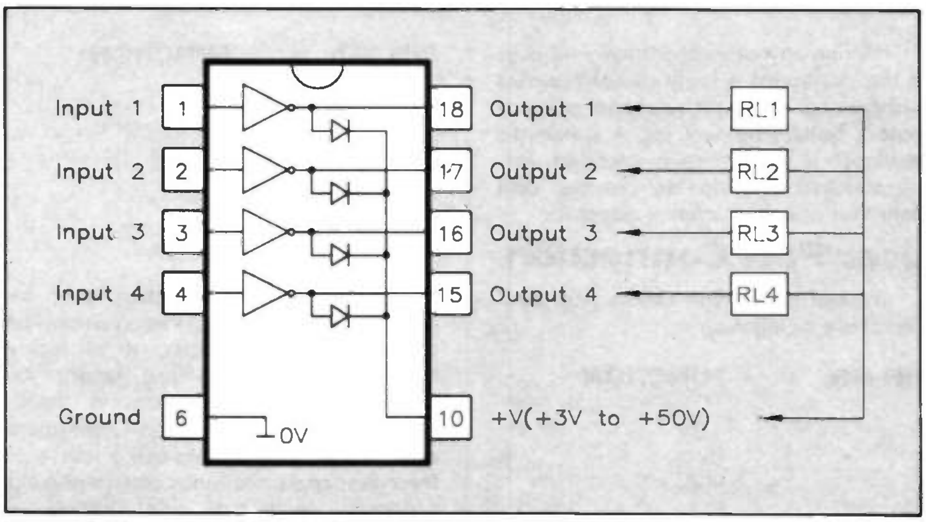


Figure 4. Pin connections and internal layout of ULN2803A.

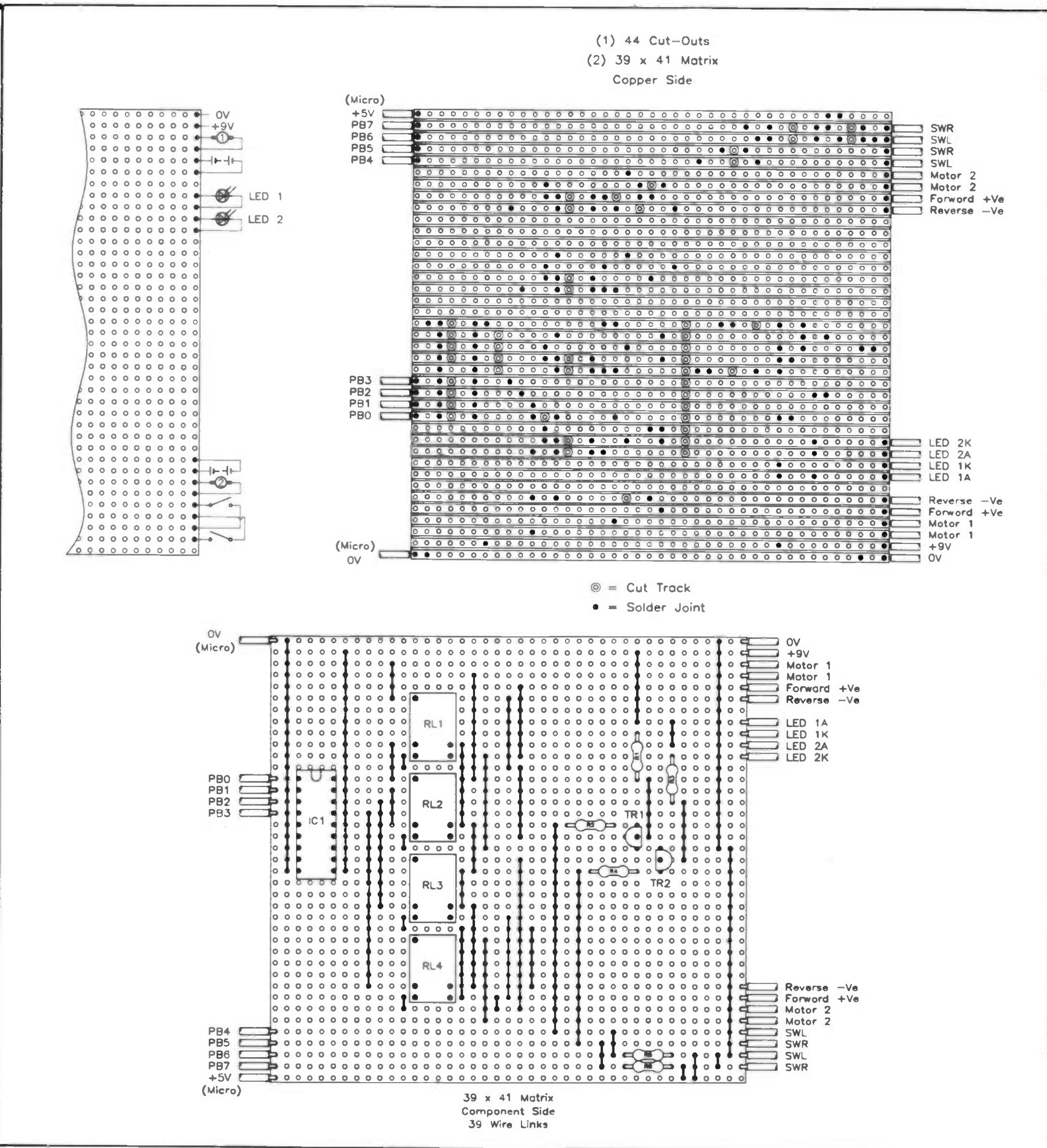


Figure 5. Suggested stripboard layout for complete control circuit of CALIBAN-8.

Wiring up motors and battery supplies to the stripboard is fairly straightforward and depends on the physical positioning of motors, battery holders, etc. A systematic approach is strongly recommended, wiring checked and double checked and some sort of colour scheme adopted.

User Port Connection

Typical connection details (e.g. BBC Micro) are as follows:

PIN NO.	FUNCTION
1	+5V
5	0V
6	PB0
8	PB1
10	PB2
12	PB3
14	PB4
16	PB5
18	PB6
20	PB7

Testing

Although manual testing may be achieved at each stage by using simple test programs and functions, it is highly recommended that a test facility for motor/battery combinations is fitted. Ideally, this should be a permanent arrangement as it will remove a source of frustration and annoyance when trying out programs which may give unexpected results!

On my prototype I mounted a small Vero box with three toggle switches forming a control front panel. One switch disconnects the control PCB power supply batteries enabling connection and disconnection from the microcomputer user port with the robot in a known, predictable state. The other two switches switched the battery supplies from the motors. Not only does this allow you to disable the vehicle but it provides a quick method for checking not only wiring polarity (during construction) but can also manually test the batteries before attempting to drive the vehicle under micro control. This front panel can also be used to house the LED's.

A recommended procedure for activating the robot is as follows:

1. Switch on computer.

2. Load required program.
3. Run program (including initialisation of ports and setting of stop code).
4. Stop program.
5. Switch on robot supplies.
6. Run program.

This simple disciplined approach can prevent frustration, annoyance and even damage!

Test Programs

The test programs shown in Part 2 were very simple: one demonstrated robot vehicle motion in the form of a repeated forward-stop-reverse-stop cycle, and another how to respond to detection of a collision. The LED devices can be tested by writing a similar program to the motor test one, but using the appropriate hex codes as shown in Figure 11, Part 2.

The BBC Micro has programmable function keys which are ideal for simple testing of control circuits. An example of a simple test program which actually uses the cursor editing keys, i.e. the four left, right, up and down arrow keys for controlling the robot is shown in Listing 1.

```
10 ?&FE62 = &0F
20 ?&FE60 = &05
30 :
40 *FX4,2
50 :
60 *KEY 11 ?&FE60 = &05|M
70 *KEY 12 ?&FE60 = &03|M
80 *KEY 13 ?&FE60 = &0C|M
90 *KEY 14 ?&FE60 = &00|M
100 *KEY 15 ?&FE60 = &0F|M
```

Listing 1. Simple test program.

Line 10 sets PB0-PB3 as outputs and line 20 causes the data value &05 to be placed in the Data Register ensuring a stationary robot. Line 40 enables programming of the 'additional' function keys 11 – 15 inclusive. Lines 60 – 100 programs the keys as shown.

Figure 6 shows an accompanying table of function key numbers and corresponding key legends and robot movements.

It should be clear that this program can be extended to include operation of the two LED's controlled by PB4 and PB5.

KEY NO.	ACTION	LEGEND
Key 11	Stop	Copy
Key 12	Right	]
Key 13	Left	[
Key 14	Reverse	↓
Key 15	Forward	↑

Figure 6. Table of function key actions.

The table in Figure 11, Part 2 shows the relevant hex values, and as an example function key 4 could be programmed with value &10 (=0010 0000) which would turn LED1 ON, and key 5 with &20 (= 0010 0000) which would turn LED2 ON and so on. From then on, it is easy to construct test programs and ultimately operating programs as required.

Hex &	Binary Right	Binary Left	Motor 2 Right	Motor 1 Left	Motor 2 Right	Motor 1 Left	Action Performed
00	00	00	On	On	R	R	Reverse
01	00	01	On	Off	R	S	
02	00	10	On	Off	R	S	
03	00	11	On	On	R	F	Right Turn (Fast)
04	01	00	Off	On	S	F	
05	01	01	Off	Off	S	S	Stop
06	01	10	Off	Off	S	S	
07	01	11	Off	On	S	F	Right Turn (Slow)
08	10	00	Off	On	S	R	
09	10	01	Off	Off	S	S	
0A	10	10	Off	Off	S	S	
0B	10	11	Off	On	S	F	
0C	11	00	On	On	F	R	Left Turn (Fast)
0D	11	01	On	Off	F	S	Left Turn (Slow)
0E	11	10	On	Off	F	S	
0F	11	11	On	On	F	F	Forword

Note : F = Forward
R = Reverse
S = Stop

Figure 7. Table of motor operation codes.

KEY NO.	ACTION	CODE
KEY 4	LED1 ON	&10
KEY 5	LED2 ON	&20
KEY 6	LED1&2 ON	&30

Figure 8. Table of LED function keys.

A complete picture of how motor codes are achieved can be seen in Figure 7. It will be noticed that there are a large number of redundant or duplicated codes, but it is possible to achieve a 'fast' and 'slow' turning speed by using one motor only or two motors working 'opposite' each other to increase the turning speed.

The table in Figure 8 provides similar detail to that of Figure 6, but in this case for the LED's.

A simple program like the one in Listing 1 can then be produced to enable LED testing. The motor stop key (code &05) could be used to turn both LED's off.

It would have been possible to have provided more comprehensive, structured programs, incorporating such features as BBC BASIC Procedures, but it is probably more appropriate for the constructor to write his or her own programs which should not be particularly difficult having got this far.

Power Supplies

The choice of batteries depends on the chosen motors and their voltage and current rating. The prototype motor unit consisted of a pair of motors in a single housing which was reclaimed from a Big Trak educational toy robot. It consists of 2 × 3V D.C. motors connected together by a magnetic clutch. I found that 4 × (HP2) cells (2 for each motor) provided sufficient voltage (about 2·8V fully charged) and current for quite lengthy periods.

The prototype control board required about +10V (a 9V battery was not adequate mainly because of the relays used), however, using the relays specified operation from 9V should not be a problem. Relays require a trade off between voltage and current and it can be quite tricky trying to operate at convenient low voltages if they draw too much current. Trial and error to suit individual requirements is necessary. I have used 8 × 1·2V (HP11) cells to give a healthy 11·2V when fully charged. Although a little cumbersome this gives reliable performance and not too much weight.

Construction

Getting hold of a suitable motor/wheel mechanism is very useful, otherwise you may have to construct a mechanical wheel/gear assembly. Having achieved this, a useful serviceable chassis may be constructed using thin plywood offcuts. Wood is cheap and fairly easy to work on.

Battery compartments and dowelling pieces can provide support between base and load platform as can be seen in the Photos of CALIBAN-8.

Machine Code Programs

Programming a robot in a high level language, although relatively inefficient, is quite acceptable for the robot hobbyist, but does make the robot vehicle dependent on the 'host' microcomputer. Machine code programs can be written and tested on a machine such as the BBC Micro which has a built in 6502 assembler. A BBC assembly language program to provide motor action (i.e. Forward then Stop) is shown in Listing 2.

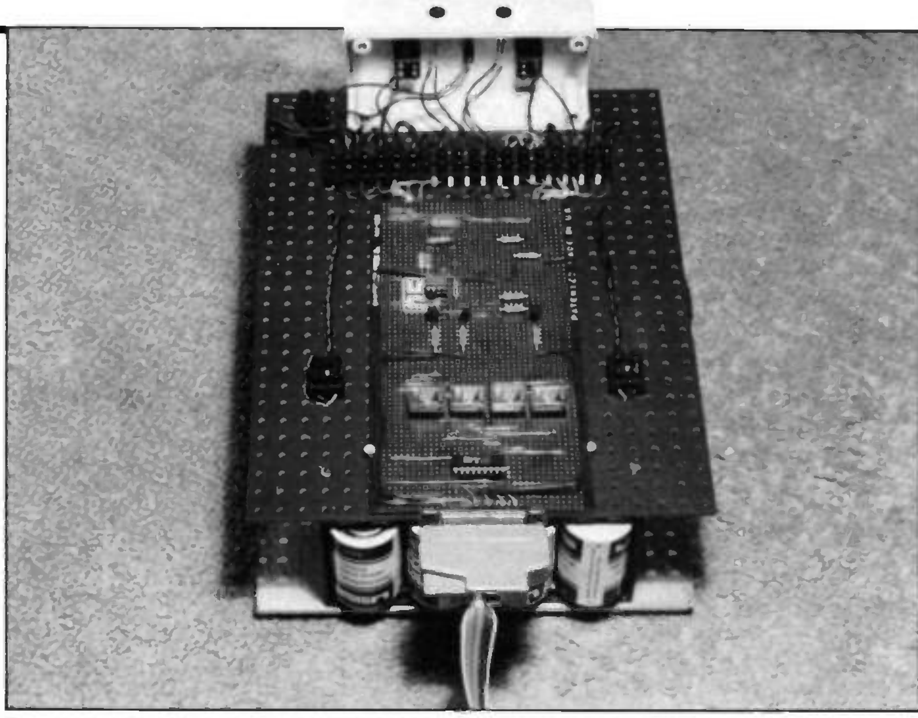
```
 20 P%=%1500
 30 CLS
 40 [
 50 LDA   #&7F
 60 STA   &FE62
 70 LDA   #&05
 80 STA   &FE60
 90 JSR   &151B
100 LDA   #&0F
110 STA   &FE60
120 JSR   &151B
130 LDA   #&05
140 STA   &FE60
150 RTS
160 LDY   #&FF
170 .LOOP1 LDX    #&FF
180 .LOOP2 DEX
190 .BNE  LOOP2
200 DEY
210 BNE   LOOP1
220 RTS
230 ]
```

Listing 2. BBC assembly language program for motor action.

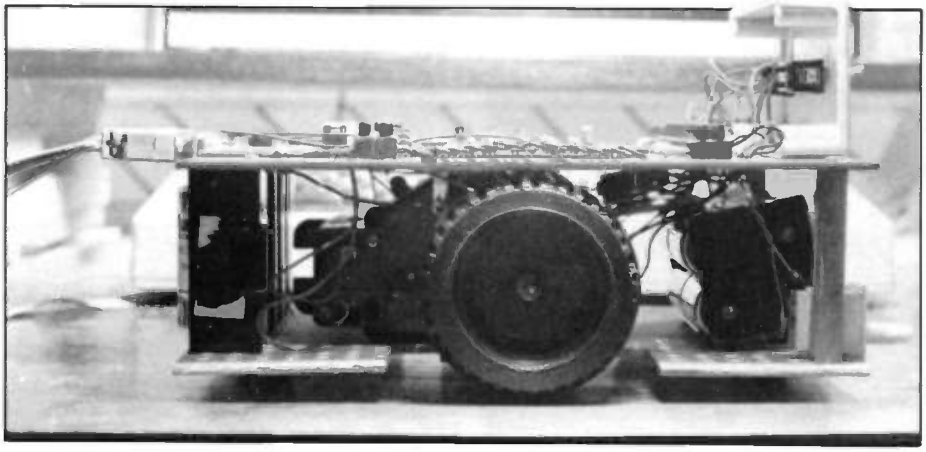
Lines 50 – 220 inclusive contained within the BBC BASIC program comprise 6502 mnemonics and data values which, when the BASIC program is RUN are assembled into a 6502 machine code program as shown in Listing 3.

```
1500 A9 7F      LDA   #&7F
1502 8D 62 FE   STA   &FE62
1505 A9 05      LDA   #&05
1507 8D 60 FE   STA   &FE60
150A 20 1B 15   JSR   &151B
150D A9 0F      LDA   #&0F
150F 8D 60 FE   STA   &FE60
1512 20 1B 15   JSR   &151B
1515 A9 05      LDA   #&05
1517 8D 60 FE   STA   &FE60
151A 60         RTS
151B A0 FF      LDY   #&FF
151D A2 FF      .LOOP1 LDX #&FF
151F CA         .LOOP2 DEX
1520 D0 FD      BNE   LOOP2
1522 88         DEY
1523 D0 F8      BNE   LOOP1
1525 60         RTS
```

Listing 3. Assembled 6502 machine code program from Listing 2.



Top/rear view of prototype CALIBAN-8.



Side view of CALIBAN-8 showing drive mechanism and batteries.

A brief explanation of the program is as follows:

1500-1504 sets lines PB0-6 as outputs
1505-1509 places 'stop' code in DR
150A-150C jumps to delay loop at 151B-1525
150D-1511 places 'forward' code in DR
1512-1514 jumps to delay loop
1515-151A places 'stop' code in DR
151B-1525 time delay subroutine using Y and X registers to produce loop within a loop (FF × FF) or (255 × 255).

Using machine code for control in this way, although more efficient and 'educational', still means that the robot is 'tied' to the host machine. To be able to fully utilise the advantages of machine code requires a means of either downloading programs into a microcontroller (microprocessor-based control board) on board the robot, and having a means of placing programs in an EPROM fitted to an on board microcontroller.

The program in Listing 4 is an extension of the one in Lisiting 3, providing a Forward-Stop-Reverse-Stop repeat cycle for testing. It does not reside in the same area of memory as the previous one, demonstrating that the program may be relocated to suit a different microprocessor system memory environment.

```
4000 A9 7F      LDA   #&7F
4002 8D 62 FE   STA   &FE62
4005 A9 05      LDA   #&05
4007 8D 60 FE   STA   &FE60
400A 20 22 40   JSR   &4022
400D A9 0F      LDA   #&0F
400F 8D 60 FE   STA   &FE60
4012 20 22 40   JSR   &4022
4015 A9 05      LDA   #&05
4017 8D 60 FE   STA   &FE60
401A 20 22 40   JSR   &4022
401D A9 00      LDA   #&00
401F 8D 60 FE   STA   &FE60
4022 A0 FF      .DELAY LDY #&FF
4024 A2 FF      .LOOP1 LDY #&FF
4026 CA         .LOOP2 DEX
4027 D0 FD      BNE   LOOP2
4029 88         DEY
402A D0 F8      BNE   LOOP1
402C 60         RTS
```

Listing 4. A simple 6502 machine code program to enable CALIBAN-8 to carry out a forward stop-reverse sequence.

Conclusion

These three articles have attempted to outline all aspects of putting together a robot vehicle system, including hardware

Continued on page 62.

Galatic Timer continued from page 15.

Temporarily connect the main PCB to the power supply PCB as shown in Figure 11. Connect a short length of 3-core mains cable to TB1 and fasten it through the side of the box using a suitable grommet. After ensuring that either the optional 9V battery is installed or P6 and P7 are shorted, fix the box lid in place using the six screws supplied.

On *no* account must power be applied to the circuit with the cover removed from the box. 240V AC mains is potentially lethal, it must therefore be treated with the greatest respect at all times.

Connect mains power to the unit and proceed to set the clock as described in the 'Operating Instructions', detailed below. After several days it may be noticed that the clock gains or looses a minute or two. If so, adjust VC1 until, over a period of several weeks, no noticeable gain or loss of time is evident.

If, for any reason, the optional Ni-Cd battery requires replacing, then mains power *must* be removed from the unit *before* the battery is removed/replaced and re-applied *only* after the battery has been re-installed.

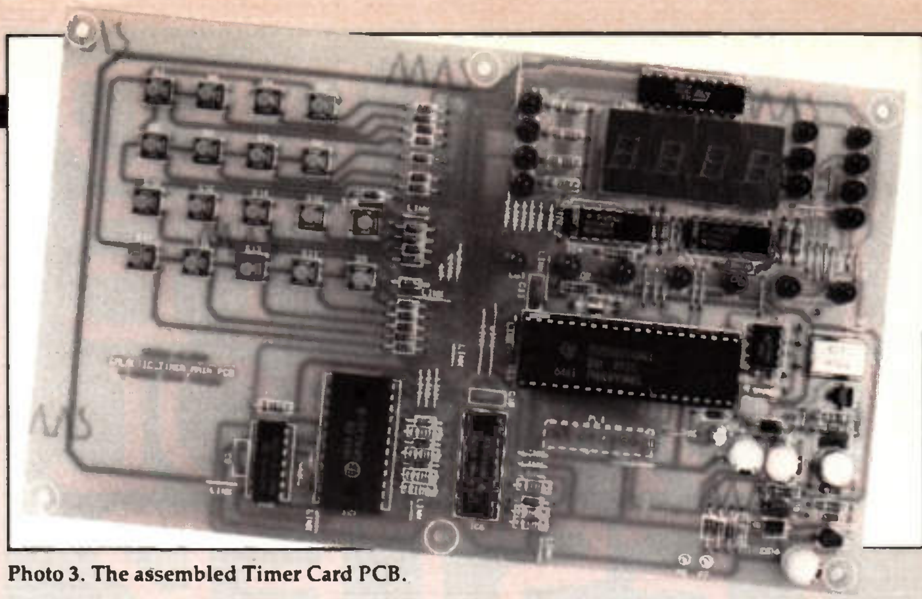


Photo 3. The assembled Timer Card PCB.

Two four channel switching boards are available for use with the Galactic Timer and will be described in future issues of *'Electronics'*; these are:

a) Relay Board. This is used for switching voltages up to 110V AC/24V DC @ 10A per output

b) Triac Board. This is used for switching 240V AC @ 3A per output.

Both PCBs provide a permanent connection between the power supply and the main PCB.

Full operating instructions are shown in the leaflet.

GALACTIC TIMER PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1	6k8	1	(M6K8)
R2	100Ω	1	(M100R)
R3,4	1k	2	(M1K)
R5	130k	1	(M130K)
R6	39k	1	(M39K)
R7–10	470Ω	4	(M470R)
R11–18	22Ω	8	(M22R)
R19	27k	1	(M27K)
R20	10M	1	(M10M)
R21,22,27,28	2k2	4	(M2K2)
R23	4k7	1	(M4K7)
R24–26	10k	3	(M10K)

CAPACITORS

C1	PC Electrolytic 1000μF 35V	1	(FF18U)
C2,4,5	Minielect 100μF 16V	3	(RA55K)
C3,9,10,11	Minidisc 100nF 16V	4	(YR75S)
C6,8	47pF Polystyrene	2	(BX26D)
C7	4μ7F Minelect 35V	1	(YY33L)
VC1	65pF Trimmer	1	(WL72P)
XT1	Crystal 50Hz × 2^{16}	1	(FY86T)

SEMICONDUCTORS

BR1	W01 Bridge Rectifier	1	(QL38R)
TR1	BC549	1	(QQ15R)
TR2	2N2905	1	(QR17T)
TR3	BC212L	1	(QB60Q)
TR4	MPSA65	1	(QH61R)
IC1	TMS1601ANLL	1	(UL65V)
IC2	M706B1	1	(UL83E)
IC3,4	75491	2	(UF53H)
IC5	ULN2803A	1	(QY79L)
IC6	74HC241	1	(UB59P)
IC7	6116/446 150nS	1	(UF33L)
IC8	74HC164	1	(UB43W)
ZD1	BZY88C/BZX55C 11V	1	(QH15R)
ZD2	BZY88C/BZX55C 5V6	1	(QH08J)
D1,2,5-28	1N4148	26	(QL80B)
D3,4	1N4001	2	(QL73Q)
LD1-14	LED Red 5mm 2mA	14	(UK48C)
LD15-18	LED Red 5mm	4	(WL27E)
DY1-4	Low Current 0·3in. Display	4	(QY54J)

MISCELLANEOUS

T1	PCB Tr 0–12V 0–12V 250mA	1	(YJ54J)
FS1	20mm Fuse 100mA	1	(WR00A)
	Fuse Clips	2	(WH49D)
P1-7	Pins 2145	1Pkt	(FL24B)
TB1	3-Way HV Terminal Block	1	(JR80B)
PL1	RA PCB Latch Plug 10-Way	1	(RK68Y)
S1-18	Tact Switch Type A	18	(JR89W)
	PCB Latch Hsng 10-Way	1	(FY94C)
	PCB Terminal	1Strp	(YW25C)
	Ribbon Cable 10-Way	1Mtr	(XR06G)
	DIL Socket 40-Pin	1	(HQ38R)
	TC Wire 0·71mm 22swg	1	(BL14Q)
	Galactic Timer PSU PCB	1	(GE51F)
	Galactic Timer Main PCB	1	(GE52G)
	Constructors' Guide	1	(XH79L)
	Instruction Leaflet	1	(XK27E)

OPTIONAL (Not in Kit)

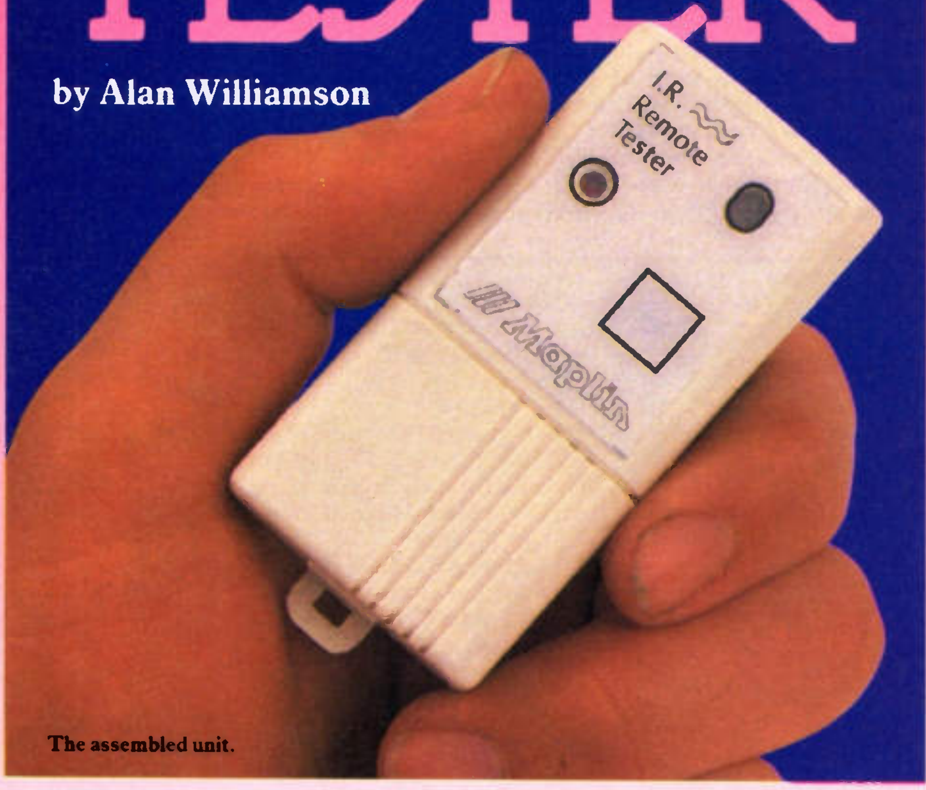
B1	NiCad PP3 Battery	1	(HW31J)
	PP3 Battery Clip	1	(HF28F)
	ABS Box MB6	1	(YN39N)
	Galactic Timer Panel	1	(JX51F)
	13 Amp Plug Nylon	1	(RW67X)
	HD Mains Cable Black	AsReq	(XR09K)
	SR Grommet 7R3	1	(LR50E)
	Pozi Screw M3 12mm	1Pkt	(BF37S)
	Pozi Screw M3 20mm	1Pkt	(JC71N)
	M3 Spacer ¼in.	1Pkt	(FG33L)
	M3 Spacer ⅛in.	1Pkt	(FG32K)
	Steel Washer M3	1Pkt	(JD76H)
	Isoshake M3	1Pkt	(BF44X)
	Steel Nut M3	1Pkt	(JD61R)

The above items, excluding Optional, are available as a kit:
Order As LP25C (Galactic Timer) Price £49.95

The following items are also available separately but are not shown in our 1991 catalogue:
Galactic Tmr PSU PCB **Order As GE51F Price £2.75**
Galactic Tmr Mn PCB **Order As GE52G Price £7.95**
Galactic Timer Panel **Order As JX51F Price £5.95**
M706B1 **Order As UL83E Price £1.48**
Instruction Leaflet **Order As XK27E Price 60p**

INFRA-RED REMOTE CONTROL TESTER

by Alan Williamson



The assembled unit.

Introduction

This handy little project first saw the light of day in the NICAM Infra-red Remote Control project (Issue 41) as the experimental infra-red detector.

So what exactly does this project do? Well basically it checks to see if a remote control unit (or any other pulsed infra-red source) is transmitting an infra-red carrier or data stream. The Infra-red Remote Control Tester ignores any ambient infra-red energy, so it can be used in full sunlight. The tester works by detecting changes in the ambient infra-red level and converts this into visible red light by means of an amplifier and red LED.

The Infra-red Tester is not just a simple yes/no device, it can show the strength of a transmission, by the distance from which the remote control is able to operate the tester. A TV/Video remote control with a fresh set of batteries will operate the tester from approximately half a metre away, whereas a remote control with almost exhausted batteries may work from only a few centimetres away.

The tester also checks its own battery; by pressing the switch on the front panel, a single flash from the LED will be seen, thus indicating sufficient battery power for the unit to operate.

TV and Video repair engineers will find this Infra-red Tester an invaluable addition to their toolbox. It is also a cheaper and more versatile alternative to the infra-red sensitive 'cards' that serve the same purpose.

Circuit Description

Figure 1 shows the circuit diagram of the Infra-red Remote Control Tester.

Infra-red transmissions are detected by the photodiode PD1, which operates in the reverse biased mode. Incident infra-red energy causes a leakage current to flow through the photodiode, thus developing a

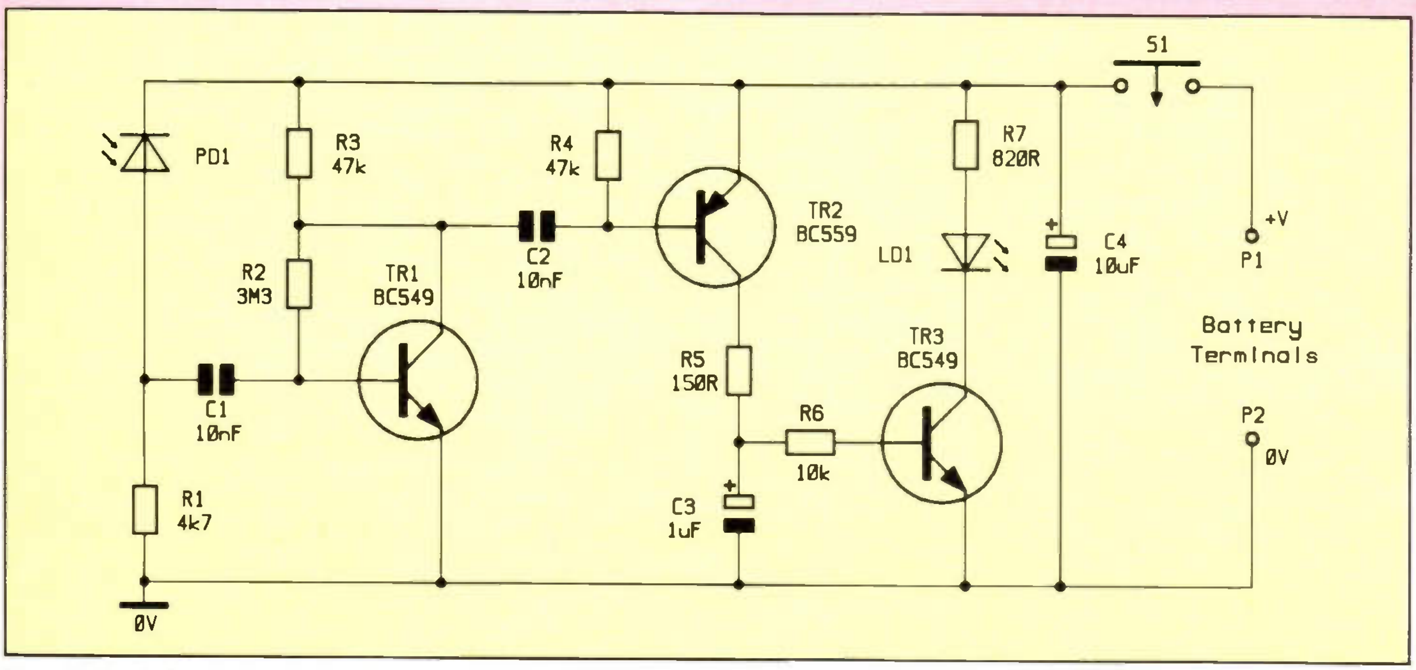
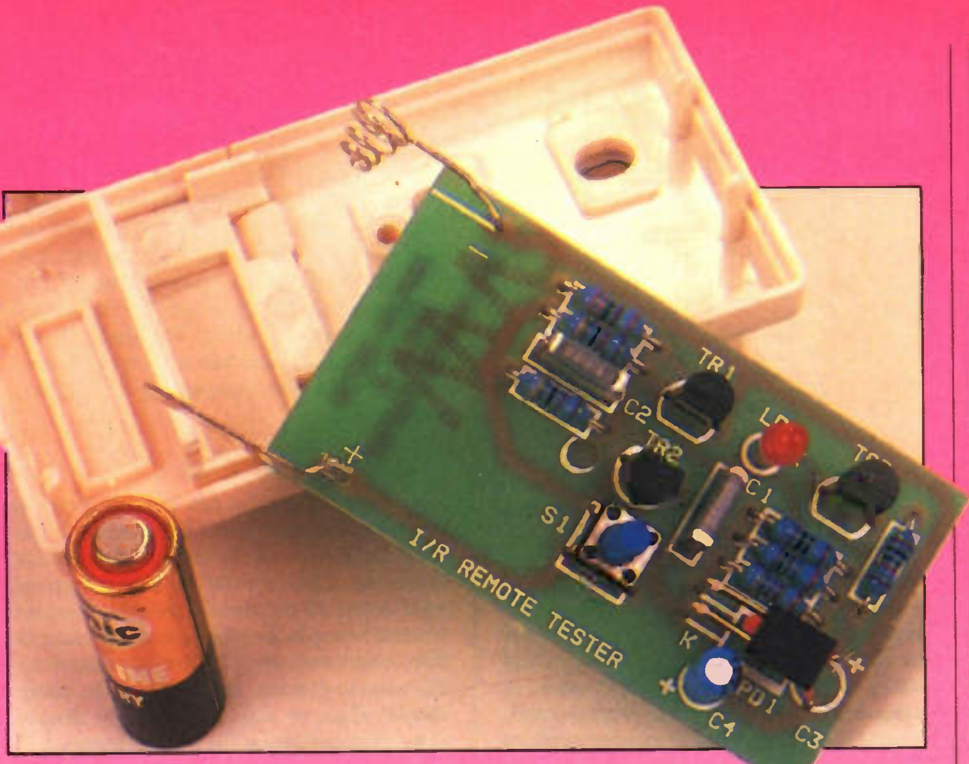


Figure 1. Circuit diagram.



