ETI
ELECTRONICS TODAY INTERNATIONAL

TOMORROW'S TECHNOLOGY TODAY

FREE DISK
AC Circuit simulation program plus comprehensive suite of PC diagnostics

PLAY LASER TAG

Make a computer controlled laser gun game

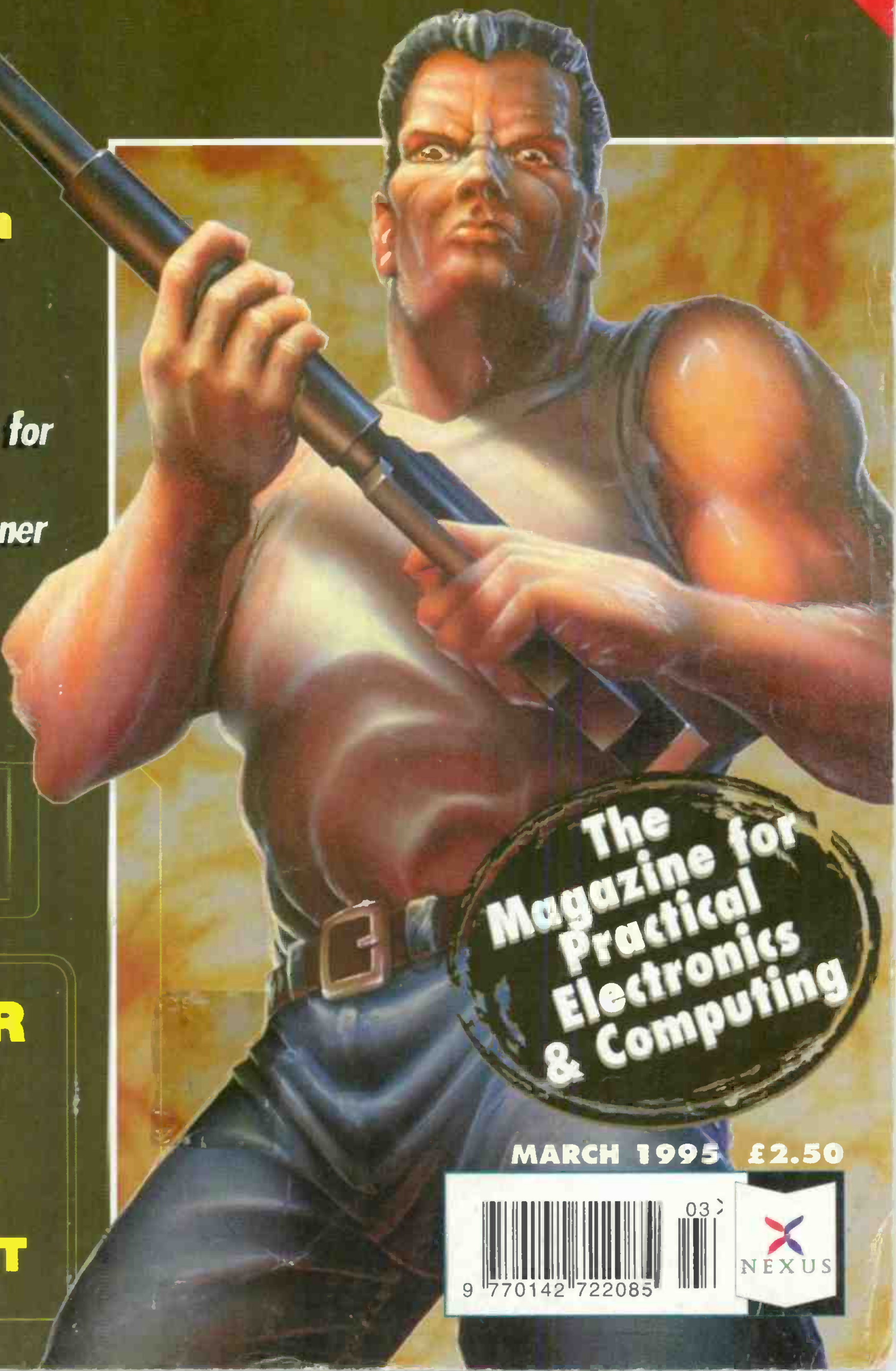
I/O ports for an Amstrad PCW

PLUS

- *Remote mains controller for your PC*
- *Remote garage door opener*
- *ETI single board PC compatible computer*
- *Shed alarm*

NO COVER DISK

THEN ASK YOUR NEWSAGENT



The Magazine for Practical Electronics & Computing

MARCH 1995 £2.50

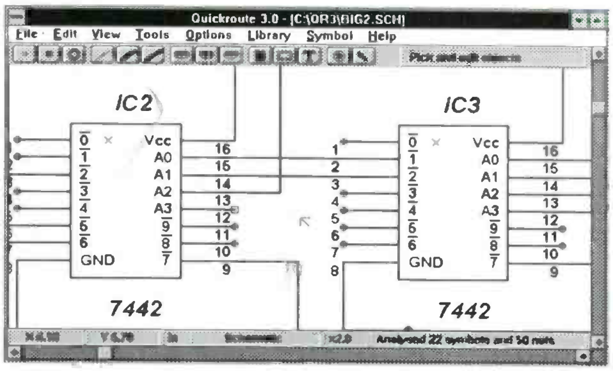
03
9 770142 722085
NEXUS

Take the

Quickroute

to successful PCB & Schematic Design

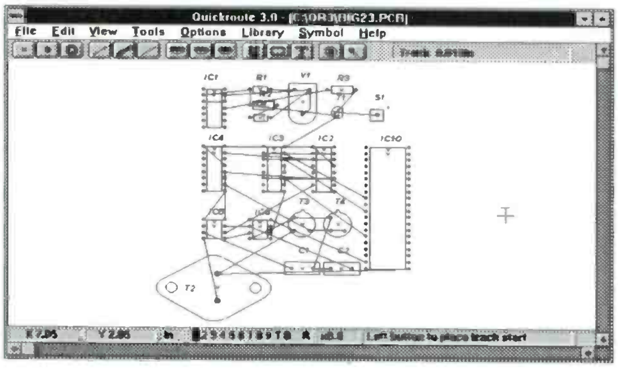
Design PCB's and Schematics quickly



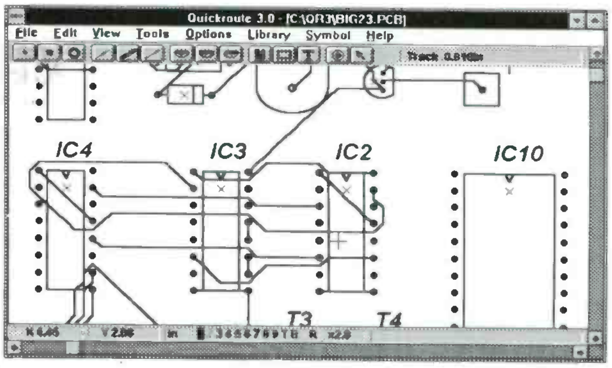
	Design Size K nodes	Gerber & NC-Drill	Schematic Capture	Auto Router Max Layers
DESIGNER	10	None	None	2 Standard
DESIGNER+	20	Export	None	2 Medium
PRO	30	Export	Standard	8 Fast
PRO+	40	Export/ Import*	Advanced	8 Fast

*PRO+ can import Gerber files

After schematic capture, components can be re-arranged prior to manual or automatic routing.



All versions include an auto-router.



Telephone or FAX POWERware on 061 449 7101

POWERware, 14 Ley Lane, Marple Bridge, Stockport, SK6 5DD, UK.

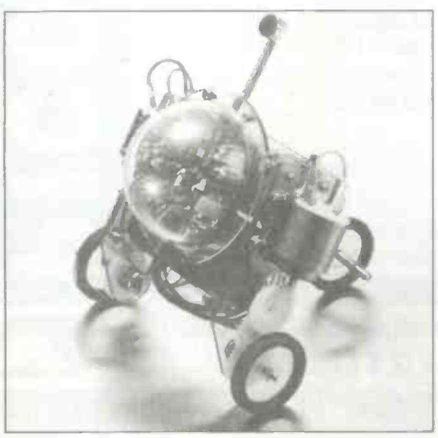
Quickroute 3.0 for Windows™ 3.1
DESIGNER £99.00 DESIGNER+ £149.00
PRO £199.00 PRO+ £299.00
All prices exclude post & packing, and V.A.T.

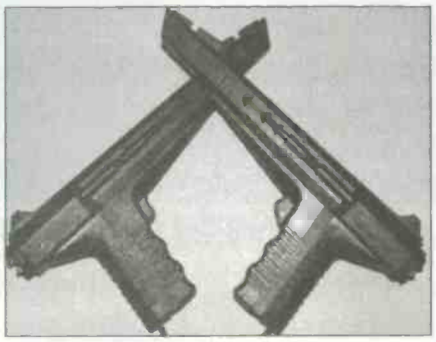
DEMO DISK Available

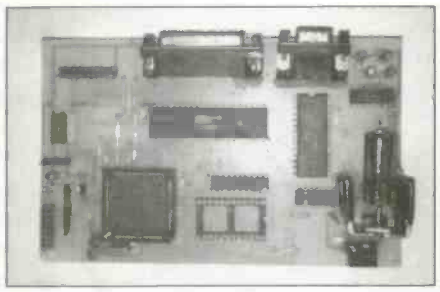
Contents

Volume 24 No.3

& Features Projects







Regulars

ETI News...

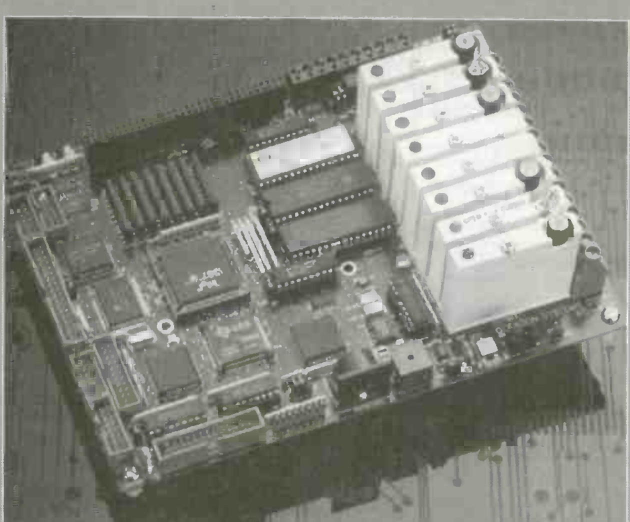
New 486 based SBC with integral Data Acquisition System

This single board computer system from Advanced Modular Computers Ltd. is intended for imbedded industrial applications. The PC-425 single board computer comes with 32 lines of I/O and will interface to a PC, Opto MUX, Pro Mux, Micro DAC and uMac systems. An eight-position opto isolated module rack mounted on the board will accept both digital and analogue I/O modules from Octagon, Opto 22, and Greyhill. The digital and analogue I/O may be expanded to 40 lines.

PC/104 interface allows up to three of these expansion modules to be mounted on the PC-425. Memory comprises 256Kbytes of flash for booting (DOS 5.0) and up to 512 Kbytes of flash EPROM for executable programmes can be inserted. On-Board dynamic RAM is expandable from 0 to 4Mbytes.

The board has all the features of a typical PC, including serial and parallel ports, watchdog timer, LCD interface and floppy disk controller. The operating temperature range is -25 to +75 degrees Centigrade. Up to 32 systems can be connected in a single network, with the capability of controlling 32,768 points using an on-board repeater.

For further information contact AMC of Slough on 0753 580660.



New 12-function lightweight cycle computer

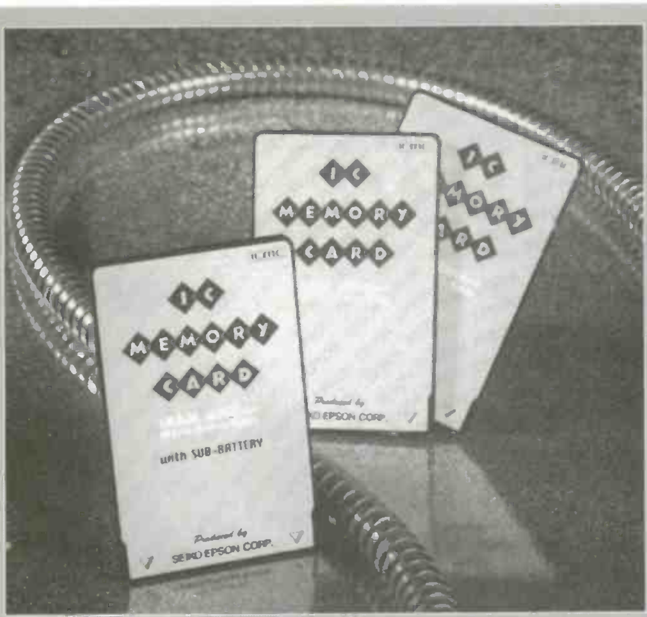
With the new 12-function compact lightweight cycle computer from Maplin Electronics, the cyclist can easily see how far and how fast he has cycled. He can also use the cycle computer to pace himself on a long journey. The function displays are grouped into Basic, Advanced, and Professional levels so that the riders have easy access to as much or as little information as is required. This allows the computer to satisfy the needs of the newcomer or professional alike and keep pace as the rider's skill increases. The handlebar mounting allows easy removal of the main unit for security and use away from the cycle. It is supplied complete with handlebar mounting, speed sensor with spoke mounting magnet, long life lithium battery and full instructions.

The 12 function cycle computer is available from Maplin Electronics and is priced at £16.99, for further details contact Maplin on 0702 554161.

Automatic gate systems

Woking based Gate-A Mation Ltd has developed a new fully electronic automatic gate system which should be of considerable interest to any security conscious company. It can be regarder as the car park equivalent of the familiar entryphone system used in most modern blocks of flats. As such, it enables security to keep a close check on all vehicles entering and leaving the premises.

For further information contact Gate-A-Mation Ltd, of Woking on 0483 747373.



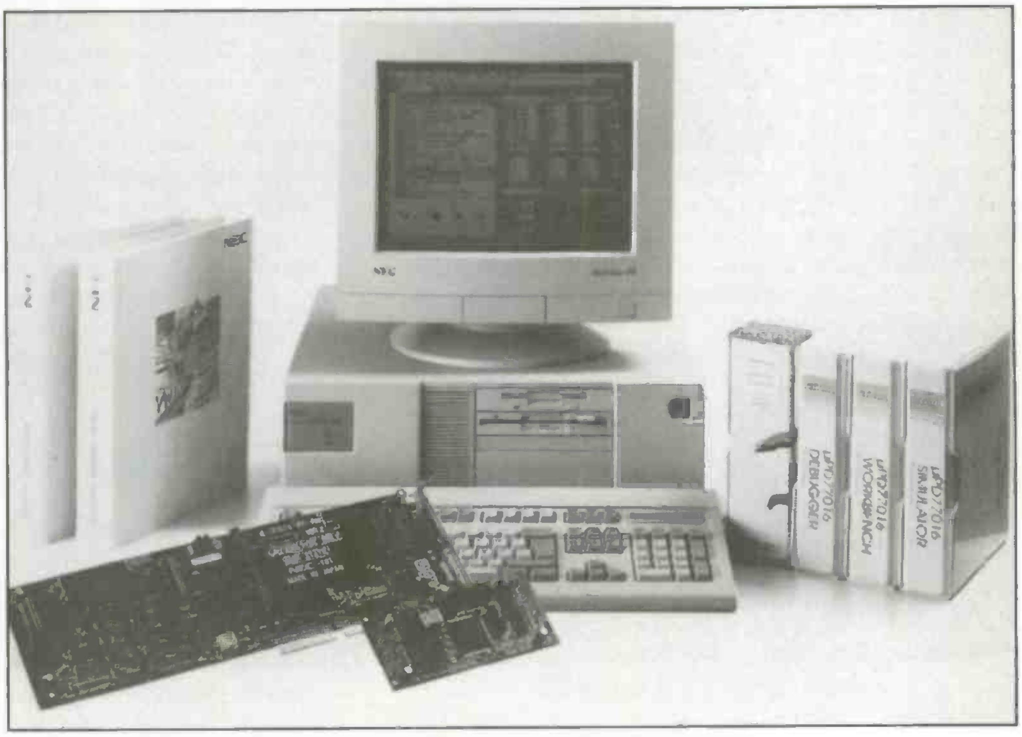
Very low power 4Mb PCMCIA card.

Epson has just launched a new ultra-low power 4Mbyte PCMCIA memory card featuring fast access times. This card, the WWB40/ES20, has a current consumption of just 250microamps and access times down to 200nS. It is a low voltage (3V) SRAM card featuring a proprietary ASIC based system for the control of the I/O and power functions. The card can be provided with or without a second battery, allowing users to change battery without loss of data and with or without attribute memory. Compatible with Jeida ver4.1 and PCMCIA ver 2.0 standards, the 68-pin, 8/16 bit card measures 85mm x 54mm x 3mm, to conform with PCMCIA Type I requirements.

As well as SRAM, DRAM, OTPROM, Mask ROM, EEPROM and Flash cards, Epson also offers combination and custom cards. A Flash/SRAM combination option allowing users to integrate program code and memory expansion onto one card, thus using only a single card slot, is available and offers low standby current. 2Kb E2PROM Attribute memory and a second battery for SRAM. Custom cards, which can be half-size, or combination cards, are also available.

For further details contact Epson of Hemel Hempstead on 0442 227331.

New DSP software tools.



NEC Electronics has announced a new suite of software development tools for its uPD7701X family of high performance 16 bit fixed floating point digital signal processors. The Atair tools, which significantly reduce overall system development time, run on IBM compatible PCs under Windows 3.1.

The new suite consists of four basic software products: the Workbench multi-tasking environment is used in conjunction with other members of the suite and undertakes many of the time-consuming procedures. The Debugger performs integrated in circuit emulation, while the Simulator uses a graphical user interface to verify the processor function without a hardware requirement.

NEC's uPD7701X devices have a 30ns instruction cycle time and a 3-stage pipeline enabling 33MIPS performance. Their architecture and powerful instruction set allow them to carry out up to eight operations in parallel, making them one of the fastest general DSPs available.

For further information about NEC DSPs and development software contact NEC in Milton Keynes on 0908 691133.

TOMORROW'S TECHNOLOGY UPDATE

Smartcards

New applications for smartcards are cropping up almost daily. The French have recently made some major commitments to the use of smartcard technology in financial applications and for the storage of personal medical information. In the UK, smartcards are also being used in customer loyalty schemes such as the one being run by Shell and the credit card company, Visa, have also announced the development of a smart credit card.

British Telecom have announced that they are to start installing smartcard phones as a replacement for their existing phonecard phoneboxes. BT have also made it clear in their announcement that they expect their smartcard phones to also be used in conjunction with various financial smartcards. Expect to see the first smartcard phoneboxes within the next twelve months.

The London Transport smartcard project has been very successful and is now being expanded with the availability of the Farecard rechargeable ticket which will allow users to prepay for tickets and then use them as and when required. A move which takes this project one step closer towards using the card as a general purpose cashless payment card.

The Royal National Institute for the Blind has also taken an interest in smartcard technology and has published a report on smartcards and disabled people. The RNIB sees smartcard technology as a means of offering a lot of advantages to the disabled. Smartcards are not only easier to use than cash but they can also be used to inform various systems that the user is disabled (it can be used to increase display size and brightness, give audio feedback, summon human assistance, etc).

If you want to find out more about smartcard applications then why not visit SMARTCARD - The International Smartcard Exhibition and Conference. to be held between the 14th and 16th of February at Olympia, London. For further information on this event ring 01733 394304

Communications satellites

Following the feature on electronics in space it is nice to be able to report that on the 21st of November 1994 a Martin Marietta Atlas IIA rocket blasted off from the Kennedy Spacecentre carrying the Orion I communications satellite - the first European sourced satellite to be purchased by an American company, thus proving that, in some areas, European space technology is on a par with that of the USA.

The Orion I satellite is designed to provide transatlantic and local low cost, high capacity, business communications services for the USA and Europe, catering for such diverse areas as business television, data transfer and electronic news gathering. It is a highly innovative design and is, in fact, the world's first all solid state Ku-band repeater with each one of the 34 Ku-band channels using solid state amplifiers. It also features very advanced and high performance antennas made from Kevlar composite and manufactured using shaped, dual skin, laser etched grid technology, a European first.

The $227million design, build, and launch contract for the Orion I was given to the Anglo/French company Matra Marconi Space and the satellite was built and designed at its facilities in Stevenage and Bristol. After launch, the satellite will be controlled and monitored from a specially built spacecraft control centre in Stevenage. This centre will control the satellite during the launch and early orbit phase of the mission with commands being relayed from the centre to the satellite using the Telstar network of ground stations.

Matra Marconi Space is now the recognised leader of the space industry in Europe and has successfully launched a whole series of commercial, national and defence satellites, including the UK's military SKYNET satellites, the French military TELECOM satellites and two NATO satellites. The company is also involved in Spacelab, in the HOTOL launcher project and in the construction of Earth observation satellites such as SPOT and HELIOS as well as many other European Space Agency projects.

Matra Marconi Space is the first fully integrated European space technology company and now employs over 4,300 people and operates from five major sites, three in the UK and two in France. They have a turnover in excess of $1billion and an order book of over $1.5billion.

Electronic Nose

Applications for the electronic nose are rapidly expanding. Systems are now being evaluated in areas as wide ranging as food, cosmetic, environmental and plastic industries. Customs are looking at the technology as a means of detecting drugs and identifying people who have been handling drugs. Meanwhile, a team at Manchester University have used this technology to build the world's first electronic truffle detector. Looks like it could be the end of the road for sniffer dogs and truffle hunting pigs.

Part of the reason why these new applications are being developed lies in recent improvements in the neural network system which provides the electronic nose with its intelligence.

Multipurpose LCD clock and timer

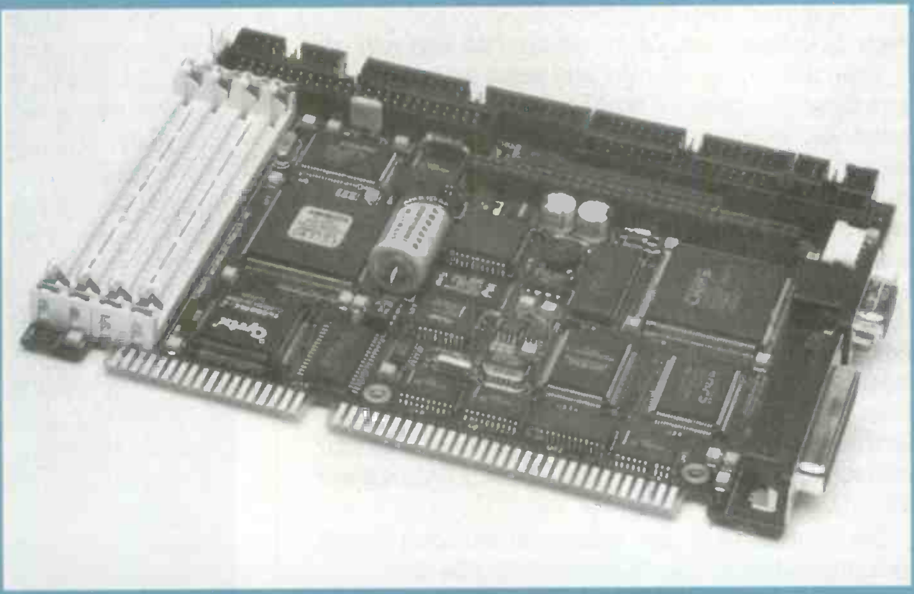
Maplin Electronics have just launched a new multipurpose LCD digital clock and timer which boasts a host of functions, making it ideal for use at home, in the office, on the sports field or in the car.

The dual time zone capability means that it can display both local time and continental time and is therefore particularly useful for business persons travelling abroad or those in contact with customers overseas.

The chronograph (stop watch) facility can time events to the nearest one hundredth of a second and up to a duration of 10 hours. Four memories are available for storing lap times, which can be recalled when the chronogroph is stopped. The pacer facility emits audible beeps at a rate from 60 to 240 beeps per minute for setting paces, oar strokes, exercises, etc.

The LCD digital clock timer costs £9.99 and is available from Maplin Electronics, for further details contact Maplin on 0702 554161.

The 2001 embedded PC



The 2001 embedded PC from Slough-based AMC is a half-sized CPU card that combines all the most eagerly sought after features in embedded designs, plus the ability to add mission-specific capabilities. It is designed as a single board solution, with expansion through a PC-104 interface, or through the ISA bus. The 2001 can be used stand alone, or in a passive backplane system.

The 2001 is a very flexible product, with the ability to choose various processors (from the 386SX to the 486SLC2) and add or remove most features so that users only pay for what they need.

The list of key features is impressive, including a Cyrix 486SLC2-66 processor, a flat panel display interface, SCSII, a PC-104 interface, optional RS-485, optional bootable 3Mbyte FLASH drive and an incredible 140,000 hour mean time between failure rate.

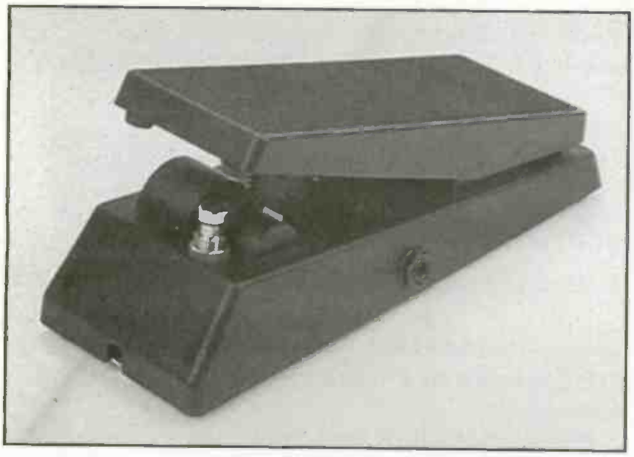
The PC-104 interface allows the addition of various features such as networking, fax/modems, data acquisition, PCMCIA, etc from a wide range of vendors. The on-board video controller drives both flat panel or CRT based displays. System parameters may be stored in EEPROM removing any worries about BIOS settings being dependent on battery condition.

For more information contact AMC on 0753 580660.

Event Diary

29 Jan - 1st Feb	European Light Show Exhibition, Earls Court, London. Tel 01952 290905
7-9 Feb	ISDN User - Integrated Communications Exhibition, Olympia, London. Tel: 01733 394304
14-16 Feb	SMARTCARD - The International Smartcard Exhibition and Conference, Olympia, London. Tel:01733 394304
1-2 March	Electronic Books International, Wembley Centre, London. Tel: 0171 976 0405
7-9 March	Computers in Libraries, Wembley Centre, London. Tel: 0171 9760405
16-19 March	Computer Shopper Show, NEC, Birmingham. Tel: 0181 742 2828
9-11 April	European Computer Trade Show, Business Design Centre, London. Tel: 0181 7422828
22 April	International Marconi Day exhibition station at Puckpool Park Wireless Museum, IOW. Tel: 01983 567665

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



New Maplin Wah Wah Pedal Kit

Maplin Electronics have just launched a new wah-wah pedal kit which should prove popular and which has a number of advantages over previous designs. These include adjustable resonance, which determines the subtlety of the effect and adjustable range used for electric guitars; in fact, on any electronic musical instruments such as keyboards and electric violins. The circuit also features a compander that reduces noise in the circuit and improves the harmonic output content, which makes for a very warm sound.

The Wah Wah acts as a kind of tone boost control, and moving the pedal adjusts the frequency point at which the boost occurs. Rhythm or lead guitar is usually used with the device. When playing rhythm, the pedal is moved in time with the 'strum' and when playing lead, extra expressive abilities become available, enabling almost 'infinite sustain' without screaming feedback.

The complete kit is easily assembled and costs £34.99. For further details contact Maplin on 0702 554161.

VMEbus PCMCIA carrier

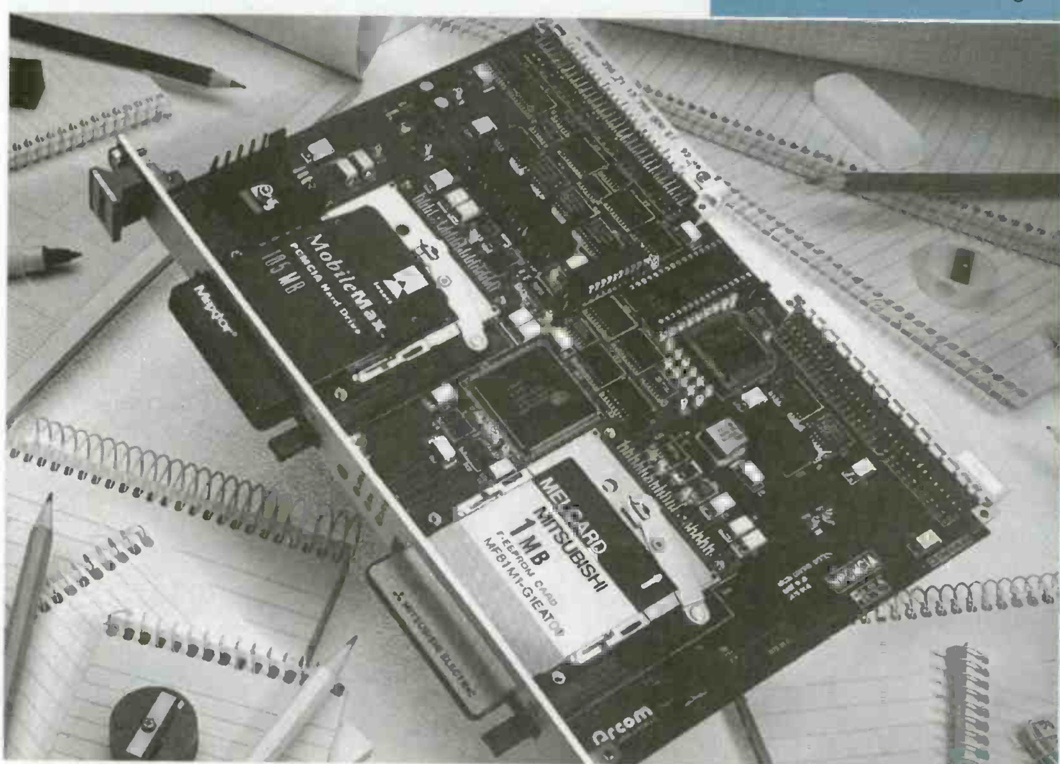
Arcom Control Systems has added a two slot PCMCIA carrier for Type I,II or III cards to its VMEbus range - a board which provides a flexible foundation for the construction of rugged dataloggers and industrial instrumentation.

Supported by PhoenixCARD Manager Plus software and backed by a range of PC compatible 486 or 386 processors, the board allows users to install, run and upgrade standard DOS and Windows applications in harsh or remote field and factory locations with great ease and with total compatibility with office PCs. The board's dual slots accept any form of PCMCIA card and give great flexibility of configuration allowing users to combine, for example, storage devices such as solid state or rotating disks with communications links via fax modems or LAN interfaces.

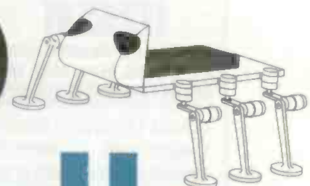
The software interchangeability this board creates between office PCs and target systems provides new levels of flexibility for designers of data acquisition and datalogging systems. With some 300 suppliers supporting the PCMCIA standard, users can choose from hundreds of plug-in options including Flash EPROM, SRAM and ATA disk storage devices, as well as a fast expanding choice of communications and I/O functions. All three PCMCIA card thicknesses, from 3.3mm to 10.5mm, are accepted.

Designated the VPCMCIA, the 6U board design is based around the powerful Cirrus Logic CL-PD6720 controller and is optimised to give system builders and OEMs considerable flexibility. Features include a 128K EPROM socket for local storage of configuration data, a DC power distribution architecture supporting both 5 and 3.3volt cards, comprehensive interrupt support, hot insertion capability, on-board buzzer and/or speaker connection and protection against electrostatic discharge from the front panel and card entry positions. Extra logic circuitry on the card allows Arcom VMEbus systems to support up to two carrier cards, or four PCMCIA slots in any VMEbus system. Each PCMCIA socket has five progerammable memory windows of up to 16MBytes in size and two programmable I/O windows. The board may be accessed as a VMEbus slave.

The VPCMCIA board costs £595 and further details can be obtained from Arcom Control Systems Ltd of Cambridge on 0223 411200.



ROBOTS which can walk



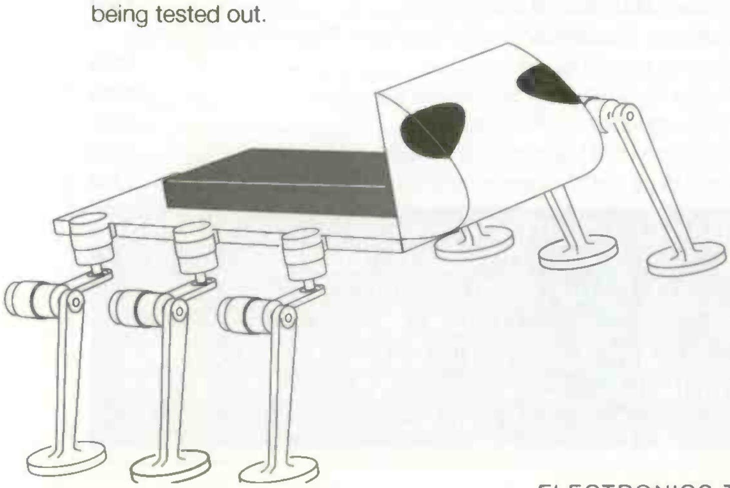
Creating a robot which can walk across an unknown terrain is one of the great challenges facing the designers of such systems. Here, we look at some of the problems and some of the solutions

Nearly all the great science fiction robots of the cinema have walked. Most have been anthropomorphic 'metal men' such as C3PO in Star Wars, others such as Huey, Louey, and Duey in Silent Running have simply used walking as a means of locomotion. However, most of the current generation of robots to be found in factories and laboratories are either static or move using wheels. Why then does science fiction put such emphasis on walking robots?

The answer to this question is that besides the obvious dramatic impact of an anthropomorphic robot, walking is a more efficient form of locomotion when faced with an uneven terrain full of obstacles. One would probably not attempt to drive a car across a field strewn with large numbers of boulders of different sizes, but one could walk across it, climbing over the boulders where necessary.

This means that if we want to have mobile robots which can operate in an uneven terrain then it is probably best to design a system which can walk rather than one which uses wheels. Given this conclusion, it is hardly surprising to discover that NASA has replaced the wheeled 'rover' of lunar exploration days with a walking robot for future unmanned planetary exploration projects.

Indeed, walking planetary exploration robots are already being tested out.



The Dante project is a good example, where NASA are experimenting with the use of a walking robot to explore an active volcano in Antarctica. The walking robot used in this project is still undergoing refinements that will overcome limitations that were brought to light in earlier tests, but it already demonstrates the kind of use to which walking robots will be put, to working and exploring extremely harsh environmental conditions, both on Earth and on the planets of our solar system.

Two feet, four feet, or more?

The first thing that we need to do when thinking about the design of a practical walking robot is to abandon any idea of building a bipedal system that mimics the human being. Building such a robot is not impossible but very complex because of the constant need to readjust the robot's centre of gravity and balance while it is walking or even just standing still; without such fine readjustment it will fall over. To demonstrate this, notice that it is virtually impossible to stand completely still, the body will continually make small side to side or back and forwards movements to restore balance.

Of course when designing a bipedal robot, one could lower the centre of gravity by putting a lot of weight in the feet, but this would make it difficult to actually lift the legs off the ground since this would again raise the centre of gravity to a point where instability would occur. The result of this approach is that one would end up with a robot that shuffled along rather like the walking robots sold in toy shops.

A robot with three legs would be stable in a stationary position but would become totally unstable when one leg is lifted in order to move it forward. The only solution to this instability would be to have two of the legs used for locomotion and the third used to counterbalance the instability resulting from movement of the other two. This type of approach is used by birds, kangaroos, some lizards and, millions of years ago, many species of dinosaur. In all these species, a tail is used as a counterbalancing third leg.

