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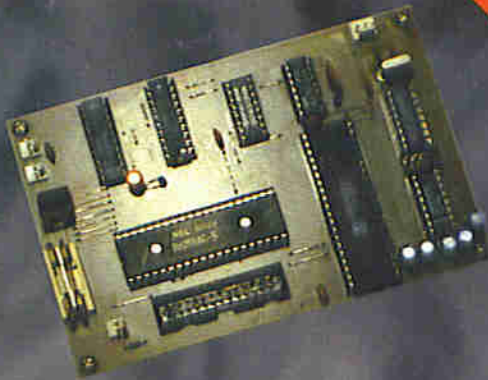
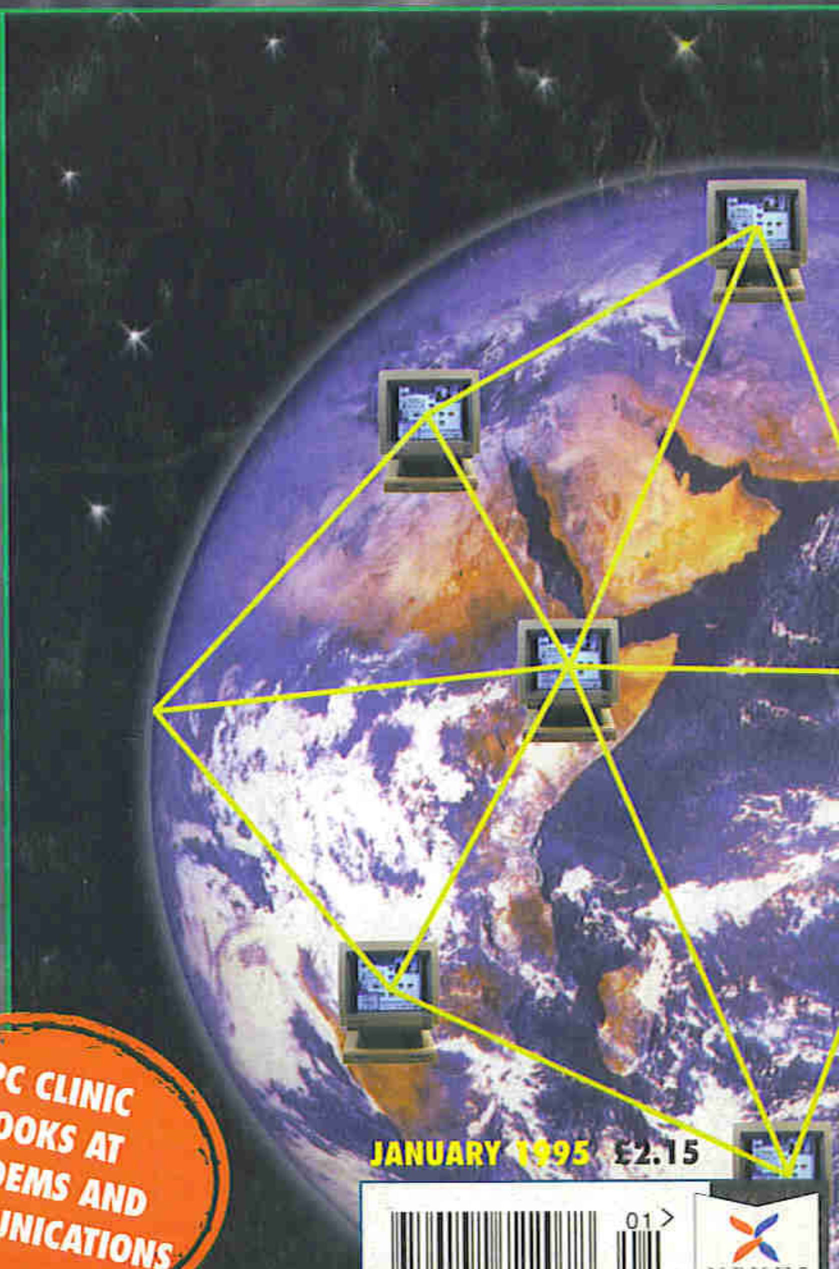


THE MAGAZINE FOR PRACTICAL ELECTRICAL & ELECTRONICS COMPUTING

Electronics and the Internet



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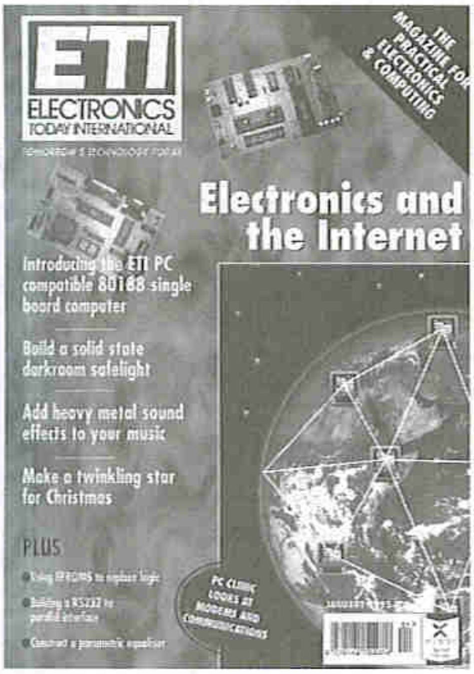


Volume 24 No.1

& Features Projects

Regulars

ETI ELECTRONICS TODAY INTERNATIONAL News...

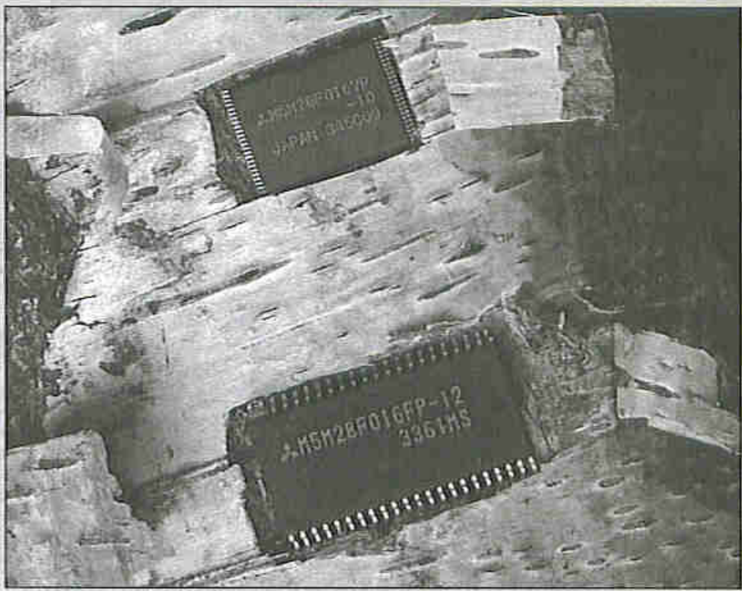
New 16Mbit flash memory

Mitsubishi is now producing 0.5um design rules 16Mbit Flash memory devices which are ideal for use in portable systems where low power operation is essential, as well as solid state disk drives and memory card applications.

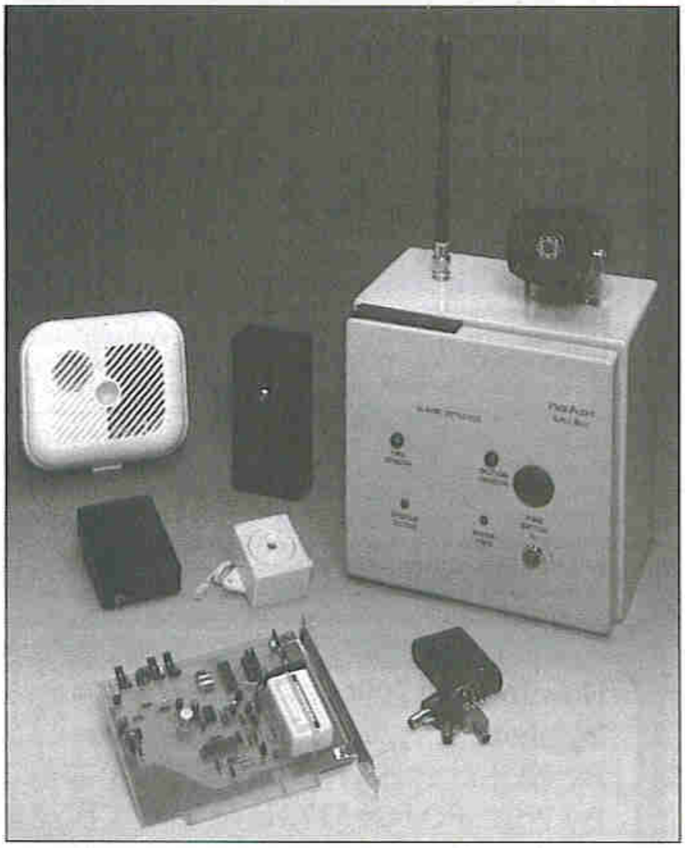
The 2Mwordx8bit organised devices are available with high speed access times of 100,120 and 150ns featuring symmetrical 64kbytes/block erase with automatic byte programming and block erasing operations. Erasing operations can further be suspended and resumed.

These 16Mbit Flash memories are available in 44 pin SOP and 48pin TSOP packaging. This first generation 16Mbit device requires power supplies of 3.3V and 12V; in operation it consumes 108mW and on standby just 3.6mW. A second generation device requiring just a 3.3V power supply will be launched in mid 95.

For further details contact Mitsubishi on 0707 276 100.



Low cost PageAlert protects PCs against theft



Derbyshire based Alliance Sales have just launched a low-cost, user-friendly system for protecting PCs against theft. It is ideally suited for securing systems in public areas, remote locations and high crime areas. Using a sensor, it detects any unauthorised movement of protected items and then automatically transmits a radio frequency warning signal to a remote control box, as well as optionally activating its own internal alarm and visual indicator. The control box then sounds its own alarm and simultaneously alerts security staff by automatically paging them, to ensure an immediate response.

The internal half-length sensor card which protects PCs is quickly and easily installed within minutes and comes complete with an integral rechargeable battery, whilst other equipment such as printers or monitors are protected by a small external sensor with a low battery indicator. PageAlert responds as soon as movement, or optionally smoke, is detected, ensuring that even if the system is quickly disabled, the signal will already have been transmitted to both the control box and pager.

The control box is able to respond to an unlimited number of sensors or, optionally, can be zoned to show which PC has been moved and where. It can also be set to automatically dial the police or external security staff.

For further details contact Alliance Sales (Europe) Ltd, on 0794 830222.

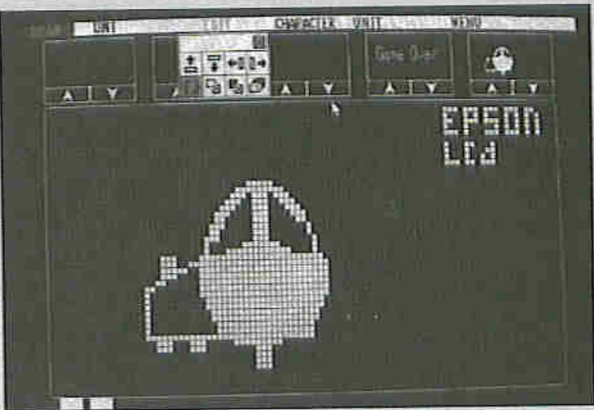
Emulator provides easy LCD panel design

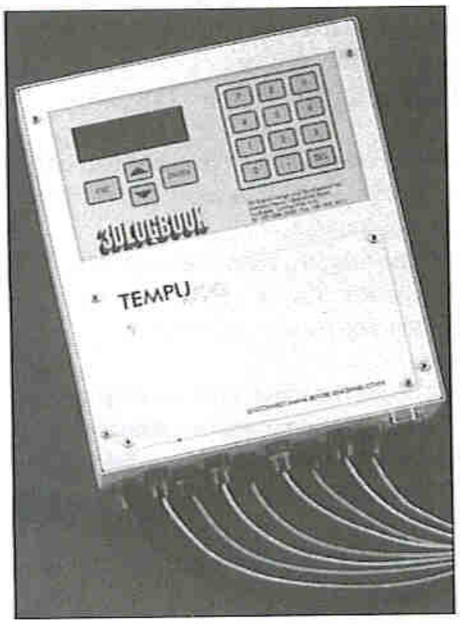
An LCD emulator, which uses the screen of a PC to simulate real-time display operation almost exactly, has been added to the suite of development tools for Epson's popular SMC62 family of very low power 4-bit microcontrollers.

Plugged into a free expansion slot of the host system, the emulation board connects the PC to the evaluation board, allowing easy on-screen design of an LCD panel. When an in-circuit -emulator (ICE) is used, a second PC is required for ICE control. Operated through clear, menu-driven commands, the emulator software gives easy control of all important parameters such as the number of segments (up to a maximum or 80) and number of commons (up to a maximum of 8), as well as allowing the user to define the LCD display size on the host PC (with a maximum of 480x240 dots) and the size of the individual display characters (up to 96x48 dots). Various patterns such as seven segment and dot matrix can be represented. Used with an i80286 CPU running at 10MHz, the emulator responds at 8Hz when configured as 50 segments x 8 commons.

The LCD emulator is an extension to a range of development tools which, in addition to an ICE and evaluation board, also includes a cross assembler, option generator, melody assembler and mask data checker. These tools can be used on any IBM PC or close compatible, platform, and together provide a comprehensive development environment for Epson's range of over 20 microcontrollers which are designed around the company's low power SMC6200 4-bit CMOR core CPU.

For further details contact Epson on 0442 227331.





Temperature monitoring, logging and alarm system.

The Tempulog is designed to monitor temperature and raise an alarm if preset upper or lower limits are exceeded, or if the drift rate exceeds a preset value. The sensors used by the system are Platinum Resistance Thermometers type PT100 or PT1000 4 wire system with resolution of 0.1C over the range -200C to 500C. Eight channels are available for the monitoring, and are scanned every ten seconds. There is sufficient battery-backed RAM on board to accommodate 10,000 readings which may be downloaded into a PC for display and analysis. PC data analysis software package is supplied with the instrument.

The alarm system consists of a highly audible signal plus a relay closure - which can be used to trigger any other signalling device. in addition to the audible and relay, a modem and an autodialler may be connected to the RS232 port of the instrument to advise that there is a problem via telephone lines.

The instrument is mains operated, but the parameters' setup, time, date, and data readings are battery-backed. However, a battery operated option is available. For further information contact 3D Digital design and Development Ltd, Tel: 081 886 3668.

Weekly plug-in timer switch

A new attractively styled weekly timer switch is now available from Maplin Electronics and can automatically turn 'plug-in' mains operated appliances on or off at predetermined times. The unit is ideal for controlling devices that are used frequently, like lights, heaters, aquariums, electric blankets, greenhouse heaters etc.

The weekly timer helps save energy by automatically turning appliances off when they are not needed and, if used in conjunction with Economy 7 electricity rate, can make considerable savings by timing washing machines, dishwashers, dryers etc to operate during the cheap rate period. A further useful security application is to automatically switch lights and radios on and off at night while away from home, to give the impression of the house being occupied.

The timer can operate one set of four daily programmes for weekdays, and a different set of daily programmes for the weekend. The unit comes complete with back-up batteries and, if purchased before Feb 28 1995, costs just £14.99 from any Maplin store or by mail order. For further information contact Maplin on 0702 554161.

Tomorrow's Technology Update
Chaotic Neural Nets

Last month we took a look at some of the developments in the quest to create intelligent machines, including the development of microchip neural networks. We follow this up with some more news of current research into neural networks.

Research workers at U.S. and Japanese universities have demonstrated that chaotic neural networks can be built from a semiconductor process commonly used for digital filters. Preliminary results of the experimental work indicate that switched capacitor circuits can tackle application problems that both conventional analytic methods and traditional neural networks have found tough to crack. The key to the chip implementation, is the digitisation of time only, rather than both time and space, as in conventional computer-based signal processing.

Professor Kazu Aihara at the University of Tokyo has invented a mathematical model of a neuron that models chaotic dynamics in discrete time. Switched capacitors do not digitise the space domain, rather, they store a continuously variable analogue charge that can be passed from one capacitor to the next, bucket brigade style. Simple weighted feedback connections to previous capacitor stages are varied to affect the signal processing.

Aihara's discrete-time equations enabled a switched capacitor microchip to model a neural network. Aihara, however, believes the most important aspect of his work is that it is based on observations of the real neurons. "My neuron model with chaotic dynamics was proposed on the basis of physiological properties of real nerve membranes and was demonstrated not only numerically, with the Hodgkin-Huxley equations, but also experimentally, with giant squid axons," he said in a recent interview.

Tokyo Denki University professor Yoshihiko Horio came up with the original idea of taking the mathematical model of professor Aihira and putting it into a switched-capacitor chip. Horio tried a software simulator written by Columbia University researcher Suyama, and achieved favourable results. Suyama was so impressed that he invited Horio to Columbia for two years during the development process.

The first chip to be developed at Columbia has nine neurons, each composed of an op-amp and four capacitors with eight switches (reminds me of an early Percepteron developed at Imperial College London - Ed.). The second generation chip adds an op-amp for the voltage -controlled resistor, which controls the amount of chaos.

Suyama's team is testing a multichip setup on a breadboard to simulate 16 neurons fully interconnected with 256 synapses. The second generation chips will house 24 neurons per chip; a separate synaps chip will interconnect the network fully, with 576 synapses. The next generation will also be cascadable so that three neuron chips and nine synapse chips can form a single neural network with 72 neurons and 5,184 synapses.

Chaos theory may yield a more accurate representation for simulating biological neural networks. From an engineering perspective, however, it may prove able to crack a residue of very complex problems that have resisted traditional solutions. Weather prediction epitomises these problems. Until now, scientists assumed that weather phenomena defy accurate long-term prediction because their initial conditions cannot be specified accurately enough.

The traditional theory maintains that a residue of random noise in the initial condition specification spoils the accuracy of long-term predictions. Statistical techniques abound to filter and catalogue the random gyrations of that noise but, as with quantum mechanics in physics, only a statistical understanding has resulted. Chaos theory, on the other hand, has demonstrated that a large measure of what once appeared to be random is actually deterministic. Using the mathematics of chaos theory, the pattern of such chaotic phenomena can be represented without the uncertainty of statistics.

By identifying the chaotic pattern - the repetitive limit cycle - many of the macroscopic characteristics of chaotic phenomena can be predicted. Aihara's use of chaos theory solved one enduring problem for neural network researchers, according to Suyama: getting stuck in local minimums.

A computer would merely go through the whole map, comparing the depth of each spot to find the deepest valley. The process taken by a neural network, however, would be analogous to dropping a marble and juggling the relief map around - an approach that could trap the marble in a depression that may not be the lowest one. A neural network would start at a random point and follow the line, say, of steepest descent. Thus, the neural network will always find a deep spot, but not necessarily the lowest spot on the map - at least not at first.

When such a local minimum is found, the most frequent solution is to re-initialise the network randomly and start again. Some neural approaches add noise at this point to jiggle the map and dislodge the marble from local minimums. Aihara's model adds chaos instead of noise, since chaos is more effective in kicking the marble out of local minimums, according to Suyama.

According to Suyama, chaos is guaranteed to find the global minimum, no matter what the initial conditions. The only problem is getting it to stay there but researchers already think that they have a solution which will keep the marble in the lowest depression.

Flexible TV Screens

As a follow-on to the feature on bio-electronics in the September issue of ETI, the CNRS Laboratory for Molecular Materials near Paris have just announced the development of a technique for the development of flexible organic transistors that uses no metallic components and are thus ideally suited to the creation of large LCD displays.

These devices have been developed by a team of researchers under Francis Garnier, a team which had already in 1990 developed an organic transistor that used gold and silver for the contacts. The latest development has replaced the metallic contacts with ones made from a graphite-based polymer ink.

The transistor is, in fact, a field effect device and can function as either a switch or an amplifier. The transistors are fairly large in comparison with those used in a standard IC; about ten times as big, about 50 micrometers square. Their large size means that they will probably not be used to construct an organic microprocessor but, because they are both flexible and virtually transparent, they will prove ideal for creating the active circuitry on large LCD display panels.

The organic semiconductor used is a 40 nanometer thick layer of a sulphur-based polymer called sexithiophene. It has properties very similar to silicon, but has the advantage that transistors and their connecting circuits can be created using fairly simple printing based techniques. This means that there is no need for all the very expensive high vacuum, high temperature equipment that is required to create silicon based circuitry.

The ease with which organic transistors can be made, and their low production cost, look set to generate a lot of new applications. Besides allowing the production of very large low-cost LCD displays, they could also be directly 'printed' onto plastic smartcards. In this application, low cost is an important factor, as is the fact that they are flexible and therefore more robust than their silicon equivalent.

The organic transistor is an area of development which we can all expect to hear a lot more of during the coming months.

BT switch to smart cards

BT has just announced that it is placing a multi-million pound contract for new phonecards and payphones based upon 'smart card' integrated microchip technology.

Three companies, GPT, Landis & Gyr, and Schlumberger will provide the payphones able to take smart cards, and two companies, GPT and Gemplus will produce the phonecards. BT plan the introduce the service some time in 1995.

The new smart phonecards will be a prepaid card similar in size and card values to the existing design, and to that used by French Telecom, and will be used in a similar way. The value of the call will be debited from the integral chip on the card.

The design of the new cards will allow more flexible and usable space for creative, customised designs and joint promotional opportunities with other companies (it is rumoured that they will be compatible with the new Mondex smart cash card).

There are currently more than 39,000 cardphones out of a total of 126,000 payphones in the UK, and BT believes that this latest evolution in its payphones will ensure the reliability of the service, with the target of over 90% of all payphones working at any one time. The company also see this new card as offering the first step towards advanced services for customers in the future, including the potential use of the card as payment for other services.

Event diary

1-4 December	Christmas Computer Shopper Show, Grand Hall Olympia, London. Tel 0181 742 2828
6 December	Open Forum - questions and answers on anything connected with amateur radio, Sudbury and District Radio Amateurs. Tel: 0787 313212
6-8 December	CD-ROM 94, Olympia 2, London. Tel: 01865730275
12 December	Open house. Stratford upon Avon and District Radio Society. Tel: 01789 740073

If you are organising an event which you would like to have included in this section please send full details to: ETI, Argus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST. Clearly mark your envelope Event Diary.

The ETI Amateur Robot Competition

Following our November feature on machine intelligence, we would like to make an initial announcement about the First Electronics Today International Amateur Robot Competition. A competition which is provisionally scheduled to take place at the Model Engineering Exhibition in January 1996.

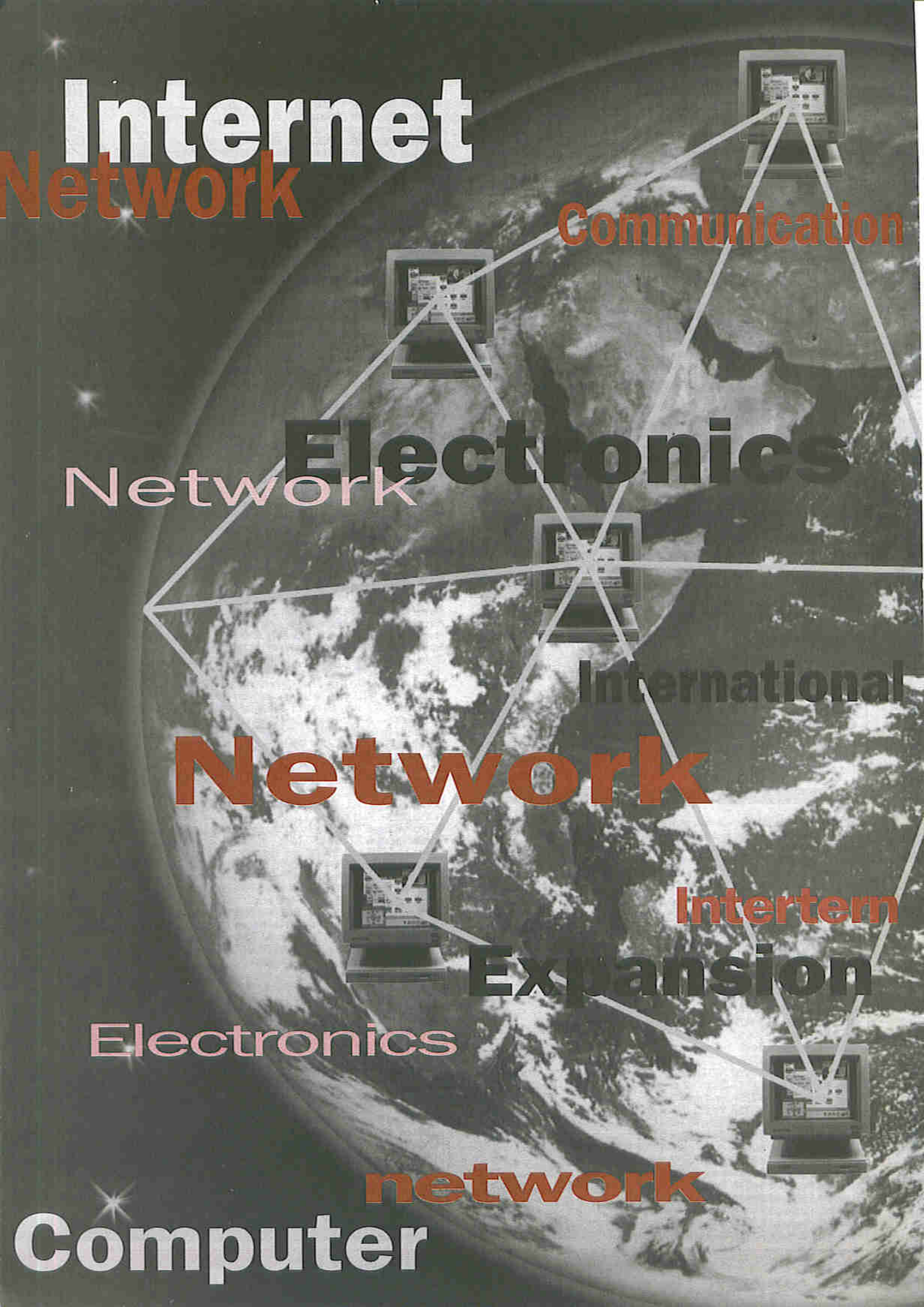
The competition is to find a walking robot which can, in the shortest time, traverse a course that will include slopes, stairs and numerous different obstacles. The robot must be completely autonomous with no connection or communication with any external computer or individual. It must therefore contain its own processor and its own power source.

The dimensions of the robot must be such that at maximum leg extension it will fit within a 50cm cube. It can have between one and ten legs, and at no time while traversing the course must the main body of the robot touch the ground. The maximum weight of the robot is set at 15Kg.

The competition is open to individuals or groups, with the exclusion of those who are professionally involved in the design of walking robots (such as teams at NASA, MIT, etc. - sorry guys! This is, after all, an amateur robot builders competition). Although those professionally involved will be more than welcome to attend the competition and show off the capabilities of their designs.

More details about the course design, the judging and of course the prizes, will be published over the coming months in ETI. We will also be publishing a series of articles on subjects which should be of assistance to robot builders and designers.

If you are interested in entering a robot for this competition then write to us as soon as possible at ETI giving your name, address, and contact phone number, plus a few details about yourself or your group. This information will help us to plan the event. Preliminary entry notification should be sent to: ETI, Robot Competition, ASP, Boundary Way, Hemel Hempstead, Herts HP2 7ST.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Electronics and the Internet

A look at how electronics engineers can make use of the very rapidly expanding international computer network

I suspect that most people reading this article will already have heard of the Internet and some will already be using it. Indeed, it has been the subject of numerous pieces in computer magazines and even the Sunday press. But it is a development which is of such great potential importance to all of us that it deserves being looked at in some depth from the point of view of those of us interested in electronics and technology.

So what exactly is the Internet, and why is it so important?

Internet is a global computer network that links some 30million people in 152 different countries. It not only links individuals together and allows them to exchange data, programmes and electronic mail, but it also links individuals to a global network of large computers and databases which can be used to obtain information about virtually every subject under the sun.

In short, Internet is the communications system of the future, the initial version of the much touted information superhighway that should link us all within the next 20 years. Indeed, the number of users around the world is already expanding at the phenomenal rate of over 5% per month.

The superhighway will be based on very high speed fibre-optic cables. Only a very small percentage of the population of the major developed countries are connected to optical cable systems, and virtually no-one in the poorer and less developed parts of the world. But with Internet this connection to a fibre-optic cable network is not necessary since it can be accessed using conventional phone lines. All that is needed to connect to Internet is a PC, a modem, the appropriate communications software, and a subscription to one of the Internet providers who will link your phone line to the Internet.

So for a fairly modestly outlay and a monthly cost of as little as £10, anyone can become connected to the Internet, but apart from acting as a global communications and information system what is so special about being connected and why should Internet be of special interest to the electronics and technology community? The answer is that via Internet one can become part of any one of over 10,000 different global special interest groups, a sort of high technology equivalent of a club.

Origins of the Internet

The origin of the Internet dates back to the late 1960s and the realisation by the US government that computers would have an enormous impact on education, military research and development. This realisation led to the funding of an experimental network that would allow information to be exchanged between computers on different sides of the continent. The network was funded by the US Advanced Research Projects Agency, and became known as ARPANET.

Work on ARPANET started at the beginning of January 1969 and initially involved research into new computer networking technologies. The contract to build the initial components of ARPANET, the Interface Message Processors (IMPs), was given to Bolt, Beranek and Newman Inc of Cambridge, Massachusetts. The first four IMPs were delivered to ARPANET sites in August 1969.

These sites were Stanford Research Institute, the University of California Santa Barbara, the University of California Los Angeles, and the University of Utah. When these four IMPs were turned on and successfully started exchanging information, ARPANET was born - the date was 2nd September 1969.

This initial experiment showed decisively that a network of this type could be built and would work. This initial work was then refined and developed to a stage where it was sufficiently robust and extra nodes could be added or removed with minimal impact. By October 1972, the developers were able to give the first public demonstration to over 1,000 attendees in Washington DC. At this demonstration 40 terminals were used to flawlessly access large computers at different locations on the ARPANET.

The main Internet providers

There are now a large number of different ways to access the Internet, but by far the most popular is to use the services of one of the commercial Internet providers, there are many of these but here are just four of the main UK Internet providers:
Compuserve - They are one of the world's largest personal computer networks and also provide a good way to access the Internet. - they can be contacted on 0800 289378.
Delphi - this organisation, part of News International, publishers of the Times, is one of the largest UK Internet providers and can provide access for as little as £10 per month. - they can be contacted on 071 757 7080.
CIX - they are one of the original personal computer networks and can offer users both the facilities of a network and full access to Internet - they can be contacted on 081 390 8446.
EASYnet - a UK-based Internet provider which can link you to the Internet via Pipex, a corporate net-supplier. Fees start from £9 per month - for further information contact them at 39 Whitfield Street, London.

A large part of the enormous technological success of the ARPANET development was undoubtedly due to the fact that it was funded by an agency that was connected with the Department of Defence. This not only gave them the funding but it also gave them access to equipment and technology which simply did not exist in the private sector at that time. This included special monitoring equipment that made it possible to perform remote problem analysis, equipment that was then totally unknown to phone company engineers.

Getting connected to Internet

Getting connected to the Internet is easy, all you need is a personal computer, a compatible modem running at between 2400baud and 14,400baud, the appropriate communications software, and a subscription to one of the Internet providers. With the basic hardware and software installed, it is simply a matter of connecting your modem to a phone line, then setting the correct baud rate and data transfer parameters for the information provider that you will be using. The next step is to use your communications software to dial the phone number for the communications link between your computer and the Internet provider's computer.

Thus, if one were using the Delphi service one would have the system dial 071 284 2424. As it is dialling, the modem should generate audible dialling tones, and then produce a high-pitched squeak; a second or so later the communications software terminal display will display a message saying what the system is connected to, in this case Delphi. One then simply enters @D followed by the Return key, the system will respond with DELPHI CONNECTED on the screen and proceed to request your user name and password.

At this stage, you are connected to the Internet provider's system and free to explore its services and those of Internet. Most such systems provide the user with an easy to use menu based access.

The communications protocols

In communications technology terms, the major development to come out of ARPANET was the creation of a formal set of rules which allowed all the computers, irrespective of who manufactured them, to communicate on the network. These rules are known as the network protocol and the networking protocol developed for ARPANET, Network Control Program or NCP included a new concept called packet switching.

The virtue of packet switching is that it allows a lot of different network segments to share a common transmission media. Prior to the development of this technology a large block of data would be sent directly over a dedicated phone line from one computer to another, but with packet switching this block of data is broken up into a large number of small chunks. Each of these chunks, or packets, contains information on the source and destination of the information. Because the information is broken into packets it can be sent through the network rather than through a single line, thereby greatly improving transmission efficiency and reliability.

These data packets are routed through the network by means of packet switching nodes. These nodes perform this function by using the source and destination data stored as part of the packet. When all the information packets have been received by the designated destination system, this source and destination data is removed and the packets reassembled to form the original data. This means that data packets from a large number of different computers can share the communications network

To increase transmission efficiency, it was necessary for the ARPANET developers to create routing algorithms which would ensure that a data packet was transferred from the source system to the destination system in the best and most direct way. This is a very complex problem and, if not solved in a satisfactory manner, can result in data packets getting lost in the network, simply going round and round without ever reaching their destination. The routing algorithm also needs to be able to cope with parts of the network failing, or being deliberately disconnected.