The completed unit prior to final assembly.

Prototype Specification	
Supply voltage range:	6 - 12V DC
Battery type:	12V lighter battery 23A
Operating current:	11·4 mA
Operating frequency:	10Hz to 100kHz
Minimum pulse width:	1μs
Detector peak spectral response:	940nm
PCB size:	31mm x 55mm

voltage across R1. Pulsed infra-red energy will produce voltage pulses across R1 and these are AC coupled by capacitor C1 to the common emitter amplifier based around TR1. R2 and R3 serve to provide bias for TR1. C2 is employed to couple the signal to the next stage without upsetting the bias of either stage. R4, TR2, C3, R5 and R6 form a pulse extending circuit. Carrier frequencies and or data streams present at the base of TR2 will be smoothed out by C3 which will slowly discharge via R6 turning on TR3 and lighting LD1.

Construction

For those with very little constructional experience, a constructors' guide has been included in the kit to help you identify components, it also gives hints and tips on soldering and constructional techniques.

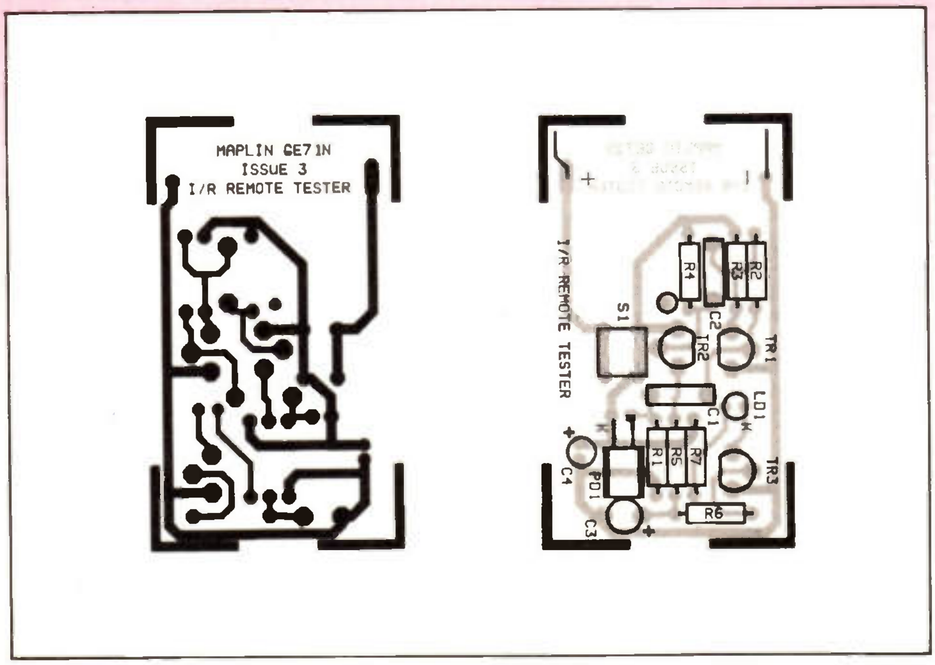


Figure 2. PCB legend and track.

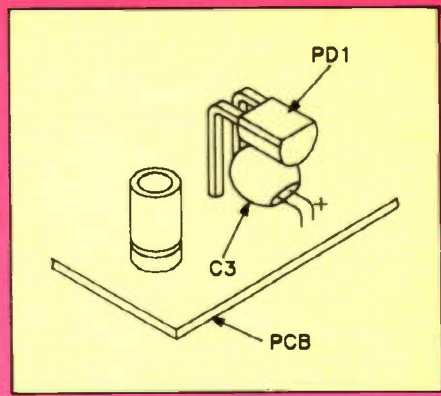


Figure 3. Fitting C3.

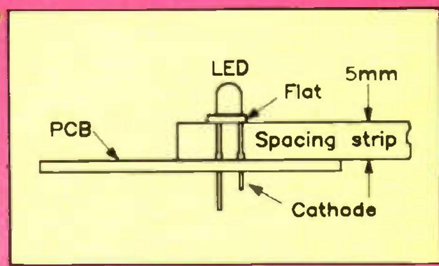


Figure 4. Fitting LD1.

Referring to Figure 2 begin construction with the resistors, followed by the capacitors, C3 and C4 are polarised devices and must be correctly orientated, C3 is fitted laying on its side positioned underneath the photodiode, see Figure 3.

The LED cathode, denoted by a 'flat' on the package and the short lead, must be aligned with the flat on the legend, also marked with the letter 'K'. Insert the LED into the holes in the PCB and position it 5mm above the PCB, this can be easily achieved by using a 5mm spacer strip (piece of card, etc), this is illustrated in Figure 4.

The transistors are the next devices to be installed, locate the BC559 transistor and fit it into the TR2 position, fit the other two transistors (BC549) into TR1 and TR3 positions.

A nylon washer is fitted underneath S1 which serves to raise the height of the switch; when fitted, the switch legs should only just protrude through the PCB, if the switch is fitted too low, it will be found that it is difficult to operate the switch when the unit is fully assembled.

Next insert the photodiode, bend the leads 5mm from the body as shown in Figure 5. Insert the photodiode with the bend in the lead 7mm above the PCB, then solder.

Last but not least are the battery terminals, identify each terminal; the positive is the strip and the negative is the 'spring' terminal which will require modification somewhat, see Figure 6. Modify

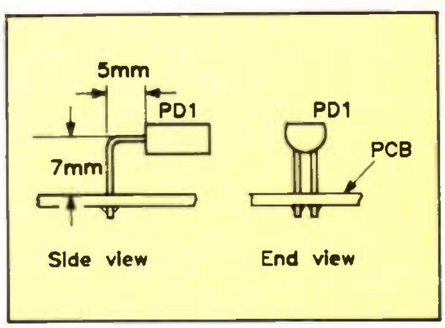


Figure 5. Fitting PD1.

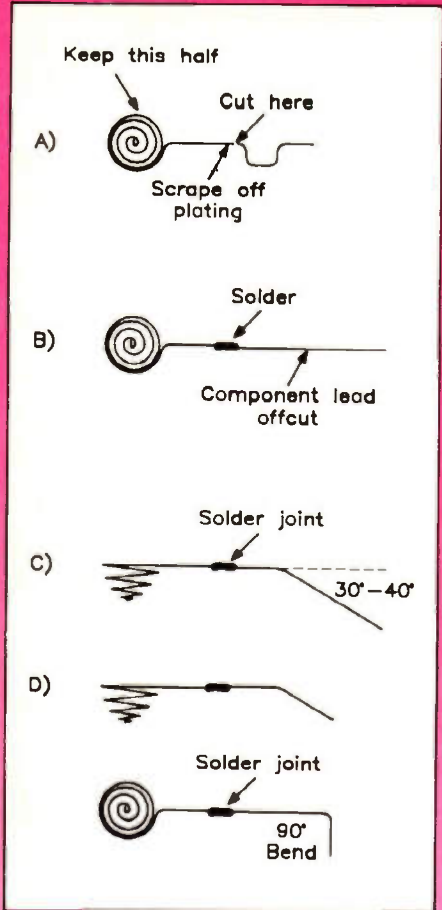


Figure 6. Spring modification.

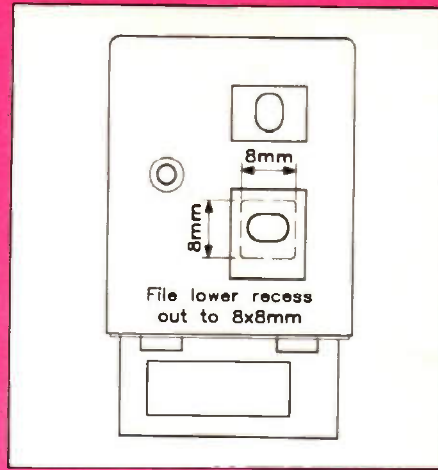


Figure 7. Box filing.

the spring and fit both the spring and strip to the PCB as follows: A Cut off the 'U' shaped bend in the spring. B Scrape away the plating, to allow solder to adhere, and solder a short length of BTC wire or component lead offcut to the prepared end. C Bend the wire to an approximate angle of 30°. D Add a 90° bend to the wire-end and insert into the PCB.

Finish the PCB by cleaning-off any flux residue with PCB Cleaner, check for dry joints and solder 'whiskers' which could cause short circuits and reliability problems.

The case also requires some modification, this is illustrated in Figure 7. Fit the PCB into the case (after filing out the hole). Clip the two halfs together and fit the case fixing screw. Place the battery into the battery compartment taking note of the symbol in the bottom of the case and replace the battery cover. The final job is to stick the panel onto the front of the case. The tester is now complete and ready for testing.

Testing and Use

To test the Infra-red Tester, a known working remote control is required. First push the switch on the tester; a single flash from the LED should be seen, keeping your finger on the switch, point the remote control towards the photodiode on tester (a few centimetres away). Push any button on the remote control, the LED on the tester should flash or stay permanently illuminated (depending on the transmission rate), slowly increase the distance between the remote control and the tester to determine the strength of transmission. As mentioned before, a TV/Video remote control with a fresh set of batteries will operate the tester from approximately half a metre away. Please note that remote controls with a single infra-red emitter LED are highly directional.

INFRA-RED REMOTE CONTROL TESTER PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1	4k7	1	(M4K7)
R2	3M3	1	(M3M3)
R3,4	47k	2	(M47K)
R5	150R	1	(M150R)
R6	10k	1	(M10K)
R7	820R	1	(M820R)

CAPACITORS

C1,2	Poly Layer 10nF	2	(WW29G)
C3	Tant. 1μF 35V	1	(WW60Q)
C4	Minelect 10μF 16V	1	(YY34M)

SEMICONDUCTORS

TR1,3	BC549	2	(QQ15R)
TR2	BC559	1	(QQ18R)
LD1	Mini LED Red	1	(WL32K)
PD1	Infra-red Photodiode	1	(YH71N)

MISCELLANEOUS

S1	Tact Switch Type A	1	(JR89W)
	Keyring Remote Case	1	(JR90X)
	I/R Rem. Tester Panel	1	(JX52G)
	PC Board	1	(GE71N)
	Nyl Washer 6BA	1 Pkt	(BF84F)
	Instruction Leaflet	1	(XK33L)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in kit)

	12V Lighter Battery 23A	1	(JG91Y)

The above items, excluding Optional, are available as a kit:
Order As LP53H (I/R Remote Tester) Price £6.45
The following items are also available separately but are not shown in our 1991 catalogue:
Keyring Remote Case **Order As JR90X Price £1.20**
I/R Rem. Tester Panel **Order As JX52G Price £1.56**
I/R Rem. Tester PCB **Order As GE71N Price £1.86**

CIRCUIT MAKER

Circuit Maker is a forum for readers circuits, ideas and tips. The circuits and information presented here must be considered as a basis for your own experimentation, no warranty is given for suitability in particular applications, reliability or circuit operation. If you would like your ideas to be considered for inclusion in Circuit Maker, please mark your submission 'Circuit Maker' and send it to: The Editor, 'Electronics - The Maplin Magazine', P.O. Box 3, Rayleigh, Essex, SS6 8LR.

Micro-power LED Flasher by Joe Fuller

Often a flashing LED may be required to indicate that a piece of equipment is operating or simply to draw attention to it. If the equipment is battery powered it is important that the LED flasher draws as little current as possible. This novel circuit is based around a TLC555 and uses the charge stored in the timing capacitor to flash the LED. The circuit will operate quite happily from supply voltages in the range 6 to 15V. With the component values shown, the circuit draws around 500μA (10V supply) and flashes the LED about once every 4·5 seconds. R2 and C1 may be altered in value to change the flash-rate. Changing C1 to 100μF will give a slightly dimmer flash, but the flash-rate will be increased to once per second. It is also possible to remotely switch the flasher on and off by using the reset pin (P4); high = on, low = off.

RESISTORS All 0·6W 1% Metal Film

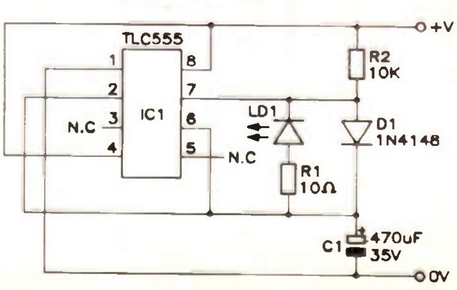
R1	10Ω	1	M10R
R2	10k	1	M10K

CAPACITORS

C1	470μF PC Elect 35V	1	FF16S

SEMICONDUCTORS

D1	1N4148	1	QL80B
LD1	Red LED	1	WL27E
IC1	TLC555CP	1	RA76H



Square One

A First Course in the Theory and Practice of Electronics

Part 8 by Graham Dixey C.Eng., M.I.E.E.

Introduction

The broadest possible classification of electronic circuits might place them all into just two such classes. In one class we should find all of those circuits that *generate* signals, while the second class would contain all the circuits that *process* them. The word 'process' is used in a very general sense and would embrace the use of various circuit types such as amplifiers, logic gates, filters, etc. Some of these circuits we have already discussed. Now it is time to look at a wide range of circuits that could be gathered together under the heading of 'oscillators'. Very often, though, distinctions are made between circuits, based on the nature of their output waveform. For example, a circuit that generates a sinewave is invariably referred to as an oscillator, while a circuit that produces regular pulses is more often known as a (pulse) generator. In fact one may often talk about 'waveform generators' when referring to circuits which produce regular though non-sinusoidal waveforms. Some examples of such waveforms were shown in Part 1 of this series.

Often there is also a real distinction between the ways in which the circuits work, in fundamental rather than detailed terms, in order to produce an output. In Part 8 we are going to look at a very fundamental idea and see how, with examples, this particular idea can be used as a means of generating oscillations. We start by considering that which the words 'oscillate', 'oscillations', 'oscillator' actually mean. To do this there are a number of commonplace examples that can be considered.

The Sinewave – a Natural Waveform

Stringed instruments, such as the guitar, violin, piano etc., produce their sounds by displacing air by means of vibrating strings. They do not sound the same because their physical construction is so different, even when they are all sounding a note of the same 'pitch'. To make the string vibrate and so move the air either side of it, it may be plucked, as in the case of the guitar, it may be bowed (or plucked), as in the case of the violin, or it may be struck, as happens in the piano. The frequency at which the string vibrates depends upon certain physical attributes, and if we were to place a microphone close by, whose amplified output was connected to the input of a CRO, then a single pluck, for example, of the string would produce a wave as shown in Figure 1(a). This is clearly a sinewave, but one that is diminishing in amplitude. It is termed a 'damped oscillation'. The string as it vibrates from side to side, seen in Figure 1(b), is said to be 'oscillating' and, if we wish, we can refer to the vibrating string as an 'oscillator'.

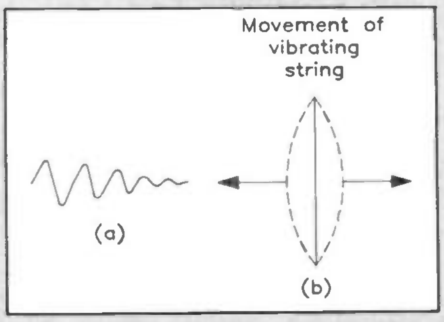


Figure 1. (a) The 'damped oscillation' produced by the vibrating string of (b).

There are other examples of natural sinewave oscillators. The pendulum is one such and an example that provides an excellent analogy with another natural oscillator, the 'resonant' LC circuit.

The pendulum is shown in Figure 2. It consists of a long arm, pivoted at the upper end, with a weight attached to its lower end. If the weight is 'picked up' and the arm consequently moved through an angle, the pendulum weight acquires 'potential energy' (point A); the higher it is raised, the greater the potential energy. This energy is 'stored' in the weight by virtue of the work that was done on it in lifting it up. If the weight is now released, gravity will make the arm swing downwards, gathering momentum

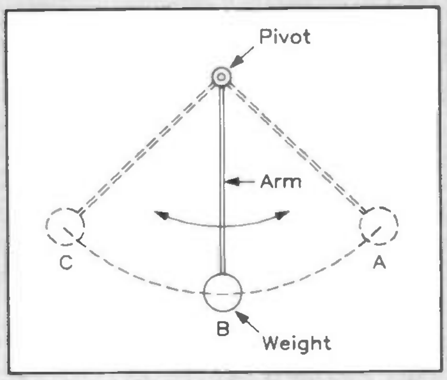


Figure 2. A natural oscillator, the pendulum.

as it goes. The weight will be tracing out an arc and, at the bottom of this arc (point B), will have acquired 'kinetic energy', the energy due to motion. The potential energy that it originally had will have disappeared since the weight is back to where it started from. In fact, the potential energy has been exchanged for kinetic energy. This kinetic energy present in the weight will cause it to overshoot point B rather than stop dead there. Its motion continues until the other extreme of the arc is reached, at point C. Here it will be momentarily motionless while it reverses direction. It has now lost its kinetic energy, having turned it once more back into potential energy, although in the opposite sense.

In the hypothetical case of a perfect pendulum the original value of potential energy, the acquired kinetic energy and the new value of potential energy would all be the same. In practice, friction in the pivot and air resistance produce losses that progressively deplete the energy. The result of this is that the swings become progressively smaller until, eventually, the pendulum comes to rest. The graph of amplitude (of the swings) against time follows a sinusoidal law and, because of the losses in the system, the oscillation is damped, just as in the case of the vibrating string of Figure 1.

Keep it Going

Oscillations of the type just described are damped because of losses in the system. This gives a clue as to how the oscillations can be sustained at full amplitude – by making good the losses. In the case of the pendulum, a mechanical device, a 'kick' of just the *right amplitude* given at just the *right point* in the cycle will replace the lost energy and allow continuous oscillations to take place. In the case of a pendulum clock, this is achieved by supplying brief but controlled bursts of energy, stored in weights or a spring, via an escapement.

The terms *right point* and *right amplitude* are deliberately emphasised. If too large a kick is given the oscillations will *increase* in amplitude until some limiting action occurs; this is because energy is being supplied at a greater rate than it is being lost, resulting in the system acquiring surplus energy, which it must use somehow. If, on the contrary, the kick is too small the oscillations will diminish. In other words, the oscillation will still be a damped one, although it will now take longer to die away. Applying the kick at the right point in the cycle is also important – just as the direction in reversing, thus helping the pendulum on its way. Applying the kick as the pendulum is approaching will merely stop it dead.

What we are saying in the last paragraph is, that the energy supplied to the oscillating device (the pendulum in this instance, but true of all such oscillators) must be correct both in *amplitude* and *phase* if continuous oscillations are to take place. This is an important idea in view of what follows shortly.

The Resonant LC Circuit

We now come to another example of a natural LC oscillator, and one perhaps more relevant to our interests. This is the resonant circuit of Figure 3. This circuit can be shown to behave in a similar way to the pendulum just described, as follows.

In Figure 3(a), the circuit is shown connected via a change-over switch to a source of electrical energy, namely a battery. With the switch in position A, the capacitor charges up to the value E volts. This is the 'potential' across the capacitor terminals, an obvious analogy with the potential energy which the pendulum acquired when its weight was lifted up initially.

If the switch is now moved to position B, the energy source is disconnected and the charged capacitor is now across the coil; it will immediately start to discharge, this being analogous to the pendulum commencing its downward swing. At some point, the capacitor will be completely discharged, though the energy that it originally possessed must be somewhere. The question is, where? The answer is that it is now stored as magnetic energy in a magnetic field produced by the coil. This field exists because of the current flowing in the coil. In other words, in the same way that the pendulum weight has kinetic energy due to the motion of the pendulum, so the coil has magnetic energy due to the motion of electrons (the current, which is the rate of flow of charge). This is equivalent to the pendulum being at point B in Figure 2.

The analogy continues: the 'momentum' due to this stored energy maintains the flow of current. The result is that the capacitor once more becomes charged, this time in a polarity opposite to the original one. Once the capacitor is charged up, the current flow stops; this is analogous to the pendulum reaching the other end of its swing (point C in Figure 2). As with the pendulum, its swings become smaller and smaller in amplitude, as the current in the resonant circuit flowing alternatively in opposite directions gradually diminishes on successive cycles.

If the energy becomes less and less, there must be a cause. In the case of the pendulum it was 'resistance' due to friction. In the case of the resonant circuit it is also resistance, the electrical resistance of the LC circuit, most of which is the winding resistance of the coil itself.

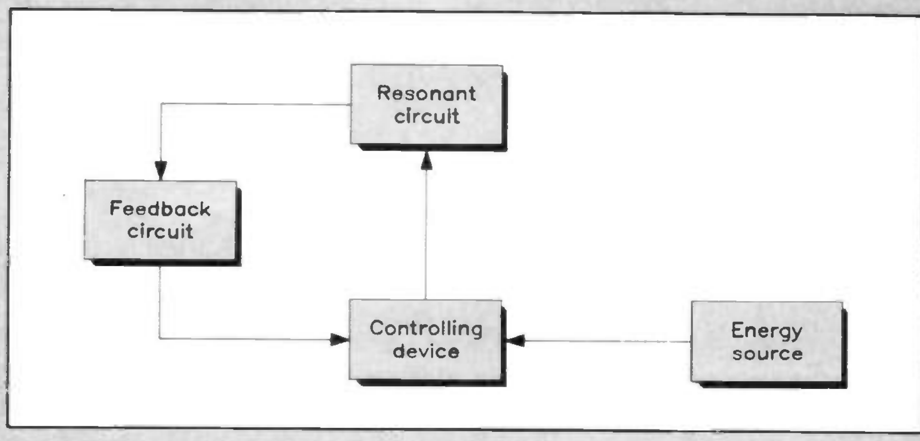


Figure 4. General block diagram for an oscillator.

Positive Feedback and Self-Oscillation

The previous argument indicates that the initial oscillations that commence when energy is first given to the LC circuit can be maintained indefinitely as long as the lost energy can be replaced. In order that this can be done it is necessary to have a source of energy available for this purpose. Let us make a bald statement at this point, before developing the argument further.

'The source of energy for maintaining self-oscillations in an electronic circuit is the power supply, whether battery or mains-derived'.

With this in mind, there is no doubt as to where the energy required is actually coming from; what must then be understood is how this energy is controlled in order to keep the LC circuit going. The block diagram of Figure 4 shows the key elements needed to make a working LC oscillator. The following blocks and their functions are identified as follows:

(i) The LC circuit which has a natural oscillatory frequency given by:

$$f_o = 1/(2\pi\sqrt{LC}).$$

(ii) An active device controlling the flow of energy. This will usually be a transistor, either a bipolar type or an FET.

(iii) A feedback circuit connecting the LC circuit to the input of the controlling device, whose function will be explained in more detail shortly.

(iv) The source of energy itself, namely the power supply.

The relationship between the first three blocks is as follows.

When power is first applied to the circuit the capacitor charges up and oscillations commence. As soon as they do so a small proportion of the oscillatory voltage (known as a feedback voltage) is fed back to the input of the controlling devices. Because this is the base (or gate in the case of an FET) of a transistor

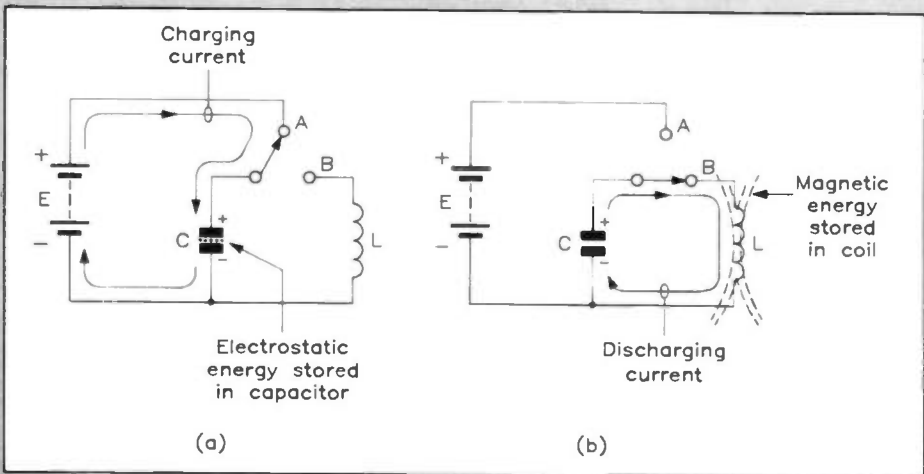


Figure 3. The resonant LC circuit (a) capacitor charging, (b) capacitor discharging.

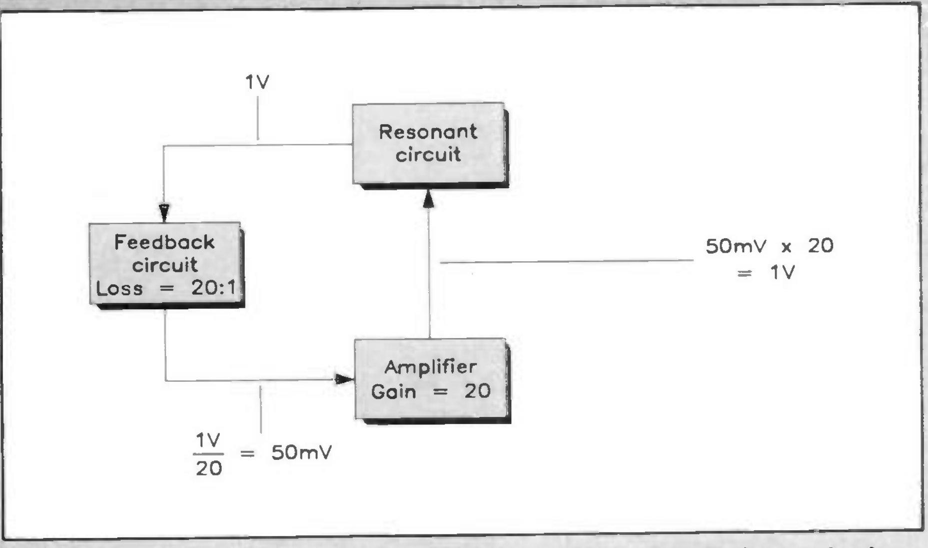


Figure 5. Illustrating the concept of loop gain and phase shift for self-oscillations to take place.

amplifier, this feedback voltage will be amplified, its power level being substantially raised in the process. This amplified version of the oscillation is developed across the very circuit (the LC circuit) where it originated. If it has the same 'phase' as the oscillations in the LC circuit at the instant it will assist them.

This, it may be realised is analogous to applying the 'kick' to the pendulum at the point in the circuit where it assists the swing.

Thus, energy at the correct frequency and in the right phase has been returned to the oscillatory circuit in order to keep it going. What is also important is that the 'amount' of this energy is correct, neither too much nor too little, for reasons explained earlier. To make this as clear as possible, Figure 5 is introduced.

This figure puts the situation on a basis that may be a little easier to comprehend, in term of voltages. It is assumed that the voltage that should exist across the LC circuit when it is working correctly is exactly 1V (a figure chosen purely for convenience); it is also assumed that the voltage gain of the amplifier is exactly 20. How much feedback voltage should there be for the circuit to oscillate at constant amplitude?

The answer is 'one twentieth of the oscillatory voltage'.

This can be appreciated by looking at the system as a combination of 'forward gain' (provided by the amplifier) and 'reverse loss' (provided by the feedback network). If the oscillatory voltage has an amplitude of 1V and the gain of the amplifier is 20, then the input voltage that the amplifier requires in order to develop the required output of 1V is 1V/20 = 0·05V or 50mV. This latter is the value of voltage fed back from the oscillatory circuit. From this the loss of the feedback circuit can be seen:

Input to feedback circuit (from the oscillatory LC circuit) = 1V. Output of feedback circuit (to base of transistor) = 0·05V.

Loss of feedback circuit = output/input = 0·05/1 = 0·05 or 1/20.

Note that the loss of the feedback circuit is the reciprocal of the amplifier gain (gain = 20; loss = 1/20).

An obvious fact can be observed at this point. The product of gain (of the amplifier) and loss (of the feedback network) is unity:

20 x 1/20 = 1.

This product is actually called the *loop gain* and it always equals unity for self-oscillations to be maintained. It is *one* of *two* vital criteria that determine whether a circuit will oscillate continuously or not. The other concerns phase.

The total phase shift of the amplifier and the feedback network (known as the *loop phase shift*) must equal 360°. This is saying nothing more than the phase of the feedback energy should be in the same phase as the original oscillation in order to sustain it. When the feedback is of such a phase as to assist the original oscillations, it is called *positive feedback*.

Summing up then, for constant oscillations the loop gain must be unity and the loop phase-shift, 360°.

Feedback Circuits

The use of a feedback circuit in the manner described implies some form of coupling between output and input. One coupling component that may be used is the transformer (Figure 6). In this figure, diagram (a) shows a 'double- wound' transformer and diagram **(b)** shows an 'auto-transformer'.

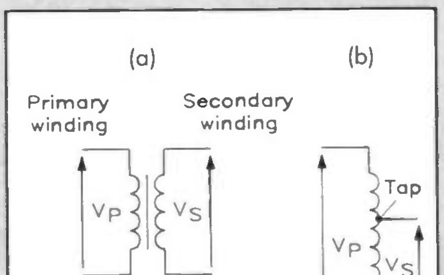


Figure 6. Two types of transformer (a) double-wound and (b) auto-transformer, used as a coupling element in oscillator circuits.

A double-wound transformer is so called because it has two separate windings known as the 'primary' and 'secondary' respectively. In use the primary winding is energised by an alternating current applied or developed in this winding and, as a result of magnetic coupling between the windings, a voltage is induced in the secondary winding. The amplitude of this induced voltage depends upon the amount of magnetic coupling between the two windings. Specifically, it very much depends upon how closely the two windings are situated to each other.

The auto-transformer performs the same essential function as the double-wound transformer but its principal physical difference lies in the fact that the two windings are merely different proportions of one single winding. In Figure 6(b) the transformer is assumed to be of the 'step-down' type in which the secondary voltage is smaller than the primary voltage. In order to effect this, the input voltage is applied across the whole winding and the secondary voltage appears between the lower end and a tapping. If this tapping is exactly half-way down the winding the secondary voltage is then half the value of the applied primary voltage. The construction is simple but there is no inherent isolation between input and output, since the lower end is common to both input and output. It is used in a particular type of oscillator circuit as we shall see later.

Some Practical LC Oscillator Circuits

Transformer Type

The circuit of Figure 7 is known as a 'tuned collector' (and sometimes 'reaction coil') oscillator and is an example of the way in which the double-wound transformer with separate primary and secondary can be used as the positive feedback element of an LC oscillator. The circuit derives its name from the fact that the tuned circuit is in the path between collector terminal and the positive supply rail. At this point it is worth making a comparison between the block diagram of Figure 4 and this circuit, in order to identify the ways in which the different blocks have been realised.

The LC circuit consists of capacitor C1 and coil L1, the latter actually being the inductance of the primary winding of a transformer referred to as T1. The oscillations will commence in this circuit at the natural frequency given by the previous formula.

The active device, TR1, is a bipolar transistor, but could equally be a field effect transistor (or of course as in the good old days a valve). The device is connected to a D.C. supply from which it draws the energy required to make good the losses in the tuned circuit L1C1.