A four-legged robot will have far greater stability than a two-legged one. For a start, the centre of gravity is lower and the four legs, assuming they are located at the four corners of a robot body, will prevent it actually falling over whilst it is standing still. However, if one of the four legs is lifted in order to move it forward as part of a walking sequence then it once again becomes potentially unstable.

The only way to overcome this instability is to monitor the system's stability and then make small adjustments in the position of the three legs still on the ground so that the centre of gravity is shifted away from the lifted leg and stability is restored. If you look at a four-legged animal like a dog you can see how it moves its body and tail to perform the movement of the centre of gravity away from any lifted leg.

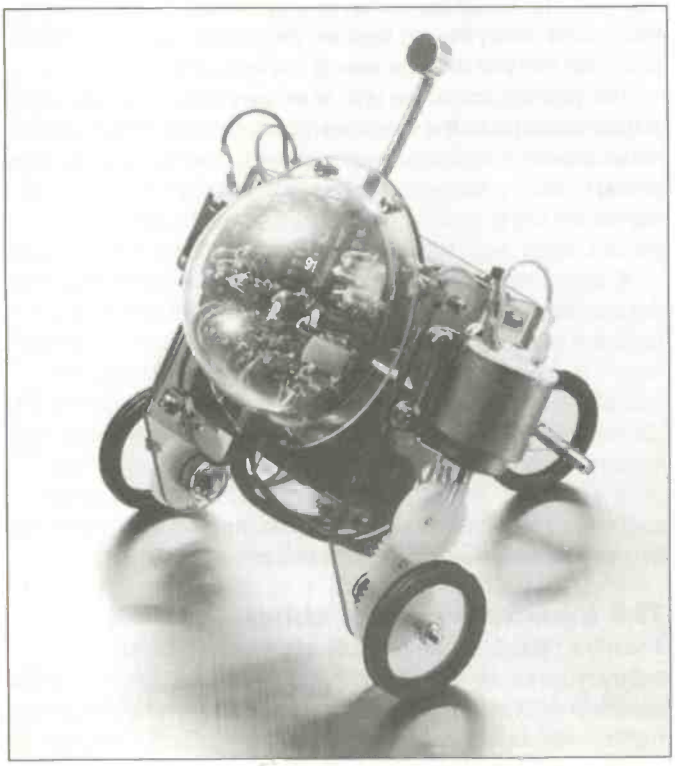
A five-legged system is another possibility that would be more stable than a four-legged system. Apart from the starfish family there are no five-legged organisms in nature. But in many four-legged animals the tail performs the same function as a leg; just think of how a monkey uses its tail.

We finally come to systems with six legs. If we look at nature we find that there are more species on this planet with six legs than there are with four, or two, or indeed any other number of legs. These six-legged species are the insect and they provide us with a perfect model of an easy to build walking system, one where instability is no longer a serious problem. An insect walks by lifting a leg and moving it forward, then swinging the rest of the body forward in order to follow it some of the way. With only one leg off the ground at a time it still has five legs on the ground and is thus perfectly stable at all times, even with three legs off the ground it can still be completely stable.

This means that if we are building a walking robot then the easiest design to implement is one with six legs. With six legs there is no need to design into the system all the fine adjustments of position which are necessary in order to achieve stability during walking. All that the design needs are fairly simple leg movement actuators and a controller which can move the legs in the correct manner and the correct sequence. In fact, if we look at most of the practical walking robots which have been built in various labs around the world, then we find that the vast majority of them are six-legged, or so-called 'insectoid robots' - robots which vary in size from just a few centimetres to several metres long, and which can be used for a wide range of different uses, from planetary exploration to military applications.

Insectoid robots

A great deal of development work has gone into the design of different insectoid robots. Indeed, at Massachusetts Institute of Technology there is a specialist 'insect lab' which is dedicated to designing and developing such six-legged autonomous walking robots. For the rest of this article we will look at some of the design concepts which have been developed by Rodney Brooks and his team at MIT.



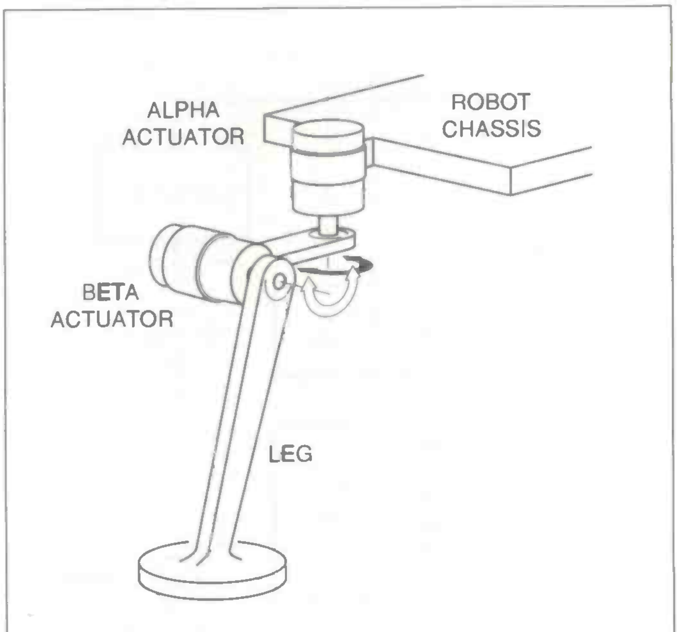


Fig.1 Single leg of 6 legged insectoid

One great advantage of an insectoid robot design is that it is modular, six identical single legs joined as pairs to make three identical pairs of left and right legs, which in turn are joined together to make a single insectoid. The legs have to be capable of swivelling forward and backwards and of being lifted up and down. This means that each of the six identical legs requires two actuators; one, the Beta Motor, lifts the leg up and down, and the other, the Alpha Motor, swivels it forward and backward (see Fig.1.).

The two actuators are in fact servo motor systems of some sort (the exact mechanics employed are up to the designer, but at ETI we have built a perfectly serviceable walking robot using commercial radio control servo motors as the actuators and pulse width proportional servos are, in general, a lot easier to use in this type of application - they only require a single I/O line between processor and servo, thus cutting down on electronics and wiring complexity). The virtue of such servo motors is that they are easily connected to a microprocessor I/O port and their position accurately controlled using very simple software.

The MIT robots are built to a design philosophy known as 'subsumption architecture'. This does not employ the traditional analytical approach to the design of robotic systems but instead uses a network of processors and hardware which is capable of developing simple behaviour patterns. This a strictly hierarchical system and no behaviour will be added to the system until the lower levels of subsumption are up and running. thus the walking robot must be able to stand before it can walk, walk before it can climb stairs and so on.

In keeping with this philosophy, each leg on the MIT insectoids has its own processor, it is an independent unit and communicates with a higher level processor simply by transferring a couple of values. It is up to each leg processor to accurately control the movements of that specific leg's motors in response to commands from the higher processor and to inform that higher level processor when the action has been executed.

The basic MIT insectoid thus has a total of twelve actuators

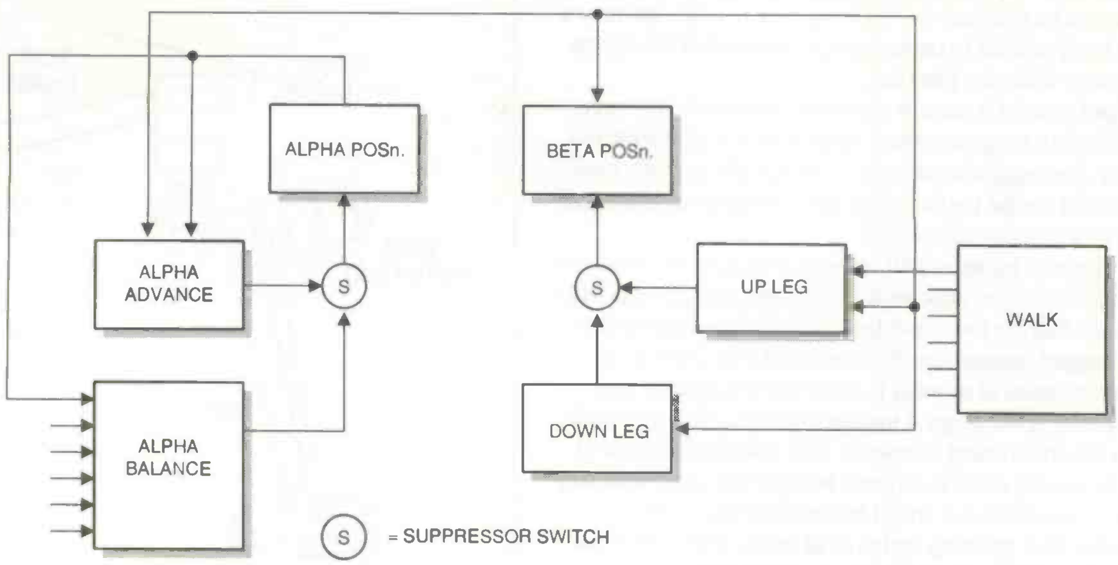


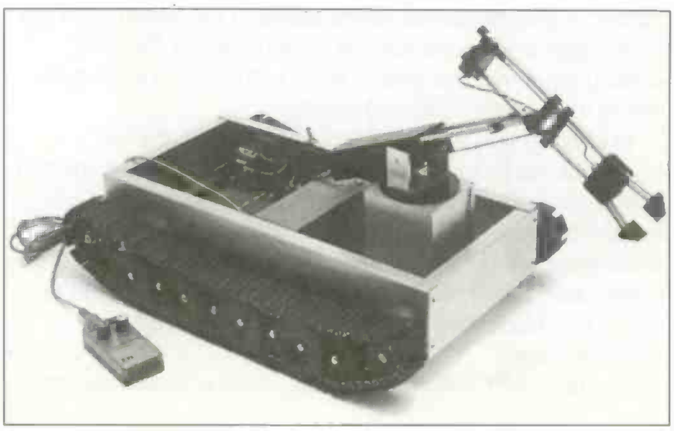
Fig.2. AFSM network for walking insectoid

and seven processors; that is one main processor and one processor and two actuators for each leg. Each of these processors runs software which is configured as a number of Augmented Finite State Machines, or AFSMs. Each basic leg processor is running five AFSMs and the main processor two AFSMs, making 32 AFSMs in total. It is the interaction between this network of AFSMs that is used to generate simple walking behaviour.

Walking with six legs

Robot system developers have traditionally looked upon the creation of a walking robot as something that poses considerable technical difficulties. Indeed if we were to use a standard analytic approach then writing the control software for such a robot would indeed be a difficult task. But, thanks to Rodney Brook's subsumption philosophy a lot of the complexity is removed and can in fact be automatically generated by the system and it is a philosophy which is, to a very large degree, independent from the hardware design.

To examine how the system works we need to look at the various subsumption layers, starting with the lowest and simplest, making the robot stand up. Each leg processor has two AFSMs which control the actuators; these are known as the AlphaPos AFSM and the BetaPos AFSM. A number sent to one of these AFSMs will cause the related servo motor to turn to the vertical or lateral position that equates to that number. So at the lowest level of subsumption we can get the robot to stand up by using the supervisor processor to transmit to all the AlphaPos and BetaPos AFSMs the appropriate leg position values to get the system to stand up.



The result of this is that all the servo motors will move to the correct position and the insectoid's legs will be correctly positioned in order to make it stand up. However, this needs to be done carefully and in the correct sequence otherwise there is a danger that the robot will simply fall over. Legs should be moved to a zero starting position first, then all moved together in the correct sequence thus ensuring that the robot stands up in an even and organised manner.

Once the robot has been made to stand, we can then add the next subsumption layer, the layer which performs the basic walking control. By basic walking we mean walking forward at a set speed and in a straight line over a level floor free from obstructions. For a six-legged insectoid, basic walking means that when any five legs are touching the ground, a sixth leg is raised. To move forward a small amount the insectoid merely swings all the legs touching the ground to the rear by a few degrees. The raised leg is then swung forward and placed on the ground, when this leg touches the ground another is raised and once more all the legs swung a few degrees to the rear.

This process continues until all six legs have been raised and is then repeated as the insectoid moves forward. It may seem rather slow and cumbersome and indeed, there are a great many different walking sequences which are used by insects, but all rely on the same basic principle; the legs which are on the ground swing back, whilst those which are raised swing forward.

A very common insect leg movement sequence is known as the alternating tripod gait, if the legs on the right side of the body are labelled R and those on the left L, and are numbered from 1 to 3 with leg 1 being at the front of the insectoid then two alternating sets of tripods are used. These two sets are R1, L2, R3, and L1, R2, L3. In walking using this gait ,an insect will leave one tripod set on the ground and lift all the legs of the other tripod set. The body is then swung forward, the raised legs moved forward, set on the ground and the other tripod set legs raised, the body swung forward, and so on.

The insectoid control software

The most important components of the basic walking subsumption layer are located in the control processor; a global controller AFSM called Alpha Balance and a walking sequence master module called Walk. Each leg processor is running a network of five AFSMs which govern leg movement by both Alpha and Beta actuators.

The AFSMs used in the MIT subsumption based insectoids communicate with each other by passing values that represent either commands or status reports from other AFSMs. This is particularly important in the Alpha Balance AFSM which is designed to receive continual reports on the position of each leg and then generate the Alpha actuator swivel commands that are responsible for the insectoid actually moving forward.

The position of each leg is represented by a number that can be either positive or negative. The position has a value of zero when the leg is at 90degrees to the body, a negative value when it is pointing to the rear of the body and a positive value when it is pointing forward; the greater the value the more the leg is rotated away from the 90degree position. The function of Alpha Balance is to add all these values together and produce an average leg value, if the sum is negative then the average leg points backward and if it is positive then the average leg points forward. When an insectoid moves it swings a leg, or legs, to the front. This leg or legs then send a positive value/values back to the Alpha Balance, the result being that the average leg value will become more positive. This upsets the balance of the system so, to restore it, Alpha Balance sends a counterbalancing negative value to the remaining legs which are on the ground and this negative signal causes them to swivel to the rear, thus restoring the balance. In other words, what Alpha Balance tries to do is ensure that the average leg value is around zero.

In a basic insectoid, all that the Walk AFSM does is generate the walk sequence. It has no feedback and its output is simply an on/off signal to the network of leg control AFSMs running in the leg processor and it will probably generate just a single sequence pattern at a standard walking speed. However, higher subsumption layers will use the Walk AFSM to generate different kinds of walking pattern that will allow the insectoid to move at different speeds, to walk backwards or turn corners.

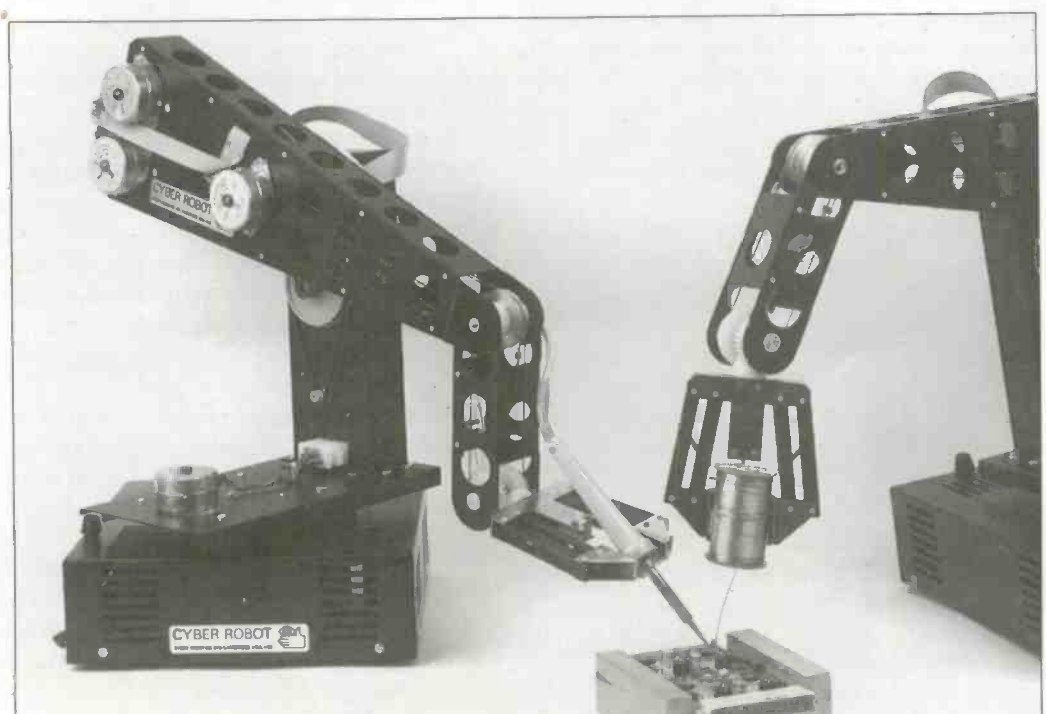
The leg processor software

Each leg processor thus has three connections to the main control processor. There is the command line coming from the Walk AFSM and the input and output to the Alpha Balance AFSM. In addition, the leg processor has a connection which drives the Alpha actuator and another which drives the Beta actuator. In practice, there will also be other connections to limit switches and some form of leg force, or foot down, sensors. The interconnections between the five leg processor AFSMs and also between them and the two controller AFSMs are shown in Fig.2. Note that, in addition to the AlphaPos and BetaPos AFSMs used in the standing subsumption level, there are three new ones; Alpha Advance, Up Leg, and Down Leg. The suppresser switches will prevent the system trying to move past the design limits and perhaps damaging itself.

The best way of describing the leg processor AFSMs, how they function individually and how they interact with each other, is to try and go through what happens when a leg movement is initiated. Leg movement initiation comes via a command line from the higher level Walk AFSM and which is connected to the leg processor Up Leg AFSM. The activation of Up Leg by this command now starts off a sequence of co-ordinated events. The first is that Up Leg sends a negative value to BetaPos, thereby activating the beta actuator and raising the leg. Normally, BetaPos will be sent a positive value by the Down Leg AFSM, thereby keeping the leg firmly on the ground, but the signal from Up Leg counteracts this and thus initiates the desired leg movement.

When the leg has been raised to the desired level the BetaPos AFSM will send a completed action signal to three other AFSMs in the network. These are Up Leg, Down Leg, and Alpha Advance and this completion signal thus initiates three simultaneous actions. The signal to Alpha Advance generates a strongly positive signal which is sent to the AlphaPos AFSM thereby causing the Alpha actuator to swing the leg forward. At the same time the completion signal from BetaPos to Up Leg causes it to cancel the negative value being sent to BetaPos and the same completion signal to Down Leg reactivates its positive signal to BetaPos. The result of these two actions is that the leg is replaced firmly on the ground, but in a new position since it has been swung forward by the Alpha actuator.

The above system will walk in a reasonable manner but it has one weakness, it will only walk on totally flat and even ground. This is because the BetaPos AFSM is designed to raise and



lower the leg to preset positions. If the ground is uneven, then the leg may meet the ground before it is lowered to the preset position, or it may not reach the ground at all. In either case, it will upset the ability of the system to walk, perhaps catastrophically. The solution is to add another level to the system by adding another AFSM that communicates with BetaPos and tells it when the leg has touched the ground, as opposed to using the preset position. This builds into the system a degree of compliance which allows the Insectoid to cope with walking on uneven terrains. The system can be designed to sense when the leg has touched the ground using either force sensors on each robot foot or by measuring the amount of force applied by the Beta actuator.

Similar sensors can be built into the system to tell another new AFSM attached to AlphaPos that the raised leg when it is being swung forward has hit something and therefore either needs to be raised higher or if this does not work then the higher level of subsumption needs to be activated to get the insectoid to avoid the obstruction.

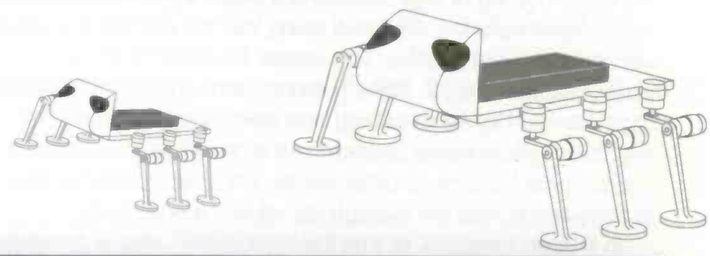
Higher levels of subsumption can be added which will enable the system to use sensors such as whiskers or infra-red/ultrasonic rangefinders that will be able to detect obstacles in front of the insectoid before they are hit by a leg and thus enable the system to take the necessary evasive action. Conversely, the sensors could be used to detect something which will attract the insectoid.

Subsumption architecture is an interesting technique for building autonomous robots that are capable of displaying complex behavioural patterns. In theory, it should be possible to go on adding new layers to the system ad infinitum, but this is only in theory, in practice systems have only been built with just a few layers, and indeed there may be some practical limit to the number of layers which can be used.

Going further

The above described technique is just one of many that can be used to create a robot that will move about by walking rather than with the aid of wheels. It is a very primitive system and will need considerable refinement, as well as the addition of further subsumption layers, before it will do more than just stagger across the floor in a very ungainly fashion.

However, the aim of this article is not to provide a complete set of instructions for building a walking robot but to simply point readers who might be considering building an entry for the First ETI Amateur Robot Competition in the right direction. So come on readers, let's see what you can do, let's show the world that anything NASA can do, ETI readers can also do.



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 course area will be 10metres square. The robot will start from one corner of the course area and will be expected to retrieve an empty standard aluminium soft drinks can located at the opposite diagonal corner of the course area and bring it back to the starting position

The robot must be completely autonomous with no connection or communication of any sort with any external computer or individual. It must therefore contain its own processor and its own power source.

The robot will be expected to walk over obstacles less than 5cms high, and locate and go around any that are higher. Stairs will have a rise height of 5cms and a tread depth of 10cms, no slope will be greater than 20degrees.

Each leg must be lifted clear of the floor at some stage whilst walking on level ground (no using wheels on the end of each leg!) and at no time can all the legs be lifted off the floor for more than two seconds (hopping is allowed but no flying).

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, although it can do so before starting the course and after completing the course.

The competition is open to any amateur robot builder or group of robot builders. It is scheduled to be held at the Model Engineers Exhibition in London during the first week of January 1996.

More details about the course design, the judging and, of course, the prizes, will be published over the coming months in ETI. Judging by initial interest in commercial sponsorship, we hope that prizes will be quite substantial. We are also expecting to have considerable media coverage of the event.

To help readers with the early stages of planning and designing an entry, we will be publishing further articles on subjects which should be of assistance and will also be arranging for various manufacturers to supply specialist items which will be needed by robot builders.

If you are interested in entering a robot for this competition then could you please 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.

Surplus always wanted for cash!

THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

LOW COST PC's - ALL EXPANDABLE - ALL PC COMPATIBLE

SPECIAL BUY

AT 286

40Mb HD + 3Mb Ram

LIMITED QUANTITY only of these **12Mhz HI GRADE 286** systems Made in the USA to an industrial specification, the system was designed for *total reliability*. The compact case houses the motherboard, PSU and EGA video card with single 5¼" 1.2 Mb floppy disk drive & **integral 40Mb hard disk drive** to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with **enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee.** *Ready to Run!*

Order as **HIGRADE 286** ***ONLY £149.00*** (E)

CALL FOR QTY DISCOUNTS

Optional Fitted extras: VGA graphics card	£29.00
1.4Mb 3½" floppy disk drive (instead of 1.2 Mb)	£32.95
NE2000 Ethernet (thick, thin or twisted) network card	£49.00

PC SCOOP

COMPLETE COLOUR SYSTEM

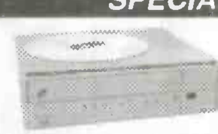
ONLY £99.00

A massive bulk purchase enables us to bring you a **COMPLETE** ready to run colour PC system at an unheard of price! The **Display Electronics PC99 system** comprises of fully compatible and expandable XT PC with 256k of RAM, 5¼" 360k floppy disk drive, **12" CGA colour monitor**, standard 84 key keyboard, MS DOS and all connecting cables - **just plug in and go !!** Ideal students, schools or anybody wishing to learn the world of PC's on an ultra low budget. **Don't miss this opportunity.** Fully guaranteed for 90 Days.

Order as **PC99COL** **£99.00** (E)

Optional Fitted extras: 640k RAM	£29.00
2nd floppy drive, specify 5¼" 360k or 3½" 720k	£29.95
Above prices for PC99 offer ONLY.	

SPECIAL OFFER



Computer Controlled Laser Video Disk Player

One of the most amazing surplus deals that we ever been able to offer you! The **Philips VP410** LaserVision player, in as new condition, unit features full computer control, Plays standard 12" LaserVision disks with **startling visual and audio quality** in two channel stereo or mono. When controlled by a computer, it may also be used as a versatile high quality storage / retrieval medium. It will play back either LaserVision CAV (active play) or CLV (Long Play) discs (which covers most types of commercially available video discs). Some of the many features of this incredible machine are:

RS-232 INTERFACE	**RGB / COMPOSITE VIDEO OUTPUT**
BNC+SCART INTERFACE	**PAL / RGB DECODER**
IR+WIRED REMOTE CONTROL	**FAST RANDOM ACCESS**

SPECIAL PURCHASE Only **£399.00** (F)

FLOPPY DISK DRIVES 3.5"- 8"

5.25" from £22.95 - 3.5" from £24.95

Massive purchases of standard 5.25" and 3.5" drives enables us to present prime product at industry beating low prices! All units (unless stated) are ***BRAND NEW*** or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. **All are IBM-PC compatible** (if 3.5" supported on your PC).

3.5" **Panasonic** JU363/4 720K or equivalent	£24.95(B)
3.5" **Mitsubishi** MF355C-L. 1.4 Meg. Laptops only *	£36.95(B)
3.5" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop	£29.95(B)
5.25" **Teac** FD-55GFR 1.2 Meg	£29.95(B)
5.25" **BRAND NEW Mitsubishi** MF501B 360K	£22.95(B)
* Data cable included in price.	
Shugart 800/801 8" SS refurbished & tested	£195.00(E)
Shugart 851 8" double sided refurbished & tested	£250.00(E)
Mitsubishi M2894-63 8" double sided *NEW*	£275.00(E)
Mitsubishi M2896-63-02U 8" DS slimline *NEW*	£285.00(E)
Dual 8" drives with 2 mbyte capacity housed in a smart case with built in power supply. Ideal as exterior drives!	£499.00(F)

HARD DISK DRIVES

End of line purchase scoop! Brand new **NEC D2246** 8" 85 Mbyte of hard disk storage! Full **industry standard SMD interface**. Ultra hi speed data transfer and access time, replaces Fujitsu equivalent model. complete with manual. Only £299.00(E)

3.5" **FUJI** FK-309-26 20mb MFM I/F RFE	£59.95(C)
3.5" **CONNER** CP3024 20 mb IDE I/F (or equiv)RFE	£69.95(C)
3.5" **CONNER** CP3044 40mb IDE I/F (or equiv.)RFE	£89.00(C)
3.5" **RODIME** RO3057S 45mb SCSI I/F (Mac & Acorn)	£99.00(C)
5.25" **MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE	£49.95(C)
5.25" **SEAGATE** ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5.25" **CDC** 94205-51 40mb HH MFM I/F RFE tested	£69.95(C)
8" **FUJITSU** M2322K 160Mb SMD I/F RFE tested	£195.00(E)

Hard disc controllers for MFM , IDE, SCSI, RLL etc. from £16.95

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!

TV SOUND & VIDEO TUNER!

The **TELEBOX** consists of an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as **MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD** etc. The composite video output will also plug directly into most video recorders, allowing reception of TV channels not normally receivable on most television receivers* (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. **TELEBOX MB** covers virtually all television frequencies VHF and UHF **including the HYPERBAND as used by most cable TV operators.** A composite video output is located on the rear panel for direct connection to most makes of monitor or desktop video systems. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

TELEBOX ST for composite video input type monitors	£34.95
TELEBOX STL as ST but with integral speaker	£37.50
TELEBOX MB Multiband VHF-UHF-Cable- Hyperband tuner	£69.95

For overseas PAL versions state 5.5 or 6mhz sound specification.
*For cable / hyperband reception Telebox MB should be connected to cable type service. Shipping code on all Teleboxes is (B)

FANS & BLOWERS

MITSUBISHI MMF-D6D12DL 60 x 25 mm 12v DC	£4.95 10 / £42
MITSUBISHI MMF-09B12DH 92 x 25 mm 12v DC	£5.95 10 / £53
PANCAKE 12-3.5 92 x 18 mm 12v DC	£7.95 10 / £69
EX-EQUIP 120 x 38mm AC fans - tested specify 110 or 240 v	£6.95
EX-EQUIP 80 x 38mm AC fans - tested specify 110 or 240 v	£5.95
VERO rack mount 1U x 19" fan tray specify 110 or 240v	£45.95 (B)
IMHOF B26 1900 rack mnt 3U x 19" Blower 110/240v NEW	£79.95

Shipping on all fans (A). Blowers (B). *50,000 Fans Ex Stock CALL*

IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

5,000,000 items EX STOCK

For *MAJOR SAVINGS* - SAE or CALL FOR LATEST LIST

VIDEO MONITOR SPECIALS

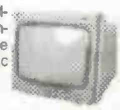
Superb quality 14" **FOREFRONT MTS-9600 SVGA** Multisync - Multimode monitor 0.28" dot pitch with resolution of **1024 x 768**. The multi mode input allows direct connection to a host of computers including **IBM PC's** in CGA, EGA, VGA & SVGA modes, **BBC, COMMODORE** (including Amiga 1200), **ARCHIMEDES** etc. The H version will also function with the **ATARI** in all modes inc **HI RES monochrome**. Complete with 'text' switching for WP use (possible minor screen bums) Syncs down to 15 kHz. Supplied in EXCELLENT little used condition with full 90 day guarantee.

Order as **MTS-9600 / H for ATARI**	£149.00 (E)
All modes as above Order as MTS-9600 / S	£129.00 (E)

ELECTROHOME ECM-1211SBU 12" VGA multisync monitor with resolution 640 x 480. Multi input selection; 9pin CGA/ EGA ; 15 pin VGA or 5 BNC connectors. 0.31 pitch. Compatible with PCs, Amiga, Atari and others. In good used condition (possible minor screen bums)90 day guarantee. ...... £99.00 (E)

KME 10" high definition colour monitors. Nice tight 0.28" dot pitch for superb clarity and modem styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13.5" x 12" x 11". Only £125 (E) Good used condition. 90 day guarantee.

KME 10" as above for PC EGA standard £145.00 (E)



NEC CGA 12" colour IBM-PC compatible. High quality ex-equipment fully tested with a 90 day guarantee. In an attractive two tone ribbed grey plastic case measuring 15"L x 13"W x 12"H. The front cosmetic bezel has been removed for contractual reasons.

Only £49.00(E)

20" 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & optional sound inputs. Attractive teak style case. Perfect for Schools, Shops, Disco, Clubs, etc. In EXCELLENT little used condition with full 90 day guarantee.

20"....£135 22"....£155 26"....£185 (F)

12" Mono. Philips BM7542 /05G for CCTV NEW £69.95 (C)

DC POWER SUPPLIES

10,000 Power Supplies Ex Stock Call for info / list

Power One SPL200-5200P 200 watt (250 w peak).Semi open frame giving +5v 35a, -5v 1.5a, +12v 4a (8a peak), -12v 1.5a, +24v 4a (6a peak). All outputs fully regulated with over voltage protection on the +5v output. AC input selectable for 110/240 vac. Dims13" x 5" x 2.5". Fully guaranteed RFE.	£85.00(B)
Power One SPL130. 130 watts. Selectable for 12v (4A) or 24 v (2A). 5v @ 20A. ± 12v @ 1.5A. Switch mode.New.	£59.95(B)
Astec AC-8151 40 watts. Switch mode. +5v @ 2.5a. +12v @ 2a. -12v @ 0.1a. 6-1/4" x 4" x 1-3/4" RFE tested	£22.95(B)
Lambada LYS-PV-12 200 watt switch mode.+12V DC @ 29a semi enclosed, 10" x 5" x 5". RFE and fully tested.	£59.95(C)
Conver AC130. 130 watt hi-grade VDE spec.Switch mode.+5v @ 15a,-5v @ 1a,+12v @ 6a.27 x 12.5 x 6.5cms.New.	£49.95(C)
Boshert 13090.Switch mode.Ideal for drives & system. +5v@ 6a, +12v @ 2.5a, -12v @ 0.5a, -5v @ 0.5a.	£29.95(B)
Farnell G6/40A. Switch mode. 5v @ 40a.Encased	£95.00(C)

SPECIAL INTEREST

INTEL SBC 486/133SE Multibus 486 system. 8Mb Ram	£1975
Zeta 3220-05 A0 4 pen HPGL RS232 fast drum plotter	£1950
3M VDA - Video Distribution Amps.1 in 32 out	£375
Trio 0-18 vdc bench PSU. 30 amps. New	£470
Fujitsu M3041 600 LPM band printer	£1950
VG Electronics 1035 TELETEXT Decoding Margin Meter	£3750
Andrews LARGE 3.1 m Satellite Dish + mount (For Voyager!)	£950
RED TOP IR Heat seeking missile (not armed !!)	POA
Tektronix 1L30 Spectrum analyser plug in	£330
Thurlby LA 160B logic analyser	£375
GEC 1.5kw 115v 60hz power source	£950
Brush 2Kw 400 Hz 3 phase frequency converter	£850
Anton Pillar 75 kW 400 Hz 3 phase frequency converter	POA
Newton Derby 70 KW 400 Hz 3 phase frequency converter	POA
Nikon PL-2 Projection lens meter/scope	£750
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
HP 7580A A1 8 pen HPGL high speed drum plotter	£1850
Kenwood DA-3501 CD tester, laser pickup simulator	£350
Computar MCA1613APC 16mm auto iris lenses 'C' mount	£125
Seaward PAT 2000 dual voltage computerised PAT tester	£585

19" RACK CABINETS

Superb quality 6 foot 40U Virtually New, Ultra Smart *Less than Half Price!*

Top quality 19" rack cabinets made in UK by **Optima Enclosures Ltd. Units feature** designer, smoked acrylic lockable front door, full height lockable half louvered back door and removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the **most versatile we have ever sold.** Racks may be stacked side by side and therefore require only two side panels to stand singly or in bays

Overall dimensions are: 77-1/2" H x 32-1/2" D x 22" W. **Order as:**

OPT Rack 1 Complete with removable side panels.	£335.00 (G)
OPT Rack 2 Rack, Less side panels	£225.00 (G)

Over 1000 racks in all sizes 19" 22" & 24" 3 to 44 U. Available from stock !! Call with your requirements.

TOUCH SCREEN SYSTEM

The ultimate in 'Touch Screen Technology' made by the experts - *MicroTouch* - but sold at a **price below cost !!** System consists of a flat translucent glass laminated panel measuring 29.5 x 23.5 cm connected to a PCB with on board sophisticated electronics. From the board comes a **standard serial RS232** or TTL output. The output continuously gives simple serial data containing positional X & Y co-ordinates as to where a finger is touching the panel - as the finger moves, the data instantly changes. The X & Y information is given at an **incredible matrix resolution of 1024 x 1024** positions over the screen size !!! So, no position, however small fails detection. **A host of available translation software enables direct connection** to a PC for a myriad of applications including: control panels, pointing devices, POS systems, controllers for the disabled or computer un-trained etc etc Imagine using your finger in 'Windows' instead of a mouse !! (a driver is indeed available !) ***The applications for this amazing product are only limited by your imagination!!*** Supplied as a complete system including Controller, Power Supply and Data at an incredible price of only:

RFE. Full Software Support Available - Fully Guaranteed **£145.00** (B)

LOW COST RAM & CPU'S

INTEL 'ABOVE' Memory Expansion Board. Full length PC-XT and PC-AT compatible card with **2 Mbytes** of memory on board. Card is fully selectable for Expanded or Extended (286 processor and above) memory. **Full data and driver disk supplied.** In good used condition fully tested and guaranteed.