Throughout the early 1970s ARPANET researchers put a lot of effort into the development of communications protocols etc in order to provide maximum stability and reliability. The result of this work was a new standard, the Transmission Control/Internet Protocol, or TCP/IP. With this standard we can see the foundations of the Internet as we now know it today (it is interesting to note that the original NCP protocol was further developed by the Xerox PARC research centre to run on coaxial cable and became the widely used EtherNet local area network standard).

Expansion of the ARPANET

ARPA or, as it was known by the mid 70s, DARPA, wanted to encourage universities to use the ARPANET and to aid this process they developed in conjunction with Berkeley University in California a low-cost implementation of TCP/IP. Berkeley was chosen to do this because of its pre-eminence in the development of UNIX. By getting the UNIX operating system to support TCP/IP they could provide a software base which most universities, scientists and researchers were already familiar with.

With the addition of Berkeley UNIX to TCP/IP came a whole range of network features which are now familiar to Internet users - remote log-in, File Transfer Protocol, e-mail and file copy protection. It was one of these features, e-mail, which was subsequently to provide the main driving force for the expansion of both ARPANET and more recently Internet.

By 1975, the US Department of Defence was using the ARPANET to carry virtually all its non-critical data communications, whilst in universities across the US scientists and researchers were getting to grips with e-mail and developing databases and tools for accessing the information. The result was an enormous expansion in uses - by 1983 the volume of traffic on the net was starting to exceed the capacity of the phone lines that linked it. This led to ARPANET being split and all the military traffic was moved to a new DoD network called MILNET.

The remaining civilian side of ARPANET became the Internet, with the old ARPANET acting as the backbone which physically connected all the major sites. The Internet was still very small; in August 1981 there were just 213 host systems on the net, but it was growing rapidly. Five years later there were ten times as many host systems and the amount of data traffic between these systems had increased even more.

Reinforcing the backbone.

In the mid 80s the US National Science Foundation, NSF, established six super computer centres that were equipped with big Cray and Cyber systems. These six centres were linked by a new high speed backbone the NSFNET. This was initially rated at 56kbps, but by 1988 had been upgraded to 1.5Mbps. The NSFNET used the Internet TCP/IP protocols and was open to any NSF funded researcher who needed access to a super computer or the databases held at the six super computing centres.

By 1987, however, the NSFNET had become more general purpose and the NSF sought to change the way in which it was both funded and managed. The result was that management was handed over to a consortium consisting of the Michigan Education Research Information Triad, or Merit, (a non-profit-making body set up by eight Michigan universities), plus IBM and MCI communications, with a continued five year funding from the NSF.

This consortium was chosen because Merit could provide the best management, IBM the routing equipment, installation, maintenance etc and MCI the long distance phone lines. This consortium was formalised in 1990 to become a non-profit-making corporation called Advanced Network and Services Inc, or ANS.

A Congressional review in the late 1980s led to a decision to allow commercial traffic over the NSFNET. The rationale behind this was that commercial users brought more resources to the network. This, together with the fact that one of the main functions of NSFNET was the provision of information services, provided the other key components of Internet as we now know it.

The Cyberspace Cafe.

The development of the Internet has led to a parallel development of places where Internet users can physically meet; these are the so-called cyber cafes. The first of these, the Electronic Cafe International, appeared in California in late 1989, and there are now similar establishments in France, Brazil, Spain, Japan, and the UK. The London cyber cafe is called Cyberia and is located just off Tottenham Court Road. At Cyberia, customers can become part of a genuine community that offers a mix of coffee and Danish pastries with the use of Internet via eight on-line PCs. Customers are charged £1.90 per half hour on the Internet and Cyberia also offer assistance on using Internet. They are also selling access to Internet via EASYnet.

Establishments like Cyberia offer the ideal introduction to Internet, as well as providing a meeting point where individuals with similar interests can meet. So if you want to find out whether Internet has anything to offer you without having to invest in hardware and software, why not try it out at Cyberia.

The Cyberia cafe can be found at 39 Whitfield Street, London.

The following are just a few of the usenet groups which might be of interest to ETI readers:

bit.listserv.emusic-l	electronic music discussion list
clari.tw.electronics	electronics makers and sellers
clari.tw.telecom	phones, satellites, media, and general Telecom
comp.ai	artificial intelligence
comp.ai.fuzzy	fuzzy logic
comp.ai.genetic	use of genetic algorithms
comp.ai.neural-nets	aspects of neural nets
(inet)comp.ai.vision	artificial intelligence vision research
rec.radio.amateur.antenna	antennas theory, design, and construction
rec.radio.amateur.digital.misc	packet radio and other digital modes
rec.radio.amateur.equipment	production amateur radio hardware
rec.radio.amateur.misc	amateur radio practices, events, rules, competitions etc.
rec.radio.amateur.policy	regulations
rec.radio.amateur.space	amateur radio transmission through space
rec.video	video and video components
rec.video.cable-tv	technical issues on cable TV
rec.video.releases	pre-recorded releases on video and laserdisk
rec.video.satellite	getting programmes via satellite
relcom.commerce.audio-video	audio and video equipment
sci.electronics	circuits, theory, electrons and discussions
sci.engr.control	engineering of control systems
sci.med.telemedicine	clinical consulting through computer networks
sci.nanotech	self reproducing molecular scale machines
sci.space	space, space programs and related research
sci.space.news	space related news announcements
sci.space.shuttle	space shuttle and STS program

Internet cybersurfing

Cybersurfing is the term applied to users who are accessing the Internet usenet groups. These groups act as electronic special interest meeting points for Internet users. To date, there are nearly 10,150 such groups, covering an enormous range of specialised subjects ranging alphabetically from - alt.1d which looks at the subject of one-dimension imaging, to vmsnet.vms-posix which is a discussion group about VMS POSIX.

These usenet groups may all have rather obscure-sounding names but, in fact, they are quite logically organised. Thus, all groups starting with comp concern computer-related subjects, alt concern countercultural activities, soc is for sociological subjects, news for news reports, rec for recreational subjects, uk for UK-related subjects, and so on. Skilfully used, these usenet groups can provide a wealth of information about all sorts of subjects and they can also be used to request help on a particular problem from others who are interested in the same subject. This latter function is probably the most important and valuable for any scientist, researcher or developer and, of course, for the knowledgeable hobbyist.

Enter the Internet.

Whereas originally there was just the single ARPANET, there was by the late 1980s a number of different wide area networks. In the US there was ARPANET, MILNET, NSFNET, DDN etc; in the UK there was the university network JANET; there was NORDUnet linking the Nordic countries; CA*NET in Canada; the EEC-funded EARN network, plus many others run by organisations such as NASA and the big multinational companies.

It is the linking together of these networks spread across the globe that has created what we now know as the Internet. That they could be linked was due to the fact that they were all based upon the original ARPANET developed TCP/IP protocols. This meant that plugging a new network into the Internet was as easy as plugging a new computer system into the Internet. It just needs the appropriate packet switching nodes and routers.

Of course the Internet is not a rigid physical structure, it has a dynamic fluid structure; indeed someone has described it as being a 'cloud of computers' constantly shifting, constantly changing. It is this amorphous fluid structure which is the Internet's greatest strength. It has allowed it to expand and evolve very rapidly without any need for the system to be rigidly controlled. But although the Internet has a fluid communications structure, it has actually got a reasonably rigid physical structure. It consists of host systems, or nodes, which are linked into the network using either public phone lines capable of transferring a few kilobits per second or special high speed data lines transferring data at hundreds of megabytes per second. The host systems can range from a super computer to a desktop PC.

The host systems are collectively responsible for transferring information from its source to its intended destination. This means that they have to be able to capture and sort incoming data, dispatch it to the proper recipient, where necessary convert data format and protocols, and of course forward data to other hosts on the network.

These are all functions of the Internet control software running on each of the host systems, and the fact that the system works so well is proof of the success of using a highly flexible system. A flexibility which should ensure that Internet is capable of evolving to incorporate new technologies and will continue to work well into the next century

The future for Internet.

The great power of the Internet is that it is not controlled, directed or moderated. It is a free access system which is open to anyone, provided they observe some fairly simple rules of Internet etiquette. It is this freedom of access and use which allowed the Internet to play such an important role in the downfall of the old Soviet Union.

The Internet is not actually controlled by any single organisation or individual, despite the fact that it was originally created by an agency affiliated to the US Department of Defence. This means that it is not subject to government control or censorship. The only controls are ones of user etiquette. Thus there is little tolerance of the Internet being used for selling goods and services to other users on a commercial basis.

In the future, we will see greatly increased data transfer rates on the Internet; already most end users are shifting up from 2400baud modems to 9600 or even 14,400baud modems and within a year we should see the widespread use of modems with speeds of 28,000 baud or even higher. This increase in data transfer rates will facilitate the transfer of new forms of

There are also a number of special mailing lists which can be accessed, these include:

ECTL	researchers interested in computer speech interfaces
Electric vehicles	all aspects of electric vehicles
Electromagnetics	issues relating to electromagnetics
Embedded systems	embedded computer system engineering
GPS digest	discussions related to use of GPS
Music research	use of computers in music
Netjam	people collaborating on music composition using MIDI
Neuron	research into neural networks
Transputer	anything concerning designing and programming transputers

data, graphics images, sound and even video images, thereby opening up the Internet to an even greater range of information sources and services.

Not only will end user data transfer rates increase, so will transfer rates between host systems. Increasingly, the links between hosts are being implemented as fibre-optic cable linkages, where data transfer rates are being pushed well into the Gigabit range. Building such linkages are the subject of enormous investment by the world's main telecommunications companies with, in many cases, considerable amounts of government backing, all part of the 'Information Superhighway'.

The extremely rapid rate of expansion of the Internet means that it is getting harder and harder to precisely locate the information that you need. To solve this particular problem, we will soon all be using new software techniques which will search out the information we require. These are known as intelligent agents - special pieces of software which can be initiated by an user and which will multiply and automatically look at all the data resources attached to the Internet for information which matches the users' requirements. A potentially very powerful technique which should put even more information at the fingertips of Internet users.

The above are just two of the many different ways in which the Internet is continuing to evolve. Within just a few years we will be looking at a global information network that will probably link virtually every computer user in every country. A communications system which will be invaluable to individuals, to businesses and to governments. A system which will truly unify the peoples of the world.

E-mail over the Internet

E-mail is probably the most widely used Internet service and in theory it allows one to directly communicate with over 50 million people in 152 countries. E-mail is a bit like using a fax, or writing a letter; communications is via the keyboard, rather than by voice.

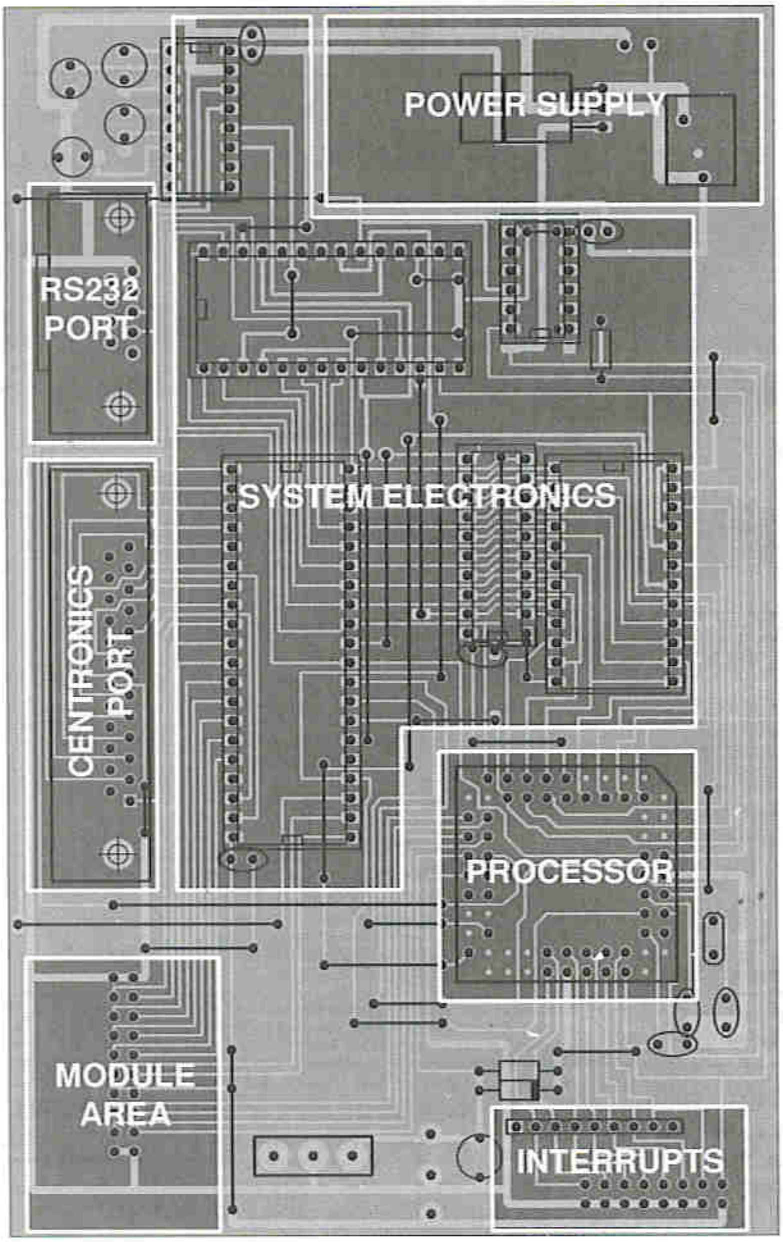
Whereas every house, business, school etc has a physical address and every phone or fax user has an assigned number, every e-mail user is assigned a unique address containing an @ sign. Thus the ETI e-mail address is eti@cix.com. Here eti is the user name, cix is the Internet provider and the .com ending shows that it is a commercial provider as opposed to an educational (.edu) or governmental (.gov) provider.

Given the way that packet switching works in order to optimise the network traffic flow, it can take anything from a couple of minutes to over an hour for an e-mail communication to arrive at its destination. This means that it is nowhere as immediate as a fax, but infinitely faster than a letter. But it has the advantage that an international fax will require an international phone call whereas an international e-mail message will only require a local call to the Internet provider.

The ETI 80188 Single Board Computer

A powerful and highly versatile 16bit processor system designed by Richard Grodzik for which software can be developed directly on any IBM PC

Single board computers, or SBCs, are usually found in 'stand-alone' products, dedicated to a single function. They can be found in washing machines, engine management systems, anti-collision radar, plant monitoring - to name but a few of the thousands of actual and potential uses.



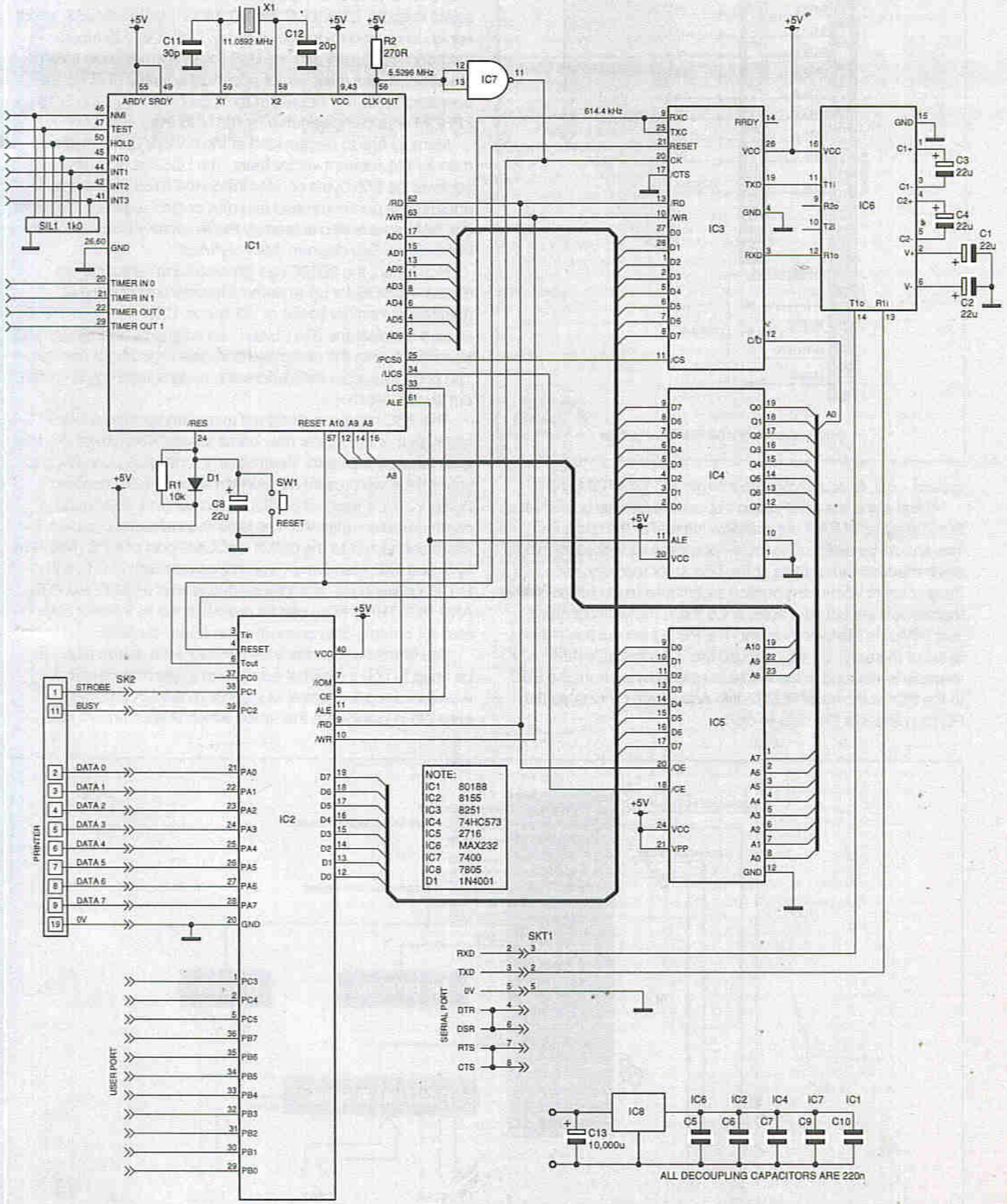
Block diagram for the 80188 SBC

The 80188 SBC

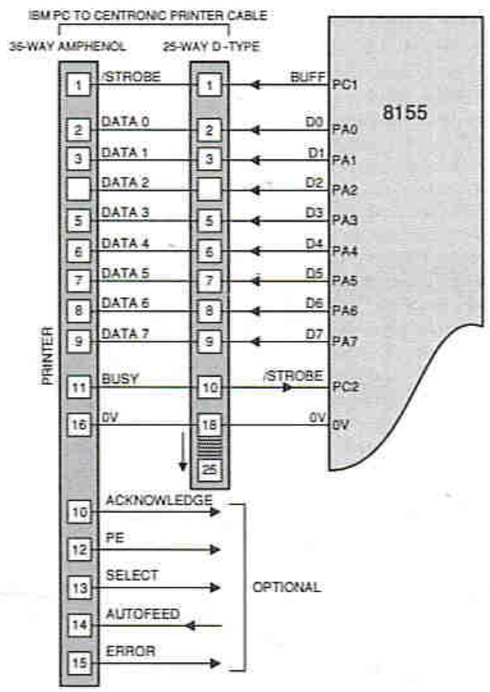
With the addition of a handful of components, this SBC provides most interface requirements for implementing a turn-key system. A Centronics parallel printer port, a 9600 baud asynchronous serial interface, a dozen I/O port lines should provide the reader with a solid foundation on which to build a system. Ram emulation is not used in developing the system's firmware due to problems associated with address relocation of final ROM and primarily to avoid the use of any of the system resources - i.e. use of serial port for downloading software. Instead, all the software is developed using any EPROM emulator. These devices simply plug into the PC's serial or parallel port down which the object code is downloaded. The emulator's RAM is then electrically connected to the SBC's EPROM socket by means of a ribbon umbilical cable. Once a definitive version of the target's board has been optimized, an EPROM is simply blown and placed in the EPROM socket.

Alternatively, the volatile RAM of the emulator can be replaced with a non-volatile lithium backed RAM, and emulator forming part of the final system. Any subsequent modifications to the software can be easily achieved by reconnecting the emulator to the PC and downloading the amended software.

As with any high integration embedded processor, the 80188 contains a plethora of internal control registers to initialise the system resources - a formidable data sheet (approx 45 pages) details the programming of these registers. It is beyond the scope of this article to detail all the programming requirements. However, included in this description are complete details of initialising the 80188 to function in the featured SBC, and where appropriate further details are included for users who wish to expand the



Circuit diagram of the 80188 SBC



Interfacing the 80188 SBC to a printer

system - e.g. to accommodate a larger EPROM/RAM area.

At first sight, the SBC doesn't appear to posses any RAM!. But 256 bytes of RAM are available internal to the 8155 PIO. This should be sufficient for stack purposes as well as forming a small interrupt vector table at the bottom of memory. Programmers who use recursion techniques (subroutines calling themselves) should take note, since these routines consume vast amounts of stack memory. The PC contains a few million bytes of memory, so why not use that? A small software example is included in the article to upload bytes from the SBC to the PC via the serial RS232 link. A program running on the PC then streams the data to disk.

Circuit Description.

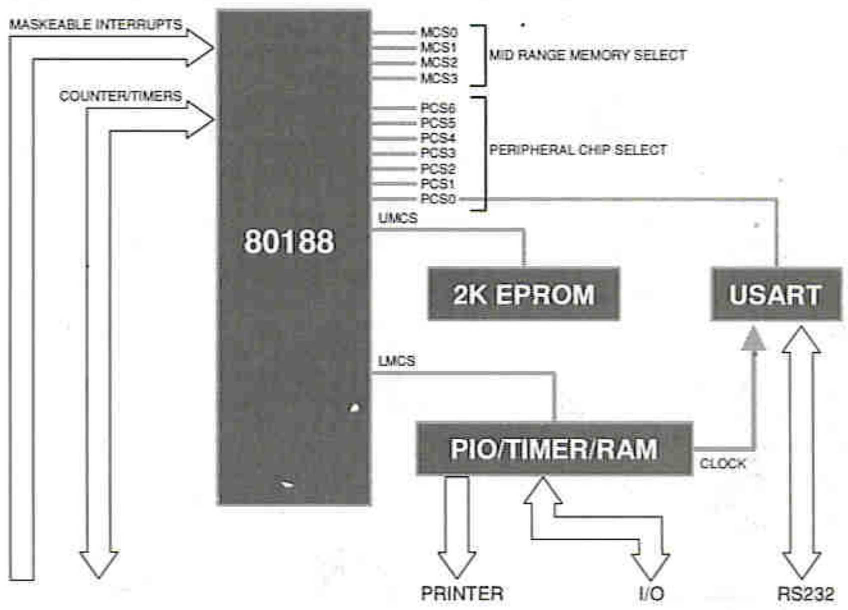
The block diagram shows how the 80188 is interfaced to the rest of the system. In total the 80188 can access 1M bytes of memory and 64 Kbytes of I/O space, although in this design, only a small proportion of this area is used. The 6 memory chip select outputs, UCS, LCS, MCS0, MCS1, MCS2, MCS3, select upper, lower and midrange memory. Only the UCS (upper memory chip select) and the LCS (lower memory chip select) are used. As the reset vector occurs at address 0FFFF0, the operating system is located at the top of memory - the 2716 EPROM area being selected by the UCS line.

Memory has to be provided at the bottom of the memory map for the interrupt vector table. The LCS line is used to address the 256 bytes of RAM inside the 8155 and also to address the port command and port control registers. Note that this RAM area is also shared by the stack for PUSH and POP instructions. See diagram (Memory Map).

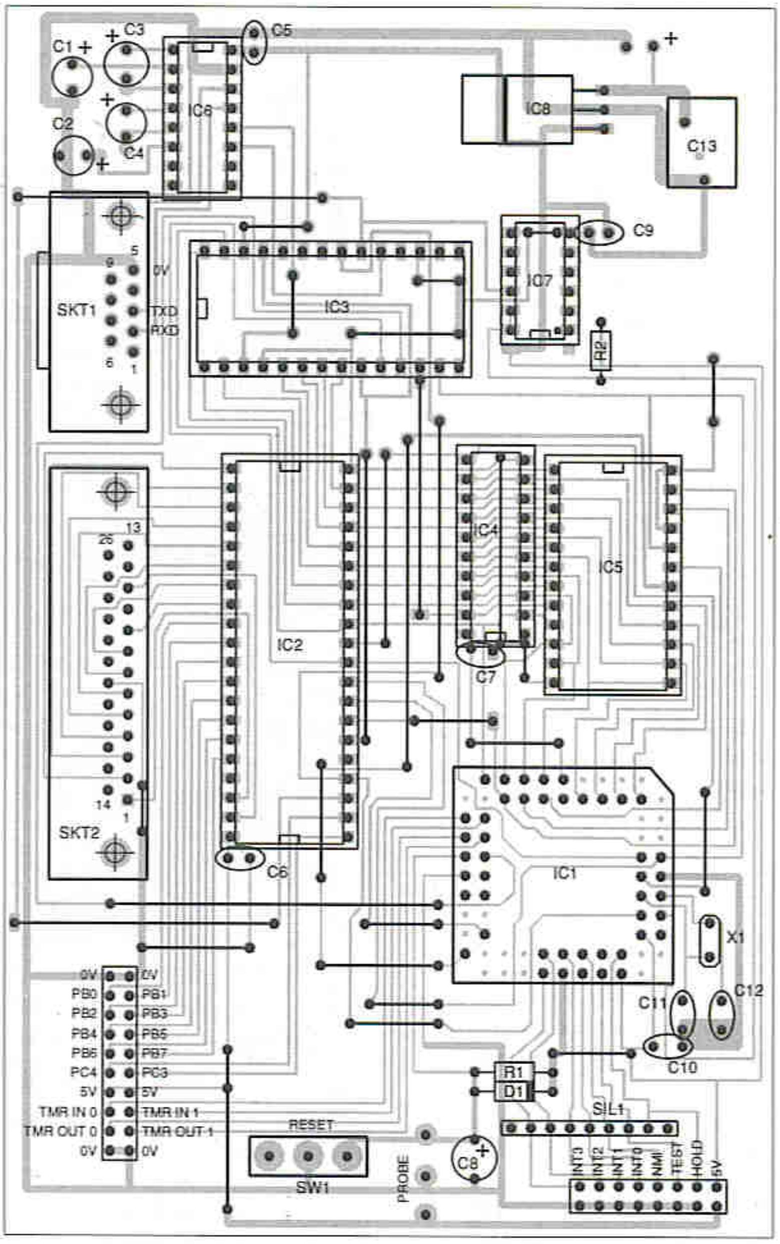
In addition, the 80188 can generate chip select signals (PCS0- PCSO6) for up to seven separate peripheral ic's, mapped in memory space or I/O space. Chip select line PCS0 is used to select the 8251 UART -an additional address line (A0) selects between the command and data registers of this chip. The usual low order data/address bus demultiplexing is carried out by the 74573.

The SBC has been designed to accommodate most peripheral type that the reader may come across. The printer interface is an industry standard 'Centronics' interface so connecting to your printer will present no problem since the PC standard printer cable is used. The RS232 port support 9600 baud communication rates with hardware handshaking disabled, easily connected to the COM1 or COM2 port of a PC. Note that RXD and TXD lines are reversed to comply with D.C.E. and D.T.E. conventions. In addition 11 port lines (PB0 THRU PB7, AND PC3 THRU PC5) can be programmed as input or output lines for control, data acquisition or display devices.

The four timer/counter lines (pins 20 - 23), active high, can be used to count external events and to generate external waveforms e.g for control of stepper motors. A software example is included in this article which utilises Timer 1 to



Block diagram for the 80188 SBC



Component overlay for the 80188 SBC

output a low frequency square wave for driving stepper motors. 80188 control pins NMI TEST and HOLD perform the same functions as th 8088. Finally, the 4 interrupt lines INTO -INT3 are active high maskable interrupt lines.

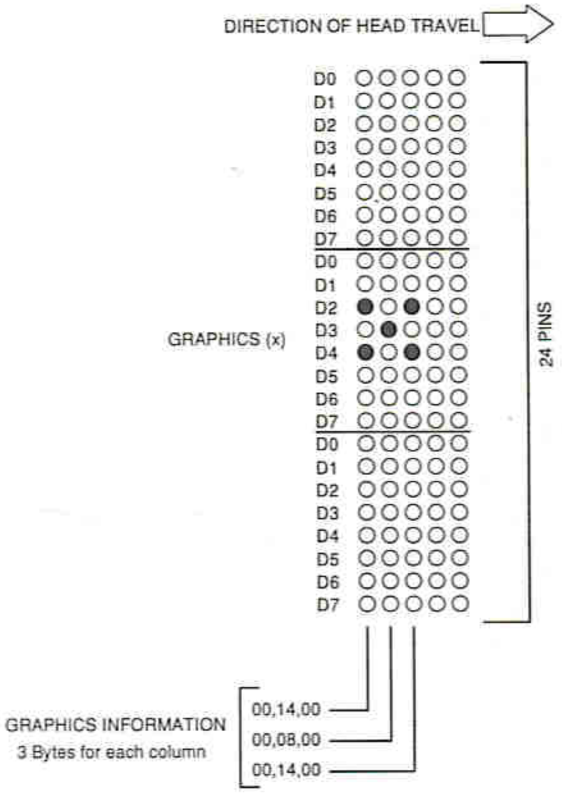
Construction Details.

The 80188 microprocessor is available in 10, 12. 5, 16 and 20 Mhz version in a 68 pin PLCC package. To provide compatibility with the design, at least a 12. 5 Mhz version (80C188XL12) should be purchased. Practice the usual static handling precautions, since this little chip does not come cheap. The SBC has been designed on a single-sided PCB with approximately 25 links, which should be connected first. It is suggested that the pcb pads for these links are not drilled, and that insulated wire used for wire-wrapping is used to make these connections on the copper side of the board, making a convenient and tidy job. Great care must be excercised when drilling the holes for the PLCC package, and a drill diameter of not greater than 0. 8 mm is required to leave sufficient copper for soldering purposes. For those users wishing to build/modify their own PCB's a Postscript file, 'Boardmaker' file and bitmapped file are provided on the floppy disk. The bitmapped file - 80188. bmp can be printed by simply issuing the MSDOS print command - i.e. print 80188. bmp.

Hints and tips

A logic probe is indispensable in hardware/software fault-finding/debugging. Once the SBC has been assembled and power applied, the following steps will point to any source of malfunction:

(a) Check that the reset line 'RES' (pin 24) responds, when the reset switch is pressed. A high to low logic transition should occur, and this will reset the 80188. A corresponding reset output 'RESET' (pin 57) on the 80188 will follow, which is the logic inverse, i.e. active high. This output signal resets the 8155 and 8251.



Data output to a printer

b) Check for presence of the clock output signal 'CLKOUT' (pin 56), which feeds the 8155 timer and 8251 UART.
(c) Download the test program 'ROMTEST. BIN' to verify the integrity of the data bus. The upper chip select line 'UCS' (pin 34) should be strobing, and activity will be found on all data lines i.e. pins 12 thru 19 of the 8155.
(d) If the system appears to be totally inert, a time-consuming, but worthwhile task is to perform a continuity test with a DVM, as well as a short-circuit test between adjacent lines. Use a meter with an audible indicator and don't forget that most meters will 'buzz' within a couple of hundred of ohms, so double-check using the resistance scale.

Next Month...

We will continue with a look at programming the 80188 SBC.

Main features:

Programmed in 8088 Assembler.
Powerful high integration Processor.
Minimum 'glue' chips - Programmable chip selects.
Centronics Parallel Port.
RS232 Serial Port.
User Port.
3 Timer/Counters.
Programmable Interrupt controller.
Documented source code programming examples

Future Add-on modules:

(a) 3 channel touch switch.
(b) Serial A to D convertor.
(c) D to A convertor - 4 to 20 mA loop.
(d) 16 key Matrixed keyboard.
(e) Stepper motor controller.
(f) Multiplexed LED display.

Software development and information on the 80188

The public domain A86 Assembler was used in all software examples. This, together with any ASCII text editor forms a complete programming environment for the 80188. Other additional tools usually found in a PC environment - a debugger (DEBUG), a terminal emulator, i.e Terminal in 'Windows', PCTools all provide programming support. The PC today is now an indispensable programming tool. The 80188 contains all the registers of the 8088, but in addition, contains a clock generator, 3 programmable 16-bit counter/timers, peripheral chip select logic (additional address decoding ic's are not required), a programmable 4 channel interrupt controller, DRAM refresh control, and speed versions available to 20 Mhz. However, in order to program and use this powerful processor the reader must already have some knowledge of 8088 assembler level programming. A good introduction to the subject is a book entitled 'IBM PC & XT Assembly Language' by Leo J. Scanlon (Pub. Brady), which takes the reader from the basic principles of number systems to writing assembler programs. The MASM assembler is featured in this book which is unfortunately not 100% syntax compatible with the A86. However, a model program using the MASM assembler will be detailed further in this article to enable the reader to use either assemblers.
The target board of such systems can utilise any microprocessor or microcontroller, but the 80188 processor is one of the most widely used embedded controllers for control and data acquisition applications. With its internal 16-bit structure and external 8-bit databus, it provides an excellent mix of high computational power and ability to interface to industry standard I/O devices. Moreover, because the processor derives from the 8088, the original processor used by the IBM PC, the 80188 features 100% PC code compatibility and shares the same Instruction set. This feature allows romable binary/object code to be directly assembled on any IBM compatible PC.