The coupling circuit consists of the transformer T1 formed from the two coils L1 and L2; the latter is, of course, the secondary winding of the transformer. The oscillations in L1C1 develop a small voltage in L2 which drives the base of the

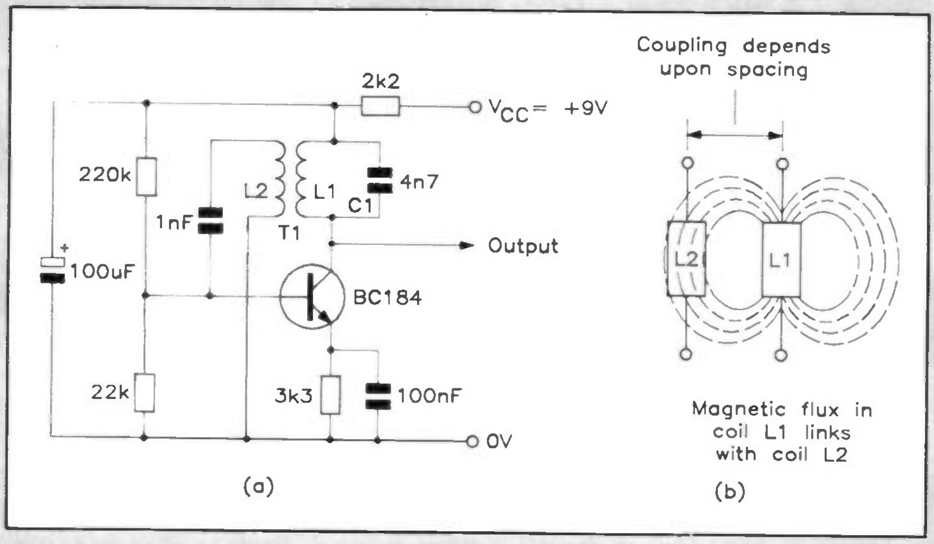


Figure 7. (a) Circuit for the tuned collector oscillator, (b) a simple transformer made from two separate coils

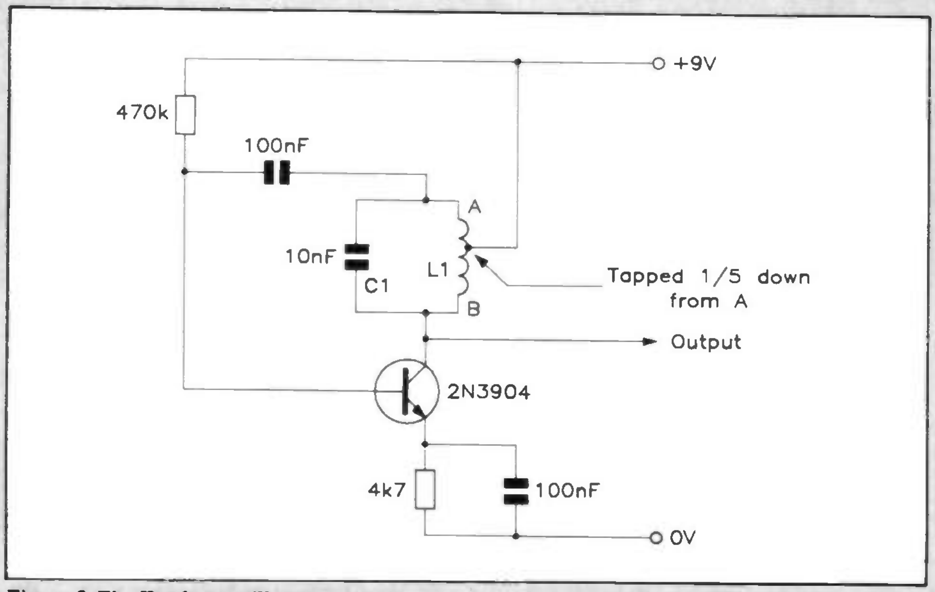


Figure 8. The Hartley oscillator.

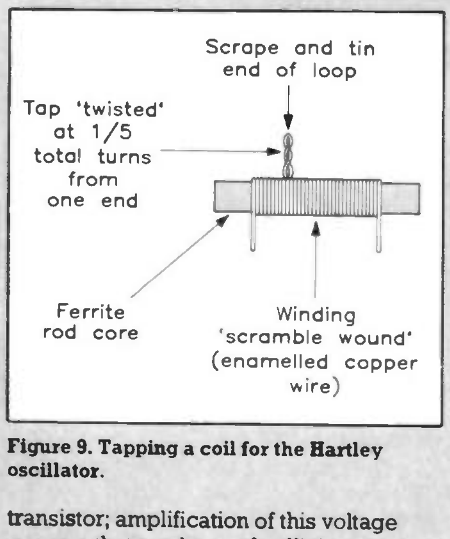


Figure 9. Tapping a coil for the Hartley oscillator.

transistor; amplification of this voltage ensures that a voltage of sufficient amplitude at the same frequency, appears across the resonant circuit so as to sustain constant amplitude oscillations. The phase of the alternating voltage in L2 relative to that in L1 depends upon which way round the voltage is taken from L2. For the circuit to work there has to be a phase difference of 180° between these two voltages, since the phase difference between the base and collector voltages is also 180°, thus giving the required total phase shift of 360°.

The source of energy is the D.C. power supply whose potential is denoted by V_{cc} (9V in the circuit shown).

If the reader wants to try putting theory into practice, then it is a fairly simple matter to build an oscillator of this type. The transformer T1 need cause no real problem for, while a suitable transformer as such may be a somewhat elusive component, the necessary action can be achieved by taking two readily available coils and laying them side by side on the circuit board (Figure 7(b)). This will certainly give enough coupling between the two coils to allow oscillations to occur. If they don't, then it is more likely to be because the phase shift between L1 and L2 is 180°out, corrected simply by reversing the connections to one of them, rather than that the coupling is insufficient. Obviously, by making one of the coils movable, it is possible to vary the distance between them to show the coupling effect. For example, instead of mounting them close to the board, they can be allowed to stand off from the board on their leads, the latter being bent to vary the distance between them.

The choice of coils is not critical but it is suggested that coils in the range 1-10mH be tried, these giving frequencies in the 'tens of kilohertz range that can be easily measured. A suggested value for C1 is given in the circuit of Figure 7(a). If a small audio transformer happens to be available it is worth trying it, as it would then be possible to get the circuit to oscillate at quite a low frequency, tens of Hz rather than tens of kHz, for example. If L1 is a 10mH coil, with the value of C1 shown, the oscillatory frequency is about 23kHz.

Tapped Coil Type

An auto-transformer can be used instead of having separate primary and secondary windings. The circuit of such an oscillator is shown in Figure 8 and follows the Hartley configuration. The auto-transformer can be made by winding a coil with a tapping of about one fifth of the total turns in from one end (end A in Figure 8). This tap then goes to the supply; the other end, end B, is connected to the collector. It is possible to 'scramble wind' a coil on a piece of ferrite rod, deciding in advance how many turns you have the patience to wind on, and then stopping to twist a loop of wire (Figure 9) for the tap after a fifth of the turns have been wound on. The enamel must be scraped off the loop wire to allow it to be tinned prior to connection to the circuit.

It is almost impossible to predict what inductance the finished coil will have but this consideration is not that important if the purpose of the circuit is simply to satisfy one's curiosity. But it is wise to make note of the coil details, the tuning capacitance used and the resonant frequency obtained. This at least gives a starting point for subsequent more specific designs if required.

The purpose of the tapped coil in the Hartley circuit is to provide the correct proportion of voltage to be fed back. This is the voltage that appears between end A and the tap. The type shown is the 'series fed' type of Hartley oscillator because the tuned circuit is in series with the collector. If the coil were between collector and base with the tap to 0V then it would be the 'parallel fed' type.

The same effect can be achieved, and more conveniently too, by effectively tapping the capacitor instead. Of course, we don't actually tap a capacitor; what we do is use two in series and make their junction the tapping point. The coil is then simpler by not having to be tapped. This makes it possible to try any old coils that happen to be available. Again something in the range 1 – 10mH gives a sensible frequency. For example, if the coil inductance in the circuit of Figure 10(a) is 2·5mH the frequency will be about 37kHz. This circuit is then 'shunt fed' since the collector current is supplied to the transistor through a 4k7 resistance load and not through the tuned circuit itself. But this not a Hartley type, but a Colpitts type whose distinguishing feature is that a capacitor chain potential divider is used

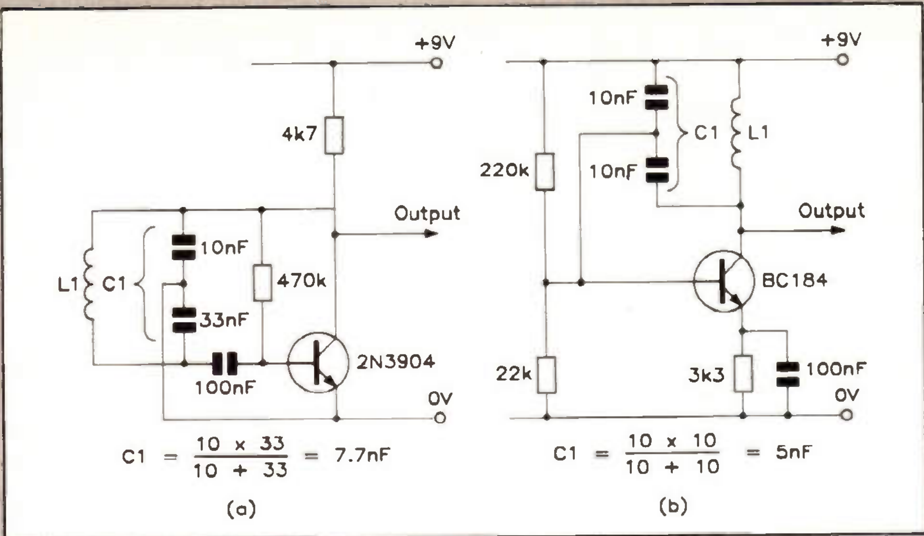


Figure 10. The Colpitts oscillator, (a) shunt fed, (b) series fed.

instead of the tap of the Hartley. Figure, 10(b) is a series fed variation of the Colpitts. Normally the feedback would be returned to the emitter and the transistor operated as a common base non-inverting amplifier, but a phase shift in the capacitor divider might be sufficient for base connection instead.

Varying the Frequency

Since the frequency of oscillation depends upon the values of L and C, varying either will cause the operating frequency to change. It is possible to switch a number of different values of either L or C to obtain a number of spot frequencies. For continuous variation of frequency, however, either L or C must be capable of continuous variation. Variable capacitors are readily available but their maximum values are strictly limited by practical considerations, rarely being greater than 500pF and often being much less. This is fine at radio frequencies, above a few hundred kHz. Designs for a variable inductor have also been produced though they are much less common. A magnetic core is moved axially in and out of the coil, giving a good range of inductance values. Using the same principle, some small coil formers have a thread down the centre in which a magnetic 'slug' can move, by means of a screwdriver. The idea of such an arrangement is to allow the coil inductance (and hence the circuit frequency) to be tuned to a precise value.

The designs for the three LC oscillators described above have used component values that give oscillations at frequencies in or very little above the audio-frequency range. However, the main application area for such oscillators is normally in the radio-frequency spectrum, up to frequencies of several hundred MHz. At the higher frequencies the coils become extremely easy to make, since the number of turns may be relatively small and often a fairly heavy gauge of copper wire can be used to make them self-supporting. As far as the inexperienced experimenter is concerned the main complication about working at the higher frequencies is the greater difficulty of making observations and measurements.

In the next issue we shall return to the subject of oscillators. The differences will be that we shall see how the LC resonant circuits can be replaced by the simpler and cheaper RC networks. Included will be a small project to make a useful piece of test-gear based on one of these circuits.

When Disaster Strikes
Continued from page 17.

should the need arise. In any case, it would be necessary for both companies to keep in step with their processor and disk configurations, software and network support in order to absorb any additional loadings.

Blowing Hot and Cold

There are of course other back-up alternatives. The installation can run a duplicate installation, or one operated by a third party. For a fee of approximately £200,000 per annum, a large IBM mainframe can be made available within 24 hours. 'Hotstart standby', says Sherwood Computers, is the only means by which medium and large scale computer users can re-establish their computer services within hours. Available 24 hours a day, year round, the resource contains an equivalent level of computer resource at an alternative location, including the provision of communications facilities, connecting the user's site to the alternative computer resources. "A Hotstart service is the only means by which computer users can re-establish their computer services within hours, unless they have several million pounds to invest in duplicating their own computer services," says Keith Windram.

Unlike the Hotstart facility where a dedicated system is ready and waiting to provide a back-up service with the absolute minimum of delay, a Coldstart service provides a similar facility – electrical power, air conditioning etc. – but without the computer hardware. Here the third party supplier provides just alternative accommodation for a replacement computer, including networking, until the original computer operation is re-established. For many companies, such a service is the cheapest way of obtaining a second computer centre with a subscription fee which is a fraction of what a fully duplicated standby facility would cost.

Threats Galore

Disaster, it seems, can strike anyone, anytime. Apart from such matters as air conditioning and related environmental problems, such as power and lighting, users also have to contend with fires – not just from the equipment, but from floors above or below, or even from *neighbouring premises*, and floods from leaking pipes, radiators and taps. It is not exactly unknown for local rivers to overflow and flood the installation, or gale force winds to blow the installation's roof off!

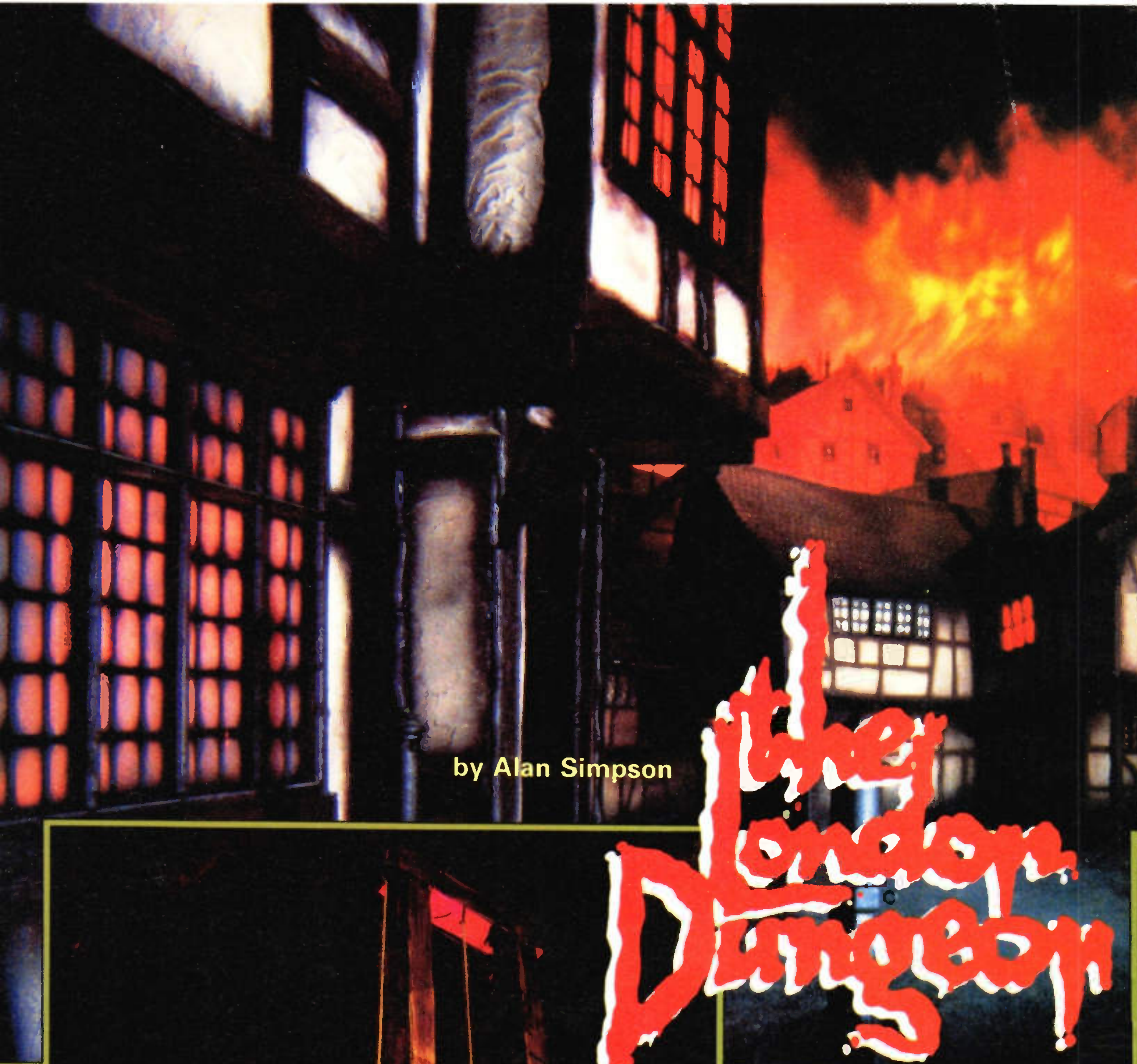
Various companies exist, both hardware suppliers such as DEC who provide a business protection service (translated this stands for disaster back-up), based on expert systems; IBM's Business Recovery Services programme, and BT's SwitchMan PC controlled protection system. However, comms managers do have a very efficient back-up system known as Mercury Communications. So if your local exchange goes down, then an alternative routing is readily available.

Given the vulnerability risk, it should be no surprise that the movement towards fault tolerant systems is growing. Some companies take fault tolerance to the ultimate, such as the Financial Times who have actually built a dividing fireproof wall across their Tandem Computer with operations rooms on both sides of the partition.

The Confidence Factor

According to Brian Wilson, manager of Computer Operations of the disaster recovery service run by GKN Computer Services in Smethwick, Birmingham, the confidence factor is all important. "Thanks to our presence, many more computer managers can sleep easy at night. We also give a large helping of piece of mind to senior management who know that even if their computer system goes down, the company will not."

Even so, at the last count, only one half of large organisations have a contingency plan in place. Of those, less than a quarter have much confidence in it. As shown by the revealing fact that, of those companies who have tested their system, three out of four discovered it did not work. Not a comforting thought given the widespread belief that "if a disaster can happen, it will..."



The London Dungeon

by Alan Simpson

Ever investigative, Alan Simpson stepped back in time to relive some of the most horrifying episodes in British history. Among the torture racks, human sacrifice, martyrdom, witchcraft, plagues and sundry gruesome reminders of our blood curdling heritage, he found a den of high tech.

Interactive Medieval Entertainment

It's dark. It's dank. It's musty. It's frightening and it's generally packed. The London Dungeon, nestling in the Arches of London Bridge station, is one of the top five London tourist venues. Last year over 600,000 visitors entered the daunting doors of the world's first – and most famous – medieval horror museum.

Gruesome in places and more than startling in reality, the London Dungeon shows history as it was;

OUT AND ABOUT

Main picture: The Great Fire of London; in four days more than 13,000 houses were destroyed and 100,000 people made homeless.

Below centre: Legend tells of St. George as a Christian in a pagan country. He was tortured 12 times for his beliefs and saved by 7 miracles before being beheaded.

Bottom left: The guillotine was first used in 1792 to execute a French revolutionary, Nicholas Jaques Pelletier.

Bottom right: Early surgery; the bodies of those hung at Tyburn were opened up for medical research!

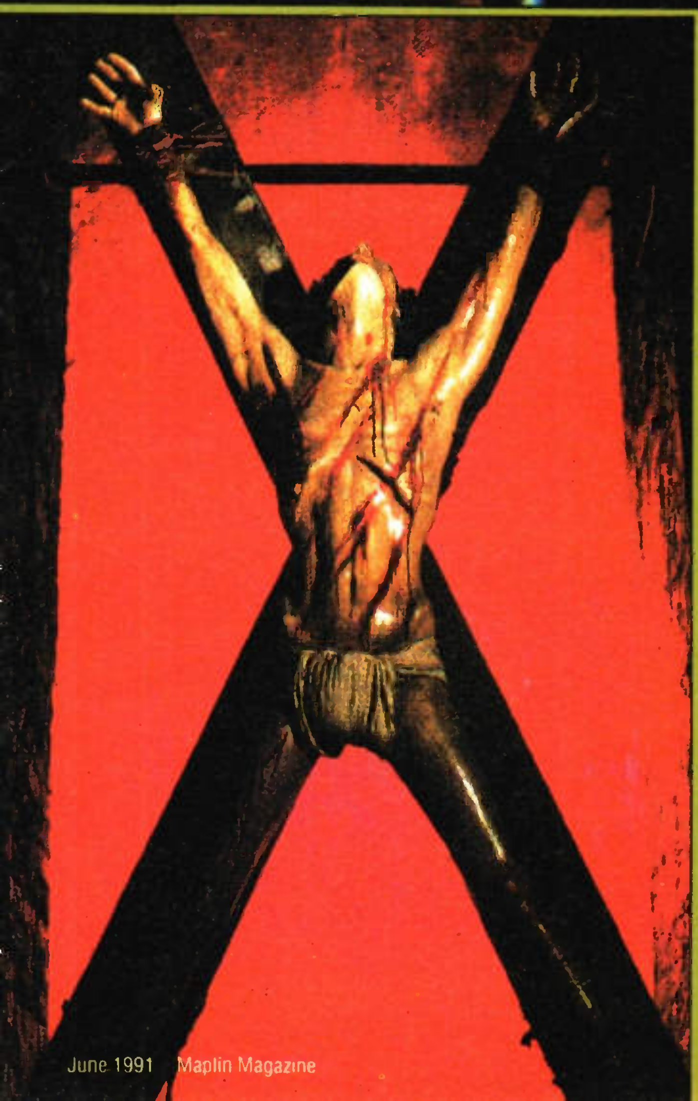
factual, uncompromising and distinctly frightening. What started as a bizarre and blood curdling idea more than a decade ago has indeed become a historic attraction in its own right. It was in fact Anabel Geddes, described as a housewife, who following a visit to the Chamber of Horrors at Madame Tussaud's decided that it was not sufficiently scary and set about opening her own house of horror.

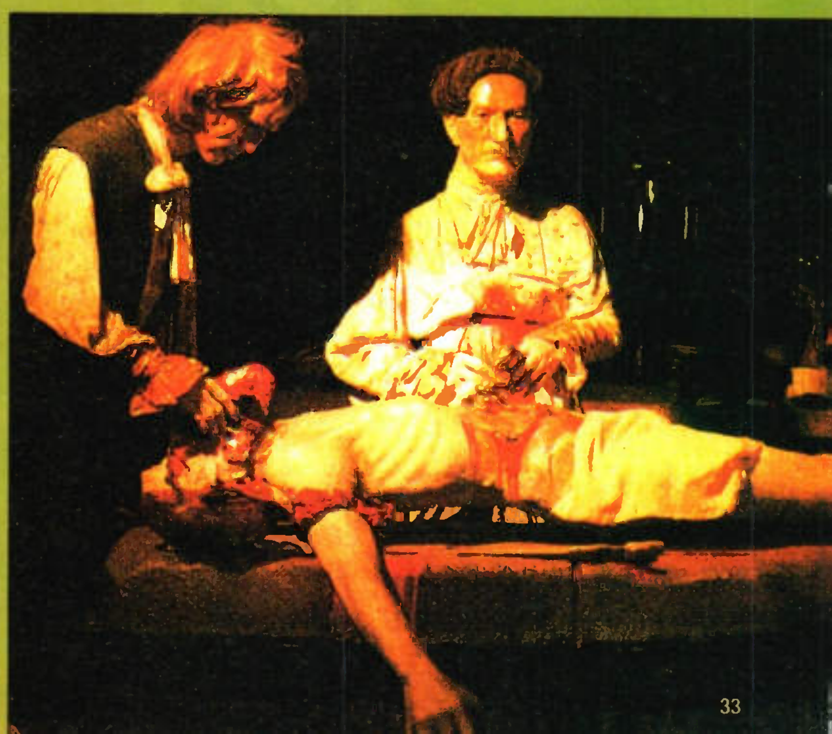
Now part of the Kunick Group, what started as a bizarre and blood curdling idea has become big business. Realism abounds, and with some 300 crimes punishable by death, the organisers have much medieval material to draw on. Based on carefully researched historical facts, a series of life-size tableaux depict superstition, torture and death in spine-chilling detail. As the promotion has it, 'set in huge dark vaults, eerie sound effects and dramatic lighting create a fantastic atmosphere, from the moment visitors step through the heavy dungeon doors and are warned to "Abandon hope, all ye who enter here" '.

The 35,000 square feet of exhibition space feature in highly theatrical style such historic characters as Boadicea, Richard the Lion-Heart, King Harold, Thomas Becket, Henry VIII and Mary Queen of Scots. The 'talking head' of Anne Boleyn kneeling in prayer explains how she was falsely accused of adultery, whilst in the background an expert swordsman prepares to behead the young second wife of King Henry.

Other exhibits or working tableaux include a wide selection of British torture instruments such as the awesomely named 'Scavenger's Daughter' (a limb-breaking instrument) and such delightful happenings as the Bubonic Plague, Witchcraft, and Martyrdom.

For one visitor, the cute Jane Nasse of Enfield, Middlesex, the highlight of the event was 'The Great Fire of London'. The spectacular display which features audio and





visual effects, in a dramatic life-sized reconstruction of Pudding Lane in that long, hot, dry summer of 1666, when a simple fire in a baker's shop in Pudding Lane resulted in the entire tinder-dry city being engulfed in a blazing inferno was just brilliant. 'I could really hear and feel the heat and confusion, and the sight of London going up in flames was memorable'.

Even more memorable perhaps is 'The Theatre of the Guillotine' designed by Keith Sparks of the Sparks Group – creative design specialists. Robespierre sentences, the tumbrels rattle across the cobbles and Madame Guillotine sends heads rolling. The 'experience', which cost some £250,000, is staged in three chambers. Pin-point lights, dimmer controls, synchronised sound tracks and voice-overs together with three-dimensional image representations set the scenes. Overall control is by a computer system making use of an Eprom Read-only memory.

Right: Anne Boleyn was executed by a French swordsman after being charged with adultery.
Below: After hanging, highwaymen and robbers were put in 'gibbet irons' to rot.

Because the sound in the chambers is all mono, depth is added by means of a digital delay unit which serves to add depth to the sound effects. At the same time, mixers allow the general crowd and background sound to be generated at pre-determined levels.

The atmosphere is heightened by the use of smoke machines. Dramatic it is, especially the action of the guillotine which slowly and audibly creaks its way to the top of the scaffold with the relayed sound of human heartbeats and crowd emotion. At certain times, a human operator takes over adding even more emotion. A tip for the unwary from your intrepid 'Out and About' reporter. Do not stand too close to the scene of action if you want to avoid a 'spray' of blood on your face. Here the sound effects are handled by a stereo solid sound system with speakers located at strategic positions – not the conventional right/left placings.

Cabling, says Feisal Khalif, the marketing director, is not really a problem. 'We have plenty of height (in fact too much) and nearly all the cables run along the walls. What could however be a problem is the general all-pervading dampness. Wherever

necessary we have to house the computer and electronic components in specially prepared 'dry' areas where de-humidifiers maintain a constant temperature – more to the liking of the equipment'.

Electronic Wear and Tear

With the exhibition open seven days a week, wear and tear of tape and related recording media is an ever present operational factor. 'However,' says Feisal, 'our maintenance team is highly creative. The company operate a PA system based at the reception which serves to page staff and help in the retrieval of lost persons. Plans are advanced to implement an electronic till which will assist the monitoring of the number of visitors on site at any one time as well as analysing the visitor flow'.

This monitoring system could well be called into heavy use given the trend towards school parties! Special school educational packs and programs are being arranged for organised tours with end of tour question papers and teachers notes. The Dungeon, say the organisers, is not recommended to the squeamish, those of nervous disposition or unaccompanied children. To make sure that this message is

Bubonic plague was brought to England by rats from the ships docking in London and elsewhere, and quickly spread throughout the country, bringing terror and death to many thousands, by the end of the year 1665, the death toll for London was 68,596.

understood, the organisers say that under no circumstances can they be held responsible for any subsequent nightmares!

In case the going gets too rough, or as a respite from the all too close encounters with the horror kind (the exhibition takes between an hour and two hours to view) there is a friendly cafe where frayed nerves can be restored while members of the staff play their acting parts by appearing as less than formidable originals. Meanwhile, the venue is becoming a favourite place for private evening functions with up to 400 people being wined and dined. The Dungeon is also popular with film and TV companies and recently BSkyB broadcast Alice Cooper live by satellite. Even the Royals have paid visits, presumably to see at first hand the fate meted out to many of their ancestors.

Exporting French Culture to the French

Last year saw the opening in central Paris of 'Les Martyrs de Paris' (Paris Dungeon) based on Medieval French and European History, while plans exist to open a similar event in New York.

As with all the best exhibitions, The Dungeon is an on-going and expanding event. Space apparently is no problem. There are dungeons galore available.

THE LONDON DUNGEON, 28/34 Tooley Street, London SE1 2SZ. Tel: 071-403 0606.

Fees: Adults, £5. Children & OAPs, £3. Students, £4.

However, you don't have to dip into your pocket to finance a visit. Maplin has secured 6 pairs of tickets for the first all correct answers pulled out of our editor's battered hat for the four questions listed below. Please note that multiple entries may be excluded from the draw. Post entries please to:

The London Dungeon Contest, The Editor, 'Electronics – The Maplin Magazine', P.O. Box 3, Rayleigh, Essex, SS6 8LR. Or fax entries to (0702) 553935 – again don't forget to make your fax 'The London Dungeon Contest' and please make sure you include your name and address.

Entries please by June 30th 1991 Good luck.

Competition

What caused the Great Plague of London in 1665?

(a) A failed harvest
(b) William of Orange importing poor fruit from Holland
(c) Rats from ships docking in London

Who first proposed the use of a beheading machine during the French Revolution?

(a) Dr Guillotin
(b) Marie Antoinette
(c) Napoleon Bonaparte

Anne Boleyn was the second wife of:

(a) Orsen Wells
(b) Robin Hood
(c) Henry VIII

Is 14th October 1066 noted for:

(a) The screening of the first Doris Day movie
(b) The killing by an arrow of King Harold II
(c) The start of motorway repairs on the M1

CLASSIFIED

If you would like to place an advertisement in this section, here's your chance to tell our 35,579 readers what you want to buy or sell, or tell them about your club's activities – absolutely free of charge. We will publish as many advertisements as we have space for. To give 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.

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For the next issue your advertisement must be in our hands by 1st June 1991.

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150W MAPLIN STEREO DISCO. Working but needs finishing! In case with tape deck, two record decks, disco lights, speakers and other bits. Suit enthusiast. £250 ono. Tiverton (0884) 821111.

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KEITHLEY 197 BENCH AUTO D.M.M. Very accurate 5½ digit. Calibrated Aug '90. Takes IEE-488. Cost new £600 approx. Best offer over £220. Tel: (0685) 811332.

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RED SEVEN SEGMENT DUAL DISPLAYS, 210 in total £50 for lot inclusive P+P. Interested? Call (0473) 216194 24 hrs. Still in packaging supplied with data!

HAMEG HM205 DIGITAL STORAGE OSCILLOSCOPE as new £350 ono. Telephone Luton (0482) 401797.

BOURNEMOUTH TECHNICIAN EMIGRATING. Selling toolkit metal case, pristine £45. Components in storage boxes, copper clad board, 15W audio amp cased. 2 x 0-50V ½A PSU cased, recent books. Offers? (0202) 309838.

FOR SALE: GRUNDIG TK120 In good condition with tape. £20 inc. postage. Tel: (0606) 888863. No offers.

PREVIOUS ISSUES OF MAPLIN MAGAZINE Issues 1-4; 21-25; 27-41. Offers to M.A. Bell, 162 Dunstone View, Plymstock, Devon PL9 8QL.

COMPUTERS

6502 SYMBOLIC CROSS ASSEMBLER FOR IBM PC and clones. At last you can write 6502 assembly code on a PC! Software runs from floppy or hard disk. Source files can be written and edited using integral line editor or standard wordprocessor. Assembled files can be output as an ASCII listing, Hex dump or Intel format dump. Intel format dump can be uploaded directly into EPP1 EPROM Programmer. Supports 1500 lines of code and 300 labels, plus user definable macros. Demo disk available. Send SAE to Maplin Mag., P.O. Box 3, (Ref: ZB), Rayleigh, Essex SS6 8LR for details.

MICROLINE CENTRONICS PRINTER 80 column tractor/friction feed, with manual £55. Delta data centronics printer 80 column bi-directional tractor feed, with manual £60. Both in full working order. Tel: (0733) 342839.

3¼ INCH DISK DRIVE, new & cased £35. Z80 Board (32K RAM/EPROMS, sockets) £15. New SP0256 Speech synthesiser £5. 8 x 4116 16K DRAMS, £5 the lot. All items working. Tel: (0684) 573960 evenings.

PUBLIC DOMAIN SOFTWARE COLLECTOR wants to buy, swap and sell Atari PD software. Write M. Jones, 72 Lancelot Avenue, Strood, Kent.

ATARI ST/STE PUBLIC DOMAIN SOFTWARE only 99p per disk. Hundreds available. Write to Nick Klee, 66 Abbey Road, Strood Kent ME2 3QB. Please enclose a disk for lists and free PD!

WANTED

WANTED: Colour code/value of resistor R2 in Hornby Zero 1. Circuit diagram/technical info appreciated. Costs defrayed. Tel: Jim F. on Carlisle (0228) 25969.

WANTED: Circuit diagram for a timer switch to turn on and off a 12V bulb. Any advice greatly appreciated. Tel: (0476) 861290 evenings.