Windows compatible. Order as: **ABOVE CARD** **£59.95**(A1)

Half length 8 bit memory upgrade cards for PC AT XT expands memory either 256k or 512k in 64k steps. May also be used to fill in RAM above 640k DOS limit. Complete with data.

Order as: XT RAM UG. 256k. £32.95 *or* **512k £38.95** (A1)

1 MB x 9 SIMM 9 chip 120ns	only	**£19.50**	(A1)
1 MB x 9 SIMM 3 chip 80 ns	only	**£23.50**	(A1)
1 MB x 9 SIMM 9 chip 80 ns	only	**£22.50**	(A1)
4 MB 70ns 72 pin simm module	only	**£89.00**	(A1)
***SPECIAL* INTEL 486-DX33 CPU**	*few only*	**£79.99**	(A1)

NO BREAK UNINTERRUPTIBLE PSU'S

Brand new and boxed 230 volts 1 KVa uninterruptible power supply system from Densei. **Model MUD 1085-AHBH.** Complete with sealed lead acid batteries in matching case. Approx time from interrupt is 15 minutes. Complete with full manual. **£575.00**(G)

EMERSON ACCUCARD UPS, brand new 8 Bit half length PC compatible card for all **IBM XT/AT** compatibles. Card provides DC power to all internal system components in the event of power supply failure.The Accusaver software provided uses only 6k of base RAM and automatically copies all system, expanded and video memory to the hard disk in the event of loss of power. When power is returned the machine is returned to the **exact status when the power failed !!** The unit features full self diagnostics on boot and is supplied **brand new**, with full, easy fitting instructions and manual.

Normally £189.00 ***NOW!*** **£69.00** or **2 for £120** (B)

Issue 13 of *Display News* now available - send large SAE - PACKED with bargains!

DISPLAY -ELECTRONICS-

LONDON SHOP
Open Mon - Sat 9:00 - 5:30
215 Whitehorse Lane
South Norwood
On 68A Bus Route
Nr.Thornton Heath & Selhurst Park SR Rail Stations

ALL MAIL & OFFICES
Open Mon-Fri 9.00-5:30
Dept ETI. 32 Biggin Way
Upper Norwood
LONDON SE19 3XF

DISTEL © The Original
FREE On line Database
Info on 1000's of items
V21,V22, V22 BIS
0181 679 1888

ALL ☎ ENQUIRIES
0181 679 4414
FAX 0181 679 1927

ESTABLISHED 25 YEARS

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Carriage charges (A)=£3.00, (A1)=£4.00, (B)=£5.50, (C)=£8.50, (D)=£12.00, (E)=£15.00, (F)=£18.00, (G)=CALL. Allow approx 6 days for shipping - faster CALL. Scotland surcharge CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices paid for surplus goods. All trademarks etc acknowledged. © Display Electronics 1995. E & O E. 1/11

Light Gun Game

Most large towns and cities now have at least one Laser Gun arena. They are usually very popular with young people and, judging by the queues and the prices charged, must be very lucrative! This project is an attempt to achieve a similar type of game for the home constructor

Having built this project, all you need to provide is a large arena with obstacles, flashing lights, sound and carbon dioxide smoke and you're set up for hordes of enthusiastic youth and enormous profits ... alternatively, you can play it just for fun in any hall or preferably outside in a common, wood, football field etc.

The light guns consist of a belt pack which is worn around the waist with the gun wired into the belt pack. The guns fire infra-red pulses and have a detector at the front and back of the belt pack. You achieve a 'kill' by hitting an opponent with the infra-red shot from the gun. The guns have a range of about 5m in daylight and considerably better at night - with careful aiming we found ranges up to 30m.

The project consists of the light guns, team bases, and an optional central 'renewal' unit. At the simplest, two guns can be built for a two player game, more guns and team bases can be added for team games and, if the central unit is built, then a variety of game types can be played, the game duration can be set, and each player has an individual score at the end of the game. This article explains the construction and use of the light guns; subsequent articles detail the bases and central unit.

For team games the players are split into two teams - the packs are painted red or green to divide the teams. The packs have LEDs which are of the same colour as the pack so that the team colour of each player is easily visible at night. Each team may have up to 15 players and a base which they attempt to defend against the other team. The bases each have Xenon

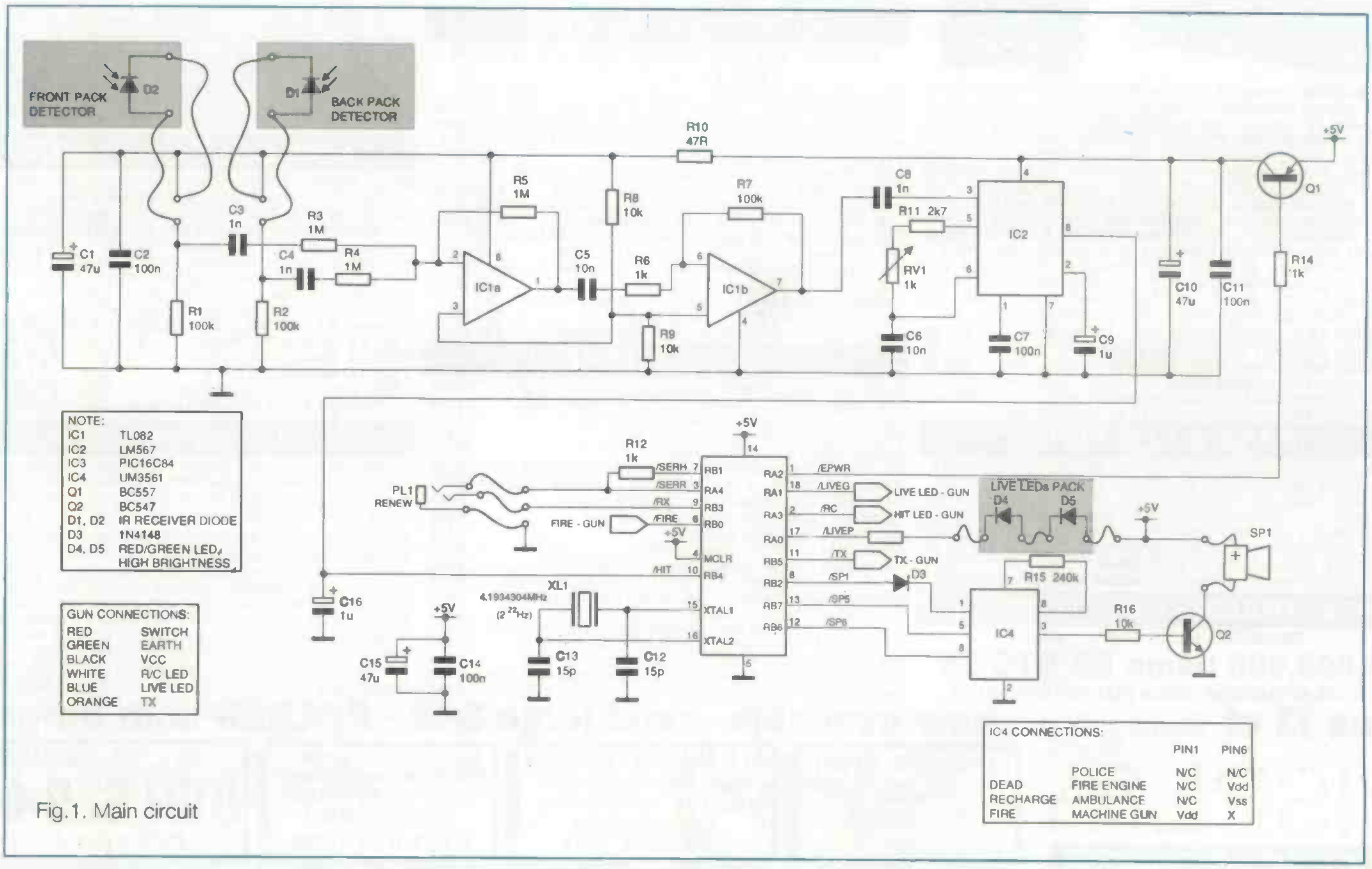


Fig.1. Main circuit

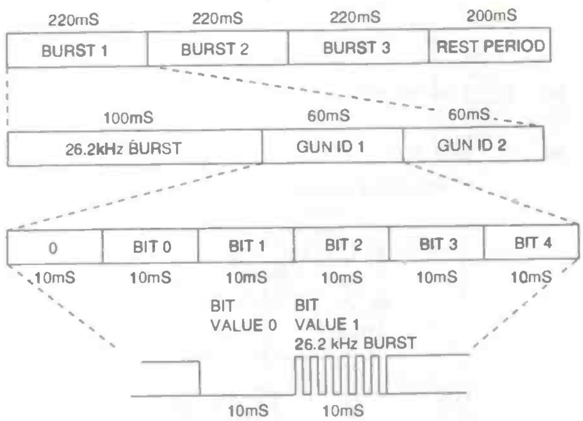


Fig.2. Firing sequence from gun

warning lights and a siren which are triggered if a member of the opposing team succeeds in hitting the base. The construction, operation and use of the bases will be explained in a later article.

Light gun features

The gun itself has a fire trigger switch, two LEDs for the information of the user, the infra-red LEDs which 'fire' at other players and the batteries and the battery recharging socket. The first gun LED is the live LED and comes on when the player is 'live', the other is the hit LED used to give information about being hit.

The pack has a case at the front containing the main light gun circuitry, and a small plastic box at the back. There is an LED and a sensor in the front case and in the back box. The LEDs inform other players about the team and the status of this player, while the sensors detect when the gun has been hit. The front case also contains a 3.5mm stereo jack socket (the 'renewal socket') which is used to renew the player when all lives have been lost.

Renewing the player

The player is 'renewed' to restore him to life. The light gun may be operated in one of two modes, depending on whether a central renewal station is in use.

The first mode is the simple mode where the gun is renewed by inserting a simple 3.5mm stereo jack plug with all its connections shorted into the renewal socket. In this mode the gun has 4 lives and 16 shots per life when it has been renewed. There is no time limit on the game except that imposed by the organisers. Players may be divided into red and green teams and aim to set off each other's bases - in this case, base hits are used to score each team. Alternatively, a solo game may be played without bases where the number of renewals may be used for individual player scores.

The second mode is normal mode where a central renewal station is used. In this mode, the game type is selected at the central renewal station and guns renewed by inserting the renewal lead from the central station. Each game offers a different number of lives and shots per life. Team games or solo games with or without bases are selectable. The game duration is set at the central station and the guns will all die simultaneously at the end of the game. In addition to this, the

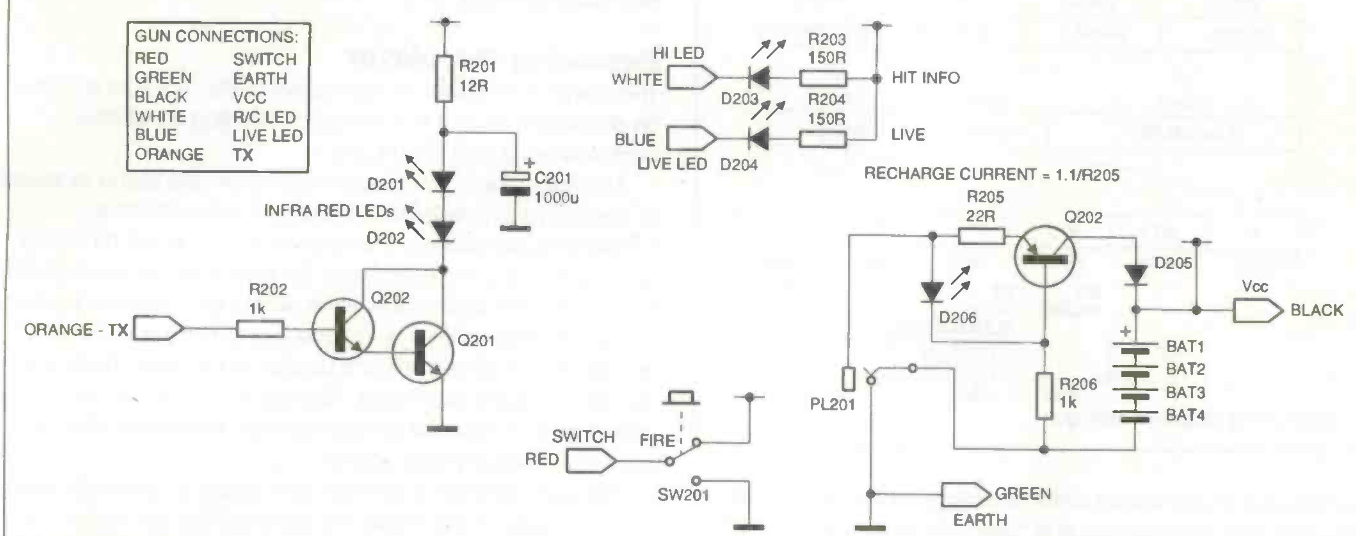


Fig.3. Gun circuits

guns may be programmed with a warrior mode which only allows certain users to hit the bases. The various games that can be played will be described in the later article on the central.

When the gun is first powered up it is in the 'dead' state, all LEDs are turned off and the gun cannot be fired. The gun is renewed either by inserting a shorted 3.5mm stereo jack plug in simple mode, or by inserting the renewal lead from the central in normal mode.

For a 4 second period after renewal, the gun cannot be fired and the pack cannot be hit. During this period, the hit LED illuminates and the pack LEDs are switched off and the pack makes the sound of an ambulance. This allows the player time to get away safely from the renewal station without being shot.

Firing and shots

Once renewed, the gun is 'live'. The LEDs at the front and back of the belt pack illuminate together with the live LED on the gun. The gun may be fired by pulling the trigger. Whilst firing, the gun cannot be hit.

The player has a limited number of shots per life. If these are used up then the player immediately loses all remaining lives and the gun returns to the dead state. When there are three or less shots left, the gun live LED flashes to warn the player.

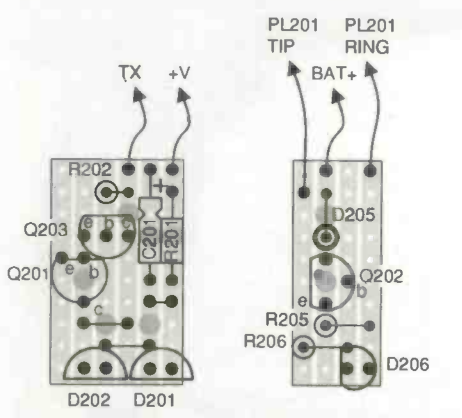


Fig.4. Veroboard overlay for gun circuits—

Being hit

The sensors at the front and back of the pack detect the infra red signal from a gun. If the pack is hit then the player loses a life.

For the first four seconds after being hit the pack makes a siren sound and the live LEDs and pack LEDs go out. During this period, no shots may be fired and the pack cannot be hit again. This is the 'protected period'. For a further four seconds after the protected period, the pack makes a sweep sound and the live LED and pack LEDs flash rapidly, the gun cannot be fired but the pack can be hit again. During this second period the player is a 'sitting duck'; the flashing LEDs make it very clear to other players that the sitting duck is an easy target.

The hit LED on the gun illuminates during both four-second periods after the gun has been hit to further warn the player that he cannot fire. The gun also has a 'revenge' shot - for a period of one second after being hit, the player can fire one shot to get the player who has just shot him - if he is quick enough to see him!

When only one life is left, the gun live LED flashes to warn the player. Once all the lives, or all the shots, have been used up the player is 'dead'. The pack and gun LEDs go out and the gun must be renewed before the player can re-enter the game.

Other Features

The gun has rechargeable batteries and may be recharged from any 10-15V DC power source. Several guns can be recharged simultaneously; each gun needs about 80mA from the recharging power source. The gun is recharged by inserting a 3.5mm mono jack plug into the recharging socket on the gun. The plug should have the tip as negative, and the ring as positive; note this is the opposite to normal power supplies.

To change the gun into simple mode, the fire trigger is held down whilst the recharging plug is withdrawn from the gun - the hit LED illuminates. Normal mode is entered by leaving the fire trigger released whilst the recharging plug is withdrawn - the gun live LED illuminates. The gun will stay in the mode set until the recharging plug is inserted again.

If the gun is not used for a period of about four minutes - if the player is not hit and if the gun is not fired or renewed - then the gun goes into sleep mode. In sleep mode, all LEDs and internal circuits are turned off and the power consumption of

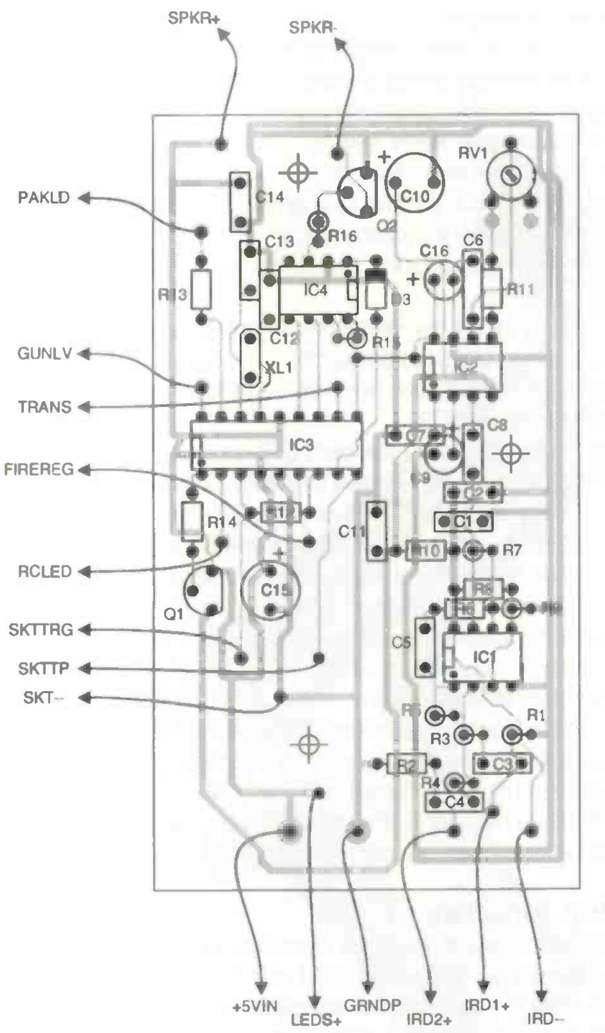


Fig 5. Component overlay for main circuit PCB

the gun drops to about 40uA; the gun cannot be fired or renewed. Pressing the fire switch wakes the gun up, after which it is in the dead state and may be renewed as normal. This means that the gun does not need an on-off switch.

Each gun has its own identity which may be programmed from the central. The gun identity is held in EEPROM and is not lost if the power is disconnected when the batteries are recharged. The gun identity is used from the central to report scores for each player at the end of the game and is used by the bases to identify which player hit them. The gun identity is not used in simple mode.

Operation of the circuit

The circuitry of the gun is split into two parts. The main circuitry is held in the case on the front of the belt, the gun holds the infra-red LEDs, the batteries and the battery charging circuitry.

Main Circuit

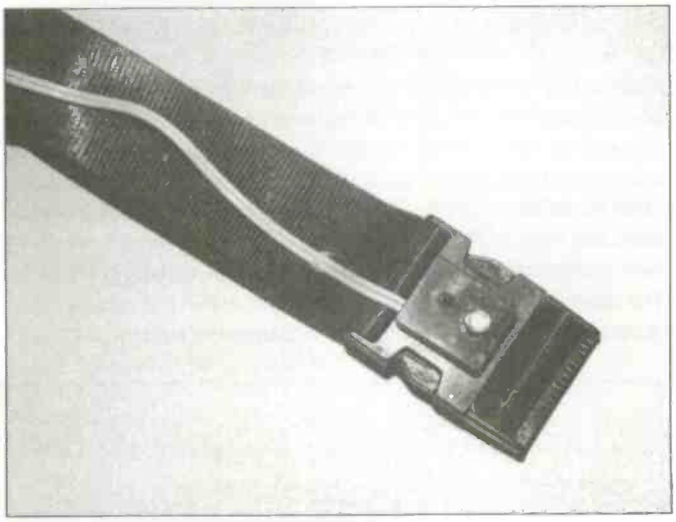
The main circuit is shown in figure 1.

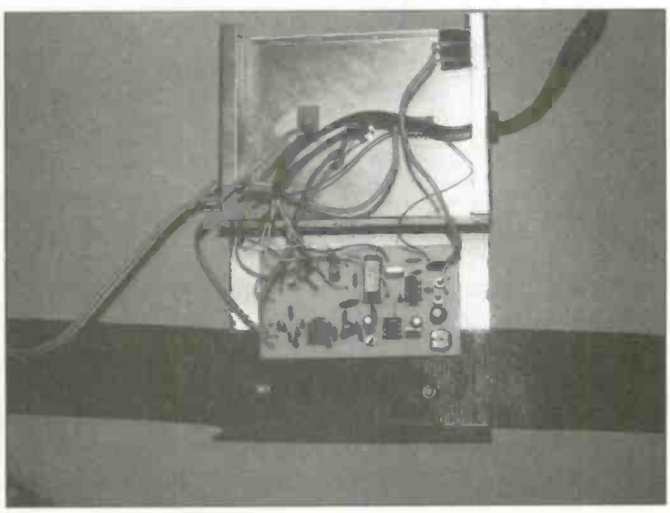
It won't come as any surprise that functionality of this complexity in an affordable and compact unit can only be achieved by using a microprocessor. In this case most of the functions are contained within a microcontroller - the PIC16C84, IC3. This device contains 1K of program store, a real time clock, an interrupt handler, two general purpose I/O ports, and 64 bytes of EEPROM data store.

The real time clock is used to keep time in the gun. The clock is set up to generate interrupts at a 1/16th of a second rate and these interrupts are used to measure the game time, operate the hit timers and enter sleep mode after a 255 second period of inactivity. The main interrupt input is used to detect the operation of the fire trigger and to bring the gun out of sleep mode. The EEPROM data memory is used to store the gun ID reliably and is held over power down to the chip.

The PIC uses a crystal for timing. This is more costly than other oscillator types but offers temperature stability and accuracy which is required for serial communication to the central renewal unit. The oscillator frequency is 4.194303MHz which is divided by 2^18 to give an exact 1/16 second timer interrupt internally. The outputs of the PIC are used to drive the main gun functions.

Communication with the central renewal unit is through a serial link on socket PL1. The tip of the socket is used to transmit information directly from the renewal unit to the PIC. The central ring of the socket is used to request and acknowledge transmission and to transmit information from the gun to the central. The gun transmits its own identity and the number of lives left to the central at a rate of about 1000 bits/S. The central transmits an 8 byte packet to the gun, including information on game type and duration, at a rate of about 10500 bits/S. The central also uses a different packet type to program the gun identity. R12 is needed for the operation of the serial protocol which is described in more detail in the later article on the renewal unit. Whilst passing information to and from the central, the gun LEDs show successful renewal.





In simple mode, the shorting of the socket tip to ground directly renews the gun.

The 20mA current drive capability of each output pin can drive LEDs directly; there are three LED drives, one for the front and back pack LEDs, one for the gun live LED, and one for the gun hit LED. The PIC also directly generates the 26.2KHz square wave used for the infra-red LEDs when firing; this output is on pin 11.

The sound chip, IC4, is powered directly from the PIC, as its power consumption is only 5mA. The output of the sound chip is buffered by TR2 to drive a speaker or sounder. This must have 64ohm or greater voice coil resistance. The sound chip is connected to generate three sound types: a machine gun noise which is used for firing, a fire engine noise which is used for the protected period and an ambulance noise which is used during the sitting duck period.

Output RA2 on pin 1 of the PIC is used to switch TR1. TR1 is used to switch power to the infra-red receiver circuitry, so that in sleep mode all unused functions are powered down minimising battery drain.

All guns have an identity, which is a number from 1 to 15, and a colour - red or green. Thus, guns may have identities such as red 12 or green 6. Internally, the gun ID is held as a 5 bit number, the bottom 4 bits are the gun number and the top bit is the colour - red is 0 and green is 1. Thus, red 12 has code 0CHex and green 6 has code 16Hex.

The gun fires using a 26KHz square wave from two infra-red LEDs; this is generated in software in the PIC. The firing stream is a 100mS burst of square wave followed by the gun identity which is transmitted in serial form as a low start bit followed by the 5 bit identity in binary form - LSB first. Each bit is 10mS long and is sent as a burst of 26KHz if the bit is 1, and no pulses at all (the Infra-red LEDs are turned off) for a 0. The ID is repeated once to make 12 bits. The whole sequence of 100mS burst followed by two identity transmissions is repeated three times to make up a total 660mS burst. A 200mS gap during which no other functions operate is left following the gun transmission to allow the internal PLL to recover so that the gun won't detect its own transmission. The whole sequence is illustrated in figure 2. The identity fired by the gun is only used within the bases; the guns use the presence of the 26KHz signal to indicate a hit as reliable detection of the identity is not possible at extensive ranges.

The IR pre-amp is made up from dual CMOS op-amp IC1. The IR detector diodes D1 and D2 operate in the reverse biased mode and their outputs are passed through capacitors C3 and C4 to remove ambient infra-red effects. The signals are added by IC1a which is configured as unity gain inverting amplifier. The output of IC1a is passed through R6 and C5 which roll off unwanted lower frequency signals. The second stage formed by IC1b has a gain of 20dB and its output is passed to the PLL tone decoder.

As the circuit operates from 5Vdc the non-inverting inputs of IC1 are connected to the junction of R8 and R9 which is at supply/2. All switching noise from the PIC is effectively filtered by R10, C1 and C2.

The PLL, IC2, is a standard 567 tone decoder which is connected to detect signals of 26KHz. The centre frequency of the PLL is set by R11, VR1 and C6. C6 must be a high stability polyester or polystyrene capacitor to ensure minimum change of frequency over a wide temperature range. The filter components are chosen to provide a fairly slow detection of the signal (approx. 5mS), and the output is further filtered by C16 and the pull-up resistor on input RB4 of the PIC. This minimises the risk of false detection.

The current consumption of the gun is about 50mA when live, 150mA when firing and 1mA when dead. In sleep mode, total consumption drops to around 40uA. This gives typically 6 to 8 hours play per recharge, and consumption in sleep mode will be lower than the self discharge rate of the Ni-Cd batteries.

Gun circuitry

Figure 3 shows the circuitry contained within the gun. The infra-red diodes are driven by TR201 and TR203 and are driven with a current of 100mA, C201 sharpens the edges of the waveform. The Ni-Cd batteries are held in the gun and are recharged at 50mA by the simple constant current source formed around TR202. When the recharging plug is inserted into PL201, the batteries are disconnected from the main circuitry. The renewal mode is selected by the PIC when the recharge plug is removed. It detects the state of the fire switch as the program starts running to choose normal or simple renewal mode.

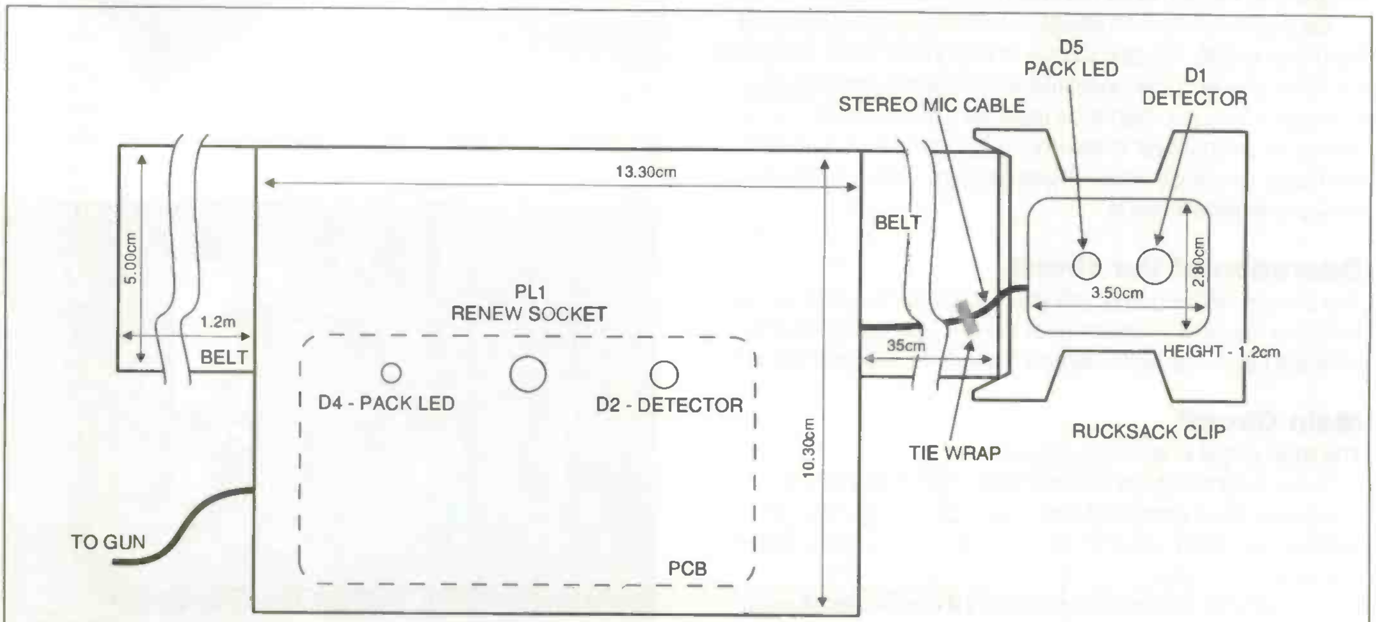


Fig.6. Belt and case

CONSTRUCTION

Obtaining components

Undoubtedly the most difficult item will be the gun itself. We were lucky enough to find a box full of old Sinclair Spectrum light guns in a Greenweld sale for £5 for a carrier bag full! Greenweld and some other surplus suppliers may still have stocks of these guns which are almost perfect for this application. Originally we had some success with modified water pistols but abandoned this idea when we found the Spectrum guns. Whatever is used, the most difficult aspect will be fitting the fire switch into a modified gun, the Spectrum guns had a change-over micro-switch which was re-used.

The case at the front of the pack is aluminium; we used Maplin's AB10 case. This front case must be metal and earthed as the receiver is very susceptible to noise. The small case at the rear of the pack which is glued to the rucksack clip is a plastic potting box.

The belt is 2' wide black nylon webbing. We eventually bought 25m at 50p/m from a tent repairer. Yacht chandlers are much more expensive and it is almost impossible to buy a car seat belt for safety reasons. The belt is held on to the player with a rucksack clip, which can be bought from camping shops for around £1.25 each.

If you buy all the parts for the gun individually and brand new, then it will cost around £30 for all electronic and mechanical parts. However, if you are building in quantity, then it becomes worth shopping around, using surplus suppliers and asking suppliers to give quantity discount. We have built 14 guns in total, the first four were prototypes which cost about £25 each, the remainder we managed to build for less than £15 each.

The most important issue to bear in mind when building the gun is mechanical robustness. The light guns are going to be worn by players who will be running around a play area with obstacles and the guns will suffer strong shaking and vibration which will soon cause failure of poorly made connections.

All nuts and bolts must be secured with shake-proof washers. Most items in the light gun are glued in place except the main circuit board. We found that by far the best glue was silicone rubber sealant. This is cheap, sticky when wet, dries fast and is very strong but flexible when dry. Despite this, glued items can still be prised apart without damage if necessary. We used Superglue to secure the red filters to the cases and to glue the photo diodes to the filter, as it has the advantage of being transparent. Secure loose wires with silicone rubber.

We found that if you build several guns in parallel at the same time, then it is possible to complete five guns in about twice as long as the time taken to complete one gun. It is also definitely much easier (and saves the sanity) to build a large quantity of guns with a team of builders rather than just one!

As in most electronics projects, the most difficult part of the construction is mechanical; the electronic circuitry in the project is straightforward. The table at the end of this article shows the complete component list for the project.

The construction of the gun is shown in photo 1, the physical construction of the gun will be very dependent on the gun case used. The two gun circuits - the battery recharger and the infra-red LED driver are too small to justify PCB construction, so veroboard is used. Figure 4 shows the veroboard overlay for the

Fig.7. Front panel graphics

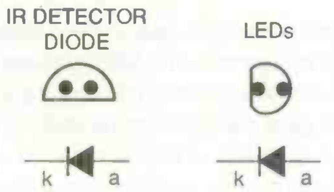


Fig.8. Pin-outs of LEDs and Detector Diodes

two circuits. This can be photocopied and glued directly to the board. The grey squares are track breaks, thick black lines are wire links and black circles are PCB pins; the other components are shown on the layout. Figure 8 shows the pin out of the infra-red LEDs. Note that C201 is glued directly to the gun case and wired to the infra-red driver board. The batteries are glued into the gun case using silicone rubber. The gun and hit LEDs are mounted by the leads, one lead is melted into the case plastic, the other to a small piece of veroboard holding R203 and R204 which is then soldered to the fire switch. The cable from the gun to the case is 6 way; the colour codes for the cable we used are shown in figure 3.

Test the gun and recharge the batteries as shown below before wiring the gun to the main case. Test the infra-red driver and battery recharge circuits before gluing them into the case. The infra-red driver circuit is glued to a spacer to place the infra-red LEDs on the main axis of the gun. LED D206 is mounted through the case so that it can be seen from outside the gun and is Superglued in place.

The main circuit board in the gun is shown in figure 5. Insert resistors R1 to R16 first, follow with diode D3, sockets for IC1 to IC4, printed circuit board pins and finally the capacitors, crystal, and variable resistor. Note that IC4 is the opposite way round on the board to ICs 1 to 3. There is one link - J2. Don't insert the ICs yet.

The front case is shown open in photo 2, it should be drilled and then painted, either red or green dependent on the team. The belt is held by two bolts and is glued to the base of the case so that when the belt is worn with the case at the front the belt is at the top of the case. Figure 6 shows the measurements for the belt. The belt is clamped firmly by the case when it is screwed shut. There are three supports for the PCB, hold it with M3 bolts and shake-proof washers and use 5mm spacers.

The front panel graphic is shown in figure 7. We found a cheap way of producing the graphics was to laser print the image in mirror form directly on to overhead transparency film, and to Superglue it to the case. The renew socket is fitted centrally into the case, the pack LED and the detector diode are fitted on either side of the socket. The LED in the front case is glued into place, or a chrome LED holder may be used. The detector diode is glued to a small piece of red filter material which is glued to the case. Figure 8 shows the pin out of the LEDs and detector diode. The renew socket should be fitted after the graphic as it holds the film to the case. Use a high power iron to solder the socket ring to the socket. The speaker is glued directly to the case. It is very important that the wires to the speaker and the speaker itself are kept away from the input circuitry on the PCB, because the input circuit will pick up signals from the speaker wiring and the player will suffer spurious hits.

The rucksack clip fixed end is fitted to the shorter end of the belt. Fold about 5cm of the belt through the clip and either glue it back on itself or, better still, sew it. Fit the rear LED into the rear case with a chrome LED holder and fix the detector diode in the same way as the front detector. Use stereo screened microphone cable to wire the rear detector and LED to the front case. The cathode of the detector and LED should be connected to the screen of the cable. You may want to test the complete circuit before gluing the rear case to the rucksack clip using silicone rubber. The cable is held to the belt using tie-wrap, self-locking cable grips. Connect the speaker, pack LEDs, detector diodes and renew socket to the main PCB. Leave the case open.

Set-up and Testing

The gun should be tested first. Break one of the battery links and insert an ammeter. An external supply of 10 to 15v DC should be used. A 3.5mm mono jack plug is used with the tip connected to negative supply. D206 should light and the current measured to the battery should be about 50mA. Leave for 14 to 16 hours to recharge the batteries.

Insert a plug into the recharge socket to isolate the supply from the gun. Wire the gun to the front case, a self-gripping cable grommet must be used as there will be high stresses on the cable during play.

Remove the recharge plug and check that there is +5v DC between pins 5 and 14 of IC3. Short the LED connections on IC3 to ground one by one (pins 2, 17 and 18) and check that the LEDs illuminate. Short pin 8 of IC3 to +5v and the speaker should emit a police siren sound. Insert the recharge plug and then insert ICs 1 to 4. Note that IC4 is the opposite orientation to the other ICs.