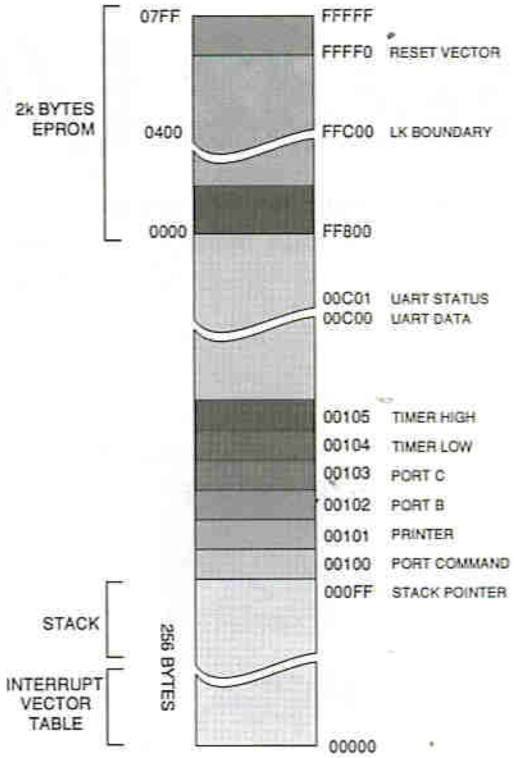
PARTS LIST

Resistors
1 x 270R
1 x 10K0
1 x SIL 1K0

Capacitors
5 x 22uF
1 x 20pF
1 x 30pF
7 x 220nF

Semiconductors
1 x 80188
1 x 8155
1 x 2716
1 x 74HC573
1 x 8251
1 x MAX232
1 x 7400
1 x 7805
1 x 1N4001

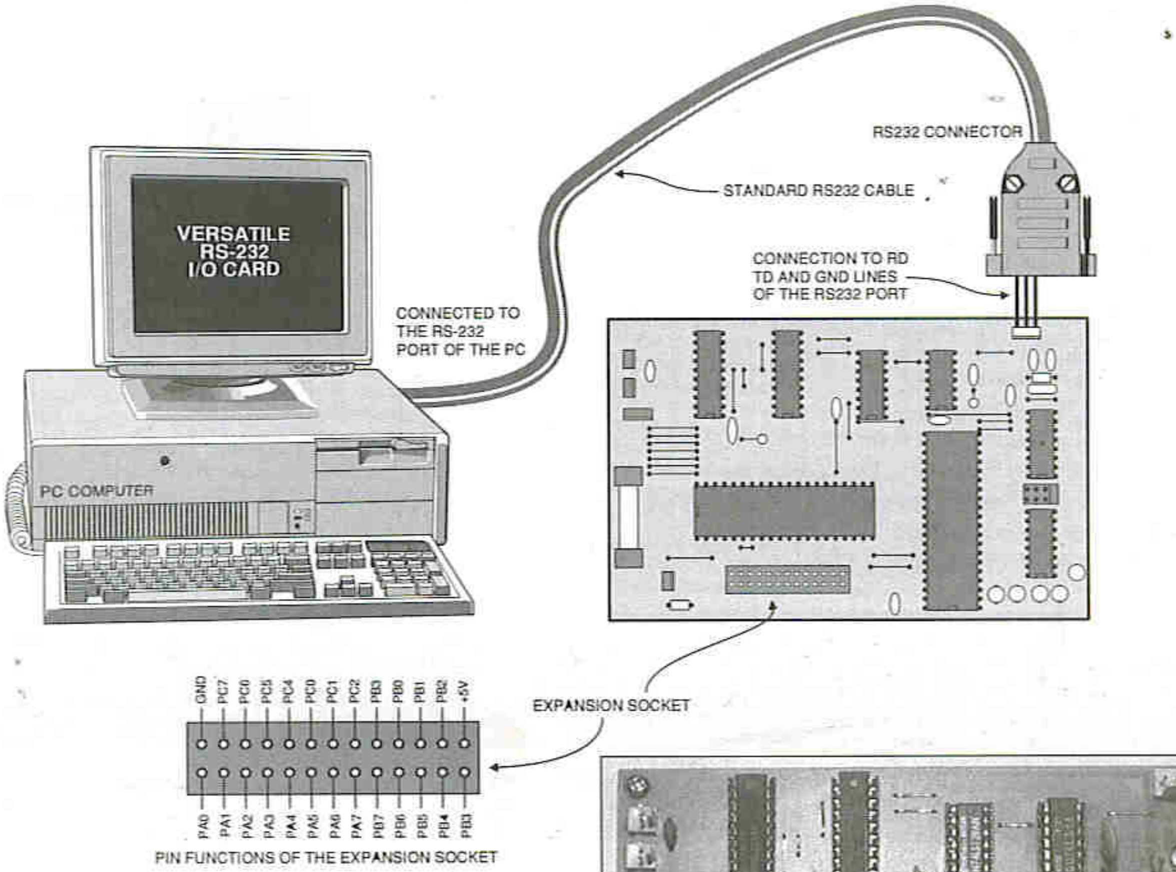
Miscellaneous:
1 x 11. 0592MHz Xtal
1 x 26 way D type connector
1 x 9 way D type connector
A floppy disk containing all program example files and the A86 Assembler is available from the author price £12. 50 P&P inc. Please send cheques or postal orders made payable to R. Grodzik, to: Mr R. Grodzik, 53 Chelmsford Road, Bradford BD3 8QN.

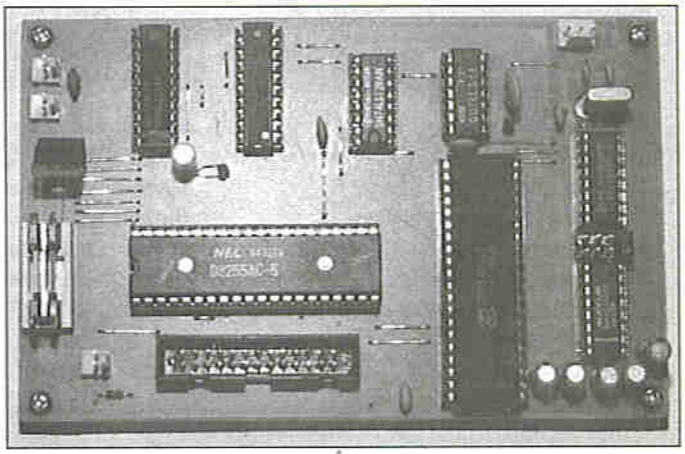


80188 SBC memory map

Versatile 24 line RS232 I/O Interface

Last month Dr Pei An looked at the fundamentals of serial data transmission, this month he looks at the actual construction of an RS232 serial to parallel interface card





So far we have just looked at the theory behind the functioning of serial interfaces, and in particular the common RS232 interface. It is now time to look at putting this theory into practice with the construction of a practical interface board.

The I/O card consists of 4 units, (i) RS232 interfacing unit, (ii) function selection unit, (iii) shift register and buffer unit, (iv) 8255 peripheral programmable interface unit plus of course the (v) power supply unit. The schematics of the unit diagram and the circuit diagram are shown in Figures 7 and 8.

The heart of the RS232 interfacing unit is the CPD6402 UART (IC4). The pin layout and the pin functions are shown in Figure 9. Pin 1 and Pin 3 are connected to +5V and the ground, respectively. Pins 35 through 39 set the serial data format. The present card is configured to an 8 bit length, no parity and 1 stop bit. Pins 17 (Receiver Register Clock) and 40 (Transmitter Register Clock) are the clock inputs for serial data receiving and transmitting which should be driven at 16 times the Baud Rate.

Pin 20 (Receiver Register Input) is the serial data input. The received data is stored in the receiver buffer registers which are accessed via Pins 5 to 12 (Receiver Buffer Registers 7 to 0). When data is successfully received and loaded into the receiver buffer registers, Pin 19 (Data Received) will go from low to high. It can be cleared (i.e. set to low) by putting Pin 18 (Data Received Reset) low. This enables the UART to receive new data. Refer to the circuit diagram (Figure 8). DR output is connected the DRR inputs via a delay and inverter circuits (R1, C6 and IC3). This enables the UART to receive data and, after a short delay to reset itself to receive new data again, pins 13 (Page Error), 14 (Frame Error) 15 (Overrun Error) give the status of errors occurring in the data transmission.

Pin 25 (Transmitter Register Output) is the serial data output. Data to be sent is written into the transmit buffer registers via

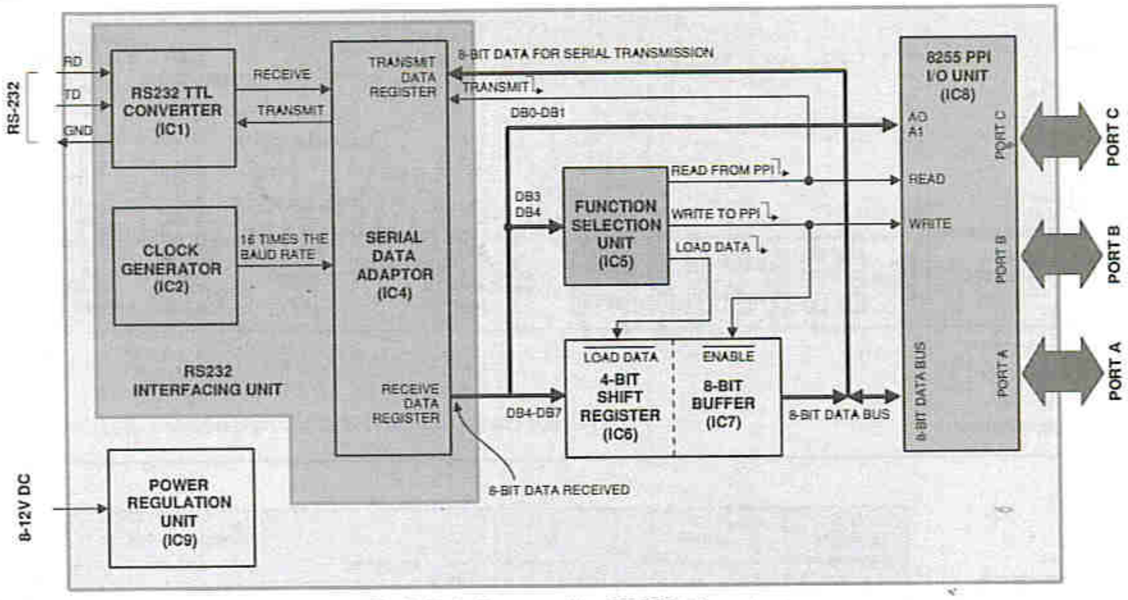


Fig.7. Unit diagram of the RS232 I/O card

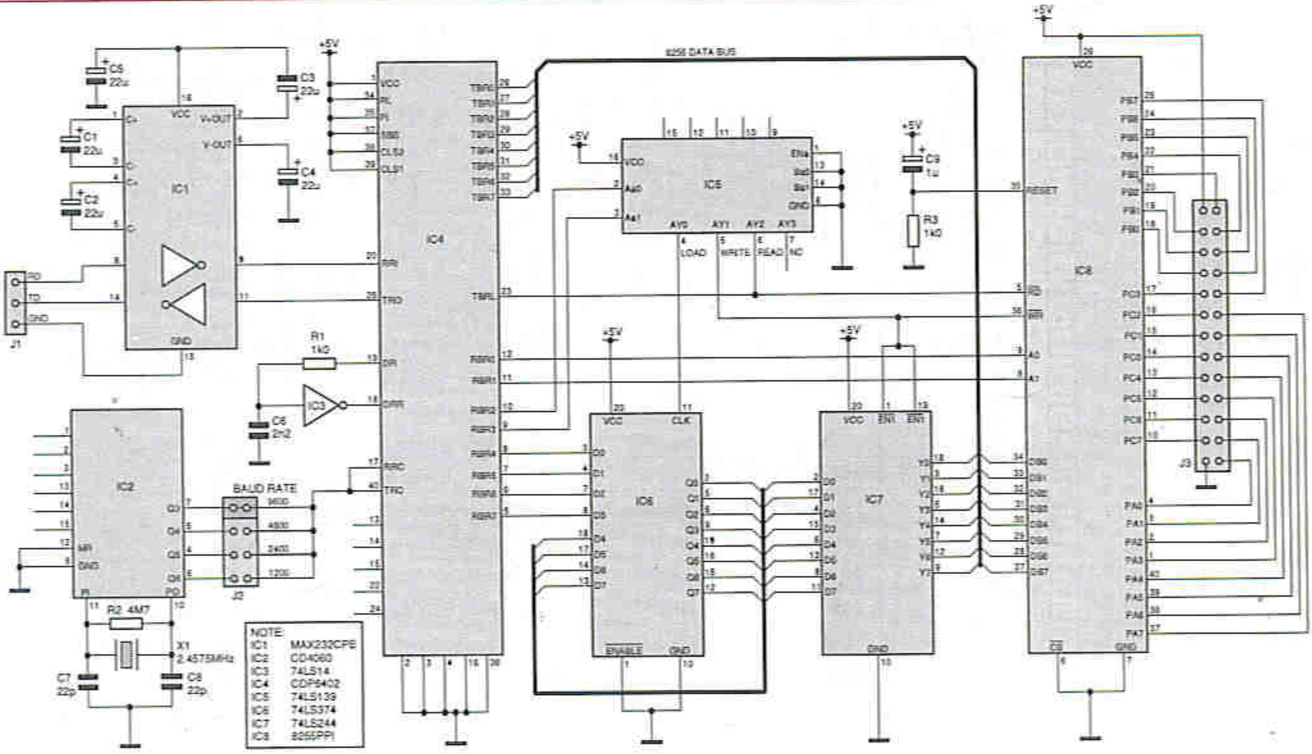


Fig.8a. Circuit diagram of the RS232 I/O card

Pins 26 to 33 (Transmitter Buffer Registers 0 to 7). When Pin 23 (Transmitter Buffer Register Load) goes low, data is loaded into the registers and start the serial data transmission.

The clock signal to the UART is generated by a circuit around a CD4060 (IC2) and a 2.4575 MHz crystal. From Pins 7, 5, 4 and 6 of IC2, clock signals at 153.6KHz, 76.8KHz, 38.4KHz and 19.2KHz are generated which set a Baud Rate of 9600, 4800, 2400 and 1200 for the UART. The Baud Rate is selected by a jumper selector J2. The conversion of the voltage levels between the RS232 and TTL is achieved by the MAX232CPD (IC1). This chip requires a single +5V power supply and is able to produce the right voltage level required by the RS232 standard.

The function selection unit controls the internal functions of the card and is based on a 74LS139 (IC5) which is a dual 4-line selector IC. The data bits DB2 and DB3 from the UART receive data register are connected to the input address lines of the IC, Aa0 and Aa1. The output lines of the IC, AY0 through AY3 are high when not selected. By putting a specific value on Aa0 and Aa1, one of the four outputs, AY0, AY1, AY2 or AY3, can be selected and pulled down to logic low. Each output has a particular function as shown below:

AY0(LOAD): This line is connected to the -CLK input of the IC6, 74LS374. It is active low (DB2=DB3=0). At the low-going edge, it allows the shift register, 74LS374, to shift the 4 low bits to 4 high bits.

AY1(WRITE): This line is connected to the -ENABLES

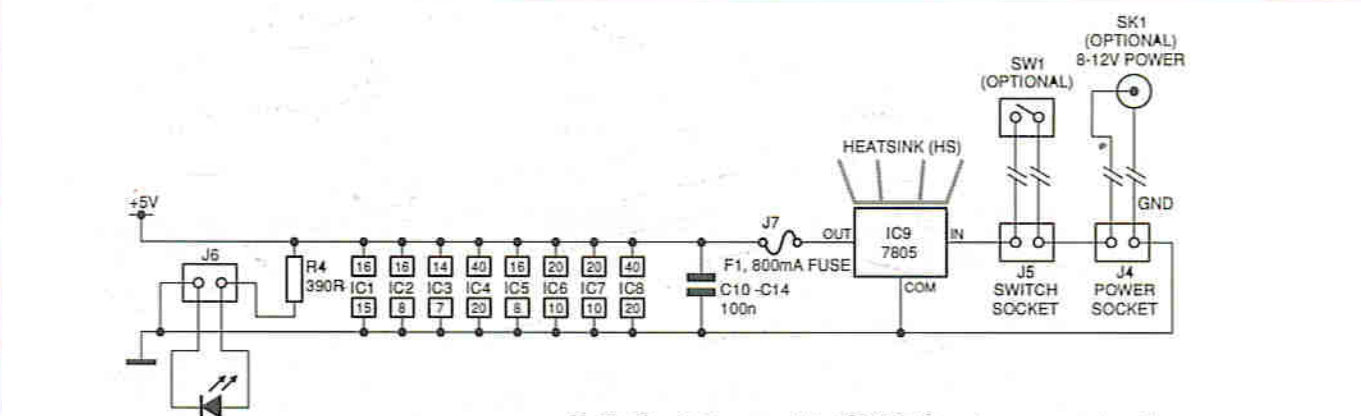


Fig 8b Circuit diagram of the RS232 I/O card power supply unit

PIN NUMBER	NAME	I/O	DESCRIPTIONS
1	VCC	INPUT	+5V, the positive rail of the power supply
2	NC	NC	Not used
3	GND	INPUT	GND, the negative rail of the power supply
4	RRE	INPUT	Read Register Disable. Input high forces the output line to be high impedance
5 - 12	RBR7 - RBR0	OUTPUTS	Receive Buffer Register, the received data output lines
13	PE	OUTPUT	Parity Error. A high indicates a parity error has been detected
14	FE	OUTPUT	Framing Error. Output high indicates an invalid stop bit
15	OE	OUTPUT	Overrun Error. Output high indicates receive data not read soon enough
16	SFD	INPUT	Status Flags Disable. Input high forces PE, FE,OE, DR and TBRE to high impedance
17	RRC	INPUT	Receive Register Clock. The ionput should be driven at 16 times the Baud Rate
18	DRR	INPUT	Data Received Reset. Input low clears the receiver output lines
19	DR	OUTPUT	Data Received. Output high indicates data has been received
20	RRI	INPUT	Received Register Input. The input serial data
21	MR	INPUT	Master Reset. Input high resets everything except the receive buffer register
22	TBRE	OUTPUT	Transmit Buffer Register Empty. Output high indicates IC is ready for next data
23	TBRL	INPUT	Transmit Buffer Register. Input low transfers data at pins to the buffer register
24	TRE	OUTPUT	Transmit Register Empty. Output high indicates data has been sent
25	TRO	OUTPUT	Transmitter Register Output. The serial data output
26 -33	TBR0 - TBRL7	INPUTS	Transmit Buffer Register. Inputs to 6402
34	CRL	INPUT	Control Register. Input high loads the control register
35	PI	INPUT	Parity inhabit. Input high selects no parity
36	SBS	INPUT	Stop Bit Select. Input low selects 1 stop bity. Input high for others
37 - 38	CLS2, CLS1	INPUTS	Character Length Select. Selects 5, 6, 7 or 8 data bits
39	EPE	INPUT	Even Parity Enable. Input high selects even parity (Pin 35 must be low)
40	TRC	INPUT	Transmitter Register Clock. This should be 16 times the transmitter Baud Rate

Fig.9 Pin.layout and functions of the 6402 UART

inputs of the 74LS244 buffers and -WR input of the 8255 PPI. It is active low (DB2=1, DB3=0). At the low-going edge, it enables the 8-bit buffer, 74LS244, to output data to the 8255 PPI data bus and to latch the data into the 8255 PPI peripheral registers.

AY2(READ): This line is connected to the -RD input of the 8255 PPI and TBRL of the 6402 UART. It is active low (DB2=0, DB3=1). When it goes from high to low, it enables the 8255 PPI to output the data on the data bus and latches the data into the 6402 UART transmit data register for serial data transmission.

AY3 (NC): This line is not used (DB2=1, DB3=1).

The shift register and buffer unit is used because of the following reason.The 8-bit data bits received by the 6402 UART are utilized for two purposes. The low 4 bits of the data (DB0 to DB3) are used for internal control purposes and the high 4 bits (DB4 to DB7) are used for transmitting the actual data. In order to transfer a complete 8-bit data, a 4-bit shift register based on a 74LS374 (IC6) is used. An 8-bit byte is transmitted by loading the 4-bit data into the shift register twice. The pin layout of 74LS374 is shown in Figure 10a and its configuration as a 4-bit shift register is shown in Figure 10b. The 74LS374 contains 8 D-type latches. At a high-to-low transition applied to -CLK (Pin 11), the outputs (Q) will follow the inputs (D), provided that the -ENABLE input is low. The 4-bit shift register is formed by connecting the outputs of the 4 latches (1st group of latches) to the inputs of the other 4 latches (2nd group of latches). Before sending a byte out of the PC's RS232 interface, the data (D7,D6.....,D0) is split into the upper half (D7,D6,D5,D4) and the lower (D3,D2,D1,D0). Refer to Figure 10b; the data inputs of 74LS374 (DB0 to DB3) are first supplied with the upper half bits

(D4 to D7). A low-going transition of -CLK (AY0=0) will latch D4,D5,D6 and D7 bits to the outputs of the first set of the latches, Q0, Q1, Q2 and Q3. Next, the lower half bits (D0 to D3) are supplied to the 74LS374 inputs DB0 to DB3, a low-going transition at -CLK will latch Q0, Q1, Q2 and Q3 bits (which have already been loaded with D4,D5,D6 and D7) to the output of the second group of latches, Q4,Q5,Q6 and Q7, and in the same time it latches the low half bits, D0,D1,D2 and D3 to the outputs of the first group of latches, Q0,Q1,Q2 and Q3. Hence an 8-bit data is successfully loaded into the 74LS374 latches. The outputs of the shift register are isolated from the 8255 PPI data bus via a tri-state buffer IC 74LS244 (IC7). The buffers will only pass the data to their outputs when writing data to the 8255 PPI (AY1=0).

The 8255PPI IC is used for the purpose of providing 24 I/O lines under the control of software. Figure 10(c) shows the pin-out functions of this chip. GND (Pin 7) and VCC (Pin 26) are connected to the negative and +5V power supply rails, respectively. This IC has 24 input/output lines which are arranged in three 8-bit ports, namely Port A, B and C. The 8255 has four internal registers, three of which are called peripheral registers and are associated with Port A, B and C. The fourth one is the control register. The three peripheral registers are used for data transactions between the 8255 PPI and external circuits and the control register is used to initialize the operation modes of the PPI. There are 8 bidirectional data lines (D0-D7, Pin 34 to Pin 27) through which data is written to or read from the internal registers under the control of -RD (Pin 5) and -WR (Pin 36) lines. The address lines A0 (Pin 9) and A1 (Pin 8) are used to select a particular register. The relationship between the address lines (A0 and A1) and the registers is shown below:

Internal Registers	A0	A1
Register A	0	0
Register B	1	0
Register C	0	1
Control Register	1	1

-CS (Pin 6) line must be taken low to enable the IC. RESET (Pin 35) line is active high and will set all the lines of Ports A, B and C as input lines. In normal operations, RESET line must be held low.

The 8255 PPI has three operation modes: Modes 0, 1 and 2. Table 1 summarises the operation modes.

Modes	Description

Mode 1 Port A can be set as an 8-bit input or output port. Mixture of inputs and outputs is not possible. Port B is configured in the same manner as Port A. Port C is split into two halves (upper 4 bits and lower 4 bits) with each half configured as either inputs or outputs. The mixture of inputs and outputs in each half is not possible. All the outputs are latched.

Mode 2 Mode 2 configures the 8255 PPI as strobed I/O ports. Port A and B are configured as two independent 8-bit I/O ports. Each of them has a 4-bit control port associated with it. These control ports are formed from the lower and upper 4 bits of the Port C, respectively. In this mode, data applied to an input port must be strobed in with a signal produced in external hardware. An output port is provided with handshake signals that indicate when new data is available at its outputs and when an external device has read the values.

Mode 3 Only port A can be initialized in this mode. In this mode, port A can be used for bidirectional data transfer. This means that data can be output or input on the same eight lines. If Port A is initialized in Mode 2, pins PC3 through PC7 are used as handshake lines. The other three pins, PC0 through PC2, can be used as ordinary I/O lines if port B is configured in Mode 0. These lines will be used as handshake lines of Port B if the port is configured in Mode 1.

Bit number	Description	Function
Bit 7	Mode set flag	1=Active
Bit 6	Mode selection	00=Mode 0 01=Mode 1 1x=Mode 2
Bit 5	Mode selection	
Bit 4	Mode control of Port A	1=Input, 0=Output
Bit 3	Mode control of upper 4 bits of Port C	1=Input, 0=Output
Bit 2	Mode selection	1=Mode 1, 0=Mode 0
Bit 1	Mode control of Port B	1=Input, 0=Output
Bit 0	Mode control of lower 4 bits of Port C	1=Input, 0=Output

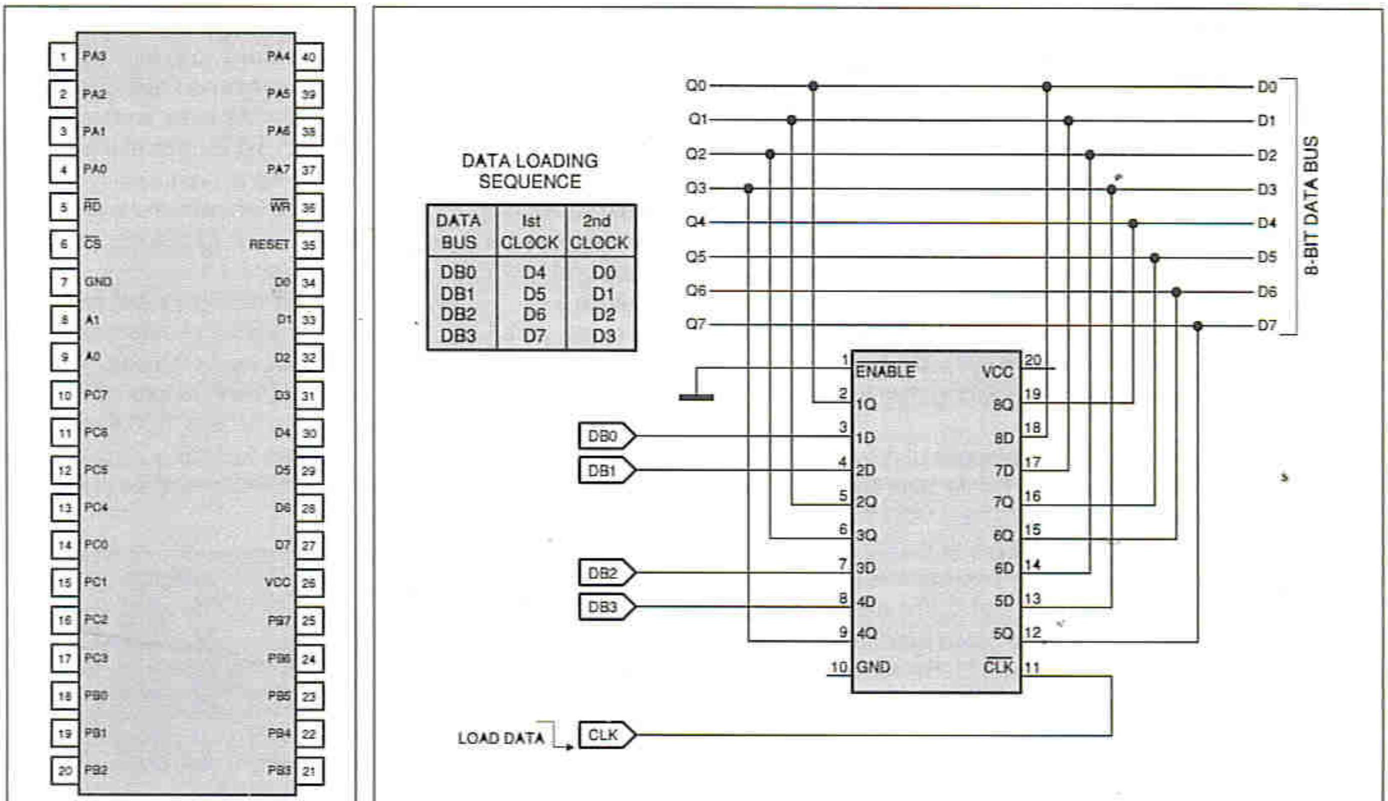
The operation modes of the 8255 PPI are initialized by writing an 8-bit control word to the control register. The bit function of the control word is explained in the following table:

In the present paper, we will concentrate on Mode 0 which is adequate for the present applications. For other modes, please refer to the manufacture's data sheets.

In Mode 0, as we already know, Port A and Port B can be configured as either inputs or outputs. Port C is split into two

Control word	Bit 4	Bit 3	Bit 1	Bit 0	Port A	Port C	Port B (upper)	Port C (lower)
128	0	0	0	0	0	0	0	0
129	0	0	0	1	0	0	0	I
136	0	1	0	0	0	I	0	0
137	0	1	0	1	0	I	0	I
130	0	0	1	0	0	0	I	0
131	0	0	1	1	0	0	I	I
138	0	1	1	0	0	I	I	0
139	0	1	1	1	0	I	I	I
144	1	0	0	0	I	0	0	0
145	1	0	0	1	I	0	0	I
152	1	1	0	0	I	I	0	0
153	1	1	0	1	I	I	0	I
146	1	0	1	0	I	0	I	0
147	1	0	1	1	I	0	I	I
154	1	1	1	0	I	I	I	0
155	1	1	1	1	I	I	I	I

Note: Bit 7 = 1, Bit 5 = Bit 6 = 0, I = Input, O = Output



DATA BUS	Ist CLOCK	2nd CLOCK
DB0	D4	D0
DB1	D5	D1
DB2	D6	D2
DB3	D7	D3

Fig.10. Pinout of 74LS374 octal latch and diagram showing 74LS373 used as a 4-bit register and pinout of 8255PPI

halves which can be also configured as inputs or outputs. All possible control words for configuring Ports A, B and C are listed below for a quick reference:

The power supply system incorporates a 7805 (1A, 5V) voltage regulator, which requires an 8-12V DC external power supply. The card consumes about 120mA. An 800mA fuse is used to limit the current usage by the external circuitry connected to the card. Figure 8(b) shows the circuit diagram of the power supply unit.

PROGRAMMING

The programming procedures for reading data from and writing data to the 8255 PPI registers are discussed below:

READING PROCEDURE

When reading data from a peripheral register of the 8255, a series of data is sent from the computer RS232 interface to the UART of the I/O card, which contains the following information. Bit 0 and Bit 1 select the address of the 8255 peripheral register, A0 and A1. Bit 3 and Bit 4 of this series of data will make AY2 (Read, Pin 5 of the 74LS139) to go from high to low and to high again. This sequence allows the 8255 PPI to output data to its data bus and enables the UART to latch the data into its Transmit Buffer Registers and initiate serial data transmission through the RS232 link. To read the data, we just read from the PC's UART Receive Buffer Registers. The way to send data out of the computer and read the received data from the PC's RS232 port have been shown earlier.

WRITING PROCEDURE

To write data into an 8255 peripheral register is slightly complicated. Firstly, the program splits an 8-bit data (D0 to D7) into two halves, the upper four bits (D4 to D7) and lower four bits (D0 to D3). Then a series of data is sent from the computer RS232 interface to the UART of the I/O card, which contains the following information. Bits 4 to 7 contain the value of the upper four bits (D4, D5, D6 and D7). Bit 3 and Bit 4 of this series of data will make AY0 (Load, Pin 4, which is connected to the -CLK of the 74LS139) to go from high to low and to high again. This sequence makes the 74LS374 load the 4-bit data into its D-type registers.

Next, another similar series of data is sent from the computer, bit 4 to bit 7 of which contain the value of the lower four bits and bits 2 and 3 control the loading of data into the 74LS374. This time, the lower four bits are latched into 4 registers and in the same the upper four bits (which is already loaded with the upper four bits) are shifted to the upper 4 registers. Therefore, after this, the 8-bit data is latched into the 8 D-type registers of the 74LS374. Writing data into an 8255 peripheral register is achieved by sending a series of data from the computer RS232 interface to the UART of the I/O card, which contains the following information. Bit 0 and Bit 1 select the address of the 8255 peripheral register, A0 and A1. Bit 3 and Bit 4 of this series of data will make AY1 (Write, Pin 5 of the 74LS139) go from high to low and to high again. This sequence enables the 74LS244 buffers and allows 8255 PPI to read the data latched by the 74LS374.