COURTESY L•I•G•H•T EXTENDER

by Tony Bricknell

FEATURES

- ★ Requires no external power supply
- ★ Optional ignition override
- ★ No setting up required
- ★ Low component count
- ★ Kit available

Introduction

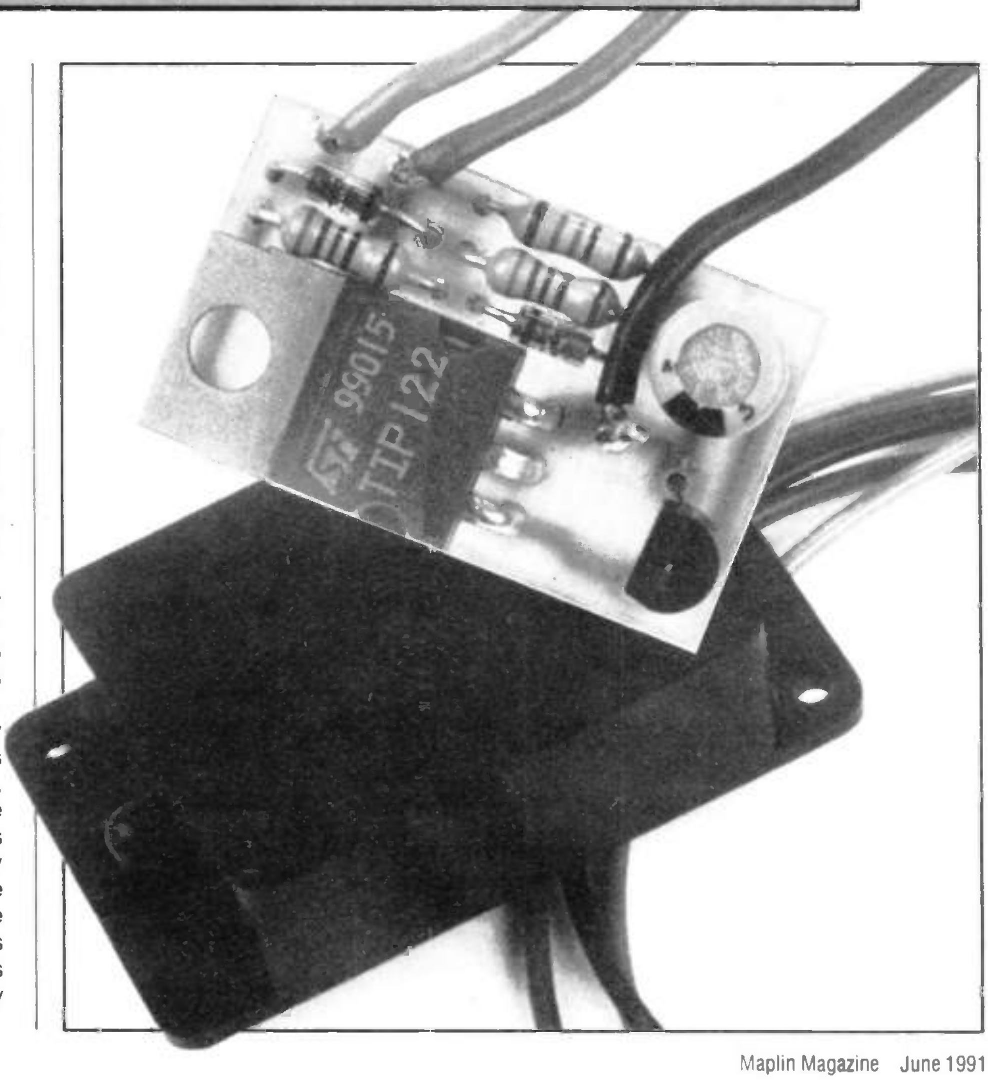
How many times have you got into your car of a night only to find the ignition switch has gone for a walk around the dash-board, as your aimless efforts to start the car only result in the ignition key gouging several grooves into the plastic?

This project keeps the interior light on after the car door has been closed, allowing time to find keys, ignition switch, or even your way out of the garage!

Circuit Description

Figure 1 shows the circuit diagram of the courtesy light extender. P1 and P3 connect directly across a door switch controlling the inferior light and P2, to a source that has power while the ignition is on.

With a door open, P1 and P3 are effectively shorted, causing C1 to discharge through D1. As soon as all doors are closed, as C1 is discharged, TR2 is turned off. R1 pulls the base of TR1 high, turning it on and causing current to flow through the courtesy light. C1 now starts to charge through R2 until TR2 turns on, pulling the base of TR1 low and halting the flow of current through the interior light. As C1 charges through R2 and the courtesy light, it can be seen that the wattage of the interior light plays quite an important role in the time delay given. Figure 2 shows typical time delays given at various values of R2 for 5, 10, 15 and 20 Watt courtesy lights.



If, during the time delay given by the unit, the ignition is turned on, C1 charges up *very* quickly through R3, turning the interior light off almost immediately. This avoids the possibility of driving away at night with the courtesy light still on.

Construction

The postage stamp sized PCB is of the high quality, single-sided glass fibre type, see Figure 3. The sequence in which the components are fitted is not critical; however, the following instructions will be of use in making these tasks as straightforward as possible.

Insert and solder the PCB pins using a hot soldering iron. If the pins are heated, very little pressure is required to press them into position. Once in place, the pins may then be soldered. It is now easier to start with the smaller components, such as the resistors, work upwards in size, and transistor TR1 is fitted last.

The diodes should be inserted such that the band at one end of the diode corresponds with the white block on the PCB legend. When fitting the electrolytic capacitor, it is essential that the correct polarity is observed. The negative lead of the capacitor, which is usually marked by a full-length stripe and a negative (−) symbol, should be inserted away from the hole marked with a positive (+) sign on the PCB legend. Insert and solder the two transistors, matching the shape of each case to its outline on the legend.

Lastly, solder lengths of wire to the veropins and mount the PCB inside the box, as shown in Figure 4.

For further information on component identification and soldering technique, please refer to the Constructors' Guide included with the kit.

Installation

When carrying out any form of electrical work on a vehicle always disconnect the battery and *never* work inside the engine compartment with the engine running!

The courtesy light extender is extremely simple to fit, however, for someone who is not familiar with automotive electrical installation it is advised that they seek the advice of a qualified person before proceeding.

There are two methods of switching the interior courtesy light;

1) Door switches are fitted to the 0V side of the courtesy light, for installation follow Figures 4a or 4b,

2) Door switches are fitted breaking the +12V supply to the courtesy light, for installation follow Figures 4c or 4d.

In its simplest configuration, the unit connects directly across a door switch; P1 connecting to the more positive side of the switch and P3 to the more negative.

If ignition override is required then P2 must be connected to a source that has power while the ignition is on (for example, +SW terminal of the ignition coil). If no easy connection can be made to the ignition circuit then P2 can be connected into the 'Accessory' circuit.

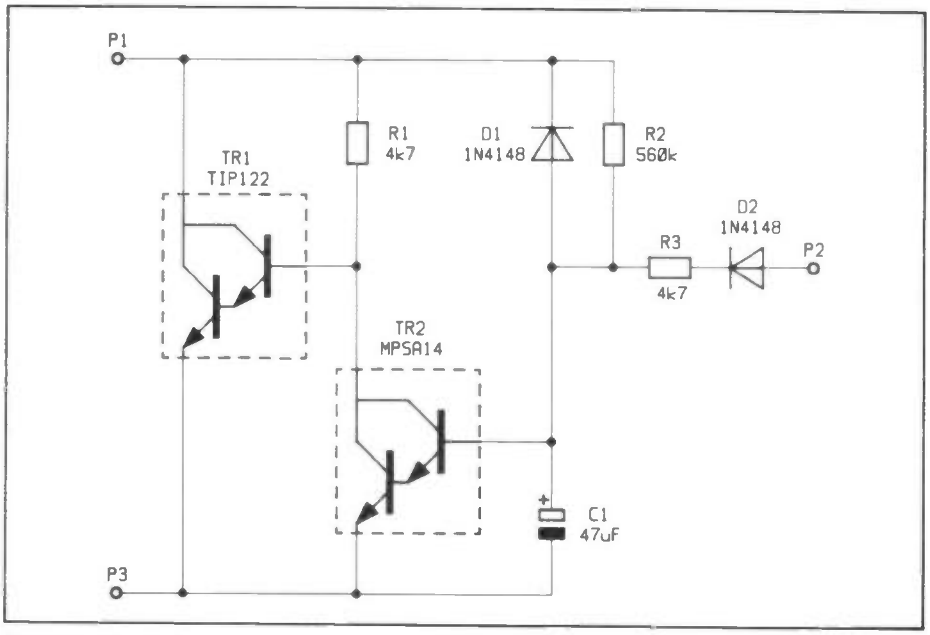


Figure 1. Circuit diagram.

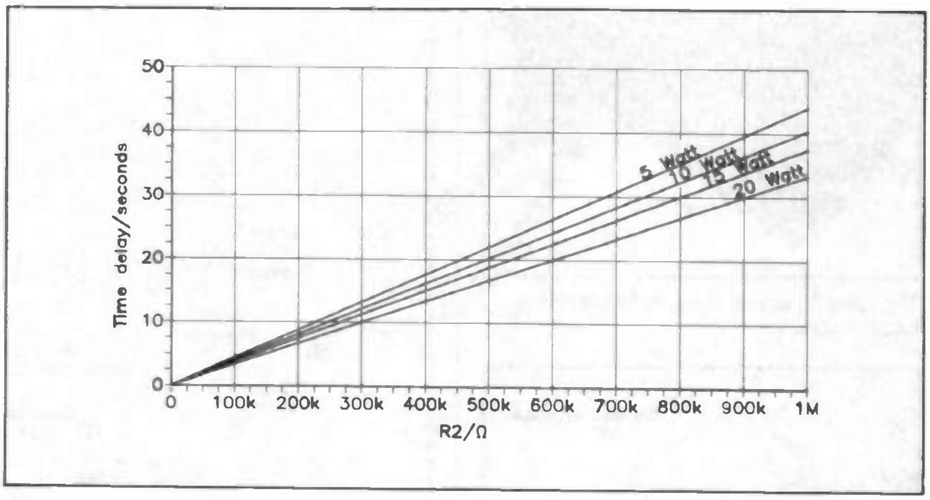


Figure 2. Graph of R2 against time delay for various wattage courtesy lamps.

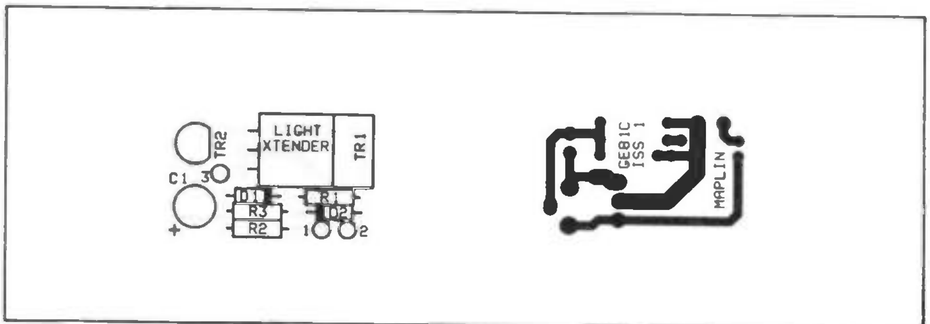
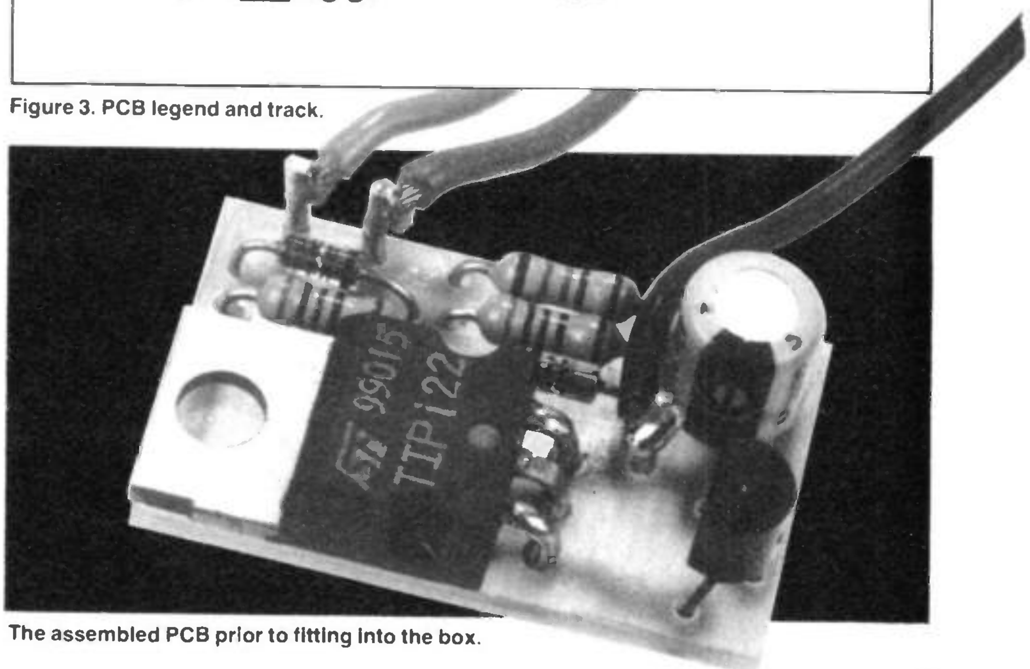
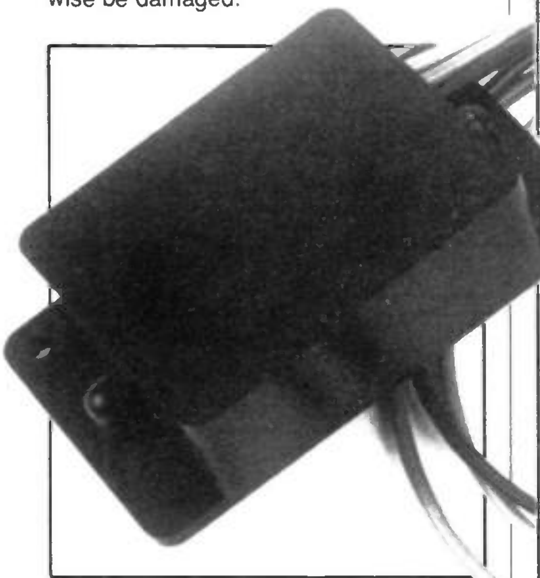


Figure 3. PCB legend and track.



The assembled PCB prior to fitting into the box.

As the complete unit is small and unobtrusive it can easily be mounted inside a door-post, behind an existing door switch. The box can be held in place using a self-adhesive pad (such as HB22Y) or bolted down using the two mounting holes provided in the base of the box. Check behind panels before drilling any holes and ensure that no wiring harness or other components are located behind panels that would otherwise be damaged.



The completed unit ready for installation into the car.

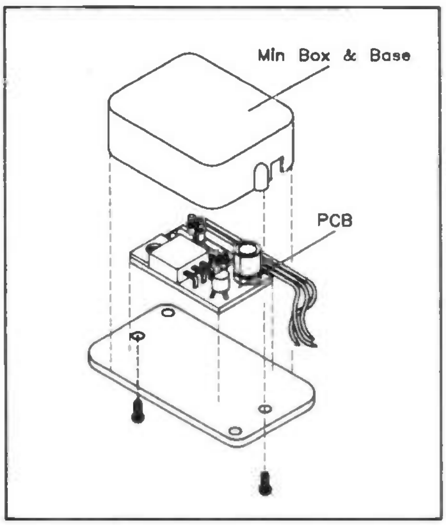


Figure 5. Fitting unit into box.

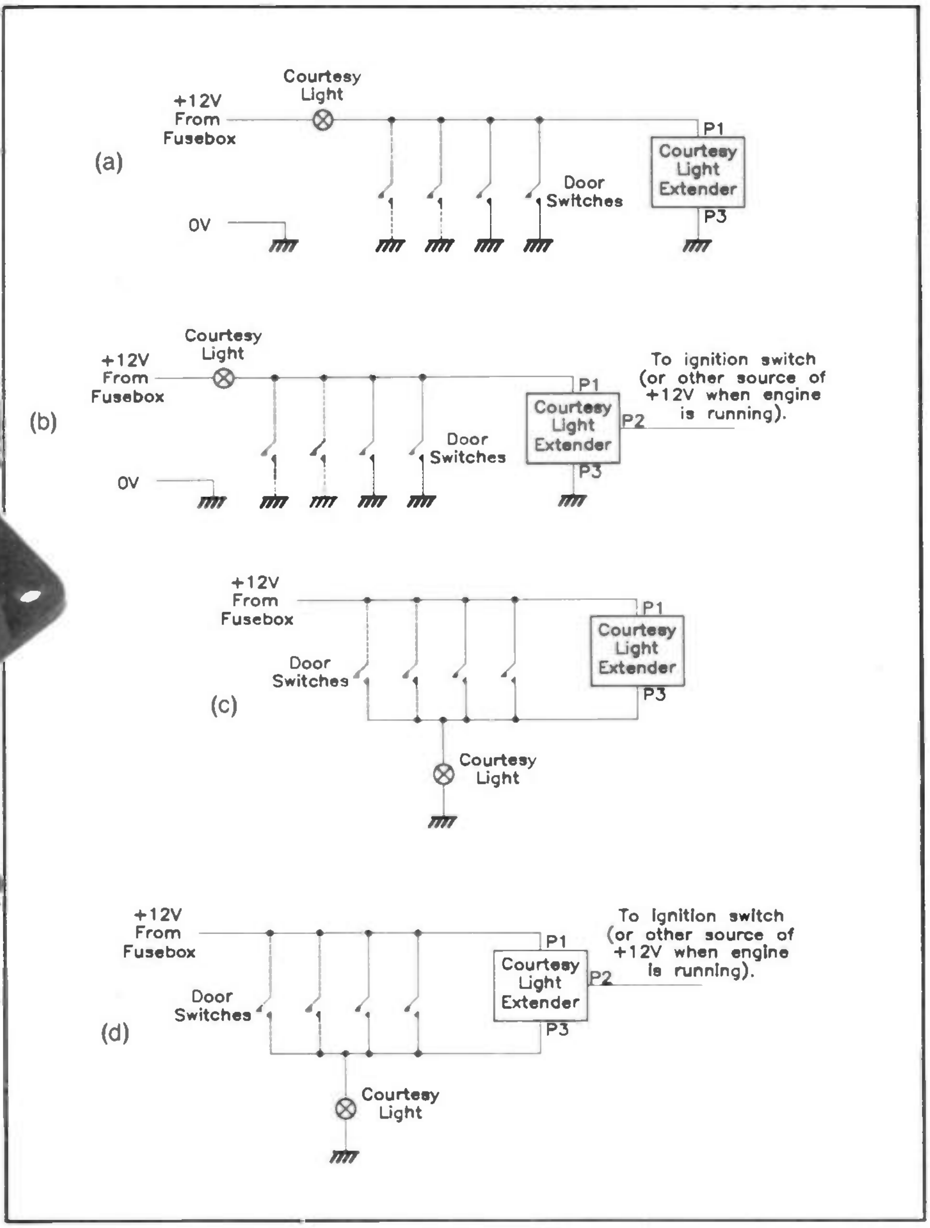


Figure 4a. Simple connection for vehicles with negative switched courtesy light.
Figure 4b. Connection for negative switched courtesy light with ignition override.
Figure 4c. Simple connection for vehicles with positive switched courtesy light.
Figure 4d. Connection for positive switched courtesy light with ignition override.

	Min	Typ	Max	Units
Operating Voltage	10	12	15	V
Quiescent Current @12V		3		mA
Maximum Switching Current			5	A

Table 1. Specification of prototype.

COURTESY LIGHT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1,3	4k7	2	(M4K7)
R2	560k	1	(M560K)

CAPACITORS

C1	47µF 16V Minelect	1	(YY37S)

SEMICONDUCTORS

TR1	TIP122	1	(WQ73Q)
TR2	MPSA14	1	(QH60Q)
D1,2	1N4148	2	(QL80B)

MISCELLANEOUS

P1,2,3	Pins 2145	1 Pkt	(FL24B)
	PC Board	1	(GE81C)
	Min Box and Base	1	(JX56L)
	Courtesy Light Leaflet	1	(XK96E)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

Hook up wire 16/0.2 Black	1	(FA26D)
Hook up wire 16/0.2 Red	1	(FA33L)

The above items, excluding Optional, are available as a kit:
Order As LP66W (Courtesy Light Extr) Price £2.75
The following items are also available separately but are not shown in our 1991 catalogue:
Courtesy Light PCB **(GE81C) Price 65p**
Min Box and Base **(JX56L) Price 65p**

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NEW BOOKS

Assembly Language Subroutines for the 8086

Routines to Run on the 8086/ 186/286/386

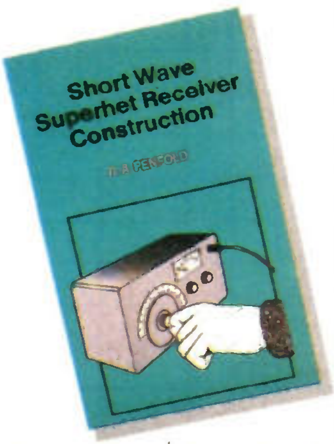
by Lance Leventhal and Sally Cordes

This book is intended as both a source and reference for the 8086/8088 assembly language programmer. It contains a collection of useful subroutines described in a standard format and accompanied by extensive documentation. The format and function of these routines are common to those other collections in other books by the same author, the variation in each book being specific to a particular microprocessor, an earlier example being *Assembly Language Subroutines for the 6502*. These routines, identical in function, are therefore transportable between different processors by using the appropriate translation to perform the same function. All the subroutines employ standardised parameter passing techniques and follow the rules for the most popular assembler. The documentation specifies the procedure, parameters, results, execution time, memory usage and each showing at least one example of execution which provides known test data. The routines from this book will also run on related microprocessors such as the 80188, 80186, 80286, 80376, 80386, and 80486, which are also popular processors for many PCs.

The nature of the library emphasises common tasks that occur in many applications. These tasks include code conversion (e.g. integer/ASCII hex, integer/ASCII decimal, packed BCD); array manipulation, 16-bit and BCD arithmetic, bit manipulation, shifting functions, string handling, data structure management, sorting and searching. There are also examples of I/O, interrupt service and initialisation routines for common family chips such as parallel interfaces and timers. You should be able to use these in actual applications and such a library makes for the possibility of producing some complex and sophisticated complete programs written in assembly language.

1989. 235 x 170mm. 410 pages, illustrated.

Order As WT35Q (8086 Assmbly Subs) Price £19.95 NV



Short Wave Superhet Receiver Construction

by R.A. Penfold

Although short wave radio seems to be regarded by many as an expensive hobby, with a little bit of DIY it is possible to build some usable equipment which is relatively inexpensive. The basic short wave receiver described in this book is a superhet with separate mixer and oscillator stages, a ceramic filter for good selectivity and a simple audio amplifier which drive headphones. An optional BFO permits reception of CW and SSB, the main operating modes used for the amateur short wave bands. The receiver also include AGC.

The remainder of the book describes a number of 'add on' enhancements. These consist of: input filter to improve image rejection; RF amplifier to boost sensitivity and image rejection; product detector for improved CW and SSB reception; higher powered audio output amplifier for loudspeaker; signal strength ('S') meter; audio CW filter; stabilised mains power supply. The fully expanded receiver provides excellent results from the broadcast and amateur bands, but remains relatively inexpensive to build.

1991. 178 x 111mm. 80 pages, illustrated.

Order As WT43W (SW Receiver Constrn) Price £2.95 NV

Timer Generator Circuits Manual

by R.M. Marston

To complement the other 'circuits manuals' by the same author in Maplin's catalogue, the 'Timer/ Generator Circuits Manual' is mainly concerned with waveform generator techniques and circuits. Waveform generators are used somewhere or other in most types of electronic equipment, and thus form one of the most widely used classes of circuit. They may be designed to produce outputs with sine, square, triangular, ramp, pulse, staircase, or a variety of other forms. The generators may produce modulated or unmodulated outputs, and the outputs may be of single or multiple form.

Waveform generator circuits may be built with transistors, op-amps, standard digital ICs, or dedicated waveform or 'function' generator ICs. One of the most popular ways of generating square and pulse waveforms is with a so called 'timer' IC of the widely available and versatile '555' type, and many circuits of this type are included in this volume, hence the title.

The book is divided into 11 chapters presenting over 300 practical circuits, diagrams and tables. These comprise basic principles; sine wave generators; pulse generators; 'timer IC' generator circuits; triangular and sawtooth generators; multiple waveform generation; waveform synthesiser ICs; special waveform generators; phase-locked loop circuits; and miscellaneous '555' circuits.

1990. 215 x 138mm. 278 pages, illustrated.

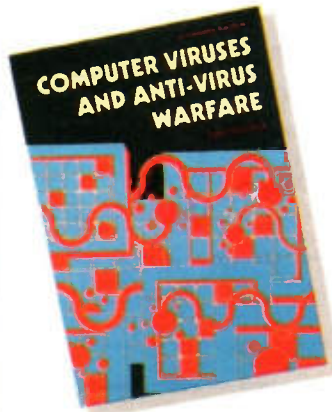
Order As WT44X (Timer Generator Circuits) Price £12.95 NV

Computer Viruses and Anti-Virus Warfare

by Jan Hruska

When the possibility of computer viruses was first mentioned in 1984, nobody took it seriously. It did not take long however before the first, wide-scale computer virus infection swept the United States in 1986. This was the 'brain' virus and caused a media sensation but not, misguidedly, a public outrage. Instead the ordinary non-computer-using man in the street was genuinely fascinated by the novel concept of a computer virus, little comprehending its full dangerous potential. To some people it was even unclear whether computer viruses were accidental occurrences or whether they were deliberate.

One or two reputable computer experts went as far as publicly



declaring that the existence of a computer virus was completely impossible, and even if it were possible, it could not last for long.

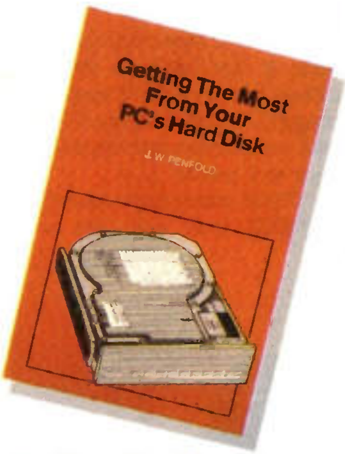
Little did they know! To date *thousands* of businesses have suffered from virus contamination. Nowadays, unlike the 'older' viruses (1986/87 vintage) which did little more than display a silly message or bouncing ball on the screen, new 'strains' are highly destructive, designed to re-format hard disks, destroy and corrupt data and programs. As viral infections become more and more widespread, the danger of damage to data is increasing at an alarming pace. This is *not* the same as losing some files on your home micro. In this case 'data' means years of information and documentation; entire records, invoices, ledgers, basically all the 'paperwork' of a business. With this erased, the business is destroyed.

The virus danger is here to stay. In the U.S., the Far East and Africa it has already reached epidemic proportions, and it is only a matter of time before it becomes more common in the rest of the world. In just the three months of Spring 1989, the number of separately identifiable viruses increased from seven to *seventeen*.

You must read this fascinating book, especially if you own a PC – some examples of the IBM DOS oriented viruses are horrifyingly simple to create and complete in their destructiveness. Read all about 'Trojan horses', 'logic bombs' and 'worms', to begin at the beginning.

1990. 241 x 167mm. 130 pages, illustrated.

Order As WT39N (Computer Viruses) Price £17.95 NV



Getting the Most from your PC's Hard Disk

by J.W. Penfold

A hard disk is fast becoming an essential part of any computer which is to be used for serious purposes. It gives you the convenience of having all your applications and data files ready to hand as soon as you switch on, and gives fast loading of programs and files alike.

For those thinking of adding a hard disk, this book gives the basic information on how a disk is fitted, and how to format it for use. The information on interleave factors and installing DOS may also be useful to those who already have a hard disk.

For those with hard disks, this book gives advice on arranging files into subdirectories so that they are easy to find, and also on making your applications easy to use. Information and advice on backup and security procedures is also included, plus a section with technical details of hard disk operations under DOS.

A hard disk is not simply a large and fast version of a floppy disk. It needs a wholly different approach to gain the most benefit from it. This book will show you how.

1990. 198 x 130mm. 90 pages, illustrated.

Order As WT41U (Get Most fr PC HDisk) Price £3.95 NV

Assembly Language Subroutines for the 68000

Routines to Run on the 68000/010/020/030

by Lance Leventhal and Fred Cordes

This book is intended as both a source and reference for the 68000 assembly language programmer. It contains a collection of useful subroutines described in a standard format and accompanied by extensive documentation. The format and function of these routines are common to those others by the same author, each being specific to a particular microprocessor. These routines, identical in function, are therefore transportable between different processors by using the appropriate translation to perform the same function. All the subroutines employ standardised parameter passing techniques and follow the rules for Motorola's resident structured assembler. The documentation covers the procedure, parameters, results, execution time, memory usage and each showing at least one example of execution which provides known test data. The routines will also run on related microprocessors such as the 68008, 68010, 68020 and 68030.

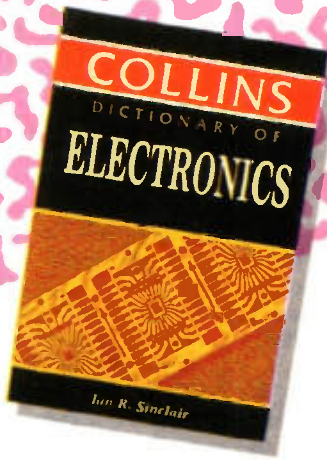
The nature of the library emphasises common tasks that occur in many applications. These tasks include code conversion (integer/hex, decimal, BCD); array manipulation, 16-bit and

BCD arithmetic, bit manipulation, shifting functions, string handling, data structure management, sorting and searching. There are also examples of I/O, interrupt service and initialisation routines for common family chips such as parallel interfaces and timers. You should be able to use these in actual applications and such a library makes for the possibility of producing some complex and sophisticated complete programs written in assembly language.

This book should save the reader both time and effort by not having to write, debug, test or optimise standard routines, or search through textbooks trying to find examples which, coming from different sources, need to be standardised somehow. Instead the reader should be able to obtain the specific information, technique or routine easily.

1989. 235 x 170mm. 416 pages, illustrated.

Order As WT33L (68000 Assmbly Subs) Price £19.95 NV



Collins' Dictionary of Electronics

by Ian R. Sinclair

The science and technology of electronics have an increasingly important role to play in all our lives. This dictionary is designed for all who need a guide to the subject, including advanced school students and those embarking on further education courses, as well as technicians and hobbyists. Contains over 2,000 entries, from *aberration* to *zero error*. Includes over 1,000 diagrams, with lists of symbols used in electronics; microprocessor technology, digital electronics, telecommunications, hi-fi, radio and television, plus coverage of the concepts of devices and of the theoretical background of the subject.

The form of the dictionary has been set out so as to make it easier to find an explanation of a device or principle under one heading rather than requiring the user to flit from one heading to another, picking up 'pollen fragments' of information from each. In addition cross references guide the reader to other related entries.

1988. 202 x 130mm. 378 pages, illustrated.

Order As WT38R (Dictionary of Elec) Price £4.99 NV

Satellite Television Installation Guide

Second Edition

by John Breeds

Satellite television is currently the most exciting development throughout the domestic television industry. By 1996 analysts expect some ten million homes in the United Kingdom to have their own satellite TV system. The explosive growth rate demands new skills, creating more jobs for installers, technicians, retailers and rental organisations.

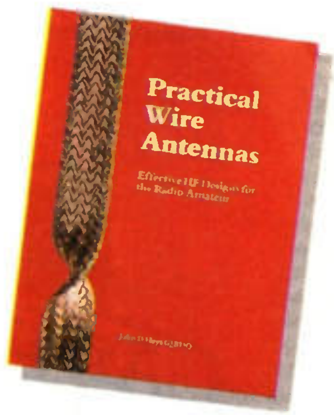
The purpose of this booklet is to help newcomers to correctly align both azimuth/elevation and polar mount dish types. If a polar mount assembly is accurately set up then the dish will be able to automatically track the satellites available now, and those launched in the future.

The usual knowledge and skills normally associated with installing terrestrial UHF aerials are assumed. The booklet provides detailed guidelines on how to install a dish and receive satellite pictures. There are no mathematical explanations or complex formulæ involved.

The notes and procedures given are based on practical experience. They provide readers with hints and tips, tricks of the trade and other quick but accurate methods of aligning a dish. The challenge of the changing technology must be continually met by all of the support services, and this guide is designed to help installation technicians achieve this, and so is equally useful to the competent home DIY enthusiast.

1990. 297 x 210mm, landscape. 60 pages, illustrated.

Order As WT45Y (Sat TV Instal Guide) Price £11.95 NV



Practical Wire Antennas

Effective H.F. Designs for the Radio Amateur

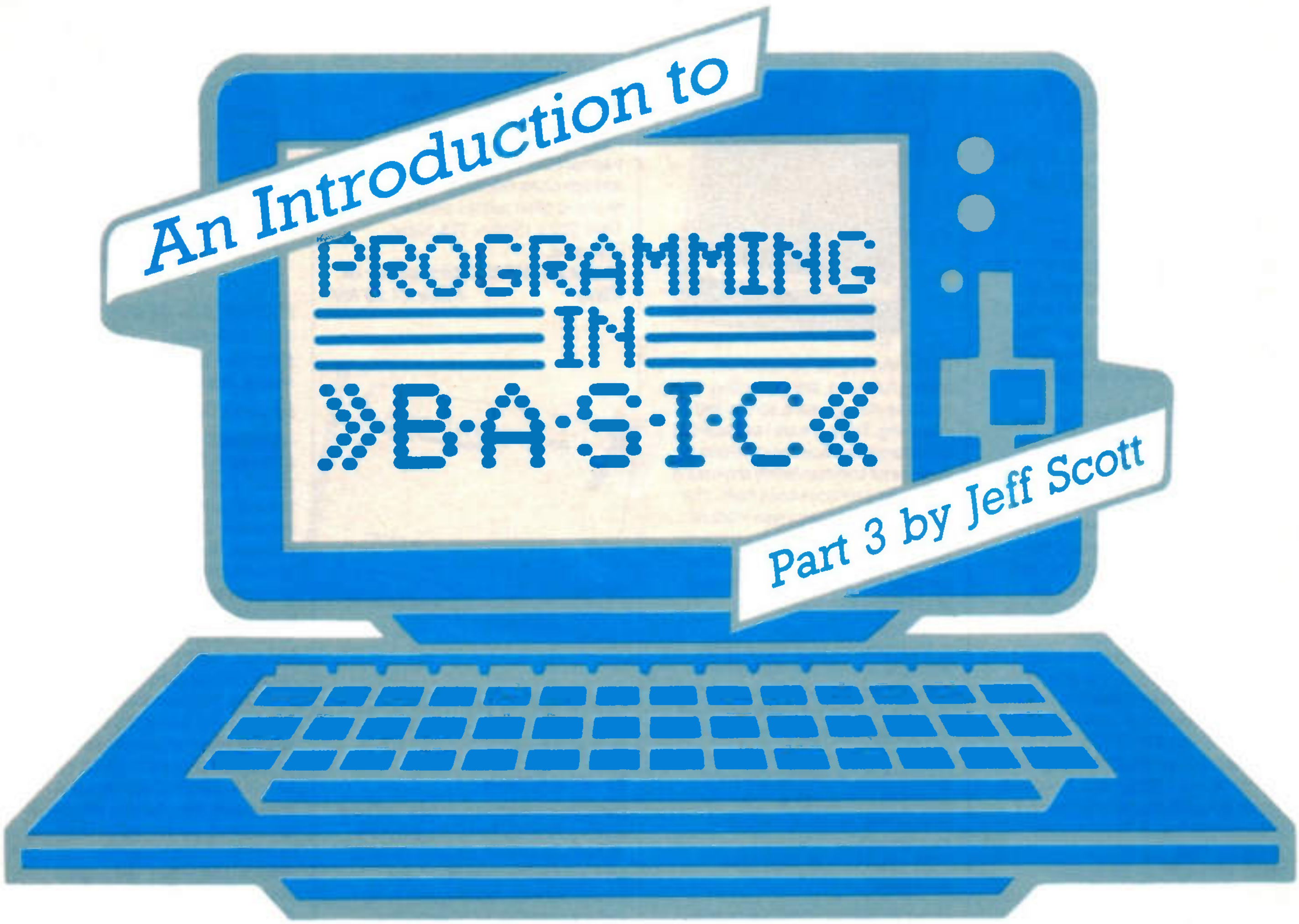
by John D. Heys G3BDQ

Wire antennas offer one of the most cost-effective ways of putting out a good signal on the HF bands, and this practical guide to their construction has something to interest every amateur on a budget. Many different types are covered, ranging from simple dipoles to ingenious multi-wire systems, even underground antennas! Full details about feeding and matching are included, making each antenna easy to set up and use successfully.