Press the fire trigger and pull out the recharge plug. The hit LED should illuminate to show that simple recharge mode is in use. Take a 3.5mm plug with all the connections shorted and insert it into the renew socket, remove it, the speaker will emit the renew tone for four seconds, and then the gun will be live. Now short both halves of the case and ensure that the PCB is bolted in place before adjusting the PLL. Measure the frequency on pin 5 of IC2 and adjust to 25.2KHz with VR1 (without a frequency meter, then adjust for maximum range of detection with the aid of another gun). We found that it may be necessary to increase R11 to 3K3 with some 567 devices to enable correct adjustment. Note that this frequency is (correctly) about 1KHz lower than the transmitted frequency from the PIC.

With the aid of another gun check all the functions. Insert an ammeter again and check that after roughly four minutes all functions of the gun cease and current consumption drops to around 40uA. Pressing the fire trigger will return current consumption to around 1mA before the next renew or sleep period. Screw the case shut, bolt the gun shell together and the gun is ready for use.

Playing the game

We found teams of around four to six were most successful in team games; individual games from two to ten players are also successful. The renewal station (either the central renewal unit, or, in simple mode, a shorted 3.5mm stereo plug attached to a length of string) should be placed at a central location. If used, the bases should be placed equidistant from the renewal station. We found lightly wooded areas to be by far the best areas to play the game and dusk, or a moonlit night, to be the best conditions for play when the range is greatest and the pack LEDs are most visible. Players must be firmly dissuaded from covering the detectors with clothing or their hands! 15 minutes for a game (the default from the central) is about right.

COMPONENT LIST

Main Circuit

Capicitors

C1,10,15	47uF Electrolytic
C2,7,11,14	100nF Ceramic
C3,4,8	1nF Ceramic
C5	10nF Ceramic
C6	10nF Polyester
C9,16	1uF Electrolytic
C12,13	15pF Ceramic

Semiconductors

D1,2	IR Receiver diode
D3	1N4148
D4,5	HE, 5mm Red/Green LED, High Bri.
IC1	TL082
IC2	LM567
IC3	PIC 16C84
IC4	UM3561
TR1	BC557
TR2	BC547

Resistors

R1,2,7	100K 1% Metal Oxide
R3,4,5	1M 1% Metal Oxide
R6,12,14	1K1% Metal Oxide
R8,9,16	10K1% Metal Oxide
R10	47R 1% Metal Oxide
R11	2K71% Metal Oxide
R13	68R1% Metal Oxide
R15	240K1% Metal Oxide
VR1	1K variable resistor horizontal

Miscellaneous

XL1	4.193MHz crystal
PL1	Stereo Jack Skt, 3.5mm
SP1	Sounder, >64ohm
Cable 1	Twin Mic Cable
Clip 1	Rucksack clip
Belt 1	Webbing Belt, 5x135cm
Case 1	Aly Case, Maplin - AB10
Case 2	Potting box, Min
Vero Board	
Tie wraps	
M3 Bolts	
M3 Nuts	
M3 Shakeproof washers	
Red filter	
PCB	

Gun Circuit

Capacitors

C201	1000uF Electrolytic Axial 10V

Semiconductors

D201,202	IR LED 5mm
D203	Orange LED 5mm
D204	Red/Green LED 5mm
D205	1N4001
D206	Red LED 3mm
TR201,203	BC547
TR202	BC557

Resistors

R201	12R1% Metal Oxide
R202,206	1K1% Metal Oxide
R203,204	150R1% Metal Oxide
R205	22R1% Metal Oxide

Miscellaneous

PL201	3.5mm Mono Jack Socket
BAT 1-4	Battery
Vero Board	1.5"x1.5"
Cable	6-way

Cover Disk

The FREE cover disk supplied with this copy of ETI includes an AC circuit simulation programme which will run on any PC under Windows 3.0, and a comprehensive collection of PC diagnostic programmes which will help the user to locate and solve a whole range of different problems on any PC AT, from 286 to Pentium

Linear AC Circuits Analysis with ACIRAN V1.4 for Windows

The following is a brief introduction to this very versatile and comprehensive programme. It is a shareware programme which means that readers who intend to use it are expected to complete the registration form that is supplied as a text file on the disk and return it, together with the registration fee, to the authors. A full version of the printed manual and the latest version of the software will be supplied to all registered users.

ACIRAN is a Linear AC Circuit Analysis Program designed to ease small signal AC analysis of active and passive circuits. ACIRAN can handle Resistors, Capacitors, Inductors, Transformers(Ideal), FETs, Transistors, Operational Amplifiers, Transmission Lines, and Voltage Controlled Current Sources.

To save time and ease design, a number of FET, Op-amp and Transistor model parameters have been supplied. More complex models can be built up using passive components and Voltage Controlled Current sources.

Installation

ACIRAN V1.4 was created using the Turbo Pascal for Windows Compiler (V 1.5) and is able to support co-processors. If your machine has a floating point chip, it is detected by ACIRAN and used for all calculations. If you do not have a co-processor, it is simulated by software. ACIRAN will run under Windows 3.0 or 3.1 in Standard or Extended mode. It requires a minimum 286 system with at least 1Mbyte of RAM.

Some of the files on the disk are compressed. You must run the install program first to unpack these to your working disk/directory. Select Run from the Program Manager and enter a:install (or whatever drive you are installing from). If you are in DOS, switch to the drive containing AFW and type win install.

Getting Started

The programme offers a conventional Windows type display which conforms to standard Windows command structure. The main menu offers the following selection:

File Edit Config Data Analyse Results Graph Help

File provides the following sub-menu:

New - is used to enter a new circuit description to ACIRAN and as it clears any previous circuit from memory you should save any data that you have in memory first. You will be given a warning first.

Open - allows you to load a previously saved circuit for analysis or modification. Circuits are expected to have extension .CIR or .CTS (automatically appended by ACIRAN). You will be presented with a Filebox. Use the cursor keys or mouse to highlight the file you wish to load and then press return or click the OK button.

Save - allows you to save your circuit description to disk. If you are entering a large circuit then you should save it periodically.

Save_As - allows you to save your circuit under a new name, perhaps to save a different version. Save_As will be called the first time a circuit is saved as it will not have an existing filename.

Printer SetUp - will allow you to configure your printer, e.g. select landscape or portrait mode.

Exit - will exit from ACIRAN and take you back to Windows. Any circuit description held in memory will be lost, so make sure you have saved any data that you want to keep. ACIRAN will give a warning if you have not saved your circuit and have made changes.

Going back to the main menu:

Edit - allows you to make changes to the circuit description such as adding or deleting components and changing component values. Edit has its own sub-menu which will be described later.

Config - allows you to set up certain flags and to request additional circuit parameters such as impedance and return loss. This information is stored along with the circuit details in the files. The Config dialog box will be described later.

NetList - allows you to inspect your circuit description by listing the components, their values and circuit connections. You can send the data to a printer by selecting Print from the system menu of the Netlist Window.

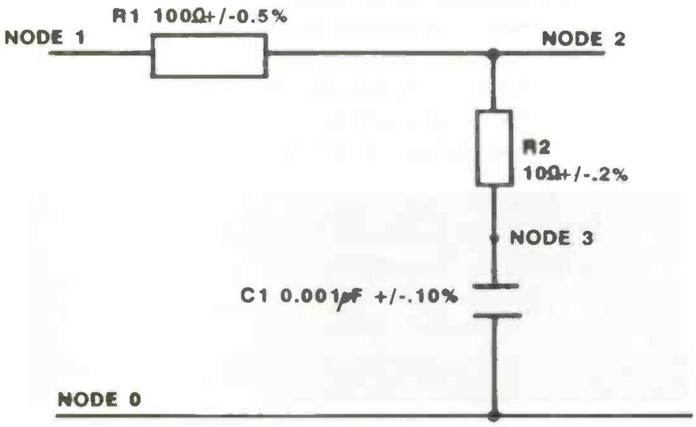
Analyse - instructs ACIRAN to analyse the circuit in memory. Logarithmic and Linear frequency sweeps are allowed. ACIRAN can also carry out Monte-Carlo analysis if component tolerances have been entered.

Results - offers the choice to Display or File. To view the results, select Display; to obtain a hard copy of these results, the Print option should be selected from the system menu of the Results Window. Results can also be stored in a text file for later use.

Graph - will plot various parameters such as Gain or phase against frequency. A hard copy can be obtained by selecting Print from the menu.

Learning to use ACIRAN

To enter a circuit, select New and enter a circuit name. This is for your benefit only and appears in listings.
Next you will see a dialog box of component types; use the normal selection methods to choose a component type. If the component type is Fet, Op amp or Transistor you will be asked if you wish to load model parameters from disk. If you select to do so, you will be presented with another file selection box to choose the component model. A number of examples are included on the disk, and they provide a good way of learning ACIRAN. However, let's first look at how to enter one from the keyboard.



The circuit is shown below:

To enter this circuit first select New from the File Menu.

● Enter the circuit description 'RC Filter' <cr>.
● When the Select component box is displayed, choose a resistor, and a form will appear on the screen. You will be asked for the component identifier; enter 'R1' and press <TAB>.(Up to 5 characters can be entered for the component identifier).
● You will now move to the next input field. You will then be asked for the value of R1. Enter 100 <TAB>.
● You will then be asked for the tolerance in %. Enter 0.5 <TAB>. (The leading zero is essential).
● Next you will be asked 'From Node'. Enter 1 <TAB>, and then 'To node', Enter 2 <TAB>.
The convention in ACIRAN is that the INPUT NODE is ALWAYS 1 and the GROUND NODE is ALWAYS 0. The OUTPUT NODE is variable (more about this later).
● Once you have completed the form you must press enter or click the OK button to exit and save your data.
● If you press Cancel, the data will be ignored. You can move around the input form changing the information, using the edit keys, until you are happy with what you have entered. Previously entered data is presented and can be accepted by entering <cr>.
● Enter component R2 in the same way. It is not important which way round the passive component is connected.
● To enter C1 select Capacitor and, for the value, enter 0.001u. The 'u' or 'U' at the end tell ACIRAN that the value is in micro farads. A number of multiplier options are allowed and upper or lower case can be interchanged in all cases except 'M' and 'm'.
The multipliers accepted by ACIRAN are:

'G' or 'g'   Giga = x1E9
'M'   Mega = x1E6
'K' or 'k'   Kilo = x1E3
'm'   milli = x1E-3
'U' or 'u'   micro = x1E-6
'N' or 'n'   nano = x1E-9
'P' or 'p'   pico = x1E-12

These multipliers can be entered in a number of formats, e.g. 1k2, 1K2,1.2K, 1200, 12e2,12E2 and 1.2e3 are all acceptable and identical.
● Now that the circuit has been entered click Cancel in response to next component and you will be asked for the Output node.
If you press <cr> without entering any data ACIRAN will assign the highest node used to the output node. In this circuit this is not the case and you must enter 2 <cr>.
It is advisable to save your work and so as soon as the main menu returns press Alt-F for File then Alt-S for Save, or use the mouse. When asked for a file name enter any valid filename, but remember to omit any file extension.
You can check your circuit configuration by selecting NetList. The circuit listing is displayed. You can scroll through it using the scroll bar on the left of the window, or by pressing the up/down arrow keys or PageUp and PageDn keys. To Print the data, select Print from the windows system menu. This allows one to check that the circuit connections are correct.

Running the analysis

The circuit to be analysed can either be entered directly or loaded from disk. At the start of Analysis a frequency input form will appear and you must complete at least the first three entries. You

Installing programmes from the ETI Cover disk.

In order to get all the programs onto this disk, it has been necessary to compress the files into self-extracting archives.

The programs are:

```
        16550PRG     -   Serial I/O test utility
        ACIRAN       -   A linear AC circuit
simulation program
        CACHETST     -   A PC cache memory test
utility
        PCUTILS      -   A collection of PC
diagnostic utilities
```

To unzip these to a hard drive we suggest the following:

Create a directory on the hard drive to hold the files
e.g. MD PCUTILS
Change to the directory created
e.g. CD PCUTILS
Place this disk in your floppy drive
Type the name of the self-extractor, including the path to the floppy drive
e.g. A:PCUTILS
The files will now be extracted to the current directory

Please note all the programmes on this disk are shareware, if you intend to use any one or more of them regularly then you must fill in the appropriate registration order form/s and send it to the address given on the form together with the requested registration fee.

can select Log or Linear sweep from the Config box, the default is Log. For the moment leave it as Log. Now enter the start frequency. Enter 100k and press <TAB>. Enter End frequency 100M (note capital 'M' for Megahertz). Finally, enter the number of frequency steps, 10 <cr>.

Leave the default number of passes as 1. Remember to press return or click OK once you are satisfied with the input data. If, however, you enter a number of Passes > 1 then ACIRAN will analyse your circuit that number of times, and on each pass it will vary the component values within the tolerance limits you specified for each component.

ACIRAN will now analyse your circuit from 100 kilohertz to 100 megahertz in 10 logarithmic steps. The Sweep mode selected will remain in force in future analysis unless you specifically change it. During Analysis the frequency sweep mode and range are displayed and a counter shows the percentage of the analysis completed. You can abort the run by pressing Escape or clicking on the Cancel button. In either case, you will get a message when the analysis is over. NOTE: Due to the numerically intensive nature of this program there may be a few seconds delay between the user aborting the run and ACIRAN recognising the abort message as it only checks the message queue once during each frequency pass.

Select Results to see a table of results. Only Gain, Phase and Time Delay are shown by default; to see impedance or return loss you must check the boxes in the Config dialog box. To print, select Print from system menu.

Close the Results window, or minimise it. Select Graph and choose Magnitude. If your printer has graphics capability you can obtain hard copies by selecting Print from the menu of the Graph Window use the mouse or press Alt + P.

For details on how to configure ACIRAN edit circuits and other aspects of using this programme, see the manual contained on the disk. This can be read by virtually any wordprocessor which can then be used to print it out. Also supplied on the disk are a number of examples of ACIRAN models. For further information on these, look at the documentation supplied on the disk or the printed version supplied to registered users.

ACIRAN for Windows Registration

ACIRAN is a shareware program and if you intend to use it regularly then there is a registration fee of £65.00. Registered users will receive the latest version of this program and a full printed manual. The software can be supplied on either 5.25" or 3.5" floppy disk and for shipping outside the U.K. there is an additional charge of £1.50 (Al payments MUST be in Pounds Sterling)

Please send your completed order form (there is a copy stored as a text file on the disk) to:
ACIRAN Software Systems, 29 Duncryne Place, Bishopbriggs, Glasgow, Scotland G64 2DP.

PC

This month's PC Clinic is devoted to a description of the useful range of shareware PC utilities which are included on the FREE cover disk included with this issue of ETI, utility programmes which will help you to track down some of the more common, as well as some of the more obscure, faults which PC users can encounter.

There are three files of utility programmes included on this disk; they are:

16550PRG	-	Serial I/O test utility
CACHETST	-	A PC cache memory test utility
PCUTILS	-	A collection of PC diagnostic utilities

16550PRG - Serial I/O test utility

16550 is a shareware program designed to allow the 'unlocking' of the internal FIFO buffer present in the UART chip of the same name. The program will scan all four COM ports (COM1: - COM4:) available on the PC and report the presence (if any) of the 16550 UART. The user may optionally set the various parameters necessary to utilise this buffered mode of operation.

Program operation

The 16550 UART initially powers up in a non-FIFO state. This makes the UART software-compatible with the 16450 and the older 8250. In most cases, the communications software doesn't know the difference. At least until the data comes in faster than the program can process it!

The 16550 program goes in and 'unlocks' the FIFO capabilities in the UART and, even in a buffered state, the 16550 still looks like the 16450 to older programs! If buffering occurs, then the data is held, and subsequently read out at a relaxed pace automatically, providing full compatibility with older software, yet giving the high-speed protection of a data buffer!

Program parameters

The 16550 automatically detects a 16550 UART and provides control for the COM port address, enabling and disabling of the FIFO, and the settings for a special interrupt based upon the number of characters being held in the FIFO buffer.

Executing the program without specifying any parameters results in a scan of all COM ports and reports the presence of a 16550 UART in each. If the user knows that a 16550 device exists, additional parameters may be specified to access the FIFO. These parameters are as follows:

COMn - Tells the 16550 program to use COM port n, where n indicates ports 1 through 4. Any value outside of this range results in an error. NOTE: A COM port MUST be specified when setting the UART!

? - Echoes a brief help text on the screen. No action is taken.

/f - Enables the 16550 internal buffers.

/r - Disables the 16550 internal buffers and resets the UART to the 8250/16450 compatibility mode.

/tn - Allows the adjustment of the FIFO-full interrupt. n specifies the number of characters allowed in the buffer before an interrupt occurs. The values for n are 1,4,8 and 14. NOTE: this is a very sensitive setting! For normal operation with old communications software, this parameter should not be used!

The program defaults to FIFO disabled, and a /t parameter of

Clinic

1. If the command line parameters are valid, the program will verify that a 16550 UART is present and that the parameters have been set. Unless another program that recognises a 16550 UART is executed, the UART should remain in the current state.

Registering

If you find that this program is useful and saves you some time and headaches, the author would appreciate a $5.00 (US) suggested donation. The author's address is: Brent Turner, P.O. Box 3612, Fullerton, CA, 92634-3612.

CACHETST
A PC cache memory test utility

This program is designed to help a user evaluate the impacts of a cache, or the changes to an existing cache, on a drive's performance. Furthermore, with users increasingly using caches during a variety of tasks, it is important to find the optimal cache settings given the task at hand. Whereas a word processor might make heavy usage of sequential files, a database might make heavy usage of random access files. With this in mind, the memory requirements, sectors cached, write delays and so forth have many possible variations.

By default, Cache Test creates a 10,000 record sequential file using 32 byte records and then a 10,000 record random access file that again uses 32 byte record lengths. Note, even if the default is changed, any sample string length will be increased by two bytes by the addition of a CR/LF. You may want to compensate accordingly if you wish to be exact in your measurements. The sample record size indicator displays the TRUE sample string size.

This program uses BIOS to do all of its reads and writes, so any hardware or software cache should be able to get some good "hits." In attempt to flush caches during the test, files are frequently opened and closed.

All of the times that this program writes are the result of subtracting the beginning time from the ending time. Nothing fancy, so the values are relatively accurate. Note, if you do some maths to compute access times per record, you will run into the age-old problem of significant digits. This program only accounts for one decimal location (0.1). As such, if you try to take the timings out to 1/100th of a second, the resulting error factor can be quite high.

Remember, if an outcome is in doubt, use a larger sample size! That is to say, increase the number of bytes that are written to the disk. The other alternative is to increase the number of sample passes. You'll notice that results begin to stabilise with file sizes of 5000 records, 32 bytes, and 5 passes.

This program is released as shareware. Its price is $5 for each concurrently used copy. The author's address is: George Spafford, 3001 LakeShore Drive, #329 St. Joseph, MI 49085.

Data: (616) 468-5026 Queued Access BBS 14.4Kb USR Dual HST
FIDOnet: 1:2340/0 NEC/NC Site.
Sysop: Tim Akright

PCUTILS - PC Hardware Utilities

There are 25 of these PC hardware related utilities; they are as follows:

AT_CLOCK.ZIP	Corrects for AT CMOS clock time slippage
AT_SETUP.INF	Information on the AT 'SETUP' utility
AT_SLOW.ZIP	Slow ATs down to 4.77 for games and such
AT_SLOW3.ZIP	Use high-res timer to slow down 80286/80386
ATCLOK.ZIP	Use hardware clock instead of DOS for time/date
ATDRTABL.ZIP	Displays AT hard disk drive table
ATFMT.ASM	Disk format program for AT (MASM source)
ATIM.ZIP	Precision program timing for AT
ATNUDG2.ZIP	Nudge AT realtime clock daily to correct time
ATROMUTL.ZIP	AT ROM BIOS and hard disk table utilities
CMOS14.ZIP	CMOS v1.4: Saves/restores CMOS to/from file
CMOSER11.ZIP	386/286 enhanced CMOS setup program
CMOSRAM.ZIP	Save AT/386/486 CMOS data to file and restore
HTMU.ZIP	Read/modify AT ROM drv types to burn new EPROM
KBDR.ZIP	Swaps control & cap lock keys on IBM AT & PS/2
KBMAP.ASM	Remap AT keyboard keys
KEYBOARD.ZIP	Kbd*.com, utilities to re-map selected keys on
ROM2.ZIP	Save AT and 386 CMOS data to file and restore
SETTD.C	Set DOS time/date from realtime clock
SETUP21.ZIP	Setup program which modifies CMOS RAM
SPEEDKEY.ZIP	Resident program to speed keyboard input
SWPKEYAT.ZIP	Swap escape and tilde keys on AT keyboard
TAD.ZIP	Set AT real-time-clock from DOS date & time
VIEWCMOS.ZIP	Display contents of AT CMOS RAM, w/C source
XKB.ZIP	Set AT keyboard repeat rate & delay, w/C source

Note that some of these utilities will only work on 286 systems. Others will only work on 386/486 based systems. A lot of these utilities are related to the CMOS RAM, and they will be of particular use in diagnosing problems with older systems.

To use any of the above diagnostic routines you will first of all have to un-zip them using the version of PKUNZIP included on the disk

IMPORTANT NOTICE: All the software included on the ETI cover disk is distributed as is, with no warranty. The authors have made reasonable attempts to ascertain their performance but cannot guarantee that they will work in every instance. Neither the authors, Electronics Today International or anyone associated with ETI are responsible for any damages or loss of data resulting from the use of this program.

The shareware version of these programs may be freely distributed as long as all files are included in the package. The registered version may not be copied or duplicated.

SMART MAINS CONTROL SYSTEM

Part two of Dr Pei An's SMART mains control system which allows a computer to control up to 93 different mains devices using signals actually transmitted through the mains power cable

Last month we looked at the principles employed in the design of this system which allows up to 93 individual mains switches to be controlled by a personal computer. We showed how the system can be described as 'smart' because the mains switches are not controlled by any control wires connected directly to the computer.

The control commands which tell the mains switches to turn on or off are generated by a computer-based controller and transmitted through the existing mains lines in a building. The switches detect the message and carry out corresponding actions. The schematic of the system is shown in Figure 1.

This system has a huge advantage over the conventional system. In the conventional system, each mains switch has to be controlled by separate wires for controlling the on and off of the switches. This requires investment as well as effort to install the wiring in the building. Once the wiring is installed, the switches cannot be moved freely. However, the SMART mains control sytem solves all these problems

Construction

The controller and switches are constructed on single-sided print circuit boards. The full size copper foil pattern is given at the end of the magazine and component layout are shown in Figures 3 and 4.

Before soldering the components on the board, check the PC board for unwanted links or cuts on the copper tracks. Small components should be mounted on the board before the larger components. The mains transformer T2 for the controller is not mounted on the board at this stage. Instead, two wires are soldered at the points of secondary outputs of the transformer (as shown in Figures 3 and 4). This is for testing the controller and the switches with low voltages. When mounting the bridge rectifier, the electrolytic capacitors, the 7805 5V regulator and the transient voltage protection diode D1, care must be taken on the polarity. Refer to Figure 11 for details on the tank coil T1. The former has six pins, arranged with three on each side. Pins 5 and 6 are LIVE connectors to the mains and are on the same side as the A042 stamp on the body. If in doubt where these pins are, check for continuity with a multimeter. Insert T1 into the PCB with Pins 4, 5 and 6 close to C1 and C2 position. This component must be fitted correctly. It is suggested that IC sockets are used for all the ICs. The controller and the switches are finally placed in proper plastic boxes. Suggested arrangements for the controller and the switch are given in Figures 6 and 7. The mains cables protruding through the wall of the boxes must be fastened by proper cable glands (see Figures 6 and 7). The mains cable for the controller should be for 5A rating or higher and the mains plugs for the controller must be fitted with a 5A fuse. The switches are designed for controlling a mains appliance up to 5A (1200 W). Therefore, a 5A mains cable or higher should be used and the mains plug and the socket of the switches should be fitted with 5A fuses. It is good practice to stick some safety labels on the controller box and the switches. The labels should warn people that the devices are connected to the 240V mains and the maximum rating is 5A. If you use the devices in other mains wiring configurations, please make sure that your mains connections meet the standard of electrical connections.

Testing

CAUTION

It must be pointed out the this mains control system is connected directly to 240V AC and therefore danger exists to the constructors. Physical contact with the mains can be lethal and every precaution must be taken to prevent this from happening. If constructors have any doubts, please ask advice from competent electricians.

After soldering, a careful inspection must be conducted to check all the soldering joints to make sure there are no shorts, especially in the area where 240V AC is present (The high voltage area on the PCB board is marked by a dotted box in Figures 3 and 4). Testing of the controller and the switch are slightly different. Firstly the testing procedures of the controller are described. Testing is performed in four stages:

Stage 1: Testing the power supplies

When testing the controller the first time, an external 12V AC or 17V DC is used to power the board via the two wires soldered to the secondary outputs of the transformer (see Figures 3 and 4). After the final checking, the Centronic connector can be connected to the computer using the printer lead and power can be connected to the controller. The first step of testing is to measure the voltage of the power supply at various points of the circuit. The voltage at the positive output of the bridge rectifier is measured first, which should be

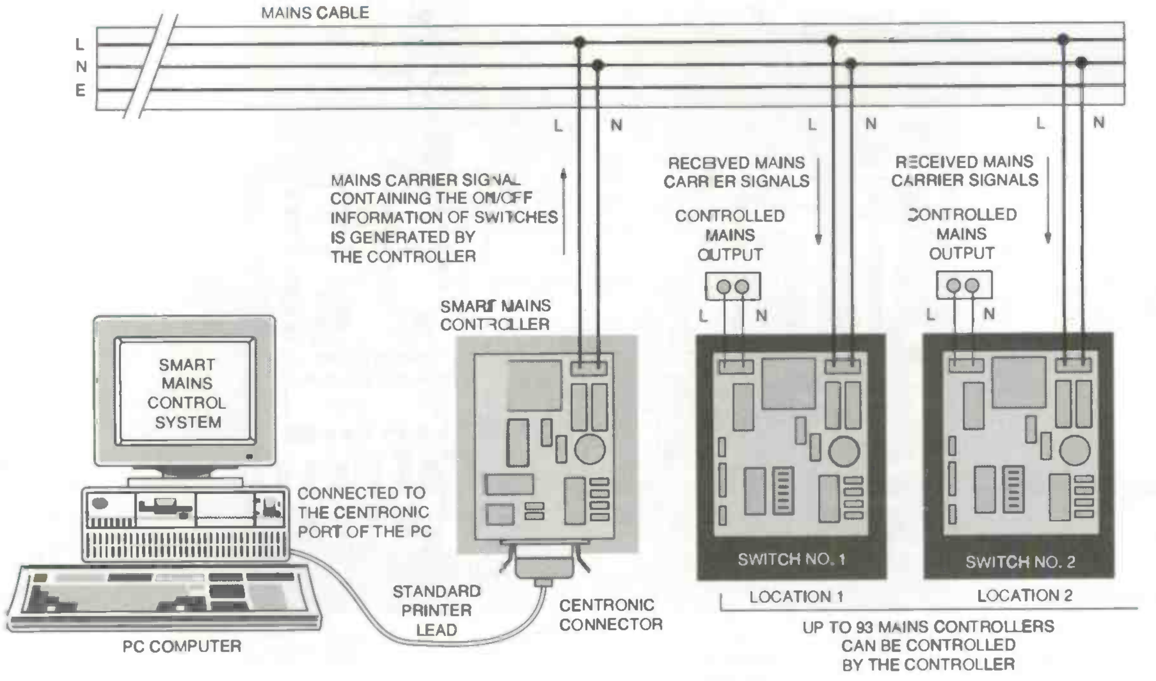


Fig. 1 Smart mains controller block diagram

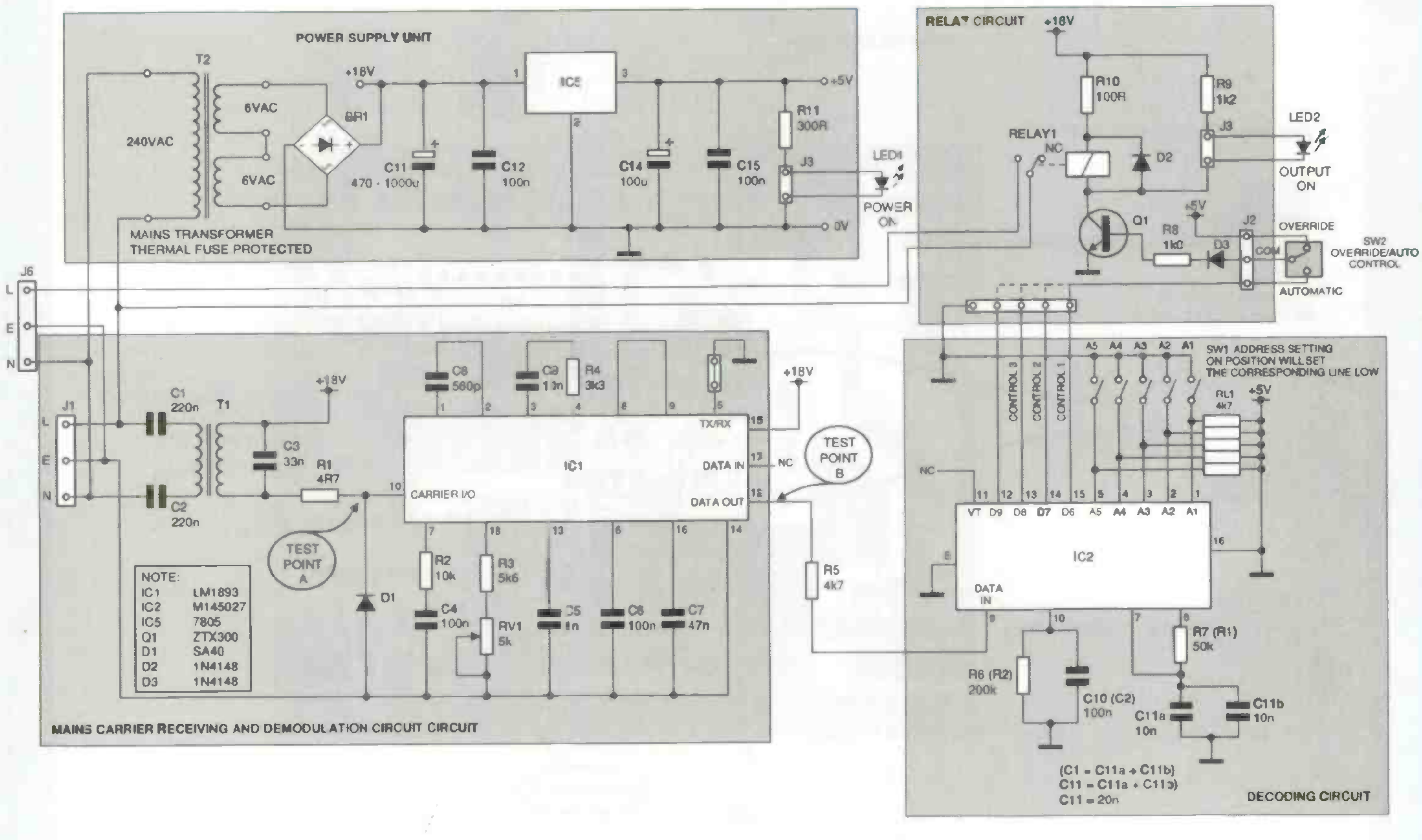


Fig. 2 Smart mains controller circuit diagram

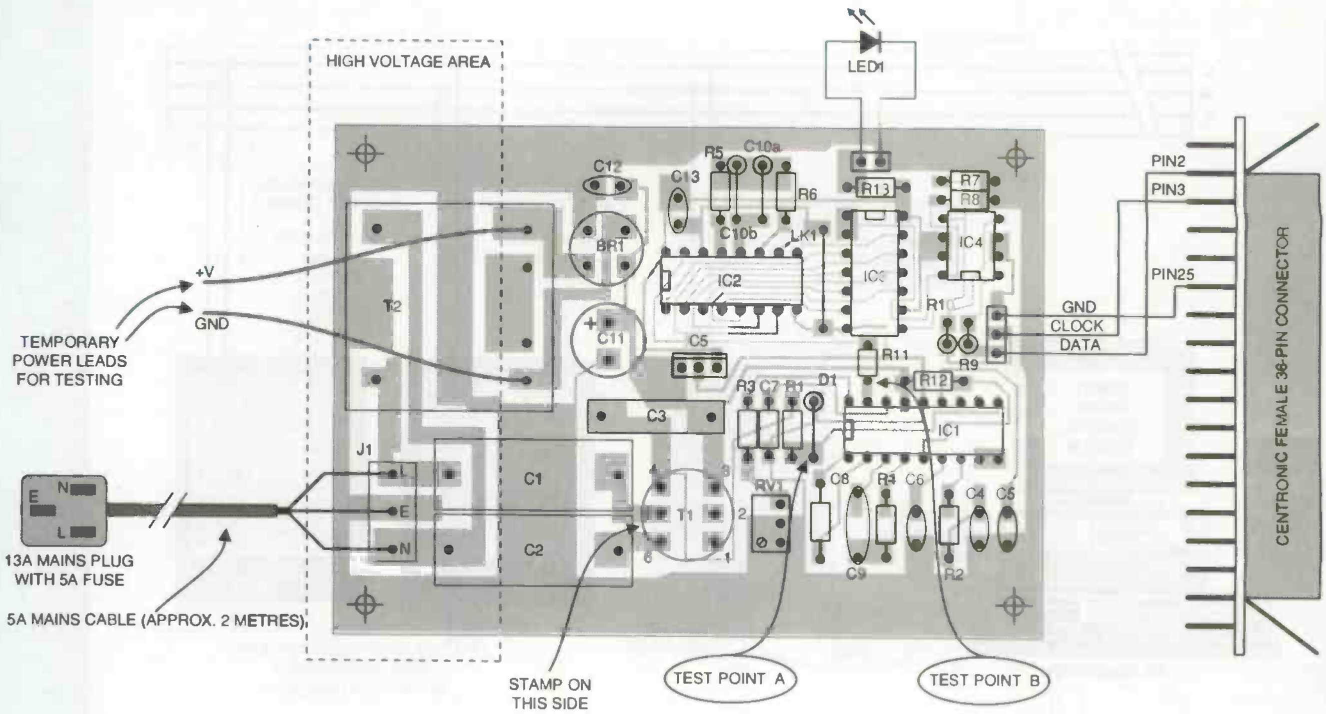


Fig. 3 Controller unit PCB overlay

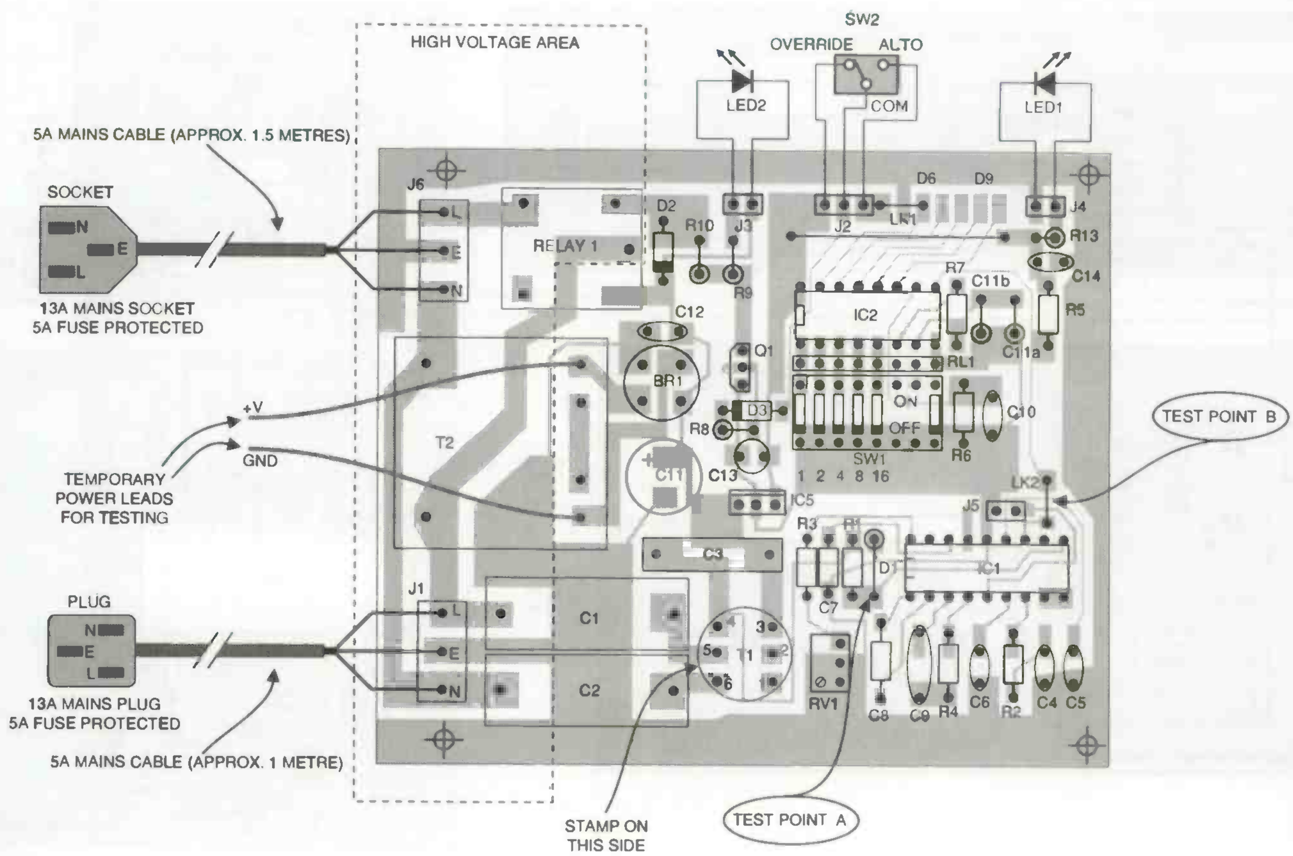


Fig. 4 Switch unit PCB overlay

consistent with the input power supply voltage. The voltage at Pin 15 of IC should be the same as the voltage measured above. The voltages at Pin 16 of the encoder IC and Pin 14 of 74LS164 should be +5V.