To program the card, a control word must be sent to the 8255 control register to configure Port A, B and C of the 8255 PPI. This is achieved using the write procedure as described above. After this, data can be written to or read from the peripheral registers in the way as described above. A sample control program written in Turbo Pascal 6 is listed below:

```
Program RS232;
{RS232 24line I/O card driver software}
{This program is based on COM1 port. The address is
      $3F8}
{The COM1 port is configured as Baud rate:
```

```
        9600/4800/2400/1200
                Data bit length:8
                Parity Check: None
                Stop Bit: 1}
{The above serial port specifications can be set by
        MODE COM1: 96,N,8,1 command}
uses
    dos,crt;
Procedure out(databyte:byte);
{Output the databyte:byte to Port[$3F8]}
begin
     port[$3F8]:=databyte; delay(2);
end;

Function Input:byte;
{Input the databyte:byte from Port[$3F8]}
begin
     Input:=port[$3F8];     delay(2);
end;

Procedure write_to_LS374(inputdata:byte);
{Data bus DB0DB7 from 6402: DB0[1]A0(8255)
        DB1[2]A1(8255)
           DB2[4]A0(LS139)   DB3[8]A1(LS139)
           DB4,DB5,DB6,DB7(1st loading) D4,D5,D6,D7
              (2nd loading) D0,D1,D2,D3}
var
   highbyte,lowbyte:byte;
begin
           {inputbyte=D7 D6 D5 D4 D3 D2 D1 D0}
     highbyte:=inputdata and 240;    {highbyte =D7
                      D6 D5 D4 0  0  0  0}
     lowbyte:= (inputdata and 15) shl 4;  {lowbyte
       =D3 D2 D1 D0 0  0  0  0}
     out(highbyte);                       {DB2=0,
         DB3=0, LS374 Strobe=0}
  out(highbyte+12);     {highbyte output, DB2=1,
         DB3=1, LS139 Strobe=1, load data}
  out(lowbyte);         {DB2=0, DB3=0, LS374
         Strobe=0}
  out(lowbyte+12);      {lowbyte output,  DB2=1,
         DB3=1, LS139 Strobe=1, load data}
end;

Procedure Write_Port(portnumber:integer;output
         byte:byte);
{Write data to the peripheral register A,B,C and
         Control

    Port_number   Register   A0(8255)   A1(8255)
        0            A          0          0
        1            B          1          0
        2            C          0          1
        3            Control    1          1       }
begin
     write_to_LS377(outputbyte);  {output the byte
       to the 74LS374}
     out(portnumber+12);          {output A0 and
       A1, 8255Write=1}
     out(portnumber+4);           {8255Write=0}
     out(portnumber+12);          {8255Write=1}
end;

Function Read_Port(portnumber:integer):byte;
{Read data from the peripheral register A,B and C}
begin
     out(portnumber+12);
     out(portnumber+8);
     out(portnumber+12);
     Read_Port:=Input;
```

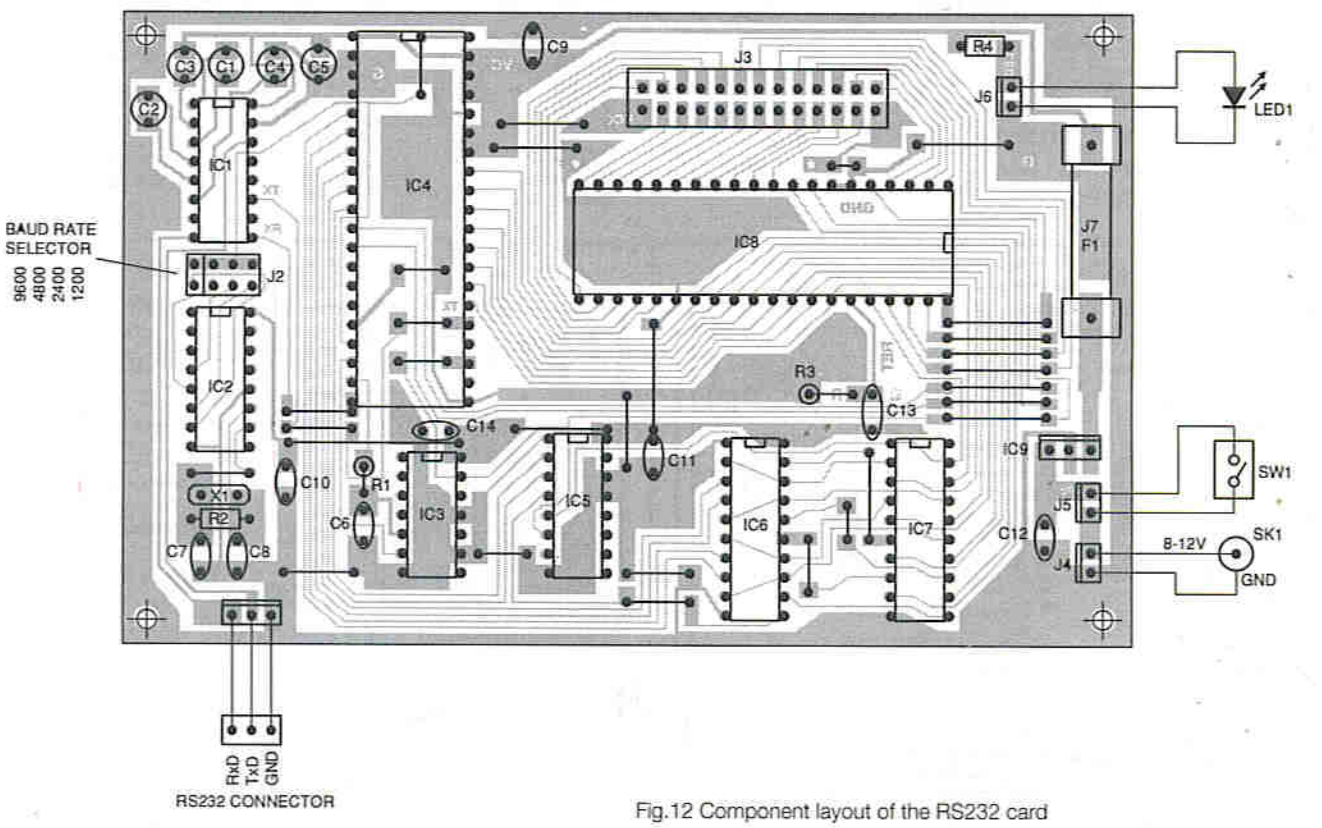


Fig.12 Component layout of the RS232 card

```
end;

{**************Main Program**************}
begin
    Write_port(3,128); {Configure all the ports as
        outputs}
    repeat
        write_port(0,0); {Output a decimal value
            0 to Port A}
        write_port(0,1); ,{Output a decimal value
            1 to Port A}
    until keypressed;
end.
```

CONSTRUCTION

This I/O card is constructed on a single-sided print circuit board. The full size foil pattern and component layout are shown in Figures 11 and 12. The PCB board is available from the ETI PCB service and a complete kit plus the control software is available from the author at a price of £37 including P&P.

Components may be mounted on the board in the following order: links, resistors, DIL IC sockets, capacitors, electrolytic capacitors, PCB connectors, voltage regulators. It is suggested that IC sockets are used for all the ICs.

TESTING

After soldering, check all the joints and connections to make sure there are no shorts due to excess solder. Only when you make sure that the board is properly constructed can you connect the power supply to the card. Since the card is simple to construct and involves no adjustment at all, it will work straight away if all the ICs are OK and properly located in position. To test the output of the ports, connect the card to the RS232 port via the RS232 cable and run the sample program which configures the 24 I/O lines as outputs. A logic probe can be used for testing the logic level of the outputs. If a logic generator is at hand the input function of the card can be also tested. When testing the card, readers should be familiar with the pin functions of the 26-way expansion socket (see Figure 1) and know the configuration of the ports. It should be pointed out that connecting a logic output to an output of the 8255 PPI may cause permanent damage to the IC.

PARTS LIST

Resistors

(Metal film, 0.25W and 1%)

R1,R3	1K0
R2	4M7
R4	390R

Capacitors

C1-C5	22uF electrolytic
C6	2n2 ceramic disk
C7,C8	22p ceramic disk
C9	1uF electrolytic
C10-C14	100nF ceramic disk

Semiconductors

IC1	MAX232CPE single voltage RS232 driver and receiver IC
IC2	CD4060 binary counter
IC3	74LS14 Hex NOR gate IC
IC4	CDP6402 UART
IC5	74LS139 dual 4 line selector IC
IC6	74LS374 Octal tri-state D-type latch IC
IC7	74LS244 Octal tri-state buffer IC
IC8	8255 PPI
IC9	7805 +5V voltage regulator

Additional components

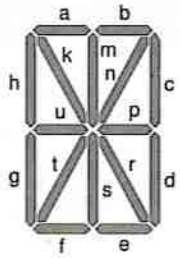
LINKS	0.6 diameter copper wire or similar
J1	3 way PCB connector
J2	4 way DIL PCB pins
J3	26 way DIL male socket
J4,J5,J6	2 way PCB connector
J7	Fuse holder
F1	800mA fuse
Spacers	6BA spacer sets for PCB mounting (4 off)
HS	Heatsinks for 7805 power regulator
OPTIONAL COMPONENTS	
SK1	2.5mm power socket
SW1	Toggle switch
D1	5mm LED

EPROMs VERSUS LOGIC

This month, Graham Reith looks at using EPROMs to replace complex logic circuitry with some more examples of practical circuitry

Alphanumeric displays are seen everywhere in the form of electronic signboards, instruction panels and other such displays. Despite appearances, they are not difficult to make. This practical illustrates how part of an alphanumeric display can be put together and how it can be extended almost indefinitely, depending on what it is to be used for.

A starsplash display has 16 segments and is laid out as shown below. As standard, each segment is named with a letter to help identify which pin links with which segment.



Note: This practical will use the common cathode type of starsplash display.

This display does have a display driver, but using an EPROM leaves more room for variation and imagination. Each character will have its own address for storing the information regarding what segments are required to form that character. A wide choice of characters is possible, a selection of which is shown below.

The coding that needs to be put into the EPROMs is as follows. '1' indicates that the segment should be lit, and '0' indicates that the segment is off.

	a	b	h	k	m	n	c	u	p	g	t	s	r	d	f	e
A	1	1	1	0	0	0	1	1	1	1	0	0	0	1	0	0
B	1	1	1	0	0	0	1	1	1	1	0	0	0	1	1	1
C	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	1
D	1	1	1	0	0	0	1	0	0	1	0	0	0	1	1	1
E	1	1	1	0	0	0	0	1	0	1	0	0	0	0	1	1
F	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0
G	1	1	1	0	0	0	0	0	1	1	0	0	0	1	1	1
H	0	0	1	0	0	0	1	1	1	1	0	0	0	1	0	0
I	1	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0
J	1	1	0	0	1	0	0	0	0	1	0	1	0	0	1	1
K	0	0	1	0	0	1	0	1	0	1	0	0	1	0	0	0
L	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1
M	0	0	1	1	0	1	1	0	0	1	0	0	0	1	0	0
N	0	0	1	1	0	0	1	0	0	1	0	0	1	1	0	0
O	1	1	1	0	0	0	1	0	0	1	0	0	0	1	1	1
P	1	1	1	0	0	0	1	1	1	1	0	0	0	0	0	0
Q	1	1	1	0	0	0	1	0	0	1	0	0	1	1	1	1
R	1	1	1	0	0	0	1	1	1	1	0	0	1	0	0	0
S	1	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1
T	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0
U	0	0	1	0	0	0	1	0	0	1	0	0	0	1	1	1

	a	b	h	k	m	n	c	u	p	g	t	s	r	d	f	e
V	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0
W	0	0	1	0	0	0	1	0	0	1	1	0	1	1	0	0
X	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0
Y	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0
Z	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	1
1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
2	1	1	0	0	0	0	1	1	1	0	1	0	0	0	1	1
3	1	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0
4	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0
5	1	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1
6	1	1	1	0	0	0	0	1	1	1	0	0	0	1	1	1
7	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0
8	1	1	1	0	0	0	1	1	1	1	0	0	0	1	1	1
9	1	1	1	0	0	0	1	1	1	0	0	0	0	1	0	0
0	1	1	1	0	0	0	1	0	0	1	0	0	0	1	1	1
8	1	0	1	0	1	0	0	1	0	1	0	1	0	0	1	0
D	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0
K	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0
V	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0
Y	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0

The range of other possibilities, such as a star, plus, minus or some two-figure numbers, is open to the imagination. The list of characters above includes the capital alphabet, figures 0 - 9, and some alternative characters depending on personal preference. Some people may prefer other ranges of characters. Each of these characters needs to be assigned an address and the codes for the characters need to be stored at their respective addresses. Each code is 16 bits long, for which two EPROMs each holding 8 bits could be used. The most sensible format might then be to have the code for the segments on the top half of the display - a, b, h, k, m, n, c and u - on one EPROM, and the code for the bottom half - segments p, g, t, s, r, d, f and e - on the other.
For example:

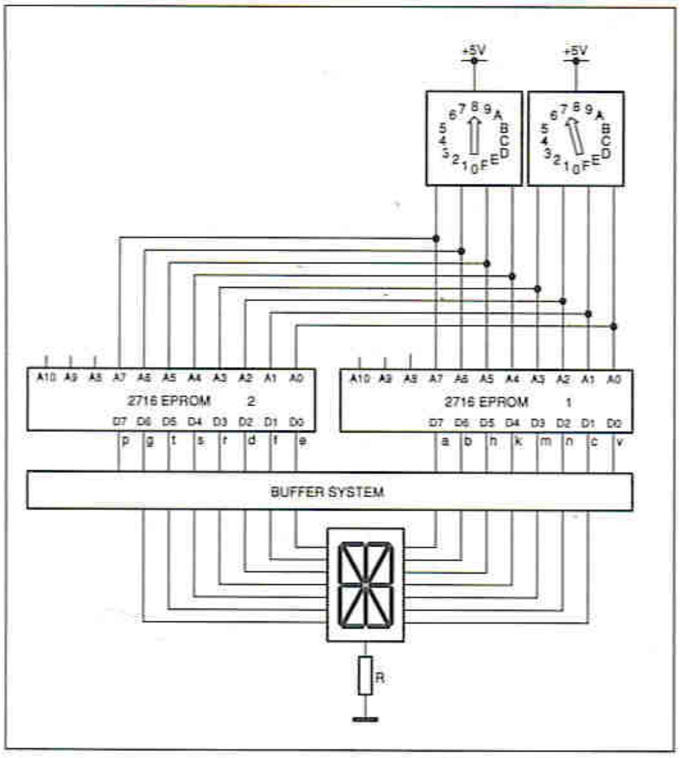
	ADDRESS											EPROM 1 DATA								EPROM 2 DATA							
	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
												a	b	h	k	m	n	c	u	p	g	t	s	r	d	f	e
A	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	0	0	0	1	0	0
B	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	1	1	1	1	0	0	0	1	1	1
C	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	1
D	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	1	1	1
E	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	1	1

Remember that, when programming the EPROMs, most programmers require the data to be in hexadecimal. In the table below, the characters previously listed are given an address in

ADDRESS	EPROM 1 DATA	EPROM 2 DATA	ADDRESS	EPROM 1 DATA	EPROM 2 DATA
001	E3	C4	016	12	0C
002	E3	C7	017	22	6C
003	E0	43	018	14	28
004	E2	47	019	14	20
005	E1	43	01A	C4	23
006	E1	40	01B	08	10
007	E0	C7	01C	C3	A3
008	23	C4	01D	C2	87
009	C8	13	01E	23	84
00A	C8	52	01F	E1	87
00B	25	48	020	E1	C7
00C	20	43	021	C2	04
00D	36	44	022	E3	C7
00E	32	4C	023	E3	84
00F	E2	47	024	E2	47
010	E3	C0	025	A9	52
011	E2	4F	026	32	40
012	E3	C8	027	18	18
013	E1	87	028	24	60
014	C8	10	029	14	10
015	22	47			

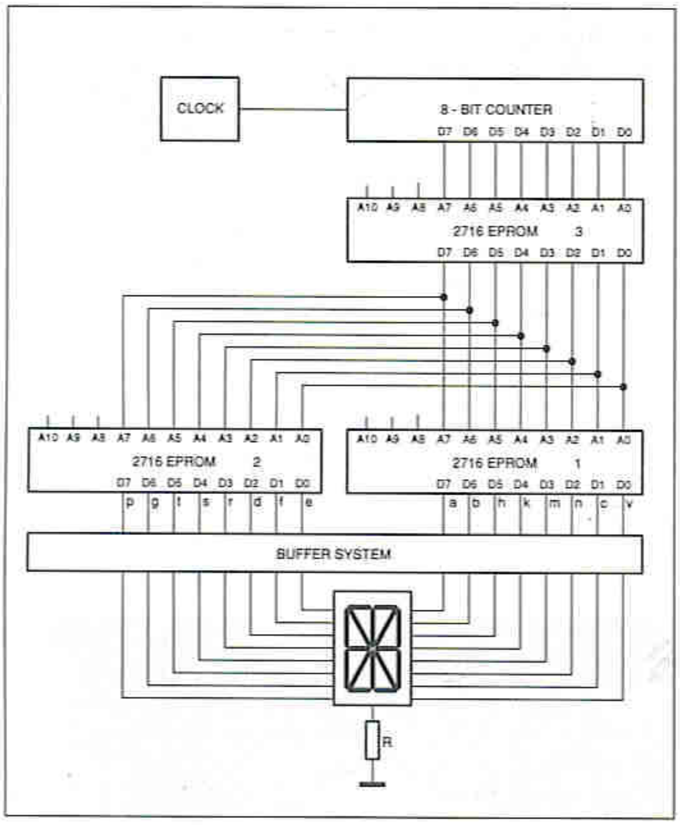
the sequence A = 001 to Y = 029 (numbers in hexadecimal).

The EPROMs should be connected up as shown below. The two BCD switches allow the user to summon up any particular character just by turning the switches to the appropriate address number, usually with a screwdriver (for A, 01; for Y, 29). Remember all unused address pins on the EPROM should be pulled low.

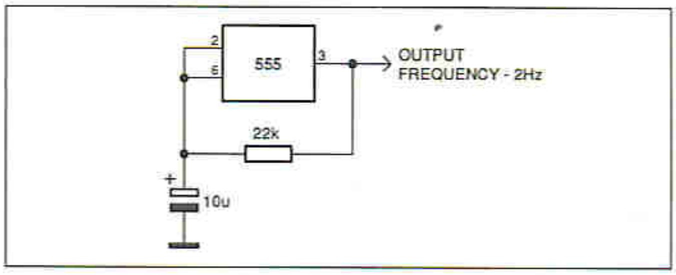


For the buffer system, use the same buffers that were used earlier with the traffic lights.

This system should work very effectively. However, it is a little awkward having to put in the addresses with a screwdriver and it is possible to improve the system by adding a third EPROM. Instead of having the BCD switches, an EPROM could be programmed to hold all the addresses required, in the order in which the user wished them to appear. A counter with a clock could then be put on to the address inputs of the new EPROM, and all the characters would flash up in the order stored in this new EPROM, and at a speed dictated by the clock. A clock speed of 1 - 2 Hz would probably be most suitable.



See notes on the traffic lights practical for suggestions on the assembly of a clock frequency of 1 Hz. For a clock with a frequency of 2 Hz:-



This system is fairly effective. It does not have a counter reset option, but that can be arranged simply by removing the input to A7 on EPROMs 1 and 2 and feeding it into the reset of the counter. It is unlikely that EPROMs 1 and 2 would have anything stored at these addresses involving A7 anyway, and so the counter can be reset by having the data line 10000000 (or 80 hexadecimal) stored at the appropriate address in EPROM 3.

Note: If the EPROMs are going to be removed from the circuit regularly, it may be worthwhile considering an EPROM holder with a release mechanism to prevent damage to the pins.

The system can, however, be cut down even more. Both EPROMs 1 and 2 have a large amount of space left on them - indeed not even one quarter of the available space on either EPROM will have been used. Therefore it is possible to take the information stored on EPROM 2 and move it across to EPROM 1, storing it between addresses 100000000 and 111111111 (in hexadecimal, between 100 and 1FF). This would mean that with the A8 pin of the EPROM pulled low, the data at the output would be segments a, b, h, k, m, n, c and u and ,with the A8 pin pulled high, the data at the outputs would be segments p, g, t, s, r, d, f and e.

Even though it is not possible to have all of the segments showing at the same time, it is possible to make it appear as though they are. If the EPROM is made to change back and forth from each set of data fast enough, then the human eye will not see one set of segments going on, and then the other, but instead will see all of the relevant segments on at the same time.

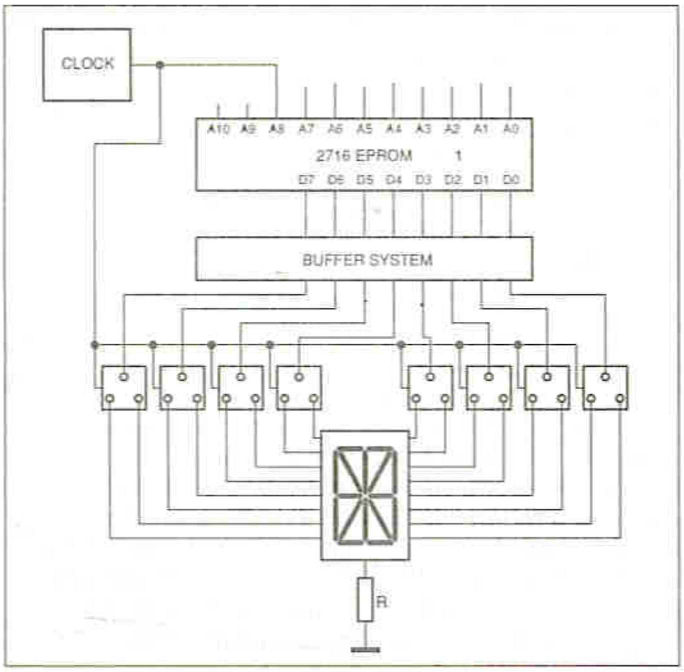
For this to happen the data should best change about 50 times every second - the same speed as television pictures change. The access time for a 2716 EPROM - i.e. the time taken for the stat to reach the output after the address has been put in is 350 nanaseconds.

Things are not quite as simple as that, as the lines between the starsplash display and the EPROMs also have to be shared. The technique is called multiplexing. Between the EPROM and the display, therefore, the eight lines have to be turned back into sixteen. This is done using 2 bit demultiplexers:(See diagram overpage)

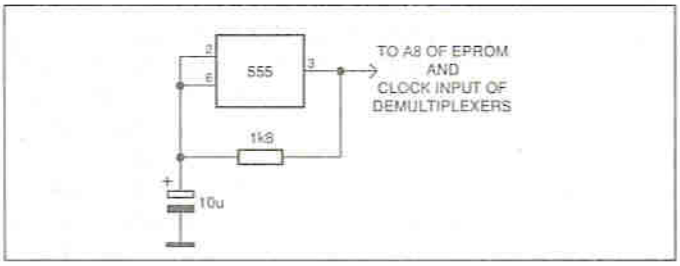
The two bit multiplexers can be found on a 40257 IC, with four of them on each chip. The multiplexers should be wired up so that, when A8 is high, the connection is made between the EPROM outputs and segments p, g, t, s, r, d, f and e, and that when A8 is low, the EPROM outputs are linked with segments a, b, h, k, m, n, c and u.

The time taken to switch the multiplexers is 150 nanoseconds. That means that there is a minimum time gap of 200 nanoseconds between the address being fed into the EPROM and the information appearing on the display. Therefore for that 200 nanoseconds the display is showing the wrong information. If we have it switching every 1/50th of a second, that means the display will be incorrectly lit for 10 µseconds every second. This will not be noticed by the human eye.

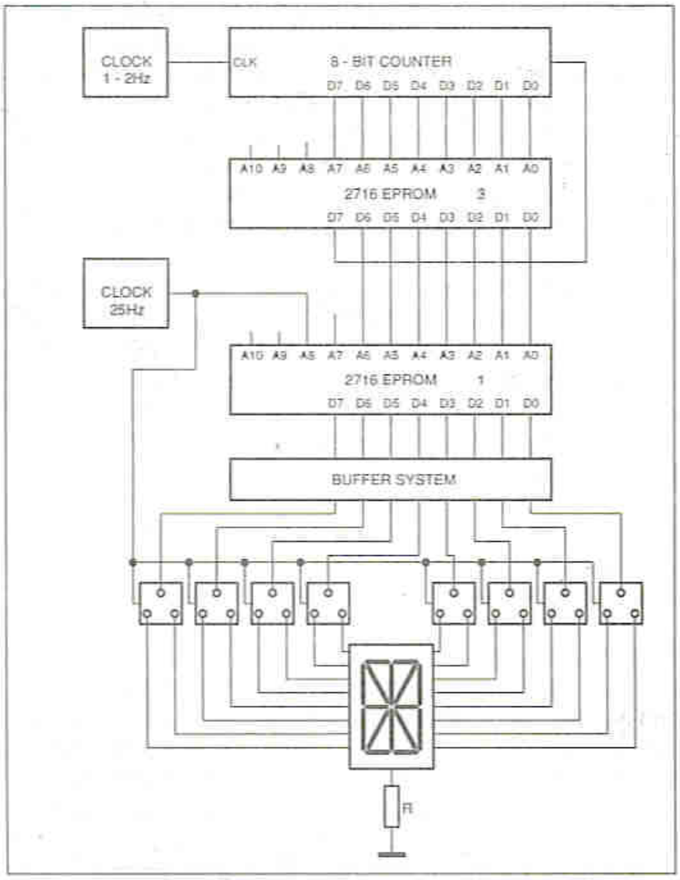
To ensure that the information changes at 50 times a



second, A8 has to oscillate at 25 Hz (in one cycle of the oscillator, the information will change twice).
A 25 Hz oscillator:



The final system is shown below:



Further Development.

The system can be extended almost indefinitely by using parallel in/parallel out shift resisters and more starsplash displays. Every time a pulse goes to the counter, the shift registers could be clocked, capturing the segment information before it changes. This information can then be shown on another display. A chain of these shift registers and displays could be formed enabling the system to cope with more characters. Every new character that came upon the first display would shift along all the characters already displayed.

Note: In order to do this, it is not necessary to use any more EPROMs, but it is important to be careful of the differences in component propagation delay and, if necessary, to delay the clock pulse to the shift registers accordingly.

In considering the design and development of this alphanumeric (starsplash) display system, it would theoretically have been possible to construct it using logic gates, after analysing the truth table to see which segments were lit and when. But the effort involved would be considerable, and the costs much greater. Nor would the logic system provide the user with the same amount of flexibility as EPROMs.

Supposing that the user decided to make up some more characters - with a logic system that would mean redesigning and rebuilding the entire logic system. With an EPROM, the extra characters can be added to the end of the program. This would not necessarily mean having to scrub the EPROM and reprogram it again - when an EPROM is programmed it is still possible to add lines at the end, as these new addresses are unbroken ground for the EPROM. The EPROM programmer does not write anything over them unless specifically told to do so.

Conclusion

As these three examples have shown, it is a case of choosing a system carefully to match the requirements of the job.
Cost will be an important factor in the choice. If a logic system is likely to be small, easily constructed and more or less permanent, it may well prove the cheapest way of doing the job. Such systems are perfectly suitable when the requirements are reasonably simple, and where any necessary changes can be made with little or no rewiring. But if the requirements of the job are complex and a logic system would have to be large, building a hardwired system and adapting it to changing requirements will be time-consuming. Being costly in man-hours, they are unlikely to be favoured in industrial and commercial uses.

Above all, logic systems leave the user with very little flexibility. EPROMs, on the other hand, are relatively small, not expensive, easy to program and more versatile, allowing the user to change the operation of a system without altering a single wire.

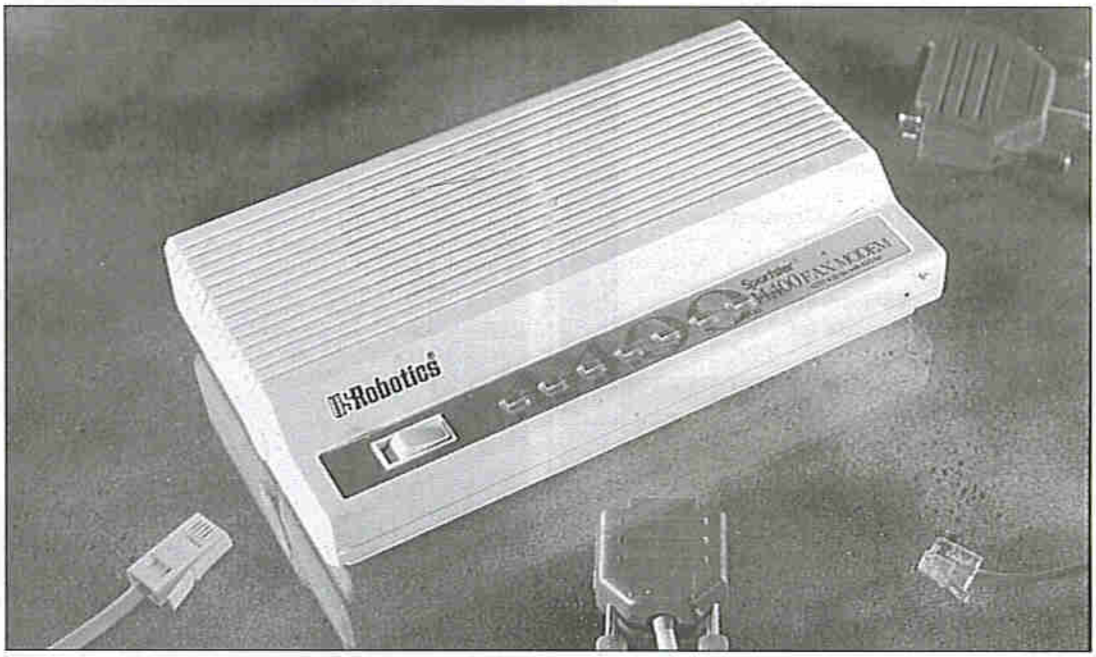
Deciding which method to use in the design of a system will usually mean weighing up what is required of the system, the cost of the components and the cost of putting them together.

NEXT MONTH

We will be looking at using pic chips

PC Clinic

This month PC Clinic looks at communications ports and modems, how they work, how to install them and how to improve their performance



Over the last couple of years there has been an explosion in the use and availability of on-line information services and wide area networks such as Compuserve, CIX and the Internet. It seems today that just about everyone is connecting themselves onto the Internet. Magazines on a host of different subject, TV programmes and Sunday papers are all now publishing e-mail addresses so that readers and viewers can interact using this new communications medium.

Indeed, if you have a PC it is now well worth investing in a modem and, in so doing, open up your horizons to a whole new world of information. Modems are quite cheap, with a reasonably high-speed device costing about £200.

Up to as recently as 18 months ago most modems sold in this country were capable of transferring data at 2400baud, or 2400 bits of information per second. The increased use of the Internet has meant that higher speed modems are now considered to be essential. Indeed, data transfer rates of less than 14,400baud are now considered too slow, and within twelve months people will probably start moving over to the new generation of 28,000baud modems.

Higher data transfer rates are important for two reasons; one is that it takes less time to transfer large amounts of information, particularly important if you want to download images or digitised video from the Internet and, secondly, a faster transfer rate means that data is transferred in less time and therefore incurs lower phone charges. This latter consideration is an important point if one intends making a lot of use of the modem and savings made here can rapidly pay for a more expensive modem.

Today there is little point in buying just a modem by itself, since for little or no extra cost one can buy a fax/modem which not only gives one the modem but also turns your PC into a full function fax machine. And using your PC as a fax machine is very cost-effective since it saves on the need for expensive fax paper and also allows one to store images on disk, thereby taking one more step towards a paperless office. With OCR software, one can also convert a fax file into a text file for storage on disk and incorporated into other documents.

When buying a fax modem, it should be noted that they usually have two speed designations as opposed to the one found on modems. There are three main speed combinations in widespread use today, they are: 2400/9600, 9600/9600, and 14,400/14,400, where the first number is the data speed and the second is the fax speed.

There are a number of standards that every modem or fax modem should conform to. For UK buyers the first of these is that it carries the green label that indicates BABT approval for attachment to the phone network. However, the BABT approval system is very cumbersome and it does mean that, by and large, products are obsolete by the time that they have obtained approval. In this respect, the US FCC approval system is far better and far quicker and any FCC approved product will eventually achieve BABT approval. Fortunately, the BABT approval system is changing, the sooner the better.

The next thing to check is that the modem supports the Hayes command set, this will ensure that it is compatible with virtually every data communications programme sold today. Whether you buy a modem that conforms to other standards is optional. But it is probably a good idea to buy one which supports MNP5 and V.42bis data compression standards (another way to get more data transferred per second), as well as V32 and V42 error correction. The latter will ensure that data is transferred with the best possible accuracy. With a fax/modem it is a good idea to buy a device which is compatible with Group III, Class 1 and Class 2 fax machines.