Theory has been kept to a minimum – instead, the author has shared his years of experience in this field, offering down-to-earth advice that will be appreciated by beginners and enthusiasts alike. No-one who builds and uses wire antennas can afford to be without this handy guide.

1990. 244 x 184mm. 100 pages, illustrated.

Order AS WT37S (Prctcl Wire Antennas) Price £7.95 NV



In this final part we shall look at a few of the ways in which a computer can be used to solve problems. In an earlier part of this series it was mentioned that problems may be thought of as being of two types. One type, the 'repetitious', is as an example purely a number crunching program, where the required processes are known and it is only necessary to carry these out equally with a batch of data records, as with employee payrolls.

The other kind, the 'iterative' type, is possibly more exciting, where one answer to a problem, or set of answers, is required, but there are several possible permutations for the input variables. Changing any one of them has a direct affect on the results. The ability of the computer to carry out just such an analysis has revolutionised design techniques for electrical, electronic and mechanical engineering, aerodynamic studies, chemical processes etc. It isn't that the computer can do what the engineer can't – it still has to be provided with all the formulae first, with which the problem can be worked out manually anyway – but that the computer can do it hundreds or thousands of times faster, and *keep on doing it with new input information modified according to the previous results, until the target criteria are reached*. In other words, you know what you want, and the computer will help you find out what you have to have to get it. This is called 'Computer Aided Design' (CAD), and one area of this which would be of great interest to electronics enthusiasts, and readers of this magazine, would be CAD for the design of real working electronic amplifiers, filters, transmission lines, tuned circuits; the plotting of frequency response graphs from reactance, signal gain and loss in decibel ratios, etc.

As one example of the iterative process let us attempt to calculate the annual mortgage repayment for £10,000 borrowed over ten years at an interest rate of 10%. If the principal £10,000 is divided into ten equal payments of £1,000, amount 'A' in Figure 1, then there will be a deficit at the end of the ten year period since the interest has not been taken into account.

If, on the other hand, 10% interest on the principal is added to each of the £1,000 slices, too much will have been paid since the principal decreases over the years and, therefore, less interest should be paid. This higher amount is 'B' (£2,000 in Figure 1).

The program is shown in Figure 2, and the amount appears as 'A' in line 70 and also 'B' in line 80. Somewhere in between these two extremes lies the true answer. This answer is found by halving the difference between 'A' and 'B' (line 90), and going into a subroutine at line 150.

The subroutine at line 300 uses the new value of repayment to see whether at the end of ten years too little or too much has been paid. If too little has been paid then the figure is increased, but decreased if too much has been paid.

The residue is required to be correct within ±2 pence and the test statements within the 'WHILE / WEND' loop (lines 160 – 240) check this (diagnostic displays of progress while at the testing stage, remember?).

The results in Figure 3 show that at the first pass of the data, the outstanding amount is £2031.288 and at the second pass, too much has been paid (−£1953.069).

In the columns for new maximum and new minimum it can be seen that the figures oscillate between 1500 and 2000 before settling at £1627.45 at the end. Also, at the end, the outstanding amount is 0.019 which is close to 2 pence.

The 'IF / THEN' statements within the 'WHILE / WEND' loop shift the new

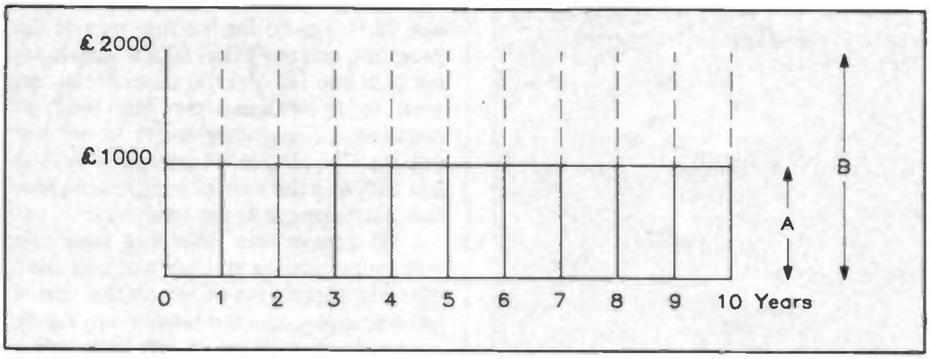


Figure 1. Mortgage repayment.

```
10 REM TO CALCULATE ANNUAL REPAYMENT FOR GIVEN MORTGAGE
20 REM P=PRINCIPAL, S=AMOUNT OUTSTANDING, I=INTEREST
30 REM N=NUMBER OF YEARS, X=ANNUAL PAYMENTS
40 P = 10000
50 I = (I/10)
60 N = 10
70 A = P/10
80 B = (P/10)+P*I
90 X = (A+B)/2
100 OPEN "O", #1, "MORT"
110 PRINT "OUTSTANDING"; "ANNUAL"; "NEW"; "NEW"
120 PRINT "AMOUNT"; "REPAYMENT"; "MINIMUM"; "MAXIMUM"
130 PRINT #1, "OUTSTANDING"; "ANNUAL"; "NEW"; "NEW"
140 PRINT #1, "AMOUNT"; "REPAYMENT"; "MINIMUM"; "MAXIMUM"
150 GOSUB 300
160 WHILE S>.02 OR S<-.02
170 IF S>0 THEN A = X : X = (X+B)/2
190 IF S<0 THEN B = X : X = (X+A)/2
210 PRINT S, X, A, B
220 PRINT #1, S, X, A, B
230 GOSUB 300
240 WEND
250 IF S<.02 OR S>-.02 THEN PRINT S, X, A, B
260 IF S<.02 OR S>-.02 THEN PRINT #1, S, X, A, B
270 CLOSE 1
280 REM PROG1.BAS
290 END
300 REM SUBROUTINE FOR NEXT BEST VALUE OF ANNUAL PAYMENT X
310 S = P
320 FOR J = 1 TO N
330 S = (S+S*I)-X
340 REM OUTSTANDING AMOUNT=PRINCIPAL + INTEREST -PAYMENT
350 NEXT J
360 RETURN
```

Figure 2. Mortgage program.

OUTSTANDING AMOUNT	ANNUAL REPAYMENT	NEW MINUMUM	NEW MAXIMUM
2031.288	1750	1500	2000
-1953.069	1625	1500	1750
39.10962	1687.5	1625	1750
-956.9794	1656.25	1625	1687.5
-458.9347	1640.625	1625	1656.25
-209.9125	1632.813	1625	1640.625
-85.40149	1628.906	1625	1632.813
-23.14661	1626.953	1625	1628.906
7.982056	1627.93	1626.953	1628.906
-7.581909	1627.441	1627.953	1627.93
.2011719	1627.686	1627.441	1627.93
-3.688599	1627.564	1627.441	1627.686
-1.746582	1627.503	1627.441	1627.564
-.7705078	1627.472	1627.441	1627.503
-.2843018	1627.457	1627.441	1627.472
-.0435791	1627.449	1627.441	1627.457
.0759277	1627.453	1627.449	1627.457
.019165	1627.45	1627.45	1627.46

Figure 3. Mortgage repayment results.

maxima and minima closer together and divide the difference in half so that an oscillatory effect is created as illustrated in Figure 4, as the answer converges rapidly towards the true value.

If one were to do this on paper the formula is:

Annual payment = $P / [1-(1+T)^{-n}]$

where P = principal, T = interest.

Annual payment

= $10,000 \times 0.1 / (1-(1+0.1^{-n}))$

= $1,000 / (1 - (1.1)^{-n})$

= 1,000 / 1 − 0.385

= 1,000 / 0.6144

= 1,627.45

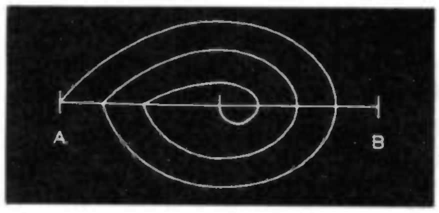


Figure 4. Convergence of results.

Straightforward Number Crunching

Since pensions have been in the news recently let us examine a hypothetical case of an electronics engineer who was earning £3,500 at age 26. His task is to see how soon after retiring he could recover his contributions in pension payments, ignoring the part that his employer was contributing.

Although this is a hypothetical case and is not meant to be financial advice for anyone, the person who researched it convinced himself that the case was real enough for himself.

In the program of Figure 5, there are three unknowns:

1. 'K', the rate of interest that his pension fund would earn. Although the fund had earned about 25% per annum over the past three years, he decided that the best return he could get if he invested the money himself was 10%, so 'K' was set to 1.1 in line 90.
2. 'L' is the increase in salary in future years. Based on the previous five years, his salary increase had averaged 6%, and so 'L' is set to 1.06 in line 90.
3. 'M', the rate at which his pension was likely to increase on retiring. Over the previous five years this had averaged 4%, and 'M' was set to 1.04 in line 100.

The initial salary of £3,500 is set in line 110, and, going back to one of our first golden rules about writing BASIC, there are plenty of explanatory 'REM' statements. The program is in two parts – the first part, up to line 230, calculates the money accumulating in the pension fund. The rest of the program calculates the *pay-outs* from the fund after retirement, remembering that the fund still continues to earn interest.

```
10 REM 6% CONTRIBUTION VERSUS PENSION RETURNS
20 OPEN "O", #1, "MON"
30 REM TO CALCULATE PENSION ACCUMULATION
40 REM A = ACCUMULATING SUPERANNUATION, K = INTEREST ON
PENSION FUND
50 REM L = SALARY INCREASE, M = PENSION INCREASE ON RETIRING
60 REM X = INITIAL SALARY, Y = SUPERANNUATION
70 A = 0
80 K = 1.1
90 L = 1.06
100 M = 1.04
110 LET X = 3500
120 PRINT "SALARY"; "PENSION FUND"
130 PRINT #1, "SALARY"; "PENSION FUND"
140 FOR I = 1 TO 34
150 Y = X*.06 : REM SUPERANNUATION
160 Y = Y+A : REM SUPERANNUATION ACCUMULATION
170 A = Y*K
180 X = X*L : REM SALARY INCREASE
190 PRINT X, A
200 PRINT #1, X, A
210 NEXT I
220 PRINT : PRINT
230 PRINT #1, "" : PRINT #1, ""
240 REM TO CALCULATE PENSION PAYOUTS
250 C = (3/80)*X*34 : REM LUMP SUM PAYMENT
260 D = A-C
270 E = (1/80)*X*34 : REM PENSION PAYMENT
280 F=D-E
290 PRINT "PENSION FUND", "PENSION INCREASE"
300 PRINT #1, "PENSION FUND", "PENSION INCREASE"
310 FOR I = 1 TO 20
320 G = F*K                    : REM INTEREST ON PENSION FUND
330 H = E*M                    : REM PENSION INCREASE
340 J = G-H
350 LET F = J
360 LET E = H
370 PRINT G, H
380 PRINT #1, G, H
390 NEXT I
400 CLOSE 1
410 REM PROGRAM NAME PENS.BAS
420 END
```

Figure 5. Pension program.

SALARY	PENSION FUND	PENSION FUND	PENSION INCREASE
3710	231	68771.53	11217.31
3932.6	498.96	63309.64	11666.01
4168.555	808.4076	56808	12132.65
4418.668	1164.373	49142.89	12617.95
4683.788	1572.443	40177.43	13122.67
4964.815	2038.817	29760.24	13647.58
5262.703	2570.376	17723.93	14193.48
5578.465	3174.753	3883.498	14761.22
5913.173	3860.407	-11965.49	15351.66
6267.963	4636.717	-30048.87	15965.73
6644.04	5514.074	-50616.07	16604.36
7042.682	6503.989	-73942.47	17268.53
7465.242	7619.205	-100332.1	17959.27
7913.157	8873.832	-130120.5	18677.65
8387.946	10283.48	-163678	19424.75
8891.222	11865.44	-201413	20201.74
9424.694	13638.8	-243776.2	21009.81
9990.176	15624.71	-291264.6	21850.2
10589.59	17846.53	-344426.3	22724.2
11224.96	20330.1	-403865.6	23633.17
11898.46	23103.96		
12612.37	26199.65		
13369.11	29652.04		
14171.25	33499.6		
15021.53	37784.86		
15922.82	42554.78		
16878.19	47861.16		
17890.88	53761.24		
18964.33	60318.16		
20102.18	67601.62		
21308.31	75688.53		
22586.81	84663.72		
23942.02	94620.84		
25378.54	105663.1		

Figure 6. Pension program results.

The period of work is 34 years from age 26 to age 60 for the first part of the program, and the 'FOR / NEXT' loop is set for 34 at line 140. For the second part, we want to know when the fund will go negative, i.e. pay-outs begin to exceed pay-ins. The loop is set arbitrarily to 20 at line 310, and the results in Figure 6 show that this happens in the ninth year.

Of course this does not take into consideration the employer's contribution which is, in most instances, double that of the employee, and the results may never eventually go negative, or only after such a long period that would exceed most people's life expectancy.

In Figure 5 there are two lots of 'PRINT' statements at line 190 and 200. The first is to print to the VDU, and the second to print to a disk file. The program illustrates carefully considered features like creating and clearing the accumulator at line 70, printing blank lines at 220 and 230 to format output, replacing an old value with a new value at lines 160, 350 and 360. Note that using 'K', 'L' and 'M' for the constants means that the actual values of these need only be altered at lines 80 – 100 if necessary, otherwise the whole program will have to be searched for these values to change if the actual *numbers* are used in the calculations. Just because a value is a constant, it doesn't mean it cannot be assigned to a variable. This method makes a program readily co-operative where future changes or updates are wanted, although in this actual case it might be better if a provision was made for these values to be input from the keyboard. In that way the program can be easily re-run using different values of 'K', 'L' and 'M'.

The formula at line 250 is the lump sum payment at retirement, and the formula at line 270, the pension payment. Thereafter, pension 'E', increasing at rate 'M' (1.04), is deducted from the pension fund 'F', which itself increases at rate 'K' (1.1).

Consider how tedious the manual method is. The person who wrote the above program first attempted a manual method, but gave up after calculating a few lines with a pocket calculator.

Figure 7 shows how the pension fund is calculated, and that is only the first part. The second part then shows the pension pay-outs. After all this trouble, the method is inflexible and if different parameters are required, the pocket calculator has to come out again.

Computer Aided Design

The beauty of the program method over the manual method of calculation is not only the speed at which the calculation can be completed, but also the fact that the program can be re-run as many times as desired with different values of the unknown quantities 'K', 'L' and 'M'. It is programs like this which enable the future results of current actions to be forecast, and forecasting is a form of computer modelling. The program previously described is a computer model, and as such it indicates what magnitude of investment in the pension scheme is required for a given pay-out amount. The process can be done manually, but is usually too time consuming, complicated and prone to human error. Businesses would have valued the ability to forecast sales for example even before computers became available, but time is money and so it was just not worth it. But the time invested in writing a computer program which can do this whenever required, at any time, and for anyone who needs the information is definitely well worth it.

A combination of number crunching and the iterative method of calculation is used in something like telephone network modelling for example. Space does not allow us to go into any great detail along these lines, as there is enough on the subject of CAD to fill several books. But a tantalising glimpse of the sort of CAD which is useful for electronics follows, a short program which, starting with some essential criteria such as device H_{FE}, supply V_{CC}, input and output impedances and required gain, actually 'builds' a bipolar junction transistor amplifier model following a standard circuit configuration. This configuration comprises a single BJT used in common emitter mode, with a collector load (RC), a series emitter resistor(RE2), AC bypass of this resistor using a bypass capacitor with a resistor in series to set the gain (RE1), and base bias from a potential divider. The program then designs the amplifier and supplies component values for building a real circuit – selecting from the standard range of E24 resistor values, naturally. If it produces silly values for the base bias resistors (R1 and R2 much too low), it means that the current gain of the device is not great enough. However it makes sensible assumptions, for example that the DC collector voltage should be half that of V_{CC} to attain the maximum peak to peak output amplitude from the given supply before clipping. Input impedance is calculated using the base/emitter resistance as a starting point, then R1 and R2 are juggled to make up the remainder, which is why too low an H_{FE} will cause the program to fail.

Letter Permutations

Sometimes competitions aimed at consumers require one to place the attributes of a product in order of merit. Somebody or something has to sort out the answers in order to arrive at a list of winners. If there were four attributes, the number of different permutations is 4 x 3 x 2 x 1 = 24. This may not be too difficult to work out manually in order to cover all possibilities, but if the attributes increase to say 6, it may be a bit mind boggling to work out 6 x 5 x 4 x 3 x 2 x 1 = 720 permutations.

This is not going to bother the

Part 1

Age	Salary	Superannuation 6%	Superannuation accumulation	Interest on fund
26				
27				
28				
⋮				
59				
60				

Part 2

Age	Pension	Residual pension fund	Interest on pension fund
61			
62			
63			
⋮			
79			
80			

Figure 7. Example of beginning manual method of calculations carried out by the pension program.

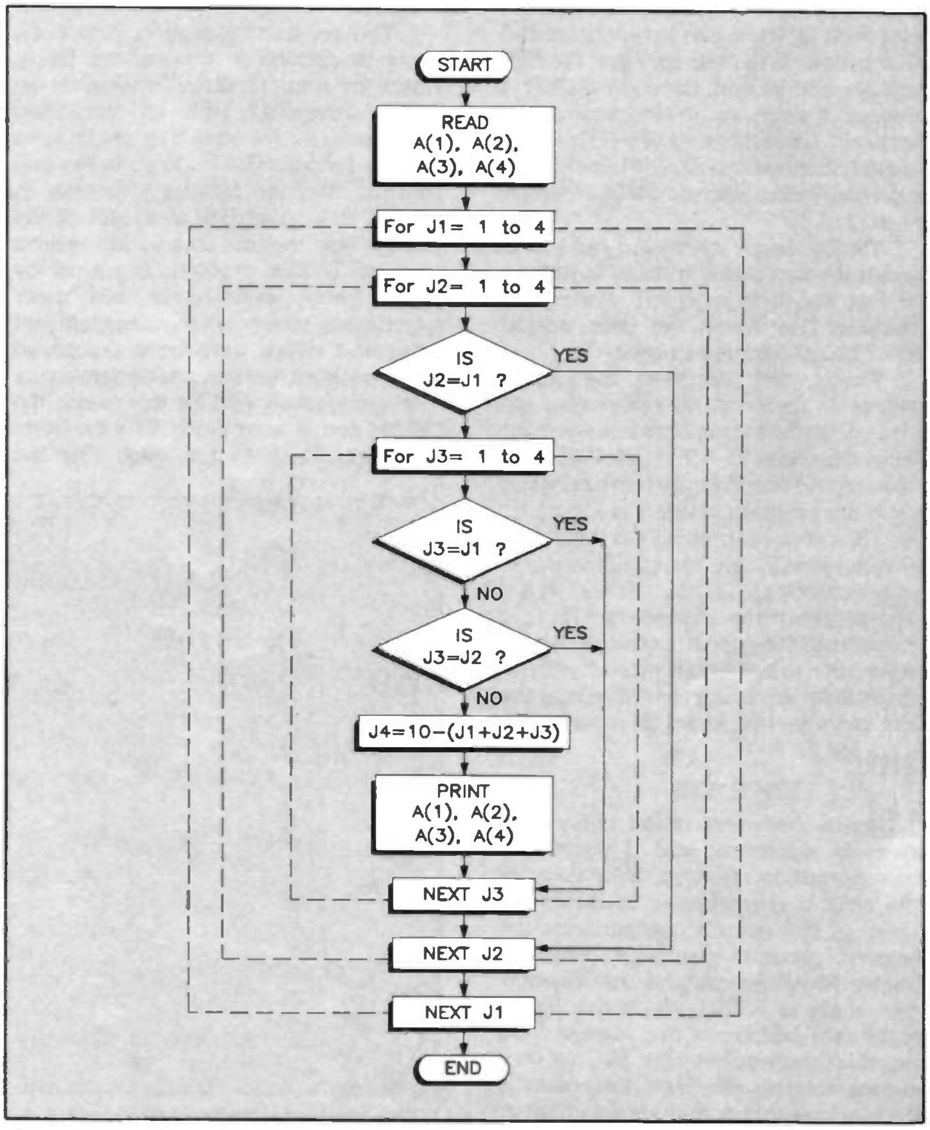


Figure 8. Flow chart of the permutation problem.

```
10 REM PERMUTATIONS OF 4 DIGITS
20 PRINT "TYPE ANY 4 DIGITS"
30 INPUT A(1), A(2), A(3), A(4)
40 FOR J1 = 1 TO 4
50 FOR J2 = 1 TO 4
60 IF J2 = J1 THEN 130
70 FOR J3 = 1 TO 4
80 IF J3 = J1 THEN 120
90 IF J3 = J2 THEN 120
100 LET J4 = 10 -(J1+J2+J3)
110 PRINT A(J1); A(J2); A(J3); A(J4)
120 NEXT J3
130 NEXT J2
140 NEXT J1
150 END
```

Figure 9. Program for permutations of four digits.

computer at all and in fact it is well suited to such a task – which incidentally also applies to such things as word unscrambling, a process which determines whether the same letters will form a new word, or smaller words exist within the permutations.

Suppose four digits are required to be placed in a list described by a subscript 'A(1)', 'A(2)', etc. by means of 'INPUT' from the keyboard. We then need to let each digit take the first position and interchange all the others. After the first digit has had its turn, the second digit is assigned a value and tested against the first to see if it is different. If it is the same then the permutation will only be repeated so the step is abandoned and the next digit is selected.

The third digit is selected and tested against the first two. If it is different from the first two it is assigned all possible positions. This means that three nested 'FOR / NEXT' loops are required.

Finally, the value of the fourth element is deduced by subtracting the values of the first three from ten, since the sum of the values T1 + T2 + T3 + T4 = 10. A flow chart of the ideas is shown in Figure 8, and the program is listed in Figure 9.

The result of inputting the digits 1, 2, 3, 4 is shown in Figure 10a, which shows all the permutations. Figure 10b shows the permutations where the letters A, P, R, T are entered. The program must, of course, be modified in line 30 to replace A with A$ when letters are being read. Similarly the print statement in line 110 requires A$ instead of A.

A Sort Program

There are many useful utility programs in existence, and if something sophisticated is required, then there is little point in struggling to 're-invent the wheel'. A few pounds can purchase the required program package. However, simpler programs can be put together quite easily in BASIC, and which by no means need be inferior, and some of them can do wonderful things for the few minutes work required in writing them. A sort program is one such useful utility.

A sort program rearranges items in a list into ascending or descending order, as required. It can be used to turn a table of contents into an index very quickly by assigning numerical weights to the characters, in other words in alphabetical order. This program is called a 'bubble sort', because the lowest values 'bubble' up through the list to the top, and the larger values 'sink' to the bottom. Or the other way round if a descending order is required.

The program, shown in Figure 11, basically comprises two nested loops, where 'I' is set to 1 and the first value in the list is compared with all the other elements in the list using 'J'. It can be seen that the lowest value ends up in the first element after the first pass through 'J'. Then 'I' is incremented to 2, and all the values are again compared against element 'I'. The problem is solved by 'brute force', since there are many superfluous steps, where elements are compared which have been compared already and are not going to change again. This wastes time, and for this reason the bubble sort is notoriously slow for large lists, but adequate for small lists not exceeding 100 elements or so (unless you are prepared to wait!).

1234	APRT
1243	APTR
1324	ARPT
1342	ARTP
1423	ATPR
1432	ATRP
2134	PART
2143	PATR
2314	PRAT
2341	PRTA
2413	PTAR
2431	PTRA
3124	RAPT
3142	RATP
3214	RPAT
3241	RPTA
3412	RTAP
3421	RTPA
4123	TAPR
4132	TARP
4213	TPAR
4231	TPRA
4312	TRAP
4321	TRPA

Figure 10a. Permutations of numbers 1, 2, 3, 4; 10b. Letters A, P, R, T.

In line 90 'TEMP' is used to temporarily store a copy of the array element in the process of swapping elements 'I' and 'J'. Some BASIC's may actually have a 'SWAP' statement which does just this, otherwise a temporary (value) variable is required.

'Run-Time' Errors and 'Bugs'

Your own BASIC manual will show a list with descriptions of all the interpreter's 'run-time errors', as they might be called. Common error messages that might appear as the direct result of mistakes made while writing any part of the program might be 'FOR without NEXT', 'WHILE without WEND', as it is still easy to forget to add the 'NEXT' or 'WEND' statements even if you are just starting to get the hang of them. 'Syntax error' usually means that the interpreter found a word or an expression it couldn't understand. This is probably BASIC's most aggravating error message, because it occurs so often. You will quickly find the BASIC interpreter an excellent spelling tutor, making you learn to key the letters correctly on the keyboard. But this is the most obvious cause of a syntax error – the interpreter simply couldn't match the misspelt word to any in its vocabulary of keywords and functions.

The most frustrating kind of syntax error is one where an expression is written in the wrong form, or a keyword is not followed by the correct statement required for proper operation. In this case, you can spend hours trying to work out what the problem is. Only when you have been writing and playing around with BASIC for a while will you really begin to see the back of the 'syntax error' – or at least it will become a rarity rather than the norm.

The other kind of syntax error is typically caused by such (elementary) mistakes as forgetting commas, quotes, spaces and even keywords in a statement or expression, or putting them in where they should not be. Beware using variable names which are also keywords; 'FN', 'CHR$' will both cause syntax errors because they are both BASIC statements. Also, some interpreters can get away with having no spaces at all in a BASIC text line, indeed, they may ignore spaces altogether. In such a case, the variable 'SINE' will cause a syntax error, because 'SIN' is a BASIC mathematical function and the interpreter will read this as 'SIN (space) E', which is wrong as it should be 'SIN(E)' (and the interpreter won't know that this is still not what you wanted). Also, a function of this sort should 'return' a value to another statement or variable, and will generate a syntax error if used on its own, e.g. you can say 'X = ASC("a")' or 'PRINT ASC("a")', but you cannot have just 'ASC("a")'.

```
10 REM BUBBLE SORT
20 DIM A$(100)
40 FOR I = 1 TO 100
50 A$(I) = STR$(RND * 10)
60 NEXT I
65 :
70 FOR I = 1 TO 100
80 PRINT I; CHR$(30) : FOR J = 1 TO 100
90 IF A$(I) < A$(J) THEN TEMP$=A$(I) : A$(I)=A$(J) : A$(J)=TEMP$
100 NEXT J, I
110 :
120 FOR I = 1 TO 100
130 PRINT A$(I);
140 NEXT I
150 REM SORT.BAS
160 END
```

Figure 11. Bubble sort program.

While we're on the subject of variables, be aware that many versions of BASIC often have what are called 'reserved variables'. These are the few permanent variables in memory, provided to contain some hardware related data and make this available to the BASIC programmer. You cannot erase these, and may only be able to re-assign some of them. Examples of these are 'STATUS' (Commodore BASIC relating to I/O), 'DATE$' (IBM PC), and 'TIME'. Trying to use these like ordinary programmer definable variables can cause any amount of problems if you are not aware of what's happening.

Too little data in a 'DATA' statement line will result in an 'out of data' error message, or on the other hand if there is too much (or the 'READ'ing loop isn't long enough), not all the items will be read and the last will be ignored and never used by the program. 'Type mismatch' errors occur where data is of the wrong type, e.g. assigning a string constant "MONDAY" to 'A' instead of 'A$'. If the 'INPUT' statement is operative this may result in 'redo from start' message.

These 'run-time errors' cause the interpreter to stop running the program and break out to the command level. In other words, such errors stop the program. But there can be problems which don't stop the program because they don't generate 'run-time' errors, but at the same time the program doesn't work properly. These are called 'bugs', and while the interpreter is reading syntactically correct statements and the program doesn't 'STOP', 'bugs' occur where the direction of program flow is not following the correct logic. This is down to programming, and tracking down and correcting these faults is called, logically enough, 'debugging'. But also be aware that 'bugs' of the logical fault variety can result in 'run-time errors'. Here are two examples.

'Out of memory'. 'RETURN' statement missing or not being executed at the end of a subroutine, it is 'GOing TO' back to the calling program or routine instead. After several calls to the offending subroutine, the processor stack becomes full up with return addresses, which is what, in this case, 'out of memory' means.

'Too many open files'. A file opened to an external device is not being closed afterward. Later the same file is reopened using different logical file numbers, and after several occurrences of this the file descriptor stack is full, meaning all of the (ten in this case) available channels are in use and none are free. In actual fact this would be unusual in BASIC since it is typical to use the same logical file number each time in the same part of the program, which for the same fault will generate 'file open error' the second time around. If however the file number were a loop count or similar variable, the described problem would be the culmination, and it is a programming fault.

Troubleshooting a program will be a whole lot easier if one inserts extra 'diagnostic' 'PRINT' statements which will show what is going on in various parts of the program or its subroutines, or at some crucial stage. When finally the program, or this particular block of code, is performing as required to your satisfaction, these statements can be removed. Also the 'STOP' statement can be used to halt the program and return control to the command level at some point. Here variable contents can be examined and/or altered in direct mode, and the program continued with 'CONT'. A program can also be stopped with 'CTRL C' or an equivalent.

For instance, in the compound interest program of Figure 12, if, in line 50, the expression 'A = P ∗ I' is written without the '+ P' on the end by mistake, where 'P' = principal, 'I' = interest and 'N' = number of years, then line 90 will wait for ever to be executed and print the answer. Even after a long wait there will be no error message. On large mainframe machines there may be a time-out message indicating that the program is taking too long to run. To find out what is delaying the answer it is necessary to establish that the program is going through all of its stages correctly. For the program in Figure 12 an extra (temporary) 'PRINT' statement is inserted as line 75:

75 PRINT P, N

which, upon running the program for even a short while, will show that the results are getting smaller instead of bigger towards the desired £1,000, as in Figure 13.

Sometimes a program that has been working well will fail when certain combinations of data are entered (using 'INPUT') by the user, causing results to go to zero, numbers to be divided by zero (an impossibility which generates 'divide by zero error' and a stopped program), negative results where there should be none, infinitely repeated loops, etc. Such combinations of data may not have been anticipated by the programmer, and so it is therefore up to him to ensure that the program can look after itself and reject data which is out of range (as mentioned in a previous part of this series).

Using extra diagnostic print statements may not be practical for debugging a very large program – in this event, it would have been better to write and debug the program in smaller stages, a piece at a time. You must have test data with known results to do the checking, and if the program is intended to process lists or arrays of information, it is usually better to start with small amounts of test data first rather than have the program attempt 1,000 items or so in the early stages of development. When eventually it performs as required with the test data, it can then start to be used for real to process unknown data.

Be aware that the program may need to be edited several times, with 'fine trimming' to get it exactly as desired (within the limitations of the language and the machine). This is normal, and not even qualified experienced programmers can get away with writing a program which is immediately perfect.