Stage 2: Testing opto-isolator and encoder circuits

Run the sample program and load a data into the shift register. Then use a logic probe or a voltmeter to measure the voltage level of the outputs of the shift register. This should be consistent with the data sent out from the computer. Next, use an oscilloscope to see the waveform of the encoded signal output from the encoder IC and the signal input to the mains carrier IC (Test Point B). The waveform should reconcile with the encoding format as explained above. The above testing requires no adjustment at all. If all the components are OK and properly located in position, the circuit should work straight away.

Stage 3: Preliminary testing of the mains carrier circuit

Testing of the mains carrier circuit is the major task and involves some minor adjustments. Firstly, turn the slug in T1 anticlockwise until it levels with the top of the can. Connect the oscilloscope to the Carrier I/O (Test Point A, Pin 10 of IC1). By adjusting the TIME knob of the oscilloscope, an oscillogram showing two sinusoid waves should appear on the CRT (see Figure 8a). If not, adjust RV1 clockwise or anti-clockwise. These two sine waves are slightly different in wavelength and in amplitude. The wave with a longer wavelength (lower frequency) is the carrier frequency representing logic 1; the wave with a shorter wavelength (higher frequency) is the one representing logic low. With a trimming tool, adjust RV1 for the longer wavelengths of the sine waves to be about 8.1 uS (corresponding to 123 KHz). The other sine wave will automatically have a wavelength of 7.9 uS.

Stage 4: Final testing

The two temporary wires on the PCB board can be removed, the mains transformer is mounted on the board and the mains lead is connected to the terminal J1. During the final testing, the controller is connected to the mains supply. Therefore it is suggested that the circuit board should be properly mounted inside the plastic case. This will prevent the operator from accidentally touching the active area of the PCB board. However, caution must be taken in the final testing stage.

Plug the controller into a mains socket and use the oscilloscope to see the waveform of the test point A. The oscellograph observed in the above stage should appear on the CRT. Now use a trimming tool to screw down the slug in T1 slowly and observe the oscellograph on the CRT. The amplitudes of the two sine waves both change. Adjust until the two sine waves have the same amplitude and both reach the maximum. This procedure is illustrated in Figures 8(c) and 8(d). The SMART controller now is ready to operate.

Stage 1: Testing power supplies

When testing the switch the first time, an external 12V AC or 17V DC is used to power the board via the two wires soldered to the secondary outputs of the transformer. After a final checking of the circuit board, power can be connected to the controller. The first step of testing is to measure the voltage of the power supply at various points of the circuit. The voltage at the positive output of the bridge rectifier is measured first, which should be consistent with the input power supply voltage. The voltage at Pin 15 of IC1 should be the same voltage as measured above. Next the voltages at Pin 16 of the decoder is checked, which should be +5V.

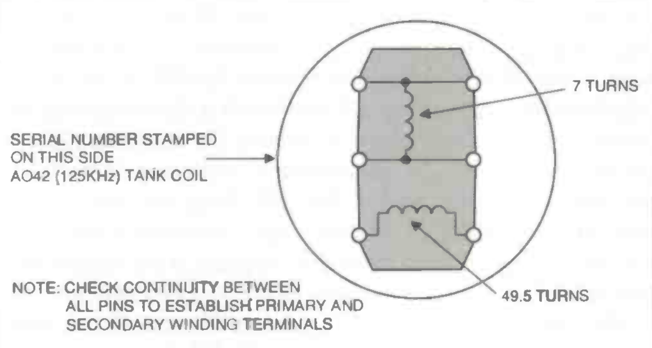


Fig. 5 Pin out of tank coil viewed from below

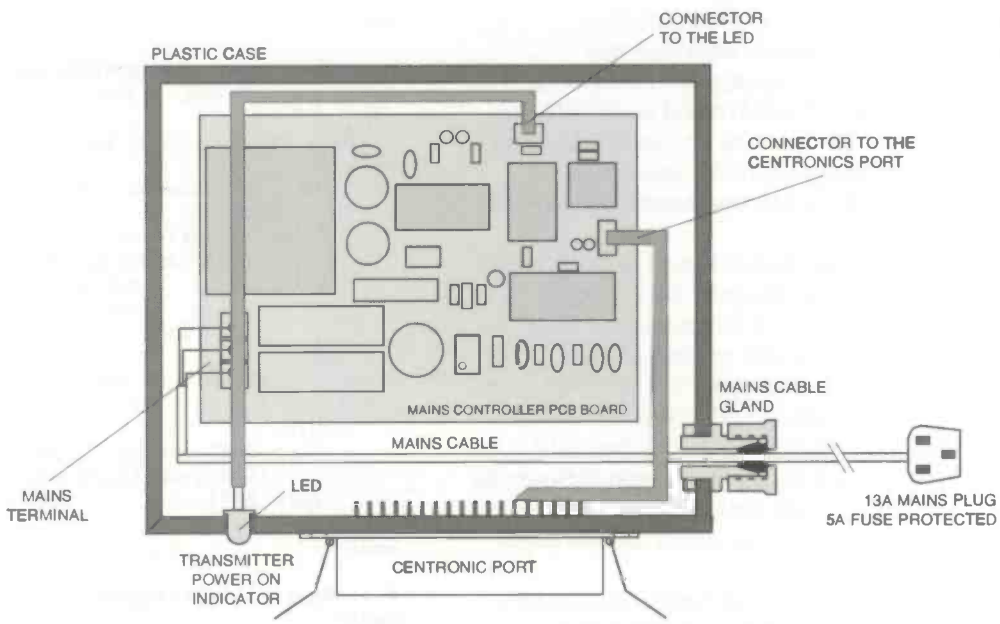


Fig. 6 Controller wiring

Stage 2: Testing the relay circuit

By connecting the COM of J2 to the OVERRIDE, the relay should be energised and LED2 should be on. If this works, it means that the relay circuit is working fine.

Stage 3: Testing the mains carrier circuit

Leaving the jumper J5 unconnected will set the mains carrier IC to the transmit mode. This is used to align the central frequency of the switch to the controller. The procedure is identical to that described in the testing Stage 3 of the controller.

Stage 4: Final testing of the switches

After the alignment, the mains transformer can be mounted on the PCB board and the mains leads are connected to the controller board for the final testing. During the final testing the switch will be connected to the mains lines. Therefore, it is suggested that the circuit board should be properly mounted inside the plastic case.

Plug the SMART controller into the mains socket and run the sample program. (When running the program, input the address to be 1 or above.) Set the address of the SMART switch (SW1) to the same number and connect J5 using a jumper. Plug the SMART switch into another mains socket and use the oscilloscope to observe the waveform at Test Point A. By adjusting the control knobs of the oscilloscope, the received mains carrier signal can be observed. Screw down the slug in T1 carefully until the maximum carrier signal is reached. Now connect the oscilloscope to the Test Point B on the circuit board which is the output of the mains carrier IC. A waveform of serial digital data should be observed on the CRT. If not, re-adjust the RV1 again. If the oscilloscope is a dual-trace one, the waveform of the output of the encoder in the controller and the waveform of the input to the decoder IC in the switch can be displayed at the same time on the CRT. These two waveforms should be exactly the same! If the relay is switched to the automatic mode, we can also hear the clicks of the relay when energised and released. The ON/OFF LED (LED2) will flash.

After the testing, the switch is ready to operate. Plug a table lamp into the mains socket on the switch; the lamp is now fully controlled by the computer.

Programming the controller

The controller is able to interface with any I/O cards of computers, provided that the cards at least have two independent outputs. The current application utilises PC's Centronic ports (printer ports). The DATA and the CONTROL lines are connected to the DB 0 and DB 1 of the DATA port of the Centronic port, respectively. On the 36-way female Centronic-type connector, those two lines correspond to Pin 2 and Pin 3 of the connector.

It is useful to give a brief introduction to the Centronic port at this point. The port originally was designed for connecting printers to the computer. However, it can be used for much wider applications. The Centronic port consists of three separate I/O ports, namely, the DATA port, the CONTROL port and the STATUS port. The DATA and CONTROL ports are output ports. The STATUS port is an input port. The DATA port transfers the actual data during the communication between the computer and the external devices; the CONTROL port is a handshake port by which the computer issues controls to the external devices; the STATUS is another handshake port from which the computer reads the information issued by the devices. A PC can support up to 3 Centronic ports which are labelled LPT1, LPT2 and LPT3. For the purpose of explaining how to control the Centronic port, let us consider LPT1. The I/O addresses of the DATA, CONTROL and STATUS are 888, 890, 889 decimal, respectively. To send data to the DATA port of the LPT1, the follow commands can be used:

```
In Turbo Pascal:  PORT[888]:=X
In BASIC:         OUT 888, X
```

In which x is the decimal value of the data to be sent. To read data from the STATUS port the following commands can be used:

```
In Turbo Pascal:  Y:=PORT[889]
In BASIC:         Y=INP(889)
```

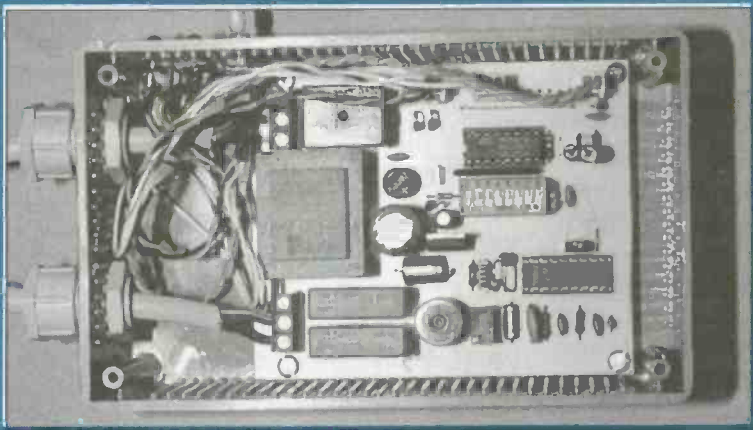
In which y is the decimal value of the data received.

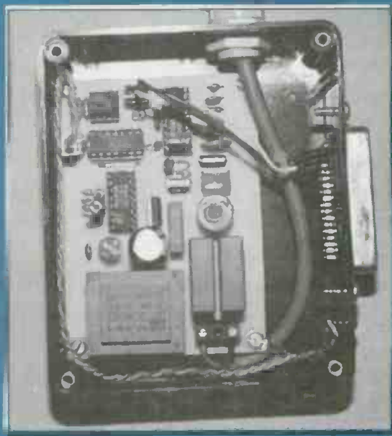
The control software for the SMART controller is described below: Firstly the 8-bit data which contains the 5-bit (D0 to D4) address and 3-bit (D5 to D7) control lines is chopped into bit form. Then the MSB of the data is sent to DB0 of the DATA port. Next, a low-to-high-then-low pulse is issued by the DB1 of the DATA port. This will latch the bit to the shift register. The above procedure is repeated seven times to send the rest of the data bits to the shift register.

A sample program written in Turbo Pascal 6 is listed below. When running the program, it first asks users to input the address of the switch to be controlled and then the time period of OFF and ON of the switch. After this, the program will make the selected switch to switch on and off according the specified time periods.

List of the SMART MAINS CONTROLLER control program

```
program smart_controller;
uses
   dos,crt;
var
   address,i,j,swaddress:integer;
   weight:array[1..12] of integer;
   delaytime,lighttime:real;

Procedure bit_weight;
begin
     weight[1]:=1;
     for i:=2 to 12 do weight[i]:=weight[i
                                           1]*2;
end;

Procedure send_address(address:integer);
{send the address to the 74LS164 shift register}
var
   sw:array[1..12] of byte;
begin
     for i:=12 downto 1 do
         begin
              sw[i]:=0;
              if address>=weight[i] then begin
                    address:=addressweight[i];
                    sw[i]:=1;
                end;
     end;
{load sw values into the 164 registers}
for i:=12 downto 1 do
    begin
      port[888]:=sw[i];    delay(1);
      port[888]:=sw[i]+2;  delay(1);
      port[888]:=0;        delay(1);
    end;
end;

Procedure intialization;
begin
     clrscr;
     writeln('SMART MAINS CONTROL');
```





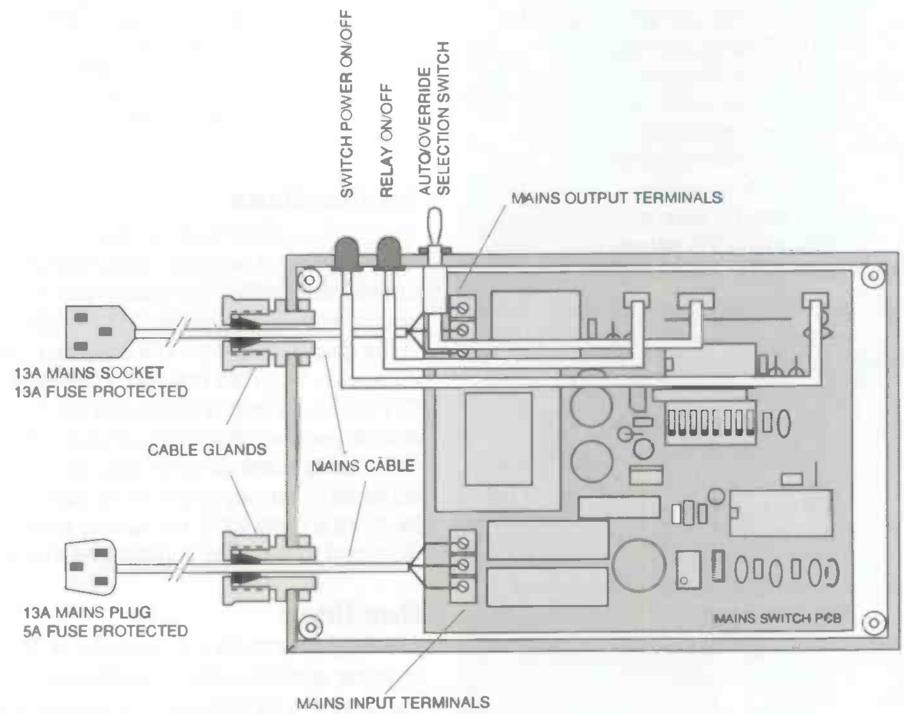
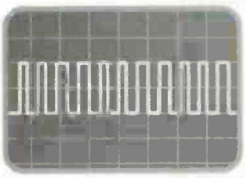
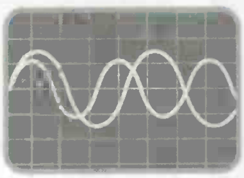


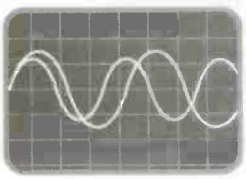
Fig. 7 Switch unit wiring



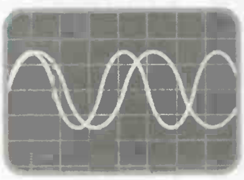
(a) The waveforms of the encoded data (Test Point B)



(c) The amplitudes of the two sin waves differ. Tank coil needs adjustment



(b) The waveforms of the modulated mains carrier signal (Test Point A)



(d) Adjust the tank coil for the ampitudes of the sin waves to be the same

Fig. 8 Test waveforms

PARTS LIST

SMART MAINS CONTROLLER (TRANSMITTER)

Resistors
(All resistors are 0.25W, 1% metal film resistors)

- R1 4R7
- R2 10K
- R3 5K6
- R4 3K3
- R5 50K
- R6 100K
- R7,R8 1K0
- R9,R10 100R
- R11,R12 4K7
- R13 390R
- RV1 Vertical 18-turn enclosed cermet, 5K

Capacitors

- C1,C2 IS CAP 220nF, 250V AC
- C3 IS CAP 33nF, 250V AC
- C4,C6,C12 100nF/50V ceramic
- C5 1nF/50V ceramic
- C7 47nF/50V polylayer
- C8 560pF/50V 1% polysty
- C9 10nF/50V ceramic
- C10a 4n7/50V 1% polysty
- C10b 330pF/50V 1% polysty
- C11 470uF/25V electrolytic

Semiconductors

- IC1 LM1893N mains carrier transceiver IC (UF50E)
- IC2 M145026 encoder IC (UJ49D)
- IC3 74LS164 8-bit shift register
- IC4 ILD74 dual opto-isolator IC (YY62S)
- IC5 7805 +5V voltage regulator
- D1 Zener SA40A (QY71N)
- LED1 5mm red LED
- BR1 1A bridge rectifier

Others

- J1 3 way PCB terminal block
- J2 3 way PCB connector set
- J3 2 way PCB connector set
- T1 Thermally protected mains transformer, 240V primary, 2 6V AC secondary (RS 196-741)
- T2 Tank coil, AO42YUK (FT56K)
- PCB PCB board for the controller
  Spacers PCB spacer sets for the PCB board (4 off)
- LKs Links on the PCB board, 0.6 mm diameter tinned copper wire
- IC sockets Various IC sockets for the ICs
- Cable gland

Optional

- J4 Centronic 36-Pin female connector
- Mains cable 5A mains cable (2 meters)
- Mains plug 5A fused mains plug
- Box Box for the controller (120 mm * 100 mm * 40 mm)

Note that the code numbers in the brackets are the stock numbers in Maplin Electronics catalogue, or otherwise stated in other catalogues.

```
     writeln('SMART MAINS CONTROL');
     write('Input the address of the SMART
switch: '); readln(swaddress);
     write('Input the delay period (second):
'); readln(delaytime);
     write('Input the light on period
(second):    '); readln(lighttime);
end;
```

Main Program

```
begin
     intialization;
     bit_weight;
     repeat
     send_address(swaddress+32); {place the
               chopped bit on DATA line, DB0 of
                    the DATA port}
     delay(round(lighttime*1000)); {CLOCK
               line, DB1 of the DATA port is made
                    high}
     send_address(swaddress+0); {Clock Line,
               DB1 of the DATA port is made low
                    again}
     delay(round(delaytime*1000));
     until keypressed;
end.
```

Applications

The present system can control up to 93 switches with each having a unique address. Switches set at the same address will operate identically. The system can be used in numerous applications. For example, lights in different rooms of a house, in the garage and even in the garden can be controlled by a computer. You may develop a software to control the ON and OFF of the lights at a touch of a key in your bedroom. You may also develop a software to program these lights to go ON and OFF during evenings when you are not at home. There are some other novelty applications associated with light decoration (such as a party light) and energy saving systems. I will be delighted to hear any suggestions from readers.

Buy lines

The PCB boards for the controller and switches are available together with the software written on 3.5 floppy diskette, from the author. A kit consisting of one controller and one switch is available from the author at a price of £75 including P&P. The assembled and test system is also available from the author. Please phone or fax the author on 061-272-8279 for information on any of the above The tank coil, the mains carrier IC and D1 are available from Maplin Electronics. Their stock numbers are shown in the Parts List .

AMSTRAD PCW 8256/512

8 Bit Input and Output Port

For readers using the Amstrad PCW 8256/512 computer, Jason Sharp has designed a simple eight bit I/O port which will allow experimenters to use this venerable computer system to control a wide range of devices

Using a computer to control devices in the real world is probably one of the most interesting aspects of computing. This can easily be achieved by using a parallel I/O port. The project presented here is a simple I/O port, with 8 binary inputs and 8 binary outputs.

Ins and Outs of the PCW

At the heart of the PCW is the popular Z80 processor. Connections to most of its pins are available via the 50 way edge connector at the rear of the machine. The pin assignments are shown in fig.1.

The Z80 has separate I/O and memory address spaces. When the Z80 is required to access I/O locations the /IOREQ line is taken low. When accessing a memory location /MEMRQ is taken low.

/WR is taken low to show the processor wishes to write to a port or memory. /RD is taken low when a read is being performed.

The Z80 can address 65,536 ports. Normally only ports 0 to 255 are used. Some of these ports are used internally by the PCW, as shown in fig.2. If we wish to add an I/O device we must select a port that is not used. Port 160 (A0 for those who prefer hexl) was chosen for this project.

Circuit Description

The circuit diagram for the I/O port is shown in fig.3

When the Z80 wants to access port 160, address lines A0 to A7 will hold 10100000 (binary). /IOREQ will also be low. IC1 is an 8 bit comparitor. When these conditions are met, the output (pin 19) goes low.

When a location is written to, the data only remains on the bus for a fraction of a second. IC3 is an octal D-type latch. When /WR and pin 19 of IC1 both go low, the output of the NOR gate, IC1a, also goes high. The rising edge of this signal causes the data to be latched to the outputs.

A tri-state buffer is used to isolate the inputs from the data bus. When the port is to be read the output of IC2c goes low. This allows the states of the inputs onto the data bus to be read by the processor. IC4 is a bi-directional buffer, wired to work in only one direction. It was used instead of a one way device as it has a bus structured pin out, simplifying and producing a neater circuit board design.

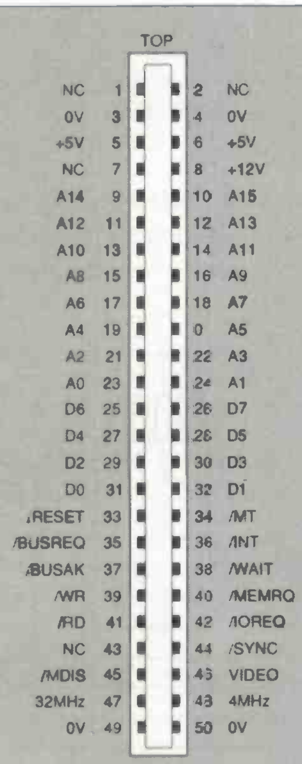


Fig.1. PCW edge connector

PORT	USAGE
0 - 127	DISC CONTROLLER
128 - 223	UNUSED
224 - 231	RESERVED
232 - 239	UNUSED
240 - 243	BANK SWITCHING
244	INTERRUPT COUNTER
245 - 246	SETS ROLLER RAM ADDRESS
247	SCREEN CONTROL
248	PRINTER CONTROL
252 - 253	PRINTER CONTROL
254 - 255	PROBABLY UNUSED

Fig.2. Port assignment data

Construction

Construction of the circuit is quite straightforward if the PCB shown in fig.4 is used. Take care not to bridge any tracks when soldering, as some are quite close. Start with the low profile components and finish with the taller components. When finished, check the board for solder bridges, etc. The 74HC devices are CMOS so take the appropriate precautions when handling them.

The I/O board can be connected to the PCW using a piece of 50 way ribbon cable. This should be terminated at one end with a 50 way IDC edge connector, and with a 50 way IDC connector at the other. The cable should be less than 50cm long or ringing may cause erratic behaviour.

Testing and Use

Plug the unit into the PCW and switch on. If the computer fails to boot or anything unusual happens, unplug the circuit and check for shorts, etc. When the computer is loaded with CP/M, run BASIC and type in listing 1.

Fig.4 shows a suitable test circuit. When used with Listing 1, switching the switches will cause the corresponding LED to be switched on or off (an expensive light switch!). Listing 2 should produce a 'bouncing light' display.

Data is output from BASIC using OUT 160,(value). Data is input using INP(160), eg. A=INP(160).

Applications

So what can this device be used for apart from producing a bouncing light? It can be used to drive relays, motors, indicators, sense light levels or temperatures and much more. Below are some circuit ideas.

Note that the PCW's internal power supply is used to power the interface. The Amstrad technical manual does not state the current rating of this supply. Therefore an external 5v power supply should be used to power external devices (especially motors and relays). This can be done by connecting the 0V output of the PCW to the 0V output of the external power supply.

If switches are to be connected to the input they may need debouncing. The circuit shown in fig 5.a will perform this task. To save on hardware costs, switches can be de-bounced using software. Read the input twice (a delay will be required between each reading if writing in Assembler). Compare the two inputs. If they are different, the switch may be bouncing. Keep reading the input until the two values are the same. If looking for very quick activations from BASIC, the de-bounce circuit is recommended.

Individual bits of the input can be checked by ANDing the value read from the input with the bit you wish to check. For example, if you want to see if bit 3 is set AND the input with 4 (i.e.. 00000100 binary). The result will be zero if that input is low. Otherwise it will be 4.

Inputs and outputs can be isolated from other circuitry by using opto couplers. Fig 5b shows the basic set-up. The exact values required will depend on the application and type of opto-coupler used.

Fig.6 shows a simple motor driver with direction control. Using this circuit a 'buggy' could be built. The more

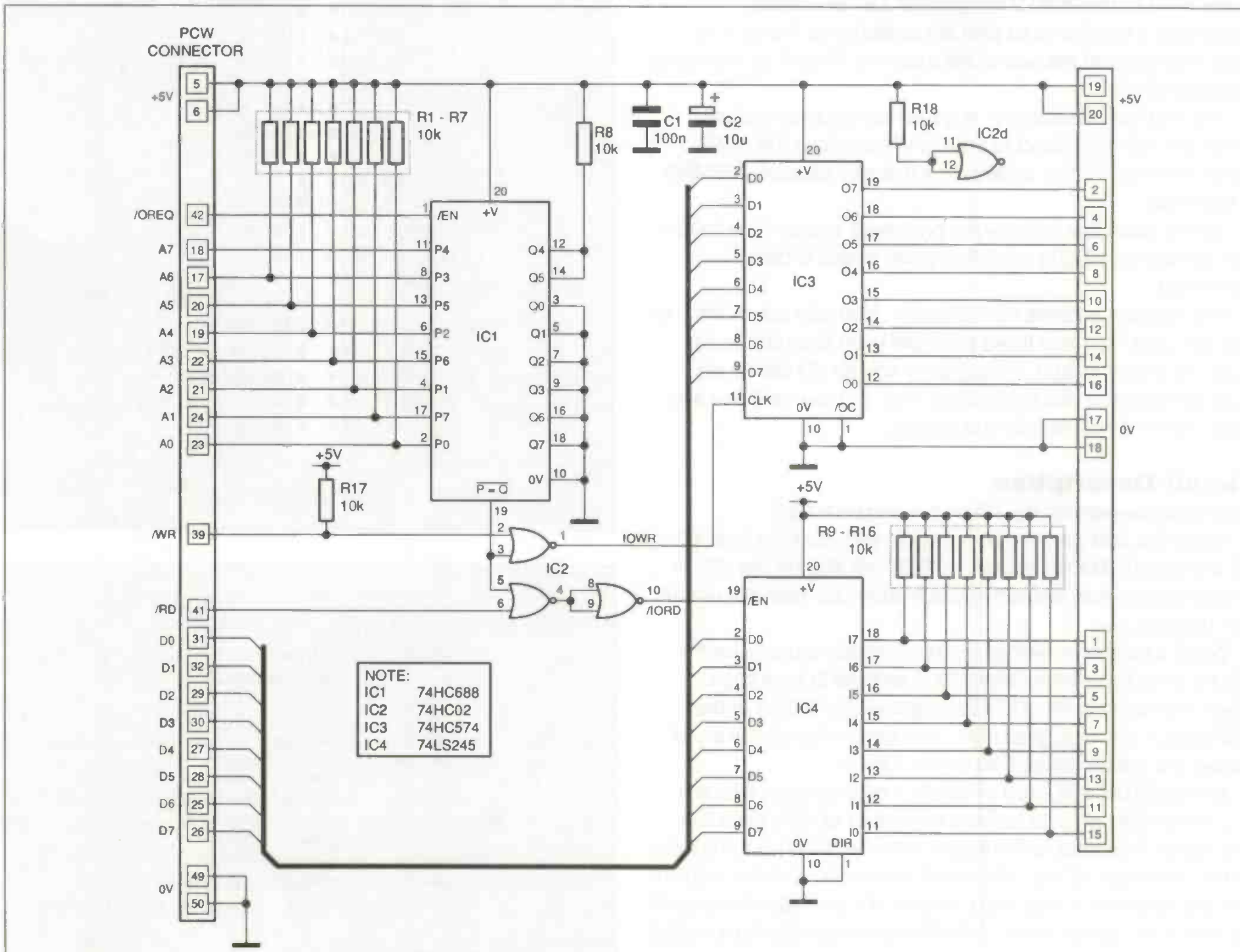


Fig.3. Eight bit input and output port circuit diagram

PARTS LIST

Resistors	
● R1-R18	10K
Capacitors	
● C1	0.1uF decoupling
● C2	10uF 16V Tantalum
Semiconductors	
● IC1	74HC688
● IC2	74HC02
● IC3	74HC574
● IC4	74LS245

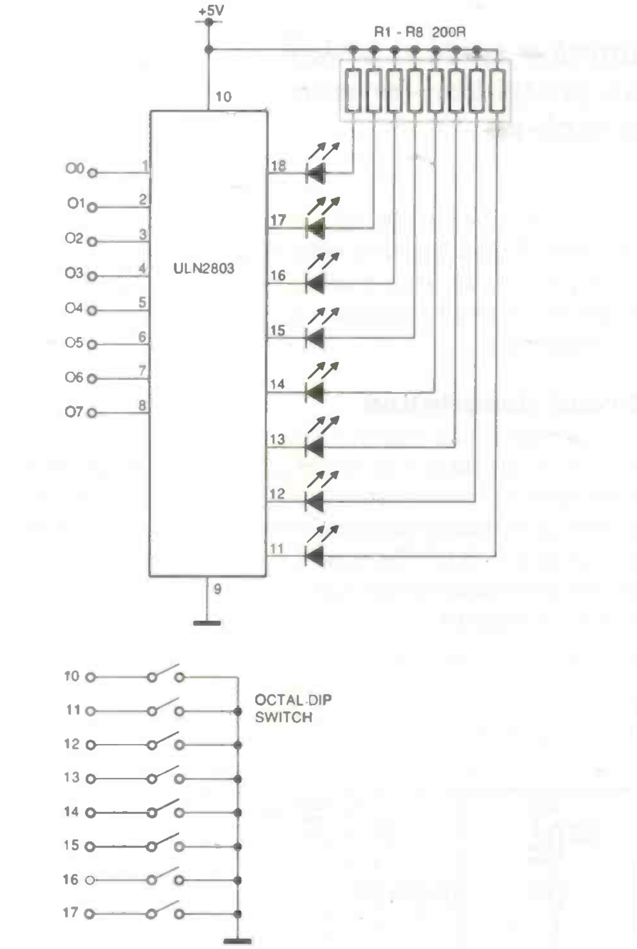


Fig.4. Test circuit

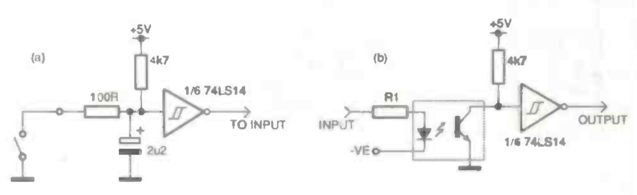


Fig.5. Debounce circuits

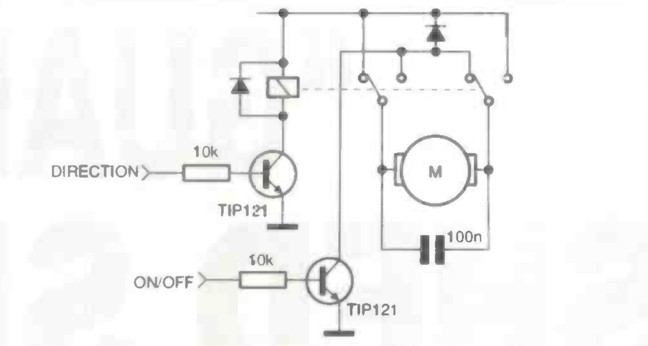


Fig.6. Motor control circuit

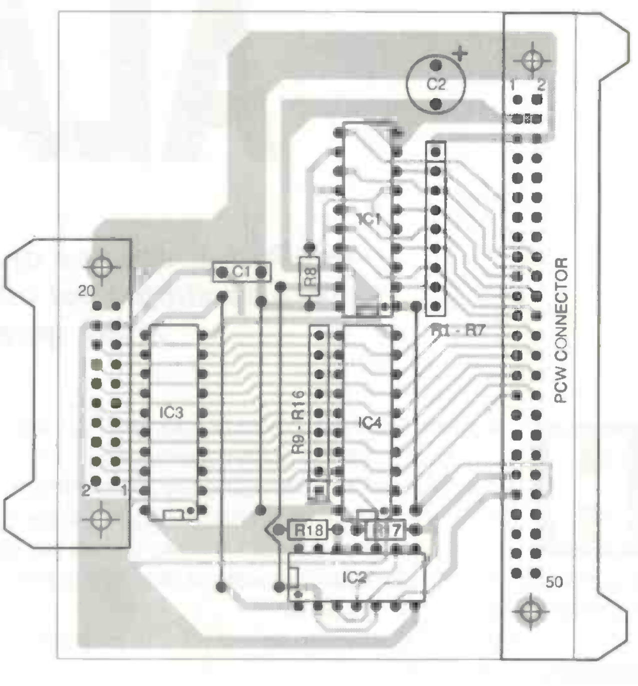


Fig.7. PCB component overlay

sophisticated technical LEGO has small motors. Sometimes opto-encoder discs are included. These can be used to sense if the motor is moving or if it has stalled. A solenoid and pen could be added for drawing. Microswitches could be fitted to enable collision detection. The buggy could be used as an educational aid. The I/O port can be accessed from DR LOGO using the following commands,

.out 160 value

and

.in 160

Using with other Z-80 based systems

Although originally designed for the Amstrad PCW, this project can be easily connected to most Z-80 based systems. Just connect the data, address, and signal lines of the board to the appropriate pins on the target system. The board is accessed by reading and writing to port 160. If several boards are required, they can be mapped to different ports by changing the states of the 'Qn' pins (see circuit diagram). The board is enabled when each Q pin is at the same logic level as its corresponding P pin (i.e.. Q1=P1,Q2=p2,...,Q7=P7). For example, to map the board to port 161, Q7 (IC1 pin 18) must be tied high.