Whether you use an internal or external modem card is by and large a matter of price and preference. However, it is a good idea to make sure that the modem you buy does come complete with communications software and all necessary cables to allow one to plug it into a phone socket and use it straight away

If you only have one phone line which is used for voice data and fax, it is a good idea to look at devices which include built-in line sharing. This means that when a call comes in this type of fax/modem will listen for a special tone to indicate that it is an incoming fax; if it does not detect that tone then it passes the call to the attached phone as a voice call. This feature is most commonly found on internal modems and can be a very useful feature where phone lines are limited.

Today a modem is almost becoming an essential piece of computer hardware. Indeed, Intel's recent announcement of a 'software' modem option for its Pentium processors will probably mean that within the year most PCs will come with a phone socket/modem built onto the motherboard as standard hardware.

Adding an internal modem or fax/modem

Whether you are using an internal or external modem they both use one of the COM ports on the PC. So if you are using an external modem, then all you will need to do is connect it to an existing COM port. But if it is an internal modem then it will have circuitry on the board which creates a COM port of its own. This means that before it can be used it must be configured to the I/O base address of an unused COM port.

Most PCs will have at least one COM port, some may have as many as four, and it is very important when installing an internal modem that its configuration does not clash with that of an existing COM port. Consult the manual to ensure that you have the correct jumper settings for the desired configuration.

Besides I/O base address conflicts there is another potential source of problems which can affect both internal and external modems, this is the problem of IRQ conflict. On a standard ISA bus PC, ports COM1 and COM3 share the same interrupt, as do ports COM2 and COM4. This means that you cannot use ports 1 and 3 or 2 and 4 at the same time because of interrupt conflict, although you can use either of them when the other is not in use. And, of course, one can use COM1 and COM2, or COM3 and COM4 together because they use different interrupts.

The above problem is further complicated if you are using a serial mouse, in which case if the mouse is attached to COM1 it is impossible to use COM3. Similarly if the mouse is on COM2 then one cannot use COM4 and one cannot use the mouse on either COM3 or COM4. What this means is that when a system has a serial mouse it should be attached to COM1 and the modem should be configured for either COM2 or COM4 and never for COM3. If, for some reason, you need to attach the mouse to COM2, then install the modem on COM1 or COM3, but never on COM4.

With the modem properly connected to the PC all that remains is to connect it to the phone line. Virtually all modems will come with the appropriate cable and phone plugs, one of which will plug into the modem and the other into a phone wall socket. If it does not come with a cable then suitable cables can be obtained from most retailers who sell phone extensions. Note that the modem will probably have two sockets, one labelled 'line' and the other 'phone'. The cable from the wall socket should be plugged into the 'line' connector on the modem, if you intend to connect other devices to the same line, such as a phone or answering machine, then these should be 'daisy-chained' and connected to the 'phone' connector.

The PC COM port

Most PCs will have at least one COM port as standard, some may have as many as four. They are used to allow the PC to communicate with a range of different peripherals, such as modems, printers, plotters etc.

The COM port is a serial port, which means that the data is transferred along a single wire one bit at a time. But since the PC does not work with data in serial form but instead uses data in parallel eight bit bytes, it is necessary for the system to have some means of converting parallel data into serial data. To do this the PC uses an UART, or Universal Asynchronous Receiver Transmitter.

On modern systems the UART will probably be on the motherboard, but in older systems it will be on a plug-in adapter card and this will still be the case where more than one COM port is installed in the system. Many older adapters will use the 8-bit 8250 UART; more modern systems will use the 16-bit 16450 UART, which provides users with a considerable improvement in performance over the 8250 based circuits.

The most modern use the 16550 UART which, because it has a 16bit FIFO buffer, offers even better performance than the 16450. This buffering allows the UART to handle more data before having to be serviced by the CPU, thus reducing the processor overheads. This can be very important in multitasking environments such as Windows, and it also allows data transfer at much higher rates, which is particularly important when using a high-speed modem.

This means that it can be a very good idea to make sure that your system is using a 16550 UART. Unfortunately, if your I/O adapter is using the old 8250 chips there is little that one can do other than throw it out and buy a new adapter card. However, if it uses a 16450 then one can simply replace the 16450 chip with a 16550, they are pin-compatible.

These chips are often socket mounted which makes replacement easy. If it is not, then take great care when unsoldering the old chip not to damage any of the tracks or the plating on the holes. In fact, you may well find it easier to cut all the pins on the old chip with side cutters before attempting to unsolder them; this makes them much easier to remove. In either case, always discharge any static before handling the board and the chips.

If you are using Windows you will need to update the entries in the SYSTEM.INI file after you have changed from the 16450 to the 16550 UART. This will enable Windows to make full use of the extra features of the 16550. Some additional lines will need to be added to the [386Enh] section, thus:

```
COM1FIFO=On
COM1Buffer=0
COM2FIFO=On
COM2Buffer=0
```

Similarly if you are using communications software make sure that it can use the extra features of the 16550.

If you are installing an internal modem then there may be no need to upgrade from a 16450 to 16550 UART. This is because all internal modem cards include all the circuitry that makes up a COM port and this will, in most cases, be based upon a 16550UART. In fact, when buying a modem it is a very good idea to check that it uses the 16550UART, particularly if it is rated at 14,400baud or above.

Next Month

We continue our look at communication ports and modems - in particular, the installation of I/O adapter cards and pin connections.

TWINKLING CHRISTMAS STAR

A novel Christmas decoration designed by Tim Parker

Apart from the Queen at 3pm and sleeping off the turkey to a repeat performance from James Bond, Christmas still wouldn't be Christmas without the tree, the decorations or the pretty lights. This twinkling star with its 11 LEDs should make a welcome change to the usually boring single arrangements of cheap imported flashing lights masquerading as Christmas decorations, with the added satisfaction of being able to say "here's one I made earlier - MYSELF"!

The design presented here incorporates one or two novel concepts. It produces more of a twinkling effect than a simple flashing or light chaser arrangement, by rapidly fading in and out each LED, which results in a far more pleasing presentation.

Secondly, the chase pattern for ten of the LEDs (two on each star point) is wiring selectable during construction (some rather optimistically-minded people call this programmable). Furthermore, it's a single board design, with all of the electronics contained on the star itself, whereas most of the past designs have consisted of two boards, sometimes with quite a lot of inter-wiring between them, simply because by the time you've laid out all of the LEDs in a reasonable pattern on the star shape, there's no room left for anything else!

To overcome this we've fitted the LEDs on the front, and surface mounted all of the controlling electronics on the back (copper track side) of the board, but without resorting to SMDs (Surface Mounting Devices). This provides the constructor with an easy, but nonetheless important introduction to surface mount techniques, albeit on a physically magnified scale, due to the use of standard size components. Using proper SMDs would make construction virtually impossible for novices, because of the tiny size of the components. Even those practised in the techniques find it difficult enough.

By fitting the components to the back of the board, the front can be decorated with glitter, tinsel, spray or whatever, prior to construction, with none of the driver components getting in the way or being visible on your finished design. Not only does this result in an attractively presentable project, but will also save you having to answer the usual "what are all these lumpy bits for?" questions from family and friends who view it.

Circuit description

The circuit diagram for the twinkling star is shown in figure 1, and is based around a CMOS 555 timer (IC1) and our good old friend the 4017 decade counter/divider (IC2). This is not the first, nor will it be the last design to use the 4017 to flash ten LEDs in sequence; in fact this device has probably been used more often to turn on and off LEDs than it has ever been used as a counter or divider.

When power is first applied, IC2 will start up in its reset state with a high output at Q0 - pin 3. On the positive half cycle of the clock pulse input to pin 14, Q0 will go low and Q1 will go high; as the next clock pulse arrives, Q1 will go low and Q2 will go high and so on, until each output has been turned on and off in turn. As Q9 goes low, the whole sequence repeats again starting with Q0, with no intermediate states, that is, at no time

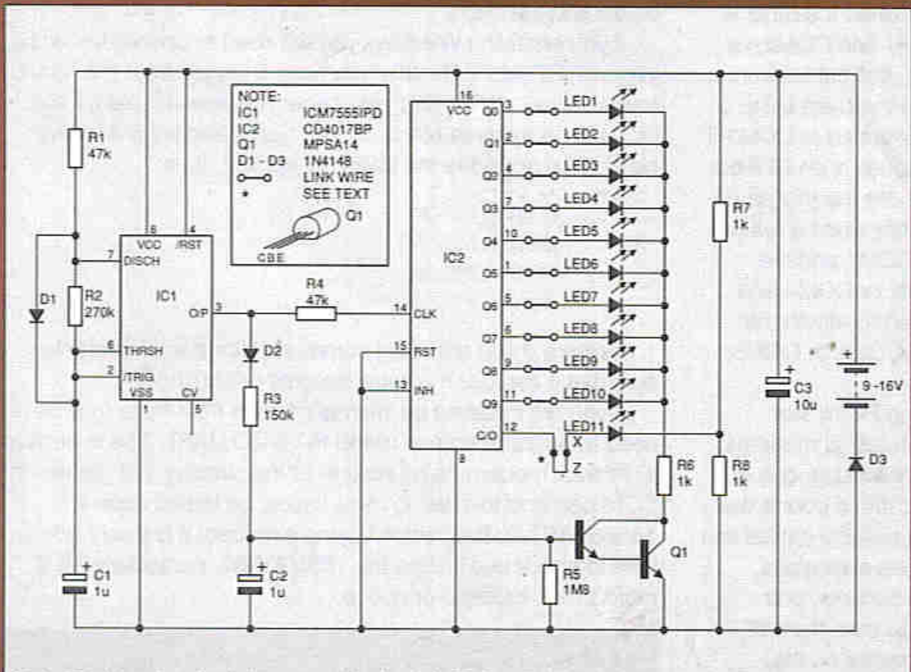
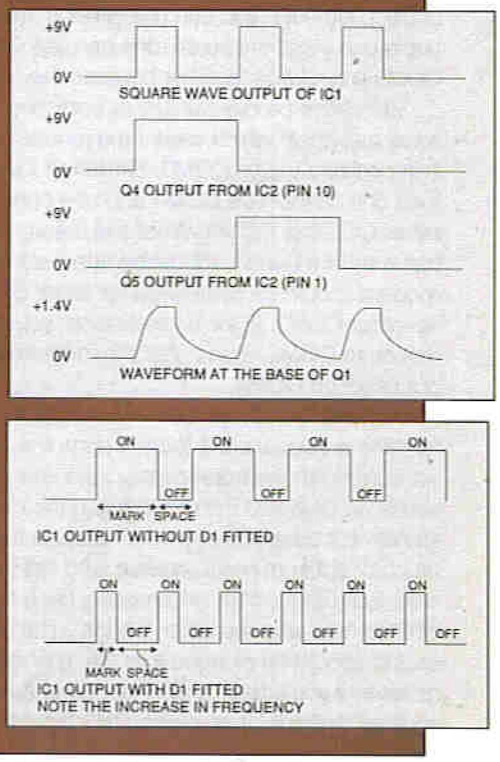


Fig.1. Twinkling star circuit diagram and to the right Fig2a and b show the various waveforms produced



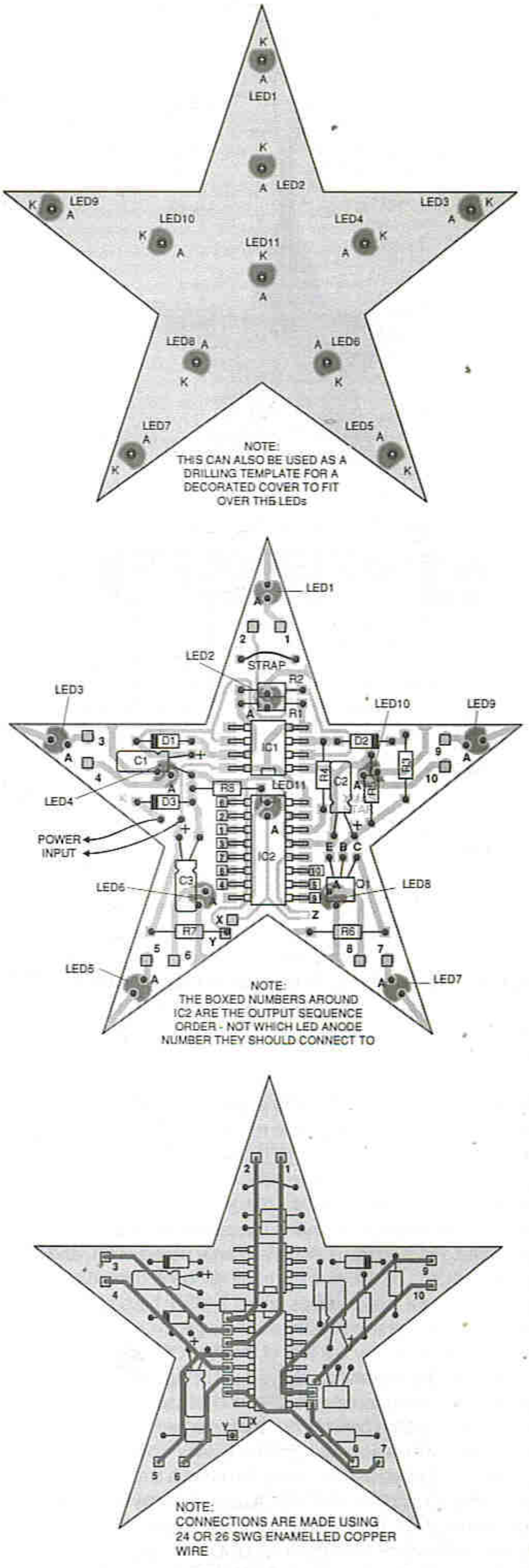
are all of the Q outputs off, there will always be one - and only one - of them on. Each Q output is connected to the anode of an LED, and if R7 were to be connected directly to the 0V rail, as each output goes high the LED connected to that output would light up. This, however, would produce what has become the more usual, less attractive and somewhat plain lighting arrangement found on most LED chaser designs, which each LED illuminating and extinguishing very abruptly, and most certainly couldn't be called a 'twinkle'.

For this reason transistor TR1 is incorporated into the 0V path to the LEDs (incidentally, the circuit diagram symbol abbreviation of TR1 has been used as opposed to the usual Q1 so as not to cause confusion with the 'Q1' output of IC2 - as if that wasn't enough!) The use of a Darlington transistor as opposed to a standard bipolar type is necessary in order to keep down the current consumption and also allow the use of a physically small capacitor for C2, otherwise we'd end up with a rather obnoxious 'lump' on the back of the star. As the output of IC1 (pin 3) goes high, C2 is charged via D2 and R3, and the next Q output in sequence from IC2 is turned on (high). The voltage across C2 is applied to the base of TR1, which gradually turns on and has the effect of slowly pulling R7 down to 0V, until TR1 reaches full saturation and is turned hard on with a base voltage of around 1.4V - the base-emitter voltage; anything above this level is shunted through TR1 to 0V. When the output of IC1 turns off (low), diode D2 prevents C2 from discharging via R3 into the low output of pin 3 which, whilst doing no harm, would influence the timing periods for the illumination of each LED. Therefore C2 can only discharge through R4 and the base-emitter of TR1, and as the base current slowly diminishes TR1 gradually turns odd, so releasing R7 from the 0V rail.

The result of all this is that as each output of IC2 turns on, the corresponding LED fades in, reaches full brightness very briefly and then fades back out again, fast enough to produce a 'twinkle', but not so fast as to lose the optical effect to what appears to be a flashing LED. It also has the benefit of reducing the overall current consumption of the finished project, since the LEDs are not lit continuously, which will give prolonged battery life if it is to be powered from these.

Figure 2a shows the various waveforms produced around IC1, IC2 and TR1. The two outputs of IC2 - Q4 and Q5 are shown only as examples and, in reality, could be any two sequential outputs of ten available.

When used as a counter or divider, IC2 provides a Carry Out (C/O) signal on pin 12, which is high whilst clocking through Q0 to Q4, and low from Q5 to Q9. This is normally used either to indicate an overflow when clocking from Q9 to Q0, or as a divide-by-ten output, since every ten clock pulse applied to pin 14 produces one clock pulse on pin12. In our application it is connected to LED11 fitted to the very centre of the star. To prevent distraction from the twinkling effect, this LED is driven at reduced brightness to the rest by the potential divider formed by R7 and R8. Together with the link marked 'Z' - which is a narrow section of copper track on the PCB that can be cut if required - this provides various options for LED11, with various results. If a standard LED is connected as shown in figure 1 it will be on whilst LED1 to LED5 are clocked, and off whilst LED6 to LED10 are clocked. By connecting the same LED in reverse, that is, with its cathode connected to point X and anode to point Y, it will be off during LED1 to LED5, and on during LED6 to LED10. If a continuously lit LED is preferred, than link 'Z' can be cut and R7 soldered to point X provided on the PCB - rather than to point Y. Alternatively, a bi-colour red/green LED can be used and fitted either way round. Like all other LEDs, bi-colour ones do have designated anode and cathode leads, yet they are



Figs.3. Twinkling star component overlays

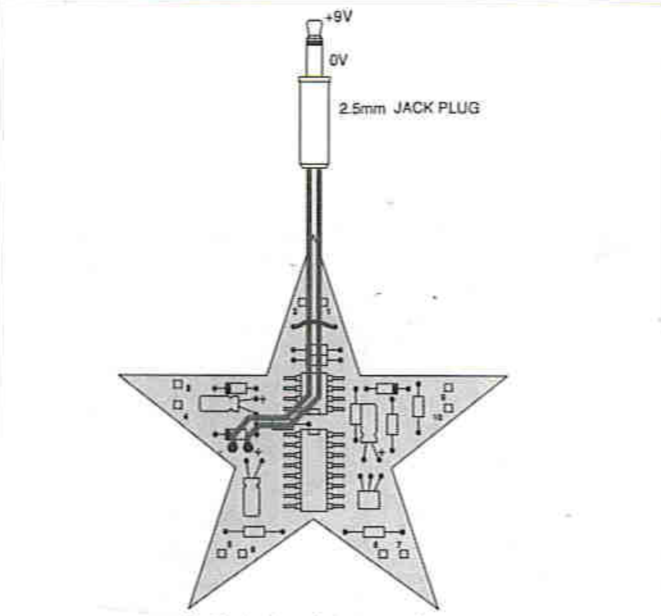


Fig.5. Jack socket connection

IC2 O/P	LED 11	PCB PAD CONNECTIONS FOR VARIOUS PATTERNS PAT. 1	PAT. 2	PAT.3	PAT. 4	PAT. 5	PAT. 6	PAT. 7
1	ON	1	1	9	1	1	2	3
2	ON	8	3	7	2	7	1	7
3	ON	3	5	5	3	3	8	1
4	ON	10	7	3	4	9	7	5
5	ON	5	9	1	5	5	4	9
6	OFF	2	2	10	6	2	3	2
7	OFF	7	4	8	7	8	10	4
8	OFF	4	6	6	8	4	9	6
9	OFF	9	8	4	9	10	6	8
10	OFF	6	10	2	10	6	5	10

not strictly polarised, save for the fact that they usually emit red light when the anode is more positive than the cathode and green light when the cathode is more positive than the anode. This will alternate from red to green or from green to red depending on which way around it's fitted, which is just sufficient to prevent the centre of the star looking otherwise bare when the C/O output from IC2 turns off.

The overall timing periods and clock signal for IC2 are generated by IC1 - a low power CMOS version of the 555 timer, operating in its astable mode as a free running oscillator. When power is first applied, C1 is charged via R1 and R2. When the voltage on pin 6 reaches 2/3 of the supply, pin 7 shorts to 0V and C1 is discharged via R2 only, until the voltage on pin 2 reaches 1/3 of the supply, at which point pin 7 is released from 0V and the cycle is repeated. Pin 3 is high during the charge period of C1, and low for the discharge period. In order to produce the desired twinkling effect, we require output pulses on pin 3 which have a mark/space ratio of about 1:2, that is, the (high) ON time or mark period needs to be only half that of the (low) OFF time or space period. From the information above it will be apparent that this cannot be achieved by using just R1 and R2, since C1 will always have a longer charge period than discharge period, no matter what resistor values are used. For this reason diode D1 is included to shunt across R2 during the charge time of C1, but has no effect during the discharge time; in this way R1 alone is used to charge C1, and R2 to discharge it. This produces the required mark/space ratio at pin 3, but it does cause an increase in frequency, so the values of R1 and R2 are chosen to take account of this. With the values shown, the frequency is between 3 and 5Hz, which governs the chase speed of the LEDs - not to be confused with the 'twinkle' period. Figure 2b shows simulated waveforms produced at the output of IC1, the top trace is without D1 fitted and the bottom trace with D1 fitted.

Construction

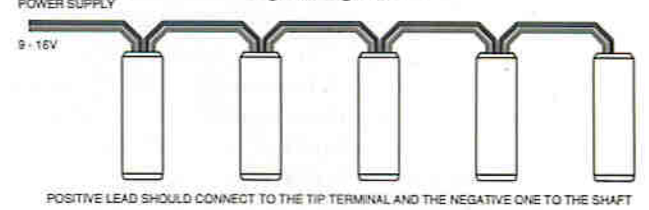
Irrespective of whether or not you have decorated the star prior to this point, decide which type and colour to use for LED11 and solder the all of the LEDs to the board FIRST; note that the pads to LED11 on the underside of the board are not accessible once IC2 is soldered in place. Follow the layout shown in figure 3, ensuring they are all inserted the correct way around with their anodes pointing to the centre. LED11 can be soldered either way around depending on whether you want it on first or off first. If a bi-colour type is used, it will depend on whether you want red light or green light first. The holes shown in the centre of the LEDs enables figure 3 to be used as a template for cutting and/or drilling a Perspex or decorated fascia panel if desired to fit over the LEDs. This allows the star to form just one part of what could be a much larger decorated panel, a scenic Christmas picture, for instance.

Here's a tip to improve the rigidity and durability of the LEDs. If the leads have raised areas of moulded body plastic around them, these will prevent the LEDs from fitting flush to the board, so countersink the holes slightly on the topside of the PCB to accept then using a 3mm drill bit. Apply a small 'blob' of impact adhesive (Evo-stick) to the underside of the body of each LED prior to inserting them into the PCB. Avoid using 'super glue' as this will 'fog' the body of the LEDs if overspill occurs. Solder each one in place and then apply a further small amount of adhesive around the base of them where they touch the PCB. When this dries it will provide an extremely durable bond, which is particularly important for LED11, because if this one gets damaged, the only way to replace it will be to first de-solder IC2 from the PCB, and that alone will be no easy task, especially since the chase pattern wiring is also soldered to the same pads. Let's face it, all of the decorations usually get put into a box after Christmas, and the following year there's always something that's broken or doesn't work, even though it was in perfect condition when you put it away and hasn't been touched since!

The prototype was fitted with all red LEDs, but there is no reason why you cannot use a combination of red, orange, yellow, green or even blue if you're feeling wealthy. The only point to bare in mind is that there is only one current limiting resistor for all of them - R7, so different colours will produce varying degrees of brightness, due to their differing electrical characteristics. The LED leads must also not have stand-offs or shoulders as they are sometimes called, these are small spurs close to the top of the leads which prevent the LED from being mounted flush to the PCB. If so, they should be very carefully cut off using a good pair of side cutters.

Once all the LEDs are soldered in place, turn the PCB over and lay it on a soft surface or a piece of cloth to prevent it skidding around and scratching the top face of the LEDs. Solder the components to the blind pads on the copper side of the board, in accordance with the layout diagram of figure 4. IC1 and IC2

Fig.7 wiring loom



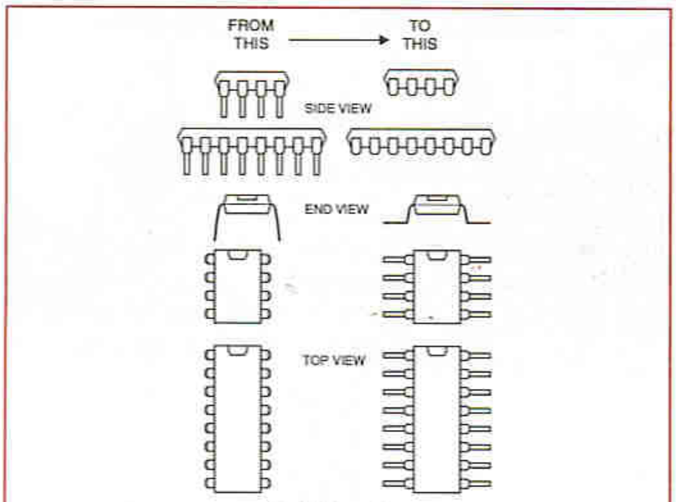


Fig.8 IC pre-forms

must have the pins re-formed to match the views shown in figure 8, and two suggestions of how to achieve this are as follows:

(1) Slot one complete side of the IC into the very edge row of a piece of stripboard, so that the opposite side of the IC overhangs the edge, grip the top and bottom of the IC and fold it backwards, bending all of the pins at the same time. Remove the IC and do the same with the other row of pins.

(2) If a piece of stripboard is not available, use a pair of insulated pliers to bend each pin in turn to an angle of about 70°, then place the IC on a smooth flat surface and apply firm but controlled pressure to the top of it until all of the pins become horizontal. Be careful not to bend the pins close to the body of the IC, they should only be re-formed from the shoulders down. Avoid touching the pins with your fingers, as CMOS devices can be destroyed by static discharge.

During soldering, a small tipped soldering iron is required to achieve the best results, not a wooden handled poker that you heat up in the coal fire! TO solder IC1 and IC2, place them centrally on the pads and 'tack' just one of the pins with solder; this will allow them to be positioned more precisely before finally soldering the remaining pins. Note that the two ICs face in opposite directions. IC2 has extended pads to the pins which will eventually have the chase pattern wiring soldered to them. Therefore the IC should be positioned centrally on the shorter pads and at no point must the pins of either IC come into contact with the copper tracks running underneath them.

The following method can be employed when soldering the resistors and diodes in place. Hold the component in the position shown, centrally between the two pads available for it, and cut the leads as equal as possible to the required length, pre-forming them beforehand where necessary (R1, R2 & R5). Tin the ends of the leads and the pads with solder, forming a small 'hump' on the pads. Hold the component vertically at 45° against one of the pads and solder it in place. Now bend the other lead downwards slightly towards the PCB, just enough to clear the body of the component when it's flush to the board. Using the tip of a small screwdriver, push and hold the component against the other pad whilst soldering it into place and allow the solder to set before removing the pressure. Be sure to fit D1 and D2 the correct way around with their cathodes pointing away from each other.

The capacitors and TR1 can be soldered in a similar way, but these can be held between the fingers throughout the process and shouldn't be quite so awkward. Note the polarity of the capacitors, and that TR1 is fitted with its flat surface against the board.

The chase pattern wiring can now be soldered between the outputs of IC2 and the LED anode pads provided close to the tips of the star. In order to keep the bulk of the wiring to a minimum, the connections are made using 24SWG enamelled copper wire. This is bare copper wire which is coated with an insulating lacquer rather than a PVC sheath, which results in a much smaller overall gauge, allowing it to be threaded underneath the ICs and in between the other components with ease. This in turn enables a lower profile to be gained on the back of the star. Enamelled copper wire does not require stripping, but does require tinning before soldering it into place. To do this, hold the ends of the wire against a hot, well-tinned soldering iron tip until the lacquer burns off, at which point apply a little more solder so as to coat the end of the wire. Cut off any excess tinned wire, leaving only enough to solder to the pads (about 1mm - 2mm).

The numbers down the left-hand side and the bottom right-hand side of IC2 in figure 4 correspond to the output sequence order of the 4017, not which LED pad they should be connected to; this is left to individual choice. Table 1 gives some suggestions of variations for different patterns and figure 5 shows the connections required to provide pattern 2 chase sequence.

Finally, thread a length of 7/0.2 twin "figure 8" (speaker) wire under the strapping link and solder it to the power supply pads as shown in figure 8. After satisfactory testing, the back of the star can be sprayed with varnish or a few spots of the afore-mentioned adhesive can be applied at various points in order to keep everything in place. By terminating the free end of the power lead into an optional 2.5mm back plug, multiple stars may be connected to a wiring loom made up of the above "figure 8" wire and 2.5mm line sockets connected in parallel. The loom will then look similar to a set of Christmas lights with all the bulbs removed - see figure 7. If four or more of these stars are plugged into the loom, the overall effect really is very stunning, even more so if the stars are wired for different chaser patterns, and will make your decoration the envy of people who themselves have nothing like it, or have never seen anything like it before.

PARTS LIST

Resistors

R1, 4 47KΩ (2 off)
R2 270KΩ (1 off)
R3 150kΩ (1 off)
R5 1M8 (1 off)
R6, 7, 8 1KΩ (3 off)
Total 8 resistors

Capacitors

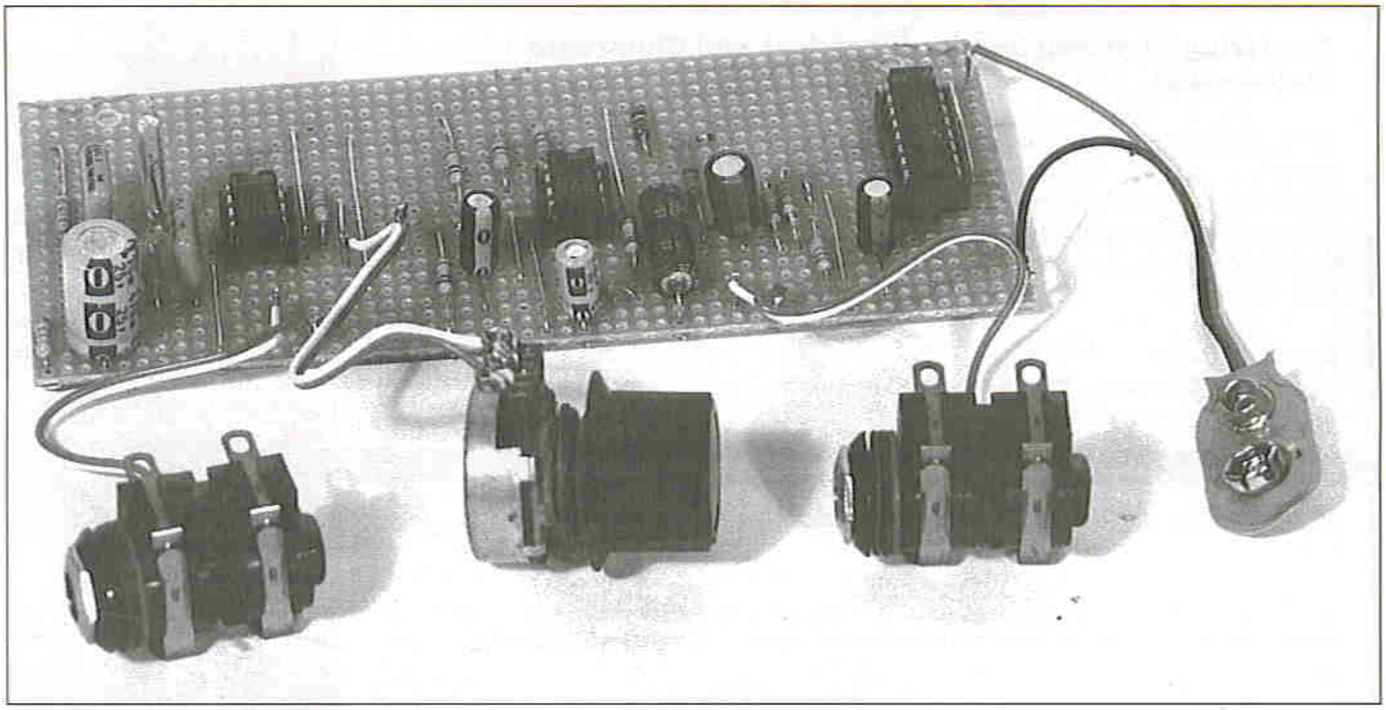
C1, 2 1µF/63V radial electrolytic (2 off)
C3 10µF/16V radial electrolytic
Total 3 capacitors

Semiconductors

D1, 2, 3 1N4148 silicon signal diode (3 off)
IC1 1CM7555IPA low-power CMOS timer
IC2 CD4017B CMOS decade counter/divider
LED1 - 11 5mm standard red LED (11 off)
Q1 MPSA14 NPN silicon Darlington transistor
Total 17 semiconductors

Hardware & Miscellaneous

2.5 mm jack plug *
24SWG enamelled copper wire (1 mtr)
Twin "figure 8" 7/0.2 flex (300mm)
PCB DTE "Xmas Star" printed circuit board
* optional - not required for basic star



METAL EFFECTS UNIT

Get into heavy metal with Robert Penfold's easy to build effects circuit

Metal effects tend to be regarded as extreme and only for those who are into "heavy metal" music. This is not a strictly accurate view of things, though, and metal effects can be pleasant, discordant or anywhere between these two extremes. The metal effects unit featured here is designed to produce a mild effect, vaguely reminiscent of a chorus unit, but it can be adjusted to produce a more potent effect if desired.

Metal Basics

Most musical instruments of the western world use a one-dimensional resonator of some kind, such as a string or metal tube. The note is changed by altering the effective length of the string, tube or whatever. The sound produced by a simple resonator of this type consists mainly of a fundamental frequency, plus harmonics (multiples) of that frequency.