Infected

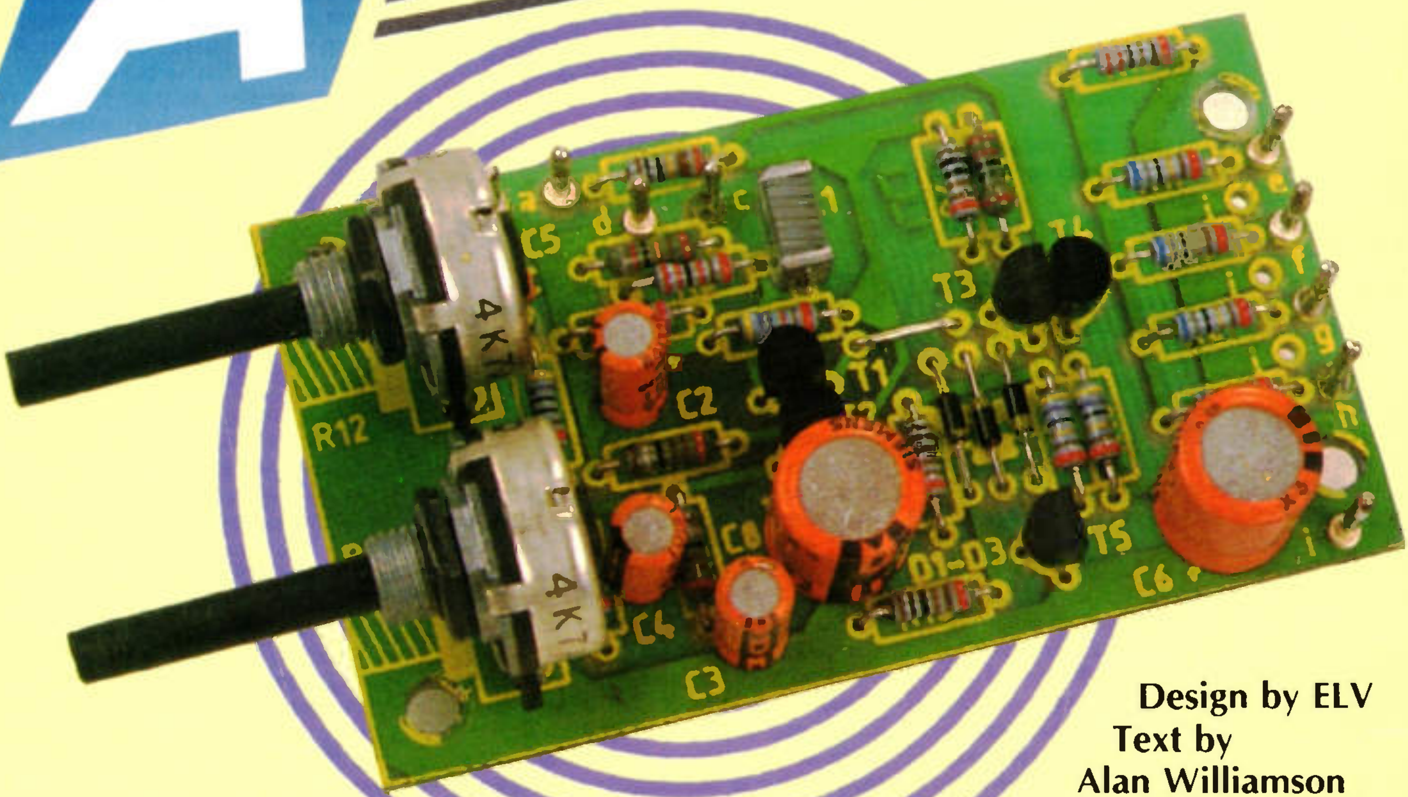
There is one other term which might be worth mentioning and which has also

```
10 REM NUMBER OF YEARS FOR P TO EXCEED 1000
20 LET N = 0
30 LET P = 100
40 LET I = 0.09
50 A = P*I+P
60 LET P = A
70 LET N = N+1
80 IF A>1000 THEN 90 ELSE 50
90 PRINT "NUMBER OF YEARS IS "; N
100 END
```

Figure 12. Compound interest program.

Continued on page 55.

VIDEO AMPLIFIER



Design by ELV
Text by
Alan Williamson

Introduction

One of the main criteria in judging the quality of a video recording is the resolution or definition, that is, picture clearness, which is directly related to the signal bandwidth that the video recorder can handle. During rerecording, some deterioration of picture quality occurs because the signal bandwidth is reduced to some degree. The amount to which the bandwidth is reduced depends on the recording system used and manifests itself primarily as a greater degree of attenuation at high-frequencies than at low-frequencies.

Further loss of quality may occur through a lowering of the overall signal level, particularly when two or more video recorders, or a video recorder and colour television monitor, are connected in parallel to the output of a master television receiver or recorder. It would be possible to simply increase the gain of the slave equipment. Unfortunately, frequency-selective amplification and good performance cannot be achieved by simple means. There is, for instance, the danger of overloading, which would result in a deterioration, rather than an enhancement, of the signal.

The video amplifier project presented here provides separate 'level' and 'HF boost' controls, and four independent outputs to enable the simultaneous feeding of up to four video recorders or monitors.

Please note that some of the circuit references used in this project differ to those normally used in other 'Electronics – The Maplin Magazine' projects and that this project is only available as a kit.

Specification of prototype

DC Voltage:	12V
DC Current:	17mA
Gain (maximum):	8dB (one output terminated into 75Ω)
	6dB (all outputs terminated into 75Ω)
Frequency:	30Hz - 10MHz
Input impedance:	75Ω (nominal)
Output impedance:	75Ω (nominal)
HF Boost:	2dB
Gain Boost:	2dB

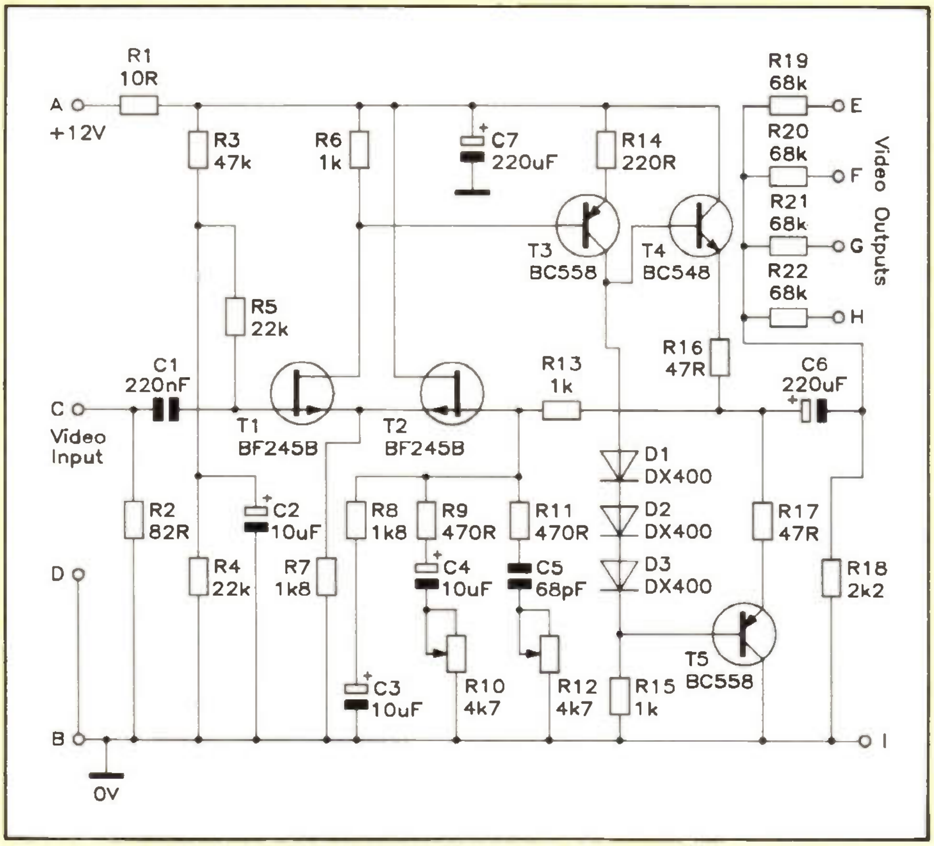


Figure 1. Circuit.

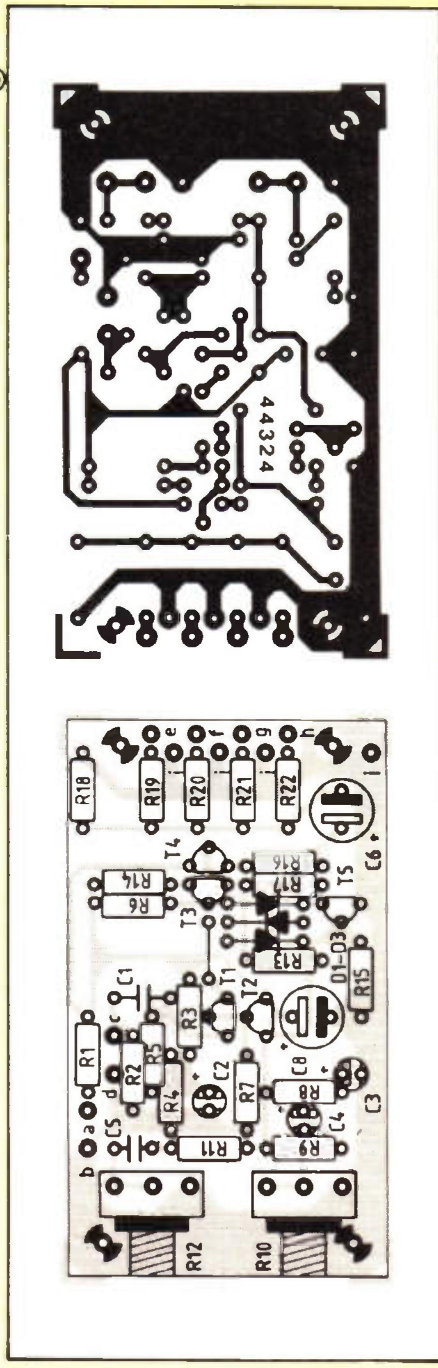
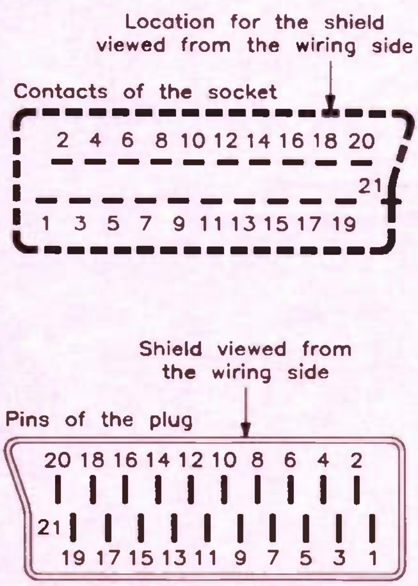


Figure 2. PCB legend & track.

Circuit Description

The circuit diagram of the video amplifier is shown in Figure 1. Power supply rails are decoupled by R1 and C7, thus reducing any noise or interference that is supply borne. Field-effect transistors T1 and T2 form a differential amplifier that offers high input impedance, minimal phase shift and excellent bandwidth. The video output of the master television receiver or recorder is applied to the gate of T1 via C1. The DC operating point of the differential amplifier is determined by resistors R3 and R5 which form a potential divider. C2 serves to provide decoupling. The output of T1 is amplified by T3 and by a push-pull amplifier based around T4 and T5, and then fed back to T2 via R13. The value of R8 ensures that the overall gain is not less than 6dB. The (negative) feed-back and the carefully designed printed circuit board ensures that stability, phase and gain characteristics are maintained. Setting of the quiescent current through the output stages is provided automatically by low-capacitance diodes



Contact Number	Signal Designation	Signal Matching Characteristics	
1	AUDIO OUTPUT B (Mono) (Stereo Right) (Independant B)	Impedance: Signal Level:	≤1kΩ 0·5V RMS (2V max)
2	AUDIO INPUT B (Mono) (Stereo Right) (Independant B)	Impedance: Signal Level	≥10kΩ 0·5V RMS (0·2V min, 2V max)
3	AUDIO OUTPUT A (Mono) (Stereo Left) (Independant A)	Impedance Signal Level:	≤1kΩ 0·5V RMS (2V max)
4	AUDIO GROUND		
5	BLUE VIDEO GROUND		
6	AUDIO INPUT A (Mono) (Stereo Left) (Independant A)	Impedance: Signal Level	≤10kΩ 0·5V RMS (0·2V min, 2V max)
7	BLUE VIDEO (Input or Output)	Impedance: Video Level Polarity	75Ω 0·7V ±3dB (black level to peak level) Positive DC component 0 to +2V
8	FUNCTION SWITCHING (Input or Output) (Slow Switching)	Logic 0: Logic 1: Input Resistance: Capacitance: Output Resistance:	0V to +2V (TV Mode) +9·5V to +12V (External Mode) ≥10kΩ ≤2nF ≤1kΩ
9	GREEN VIDEO GROUND		
10	COMMUNICATION DATA LINE 2	Undefined	
11	GREEN VIDEO (Input or Output)	Impedance: Video Level Polarity DC component	75Ω 0·7V ±3dB (black Level to peak level) Positive 0 to +2V
12	COMMUNICATION DATA LINE 1	Undefined	
13	RED VIDEO GROUND		
14	COMMUNICATION DATA GROUND		
15	RED VIDEO (Input or Output)	Impedance Video Level Polarity DC component	75Ω 0·7V ±3dB (black level to peak level) Positive 0 to +2V
16	BLANKING (Input or Output) (Fast Switching)	Logic 0: Logic 1: Impedance	0V to +0·4V +1V to +3V (Blanked & Ext RGB) 75Ω
17	VIDEO GROUND		
18	BLANKING GROUND		
19	VIDEO OUTPUT (Composite Video) OR SYNCHRONISATION OUTPUT	Impedance: Video Level Polarity DC component Impedance: Sync Level	75Ω 1V p-p ±3dB Positive 0 to +2V 75Ω 0·3V -3dB +10dB
20	VIDEO INPUT (Composite Video) OR SYNCHRONISATION INPUT	Impedance Video Level Polarity DC component: Impedance: Sync Level	75Ω 1V p-p ±3dB Positive 0 to +2V 75Ω 0·3V -3dB +10dB
[illegible]	COMMON GROUND (Shield)		

Source Selection Table

P8	P16	Source Selected
0	0	Normal 'off-air' signal
0	01	RGB Input
1	0	Composite Input
1	1	RGB Input

Figure 3. SCART connector wiring.

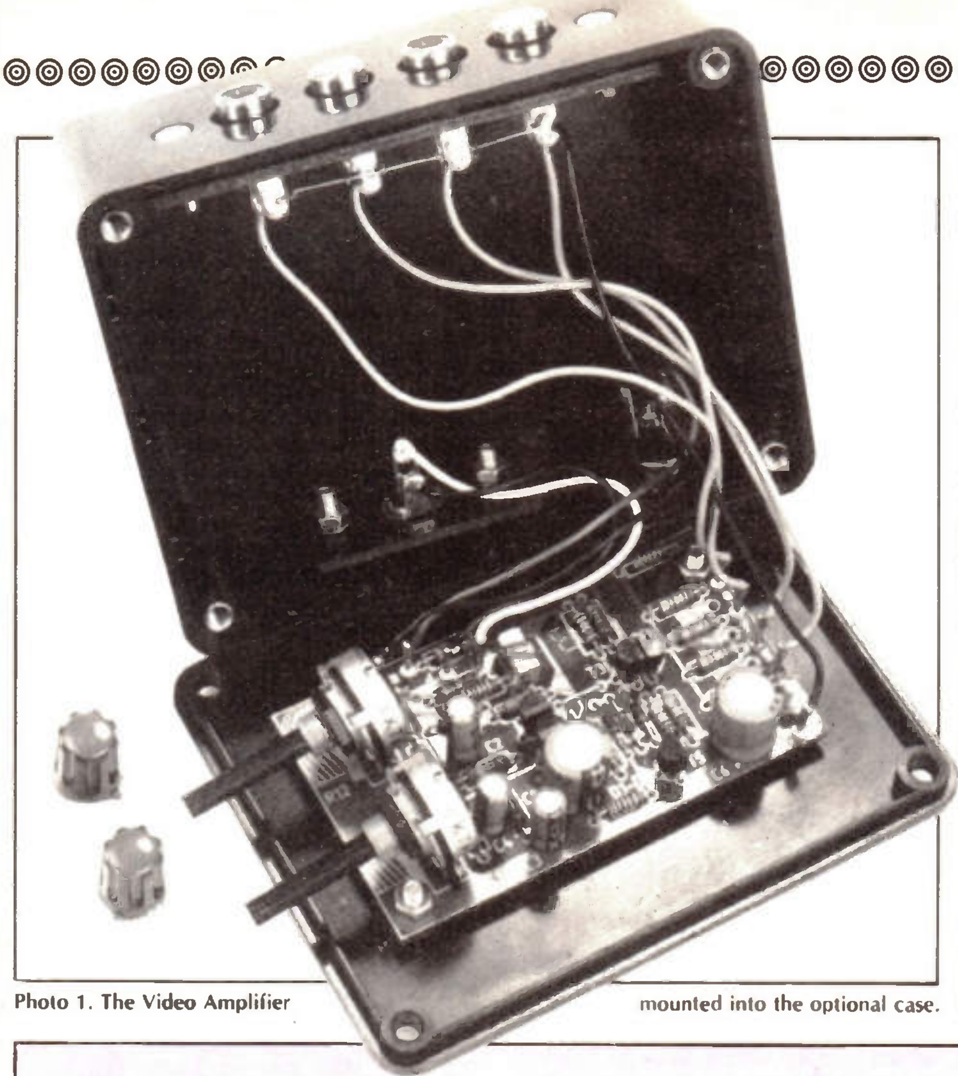


Photo 1. The Video Amplifier mounted into the optional case.

D1 to D3 and emitter resistors R16 and R17. The video signal is fed to the four outputs via capacitor C6 and resistors R19 to R22.

The video input of video recorders and monitors is generally terminated by a 68-82Ω (nominally 75Ω) impedance, so that connection to the video amplifier results in a 6dB attenuation of the signal. Since the amplifier has a gain of not less than 6dB, the level of the effective input to equipment connected to its output is at least equal to that of its own input. Level control potentiometer R10 affords additional amplification of the output signal, which is particularly useful if all four outputs are loaded simultaneously. HF boost control R12 enables extra amplification of the high-frequency part of the signal. The required bandwidth of 50Hz to 5MHz is exceeded by a good margin: the power bandwidth of the prototype stretched from 30Hz to 10MHz. Supply requirements of the amplifier is 10 to 15V DC (nominally 12V) at 50mA.

Construction

For those people with little experience in constructional techniques, a Constructors' Guide (stock code XH79L) is available to help with component identification. This helpful booklet also contains hints and tips on soldering and

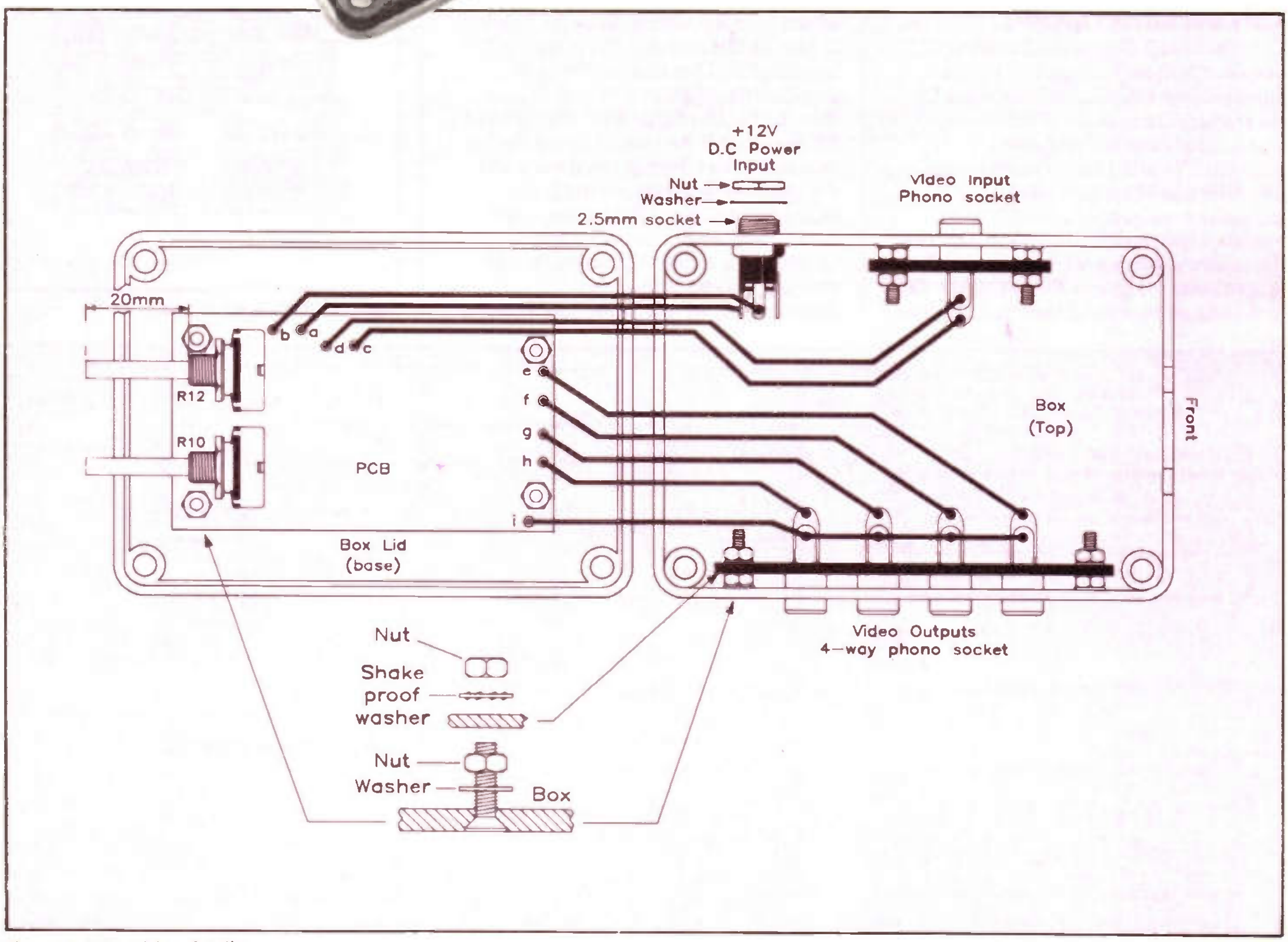


Figure 4. PCB wiring details.

constructional techniques. Please note that unlike most other Maplin kits this Guide is *not* included in the kit.

The PCB supplied in the kit is a single-sided, fibreglass type. The sequence in which the components are fitted is not critical. However, the following instructions will be of use in making these tasks as straightforward as possible. Please double-check each component type, value and polarity where appropriate, *before soldering* as it is much harder to correct a mistake after a

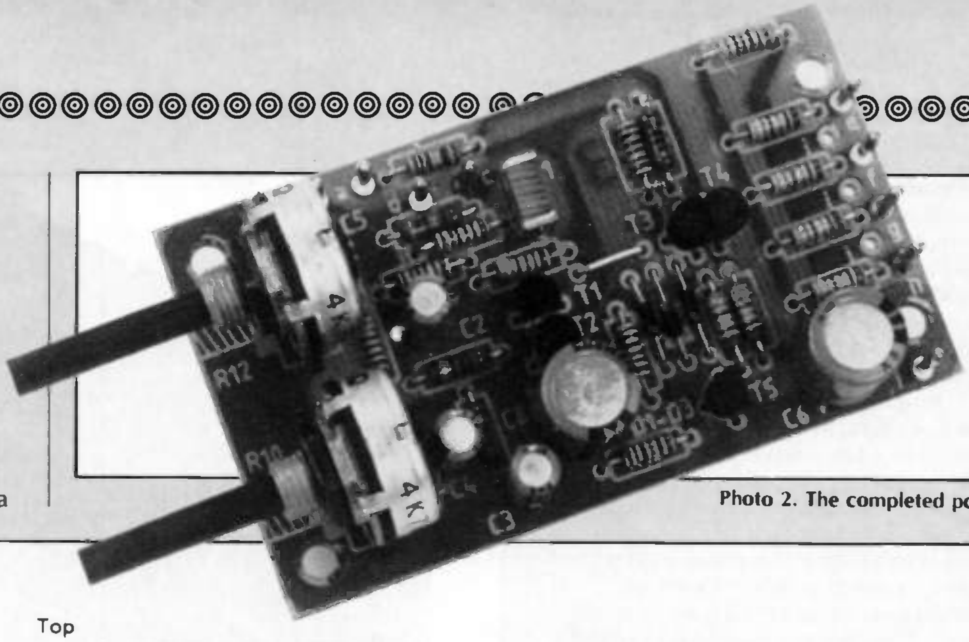


Photo 2. The completed pcb.

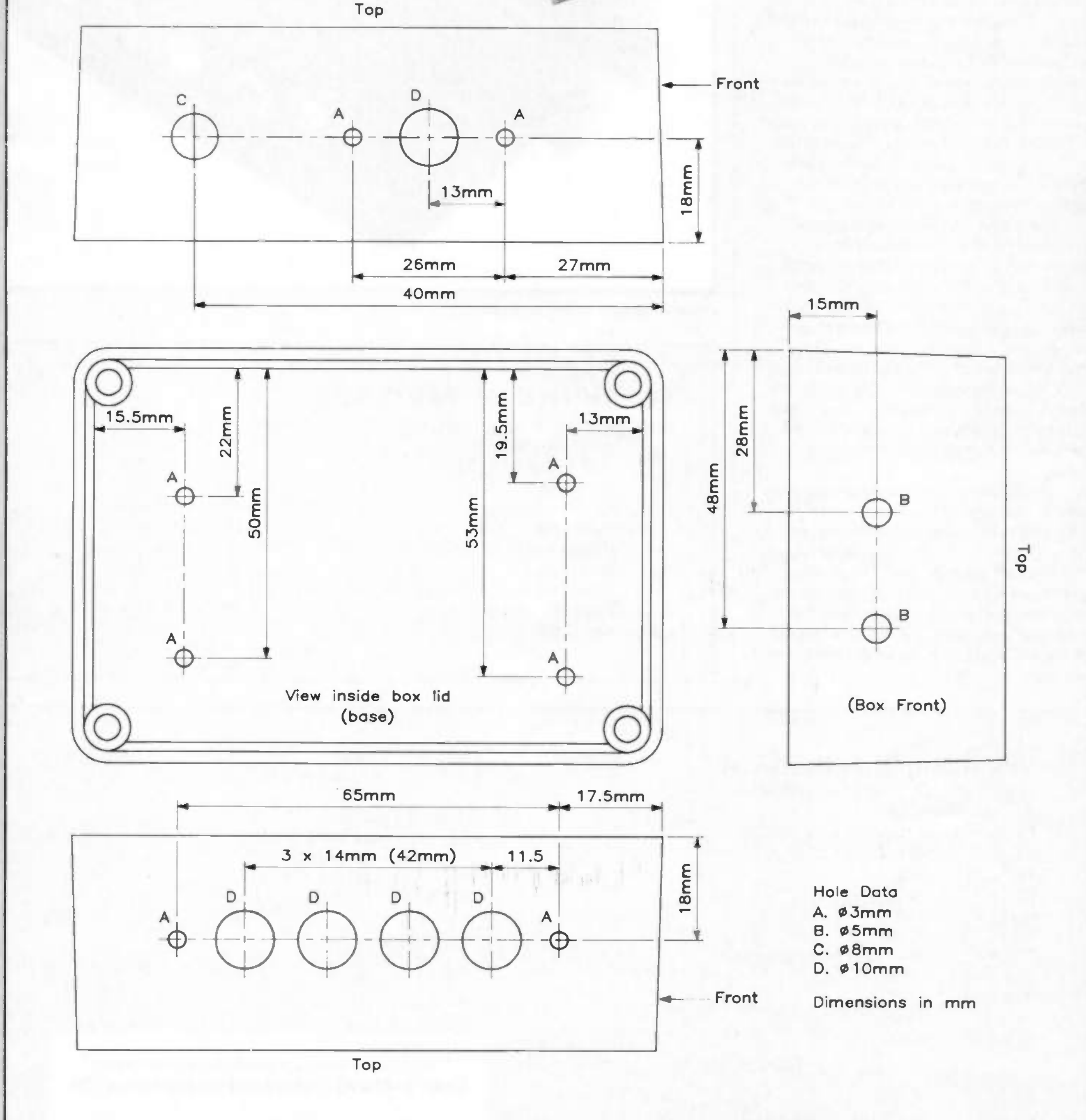


Figure 5. Box drilling details.

component has been soldered! It is usually easier to start with the smaller components. Referring to the Parts List and Figure 2 begin with the resistors R1 to R9, R11, R13 to R22, do not fit the potentiometers R10 and R12 at this stage. Use one of the off cuts from the resistors for the link, located between T1 and T3.

Next install the capacitors, diodes and transistors, followed by the PCB pins. The pins are fitted from the component side in positions marked a to i. Extra earth positions have been provided next to pins e to h to facilitate the use of screened or coaxial cable. Note that points a to i in Figure 1 correspond to the identically marked ones on the PCB (Figure 2). Finally fit the two potentiometers R10 and R12. As there is quite a variety of plugs and sockets that are used on video equipment the constructor is referred to the connectors and cables section of the current Maplin Catalogue for a wide range of suitable items. However it is important to use screened cable to provide proper impedance matching and to avoid the pick-up of interference.

The audio signals from the master television receiver or video recorder output may be connected directly to the slave VCR(s) as the video amplifier does not cater for audio signals. Direct connection will usually be found to be acceptable. It is unlikely that excessive attenuation of the audio signals will occur since the audio inputs on VCRs are nearly always terminated into a high impedance. However it is important to use screened cable to prevent pick-up of hum and noise.

The Peritel audio/video connector is now in common use on recent and new televisions and video recorders. Figure 3 shows the pinout for the Peritel connector.

Figure 4 gives details of interwiring and Figure 5 shows drilling details for the suggested box. Photo 3 shows how the prototype video amplifier was completed by the addition of a number of connectors and fitted into a box.

Photo 3. Typical boxed project.

OPTIONAL PARTS LIST

The following optional items are standard Maplin stock items

ABS box MB2	1	(LH21X)
Pozi Screw M3 12mm	1 Pkt	(BF37S)
Steel Nut M3	2 Pkts	(JD61R)
Isoshake M3	1 Pkt	(BF44X)
Steel Washer M3	1 Pkt	(JD76H)
Phono socket twin	1	(JK15R)
Phono socket quad	1	(BW74R)
Power socket 2·1mm (single hole fixing)	1	(JK09K)
Hook-up wire (7/0·2) Black	1 Pkt	(BL00A)
Regulated 300mA PSU	1	(YB23A)

Video Amplifier Parts List

RESISTORS: All 0·6W 1% Metal Film		
R1	10Ω	1
R2	82Ω	1
R3	47k	1
R4,5	22k	2
R6,13,15	1k	3
R7,8	1k8	2
R9,11	470Ω	2
R10,12	4k7 linear potentiometer	2
R14	220Ω	1
R16,17	47Ω	2
R18	2k2	1
R19,22	68Ω	2
CAPACITORS		
C1	220nF	1
C2,4	10μF 16V PC Electrolytic	2
C5	68pF	1
C6,7	220μF 16V PC Electrolytic	2
SEMICONDUCTORS		
T1,2	BF245B	2
T3,5	BC558	2
T4	BC548	1
D1,2,3	DX400	3
MISCELLANEOUS		
	PCB pins	9
	PCB	1

The above items are available as a kit only:
Order As LP60Q (Video Amplifier Kit) Price £9.95

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Stray Signals

by Point Contact

The ever-accelerating rate of advancement in 'state-of-the-art' technology leaves one truly breathless. In America, technologists at the Bell Research Laboratories of AT&T have succeeded in producing individual light pulses lasting only 0·6ps – less than a millionth of a microsecond. In principle, given further development, this will allow fibre-optic digital data transmission at a clock rate of one thousand GHz – a data rate not far short of this is said already to have been achieved down 24km of optical fibre. Another American company has succeeded in making a depletion mode FET using diamond instead of silicon or gallium arsenide. In principle, it should switch at twice the speed of the latter and operate at temperatures of hundreds of degrees Centigrade to boot. Whilst in another ambitious project, a consortium of American and Japanese companies is reportedly planning to grow a diamond film of 10 square metres in area, eminently suitable for solar cells for space vehicles and a host of other applications. If only Man's wisdom equalled his ingenuity, what a vastly improved world we would live in! For it must be said that most of these mind-boggling technological achievements will not improve the lot of the majority of humankind by one iota.

Perhaps Point Contact is being too pessimistic though, for there are glimmers of an increasing awareness on the part of mankind that he cannot continue to misuse the planet Earth in the future, in the way he has in the past. Witness the fact, to take but one example, that everyone is talking about the greenhouse effect. With car exhaust fumes being one of the major offenders, will we see a move to encourage economy by linking the road tax on cars to the amount of fuel they use? The Treasury HP (Horse Power) rating as a basis of a graduated road-tax sought to do this in the past, but having been conceived by civil servants rather than engineers, failed miserably. (Being based, for some strange reason, purely upon the cylinder diameter, it had the unforeseen effect of encouraging the design of very long-stroke engines, to minimise the Treasury Rating for a given real horsepower.) Nowadays, with the mandatory publication of urban and constant 90km/h consumption figures, it would be so simple to link the size of the Road Tax to the degree of *un*economy of the vehicle.

But of course, whatever car you drive, you can always resolve to drive it in a more economical way. For example, you could buy and fit an electronic fuel consumption meter which continually tells you the MPG you are achieving as you drive. Equally effective, if not more so, is a large block of Sorbo rubber under the accelerator pedal – Point Contact offers you this low-tech, low-cost solution free and gratis, having discovered it by accident as a result of fitting a somewhat oversize rubber mat in Mrs Point Contact's Metro. (As she stands only four foot seven inches tall in stockinged feet, Mrs P.C. has only recently graduated to such a 'large' car, previously preferring to drive only Minis.) However, as technical people (as I am sure all readers of this column undoubtedly are), we should all be able to drive more economically, just by thinking about what we are doing, like slackening off before you reach a bend, instead of having to apply the brakes at the last moment. After all, your kinetic energy – energy of motion – is proportional to the square of your speed, and it has cost you petrol to build up that speed. So if, as you approach a bend, you apply 'just a touch' of the brakes, to steady you down from 50 to 40mph, you have wasted the same amount of petrol as you would coming to a complete standstill from 30mph. Being the same sort of sum as a 3, 4, 5 triangle, this is neatly proved by a mathematical relation formulated by a Greek gentleman whose name escapes me at the moment; no, I never met him – he lived rather a long time ago, but I'm sure his name began with P. I'm certain it will come to me in a moment, but in the meantime, let me tell you that I have come to regard the footbrake as a foot-operated tap which pours neat petrol out onto the road. Not so Fred, whom I mentioned in my last jottings, for he was a much more extrovert fellow and drove his car with dash – insofar as one could in a pre-war Standard 8! I remember thinking once, when he had the head off, how tiny the bore of the cylinders was. But that was the Treasury Rating for you – ah, such a long time ago.

Yours sincerely,

Point Contact

PRICES May 1st to August 31st 1991

Price Change Leaflet
The new leaflet for May to August 1991 is now available. Copies are available free of charge on request (CA99H). Prices shown on this leaflet include VAT at 15% (except zero rated items). See note below.

Prices in this Magazine and Digest
All prices shown in this Magazine and Digest include VAT at 15% (except zero rated items). See note below.