"GUARDEN" SHED SECURITY ALARM

Tim Parker offers a multi-function system which provides simple yet effective protection for your shed, garage or lock-up

How much are the contents of your shed, garage or lock-up worth? Chances are it's quite a lot when you add it all up, especially if it got stolen and you realise the cost of replacing it at today's prices. Most crimes of this sort are carried out by opportunists and it could be only a matter of time before the "it'll never happen to me" happens!

This security alarm should help safeguard your property from being the next in line.

One thing should be made quite clear; burglar alarms do not prevent break-ins but they can help to deter the culprit from attacking what might otherwise be easy pickings by sounding a loud alarm, not only to disorientate and warn off the attacker but also to draw the attention of possible passers-by.

It has a built-in exit buzzer, fault indication and the ability to detect shock vibration, torch beam illumination and door or window movement, each of which may either be adjusted or disabled if any of the particular functions aren't required for your purposes.

Circuit description

The complete circuit diagram for the shed alarm is shown in Figure 1. As simple as it is, the versatility of the design offers a multitude of selectable features, only one of which must be decided upon during construction - and that's only whether or not you want to fit C7! Because there's a certain amount of interaction between various parts of the circuit, it is best to explain it in sections.

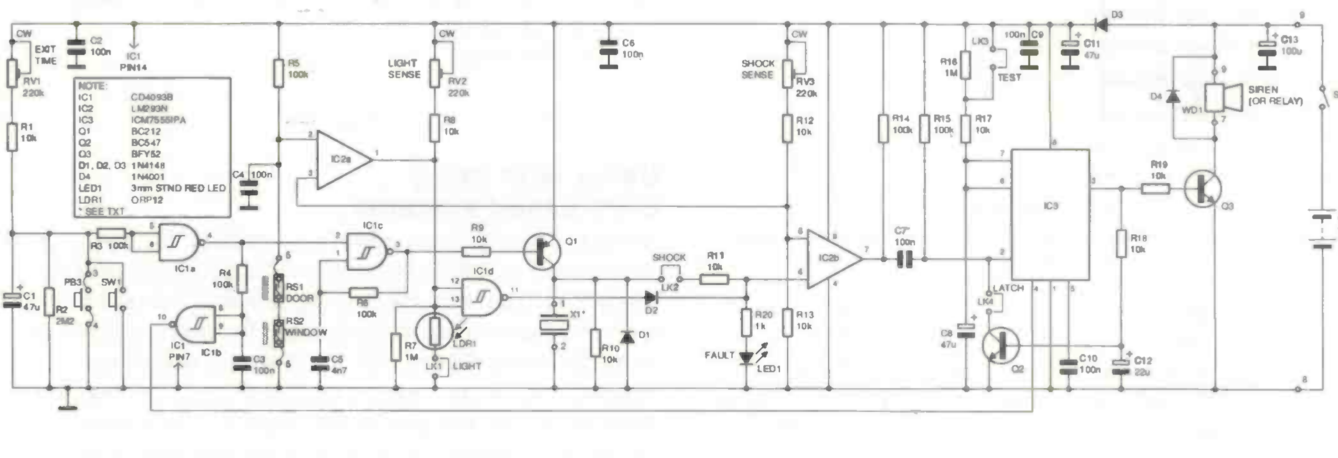


Fig.1. Circuit diagram for 'Guarden' shed alarm.

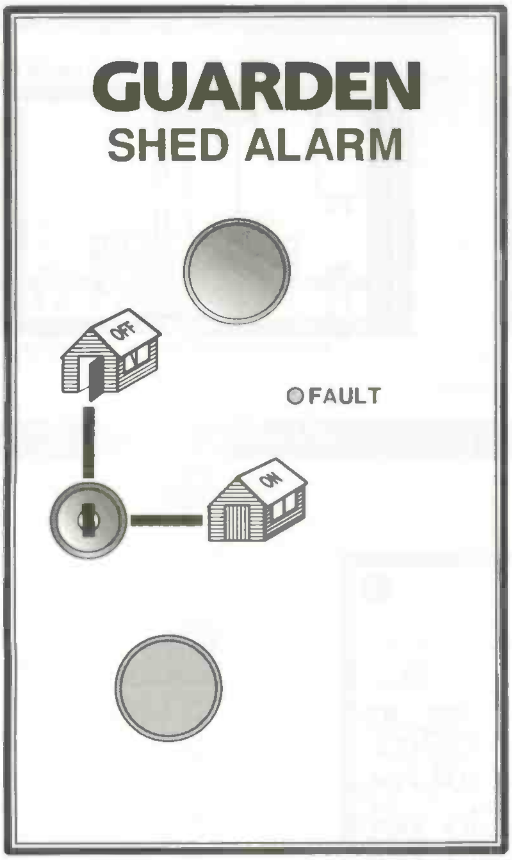


Fig.6. Front panel layout suggestion

Exit timer/buzzer

The exit timer and buzzer circuits are based around IC1a, IC1c, Q1 and X1, with their associated components. When power is first applied via keyswitch SW2, capacitor C1 will be discharged, and the voltage on its positive side will slowly increase from zero to a maximum of almost the positive rail - depending on the setting of VR1. This rising voltage is fed via R3 to the input (pins 5 & 6) of an inverter formed by IC1a and, whilst C1 is charging, the output at pin 4 will be high. This is used to enable the oscillator based around IC1c, C5 and R6. Note that only Schmitt trigger devices can be made to oscillate using a single gate in this manner - normal NAND gates will not work. The squarewave output at pin 3 of IC1c is used via R9 to drive the base of transistor Q1, which is configured as a common emitter open collector switch and, in turn, drives the piezo transducer X1. It is possible to drive these types of transducers directly from the output of CMOS devices such as IC1 but, because X1 serves two functions, this method is impractical in the design here.

At DC levels, X1 appears as an open circuit to the collector of Q1, so resistor R10 is included across X1 to draw current from the collector of Q1 - without it, Q1 won't conduct and so no sound would be produced by the transducer. With the shock sensor enable link LK2 fitted, the fault indicator LED1 will glow dimly while the exit buzzer is sounding, due to the pulses being fed to it through R11. This is not a fault, it is done intentionally so that LED1 gives a low light level output to indicate that the exit timer is running and a high brightness to indicate a fault warning. The lower light level is obviously not available if LK2 is not fitted.

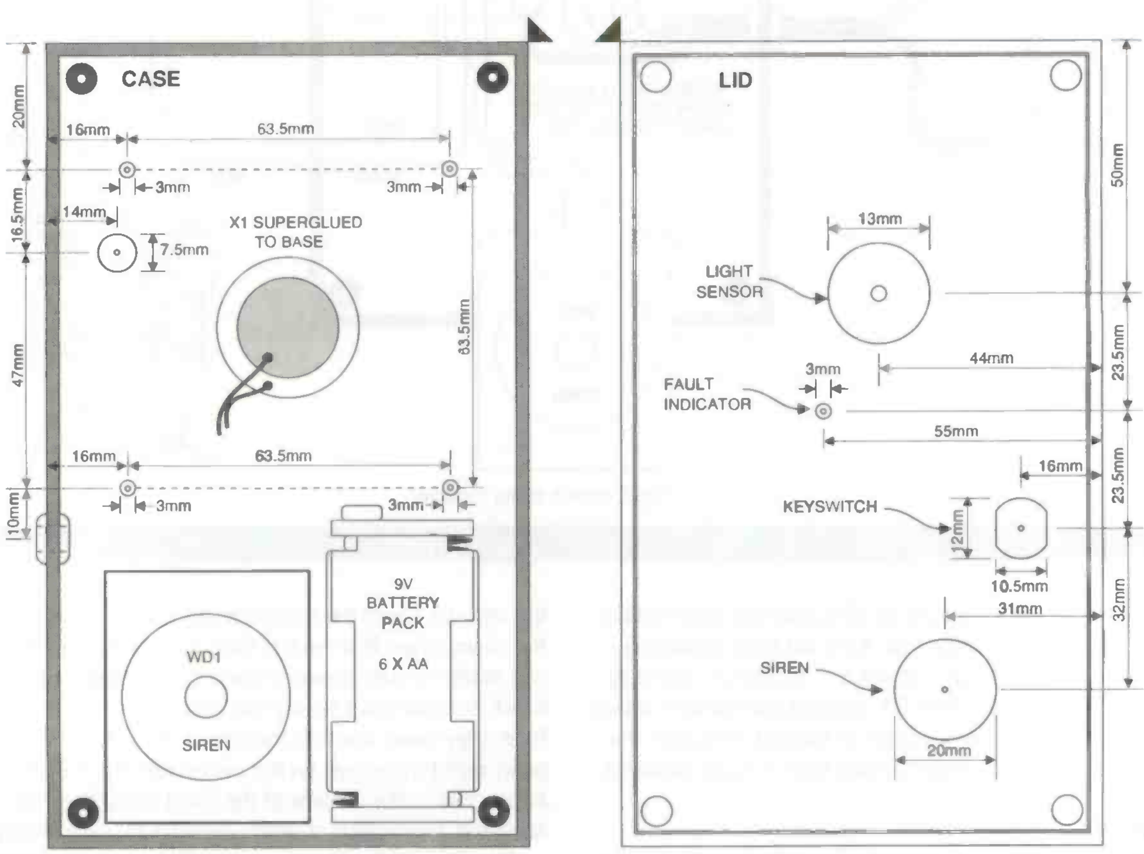


Fig.3. Drilling details for case and lid

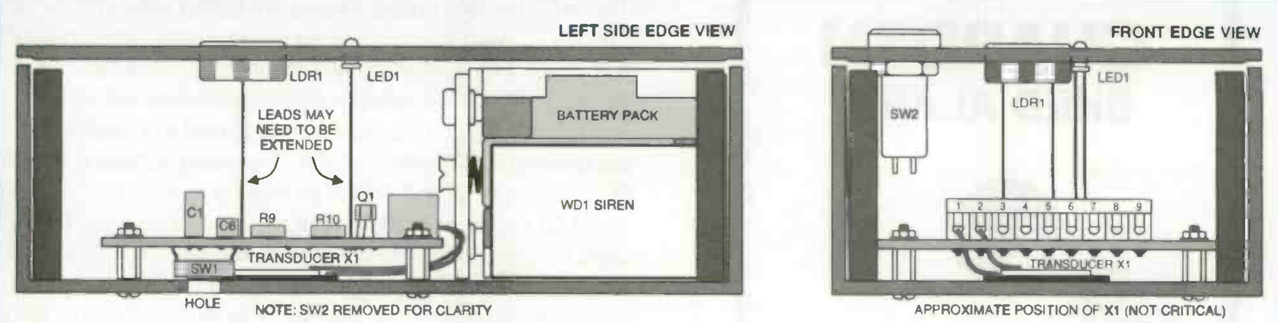


Fig.4. Fixing positions inside case

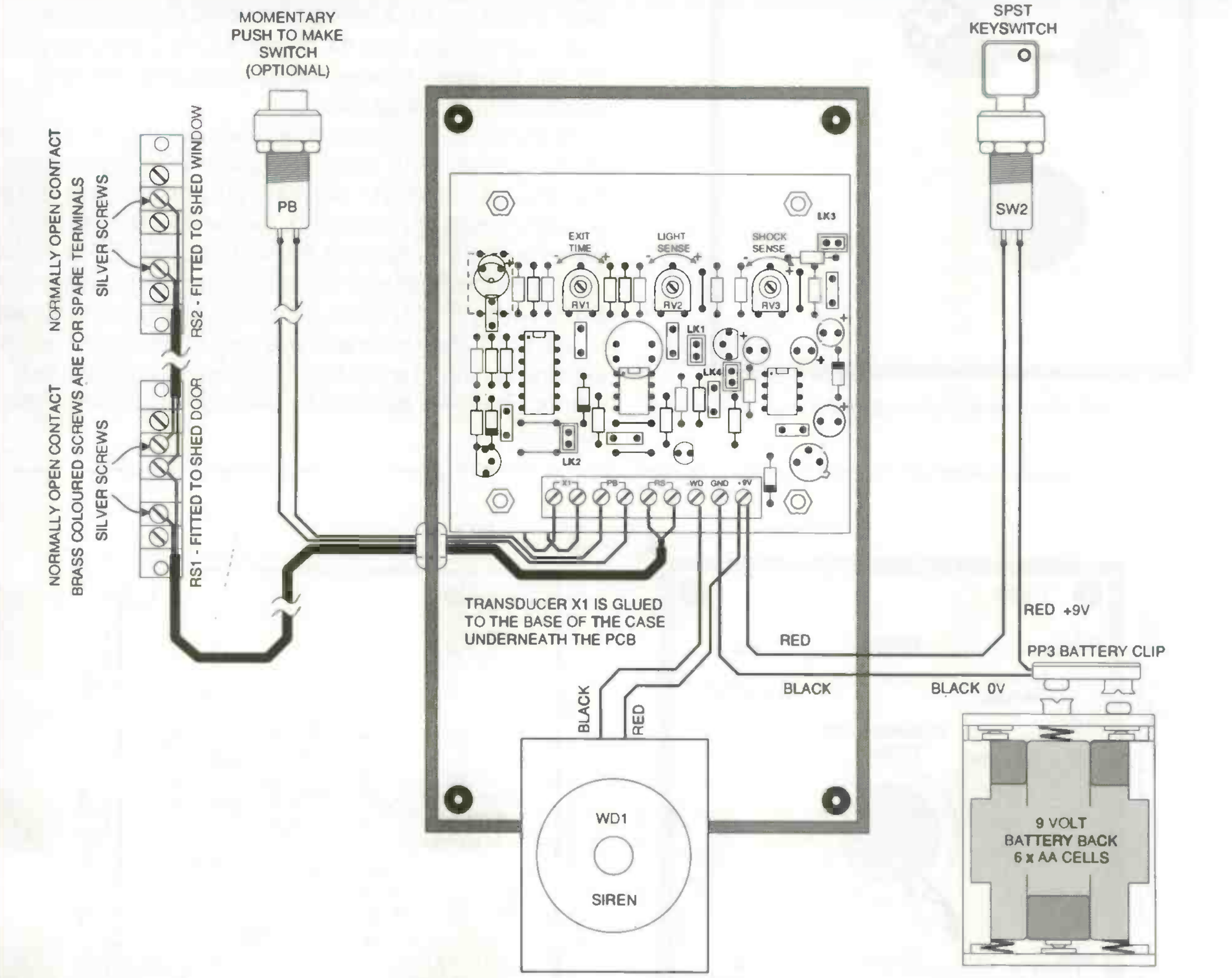


Fig.5. How it all fits together

When the voltage at the inputs to IC1a reaches about 2/3 of the supply voltage, pin 4 will go low, IC1c will stop oscillating - leaving its output at pin 3 high, Q1 will turn off and X1 will stop sounding. The charge current for C1 is adjustable via VR1, which results in a corresponding adjustment of the exit time, with the values shown this gives a range typically from 1 to 20 seconds.

Entry timer

Most domestic burglar alarms sound a low volume entry buzzer as soon as the entrance door is opened, but this principle cannot be practically applied in our application, because the shed alarm is intended for use in somewhat confined areas. If the intruder heard the buzzer as soon as the door was opened, the chances are that the first thing to go would be the whole alarm unit itself! For this reason there is no designated entry timer fitted, but that's not to say that provisions haven't been made for it; they have, through the use of SW1. This is a small tactile push switch mounted on the underside of the PCB and made accessible to the outside of the shed through a 'tiny' hole in the shed wall, the location of which should only be known by the owner.

Pressing SW1 will activate the EXIT timer and disable the alarm during this period, which should be set to allow sufficient time to enter the shed and turn off the alarm with the keyswitch. Where the use of SW1 is impractical, the optional push button

PB1 can be fitted to a remote location, again known only by the owner; pressing this will have the same effect. Alternatively, if you don't mind the noise for a few seconds, you could simply allow the alarm to sound as you open the shed door, before turning it off with the keyswitch.

Door and window sensors

Reed switches RS1 and RS2 are standard surface-mounting security fittings with normally open contacts and, although only two are shown in the drawing, many more can be added by connecting them all in series. These are fitted to the outer frames of the door and window and a magnet (usually supplied with them) fitted to the actual opening light and door themselves, such that they are in close proximity of, and in parallel with, the reed switch when the door or window is closed. In this way, as the door or window is opened, so the contacts inside the reed switch open, and vice versa.

IC2 is a dual comparator which has open collector outputs. IC2a performs a simple inverting function. If the voltage on pin 2 rises above that on pin 3 the output on pin 1 will be pulled low (OV). If the potential on pin 2 falls below that on pin 3 the output will effectively go open circuit or "float". Depending on the setting of VR3 pin 3 of IC2a is held somewhere between about 4% and 50% of the supply voltage - 0.4V to 4.5V with a 9V supply. The voltage itself is unimportant so long as pin 2 can swing above and below it by more than a few millivolts - the input offset voltage of the comparators.

When the window and door are closed, RS1 and RS2 will also be closed. This will hold pin 2 of IC2a at 0V. The output at pin 1 will therefore "float" and have negligible effect on the inputs of IC1d to which it is connected. If either the door or window are opened the 0V continuity will be removed and pin 2 will be pulled up to the supply voltage via resistor R5 and pin 1 will go low, taking with it the inputs to IC1d. The resulting high output of IC1d (pin 11) is fed via D2 to the alarm triggering input (pin 6) of IC1b in order to sound the alarm.

Capacitor C4 is used to debounce the reed switches if the occupants turn on the alarm, but don't exit the shed until after the exit time has elapsed (see ALARM TRIGGER).

Light sensor

There were a number of beneficial factors which influenced the addition of a light sensor in the design of the shed alarm. What if you don't have a window to protect using the method above and the would-be thief suspected the door to be alarmed, so decided to remove a roof panel to gain access (this is not just some far fetched idea, it happens more often than you may realise)? With the door closed, it would be dark inside - even during the daytime, in which case the inrush of light would trigger the alarm. If the attack were to take place at night, it's going to remain dark (ish) inside even with the roof panel removed, but the chances are our intruder is going to need some kind of illumination (a torch, matches or cigarette lighter) in order to see what's worth taking and this will activate the alarm once sufficient light is detected, whether directly from the source or reflected off any suitable surface.

The light sensing element LDR1 is an ORP12 - Light Dependent Resistor (LDR). This device has a very high resistance in total darkness - well in excess of 1MΩ, but this resistance falls quite substantially when exposed to light, being typically 10kΩ - 20kΩ in average (cloudy) daylight and can be as low as only 30Ω in bright sunlight. It forms part of the potential divider chain based around VR2, R8, R7 and LDR1 itself and is connected to the input of inverter IC1d (pins 12 & 13).

NOTE: SW1 IS MOUNTED ON THE UNDERSIDE

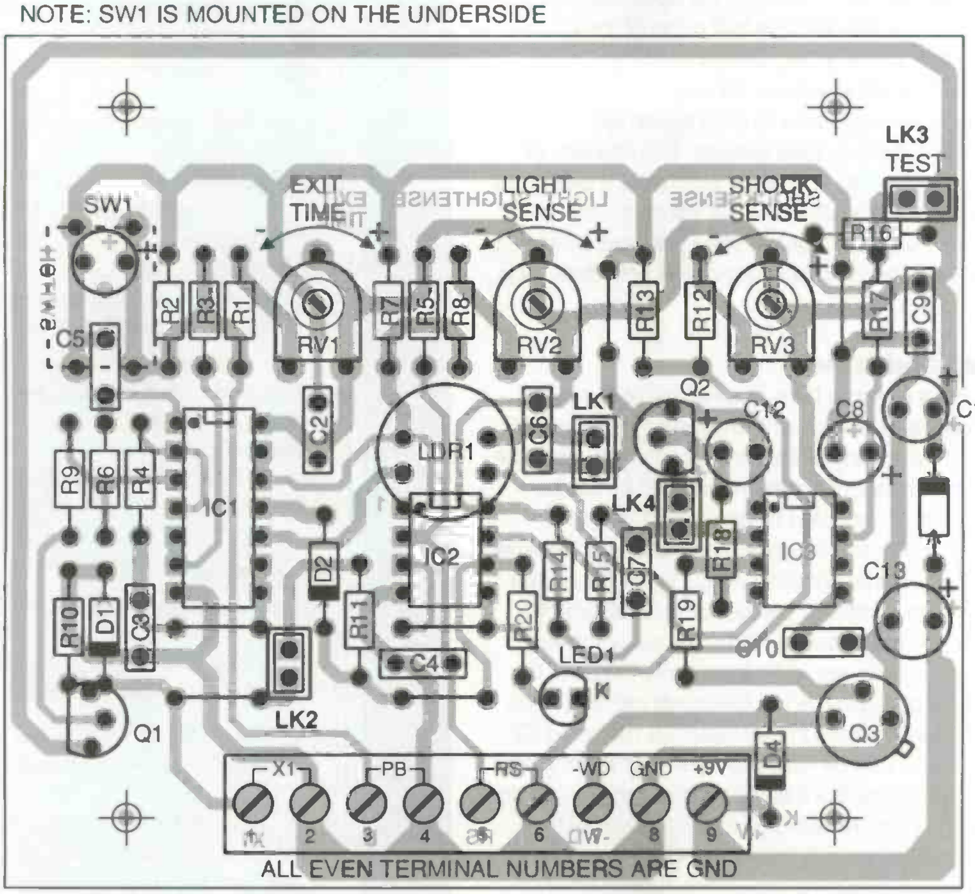


Fig.2. PCB component layout

Under dark conditions, the high resistance of LDR1 results in a voltage greater than 2/3 of the supply at the inputs to IC1d, the output on pin 11 will be low and so too will be the anode of D2. Since D2 allows only positive voltages through to the alarm triggering circuit, the output of IC1d has no effect in this state. As the light level increases, the resistance of LDR1 decreases, thereby reducing the voltage at the inputs of IC1d. Once this reaches a point below 1/3 of the supply, pin 11 will go high, D1 will conduct and apply this voltage to the triggering circuit and thus set off the alarm. The amount of illumination required to trigger the alarm is adjustable via the sensitivity control VR2. If the light sensing feature of the alarm is not required, jumper link LK1 can be opened to disconnect LDR1 without having to remove it from the circuit.

Shock vibration sensor

As mentioned earlier, the piezo transducer X1 performs two functions, one is the exit buzzer and the other is here, as the sensing element for shock vibrations. X1 is an un-housed (open) transducer which, although it will work in free air as a resonator (though not very loud), in order to operate reliably as a shock sensor, it must be hard glued (using super glue) to the case of the alarm, which in turn must be secured very firmly to a reasonably resonant section of the shed structure. In this way, the shock vibrations produced by (say) the door being attacked with a crowbar, or a window being smashed will be transmitted through the shed structure to the case of the alarm and be detected by X1, setting off the siren.

When X1 receives shock vibrations, it produces output pulses with an amplitude relative to the intensity of the vibrations. This output level can be quite high. Indeed, when tapped lightly with just the tip of a fingernail, the output pulse can easily peak above 10V. These pulses are fed to the alarm triggering circuit via resistor R11. Diode D1 is connected in parallel with X1 to prevent the negative half cycle of the pulses reaching IC2b, as this causes erratic operation of the comparator function - resulting in false alarms.

The operation of IC2b is identical to IC2a explained previously in the doors and windows section. The intensity of the shock vibration required to trigger the alarm is adjustable via the shock sensitivity control VR3. When set correctly, the alarm should be quite immune to 'normal' vibrations caused by strong winds, flapping roof felt, hanging or rubbing tree branches, pets and birds etc.

Alarm trigger and timer

After signal processing of some form or other, all of the alarm sensors result in a positive voltage at the inverting input (pin 6) of comparator IC2b. When any of the sensors are activated, the output of IC2b - which is normally held high by R14 - will be pulled low. This is then AC coupled by capacitor C7 and provides a low-going pulse to the trigger input of the alarm timer IC3. The reason for AC signal coupling via C7 is to ensure that the alarm timer can turn off after a pre-determined length of time, even if the sensor which caused it (or any other for that matter) is still active, such as would be the case if the door or window were forced open and the would-be intruder fled once the alarm sounded, leaving them in that state. By replacing C7 with a wire link the alarm can be made to sound for as long as any of the sensors are active, but this will have a significant drain on the batteries if left un-acknowledged for any length of time.

There is an advantage and a possible disadvantage of having C7 fitted. The advantage concerns the use of the exit timer. If the shed door is open before the alarm is switched on or is

PARTS LIST

COMPONENTS LIST FOR DTE "GUARDEN" SHED SECURITY ALARM

RESISTORS

- R1, 8 to 13, 17, 18 — 10kΩ (9off)
- R2 — 2M2 (1 off)
- R3 to 6, 14, 15 — 100kΩ (6 off)
- R7, 16 — 1MΩ (2 off)
- R19 — 4K7 (1 off)
- R20 — 1KΩ (1 off)

Total 20 resistors

POTENTIOMETERS

- VR1, 2, 3 — 220KΩ horizontal preset (3 off)
- Total 3 presets

CAPACITORS

- C1, 8, 11, 12 — 47μF/16V radial electrolytic (4 off)
- C2, 3, 4, 6, 7, 9, 10 — 100nF ceramic - 5mm pitch (7 off)
- C5 — 4n7 ceramic - 5mm pitch
- C13 — 100μF/16V radial electrolytic

Total 13 capacitors

SEMICONDUCTORS

- D1, 2, 3 — 1N4148 silicon signal diode (3 off)
- D4 — 1N4001 1 amp silicon rectifier diode
- IC1 — CD4093B quad 2-input nand Schmitt trigger
- IC2 — LM393N dual low-power comparator
- IC3 — ICM7555IPA low-power CMOS timer
- LED1 — 3mm standard red light emitting diode
- Q1 — BC212 PNP silicon transistor
- Q2 — BC547 NPN silicon transistor
- Q3 — BFY52 NPN silicon transistor

Total 11 semiconductors

HARDWARE & MISCELLANEOUS

- B1 — 9V battery back - 2 x 3 "AA" cells
  PP3 size battery clip to suit B1
- CASE — ABS plastic box 150 x 90 x 45 (internal)
- GROMMET — 6.5mm (internal) PVC grommet
- LK1 to LK4 — 2-PIN PCB pin header (4 off)
  Jumper links for above (4 off)
- PB1 — Panel mounting N/O push button *
- RS1, RS2 — N.O. surface mount reed switch with magnet
- SW1 — 12mm PCB mounting tactile button switch
- SW2 — Miniature panel mounting keyswitch

TERMINALS

- 9-way (3 x 3-way) PCB terminal block
- WD1 — Two-tone single piezo electric siren
- X1 — 27mm 1.8KHz open piezo transducer
  twin "figure 8" 7/0.2 flex (10 metres)
  M3 fixing hardware (screws, nuts, washers)

PCB — DTE "GUARDEN" SHED ALARM BOARD (ring 0283-542229 for details)

* Optional - not required for main unit

opened during the exit time, then although the fault indicator LED1 will be brightly lit, the exit time can be allowed to elapse and the alarm will go into the armed state but will not sound the siren, nor will activating any of the other sensors with the fault indicator lit. The occupants will still be allowed to exit the shed and close the door behind them, which will extinguish the fault indicator, but should the door now be opened again the alarm will sound. Note that this feature only applies if the door is open before or during the exit time, and only then if C7 is fitted. The possible disadvantage is that once triggered, the alarm will time out and turn off as normal but if, after this time, any of the sensors are still active, the alarm will show a fault and will not be allowed to sound again until the fault is rectified - even if a different sensor is now activated.

Alarm timer

As mentioned, the alarm timing function is carried out by IC3, which is a low power CMOS version of the 555 timer, configured in its monostable mode. Once a low-going trigger pulse is applied to pin 2, C8 is allowed to charge up at a rate determined by R16 and R17. The output at pin 3 will go high, turning on transistor Q3 via R19, sounding the siren. Diode D4 protects Q3 from back emf produced by the siren or any other inductive load such as a relay connected to the output terminals. When the voltage on pin 6 reaches 2/3 of the supply, C8 is discharged into pin 7 and the output on pin 3 turns off (low).

The timing period for the high output is set by R16, R17 and C8. With the given values, the timer should run for about 30 seconds. Experience has shown, however, that this time period can vary quite substantially depending on which manufacturer's version of the IC is used, so these values should serve as reference only. For testing purposes, jumper link LK3 can be inserted to short out R16; this shortens the timing period to about 1 second and is useful for checking the operation of the alarm during setting up.

Transistor Q2 is also turned on by the output of IC3 - via R18. If jumper link LK4 is fitted, once triggered, the collector of Q2 will hold pin 2 of IC3 low, and the output will remain in the high state indefinitely - even after the time period has expired, and irrespective of the state of the fault indicator (pin 7 of IC2b). Again, experience has also shown that not all versions of the CMOS 555 have this facility, some of them will turn off after the time period even with pin 2 held low; this will obviously render the latching function non-effective, a point to bear in mind when selecting this device.

The reset input (pin 4) of IC3 is connected to the output of IC1b, which prevents the alarm sounding during the exit time. Whilst pin 4 of IC3 is low the output remains low and the IC will not respond to any signals at pin 2. At the start of the exit time period, pin 4 of IC1a goes high, C3 is charged rapidly via R4 and pin 10 goes low. At the end of the exit time, pin 4 of IC1a goes low, but the corresponding high output at pin 10 is delayed slightly as C3 is discharged by IC1a through R4. This slight delay - which is only a few milliseconds - is required if the shock sensor feature is enabled by inserting jumper link LK2, because of the electromechanical properties of the transducer X1. If IC3 was enabled immediately after the exit buzzer ceased, the self resonance of X1 would produce enough output to be detectable as a shock vibration and would trigger IC2b, which would obviously set off the alarm. Delaying the release of the reset signal therefore allows sufficient time for X1 to settle to its normal operating level before the alarm circuit is enabled.

Capacitors C2, C6, C9, C11 and C13 decouple the supply at various points throughout the circuit. Diode D3 ensures that any heavy duty current stages produced by the load across the output do not interfere with the operation of the lower current parts of the circuit.

Construction

Before you solder any components to the PCB, it's a good idea to use the board as a template for the 5 hole positions in the base of the case, even though full drilling details are given in Figure 3, this will make it much easier to obtain the precise hole position for SW1. Although not strictly necessary, a hole of about 10mm can be drilled underneath X1 to give a slight increase in volume to the exit buzzer, but remember to do it before you super glue it in place - it'll be too late afterwards!

The complete PCB component layout is show in Figure 2. Assembly should be reasonably straight forward; start with the low profile components, building up to the highest ones, leaving SW1, LDR1 and LED1 until last. There are seven wire links on the board; don't overlook the one underneath LDR1 just above IC2. Ensure the correct orientation of all the polarised components - electrolytic capacitors, all three transistors and the three ICs. Take special care not to touch the pins when handling IC1 and IC3, and use an earthed soldering iron tip where possible - these CMOS devices can be destroyed by static charge which builds up on the human body. If in doubt, solder IC sockets to the board first and insert the ICs when the assembly is complete. Before soldering LDR1 and LED1, turn the PCB over and carefully solder SW2 to the underside in the position shown dotted on the layout.

The only awkward component is LDR1; the mounting height for this will depend on the depth of the case you intend to use, but should fit almost flush with the outside of the lid when it's fitted. You may even find that you have to extend the leads slightly. The easiest way to fit LDR1 is to 'kink' the lead and solder it into the board slightly higher than required so as to protrude through the lid. In this way, once the PCB is finally fitted and the lid is in place, it can be pushed back into position without the risk of forcing the pads off the back of the PCB. A similar situation occurs with the fault indicator LED1 but, since this can protrude through the front of the case by a variable amount, positioning should cause no real problems.

Once the board is completed, don't fix it into the case if you intend to use the entry timer switch SW1, as you will need to have access behind the PCB to drill the hole in the shed for it.

Be careful when drilling the hole for the keyswitch SW2. This is a 'snug' fit between the top of the siren and the bottom of the terminal block on the edge of the PCB, and you could experience problems with long-barrelled version if the hole is slightly out of line. The hole for the grommet should be close to the bottom of the case so that the wires passing through it don't end up jammed between it and the keyswitch. Finally, the hole above the siren is just to let the noise out and can, if desired, be covered from the inside of the lid with a small piece of loudspeaker fabric (just to make it look nice).

Next month...

we will continue this project with a look at installation and testing.

CVC Chelmer Valve Company

For High Quality Audio Valves

We offer below a selection of our CVC PREMIUM range of audio valves. These CVC BRAND valves are from selected world wide sources, processed in our special facility to provide low noise/hum/microphony PRE-AMP valves and Power Valves burnt-in for improved stability and reliability. Use this sheet as your order form. If you require matched pairs, quads or octects etc. Please allow £1.00 extra per valve for this service and mark alongside the valve type number 'M2, M4, M8' etc as required.

	UNIT PRICE	QTY.	TOTAL PRICE
PRE-AMP VALVES			
ECC81	5.00		
ECC82	4.00		
ECC83	5.00		
ECC85	4.00		
ECC88	5.00		
ECF82	5.00		
ECL82	5.00		
ECL86	5.00		
EF86	4.00		
E80F (GOLD PIN)	9.00		
E81CC (GOLD PIN)	6.00		
E82CC (GOLD PIN)	6.00		
E83CC (GOLD PIN)	6.00		
E88CC (GOLD PIN)	7.00		
6SL7GT	4.00		
6SN7GT	4.20		
6922	5.00		
7025	6.00		
POWER VALVES			
EL34/6CA7	7.50		
EL84/6BQ5	4.00		
EL84/7189A	5.10		
KT66	9.20		
KT77	12.00		
KT88	12.50		
KT88 (Gold Special)	19.50		
2A3 (State 4 Pin or Octal)	14.00		
211	22.00		
300B	50.50		
6C33C-B	36.00		
6L6GC	6.50		
6L6WGC/5881	8.00		
6V6GT	5.00		
6080	14.00		
6146B	10.20		
6336A	40.00		
6550A	11.00		
6550A(S)	13.50		
7581A	11.00		
811A	9.50		
845	29.90		
TOTAL CARRIED FORWARD			

	UNIT PRICE	QTY.	TOTAL PRICE
RECTIFIERS			
EZ80	4.00		
EZ81	4.25		
GZ32	5.00		
GZ33	5.00		
GZ34	5.00		
GZ37	5.00		
5U4G	5.00		
5V4G	4.00		
5Z4GT	3.50		
SOCKETS			
B9A (state chassis or PCB)	1.60		
B9A Gold Pltd (State Chassis or PCB)	3.50		
OCTAL (State Chassis or PCB)	1.75		
OCTAL Gold Pltd (State Chas or PCB)	4.20		
4 PIN (For 2A3, 811A etc)	3.00		
4 PIN (FOR 211 & 845)	11.00		
4 PIN Gold Pltd (For 211, 845)	15.00		
7 PIN (For 6C33CB)	4.50		
Screening Can (For ECC83 etc)	2.00		

MATCHING CHARGES	
POST & PACKING (UK)	3.00
TOTAL EXC. VAT	
VAT @171/2% (UK & EEC)	
TOTAL TO PAY	£

Please make CHEQUES payable to 'CHELMER VALVE COMPANY or pay by ACCESS/MASTER CARD/VISA, give details:

Signature .... Expiry Date ....

Name ....

Address ....

....

....

.... Post Code ....

Valve amplifiers sound better still with CVC PREMIUM valves!