The majority of effects units produce relatively mild effects which result in the generation of few (if any) entirely new frequencies. Even a distortion unit leaves the signal basically unchanged in that the output still consists of a fundamental frequency plus harmonics. The change in the signal is brought about by greatly boosting the harmonics relative to the fundamental frequency. This undoubtedly changes the sound of the guitar quite radically, but it still gives what is clearly a guitar type sound.

A metal effects unit produces output frequencies that are not necessarily harmonics of the fundamental input frequency. This tends to produce a much more radical change in the sound of an instrument. Unless care is taken it can also produce rather discordant results. The "metal" name is derived from the fact that many metal instruments (gong, bells etc) have two or three-dimensional resonators and they consequently produce complex sounds that do not simply consist of a fundamental

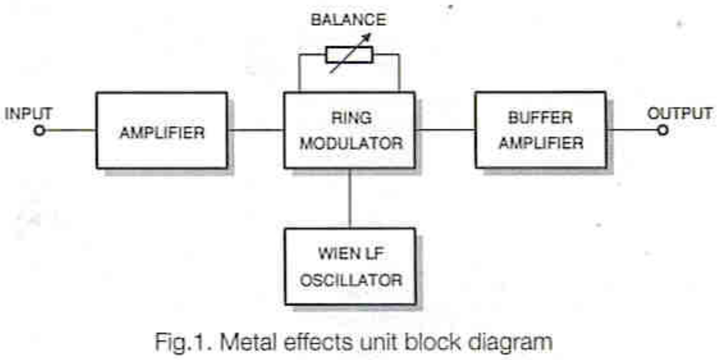


Fig.1. Metal effects unit block diagram

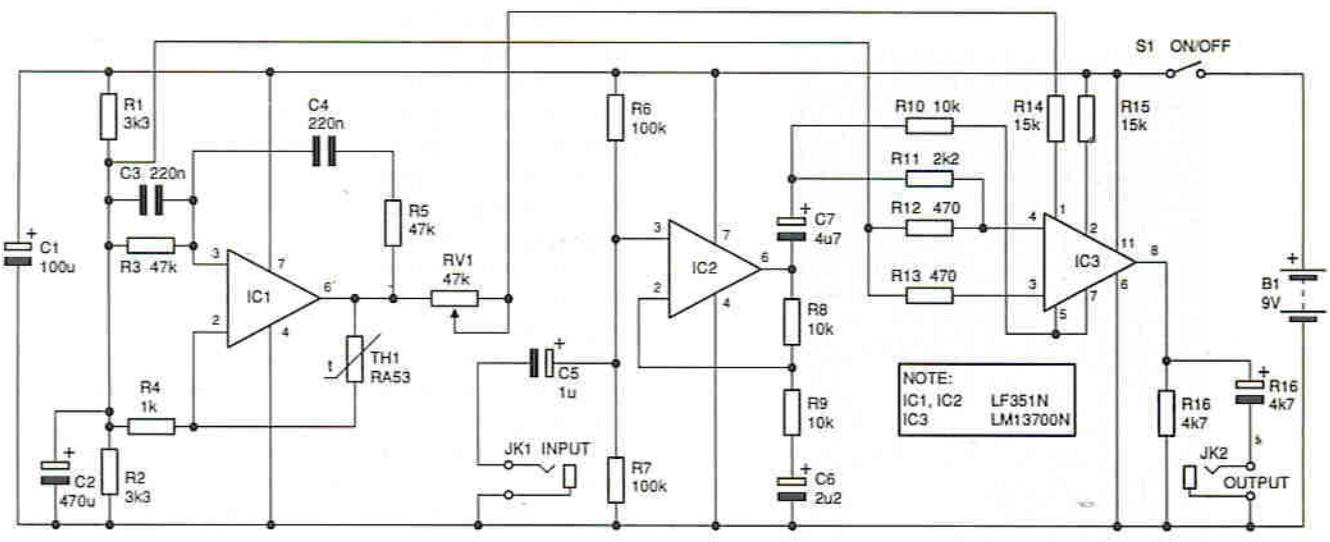


Fig.1. Metal effects unit block diagram

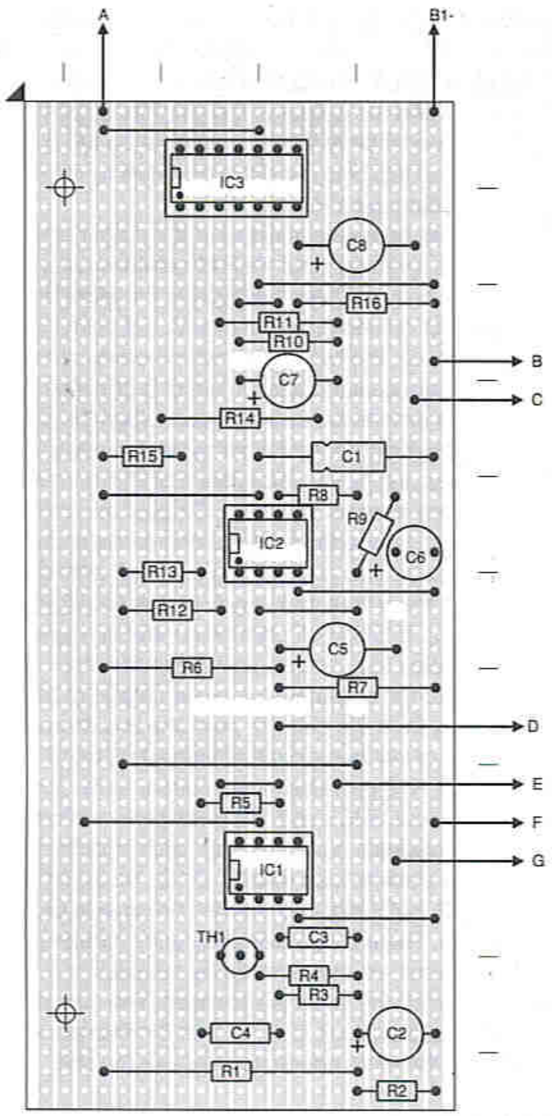


Fig.3. Component layout for the stripboard panel (52 holes and 21 strips)

frequency plus various harmonics. If designed correctly, the frequencies produced by a bell produce harmonious results and a pleasant sound. Likewise, if a metal effects unit produces suitable output frequencies, a single note at the input will produce what is effectively a simple chord at the output.

In practice it tends to be rather difficult to get a metal effects unit to operate in this way. The effect is produced using what in musical circles is usually called a "ring" modulator, but in general electronics this would normally be referred to as a balanced modulator. Whichever term you prefer, its effect is exactly the same. Fig.1 shows a block diagram for the metal effects unit. The input signal is applied to the ring modulator via an amplifier which provides a small amount of voltage gain, but the main purpose of this amplifier is to provide buffering. A buffer amplifier is also used at the output of the ring modulator.

The modulation input of the ring modulator is fed from a low frequency Wien oscillator which generates a stable and pure sinewave signal. The effect of the ring modulator is to produce sum and difference frequencies. If the oscillator operates at 20Hz and a 100Hz input signal is used, this generates sum and difference frequencies of 120 and 80Hz respectively. By using a suitable oscillator frequency it is possible to generate new output frequencies that will blend well with the fundamental input frequency, and give a pleasant sounding effect. The problem is that changing the pitch of the input signal often requires a change in the operating frequency of the oscillator in order to avoid discordant results. There is no single oscillator frequency that suits all input frequencies.

A simple way around this problem, and the one used in this case, is to opt for a low oscillator frequency. This generates sum and difference frequencies several hertz either side of any input frequency, giving a sort of extra strong chorus type effect. The choice of oscillator frequency is important since too low a frequency will give a form of tremolo effect rather than a metal type effect. Using a frequency that is too high can result in audible breakthrough at the output, and an effect that is far too strong for most tastes. The best compromise seems to be a frequency of around 15Hz. The oscillator signal must be a good quality sinewave having a low harmonic content, as even weak harmonics could produce audible breakthrough at the output. A good quality Wien oscillator is therefore used.

The ring modulator is equipped with a balance control. With the modulator well out of balance the input signal appears

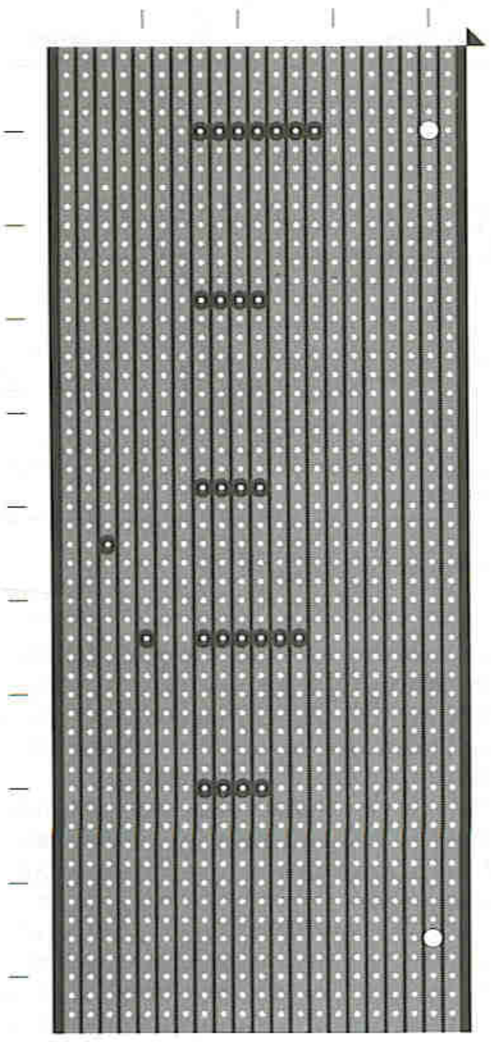


Fig.4. Underside of the component panel

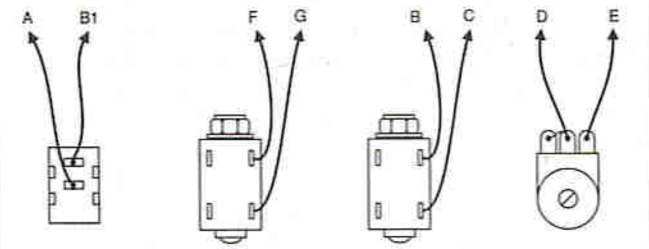


Fig.5. The point-to-point wiring (use in conjunction with Fig.3.)

strongly at the output, together with the newly generated frequencies. Adjusting the modulator for a high degree of balance results in the input signal being virtually suppressed at the output, but the sum and difference frequencies are still present at good strength. In order to get a good effect it is necessary to adjust the balance control to attenuate the input signal to some degree. Using a high degree of balance gives a strong effect that might be too much for many users. Setting this control is really a matter of personal preference.

How It Works

The full circuit diagram for the metal effects unit is shown in Fig.2. The low frequency oscillator is based on IC1, and this is a conventional thermistor stabilised Wien oscillator. Biasing for the oscillator and the ring modulator is provided by R1, R2, and C2, which effectively provide a centre-tap on the supply lines. Positive feedback is provided via the Wien network (R3, C3, C4, and R5) and the values used set the operating frequency at about 16 hertz.

A circuit of this type will provide a highly pure sinewave output signal, but only if the closed loop voltage gain of the amplifier is accurately regulated at a level which is just high enough to sustain oscillation. This gain regulation is provided by Th1, which is a self-heating thermistor having the usual negative temperature coefficient.

If the circuit oscillates strongly, Th1 passes relatively high currents, causing it to rapidly heat up. Its resistance then reduces and increased negative feedback is applied to the amplifier. This reduces the closed loop voltage gain of IC1, and produces less strong oscillation. The weaker oscillations cause reduced current through Th1, which in turn produces a smaller current flow, increased resistance and a greater closed loop voltage gain from IC1. This gives stronger oscillation. Initially the strength of oscillation varies considerably as Th1 repeatedly heats up and cools down, but after a second or two oscillation stabilises at an intermediate level, with a high quality sinewave at about 1 volt r.m.s. being produced at the output of IC1.

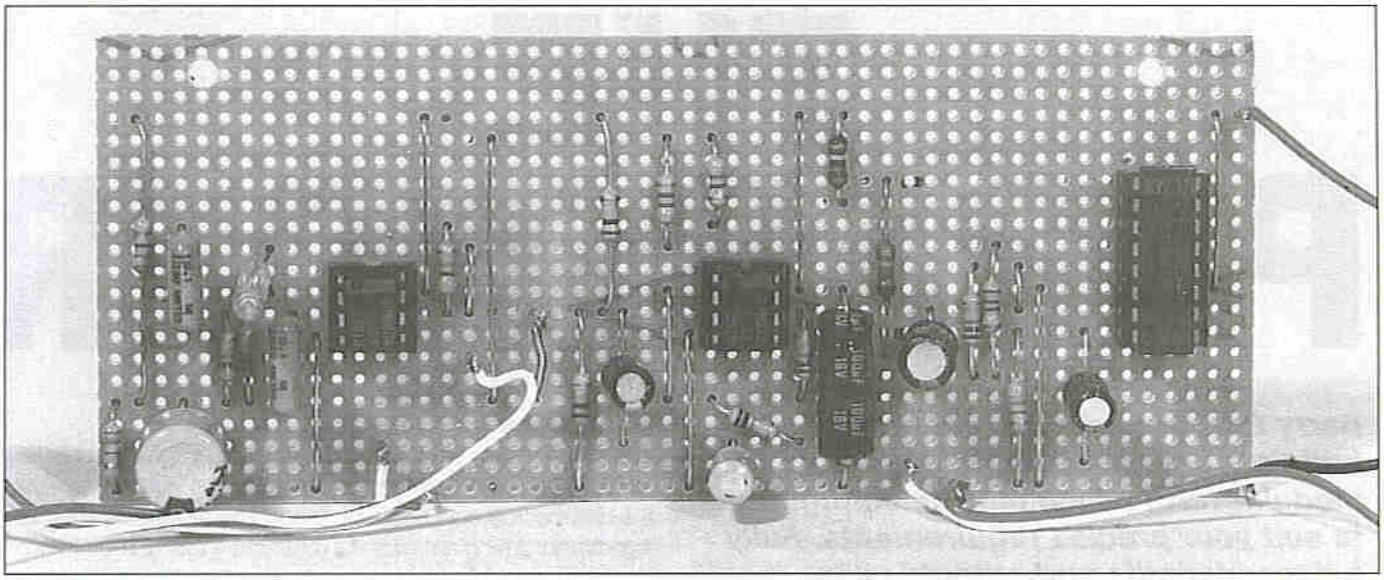
The input amplifier is a simple non-inverting type based on IC2. R8 and R9 set the closed loop voltage gain of IC2 at two times (6dB). The ring modulator is based on IC3, which is a dual transconductance operational amplifier. In this circuit, only one section of IC3 is used and no connections are made to the other amplifier. The input signal is applied to the inverting input of IC3 via R11 and the output of the amplifier by way of R10. The output impedance of IC3 is dependent on the bias current fed to pin 1, and this bias current is provided by the low frequency oscillator via VR1 and R14.

R10 provides an in-phase signal at the output of IC3, but the coupling to the inverting input via R11 provides an anti-phase signal at IC3's output. These two signals therefore have a cancelling effect on each other and, with IC3 set for a certain output impedance, the two signals will precisely cancel out one another. The strongest modulation effect is obtained with VR1 set so that this precise cancelling occurs when the output from IC1 is at the beginning/end of a half cycle. On negative going oscillator cycles, the output impedance of IC3 increases, and the non-inverted signal is dominant. On positive oscillator half cycles, the output impedance of IC3 decreases and the inverted signal is dominant. This gives strong sum and difference frequencies at the output, but largely blocks the input signal from the output. Backing off balance control VR1 gives less strong modulation frequencies, and allows the input signal to pass through to the output with a lesser degree of attenuation. If set well away from the balance point the circuit provides what is really a form of fast tremolo rather than a true metal type effect.

The resistor R15 provides a bias current to the linearising diodes at the input of IC3 and this gives better distortion performance. IC3 includes a built-in emitter follower buffer stage, and this requires a discrete load resistor (R16). No in/out switching is shown in Fig.2, but if required this can be provide by a DPDT bypass switch. There is approximately unity voltage gain through the circuit, so there should be no major change in the volume level when the effect is bypassed. The current consumption of the circuit is about 5 to 6 milliamps, and a PP3 size battery is therefore adequate to power the unit.

Construction

Details of the stripboard panel are shown in Fig.3 (component side) and Fig.4 (copper side). The board measures 52 holes by 21 copper strips, and it must be cut from a larger board using a



hacksaw. Smooth any rough edges using a large flat file and then make the breaks in the copper strips. A special tool is available, but a handheld twist drill bit of about 5 millimetres in diameter will do the job well. Either way, make sure that the copper strips are cut across their full width, but do not cut deeply into the board (which might seriously weaken it). The two mounting holes are also drilled at this stage. 3.3 millimetre diameter holes will accept either metric M3 or 6BA mounting bolts. I would recommend the use of mounting bolts, since most types of plastic stand-off do not work well with stripboard.

The board is then ready for the components and link-wires to be fitted. The link-wires can be made from 22 or 24 s.w.g. tinned copper wire. None of the integrated circuits are static sensitive, but I would still recommend the use of holders for all three of them. IC3 can be an LM13600N, or the almost identical LM13700N (which is the only version most retailers now stock). Take due care with thermistor Th1, which is not particularly cheap and is contained in a glass encapsulation. This is sold as both the R53 and the RA53 and obviously both types are suitable for use in this unit. Fit single-sided solder pins to the board at the points where connections to the battery and other off-board components will eventually be made.

Any medium size metal or plastic box should be able to accommodate all the parts. The circuit is not particularly sensitive to stray pick-up, but there is probably some advantage in using a case of all-metal construction. The hard wiring is illustrated in Fig.5 (which should be used in conjunction with Fig.3) and is very straightforward. Insulated jack sockets are used on the prototype, but "open" sockets are equally suitable.

Testing

Screened jack leads are used to connect JK1 to the guitar or other instrument and JK2 to the amplifier. The unit is designed to operate with an input level of about one volt r.m.s., so a preamplifier will be needed if it is used with very low output guitar pickups. Otherwise a poor signal to noise ratio will be obtained and there could be problems with the small amount of low frequency oscillator breakthrough at the output.

The effect of the unit should be fairly obvious with VR1 at any setting. With the wiper set towards either end of the track there should be a sort of rapid tremolo effect. Adjusting VR1 to a more central setting should produce a change in the sound and it should be possible to generate quite a strong metal effect if VR1 is carefully adjusted for optimum balance. Simply set VR1 for whatever effect you like best.

PARTS LIST

Resistors (0.25 watt 5% carbon film)

R1,R2	3k3
R3,R5	47k
R4	1k
R6,R7	100k
R8,R9,R10	10k
R11	2k2
R12,R13	470R
R14,R15	15k
R16	4k7

potentiometer

VR1	47k lin carbon

Capacitors

C1	100u 10V axial elect
C2	470u 10V radial elect
C3,C4	220n polyester
C5	1u 50V radial elect
C6	2u2 50V radial elect
C7	4u7 50V radial elect
C8	10u 25V radial elect

Semiconductors

IC1,IC2	LF351N
IC3	LM13600N or LM13700N

Miscellaneous

Th1	R53 or RA53
JK1,JK2	Standard 6.35mm (0.25 inch) jack
B1	9 volt (PP3 size)
S1	s.p.s.t. miniature toggle

0.1 inch pitch stripboard having 52 holes by 21 copper strips,
control knob, 8-pin DIL IC holder (2 off), 16-pin DIL IC holder,
battery connector, wire, solder, etc.

THE PARABENDER

Barry Porter concludes his project to build a stereo parametric equaliser in modular form which may be configured to suit your precise requirements. Fully balanced inputs and outputs with professional facilities and performance mean that no audio system should be without one ...

When any form of equalisation is in use, it is very useful to be able to keep an eye on the signal level, as it is very easy to drive some part of the circuitry into clipping. Any form of level metering needs to have a fast response time, which rules out the common V.U. meter. Even the best of these are designed to give an average reading, and have a mechanical movement incapable of responding to short transients.

The broadcasting standard PPM, or Peak Programme Meter, is much better, as it is designed to react to the signal peak levels; the drawback is cost and size. A good meter with its associated logarithmic driving amplifier can cost more than £100 and would have to be mounted external to the ParaBender, as miniature PPM's do not exist.

Luckily an answer does exist in the form of a Bar-Graph LED meter, which is rugged, accurate, and can be scaled to suit individual requirements. Although Bar-Graph driving I.C.'s such as the LM3915 make the design of a meter very easy, they invariably have an internal reference voltage and divider chain, which means fixed calibration steps that are guaranteed to be totally different to what you want.

The answer is to build a meter using discrete components, so that it can be optimised for the job in hand. A suitable circuit is shown in Figure 9.

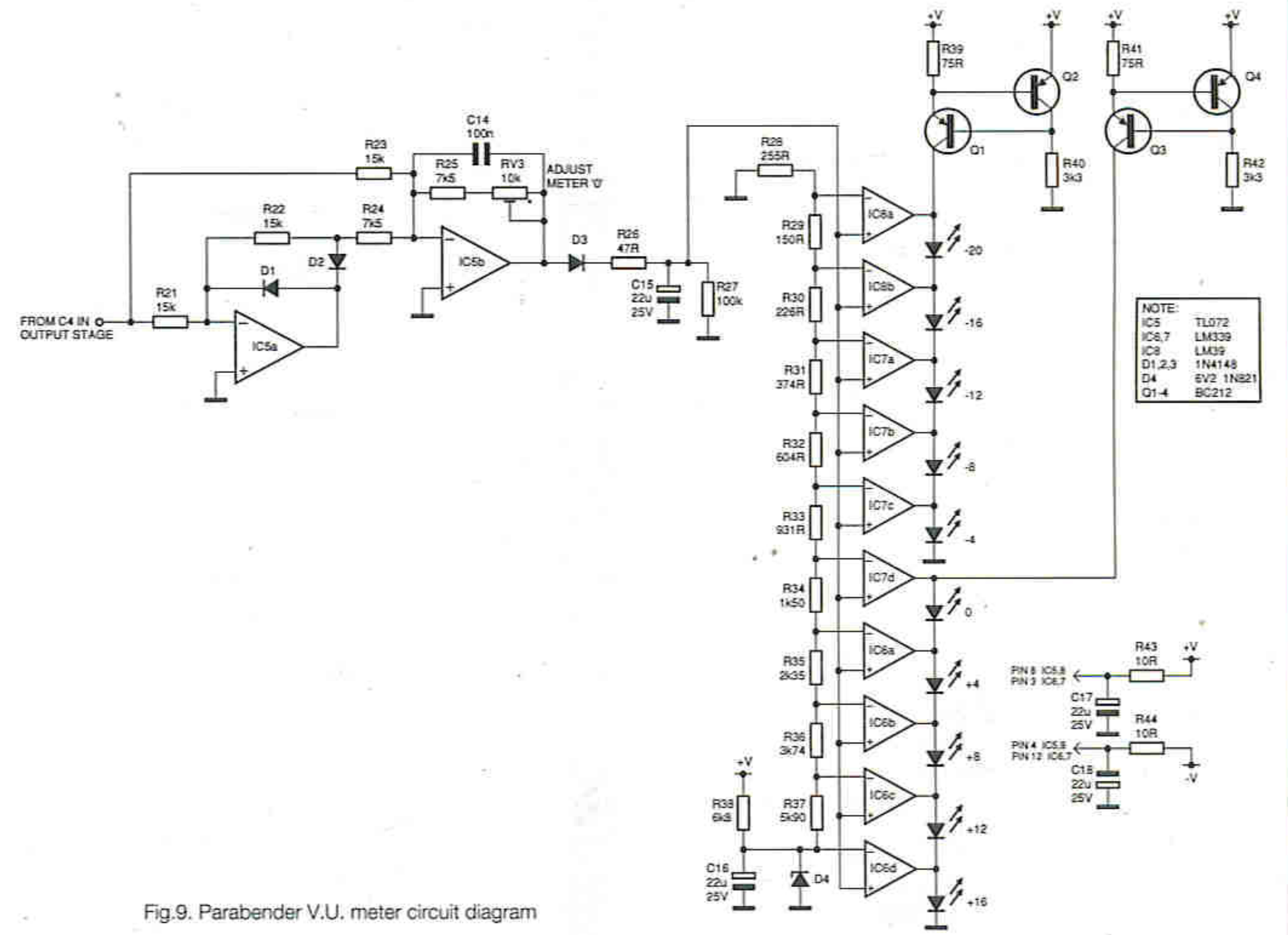


Fig.9. Parabender V.U. meter circuit diagram

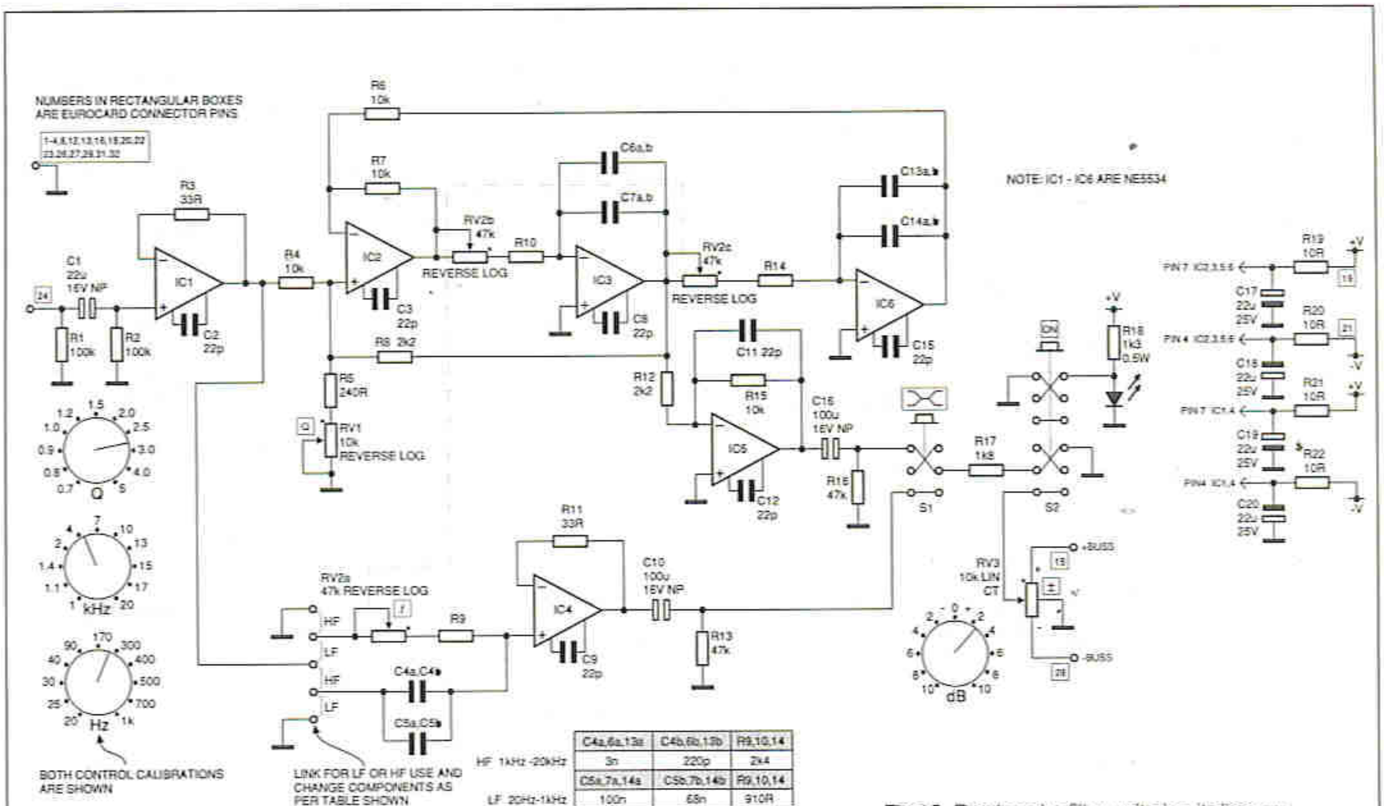


Fig.10. Parabender filter unit circuit diagram

Signal from the output amplifier is A.C. coupled by C4 to a precision rectifier formed by I.C.5 a & b. The scale factor of I.C.b may be adjusted by VR3 to obtain the initial calibration. The attack and decay times are a function of R26, R27 and the timing capacitor C15.

The rectified signal drives the +input of ten comparators contained in I.C.6, 7 & 8, comparing the signal voltage with the fixed voltages on the resistor chain formed by R28 to R37. The top of this chain is held at 6.2V by Zener diode D4 which is temperature compensated with a coefficient of 0.01%/°C. The chain is then easily calculated to have trigger points that correspond to the required calibration.

With no input signal, the open collector comparator outputs are all low, so each LED in the Bar-Graph is shorted out and the current from the two current sources, Q1-4 is sunk to ground. As the input signal and subsequent voltage on C15 rises and the comparator +inputs go higher than the resistor chain steps, the outputs go high, allowing the LED's to illuminate. By placing the LED's in series, the total current drawn from the V+ supply rail is reduced by a factor of five at the expense of providing double current sources. But this can have an advantage - if you use two five-way LED strips, the current through each can be controlled by changing R39 or R41 so that the illumination appears even.

The Filter Modules

Now for the fun part - the separate filter modules. The circuit of one of these is shown in Figure 10.

The input signal is buffered by I.C.1 to provide a high impedance load to the driving stage (I.C.4, Figure 4), and then filtered for a band-pass response by a State Variable filter comprising I.C.2, 3, 5 & 6 and a shelving response by I.C.4.

It is suggested that two types of module are built - one covering the lower frequency range of 20Hz to 1kHz and the other working between 1kHz and 20kHz.

The frequency of both filters can be calculated from:

F = (2_RC) -1

Where R = VR2 + R9 (or R10 or R14)
C = C4 + C5 (or C6 + C7 or C13 + C14)

Note that provision has been made on the PCB for a variation in capacitor size and value so that virtually any frequency range can be covered in addition to the recommended ones. Also, the input to I.C.4 may be linked to give a high or low pass response. Remember that for a module operating in the 20Hz to 1kHz region, I.C.4 needs to be configured as a low pass filter as it is the output of I.C.4 adding to the main signal that provides lift and cut. It is just a case of interchanging the resistor and capacitor combinations, which is taken care of by the links shown.

The band-pass filter Q is a function of input resistor, R4, feedback resistor R8 and the Q adjustment resistance R5 + VR1, the Q value being:

$$Q = \frac{Rx + R8}{2Rx}$$

Where Rx = R411 R5 +VR1

therefore: $Rx = \frac{R8}{2Q - 1}$

In order to obtain a low Q value of around 0.7 at one end of the adjustment range, the value of R8 has to be somewhat lower than R4. As far as the input signal is concerned, I.C.2 and I.C.3 act as just like a single inverting amplifier, so with reference to the input signal, the output of I.C.3 is:

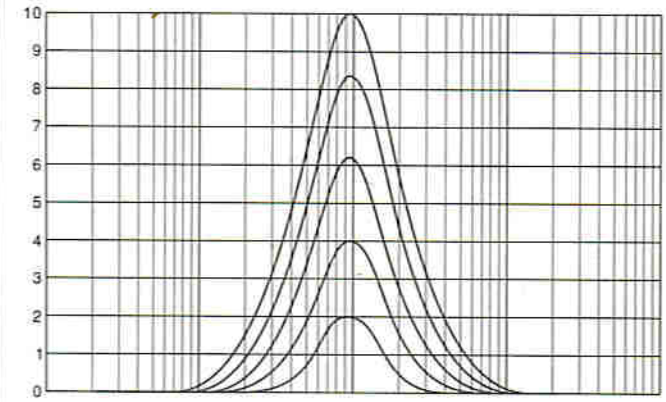


Fig 11a Parabender amplitude variations at constant Q or 1

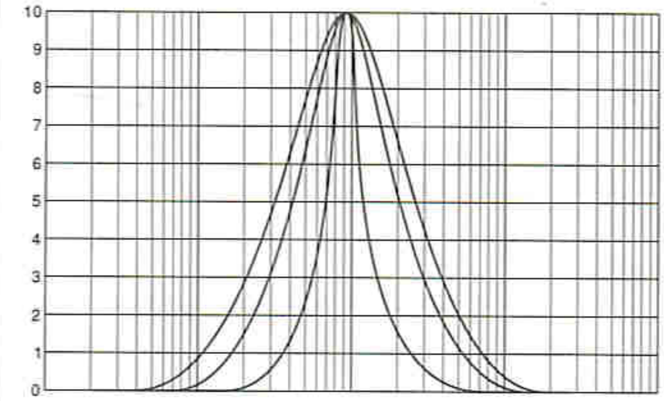


Fig 11b Parabender Q variations

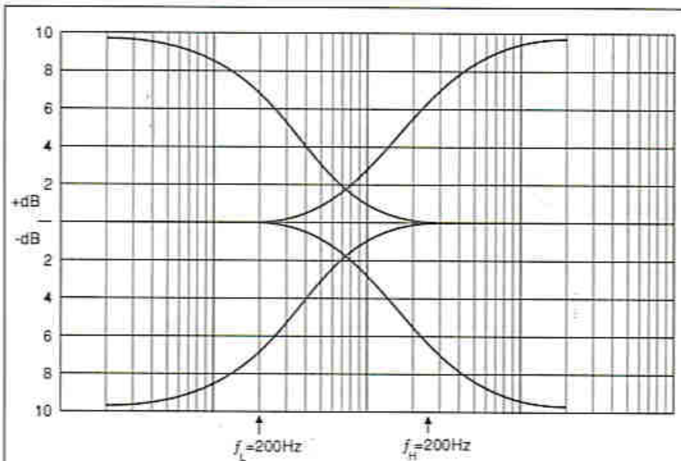


Fig 11c Parabender shelving response

Fig.16 Parabender Output unit PCB component overlay

$$20\log\frac{(R8)}{(R4)} = -13.15dB$$

In order to give the state variable stage unity gain at resonance, this loss must be replaced, which is done by I.C.5, using the same resistor values as R4 and R8, but the opposite way around.