Government Increase in VAT
The government have increased the rate of VAT from 15% to 17½%. In our catalogue, price change leaflet, magazine and Digest prices are shown including 15% (except those marked *NV*). To find the new price, take the price each and add 2% (two per cent) and round to the nearest whole penny (i.e. up to and including 0.5p round down to the nearest whole penny below, over 0.5p round up to the nearest whole penny above). The table below shows you what to add for prices up to £20.25.

Examples:

Current price each	New price
3p	3p
25p	25p
£1.50	£1.53
£9.95	£10.15
£14.25	£14.53
£14.26	£14.55
£99.95	£101.95
£9.95*NV*	£9.95*NV*

There is no change to the carriage or handling charges.
From September 1st 1991, all published prices will include VAT at 17½% where applicable. See our 1992 Catalogue on sale from September 1991.

Price each	New price	Price each	New price	Price each	New price
Up to 25p	No change	£6.76 to £7.25	add 14p	£13.76 to £14.25	add 28p
26p to 75p	add 1p	£7.26 to £7.75	add 15p	£14.26 to £14.75	add 29p
76p to £1.25	add 2p	£7.76 to £8.25	add 16p	£14.76 to £15.25	add 30p
£1.26 to £1.75	add 3p	£8.26 to £8.75	add 17p	£15.26 to £15.75	add 31p
£1.76 to £2.25	add 4p	£8.76 to £9.25	add 18p	£15.76 to £16.25	add 32p
£2.26 to £2.75	add 5p	£9.26 to £9.75	add 19p	£16.26 to £16.75	add 33p
£2.76 to £3.25	add 6p	£9.76 to £10.25	add 20p	£16.76 to £17.25	add 34p
£3.26 to £3.75	add 7p	£10.26 to £10.75	add 21p	£17.26 to £17.75	add 35p
£3.76 to £4.25	add 8p	£10.76 to £11.25	add 22p	£17.76 to £18.25	add 36p
£4.26 to £4.75	add 9p	£11.26 to £11.75	add 23p	£18.26 to £18.75	add 37p
£4.76 to £5.25	add 10p	£11.76 to £12.25	add 24p	£18.76 to £19.25	add 38p
£5.26 to £5.75	add 11p	£12.26 to £12.75	add 25p	£19.26 to £19.75	add 39p
£5.76 to £6.25	add 12p	£12.76 to £13.25	add 26p	£19.76 to £20.25	add 40p
£6.26 to £6.75	add 13p	£13.26 to £13.75	add 27p	Any item marked *NV* – No change.	

Programming In Basic Continued from page 47.

been in the news recently, the computer 'virus'. This is different from a 'bug' in that while it is a programming error which can cause problems, it is in fact deliberate. Viruses have to be written by a programmer, and some of them are quite sophisticated. The virulent program, or part of a program, comes into operation upon a prescribed set of circumstances being true, for instance where the user enters the date 'Friday 13th'. It requires that the actual routine which is requesting the input of the date recognises this unlucky combination and branches to perform some activity which is extremely undesirable, like erasing all the data files in the storage medium and saving the version of the program of which it is a part with this function active, so that the program won't operate properly afterwards no matter how many times and different ways it is loaded. Such a 'virus' will either have to be put into the program by the same person who wrote the program (for some reason), or, in the case where the computer loads in an operating system of some kind as soon as it is switched on, the virus is present as a part of a sequence of initialisation and start-up routines, and the offending function is 'wedged' into the program we want to load and run somehow. In the first case, where a spiteful programmer has created a program with a built-in booby-trap there is no option but to avoid triggering the trap if we want to use the program, i.e. never enter 'Friday 13th' as a date.

In the latter case, there is no real problem if *back ups exist* for both programs and data. A virus cannot survive in a computer which is turned off, and so it is merely a matter of going back to the back up copies to make further working copies. Operating systems and programs should be copied from the master and/or back up copies *forward* to working copies, and never the other way round.

Take a tip from the professional computer programmers working with mainframe systems, and think about data security. Accidents can happen and you only need lose your latest version of a long

```
P          N

9          1
.81        2
.0729      3
.00656     4
.00059     5
...        ...
...        ...
etc.       etc.
```

Figure 13. Results from a faulty version of Figure 12.

program once, that you spent hours over, to learn not to be bitten twice. The convention is, 1. keep a copy of the previous version of the program in a safe place; 2. keep the latest updated version as a 'master' in a safe place; 3. make a 'working copy' from the 'master' and use that to load from for everyday usage, never the 'master'; and 4. carry out modifications on a new copy of the master, not the original. The original then becomes the 'previous' and the modified copy becomes the new 'master'.

Applications of Computer Programming

The diversity of these is really limited by your imagination. The general trend is for people who have done without a computer at all quite happily thank you very much, both at work and at home, to wonder how they ever managed without one once they start. Leaving games playing aside, probably the most popular applications programs for home computers might be for word processing and home accounts, going on the mini-databases which come in useful for small businesses and for stock control if you were the proprietor of a small shop, for instance. Although in fact a microcomputer database program need not be restricted to these and can be pressed into service for all sorts of purposes, like keeping servicing and expenditure records for a car. But for the electronics enthusiast, being able to program in BASIC will mean being able to put all his most often used ohms law and reactance formulae, decibel conversions etc. into program form, which, once written and proved, will remain readily available for use ever after to make system and circuit design so much quicker and easier. What's more, special 'custom' programs can be written for specific problems.

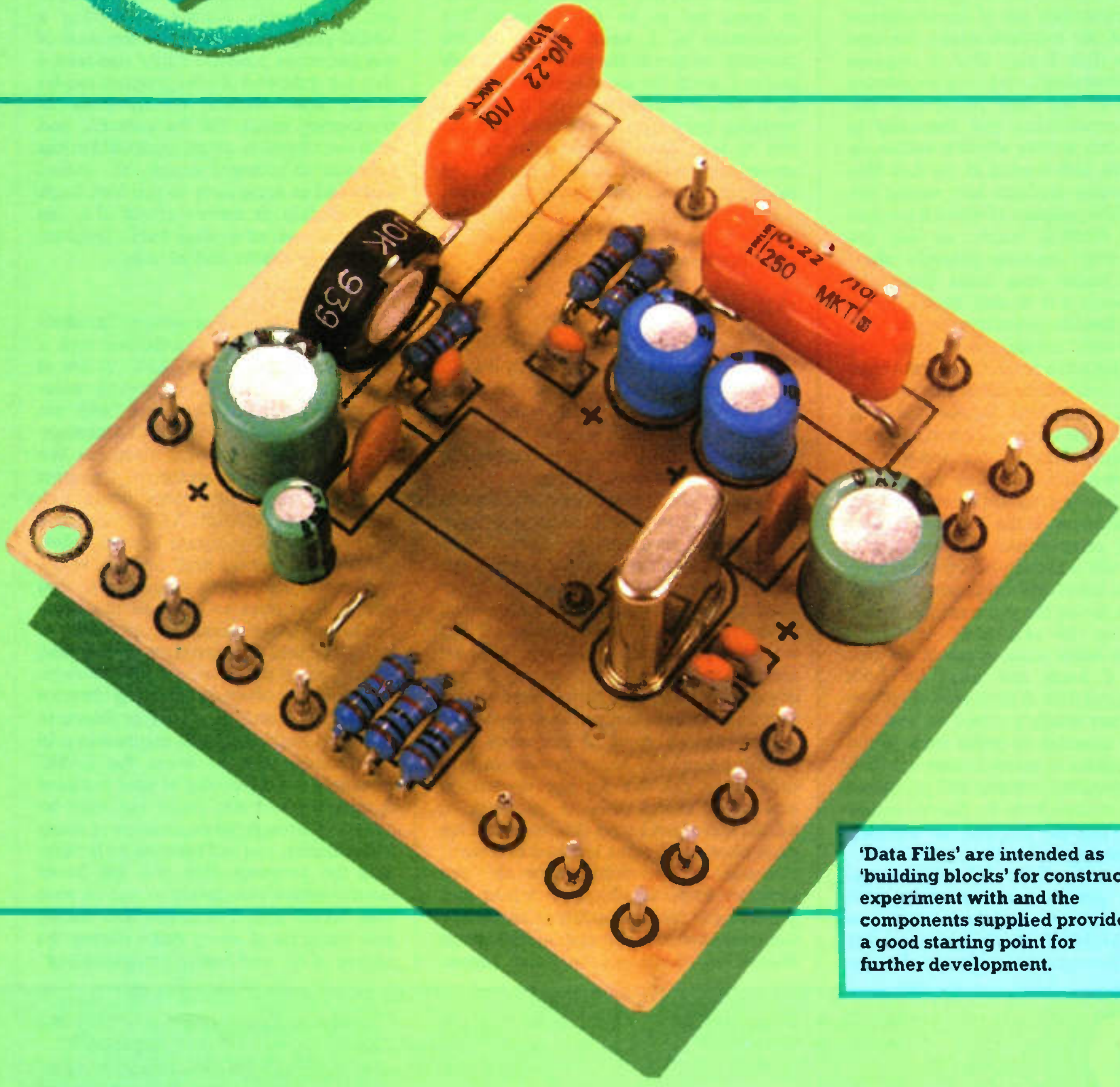
For instance, to work out a complete frequency response curve for a complex R/C network with a particular set of component values, producing a graph calibrated in decibels, might take a day using conversion tables and a calculator to cover one or two variations in the value of the components. Alright, so writing a BASIC program to solve one iteration of this particular problem might also take a day, but at the end of it the program can be re-run with endless combinations of component values for the network, and with each iteration being computed in just seconds, to produce exactly the values you need as accurately as you like. Later this program, or some element of it, can form the basis of another future program for another similar sort of task.

Summary

This series has just been an introduction to some of the possibilities with a computer language like BASIC. A few of the elementary BASIC command statements have been illustrated, and we haven't even mentioned BASIC's armoury of complex mathematical functions. We have seen how to structure programs properly using logical loops made with 'FOR / NEXT', 'WHILE / WEND' and 'IF / THEN' to cause program flow to follow fundamental 'repeat until' and 'do while' constructs, and with subroutines. You should now refer to some of the many books published about programming in BASIC to find out more about handling strings, array structures and file storage, and are some around containing libraries of small programs for solving problems in electrical and electronic engineering. In the process, get to know the BASIC 'vocabulary' (keywords) of your machine thoroughly, and this really can only be achieved through the experience of doing it. Eventually, you will become so familiar with the language that you will know exactly which statements to use in your next BASIC line. Try to test and debug your program at every stage during the writing of it – and happy programming!

DATA FILE

MSM6322 SPEECH PITCH CONTROLLER



'Data Files' are intended as 'building blocks' for constructors to experiment with and the components supplied provide a good starting point for further development.

FEATURES

- ★ Built-in microphone preamplifier
- ★ Speech pitch alterable in 17 steps
- ★ Built-in low pass filters
- ★ Single +5V power supply
- ★ Kit available

APPLICATIONS

- ★ Voice disguising
- ★ Office parties
- ★ Childrens toys
- ★ Stage shows

Introduction

The MSM6322 is a real time audio pitch controller specifically designed for speech. Available solely in surface mount (with a package size of only 16 x 12mm!), the IC contains a fourth order low-pass input filter and 8-bit A-to-D, a 9-bit D-to-A with a third order low-pass output filter, as well as a microphone preamplifier. Over the time that this IC has been available to trade and industry it has found its way into many childrens toys, transforming their voice into that of 'Darth Vader' or 'Mickey Mouse'!

Figure 1 shows the IC pinout and Table 1 gives typical electrical characteristics for the device.

IC Description

Figure 2 shows the block diagram of the MSM6322. Analogue and digital power supplies to the chip are completely isolated to reduce the chance of digital noise introducing itself into the analogue signal path.

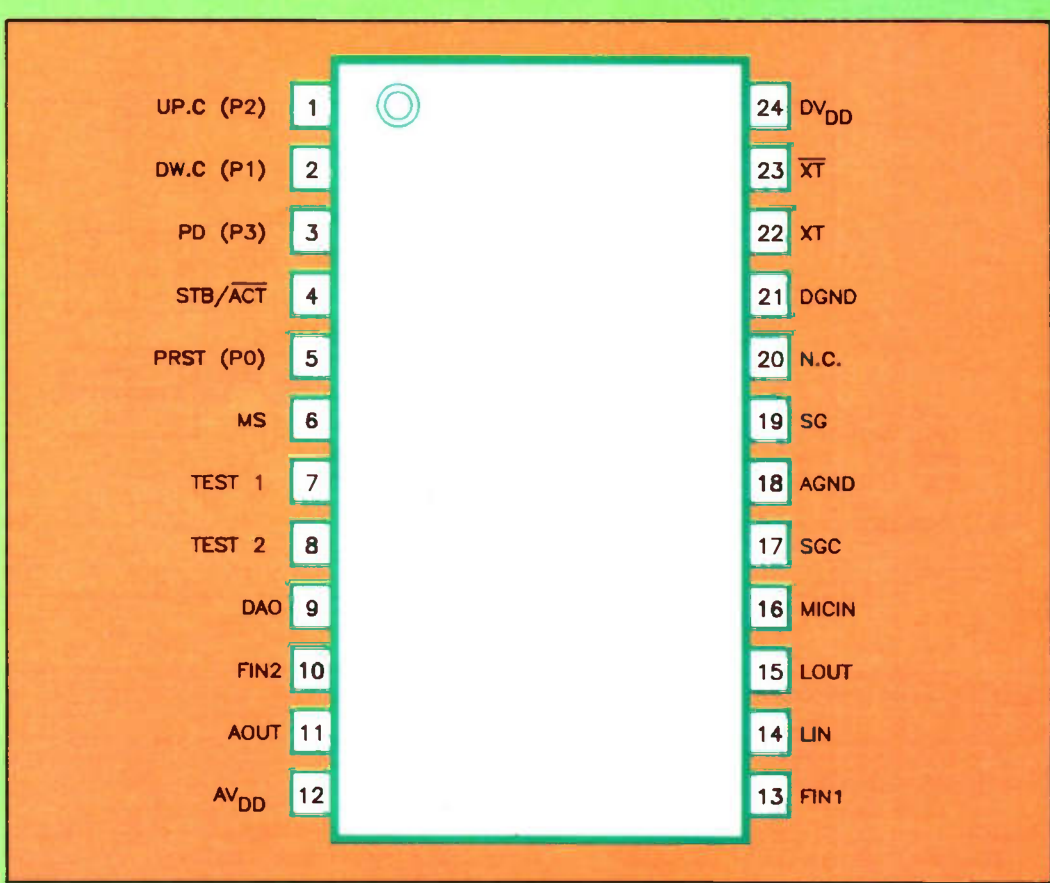


Figure 1. MSM6322 Pin-out.

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Digital supply voltage		DV_{DD}	For D_{GND}	4·0	5·0	6·0	V
Analogue supply voltage		AV_{DD}	For A_{GND}	4·0	5·0	6·0	V
Operating current consumption		I_{DD}	In case of 4MHz oscillator			10	mA
Standby current		I_{DS}	In case of 4MHz oscillator with STB/$\overline{ACT}$ = "H"			7	mA
Power down current		I_{DP}	In case of PD = "H"			1	mA
A-to-D conversion precision			$AV_{DD}=V_{DD}=5V$			40	mV
D-to-A conversion precision			$AV_{DD}=V_{DD}=5V$, No load			40	mV
Input impedance	MICIN	RI_{MICIN}			100		MΩ
	LIN	RI_{LIN}			100		MΩ
	FIN2	RI_{FIN2}			30		MΩ
Output impedance	LOUT	RO_{LOUT}			15		kΩ
	DAO	RO_{DAO}			10		kΩ
	AOUT	RO_{AOUT}			15		kΩ
	FIN1	RO_{FIN1}			15		kΩ
Operating frequency		t_{CMAX}			4·0	4·5	MHz
Time between UP.C and DW.C pulses		t_{RUD}		30·72			ms
Pulse width of PRST, UP.C, DW.C pulses		t_{UDPW}		30·72			ms

Table 1. IC Electrical Characteristics.

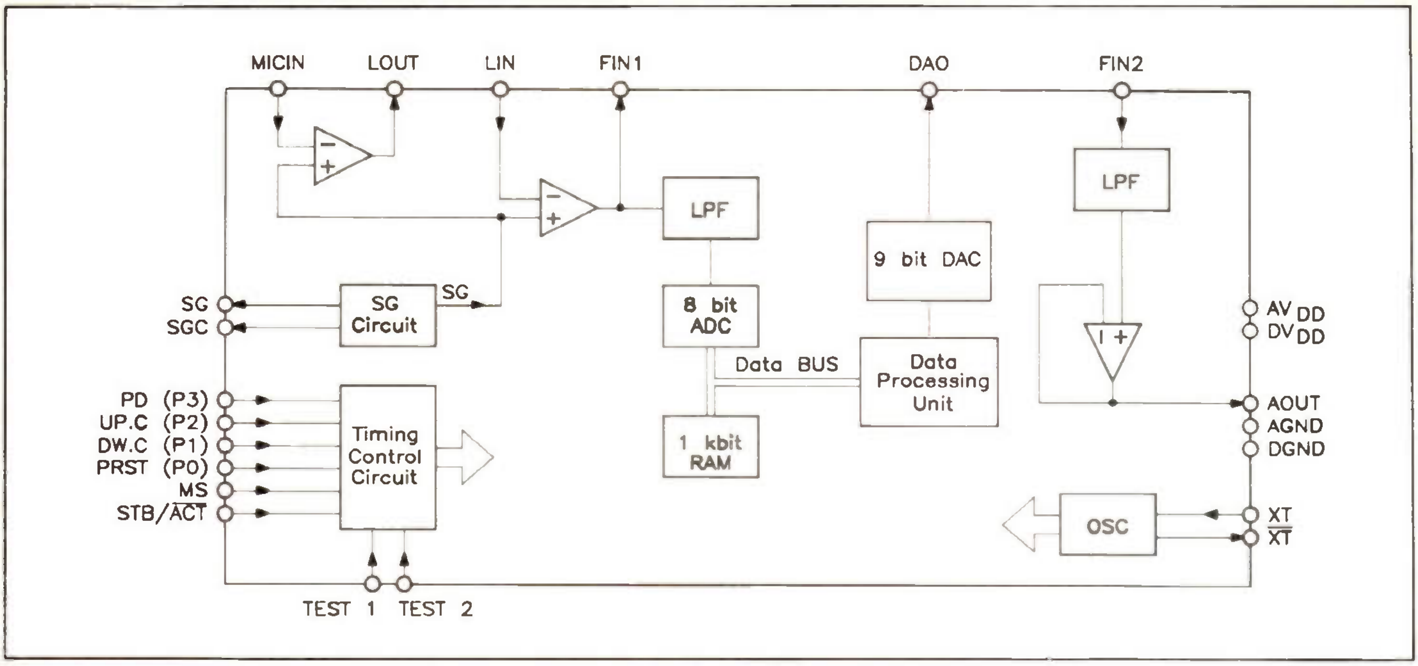


Figure 2. IC Block Diagram.

Pin Name	Pin Number	DI/AI/AO[1]	Function
MICIN	16	AI	Input to the microphone preamplifier. MUST be capacitively coupled.
LOUT	15	AO	Output of the microphone preamplifier.
LIN	14	AI	Input to the line amplifier. MUST be capacitively coupled to either LOUT or the line out signal from other audio sources.
FIN1	13	AO	Sets the input audio signal amplitude in combination with the LIN pin.
STB/$\overline{ACT}$	4	DI	Chip select pin. The processing is interrupted by stopping clocks other than the oscillator when the chip select pin is at the "H" level. The DAO pin outputs ½ V_{DD} for about 15ms (in the case of 4MHz oscillator) after the chip select pin is set to the "L" level.
TEST1	7	DI	Manufacturers test pins.
TEST2	8		MUST be connected to 0V.
XT, $\overline{XT}$	22, 23		Crystal oscillator connection pins.
SG, SGC	19, 17		External capacitors are connected here to stabilise the internal analogue voltage references of ½ AV_{DD}.
DAO	9	AO	Output from the digital-to-analogue converter.
FIN2	10	AI	Input pin for internal low-pass filter (for output).
AOUT	11	AO	Output of low-pass filter (for output).
D_{GND}	21		Digital power supply pins.
DV_{DD}	24		
A_{GND}	18		Analogue power supply pins.
AV_{DD}	12		

Note: 1) DI (Digital input), AI (Analogue input), AO (Analogue output)

Table 2. Pin functions common to both modes.

Two operating modes are available:
1) With the mode select (MS) pin set to logic low (0V) the MSM6322 is placed in 'UP/DOWN' mode. Pulses to the 'Up Conversion' (UP.C) and 'Down Conversion' (DW.C) pins raise and lower the pitch of the signal by one step per pulse.
2) With the MS pin set high (5V), the device is placed into 'BIN' mode. P0–P3 become binary inputs selecting the stage of pitch conversion.

Table 2 gives the pin functions common to both

Pin Name	Pin Number	Function
MS	6	Mode select pin, always connected to D_{GND}.
UP.C	1	Pulse input to raise pitch by one stage at a time.
DW.C	2	Pulse input to lower pitch by one stage at a time. Cyclic up or down operation is also possible. See Table 5 for scale stages.
PD	3	Power down pin. All clocks including the oscillator are stopped when the power down pin is set to the "H" level.
PRST	5	Pulse input sets the scale to stage 8 (no pitch change).

Note: All the above pins are digital inputs.

Table 3. Pin functions for UP/DOWN mode.

modes, Table 3 shows the relevant pin functions for 'UP/DOWN' mode, and Table 4 for 'BIN' mode. Table 5 shows the relationship between scale stage, D-to-A sampling cycle, and low pass filter cut-off frequency.

Kit Available

A kit of parts including a high-quality fibreglass PCB with printed legend is available as an aid to constructors, facilitating developments around this, sometimes tricky to mount, surface mount device. Figure 3 shows the circuit diagram of the module and Figure 4 shows the PCB layout.

The application circuit has an on-board 4MHz clock, supply decoupling for both analogue and digital supplies. The gain of the microphone and line-level preamplifiers are set by two resistors in each case (the line-level pre-amplifier's gain is however, variable through RV1).

In constructing the module, take *great* care when soldering IC1, which mounts on the *solder* side of the PCB. It is recommended that the smallest possible size soldering iron bit is used (<1mm), with 22 SWG solder. Using a pair of tweezers, place the IC squarely on all 24 pads. Solder the four corner pins, ensuring the IC stays straight on the pads. Now solder the remaining pins, allowing several seconds between each solder joint for the IC to cool down.

Pin Name	Pin Number	Function
MS	6	Mode select pin, always connected to DV_{DD}.
P0	5	16 pitch stages are set by 4 bits of P3 (MSB) to P0 (LSB). Stages 0 (P3 = P2 = P1 = 0) to 16 (P3 = P2 = P1 = 1), as shown on Table 5, can be set.
P1	2	
P2	1	
P3	3	

Note: All the above pins are digital inputs.

Table 4. Pin functions for BIN mode.

'BIN' mode settings P3	P2	P1	P0	Scale Stage	DA sampling cycle (μS) frequency (KHz)	LPF cut-off frequency (KHz)	Pitch Change
Not available				16	60/16·6	7·60	One octave up
1	1	1	1	15	71/14·0	7·60	Nine semi-tones up
1	1	1	0	14	76/13·1	5·70	Eight semi-tones up
1	1	0	1	13	80/12·5	5·70	Seven semi-tones up
1	1	0	0	12	90/11·1	5·70	Five semi-tones up
1	0	1	1	11	95/10·5	5·70	Four semi-tones up
1	0	1	0	10	101/9·90	4·56	Three semi-tones up
1	0	0	1	9	113/8·84	4·56	One semi-tone up
1	0	0	0	8	120/8·33	3·80	No pitch change
0	1	1	1	7	127/7·87	3·80	One semi-tone down
0	1	1	0	6	143/6·99	3·26	Three semi-tones down
0	1	0	1	5	151/6·62	3·26	Four semi-tones down
0	1	0	0	4	160/6·25	3·26	Five semi-tones down
0	0	1	1	3	180/5·55	2·85	Seven semi-tones down
0	0	1	0	2	190/5·26	2·53	Eight semi-tones down
0	0	0	1	1	202/4·95	2·53	Nine semi-tones down
0	0	0	0	0	227/4·40	2·07	One octave down

Table 5. Pitch conversion table.

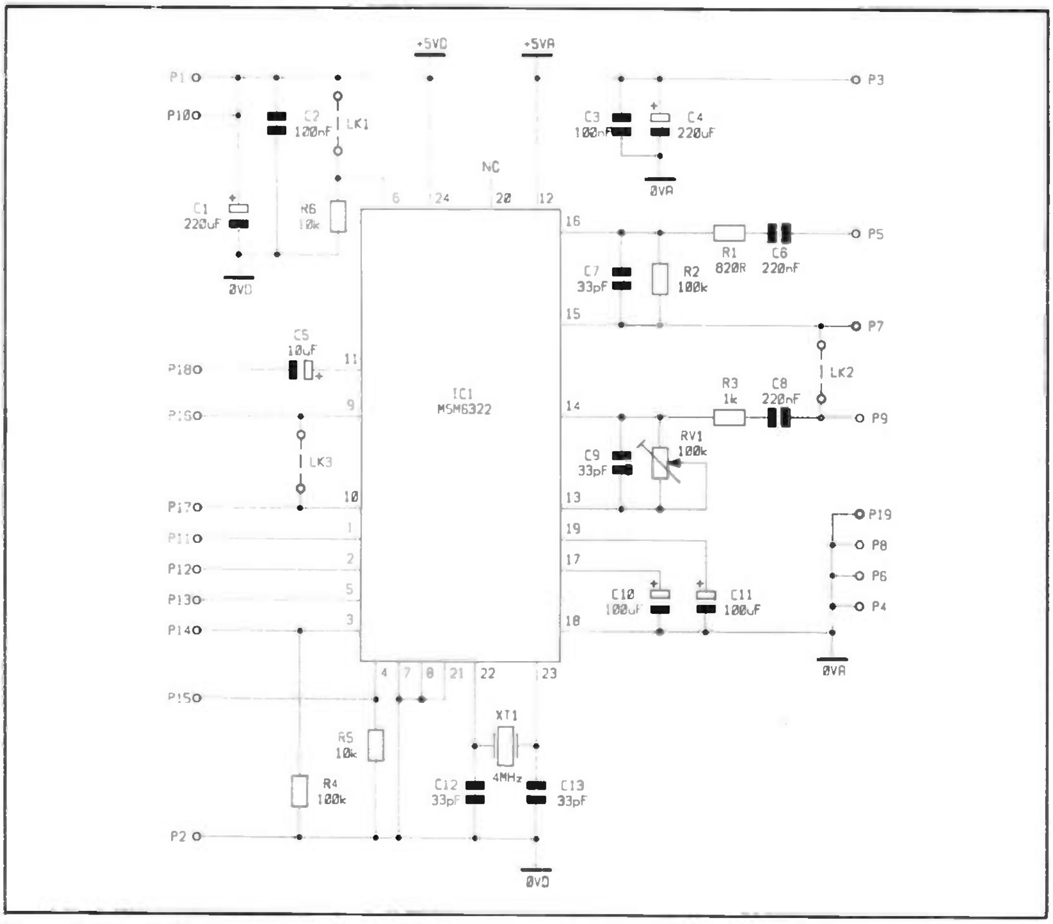


Figure 3. Circuit Diagram.

To use the device in 'BIN' mode it is necessary to insert link LK1, otherwise 'UP/DOWN' mode is selected by R6 pulling the mode select pin 6 low.

Connection information is given in Figure 5. Analogue and digital 5V power supplies should be kept completely separate, meeting only at the power source to reduce the chance of digital noise introducing itself into the analogue signal path.

With reference to Figure 6, the gain of the microphone preamplifier is set to 122 (42dB). The gain of the line-level preamplifier is variable, through RV1, from 0 to 100 (40dB). If using the microphone preamplifier, link LK2 has to be installed to route the output from this preamplifier into the line-level preamplifier.

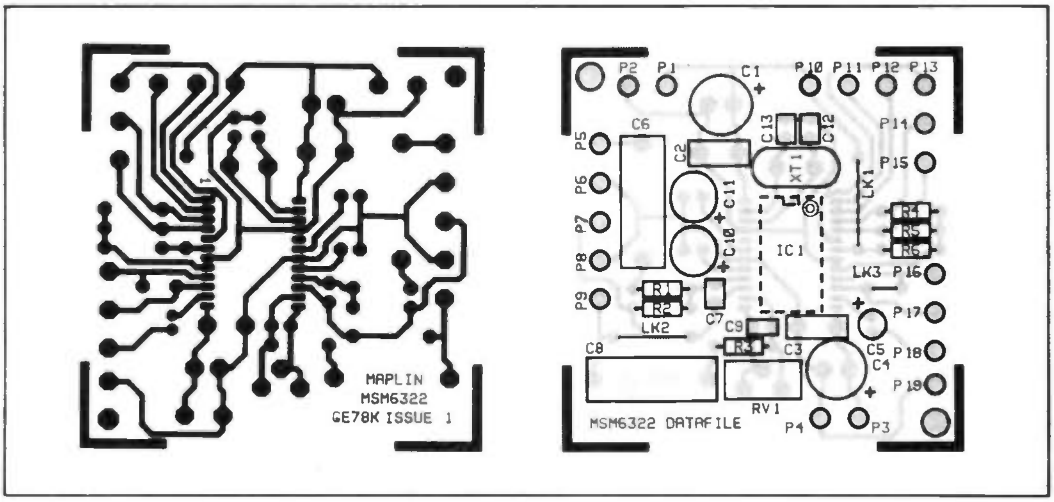


Figure 4. PCB legend and track.

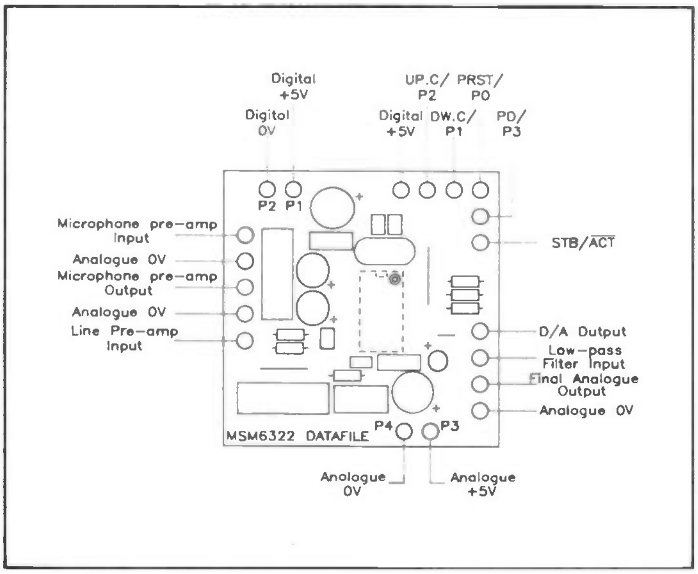


Figure 5. Wiring Diagram.

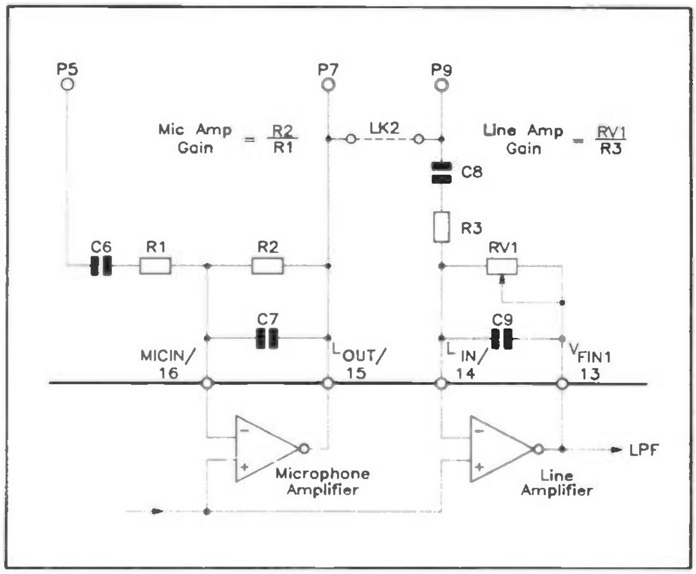


Figure 6. Setting the gain of the input amplifiers.

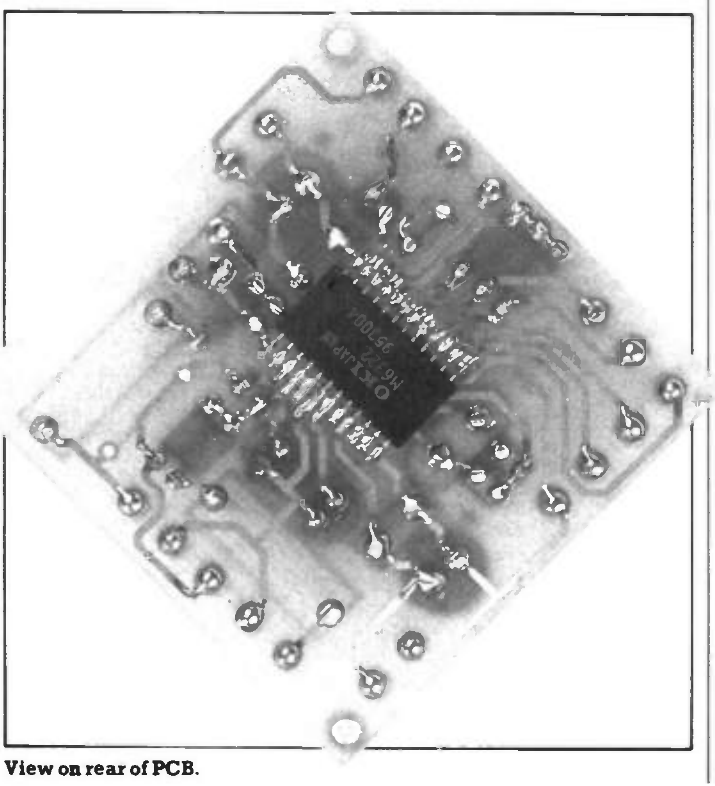
The output of IC1's D-to-A is brought out to P16. This is *before* any output filtering has taken place. Note that this output has a +2·5V DC offset, and will therefore need to be capacitively coupled to any external equipment. Link LK3, when installed, routes the output of the D-to-A through IC1's low-pass filter, the output of which is brought to P18.