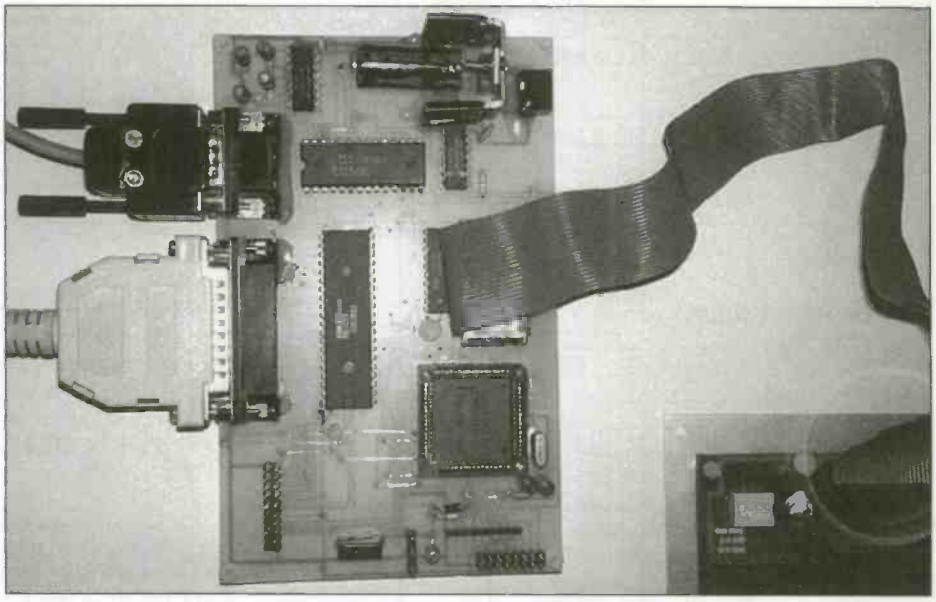
130 New London Road, Chelmsford, Essex CM2 0RG, England. Telephone 0245 355296/265865 or FAX. 0245 490064.

The ETI 80188 single board Computer

PART 3

A powerful and highly versatile 16bit processor system designed by Richard Grodzik for which software can be developed directly on any IBM PC, this month we continue our look at programming the board.

Last month we took an initial look at programming the 80188 SBC, and showed how this versatile board can be used for a wide range of applications. Part of this versatility can be attributed to the fact that it is software compatible with the family of processor chips used in the IBM PC. This means that software can be directly developed and tested on the PC and then downloaded onto the 80188 SBC, thereby making software development for the SBC much easier and quicker. It also means that software can be developed using the enormous range of software development tools which are available on the PC.



Serial Communications

Inter-communication between two computers is effectively achieved over an asynchronous RS232 link. The 80188 SBC and the P.C. both must execute communications software simultaneously to enable serial data to pass in either direction. The following chapter details the software necessary for the 80188 SBC and the P.C.

The 8251 USART is capable of both synchronous and asynchronous serial data communication. The 80188 SBC uses the asynchronous communication format on which the industry standard RS232 communication protocol is based. Therefore all programming details of the 8251 will be confined to the asynchronous mode.

Programming the 8251

Following a reset operation, the 8251 must be loaded with a control word (MODE) which initialises the 8251 to support the desired communications protocol regarding speed of transmission and word length. Control words written to the 8251 after the MODE instruction will load the COMMAND instruction. To return to the MODE instruction, the master reset bit in the command instruction word can be set to initiate an internal reset operation which automatically places the 8251 back into the MODE instruction format. Alternatively, a power-up reset or system hardware reset will achieve the same result. The C/D input line of the 8251 (pin 12), connected to the Ao system address line, is raised high whenever a control word

(MODE or COMMAND) is written the 8251. It is also high whenever a status read is performed. The base address of the 8251 (0C00H) in the 80188 system IO Map is reserved for the reading/writing of data for the 8251, (C/D input line low). Address 0C01H is therefore the MODE/COMMAND/STATUS address of the USART.

Once programmed, the 8251 performs as a UART (universal asynchronous receiver/transmitter) and is ready for communications. The command instruction controls the operation of the 8251. It cannot begin transmission until the TXenable bit is set in the command instruction and it has received a CTS (clear to send) logic low input. Likewise, the 8251 cannot begin reception of data until the RXenable bit is set in the command register. The following two programs demonstrate serial asynchronous transmission and reception of data using polled operation to determine the status of the UART. For transmission, the TxRDy flag is polled. This flag signals that the transmitter buffer is empty (a character has been transmitted) and that the buffer is ready to accept another character. For reception, the RxRDy flag is polled. This flag signals that the receive buffer contains a received character and is ready to be read by the CPU.

The logic level of the RxRDy output pin follows the logic level of the RxRDy status bit, and therefore this pin may be connected to the interrupt structure of the CPU, so that whenever a character is received and this pin is raised logic high, an interrupt service routine will execute to read the received character. The logic level of the TxRDy output pin similarly follows the logic level of the TxRDy status bit, but on condition that the CTS pin is low and the TxEN bit of the command instruction has been set. The TxRDy output pin is raised logic high and can also be used to generate an interrupt; the service routine loading a new character to the transmitter buffer.

```
;PTXD.ASM

CODE SEGMENT
ASSUME CS:CODE
ORG 0

ORG 0400H
      CLI
      MOV SP,0FFH       ;INITIALISE STACK
                         POINTER

      MOV DX,0FFA2H     ;SELECT LMCS 0000-00FFH
                         8155 RAM
      MOV AX,038H
      OUT DX,AX
      MOV DX,0FFA4H     ;PACS REGISTER ADDRESS
      MOV AX,0F8H       ;CONFIGURE PCS0 CHIP
                         SELECT TO START
                        ;ADDRESS 0C00H
      OUT DX,AX

      MOV DX,0FFA8H     ;MPCS REGISTER ADDRESS
      MOV AX,081B8H
      OUT DX,AX

;MAIN PROGRAM STARTS

        CALL TIMER
        CALL USART_INITIALISE
      MOV BL,030H          ;OUTPUT ASCII '0'

CYCLE:CALL TRANSMIT
      JMP CYCLE
TRANSMIT PROC NEAR
      MOV AL,BL            ;DATA
      ADD BL,+1            ;TRANSMIT NEXT ASCII
CHARACTER
      MOV DX,0C00H
      OUT DX,AL

NOTR:MOV DX,0C01H          ;STATUS
      IN AX,DX
      AND AL,1
      CMP AL,1
      JNZ NOTR

      MOV CX,01FFH         ;DELAY
DEL5:LOOP DEL5
      RET

TRANSMIT ENDP

TIMER PROC NEAR
      MOV DI,0105H     ;8155 TIMER ADDRESS HIGH
                         BYTE
      MOV AL,040H      ;SQUARE WAVE OUTPUT
      MOV [DI],AL

      MOV DI,0104H     ;8155 TIMER ADDRESS LOW
                         BYTE
      MOV AL,9         ;DIVIDE BY 9
      MOV [DI],AL
      MOV DI,0100H     ;8155 COMMAND ADDRESS
      MOV AL,0C3H      ;START 8155 TIMER
      MOV [DI],AL

      RET

 TIMER  ENDP

USART_INITIALISE PROC NEAR
      ;USART INITIALISATION  FOR TRANSMISSION
      ;AT 9600 BAUD
      ;1 STOP BIT,8 DATA BITS,NO PARITY
      ;USART ADDRESS 0C01H=COMMAND,0C00H=DATA

      MOV AL,04FH
      MOV DX,0C01H
      OUT DX,AL

      MOV AL,3
      MOV DX,0C01H
      OUT DX,AL

      RET

USART_INITIALISE ENDP

      ORG 07F0H
      JMP 0FFC0H:0000
      ORG 0800H
      ENDS
      END
```

The 8251 requires two clock signals - the system clock applied to the CK input is derived from the master crystal frequency which is divided by two to produce a frequency of 5.5296 Mhz at the CLK OUT pin of the 80188.

The clock feeding the Rxc and Txc has to be an exact multiple of the required baud rate - in this case 9600 baud. The 8155 contains a 12 bit timer which is used to provide the Txc and Rxc signals. The CLK OUT signal is fed to this timer which is programmed by procedure TIMER to provide a divide by 9 function. The resulting frequency of 614.4 Khz after a further division by 64 by the USART results in a transmit and receive baud rate of 9600.

Procedure USART_INITIALISE programs the 8251 for the RS232 protocol - 1 stop bit, 8 data bits, no parity. See diagrams for details of programming for other protocols.

Chip select of the 8251 is performed by the PCS0 line of the 80188. The 80188 can generate several chip selects (PCS0 - PCS6) which are active for seven contiguous blocks of 128 bytes above a programmed base address. The PACS register defines the start address of the peripheral select block - in this case 0C00H. The MPCS register selects the size of block located in IO space (2K). The following peripheral chip selects will therefore be active for the following address ranges:

PCS0=0C00-0C7F
PCS1=0C80-0CFF
PCS2=0D00-0D7F
PCS3=0E00-0E7F etc.

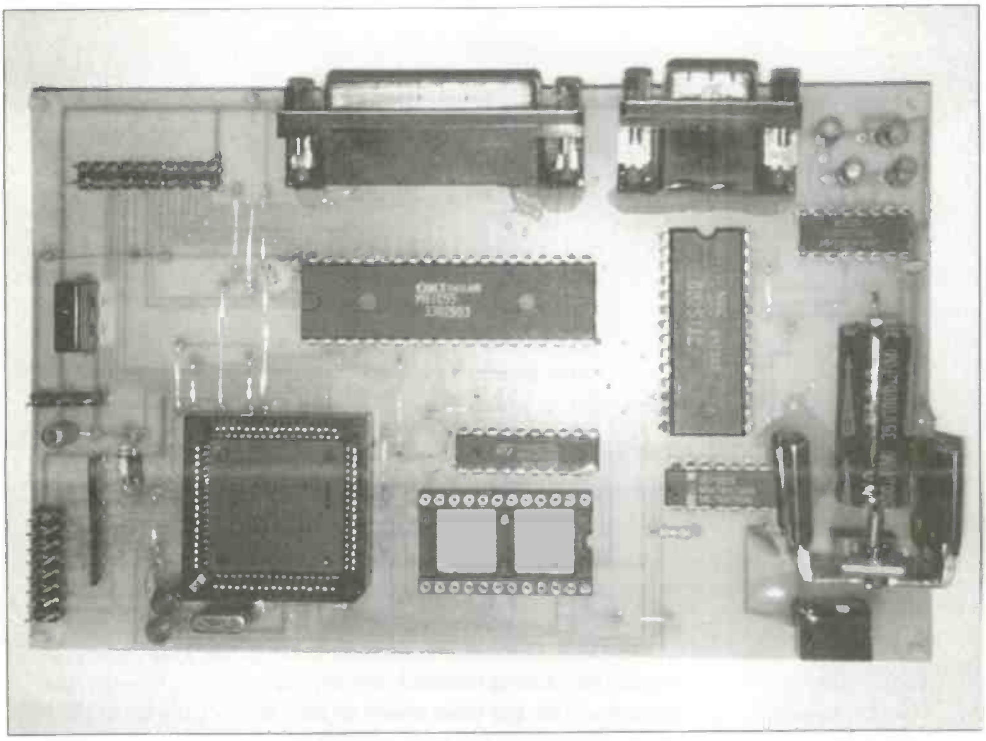
Receiving Data

Again, the mode and command bytes are written to the command register at address 0C01H. The RXRDY bit is set and the status register is polled to indicate when a byte has been received.

```
;RXD.ASM
            PAGE ,132
CODE SEGMENT
ASSUME CS:CODE
ORG 0
ORG 0400H
     MOV SP,0FFH       ;INITIALISE STACK POINTER
     MOV DX,0FFA2H     ;SELECT LMCS 0000-00FFH
                        8155 RAM
     MOV AX,038H       ;038H
     OUT DX,AX

     MOV DX,0FFA4H      ;CONFIGURE PCS0 CHIP
                         SELECT TO 0C00H
     MOV AX,0F8H
     OUT DX,AX

     MOV DX,0FFA8H
     MOV AX,081B8H
     OUT DX,AX

     CALL TIMER              ;INITIALISE 8155'S
                        TIMER
CALL USART_INITIALISE  ;INITIALISE 8251 FOR
                       ;9600 BAUD
                       ;8 DATA BITS,1 STOP
                       ;BIT,NO PARITY

;MAIN PROGRAM

CYCLE:

NOTR:MOV DX,0C01H      ;POLL USART STATUS
                        REGISTER
     IN AX,DX
     AND AL,2
     CMP AL,2
     JNZ NOTR          ;IF BYTE
                        RECEIVED,CONTINUE

     MOV DX,0C00H
     IN AX,DX          ;GET DATA

     MOV DI,0102H      ;SEND BYTE TO PORT B
     MOV [DI],AL

     JMP  CYCLE        ;REPEAT FOREVER

TIMER PROC NEAR
     MOV DI,0105H      ;TIMER HIGH BYTE
     MOV AL,040H       ;SQUARE WAVE OUTPUT
     MOV [DI],AL       ;PORT B OUTPUT
     MOV DI,0104H      ;TIMER LOW BYTE
     MOV AL,9          ;DIVIDE BY 9
     MOV [DI],AL

     MOV DI,0100H      ;8155 COMMAND REGISTER
     MOV AL,0C3H       ;START TIMER
     MOV [DI],AL

     RET

TIMER ENDP

USART_INITIALISE PROC NEAR

     MOV AL,04FH
     MOV DX,0C01H
     OUT DX,AL
     MOV AL,4
     MOV DX,0C01H
     OUT DX,AL
     RET

USART_INITIALISE ENDP

ORG 07F0H               ;RESET VECTOR  AT FFFF0H
JMP 0FFC0H:0000         ;START EXECUTING AT
                         0FFC0H

ORG 0800H               ;FILE SIZE = 2048 (2
Kbytes)
CODE ENDS
END
```

Programming for Interrupts

The 80188 has the same basic software interrupt structure as the 8088 processor. Up to 256 interrupt pointers can be generated which define the start address (CS:IP) of the interrupt



CS:IP doubleword points to the starting address of the interrupt service routine. Once the interrupt has been serviced, an IRET instruction will pop the CS and IP doubleword and the flag register from the stack and normal sequential program execution will continue from the point of interrupt.

service routine. The 80188 SBC has an area of RAM internal to the 8155, from address 0000 to 00FFH which can contain the interrupt pointers required by the system's software. Although this area of memory is also shared by the memory stack, it should be sufficient to include several interrupt pointers.

The 80188 interrupt system responds to the same software generated interrupts as does the 8088 processor. These include TYPE 0, divide overflow, TYPE 1, single step and TYPE 2 NMI. In addition, the 80188 will generate internal interrupt vectors (pointers) when interrupt lines INT0, INT1, INT2 or INT3 are asserted high. For example, an INT0 interrupt will generate addresses 30H and 32H - and cause the IP and Code segment register values at these locations in RAM, to be loaded, defining the start address of the interrupt service routine to be executed for that interrupt.

Software Interrupts

Any interrupt service routine can be program generated by means of a software INT instruction. It has the general form:

INT TYPE No.

For example, a type 17 pointer will generate vectors 44H and 46H (17 x 4) and (17 x 4)+2; these address locations in RAM will contain the IP:CS address information of a service interrupt routine. Whenever a software interrupt is executed, the following occurs:

- The flag register is pushed on stack.
- The trap flag and the interrupt flag (IF) is cleared to disable other maskable interrupts and disable single-stepping.
- The CS register is pushed on stack.
- The address of the interrupt vector is calculated - the 80188's hardware does this automatically by multiplying the interrupt type by 4.
- The CS base address of the interrupt service routine is loaded from the vector table into the CS register.
- The IP register is pushed onto stack.
- The IP offset of the interrupt service routine is loaded from the vector table into the IP.
- In summary, after an INT instruction has been executed, the

Using hardware Interrupts

The following program demonstrates how the 80188 system is programmed to activate the INT0 line. Procedure INITIALISE programs the 80188's

internal registers as follows:

- The mask register (address FF28H) enables type 12 interrupts. To enable other interrupts, the following mask bytes are written to this register:

Type 13	INT1 =DDH
Type 14	INT2 =BDH
Type 15	INT3 =7DH

INT0 control register (address FF38H), is programmed for level or edge (040H) interrupts. Control register for other interrupt sources are:

INT1 FF3AH
INT2 FF3CH
INT3 FF3EH

Again, loading 040H for edge and 050H for level interrupts. Procedure VECTOR loads the IP offset and the CS value of the interrupt service routine (ISR) into the vector table at address 30H and 32H.

Finally, the STI instruction enables the interrupt structure. A high level transition at the INT0 pin will cause the program to vector to the interrupt service routine and 55H will appear on port B output lines. To enable further interrupts after the IRET instruction, the end of interrupt register at location FF22H must be loaded with word 0800FH. This register is common for all interrupt sources.

```
;INT0.ASM
                PAGE ,132
CODE SEGMENT
ASSUME CS:CODE,DS:CODE
ORG 0
ORG 0400H

      CLI               ;DISABLE INTERRUPT
      MOV SP,0FFH
      MOV DX,0FFA2H     ;CONFIGURE LCS 00-0FFH
```

```
    MOV AX,038H       ;038H
    OUT DX,AX

;MAIN PROGRAM

    CALL VECTOR
    CALL INITIALISE

    STI             ;ENABLE INTERRUPT
                    ;WAIT FOR INTERRUPT  AT
                     INT0 PIN 45

    HLT             ;STOP


VECTOR PROC NEAR
      C_S EQU 0FF80H              ;BASE ADDRESS
                                   OF EPROM

      INT_TYPE   EQU 12
      INT0 = INT_TYPE *4          ;ADDRESS 30H

      MOV AX,OFFSET ISR           ;LOAD ADDRESS
                                   OF INTERRUPT
                                  ;ROUTINE
      MOV DI,INT0                 ;INTO
                                   INTERRUPT
                                   VECTOR TABLE
      MOV [DI],AX                 ;ADDRESS 030H
                                   = IP OFFSET

      MOV AX,C_S
      MOV DI,INT0+2               ;ADDRESS 032H
                                   = CODE
                                   SEGMENT
      MOV [DI],AX
      RET
VECTOR ENDP


INITIALISE PROC NEAR
      MOV DX,0FF28H        ;MASK REGISTER ,ENABLE
                            INT0
      MOV AX,000EDH
      OUT DX,AL

      MOV DX,0FF38H        ;INT0 CONTROL REGISTER
      MOV AL,050h          ;040h   ;EDGE
                            INTERRUPT
      OUT DX,AL

      MOV DI,0100H         ;PORT A,B OUTPUT
      MOV Al,03
      MOV [DI],AL
      RET
INITIALISE ENDP
ISR:                       ;INTERRUPT SERVICE
                            ROUTINE
    CLI                    ; DISABLE INTERRUPT

    MOV DI,0102H         ;SEND 55H TO PORT B
    MOV Al,055H
    MOV [DI],AL
    MOV DX,0FF22H        ;EOI REGISTER NON
                          SPECIFIC EOI VECTOR
                          TYPE
                         ;12
    MOV AX,0800FH
    OUT DX,AX

    IRET                 ;RETURN FROM INTERRUPT

    ORG 07F0H
    JMP 0FFC0:0000

    ORG 0800H
    CODE ENDS
    END
```

Using the timer to generate waveforms

The following example demonstrates how the 80188's timers may be programmed to generate waveforms of any duty cycle. In this case, a square wave is generated by timer one and is presented to timer1 out output pin. Two registers - MAXA and MAXB define the maximum count value of the timer; when maximum count is reached, the logic level on the timer output pin is inverted, the timer resets to zero and counts up to MAXB value, whereupon the logic level on the output pin once again inverts, and so on. Since each incrementation of the timer takes .72 uS (System clock frequency/8), the width of the mark/space of the resultant waveform is directly proportional to values programmed into MAXA and MAXB registers.

```
;TIMER1.ASM (100HZ)
;CONNECT TIMER IN 1 (PIN 21) TO +5V
;100HZ SQUARE WAVE PRODUCED AT TIMER OUT 1
(PIN 23)

CODE SEGMENT
ASSUME CS:CODE

ORG 0

ORG 0400H

     TIMERMODE  EQU 0FF5EH    ;TIMER 1 CONTROL
                               REGISTER
     COUNTER    EQU 0FF58H    ;16 BIT COUNT
                               REGISTER
     MAXCOUNTA  EQU 0FF5AH    ;MAX COUNT
                               REGISTER A
     MAXCOUNTB  EQU 0FF5CH    ;MAX COUNT
                               REGISTER B
     SQUAREWAVE  =   0C003H
     MAXA    =    01B00H      ;MAX COUNT VALUE
                               A
     MAXB    =    01B00H      ;MAX COUNT VALUE
                               B

                              ;SQUARE WAVE ON
                               TIMER 1 OUT PIN
                              ;PULSE LENGTH =
                               6912 X 0.72 uS
                              ;= TP OF 10 MS =
                               100 Hz
     CLI                      ;DISABLE
                               INTERRUPTS
```

```
MOV DX,MAXCOUNTA          ;LOAD MAX COUNT
                           REGISTERS
MOV AX,MAXA
OUT DX,AX

MOV DX,MAXCOUNTB
MOV AX,MAXB
OUT DX,AX
MOV DX,TIMERMODE         ;PROGRAM TIMER 1
                          CONTROL REGISTER
MOV AX,SQUAREWAVE        ;FOR SQUARE WAVE
                          OUTPUT
OUT DX,AX

HLT                      ;STOP

ORG 07F0H
JMP 0FFC0:0000

ORG 0800H
CODE ENDS
END
```

Streaming data to the Hard Disk

Data logging by the 80188 SBC can be achieved by uploading the acquired data to the PC via the RS232 serial link. The following program allows serial data received at the COM1 terminal to be written to disk in real time. A file 'UP' is created which contains the captured data. Pressing the enter key will cause exit to DOS.

The executable file is assembled via the A86 assembler and results in a DOS COM file, which will run on any PC.

```
;DATAIN.ASM
CODE SEGMENT
ASSUME CS:CODE,DS:CODE

ORG 100h

               INDEX         DW 0
               FILENAME      DB
'C:\8088\ASM\UP',0 ;Filename
               FILE_HAND     DW 0
               ACQUIRED_DATA DB 1 DUP(0)

COM1 EQU 03FDH            ;Serial port
                          address
START:
LEA DX,FILENAME           ;Create file
MOV CX,00h
MOV AH,03CH               ;DOS function
                           call 3CH
INT 021H
MOV FILE_HAND,AX        ;Open file

LEA DX,FILENAME
MOV AL,1                 ;Write only
MOV AH,03DH              ;DOS function call-3DH
INT 021H

                         ;Configure
                          communications
                          protocol
MOV AL,0E3H          ;9600 baud,8 data bits,1
stop bit, no parity
MOV DX,00            ;COM1
MOV AH,00            ;BIOS call-serial
communications
INT 014H

NEXT:
MOV AH,1             ;Test for received
character
INT 16H
JNZ FINISH

      MOV DX,COM1
hsk:  IN AL,DX
      TEST AL,01           ;Byte received?
      JZ hsk               ;No

SUB DX,+05                 ;COM1 port address
IN AL,DX                   ;Fetch data byte

MOV BX,index
MOV BYTE PTR DS:ACQUIRED_DATA[BX],AL   ;Write

byte
CALL WRITE

     JMP NEXT

FINISH:
MOV BX,FILE_HAND           ;Close file
MOV AH,03EH                ;DOS function call-3EH
INT 021H

           MOV AH,04CH     ;Return to
           DOS
           INT 021H


WRITE PROC NEAR
PUSH CX

MOV BX,FILE_HAND           ;Write buffer contents
                            to file 'UP' MOV
CX,1                       ;Write byte to file
LEA DX,ACQUIRED_DATA
MOV AH,040H                ;DOS function call-40H
INT 021H

POP CX
RET
WRITE ENDP

                           CODE ENDS
                           END START
```

Next Month...

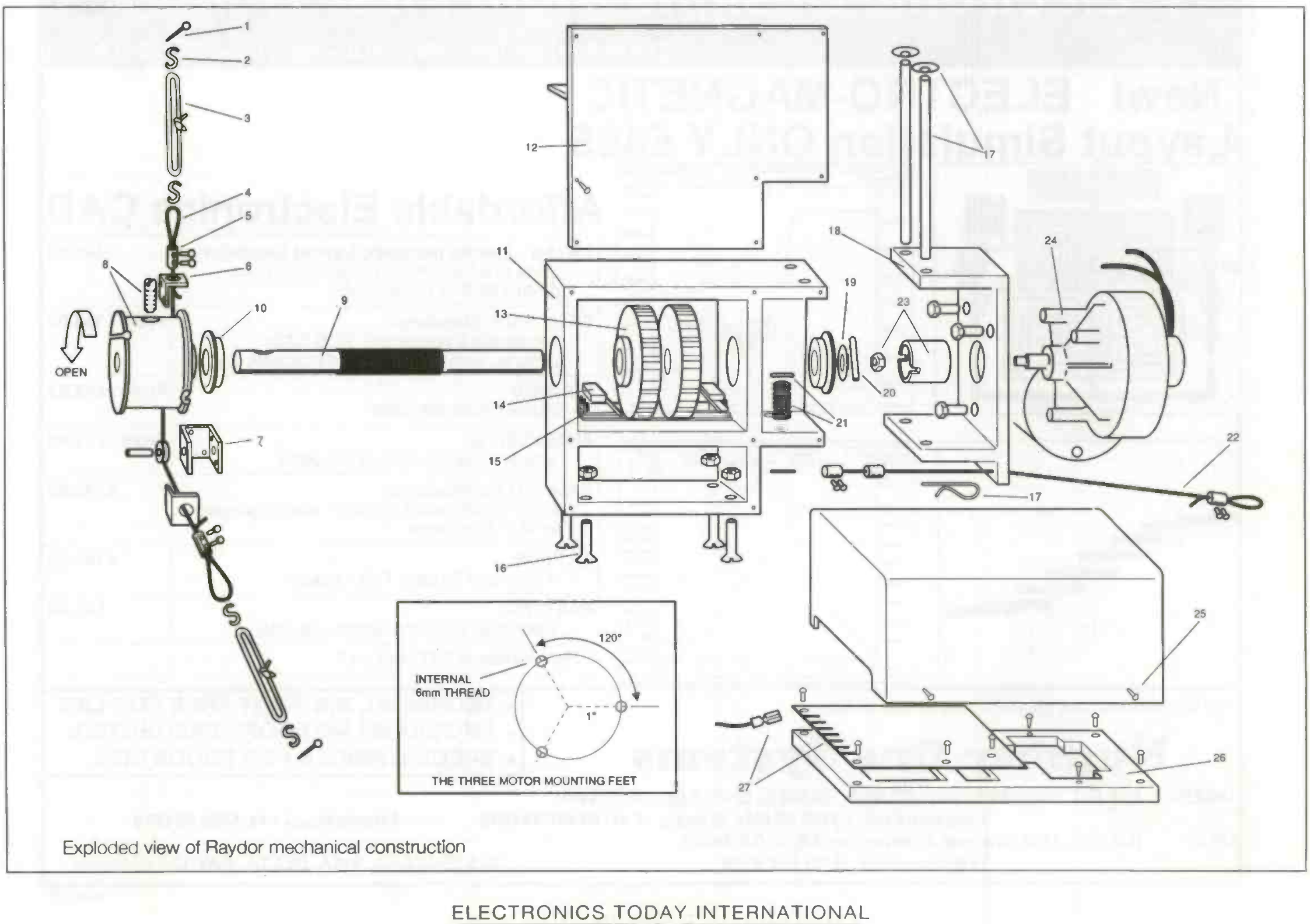
we will continue be lookingat the first of the 80188 SBC add-on boards.

RAYDOR

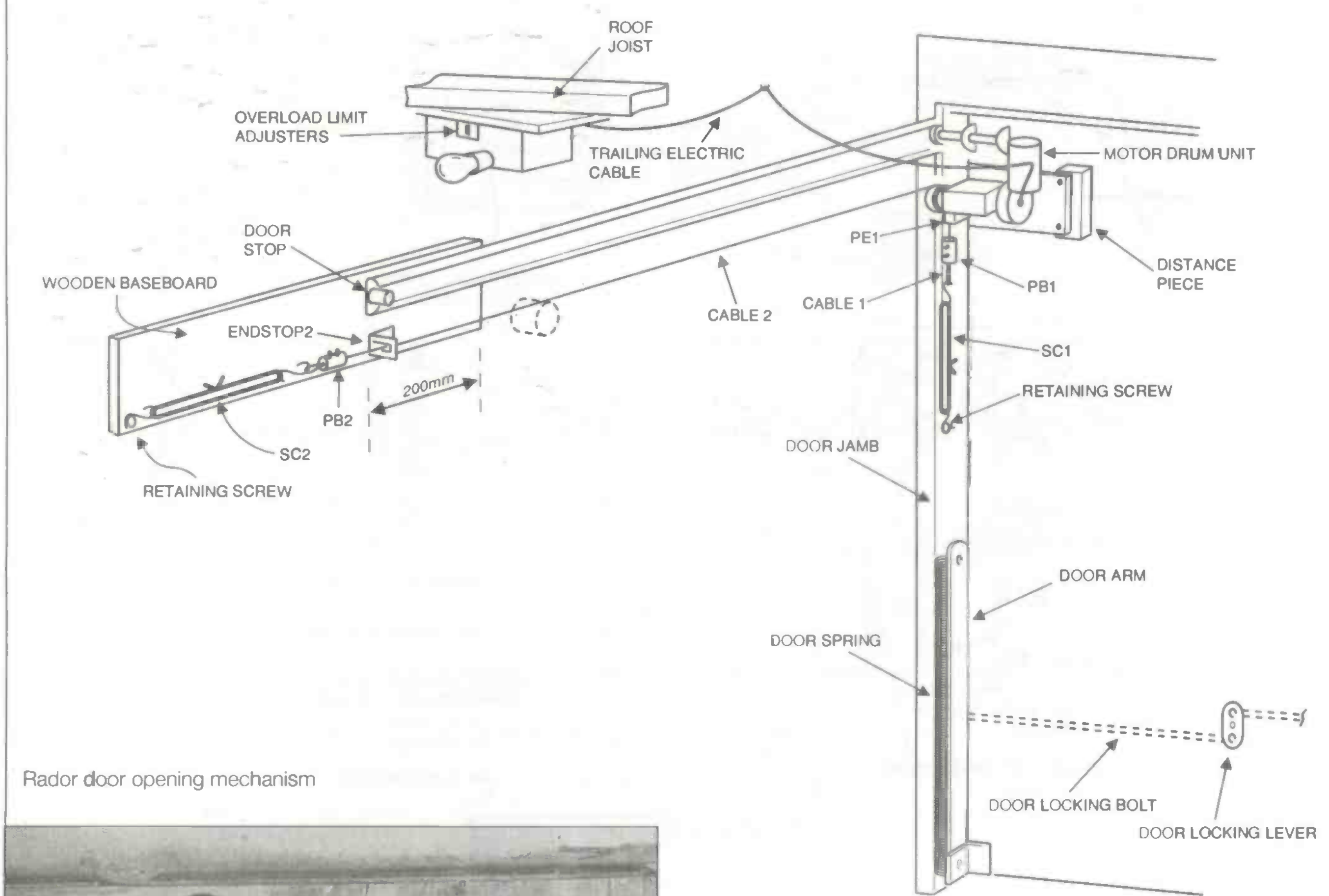
Part two of Pat Alley's patented remote controlled automatic garage door opener

Last month we looked at the basic mechanics of the Raydor remote controlled garage door opener. This month we look at the controlling electronics

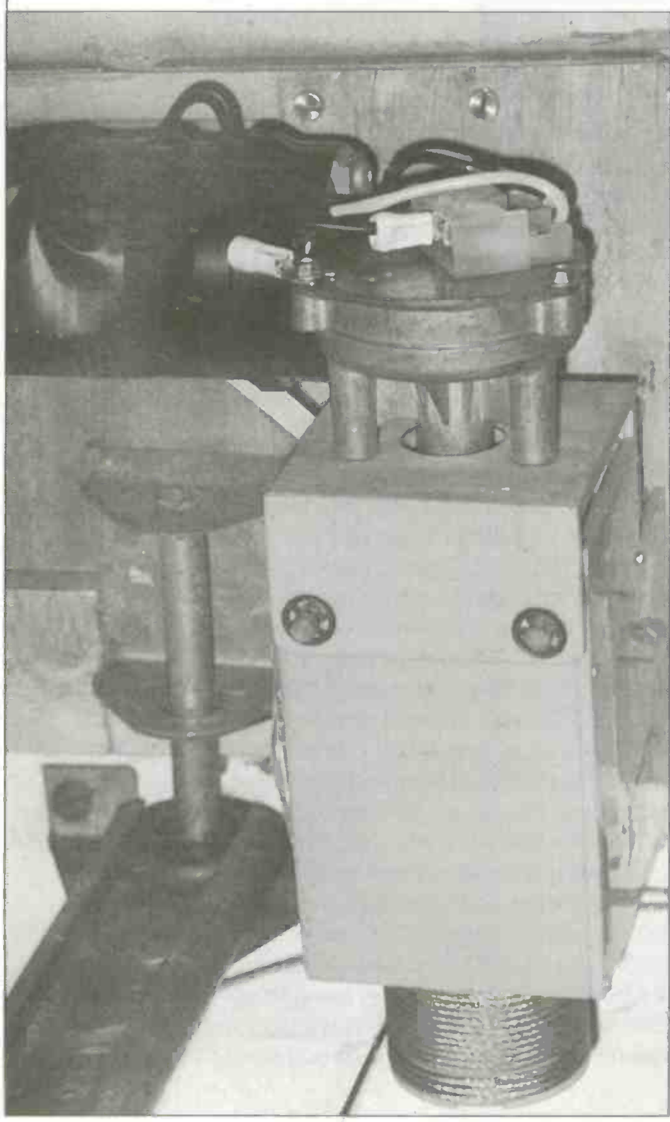
The mains fused at 2 amps at the plug and a back-up 3amp thermal FS1 on the PCB, is fed straight to the primary of a 15-0-15V 50VA fully isolated transformer and relay RLC contacts, timed to switch off the control box light three minutes after the door closes. The centre tap of the transformer secondary is connected to mains earth, as is the motor body. The low 30VAC is fully rectified into +15V and -15V (but not smoothed) relative to mains earth. This is used to power the motor forward or in reverse when relay contacts RLA or RLB are closed respectively. FS2 and FS3 protect both the transformer secondary winding and RLA/RLB contacts against simultaneous operation of RLA/RLB. High spikes of back emf from the motor are limited to 68V by the paralleled VDR across the motor. The electronic circuit 0V line is meanwhile connected to the -15V line which allows diode D2 to sample the full +30VDC alternating current, which is smoothed by C1 to about 40VDC and fed by a resistor chain to two voltage comparators IC4a and IC4b. These comparators act as motor overload detectors. Should the voltage fall to a value preset by VR1 on door opening (or VR2 on door closing), the respective comparator outputs a low. D1 rectifies only 15VAC and C2 smoothes it to about +21VDC which is used for the relay coil



Exploded view of Raydor mechanical construction



Rador door opening mechanism



circuits and for powering the radio receiver, Q1, ZD1, R1, R2, C3, and C4 regulate and smooth the voltage for the ICs to about 8.1V.

The four gates of IC1 are configured as an alternate action switch (A/S) with IC1b controlling the up-line or opening phase of the door and IC1a the down line or closing phase of the door. C10 ensures that IC1a outputs a high when the mains is first switched on. The A/S can be triggered from the press switch SW1, or the radio transmitter via its receiver. On triggering the A/S, IC1b outputs a high which charges the down-line timing capacitor C13 (when IC1a was high it charged the up-line capacitor C12) and charges timer capacitor C14 which, via IC2a, Q5 and RLC, switches on the mains light. Meanwhile, slugging components R14/C11 introduce a 1 second delay before IC2b outputs a high which, via microswitch MS2, switches on Q2 causing the RLA1 contact to close and run the motor forward to open the door. On commencing to open, the mechanical disc nuts (DNs) move axially and MS1 contacts close which is incidental. When the door reaches the fully open position, MS2 is operated by DN2. This physically interrupts power to Q2 and thus RLA de-energises to stop the motor.