At resonance, the +input of I.C.2 is a virtual earth point, so the Q control will have no effect on either amplitude or frequency of the bandpass filter.

I.C.5 is configured as an inverting amplifier so that the overall input phase of the bandpass and shelving filters is the same - i.e. non-inverting.

The gain correction could be carried out by placing I.C.5 in front of I.C.4, but this would reduce the overload margin of the filter by over 13dB, so although there is a very small increase in noise brought by placing gain at the output stage, it was found to be the best compromise.

Selection switch S1 routes the required filter output, via level setting resistor R17, to the On-Off switch, S2 and the amplitude control VR3.

The value of R17 decides the maximum amount of available lift and cut.

Referring to Figure 4 it will be noted that resistors R17, 18, 19 & 20 are the same value - 3k9. When the amplitude control is at either end of its travel, R17 (Back to Figure 10 again) will be in parallel with one of the equaliser input resistors, (let's call it Rx to avoid confusion) so the maximum lift or cut becomes:

$$20\log\frac{(Rx)}{(Rx\ 11\ R17)} = 10.01dB$$

Where Rx = 3k9, R17 = 1k8

For different amounts of lift and cut, a bit of number crunching is required, but a couple of possible combinations are:

Rx = 7k5	R17 = 1k6	±15dB
Rx = 11k	R17 = 1k2	±20dB (Brave man!)
When Rx = R17		

Power for the ParaBender

A stereo ParaBender requires a bi-polar power supply with a nominal ±16V (15 - 18V acceptable) at about 0.5A.

If you are using a single supply to provide power to more than one unit, such as a ParaBender and a MicroAmp, there may be a hum problem caused by the 0V loop - unit 1 0V, along the interconnect screen to unit 2, along the power lead to the power supply and back to unit 1 via its power cable.

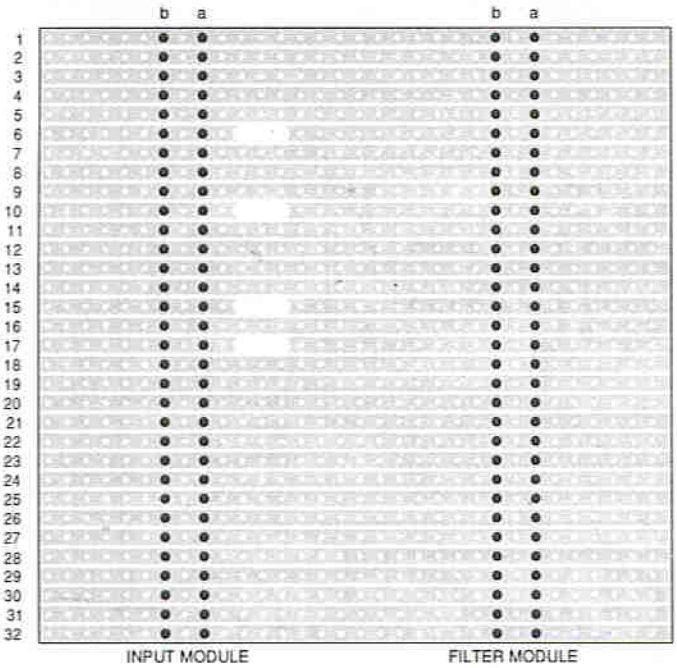
This type of loop is easily broken by inserting a small amount of resistance into one of the 0V paths, the only question being "which one?"

There are obviously three possible places to insert the resistance, and the one most likely to be successful is the power supply feed to the unit furthest from the initial signal input - in the case described, this being the ParaBender. All that is necessary is to place a parallel combination of a 3R3 resistor and 0.1uF capacitor in series with the incoming power supply 0V rail. The resistor should be overrated by a large amount to remove any danger of it ever burning out, a 2.5W wirewound type being ideal.

Of course, if you are building a separate supply for the ParaBender, there is no need for this resistance. Just provide a well established, noise-free 16-0-16V supply, making sure that there is no connection between the 0V and mains earth. The ParaBender frame should be connected by a separate wire to a terminal on the power unit, allowing various earthing combinations to be tried to keep hum to an absolute minimum.

Construction

The ParaBender circuitry is on standard 100 x 160mm Eurocard



EXTERNAL CONNECTIONS:

PIN	WIRE TO:
6	INPUT XLR PIN 3
8	INPUT XLR PIN1
10	INPUT XLR PIN 2
13	OUTPUT XLR PIN 1
15	OUTPUT XLR PIN 2
17	OUTPUT XLR PIN 3
19	POWER INPUT +V
21	POWER INPUT -V
31	POWER INPUT 0V

CUT VEROBOARD TRACKS WHERE SHOWN

Fig.12 Parabender back plane

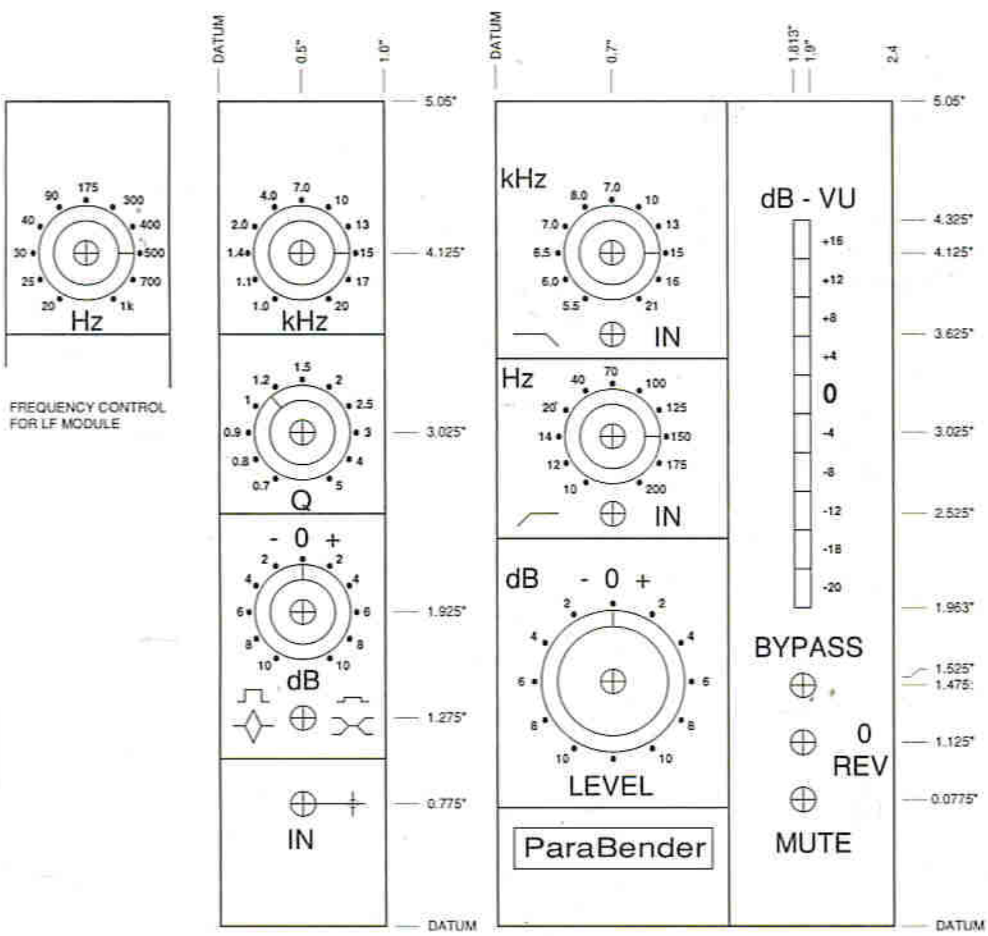


Fig.13 Parabender front panel layout

circuit boards, which should be fitted into a 3U x 19" card frame. If you are new to card frames and the seemingly countless bits and pieces that go with them, briefly it goes like this:

19" refers to the overall width of the front panel, which is designed to mount into a standardised rack cabinet that can be of any height up to 6 feet or more. The front panel has four elongated holes at specified spacings, allowing it to be screwed to the rack with M6 x 18 pan head screws which are normally fitted with plastic cup washers to protect the panel finish. The "U" refers to the front panel height, 1U being 1.75", but normally this is rounded down to 44mm to allow a slight clearance between separate pieces of equipment mounted in a rack - 3U is therefore 132mm high.

The enclosure dimensions are smaller than the front panel, typically being 430 x 125mm; the reduction in width is so that the enclosure can pass between the mounting flanges of the rack, and the height so that separate units in a rack do not rest on each other and cause intermittent earthing problems.

The next strange dimension you will come across is termed HP (no, it has nothing to do with how far Frank Bruno can throw a bottle of sauce). One HP is 5.08mm (0.2") and is used to describe the width of things such as modules and card front panels that fit into a card frame. A typical frame has a maximum width capability of 84HP, so the panels fitted should add up to this or there will be a gap somewhere.

A stereo ParaBender has 12 filter units, each with a 5HP front panel, and two input/output modules, each with a 12HP panel, so:

(12 x 5) + (2 x 12) = 84HP

A mono unit will hold 14 filter modules, but the input/output module will require a 14HP panel, which is no hardship.

(14 x 5) + 14 = 84HP

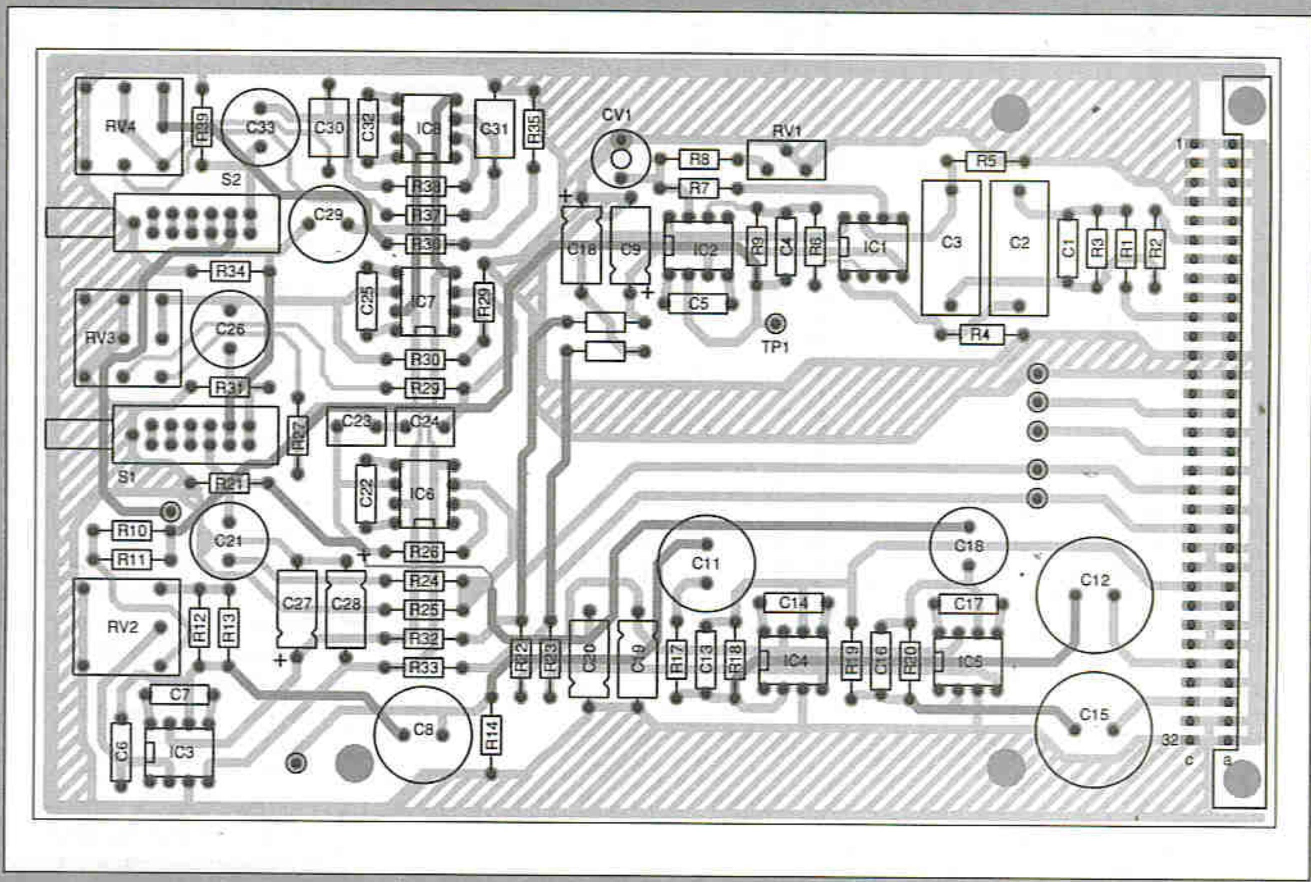


Fig. 14 Parabender Input unit PCB component overlay

In order to keep the filter controls central on each panel, it has not been possible to use standard card mounting brackets, so the panels are attached by the potentiometer mounting hardware. This places the top surface of the card 6.35mm to the left of the panel centre line, which does not fall in line with one of the usual guide or connector mounting positions. This causes no problems providing the guides can be freely positioned, and the connectors are attached to a tapped strip which can be moved in a groove in the frame rear extrusion. The recommended frame has this facility, so unless you are sure of your ground, this is obviously the one to use.

The card connector is a standard DIN41612 with 64 pins placed in rows A and C. As no single pin connections have to be made, a length of 0.1" pitch Veroboard can be used as a backplane. Connections that are common to the Input/Output module and the filter units have been placed on the same pin positions, so all that is required is that a few copper strips are cut to isolate the input and output connections.

The XLR input and output connectors, together with the power supply input socket should be mounted to a rear panel which attaches to the card frame horizontal extrusions and these are wired to the Veroboard as shown in Figure 12.

Now that it's finished ...

Once the construction phase is over and you have finished explaining away all those little blobs of solder on the living room Administer, the time has arrived to switch on and start testing. Initially, remove the modules and apply power to the frame to make sure there are no shorts. Check the power pins on each connector to confirm that the correct + and - rails are present, then plug in one of the Input/Output modules.

A signal applied to the input of this should arrive at the output with the level control, high and low pass filters, by-pass, phase and mute switching all operating as intended. These functions should all be thoroughly checked, and when their correct operation is confirmed, the filter modules should be added, one by one, checking the functions of each one before proceeding to the next.

Once one channel is fully operational, carry out the same procedure with the other, and when complete you will have a functional ParaBender, ready to be put to whatever use your heart desires ...

The ParaBender in use

If you are so inclined, you could probably spend many happy hours (or even years) and use a forest worth of graph paper plotting all the possible response curves that the ParaBender is capable of producing.

Before you start however, remember that the ParaBender is a tool, intended to be put to use, no matter how ill-conceived.

Although the control calibrations are reasonably accurate, the use of reverse logarithmic pots means that they can only be approximately scaled. In use, this is relatively unimportant as the best way of setting any equalisation is by listening to it.

Having said that, there is very little left to say, but it is generally true that the operation of any equaliser becomes easier with use, so get out there and ParaBend to your heart's content ....

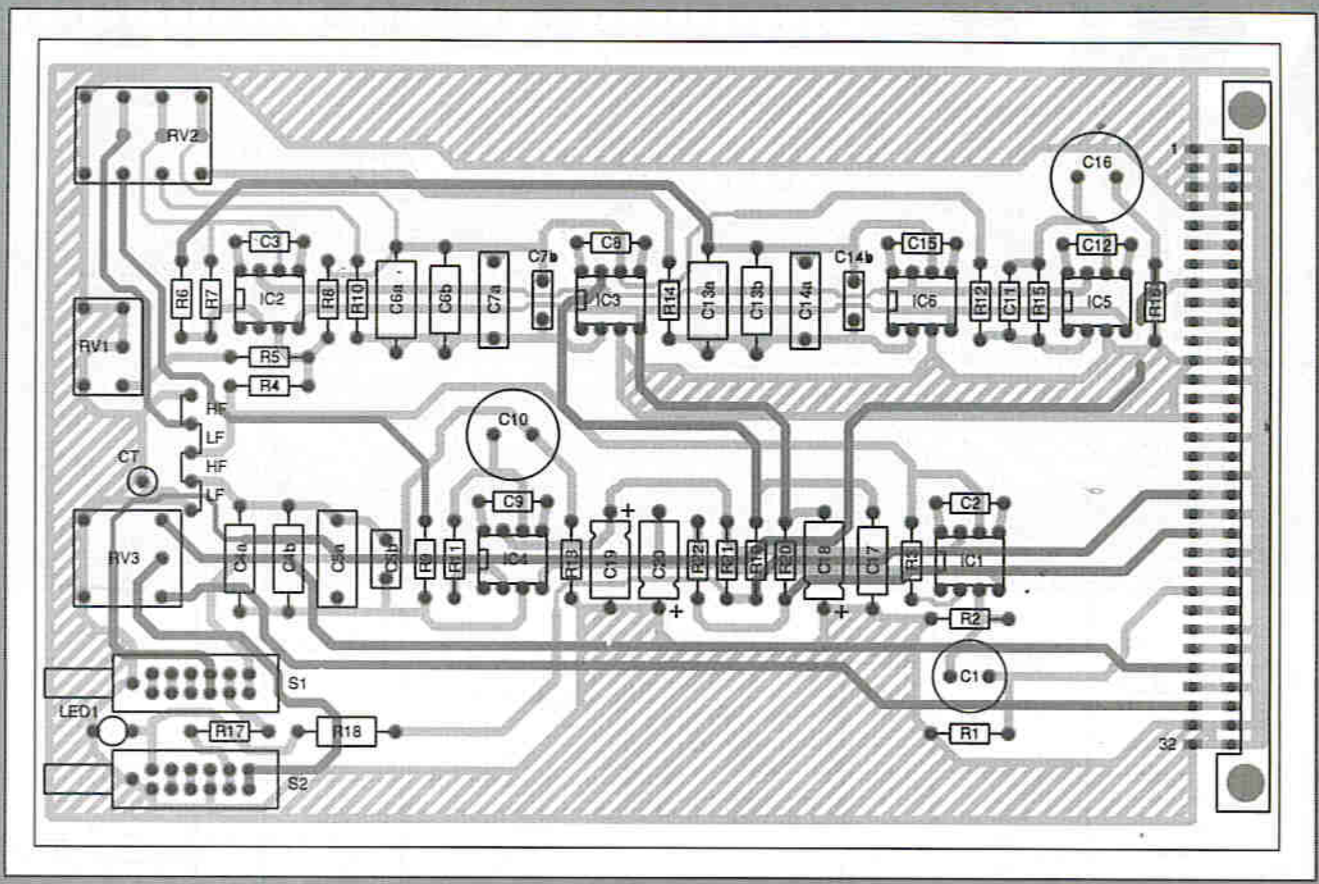


Fig.15 Parabender Filter unit PCB component overlay

Mini Photographic SAFELIGHT

Bring light to your darkroom with Terry Balbirnie's handy portable LED based unit

This Mini Safelight project will be useful to anyone needing to do occasional photographic work. Since it is battery-operated, it has the advantage of being completely portable. In fact, the prototype unit was designed to be small and light enough to be hung round the neck. Since the light is not as bright as a mains safelight, carrying it in this way gives good illumination wherever you go in the darkroom. In fact, taking the directional effect into account, the effect is similar to using a conventional "beehive" safelight fitted with a 15W bulb. The on-off switch is combined with a bright/dim function - this allows power to be saved when a reduced light output is sufficient.

LEDs go

This design is innovative in that 10mm "superbright" light-emitting diodes (LED's) are used for illumination. This has several advantages. Firstly, current consumption is very small for a given light output - about 300mA (on full power) - which is about the same as a single small torch bulb. Also, LED's remain cool in operation, are very robust and almost totally reliable. Another important advantage is that the red light was found to be "safe" when used with the standard black-and-white photographic papers tested. Readers should, however, check that the light is suitable for use with their own materials - particularly if they use non-standard papers (such as those having a panchromatic emulsion). A simple method of checking the safelight will be described at the end. Note that those wishing to use colour materials must use a commercial safelight fitted with the correct type of filter - this light is not suitable.

The supply consists of three alkaline AA cells. These should provide about 6 hours of service on full-power or 15 hours on the lower one. It will be obvious when the batteries need to be replaced since, when the voltage falls below 3V, the LED's become too dim for service. It would also be possible to operate the unit from a commercial unregulated 4.5V d.c. mains power supply.

Circuit description

The circuit for the Mini Safelight is shown in Fig. 1. It will be seen that ten LED's are used grouped into two sets - one of 4 (LED 1-4) and one of 6 (LED 5-10). Some readers will wish to experiment with other types, sizes and arrangements of LED's but those specified gave good results in the prototype. Since the maximum current allowed for each LED is 30mA, series resistors are needed of sufficient value to keep this current within safe limits when the batteries are new. Since an LED develops 2V approximately between its ends while operating, there will need to be about 2.5V "dropped" across the resistor. The group of 6 LED's requires 180mA and the group of 4, 120mA maximum The values of resistors needed, as calculated using Ohm's Law, are 14 ohms and 21 ohms respectively.

The resistor placed in series with the group of 6 LED's is formed by using two 33 ohm resistors (R2 and R3) connected in parallel (using the resistors in this way provides a near-correct value with the required power dissipation) and the resistor (R1) for the group of 4 LED's is 22 ohms which is a standard value. It would be more usual to use one resistor for each LED but serving groups of LED's in this way is acceptable if all members of the set are identical. S1 is a four-pole 3-position switch but only two of the poles are used (labelled A and B). In the first (OFF) position, the supply is disconnected completely. In the second one, the group of 4 LED's are connected via Pole A. In the third position, Pole A maintains the set of 4 and Pole B operates the set of 6 - i.e. all 10 LED's are on.

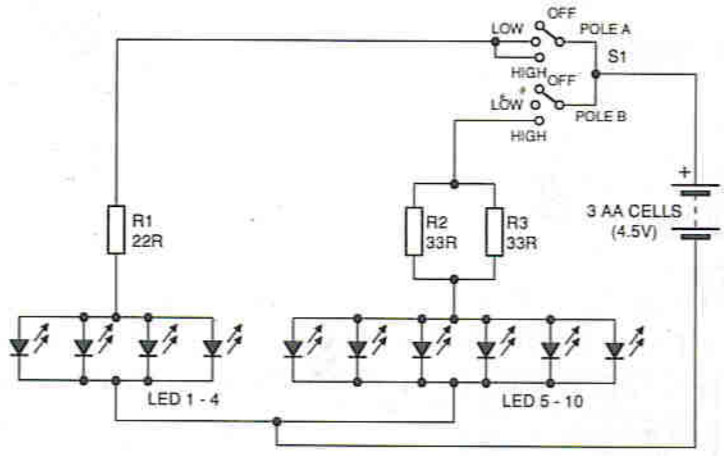


Fig.1. Mini Safelight circuit diagram

Construction

Construction is very straightforward and the method used in the prototype was to mount the LED's on a piece of stripboard (see Fig. 2). A convenient arrangement is an outer group of 6 and an inner one of 4. In this diagram the copper strips on the reverse side run vertically. If this material is not available, use a piece of plain matrix board or other rigid insulating material drilled with small holes in the required positions. Bend the LED end leads at right angles and make the connections on the underside using tinned copper wire. Whatever method of construction is used, the polarity of the LED's must be observed as indicated in Fig. 2 - the slightly longer end lead is the positive one. The LED bodies should be arranged to stand about 5mm above the base material. Solder 8cm pieces of light-duty stranded wire to the points labelled "S1a" and "S1b". Solder the negative lead of the battery snap connector to the point marked "Battery -" (if the battery holder has solder tags connections use a further piece of stranded wire).

The plastic enclosure is prepared by cutting a large window in the front for the light to pass through (see photograph). The hole for the switch should be carefully marked and cut out. Make sure the battery holder when in position will not be in the way of the switch body. Take particular care to use the correct length of fixing bolts to secure the switch - if they are slightly too long they will foul its action. Mount the circuit panel behind the window using adhesive fixing pads. Refer to Fig. 3 and complete the internal wiring. Attach the battery holder using further adhesive pads or small nuts and bolts.

Pain in the neck

If the safelight is to be worn round the neck, you will need a wire loop attached to the box for the cord to pass through. This may be made using a paper clip. This should first be straightened then bent tightly around a 6mm drill using a vice or pliers. The ends are then passed through two small holes drilled in the top of the box and bent outwards. The prototype used a piece of rope obtained from a bar of shower soap This rope is soft and comfortable to wear. Perhaps a piece of thick wool could be used - even string would do at a pinch. Pass the material through the loop and knot the ends together.

A choice needs to be made as to whether to use a diffusing front cover for the window or not. Diffusers absorb some of the light but give better all-round illumination. Without a diffuser the display will be brighter but directional with most of the light

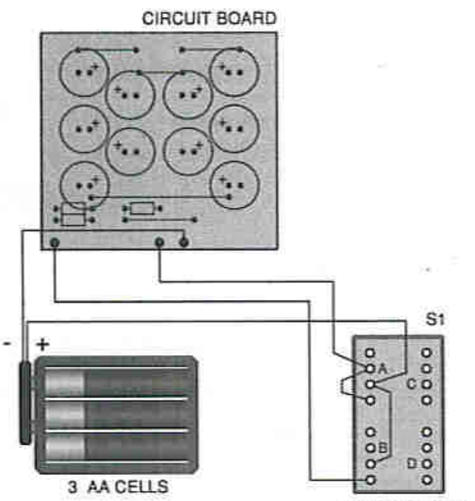


Fig.3 Mini Safelight wiring diagram

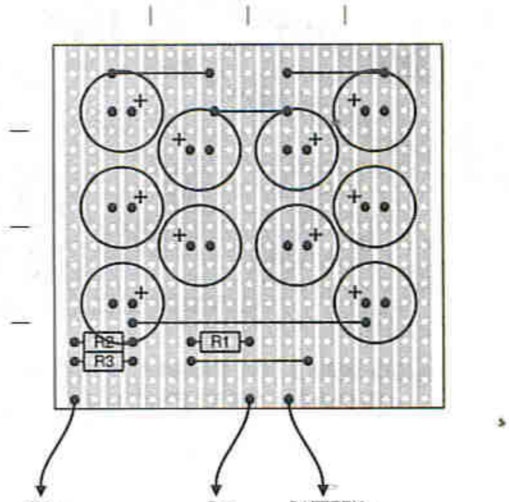


Fig.2. Mini Safelight component layout

being emitted over a small angle. If a diffuser is to be used, find some thin plastic material - perhaps from an old ice cream container. It will need to be checked to make sure it does not absorb too much light. If the safelight is to be worn round the neck it is suggested that a diffuser is not used since, as the body is turned, the light will naturally follow it. A diffuser is simply stuck over the window on the inside of the box. The photograph shows the prototype unit without a diffuser.

Safe encounters

Before using the safelight, it must be checked with the photographic paper intended to be used with it. A convenient method is to remove a piece of the paper in total darkness then wrap the rest up. The material is then laid on the bench, emulsion side up, with a coin on top. The safelight is shone on it for rather more than the normal processing time at a distance of about 50cm (about 2ft) and the paper developed and fixed in the usual way. When inspected, there should be no sign of darkening where the light reaches it. This would show up as a white shadow of the coin. If there is, the light is unsuitable for that particular material.

COMPONENTS

Resistors

R1	22R
R2,3	33R

All 0.6W metal film

Semiconductors

LED1-10	10mm "super bright" red LEDs

Miscellenious

S1	Miniature 4-pole 3-position slide switch

3 AA alkaline cells. Holder for cells and PP3-type snap connector. 0.1in matrix stripboard (see text), plastic box size 114 x 76 x 38mm

Buy Lines

The LED's used in the prototype were obtained from Maplin (order code UK53H). The miniature 3-position switch was obtained from the same supplier (order code FH38R)

Practically Speaking

by Terry Balbirnie

Soldering - art or science? - Part 2

This month we complete our survey of soldering equipment then go on to look at the techniques needed to make a good job

Where no conventional supply is available, various types of self-contained soldering iron may be used. Maplin sell a battery-powered model for £4.95 which uses either alkaline C-size cells or Ni-Cad (rechargeable) ones. There are also some professional rechargeable types such as the Weller WC100. However, for long periods of use, butane gas-operated soldering irons are useful. These have become quite sophisticated with a wide range of spare bits available. They are replenished using a standard lighter refill can. Operating at full power, one of these can produce the same heat as a 60W electric iron but for light electronics work it will be turned down and will then provide some 55 minutes of operation from one filling. Prices start at about £15.

Do not try to make do without a proper soldering iron stand. Invariably the iron will be put down on a wooden or plastic surface and cause damage or even a fire. The "spring" type is good because the hot stem is fully enclosed. Do not use the hook on a soldering iron if one is fitted - it is all too easy to brush a hand against the hot end.

Soldering art

Like any skill, soldering is developed by practice so don't expect perfect results first time. Practise with scrap materials first before building a project.

A new soldering iron should be brought to its operating temperature and the bit "tinned" by applying a little solder. Check that the components to be soldered are clean. New ones will probably be pre-tinned (already coated with solder). However, those which have been lying around for some time will have a dirty surface and the leads should be cleaned using a knife blade or a piece of emery paper.

When soldering components to a PCB, insert the leads through the holes and apply the hot bit and a little solder. Do not apply solder to the bit then carry it to the work - the flux will have burnt off before it arrives. The solder should flow around the joint making the shape shown in Fig. 1(a). It should look clean and bright - if it appears grey and cracked, or if it gathers into a ball (Fig. 1b), the joint must be re-made. Components must be kept still while the solder sets or a poor "dry" joint will result. It is best to allow the joint to cool naturally - blowing on it may cause uneven contraction with subsequent cracking. Every so often, clean the hot bit using a damp sponge.

For some work it is appropriate to "tin" both components to be soldered first - that is, apply solder to the parts individually. The two may then be brought together with a little extra solder and the bit applied for the joint to be made. Wherever possible, provide some mechanical strength - hook a wire through the hole in a switch tag, for example.

From time to time, check that the soldering iron bit is clean and free from pitting. Copper bits may be filed to clean and reshape them but "long life" iron-clad ones must be replaced.

Suckers and wicks

There will be times when you need to remove solder - perhaps to take out a faulty or wrongly-placed component or to remove a blob of solder which has bridged copper tracks. Here, a solder sucker (de-soldering pump) is invaluable. This has a barrel and a spring-loaded plunger. When the tip is placed on the melted joint and a button pressed, the plunger is released and the solder sucked into the body. The Teflon tip will go out of shape with time and will need to be replaced occasionally.

De-soldering pumps are available from various manufacturers such as Antex (see illustration). However, there are some non-branded types for about £3 with spare nozzles at 60p. An alternative method is to use a de-soldering wick. This draws molten solder into fluxed copper braid.