The functions of P11 to P14 vary depending which mode the MSM6322 is set to, as shown in Table 6.

In Use

Interesting effects can be found by slowly increasing the line amplifier's gain via RV1, until distortion *just* starts to set in. This, coupled with a low pitch shift can generate very convincing 'Dalek' effects. Also, in 'UP/DOWN' mode, continuously pulsing the UP.C or DOWN.C inputs produces a rather strange effect.

As the MSM6322 does not boast a very high signal-to-noise ratio it may be beneficial to route the audio signal


View on rear of PCB.

Pin Number	'UP/DOWN' mode	'BIN' mode
P11	UP.C	P2
P12	DW.C	P1
P13	PRST	P0 (LSB)
P14	PD	P3 (MSB)

Table 6. Pin functions dependent on mode.

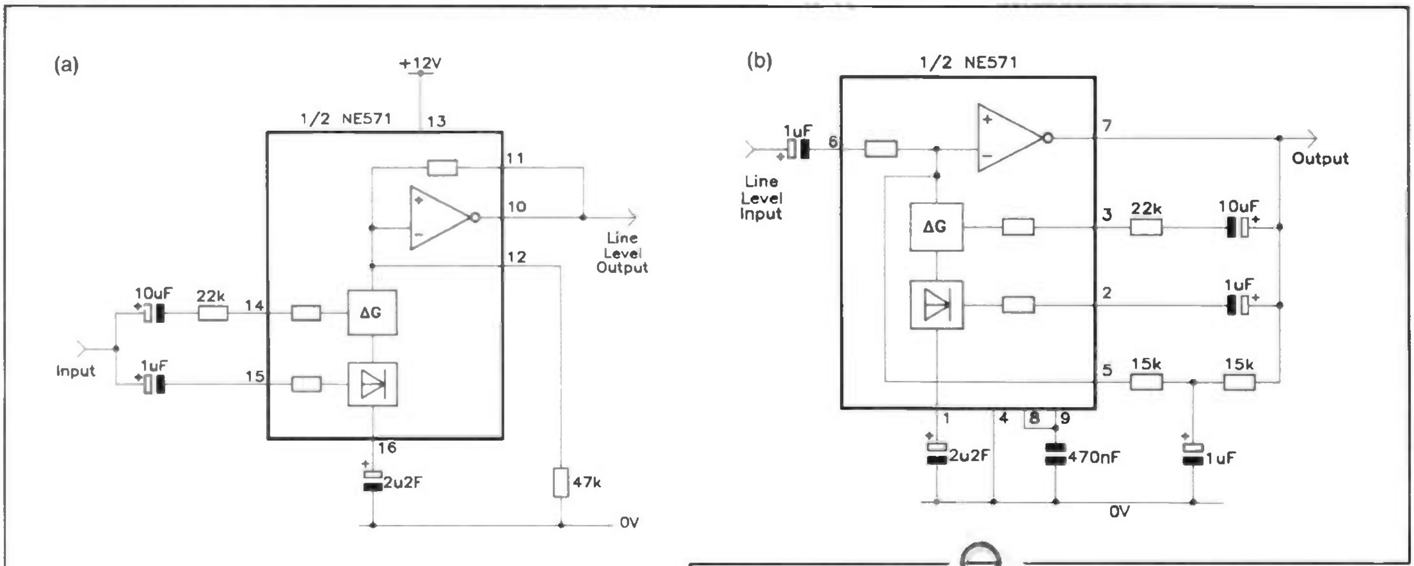
through a compander. A suitable circuit is shown in Figure 7.

The process of compansion can be broken down into two stages, compression (Figure 7a) and expansion (Figure 7b).

Compression involves reducing the dynamic range of the material that is being processed, so that, with a 2:1 compression ratio, if the input to the compressor increases by 12dB, then the output of the compressor will increase by only 6dB.

Conversely, expansion involves increasing the dynamic range, so that if the input to the expander increases by 6dB, the output will increase by 12dB, i.e. a 1:2 expansion ratio.

At the same time, the noise introduced in the system will be rendered nearly inaudible on expansion since this unwanted signal is not subject to the initial compression treatment and is therefore expanded downwards below the lowest dynamics of the wanted audio signal. Figure 7c shows how to connect to the PCB.



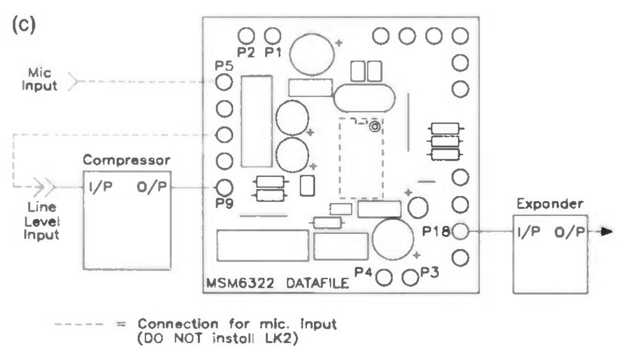
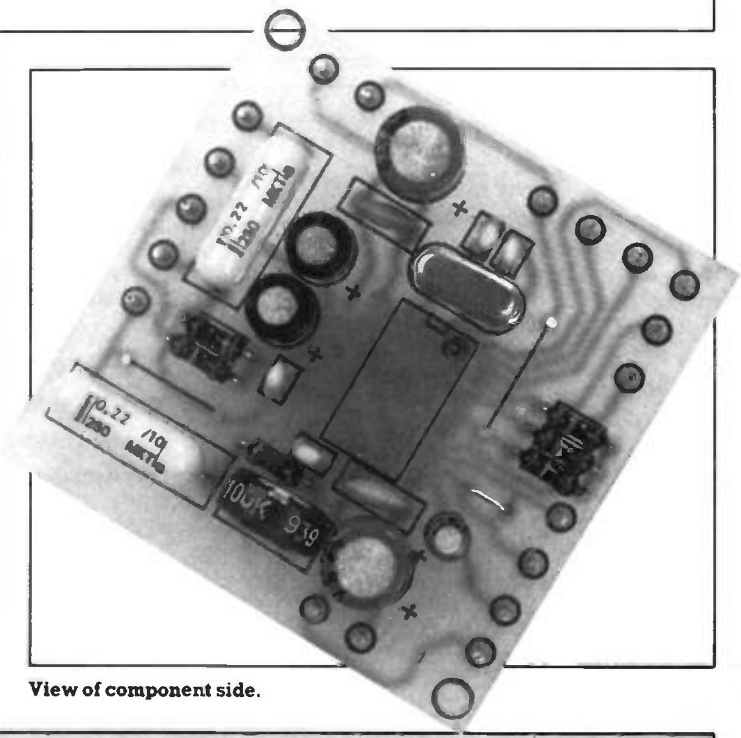


Figure 7. Simple compander circuit.



View of component side.

MSM6322 PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1	820R	1	(M820R)
R2,4	100k	2	(M100K)
R3	1k	1	(M1K)
R5,6	10k	2	(M10K)
RV1	Vert Encl Preset 100k	1	(UH19V)

CAPACITORS

C1,4	220μF 10V Minelect	2	(JL06G)
C2,3	100nF 16V Minidisc	2	(YR75S)
C5	10μF 16V Minelect	1	(YY34M)
C6,8	220nF Polyester	2	(BX78K)
C7,9,12,13	33pF Ceramic	4	(WX50E)
C10,11	100μF 10V Minelect	2	(RK50E)

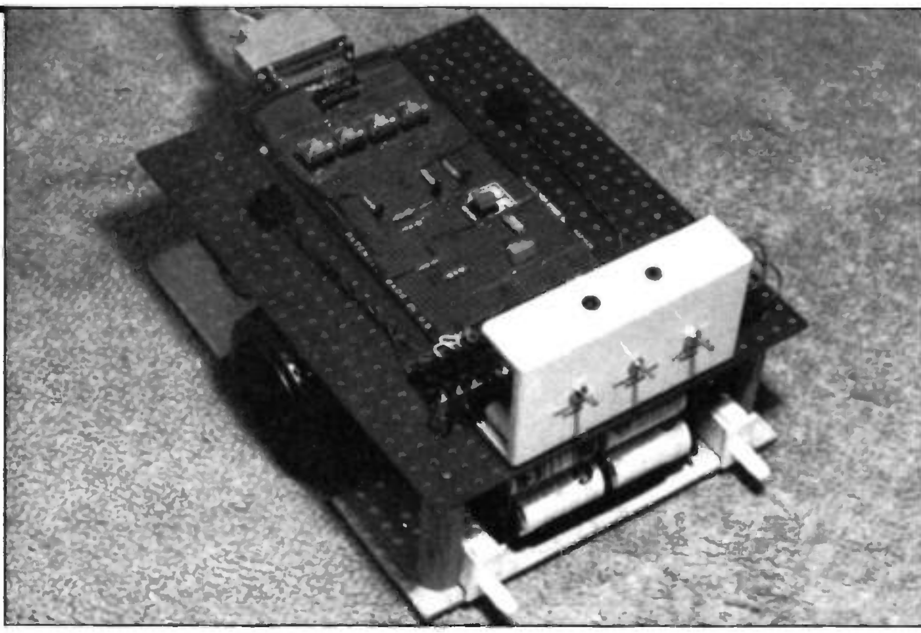
SEMICONDUCTORS

IC1	MSM6322	1	(UL76H)

MISCELLANEOUS

P1-19	Pin 2145	1 Pkt	(FL24B)
XT1	MP Crystal 4MHz	1	(FY82D)
	PC Board	1	(GE78K)
	Constructors' Guide	1	(XH79L)
	Instruction Leaflet	1	(XK43W)

The above items are available as a kit:
Order As LP58N (MSM6322 Kit) Price £10.95
The following item is also available separately but is not shown in our 1991 catalogue:
MSM6322 PCB **Order As GE78K Price £1.45**

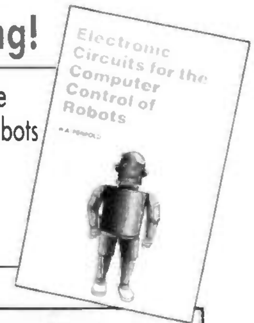


CALIBAN-8 on the move!

Practical Robotics Continued from page 22.

(mechanical and electronic), software and all the practical considerations. Building a robot vehicle is not particularly difficult, but requires a systematic, step-by-step approach, patience and perseverance. Having said all that, the rewards are high and great satisfaction and a sense of achievement can be gained from putting together a fairly complex but manageable system which can be fully understood by the user and developed further.

Further Reading!



Electronic Circuits for the Computer Control of Robots by R. A. Penfold
Order WP66W
£2.95 *NV*

PARTS LIST

RESISTORS: all 0·6W 1% Metal Film

R1,3	270Ω	2	(M270R)
R2,4	22k	2	(M22K)
R5,6	1k	2	(M1K)
SEMICONDUCTORS			
TR1,2	BC182L	2	(QB55K)
L1,2	LED Red	2	(WL27E)
IC1	ULN2803A	1	(QY79L)
RELAYS			
RL1-4	Ult-Mn 6V SPDT	4	(FM91Y)

MISCELLANEOUS
D.C. motors, battery holders, microswitches (momentary push to make), user port connector (e.g. 25-way D type), stripboard (JP51F), materials for chassis, load platform, etc.

COMPETITION WINNERS

The Wall Competition

The questions and correct answers were as follows:

1) Name the odd one out (Roger Waters, Nick Mason, Mike Rutherford, David Gilmour): **Mike Rutherford.**

2) Who did not perform live in London during summer 1990 (Prince, U2, Madonna, The Rolling Stones): **U2.**

3) Which tracks are not featured on the hit album by Sinead O'Connor (Mac Arthur Park, I Am What I Am, Can't Buy Me Love, Nothing Compares 2U): **Mac Arthur Park, I Am What I Am, Can't Buy Me Love.**

4) Which does not fit (Dark Side of the Moon, The Wall, Wish You Were Here, Then There Were Three): **Then There Were Three.**

The following lucky people who entered The Wall Competition will receive as their prize a Double CD Album, Double LP Album, Double Cassette Album or VHS Video Cassette.

Winners of the Double CD Album:

Mr Colin Dark, Epsom, Surrey; Mr William Mortada, London; M. D. Hall, Wembley, Middlesex; Mr A. A. Boreham, Barry, South Glamorgan; Miss J. Whiteley, Formby, Merseyside; Mr Mike Smith, Banbury, Oxon.

Winners of the Double LP Album:

Mr C. Floyd, Woburn Sands, Milton Keynes; Mr A. C. Nielsen, Westmoor, Tyne & Wear; Ms Hazel Lawrence, London; Mr Brian Nissim, London; Mr J. T. McIntosh, Long Eaton, Nottinghamshire; Mr Neil Plastow, Wood End, Coventry.

Winners of the Double Cassette Album:

Mr P. Weddeck, Evesham, Worcester; Mr Adrian Pike, Middlesbrough, Cleveland; Mr Robert Dailey, Livingston, West Lothian; Mr C. Waters, Leigh-on-Sea, Essex; Mr P. Maddocks, Needham Market, Ipswich; Mr D. J. Sparks, Broomfield Chelmsford.

Winners of the VHS Video Cassette:

Mr Michael Tapley, Stalybridge, Cheshire; Mr Stuart Kitching, Chatham, Kent; S. E. Greenway, Walsgrave, Coventry; Ms Janet Donaldson, Stalybridge, Cheshire; Mr S. Flint, Morpeth, Northumberland; Mr Virie Williamson, Newmarket, Suffolk.

P&O Ferry Competition

The questions and correct answers were as follows:

1) How many land miles is it from Dover to Calais: **22 Miles.**

2) What is the approximate sea crossing time from Dover to Calais: **1 Hour 15 Minutes.**

3) Is Zebrugge in Holland, Belgium, France or Germany: **Belgium.**

4) An international insurance certificate is stongly recommended when taking your car abroad, what is it known as: **The Green Card.**

The First Prize-Winner will receive return tickets from Dover to Calais for one car and four passengers. Second and Third Prize-Winners will receive, return tickets from Dover to Calais for one car and two passengers:

First Prize-Winner
Mrs C. Horn, Scale Hall, Lancaster.

Second and Third Prize-Winners
Mr Kim Whyte, West Kingsdown, Sevencaks; Mr R. S. White, Worthing, West Sussex.

BSkyB TV Competition

The questions and correct answers were as follows:

1) Norman Tebbit is a regular BSkyB TV current affairs commentator. He is perhaps best known as: **An advisor to the unemployed on cycling.**

2) Which artist would you not normally expect to be specially featured on MTV (Madonna, Michael Jackson, The Rolling Stones, Gracie Fields): **Gracie Fields.**

3) The ASTRA satellite was blasted into space by which rocket: **Ariane.**

4) In the future who will regulate BSkyB TV: **The Independent Television Commission.**

The lucky First Prize-Winner will receive a BSkyB Satellite System, the first runner-up (plus another guest) will have the opportunity to visit BSkyB Studios in London and the second runner-up (plus another guest) will have the opportunity to visit MTV Studios in London:

First Prize-Winner:
Ms Mary Kaup, London.

First Runner-Up:
Mr Dave Hilton, Macclesfield, Cheshire.

Second Runner-Up:
Mr Graham Wickman, Tonbridge, Kent.

The Imperial War Museum Competition

The questions and correct answers were as follows:

1) Name the odd one out (Messerschmitt, Hurricane, Spitfire): **Messerschmitt.**

2) What is 'Matilda': **A Second World War Tank.**

3) What is the Sopworth Camel: **A First World War Aircraft.**

4) 'ENIGMA' played a major role in the Second World War. What was it: **An Encyphering Machine.**

The following six lucky people will each receive free tickets to the Imperial War Museum:

Mr D. R. O'Conor, London; J. S. R. Lawson, London; Mr N. Tree, Bristol; J. K. Clark, Broadstairs, Kent; Mr R. Lowe, Dundee; A. J. Hudson, Clacton, Essex.

A readers forum for your views and comments. If you want to contribute, write to: **The Editor, 'Electronics – The Maplin Magazine' P.O. Box 3, Rayleigh, Essex, SS6 8LR.**

AIR YOUR VIEWS

Dear Editor

CASHTEL Comments

Dear Sir,
I have just used your CASHTEL service for the first time and liked the facilities it offers. However, I would like to make a couple of suggestions that might make it of more use to your customers, after all, placing orders and checking stock can probably be achieved as quickly over the phone by voice. How about introducing a message area? In this people who are having problems with projects can ask for help from others, or if they've solved a problem, could leave a message containing the solution. Letters to 'Electronics' could also be sent this way. There could also be an area for small ads run along the same lines as the Classified Ads section in the magazine. Another suggestion is the introduction of a file area. As more and more projects these days are micro processor based, or are for use in a computer, software is needed for them. This area could then be used to enable this code to be downloaded. Anyone who has written applications for one of your projects e.g. the PC multi IO card in the April/May issue of 'Electronics' could upload it for others to look at, play with and modify for their own use. Well that's it, and keep up the good service.
N. Smith, Northumberland.

Thank you for your suggestions they have been passed onto the Data Processing Department.

Thumbs up for NICAM

Dear Sir,
I am writing to say what a superb project the NICAM decoder kit is. I have completed the project, complete with remote control and am enjoying listening to the stereo broadcasts (when the TV companies actually transmit them). This brings me to the next point and I would appreciate your comments. Firstly, is it possible to design, as a future add-on, a loop-through facility so further TVs/Videos can be placed down line of the NICAM unit. Secondly, the indicators to show NICAM/FM work okay but is it possible to have a stereo/mono indicator as well? As you mention, all the TV companies seem to transmit the NICAM carrier and hence turn on the NICAM light. However, is it possible to have a detector to show a mono or true stereo broadcast? A commercial unit does have this facility and if the cost is not too prohibitive, could it be considered for a '2nd time around'?
J. Herd, Middlesex.

I assume that you wish to re-modulate the composite video signal from the NICAM unit in a similar way that a VCR does. This would enable the video signal to be routed into a TV without a composite input, so that when you change channels on the NICAM unit the TV picture follows suit. To achieve this the Audio/Video Modulator Kit (LM78K) can be used, please note that it will not re-modulate the NICAM carrier! The stereo audio signals should be routed to your Hi-Fi in the normal way. Constructional details may be found in 'Electronics' issue 30, order as XA30H. Regarding the stereo indicator LED, a number of commercial units erroneously label the NICAM indicator as 'stereo'! However, it is possible to deduce whether the NICAM broadcast actually is in stereo or just 'digital quality mono' by comparing the signals in the left and right channels. If the left and right channel signals are exactly the same, the broadcast is mono, whilst if they are different (over a period of time) then the broadcast is in stereo. In fact a number of stereo TVs use this method to indicate stereo video cassette soundtracks.

★★★★★★★★★★★★★★ S·T·A·R L·E·T·T·E·R

This issue, J. M. Clark from Newcastle-upon-Tyne receives the Star Letter Award of a £5 Maplin Gift Token for his letter in defence of the beginner.

Dear Editor,
Yes, it's me again on about Square One and P. Baxter's letter. You are still hedging and the thought of P. Baxter of Gosport getting the £5 Gift Token for slagging beginners has me almost in a fit of apoplexy. There again it is your magazine and you can favour those who criticise those who criticise you. I must admit I admire your editorial style, if nothing else it generates a lot of mail.
Just a couple of small points P. Baxter, I do not require help with double-sided 'painting by numbers' style circuit boards and the assumption that I use my legs to visit the local library grossly offensive. Particularly as I work with the profoundly disabled, some of which were until recently considering electronics as a worthwhile hobby.
I am also a Qualified Adult Trainer in the field of Information Technology and know intimately the value of initial success and positive feedback.
Perhaps it was the fault of the educational system as was, and the Germans will do it for me, but in order to beat the Germans at their own game it is necessary for me to learn NOW! I was hoping the beginners course would fill some of the gaps in my education, at present it has made me realise how much I have yet to learn.
My main bitch is with the patronising style of your reply, the letters you have chosen to publish and handling of the situation in general. A small layout diagram (remember it was a series for beginners, and the very first of the series at that) would have shot this whole thing down. It was the very fact that not only was there a difference between the photograph and the circuit diagram, the photograph was also not particularly clear.
In your reply to my previous letter, you highlight the constructors guide which I have found useful. Also I have used many books from my local library and have had success with the follow-up circuits in the same series, but then again these are in the form of 'painting by numbers', to quote P. Baxter.
Please note, on most, if not all of your project circuits you include a copy of the two sides of the PCB legend and track.
I am even finding writing this letter very frustrating. I do not want to be the type who spends his/her time whining. I would like a simple line diagram of a vero board circuit from which I am sure I can work out where I have gone wrong. Please stop being ambiguous and patronising and expedite this situation. There have been far too many letters on this subject. I feel I have been more than patient waiting for a simple solution to a simple problem and if it were not for my determination and bloody mindedness I would have long ago let this drop.

Thank you for your comments and we hope that printing your letter goes some way towards redressing the balance. In future we will, where it is possible and practical, include more data, strip-board layouts, etc.

★★★★★★★★★★★★★★★★★

Composite to RGB Encoder

Dear Sir,
In continuation from R. Follet's letter in your latest issue of the Maplin Magazine, I would like to ask if it would be possible for you to incorporate a 'video demodulator' similar to the Audio and Video Modulator (p278 1990 catalogue) but the other way round. Giving RGB video and audio outputs from a modulated UHF input, so that other people like myself who have a TV and RGB computer monitor virtually next to each other, can do away with their TV and use their monitor as a TV. I have seen such items advertised, however, their price is a little bit over the top, I think!
Chris Willoughby, Sheffield.

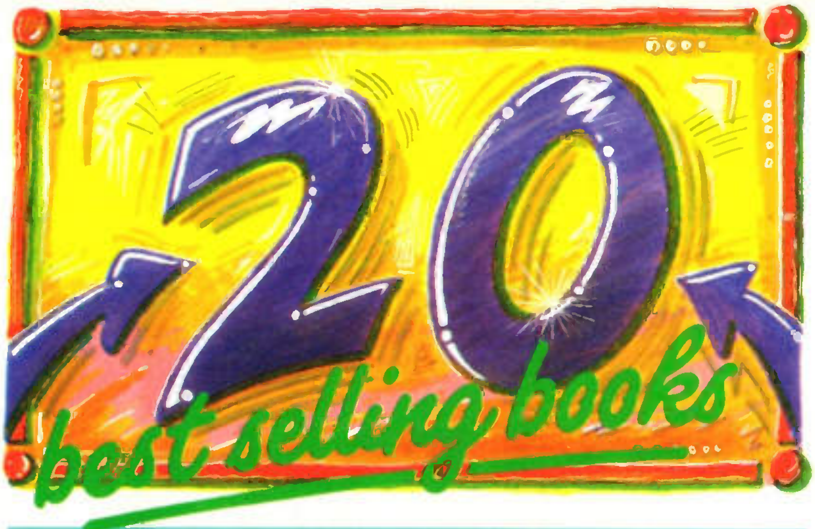
Thank you for your suggestion it has been passed onto the lab.

Cover Story

Dear Sir,
Re 'Air Your Views' in the Apr/May issue, yes, the catalogue also makes me see red. Although we have only fairly recently started to order from you we have already acquired some 'odd' items through misreading the red order codes. Also while we are writing, the advertisement for the catalogue on the rear of the recent issues looks more like a horror comic than a serious publication and it is not welcome on my desk for view by customers and engineers. Incidentally, there are not many W H Smith outlets in Scotland, Menzies have most of this trade. Anyway thanks for the prompt despatch of orders but it would be nice to get the right stuff all of the time.
Electro-Acoustic Developments, Berwickshire.

Comments noted.

These are our top twenty best selling books based on mail order and shop sales during February and March '91. Our own magazines and publications are not included in the 'chart' below.



The Maplin order code of each book is shown together with page numbers for our 1991 catalogue. We stock over 250 different titles, covering a wide range of electronics and computing topics.

Number ONE

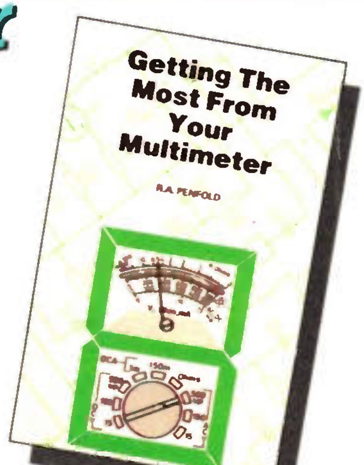
Getting The Most From Your Multimeter

by R.A. Penfold

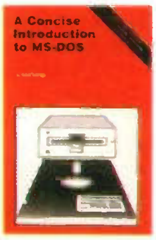
A unique, and very useful book, showing you how to best use your multimeter. *(WP94C) Cat. P74.*

Previous Position: 1

Price £2.95



2 NO CHANGE

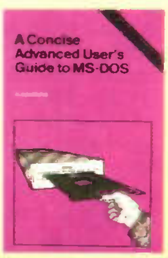


A Concise Introduction to MS-DOS, by N. Kantaris. *(WS94C) Cat. P91.* Previous Position: 2. **Price £2.95.**

3 ▲

How to Expand, Modify and Repair PC's and Compatibles, by R.A. Penfold. *(WS95D) Cat. P93.* Previous Position: 4. **Price £4.95.**

4 ▼



A Concise Advanced User's Guide to MS-DOS, by N. Kantaris. *(WS44X) Cat. P91.* Previous Position: 3. **Price £2.95.**

5 ▲

IC555 Projects, by E.A. Parr *(LY04E) Cat. P78.* Previous Position 6. **Price £2.95.**

6 ▲

Power Supply Projects, by R.A. Penfold. *(XW52G) Cat. P77.* Previous Position: 7. **Price £2.50.**

7 ▲

An Introduction to Loudspeakers and Enclosure Design, by V. Capel. *(WS31J) Cat. P80.* Previous Position: 10. **Price £2.95.**

8 ▲

How to Use Oscilloscopes and Other Test Equipment, by R.A. Penfold. *(WS65V) Cat. P74.* Previous Position: 9. **Price £3.50.**

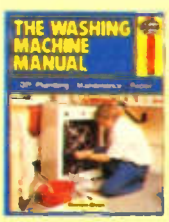
9 ▼

International Transistor Equivalents Guide, by Adrian Michaels. *(WG30H) Cat. P70.* Previous Position: 8. **Price £3.95.**

10 ▼

The Maplin Electronic Circuits Handbook, by Michael Tooley. *(WT02C) Cat. P75.* Previous Position: 5. **Price £10.95.**

11 ▲



Washing Machine Manual, by Graham Dixon. *(WS98G) Cat. P87.* Previous Position: 15. **Price £11.95.**

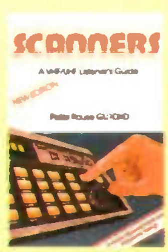
12 ▲

How to Use Op-Amps, by E.A. Parr. *(WA29G) Cat. P73.* Previous Position: 14. **Price £2.95.**

13 RE-ENTRY

Electronic Music Projects, by R.A. Penfold. *(XW40T) Cat. P82.* Previous Position: Re-Entry. **Price £2.50.**

14 ▼

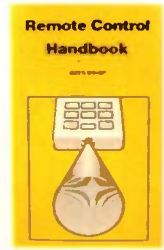


Scanners, by Peter Rouse. *(WP47B) Cat. P85.* Previous Position: 12. **Price £8.95.**

15 ▲

Electronic Security Devices, by R.A. Penfold. *(RL43W) Cat. P77.* Previous Position: 17. **Price £2.50.**

16 ▼



Remote Control Handbook, by Owen Bishop. *(WS23A) Cat. P77.* Previous Position: 13. **Price £3.95.**

17 NEW ENTRY

Newnes Guide to TV and Video Technology, by Eugene Trundle. *(WS34M) Cat. P86.* Previous Position: New Entry. **Price £12.95.**

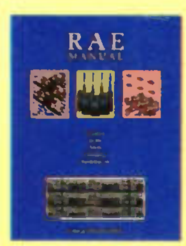
18 ▼

Practical MIDI Handbook, by R.A. Penfold. *(WP96E) Cat. P82.* Previous Position: 16. **Price £6.95.**

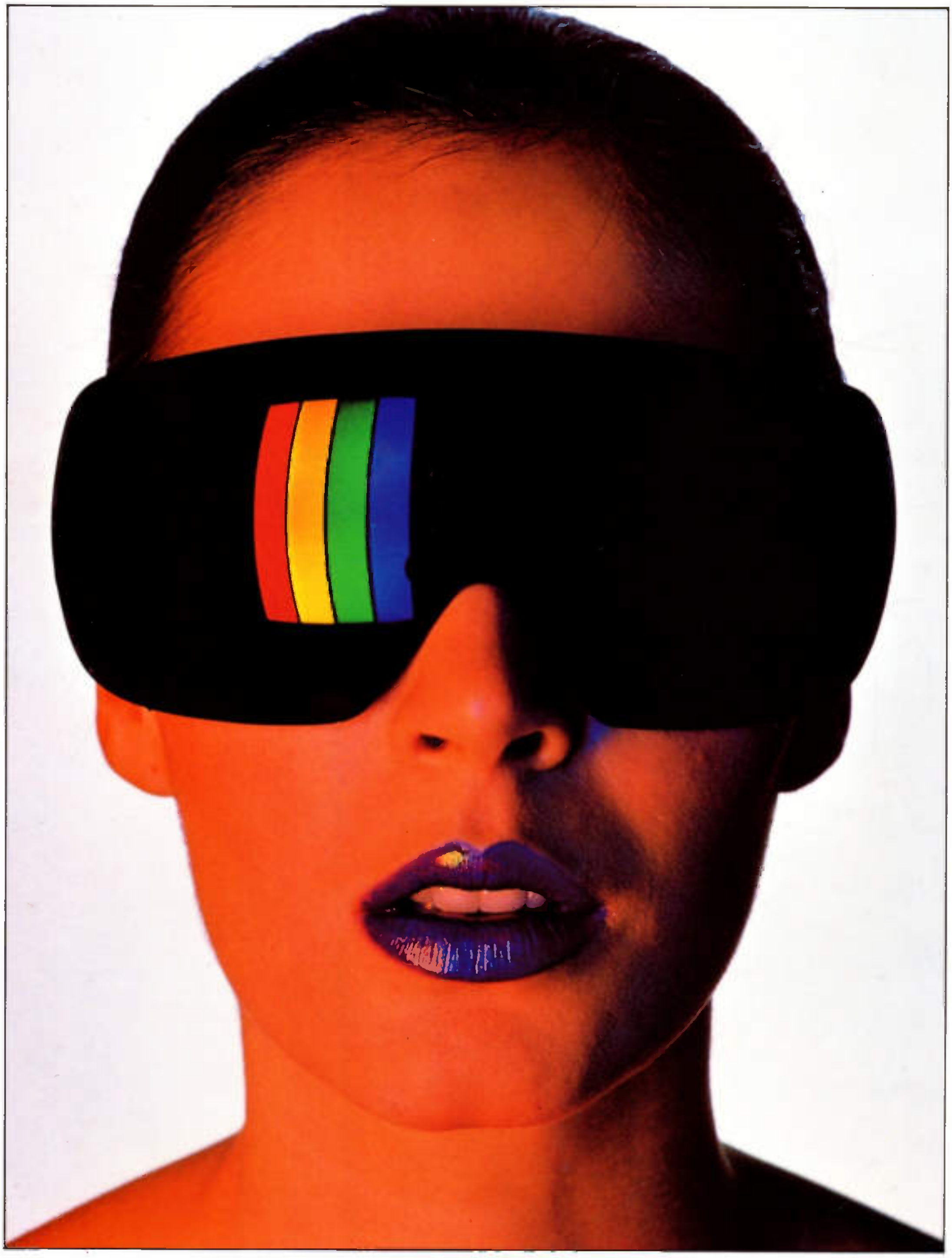
19 RE-ENTRY

Mastering Electronics, by John Watson. *(WM60Q) Cat. P74.* Previous Position: Re-Entry. **Price £5.99.**

20 NO CHANGE



Radio Amateurs Examination Manual, by G.L. Benbow. *(WP87U) Cat. P83.* Previous Position: 20. **Price £6.45.**



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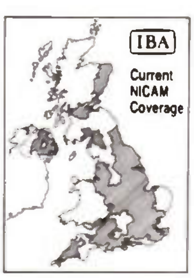
Nicam hi-fi stereo will turn your living-room into a living room of sound! You don't settle for second best with television picture quality, why settle for second best in television sound quality? Nicam sound is the new high quality digital stereo sound system, pioneered by BBC, ITV and TV/video manufacturers. In fact so good is Nicam it is comparable to the superb sound reproduction of the compact disc, when played through your existing hi-fi arrangement. If your television hasn't got a built-in Nicam decoder, you will need the Maplin Nicam Tuner System. Ultimately almost all of your favourite programmes will be broadcast in superb hi-fi quality stereo-sound. Without a Maplin Nicam Tuner you won't be able to capture every sound to its full.

Nicam hi-fi stereo. Catch your breath, open your eyes, and pin back your ears! It's what your hi-fi system was made for . . . It's what your ears are made for!

DIGITAL STEREO TV SOUND FROM YOUR HI-FI

The complete kit contains all the components required to build the unit. However you will also need: a power supply, 12V at 600mA regulated e.g. YZ21X at £8.95; a co-ax Y adaptor e.g. FS23A at £1.20; a co-ax lead to connect to your TV or video; RW36P 2m long at £1.28, JW39N 5m long at £1.98, or JW40T 10m long at £2.95; a phono lead to connect to your hi-fi e.g. RW50E at 98p or a SCART/Peritel lead JW36P at £4.95. An infra-red remote control kit is also available LP20W at £29.95.

Complete kit LP19V only £139.95 incl. VAT + £1 mail-order handling charge.



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