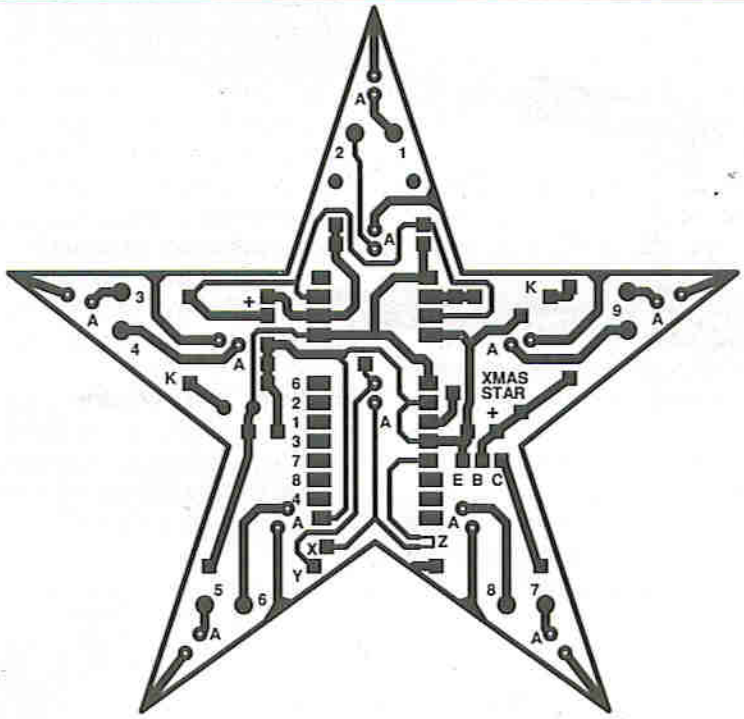
Fume extraction

Good ventilation must be maintained while soldering. An inexpensive method of removing fumes is to use the Litesold Solder Fume Captor. Readers who wish to remove fumes from confined spaces or who suffer from bronchitis or asthma should read Part 1 of this series where this product was mentioned

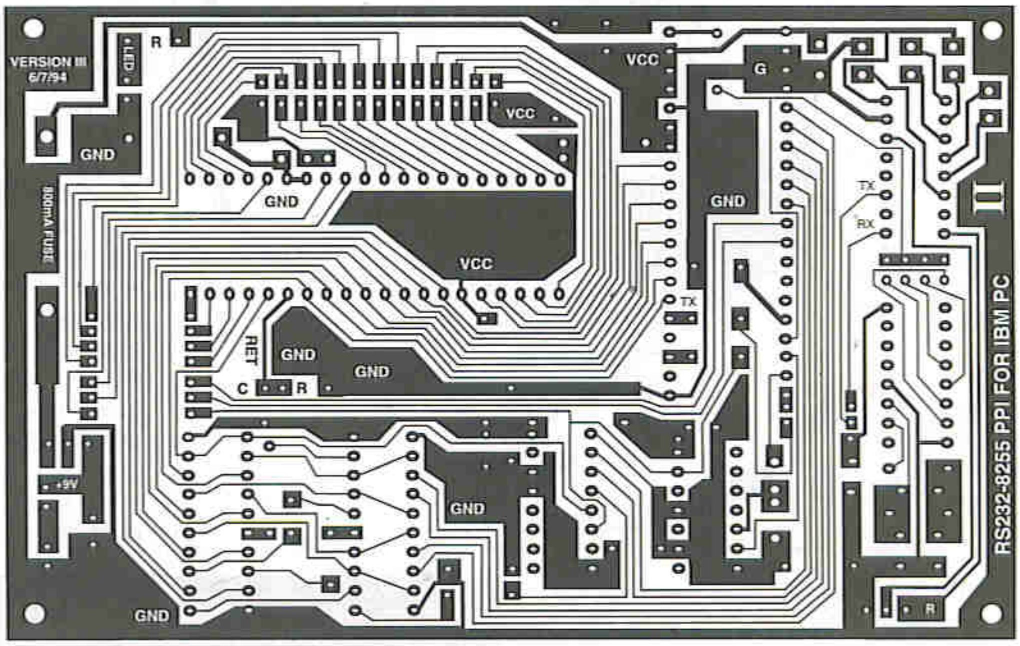
Next time

we shall look at some of the other tools which are needed in the workshop.

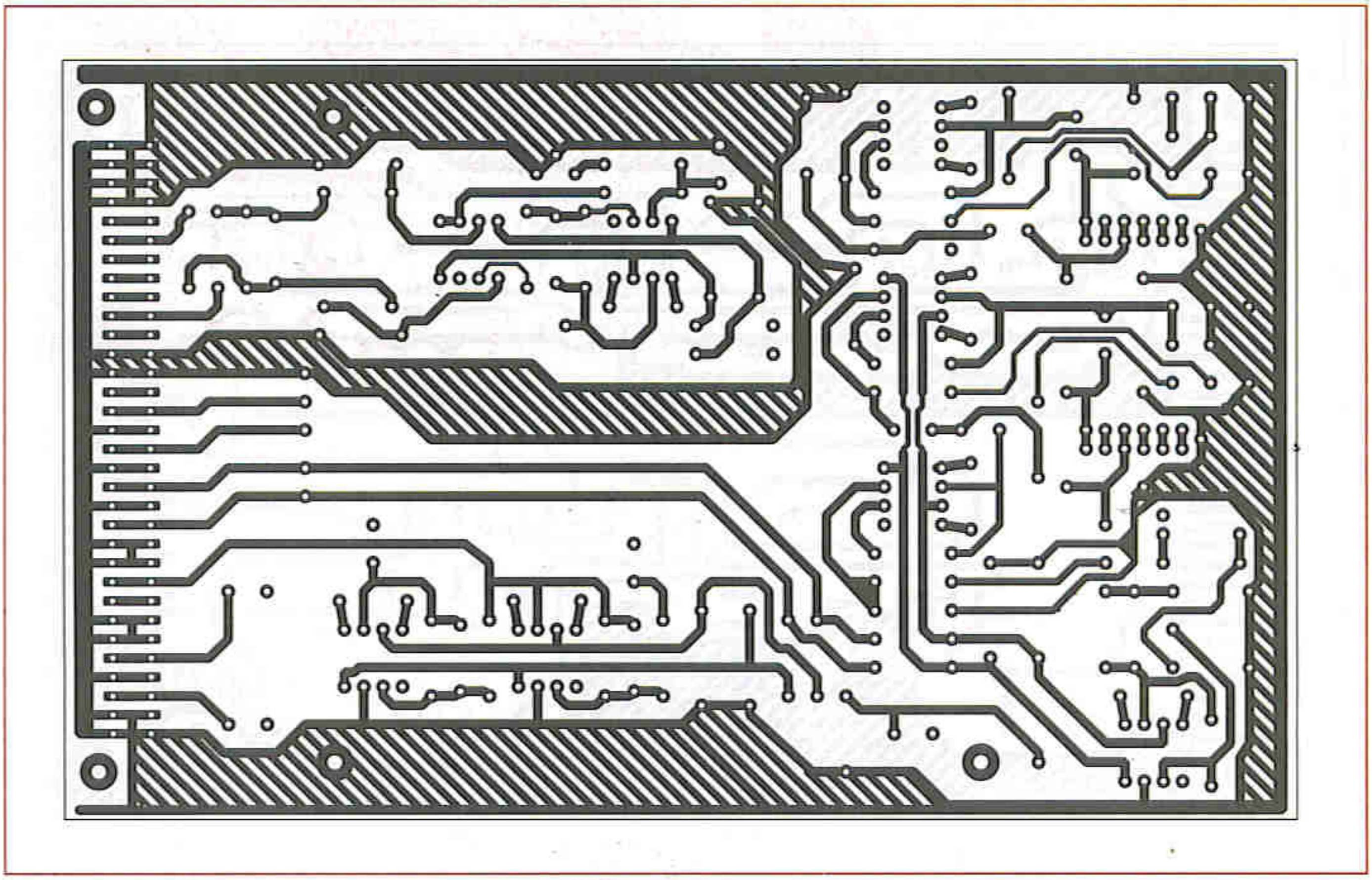
Foils for this issue



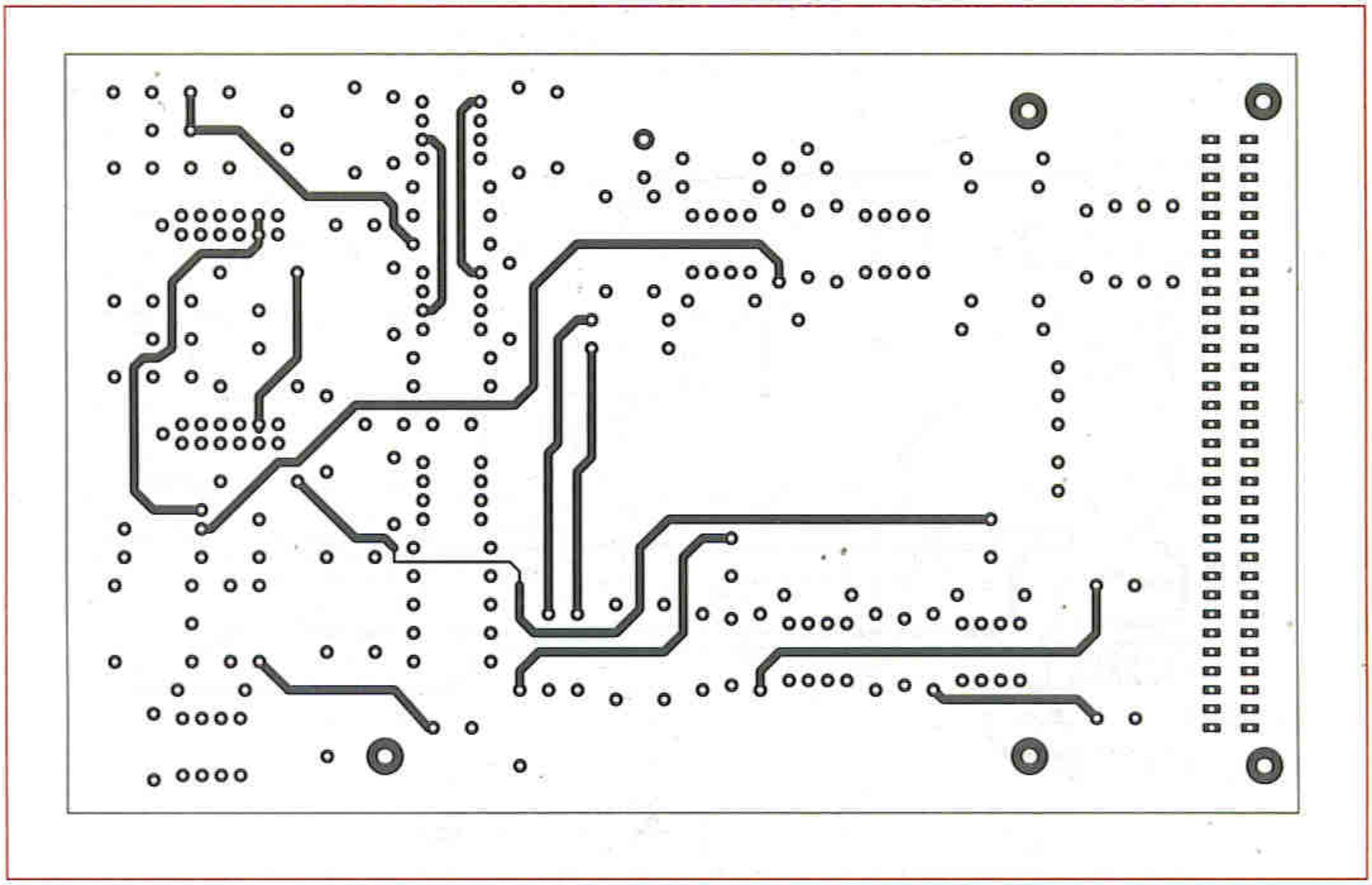
Twinkling Star



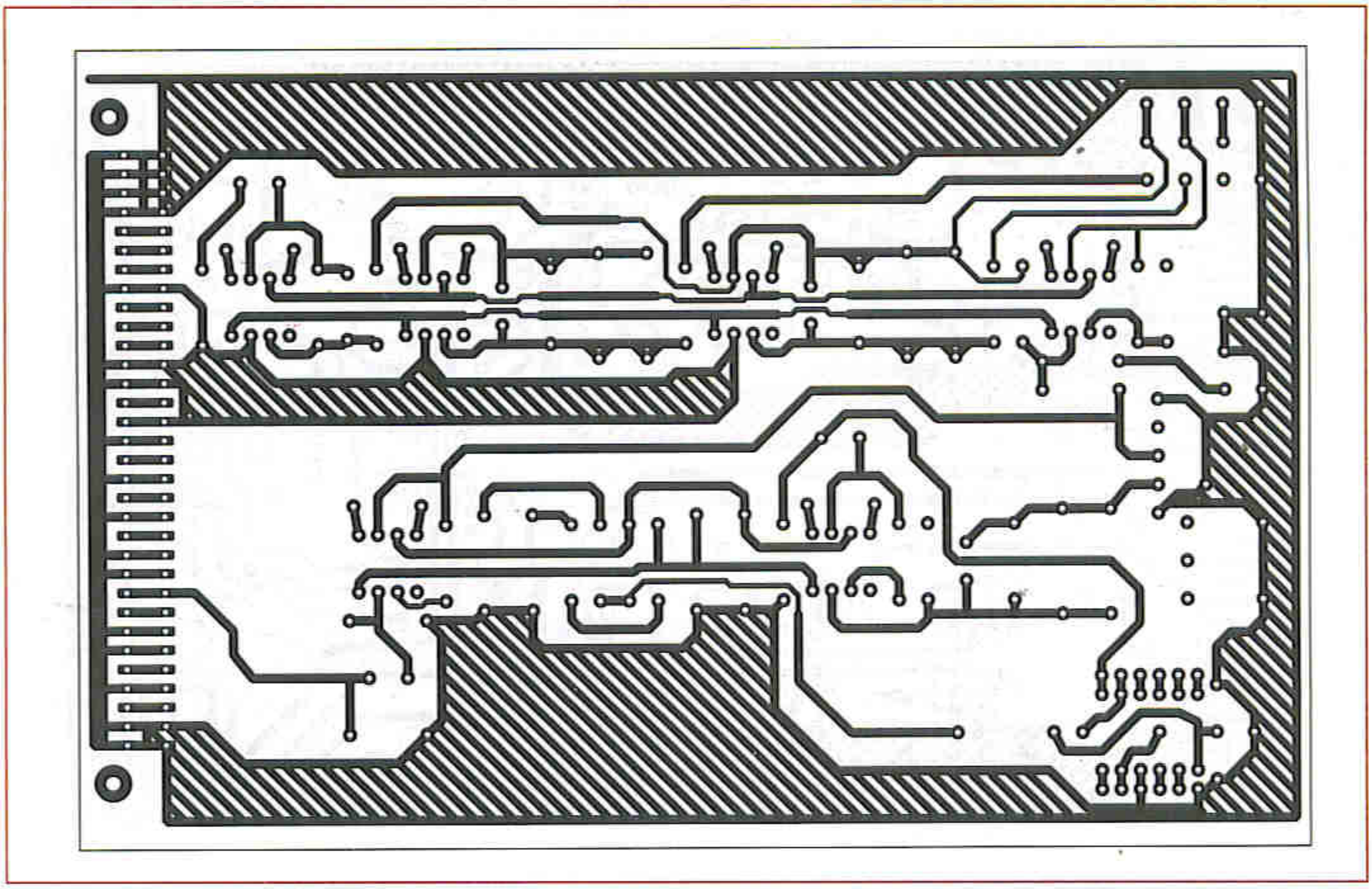
RS 232 to Parallel interface



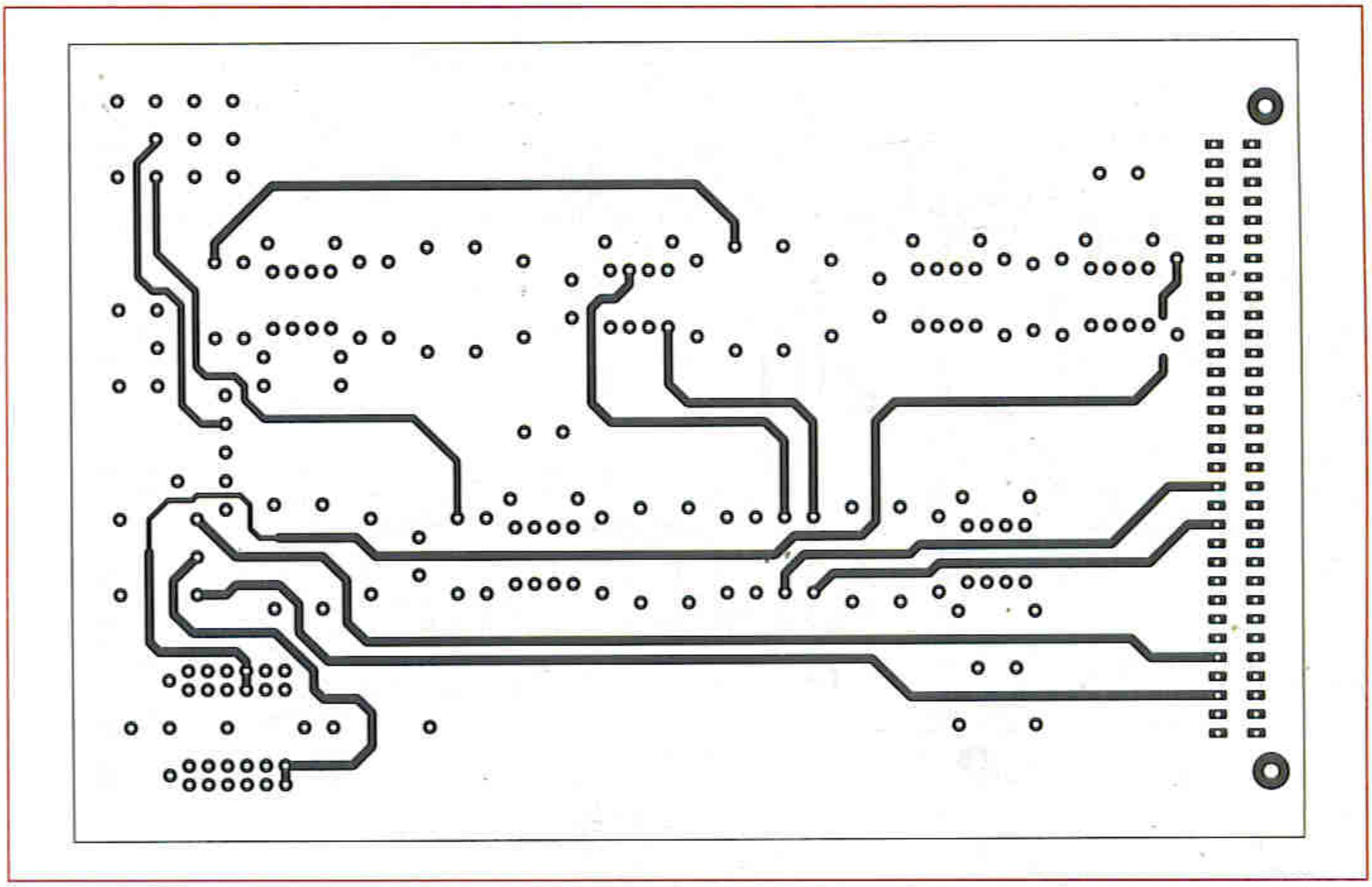
Parabender Input Unit



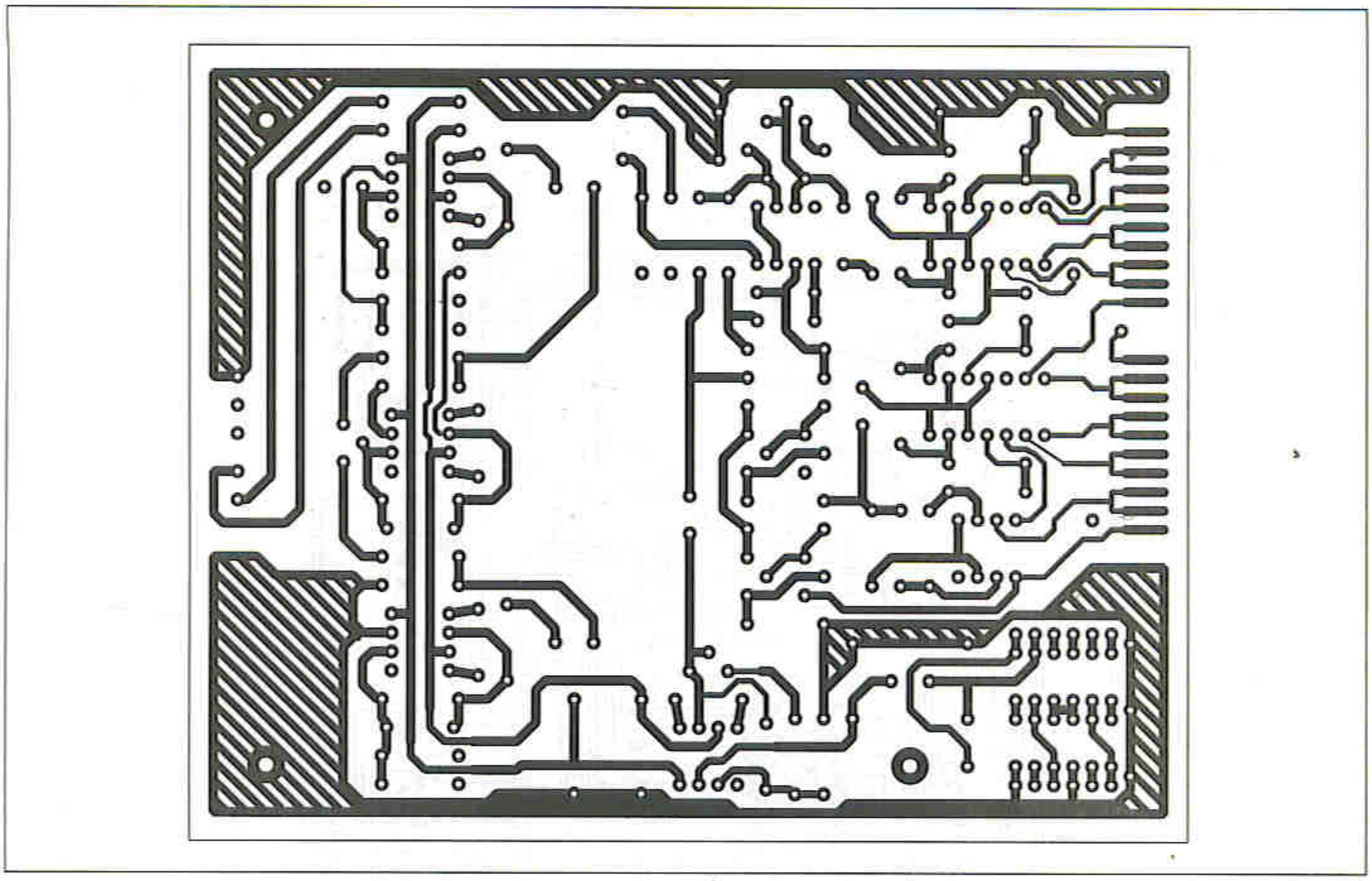
Parabender Input Unit



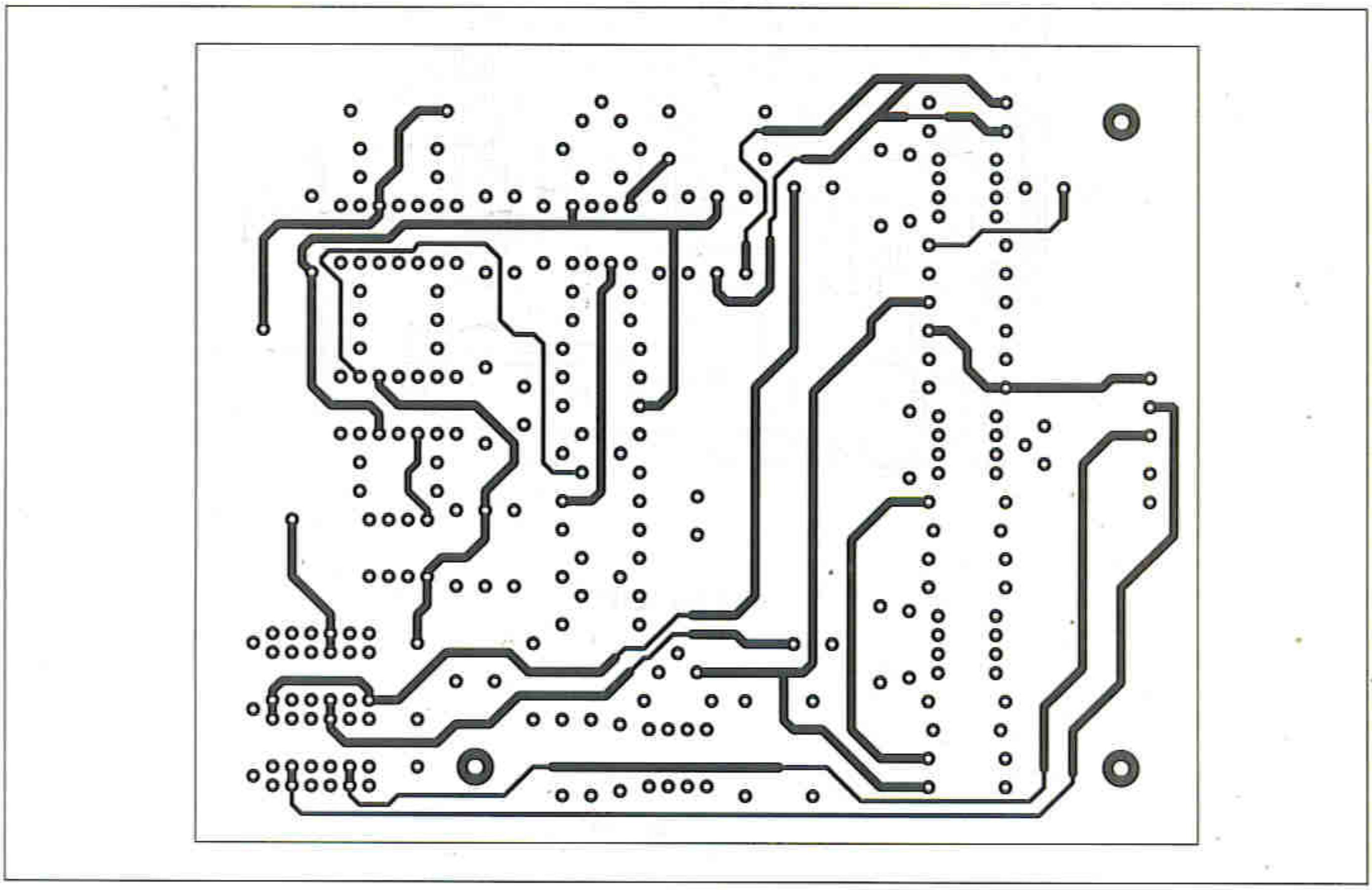
Parabender Filter Unit



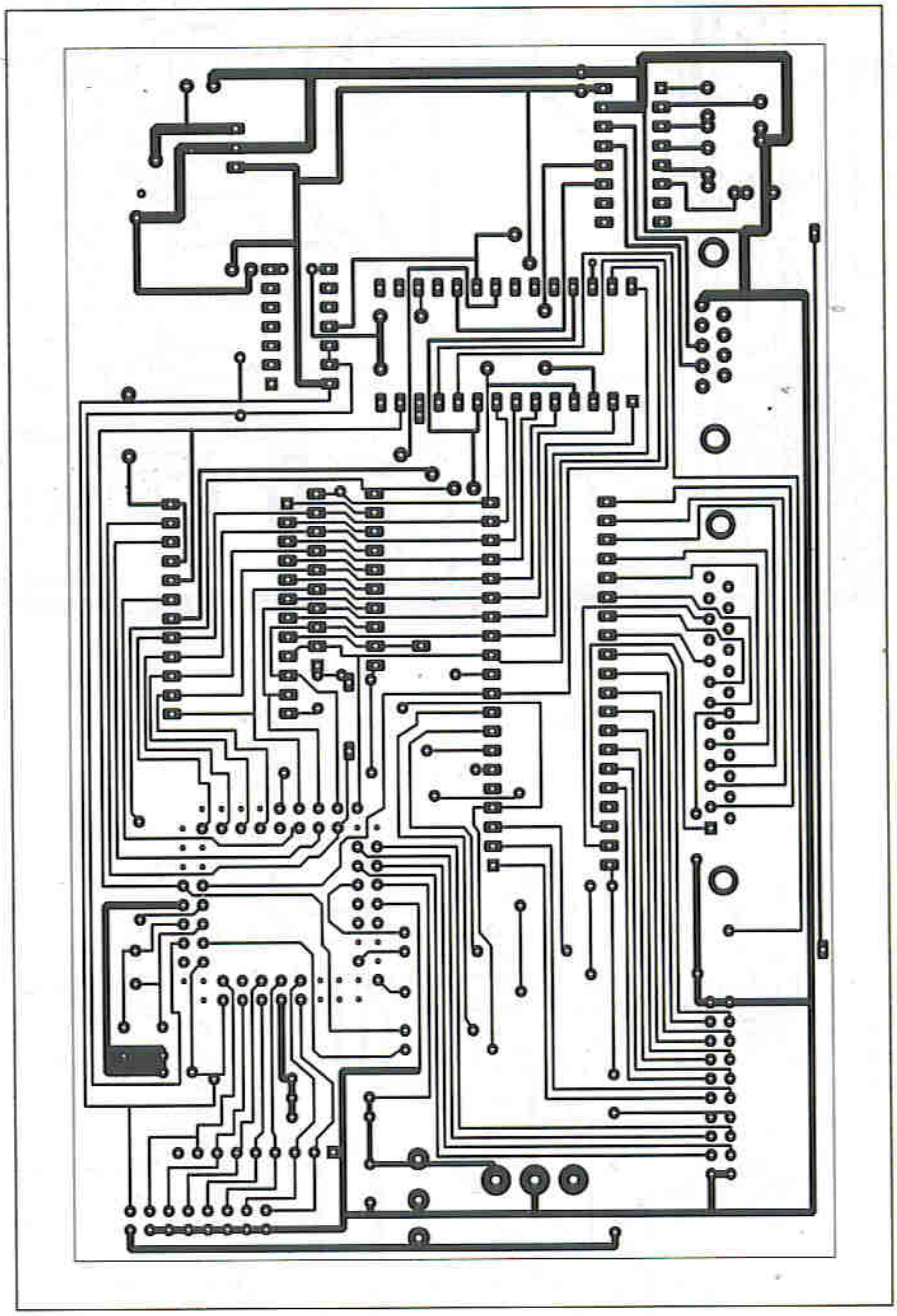
Parabender Filter Unit



Parabender Output Unit



Parabender Output Unit



80188 SBC

Open Forum

We live in times of very rapid change. Just think how in less than 20 years the whole concept of personal computing has been created, and on the back of this concept an enormous industry has been built. The semiconductor manufacturers, the system builders, the software houses and all the various retailers, maintenance and support companies.

Now the personal computer is beginning to blur the distinction between computing and telecommunications. The PC is no longer just a computing and data storage device, it is a fully fledged and fully functioning communications terminal, capable of acting as a phone, a fax and answering machine, as well as a data terminal.

With the number of people connected to Internet growing between 5 and 10% per MONTH, this is ample evidence of the enormous surge in the use of PCs for such applications. This is just the beginning.

Within no more than a couple of years, PCs will begin to widely replace the domestic audio system, then the TV and the video re[illegible]der. Indeed, the PC is destined to becom[illegible]gle central piece of electronics w[illegible]s nearly all the functions of a w[illegible] range of different pieces of consumer [illegible]ctronics, even including such items as security systems, and environmental controllers.

Already in the USA and the UK the number of PCs sold into homes is beginning to equal the number sold to businesses. Now with the rapid expansion of multimedia and high speed communications links such as cable TV networks, we are today on the brink of a huge expansion in the market for personal computer-based systems. An expansion which will bring with it enormous changes in the electronics industry.

By the end of this decade, broadcast TV and radio as we know it today could be virtually dead. The centre of focus for entertainment and information in every home will be a high resolution computer screen rather than a TV set. It could well prove that technologies such as HDTV will be delivered too late and will be obsolete before they even have a chance of becoming widely used. The same could well be true of satellite broadcasting systems, obsolete in the face of the information superhighway.

Already I can sit working at my PC and listen to a CD playing on its integral CD-ROM drive, whilst the system will automatically receive incoming fax, or e-mail messages. I can even monitor a small display of one of the TV channels in the corner of my high resolution display.

The technology for the domestic PC is with us today, and it is a technology which is dominated by the big American personal computer giants - the new titans of industry; companies like Microsoft, Intel, AMD, Silicon Graphics, and a few much smaller companies with great futures such as Acorn in the UK.

This of course leaves a big question mark over the future of the current giants of the consumer electronics industry. The inescapable conclusion is that many of them could lose their leading innovative role and simply become assembly operations for what, in electronics terms, will become an increasingly standard, and in consequence very cheap, consumer product, the domestic PC.

The big profits and the innovative lead will go to the likes of Microsoft and Intel, and perhaps IBM, or the big communications companies and their suppliers such as AT&T, BT, Cable and Wireless, GPT, Seimens, Alcatel, and BICC. Plus of course the suppliers of all the wide range of different types of information, entertainment etc, which will become available to users of these new computer based systems.

All of us should think very carefully about what this revolution will mean to us. Some areas of consumer electronics such as domestic audio and TV equipment and some service industries such as letter delivery, could be subject to a considerable decline. But, in other areas, brand new industries will develop. Whether we are choosing a new career, changing job or investing money, this tide of change will affect us all.

Next.Month...

In the February 1995 issue of ETI we will be starting a short series by Robin Abbot on using and programming PIC microcontroller chips. We will also be continuing Richard Grodzik's ETI 80188 single board computer project, and will be looking at using and programming the board.

There will be two projects which should be of interest to PC owners, the first of these has been designed by Jason Sharp and is a PC anti-theft device. The second is a project by Dr Pei An to build a PC-based smart mains control system.

From Pat Alley there is a project to build a special patented remote controlled automatic garage door opener, the Raydor. From Robert Penfold there is a design for an opto compressor which will overcome the problem of massive variation in output level on PA systems. And, for electronic music enthusiasts, there is an interesting piece by Dimitri Danyuk on active guitar electronics.

Next month's feature will examine the current and future use of electronics in medicine, whilst PC Clinic will look at audio adapters and CD-ROM drives.

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