Meanwhile on the way open various exigencies could occur requiring the door to be stopped immediately (e.g. door in jeopardy of hitting obstruction). The user could anticipate this by sending a normal trigger signal via SW1 or the remote radio transmitter. This will operate the A/S, sending IC1b low, D7 and R13 will discharge C11 quickly and Q2 will switch off, causing RLA1 contacts to open and switch off the motor. Alternatively, if the door should hit the obstruction, the motor current will increase rapidly as it begins to stall and the voltage on C1 will drop rapidly such that IC4b will output a low, IC3d will output a

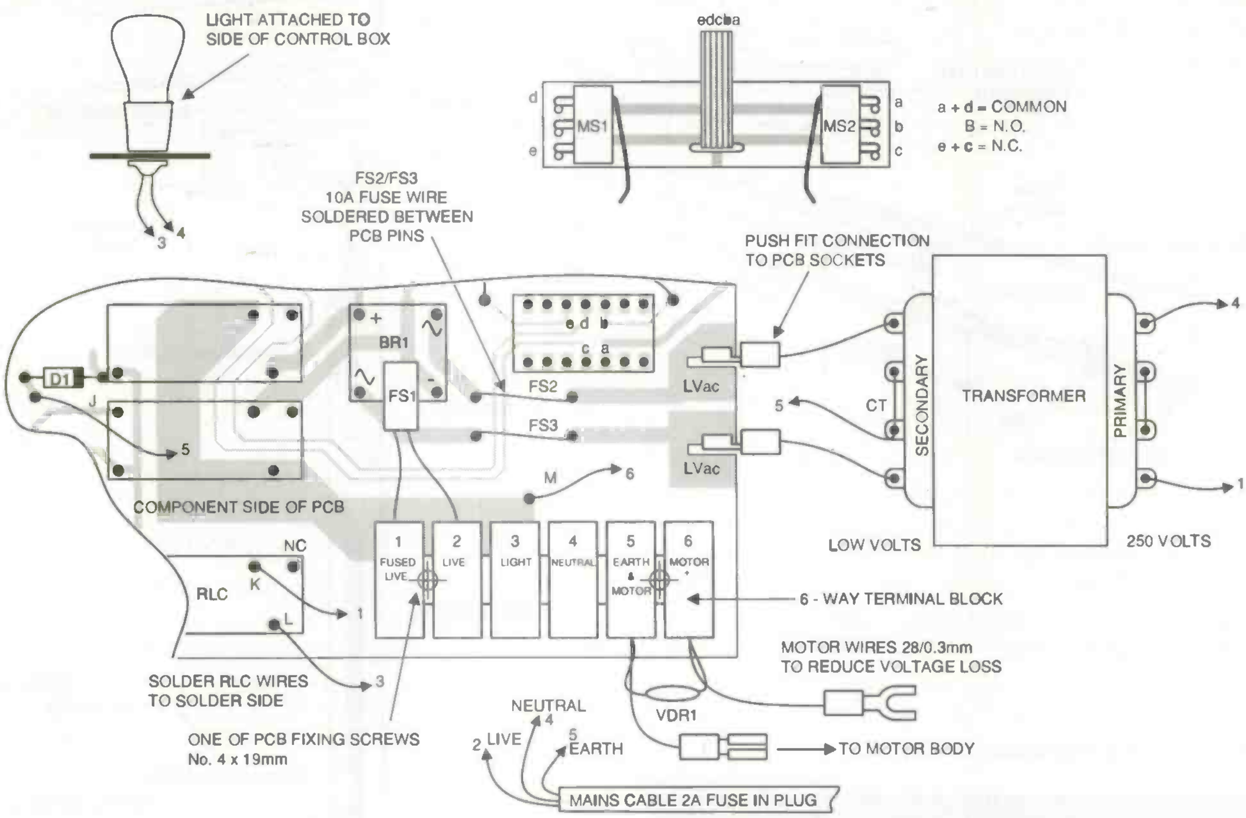


Fig.3 Raydor circuit wiring

high and, via slugging components R9/C7, IC2c will output a high within 1/10 second and trigger the A/S to stop the motor. In all the above cases, subsequent re-triggering of the A/S will cause the motor to restart.

Once the door is opened it can be triggered closed, this time IC1a outputting a high. Simultaneously, two actions occur which are features of this circuit. The first action is that IC2d goes high, Q3 switches on and supplies only holding current to RLB which is insufficient to energise RLB. The second action (which can only ever happen when the door is fully open) is that IC3a outputs a high, Q4 switches on and augments the current to RLB sufficient to energise it, causing the motor to run in reverse to close the door. As the DNs start to travel, MS2 is released, causing IC3a to output a low and Q4 switches off, leaving only the holding current from Q3 to maintain RLB energised (it will be appreciated that a relay needs less current to remain energised than it takes to energise it). Normally the door will run to the closed position where DN1 will operate MS1 to open its contacts, physically interrupting power to Q3 which de-energises RLB and stops the motor. Also, once the door begins to run closed and IC1b outputs a low, C14 will begin to discharge and, three minutes later, Q5 will switch off and RLC1 opens to switch off the light.

Meanwhile, during the closing cycle, similar exigencies as before may occur to necessitate prompt re-opening of the door (a better proposition than simply stopping it). Once again, the user can anticipate it by initiating a normal trigger signal or, if the door hits the obstruction, it will occur automatically via the closing overload circuit IC4a, IC3b and IC2c. In either case, the A/S will operate causing IC1a to output a low which via IC2d and Q3 will quickly de-energise RLB to stop the motor.

Simultaneously, IC1b will output a high but, due to the slugging components R4/C11, RLA does not energise for 1 second and this prevents immediate reversal of motor rotation which may otherwise cause both electrical and mechanical damage. The door now runs open (but can be stopped once again as previously described) until, when fully open, MS2 is operated by DN2. Thus, it will be appreciated that, in spite of fully automatic door operation and safety devices, the user never loses overriding control.

Finally, if for some reason during operation the safety features failed (e.g. the motor stalled) or the drive was lost between motor and the door (e.g. the cable broke, unwound etc. leaving the motor to run all the time you were away on holiday!), C12 or C13 would discharge as appropriate within about 25 seconds resulting in power being removed from the motor. It may be of interest to note that, given a low impedance power output such as a car battery, windscreen wiper motors can develop a power approaching 1hp. Fortunately, with Raydor, maximum power is curtailed to 50 watts (all the transformer can output) and 7 amps (due to the relatively high output impedance of the transformer secondary) which the motor, transformer and BR1 can easily sustain for 25 seconds. In a destruction test carried out, the motor remained cold and could withstand being permanently stalled. The transformer got quite warm but could no doubt also sustain a permanently stalled motor. However, BR1 reached a temperature exceeding 150°C after 5 minutes and went short circuit. This is the reason for the 85°C thermal fuse FS1 being fitted in close contact with BR1 so that, if all else fails, FS1 will blow early thus disconnecting the mains voltage and source of the heat.

CONSTRUCTIONAL DETAILS

PCB and soldered components

With regard to the main PCB supplied and the screen printed component overlay, ignore R7. A dashed line indicates a shorting wire. A modification needed to be carried out on the PCB is to out the track as shown between R5 and D4 and then with a short length of insulated wire join the two points both marked X i.e. D4 to D3 and C5 as per the circuit diagram.

Solder in the shortest components first. This means starting with all the resistors and finishing with the relays. Ensure you get the polarity correct for the electrolytic capacitors and BR1. Solder in the pins for FS2 and FS3, wrap 10amp fusewire round them then solder to the pins. Finally solder the four short wires J - M to the PCB as shown in fig. 3. Note that the only parts of the PCB carrying mains voltage are the two RLC contacts.

Once all the components have been soldered in, fit the PCB into position onto its integral base standoffs, ensuring minimum clearance from the side of the lid and that the overload limit pots VR1 and VR2 align with the lid cut-outs. Hold the PCB down with a finger, remove the lid and mark the integral base plate standoffs coincident with the 5 PCB holes. Drill 1.5mm pilot holes and screw the board down onto the control box base plate using three No.2 x 8mm self-tapping screws. Now screw down the 6-way terminal block with two No.4 x 19mm screws. Drill 3mm holes and screw down the transformer using two No. 6 x 19mm self-tapping screws.

Transformer

The transformer supplied has both primary (mains) and secondary (low voltage) connections on one side which should face toward the rear of the base plate away from the PCB. The four top primary connections and four bottom secondary connections are well marked but, for those unfamiliar with the conventions, the two inner tags in both cases should be soldered together with a short lead as shown in fig.3 and, in the case of the secondary windings, both of the two inner tags constitute the centre tap. For those who supply their own transformer, ensure the primary connections face away from the PCB as shown in fig.3.

Wiring details

In all cases, normal 7/0.2mm equipment wire can be used except for the 3-core mains cable from the plug (fused to 2 amps) and the two 3 metre long 28/0.3mm motor connecting wires. Fig.2 shows all the wiring connections to the 6-way terminal block, each wire annotated with a number e.g. that from D1 is connected to terminal block No.5. The two 15vac connections are plugged into the rear PCB sockets and being unpolarised, can be connected either way round. A crimping tool is best used to connect the 7/0.2mm equipment wire to a PCB connector and the 28/0.3mm motor wires to their spade grips but, if one is not available, then use ordinary pliers. The lightbulb holder is fitted into the control box lid hole. The 3 amp

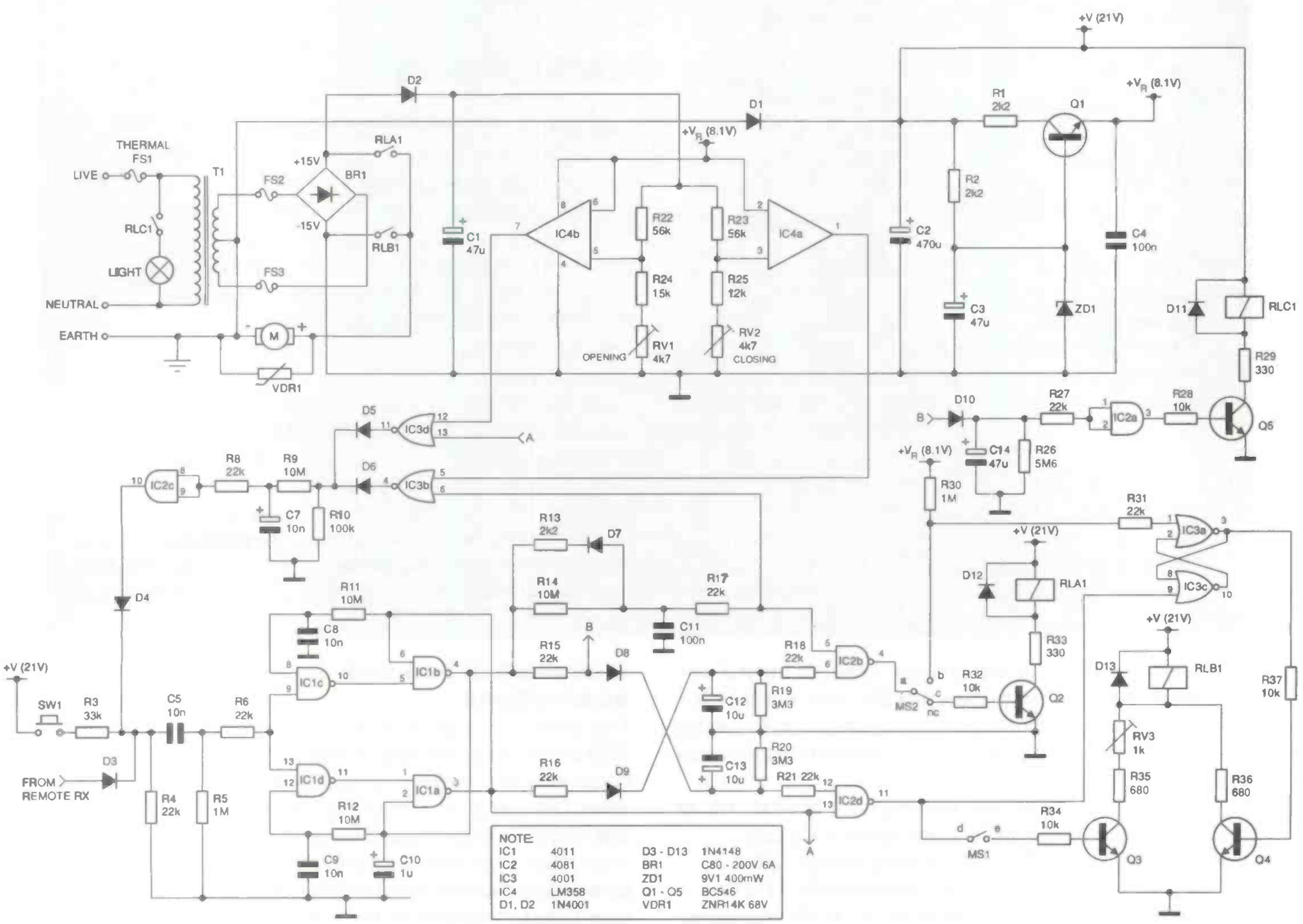


Fig.4. Raydor circuit diagram

PARTS LIST

Electronic components list for Raydor

RESISTORS all 1/4W, 5%

- R1 - 2K2
- R2 - 2K2
- R3 - 33K
- R4 - 22K
- R5 - 1M
- R6 - 22K
- R7 - NOT USED
- VCR8 - 22K
- R9 - 10M
- R10 - 100K
- R11 - 10M
- R12 - 10M
- R13 - 2K2
- R14 - 10M
- R15 - 22K
- R16 - 22K
- R17 - 22K
- R18 - 22K
- R19 - 3M3
- R20 - 3M3
- R21 - 22K
- R22 - 56K
- R23 - 56K
- R24 - 15K
- R25 - 12K
- R26 - 5M6
- R27 - 22K
- R28 - 10K
- R29 - 330
- R30 - 1M
- R31 - 22K

- R32 - 10K
- R33 - 330
- R34 - 10K
- R35 - 680
- R36 - 680
- R37 - 10K

- VR1 - 4K7
- VR2 - 4K7
- VR3 - 1K

CAPACITORS

- C1 - 47 µF/50V ELECTROLYTIC
- C2 - 470µF/25V ELECTROLYTIC
- C3 - 47 µF/16V ELECTROLYTIC
- C4 - 100n/25V ELECTROLYTIC
- C5 - 10n
- C6 - NOT USED/SHORTED
- C7 - 10n
- C8 - 10n
- C9 - 10n
- C10 - 1µF/16V ELECTROLYTIC
- C11 - 100n/16V ELECTROLYTIC
- C12 - 10µF/16V ELECTROLYTIC
- C13 - 10µF/16V ELECTROLYTIC
- C14 - 47µF/16V ELECTROLYTIC

SEMI-CONDUCTORS

- IC1 - 4011
- IC2 - 4081
- 1C3 - 4001
- IC4 - LM358
- D1, D2 - IN 4000
- D3 - D13 - IN 4148
- BR1 - C80-200V 6AMP
- ZD1 - GVI 400mW
- Q1 - Q5 - BC546
- VDR1 - 2NR 14K 68V

MISCELLANEOUS

SW1 - PRESS TO MAKE (BELL PUSH TYPE)
6 WAY TERMINAL BLOCK 5 AMP
DIL SOCKETS - 14 PIN X 4 8 PIN X 1
IDC TRANSITION CONNECTOR - 14 WAY
5-WAY RIBBON CABLE - 3 METRES
PCB PINS - 4 PLUS 10 AMP FUSEWIRE FOR FS2 & FS3
FUSE FS1 - 3 AMP THERMAL FUSE 85°C
EQUIPMENT WIRE 7/0.2mm - 10 metres
T & E CLAMPS X 2
RELAYS RLA1}
RLA2} G2L
RLA3}1N/O - 10 AMP CONTACTS

TRANSFORMER: 15 - 0 - 15V 50VA

The mechanical components detailed last month can be obtained directly from the author: Mr P H Alley, Squirrel Leap, Hagley Road, Fleet, Hants GU13 8LH. (Tel: 01252 621505)

thermal fuse FS1 is connected between terminals 1 and 2 with its insulated body laid flat on the top of BR1 (with a spot heat sink compound if available to enhance conductivity). For added safety. enclose the two leads of FS1 in insulated sleeving since they carry mains voltage.

Finally, fit the lid to the base, ensuring it is a good fit onto its base, if necessary filing away any high spots, the plastic urethane being easily drilled, filed or sandpapered. Drill four 1.5mm pilot holes, two either side, then screw the lid to the base using four No.2 x 12mm self-tapping screws. The mains lead, the two motor leads and ribbon cable can be taken out through the rear hole in the lid which may be enlarged as required.

Microswitch pcb and ribbon cable connections

First divide the copper side of the 76mm x 20mm microswitch PCB into six equal sections as shown dotted in fig.3, using a hobby knife and steel rule to isolate each section one from the other. Drill a series of 1.5mm holes the width of the ribbon cable then drill at an angle to join them all to form a slot. Drill three 1mm holes, 2mm from each end then solder in the six PCB pins. Laying each microswitch flat on the insulated side of the board, solder their tags to the pins. The levers of the microswitches can later be gently contoured for reliable contact with their respective DNs (disc nuts). For identification purposes

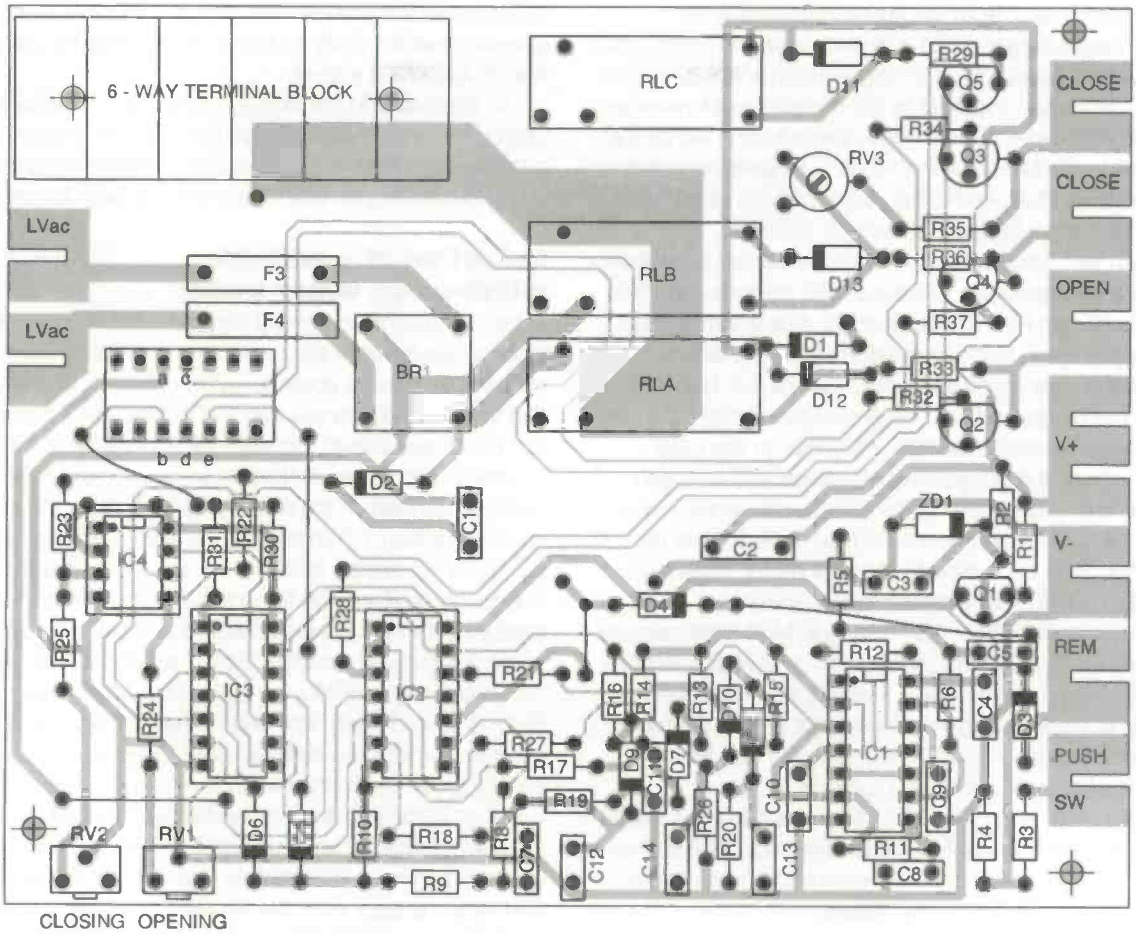


Fig.5.PCB component overlay

the connections of the microswitches are annotated a - e in fig.3 to correspond with the circuit diagram.

Care is needed when assembling the ribbon cable to its IDC connector. This is best done by placing the IDC connector base in its DIL socket, aligning the ribbon cable with the appropriate connectors then pressing the top down firmly. Next, polarise the IDC connector by cutting off pin 1 and placing a spot of glue in its corresponding DIL socket 1. Now identify each wire at the other end of the cable which also doubles as a continuity check. Drill a hole or slot in the rear of the drum unit, push the ribbon cable through then through the microswitch PCB slot and solder each lead to its appropriate copper strip.

Re-confirm continuity between each switch tag and its appropriate IDC pin ensuring isolation one from the other, noting of course that there is a switch continuity between C (common) and NC of the microswitch when the lever is not pressed and between C and NO when it is pressed. Place some glue along the PCB slot to act as a strain relief then, after wiping clean the copper side of the PCB, press down onto the double-sided adhesive strip. Wind the disc nuts to the centre, remove the protection paper from the double-sided adhesive then carefully position the microswitch PCB and press down.

For those who wish, the IDC connector and its DIL socket can be dispensed with and the ribbon cable soldered direct to the PCB. This will mean that the drum unit and control box are joined together by the ribbon cable but this does not make installation of Raydor any more difficult. Also, if desired, the microswitch PCB can be screwed or bolted down but drilling suitable holes in the main frame is difficult unless the microswitch assembly is reversed and placed in front of the disc nuts, in which case remember to reverse the positions of MS1 and MS2. MS2 is always the one nearest the motor.

BENCH TEST

To save time, it is advisable to carry out a bench test before installation begins. Simply connect the drum unit to the control box and push switch SW1 to the PCB sockets marked PUSH SW and V+. Remove the drum unit lid, wind the DNs close together away from MS1 and place a rubber band around MS1 so that its lever remains depressed. Press push switch momentarily and make sure the motor rotates in the door opening direction i.e. clockwise viewed from the motor. After a few seconds, press push switch again and ensure the motor stops. Now remove the rubber band from MS1 and ensure that the motor does not restart. Press push switch to restart the motor. After a few seconds, depress MS2 with your finger to stop the motor. Keeping MS2 depressed press push switch ensuring the motor runs in reverse then release MS2.

After a few seconds, press MS1 momentarily to stop the motor. After a few seconds, press push switch and allow the motor to run until it finally stops of its own accord after about 25 seconds. Now wind DN1 and DN2 about 15mm apart then, using two fingers to prevent them rotating, press push switch to start motor and this time allow DN2 to operate MS2. On the reverse closing cycle press push switch to check the stop/reverse feature.

Repeat as necessary and finally check that the light extinguishes three minutes after MS1 is operated. I do not advise checking the overload feature on the bench.

Selection of relay rib

For those using their own relays, choose a 6v - 12v relay for RLB and carry out tests to determine the limits of energisation and holding currents, including VR3 of appropriate resistance to trim RLB current in situ. (It will be understood that if, for example, a normal trigger signal is given to stop the motor when the door opening the output of IC1a goes high and R35 should ensure that the current supplied by Q3 is insufficient to energise RLB. Should R35 prove to be too low, the outcome will be that the motor will immediately reverse when IC1a goes high and since momentarily RLA and RLB contacts may be closed at the same time then either FS2 or FS3 or both will blow.

The bench test described in the previous section is designed to avoid the relays operating simultaneously by employing the rubber band to keep MS1 contacts open, thus ensuring RLB cannot energise when SW1 is pressed to stop the motor. If now the rubber band is removed within 25 seconds (i.e. before C13 has time to discharge) and RLB does energise (indicated by the motor running in reverse) then R35 is too low. In this case remove the power and progressively increase VR3 between repeated tests employing the rubber band (or keep MS1 lever depressed with your finger) until such time as RLB does not energise when SW1 is pressed to stop the motor. Note this VR3 setting (call it X). Now increase VR3 to maximum. Subsequently with the "door" fully open (i.e. MS2 is depressed), repeatedly press SW1 whilst reducing VR3 until RLB energises reliably to run the motor in reverse (call this Y). A suitable final setting for VR3 would be halfway between X and Y, so long as the difference between X and Y is significant. If not, then a change in value of R35 and/or R36 is called for.

Note that, in the case of the G2L relays supplied, the values of R35 and R36 are the result of exhaustive tests. VR3 should be set to 0 ohms (i.e. max anti-clockwise) and on no occasion so far has it ever needed to be increased.

MainPCB socket connections

These are all located along the free end of the main PCB. The two leads of the push switch SW1, located in the garage, are connected across the sockets marked PUSH SW and +V. The remote radio receiver is powered from socket marked -V (0V) and the socket marked V+ (+21V). If the receiver has an isolated relay output then its two signal leads are connected as for the push switch above (each socket can take two connections back to back). If the receiver has a CMOS or transistorised output of around +9V referenced to 0V then its one signal output lead is connected to the socket marked REM (remote).

The other sockets marked UP and DOWN are for test purposes and troubleshooting where, for example, a technician may want to simply run the door in one direction or another unencumbered by the automatics. Should you wish to use these at any time, a small modification will be required consisting of soldering a short wire to the ZD1/C3/R2 connection on the copper side of the PCB. Place a PCB connector, protected by an insulated plastic boot, on the other end of the wire. This short wire is hidden under the board. To make use of it, first remove the plug from the mains, pull the shorting wire out with a hook, slide the insulating boot off its connector and plug into the socket marked V-. Power is switched on and since the Zener and C3 are now shorted out, Q1 output is 0V and therefore all ICs rendered inoperative.

To run the door open - Connect SW1 to sockets marked V- and UP. The motor will now run forward whilst SW1 is kept depressed (i.e. the UP socket is connected on the PCB to Q3 collector and closing SW1 simply shorts the Q2 collector - emitter junctions).

To run the door down - Place a shorting connection across the two DOWN sockets and transfer SW1 lead from UP to DOWN. The motor will run in reverse whilst SW1 is kept depressed (the shorting connector, which simply connects the collectors of Q3 and Q4, can be left in so that running the door up and down is merely a case of transferring the SW1 lead from the UP to DOWN socket).

An alternative to the above is to use a 12V battery. First, unplug the control box positive lead from the motor, then connect the 12V battery (1 amp hour upwards) across the motor depending on which direction you wish to run the motor.

Selection of a suitable windscreen wiper motor

There are several sources of second-hand windscreen wiper motors, varying from the removal of one from a car you, a family member or friend is about to scrap or one from a scrapyard. Get the smallest one you can find - it shouldn't cost more than £5. The motor should rotate about 40 - 70 RPM offload at around 1 amp or less in the normal direction of rotation (DOR) and should rotate in the reverse DOR at about the same speed at no more than 1.5 amps. For those who wish to purchase the drum unit but supply their own windscreen wiper motor, ensure that the three 6mm bolt fixing feet are spaced according to fig.1 (bottom centre) of the previous article. As already stated, this spacing is virtually standard for all car windscreen wiper motors. Also most output shafts are about 10 - 15mm long with either a 6mm or 8mm thread. The end of the simple drive block you construct, should be screwed onto the shaft and the free end should extend no more than 28mm from the inside surface of the pivot frame (if it does exceed 28mm you will have to use spacers under the motor's fixing feet). The free end of the drive block should have diametrically opposed slots which can be filed to just greater than the diameter of the drum shaft drive pin (1/8" diameter Selok pin) and about the same depth.

Although the 50 watt transformer used in Raydor hardly begins to utilise the tremendous torque of which a windscreen wiper motor is capable, it makes sense to use the normal DOR (i.e. polarity) for opening the door (which needs more torque than for closing). One reason for this is because not all wiper motor armatures are neutrally wound (i.e. consume approximately the same current in both DORs) and another is that the worm and gear may be cut so as to transmit torque more efficiently in the normal DOR it was designed for. If it is found that with normal polarity the shaft rotates anti-clockwise as viewed from the motor then use this DOR for opening the door. In such a case there will be the small advantage of height clearance in fitting the motor/drum unit to the right-hand side of the door where the cables will come off the top of the drum.

WARNING

Be aware that if the Raydor circuit is powered from the mains then the 0V line of the electronic circuit is -15V below mains earth. For this reason an oscilloscope should not be used to check circuit operation unless suitable precautions are taken to prevent heavy low voltage do current flow through the oscilloscope ground lead which will blow FS2/FS3.

Practically SPEAKING

BY TERRY BALBIRNIE

Tools of the trade

This month and next, we shall look at some of the tools which are needed by the electronics hobbyist. Soldering equipment is not included because this has already been discussed in previous parts of the series

Some amateurs try to avoid buying special tools and rely on those found lying around or in the car toolbox. Others buy dozens of items which they will rarely use. Only a few special tools are really needed and they cost very little. Before proceeding, it should be stressed that the first requirement is a pair of safety goggles. Whenever working with materials where pieces could fly into the eyes, these must be worn.

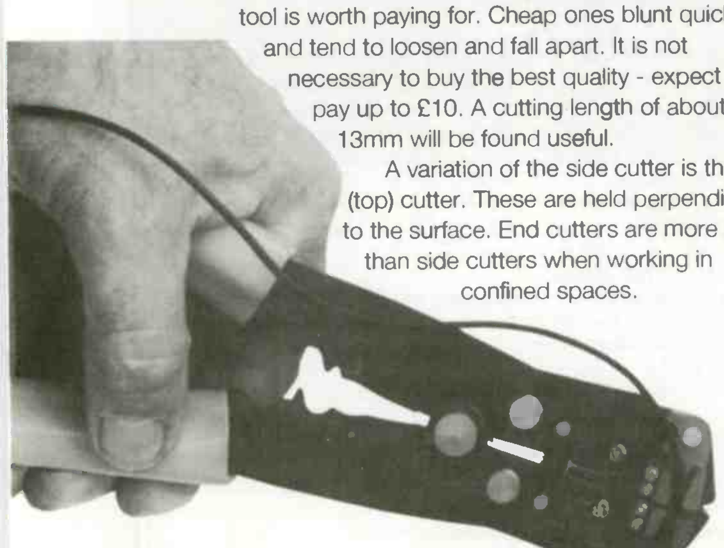
A bit screwy

Some small screwdrivers will be needed for inserting and removing fixings in cases, tightening grub screws in control knobs and similar jobs. For low-volume amateur use, cheap ones will be adequate - you need pay no more than 60p each. Buy a minimum of two flat-blade screwdrivers, one with a 3mm blade and one a little larger - say, 5mm. You will also need two or three small crosspoint screwdrivers. Do not try to make do without these by jamming a flat blade into a crosspoint head. Either it will chew up the head, damage the screwdriver or will not grip properly. Worse, it may jump out of the head and scratch the surface or injure your hand. If you decide to buy a set of screwdrivers, ask yourself if you are likely to need all the styles and sizes.

Cut up

Side cutters are used to snip off lengths of wire. They are also used to cut excess component lead from the soldered joints on a circuit panel. This is an area where a good quality box-jointed tool is worth paying for. Cheap ones blunt quickly and tend to loosen and fall apart. It is not necessary to buy the best quality - expect to pay up to £10. A cutting length of about 13mm will be found useful.

A variation of the side cutter is the end (top) cutter. These are held perpendicular to the surface. End cutters are more useful than side cutters when working in confined spaces.



Again, it is best to avoid the cheapest ones - pay the same as for side cutters. Many people use end cutters exclusively for cropping excess wire from the underside of a circuit panel.

The heavy type of combination pliers may be occasionally useful but the snipe nose variety will be found handier for light electronics work. These serve several purposes. They may be used to grip components or pieces of wire while they are being manipulated into place. Pliers may also be used for bending end leads, component tags, etc. It is better to use pliers for this type of job rather than using the fingers - they give a tighter bend and a more professional-looking finish. Pliers are also useful as a heat shunt when soldering heat -sensitive components into position. If they are used to grip the lead between the component and the soldering iron, they will conduct the heat away and prevent damage.

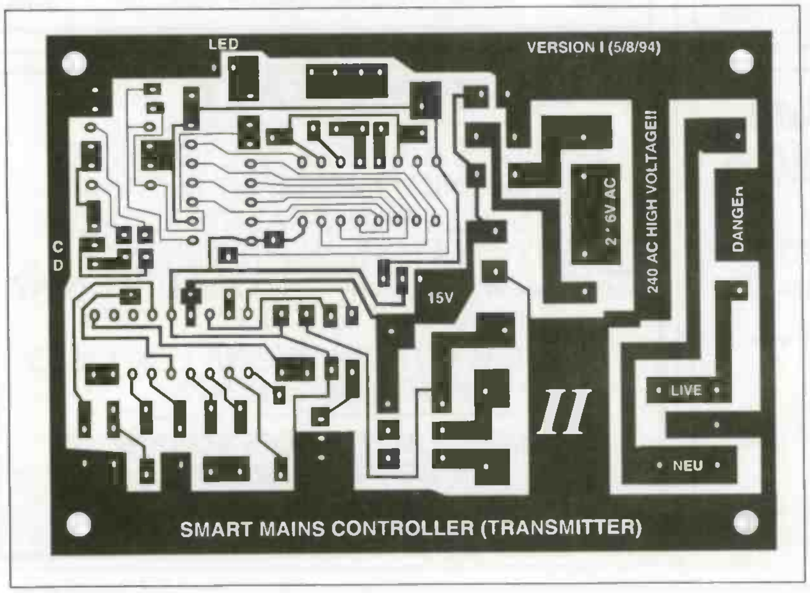
Every electronics hobbyist needs a pair of wire strippers. These are needed to remove the insulation from a piece of wire. Do not rely on using pliers, side cutters or - worse still - scissors or teeth! The danger is that if the wire is of the stranded type, some of the copper conductors will be lost. This means that the wire will end up with a lower current-carrying capacity than before. If the wire is of the single strand type, a small nick is often made in the wire. This may not be noticed but, sooner or later, the wire will break at that point. Wire strippers avoid this problem.

There are various types of wire strippers - those which need an adjustment for the wire size and those that do not. The "single-action" type is particularly useful. These may seem clumsy and it is not always possible to manoeuvre them into difficult positions but they work well. The wire is simply placed in position and the handles squeezed. The tool grips the work then cuts and strips the insulation. If possible, try out different types of wire stripper before buying the one which seems best for you.

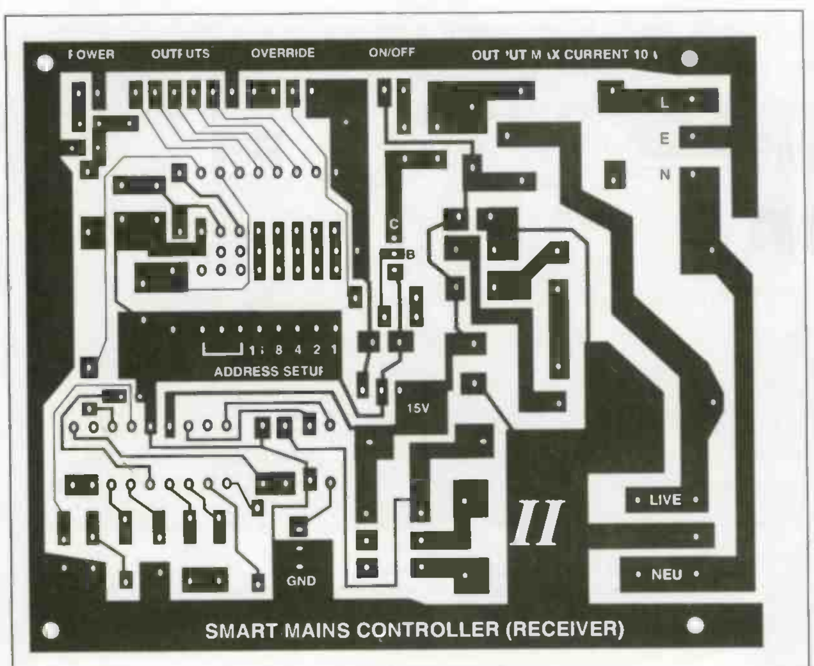
That's all for this month. Next time we shall pursue our look at workshop tools.

ETI ELECTRONICS TODAY INTERNATIONAL

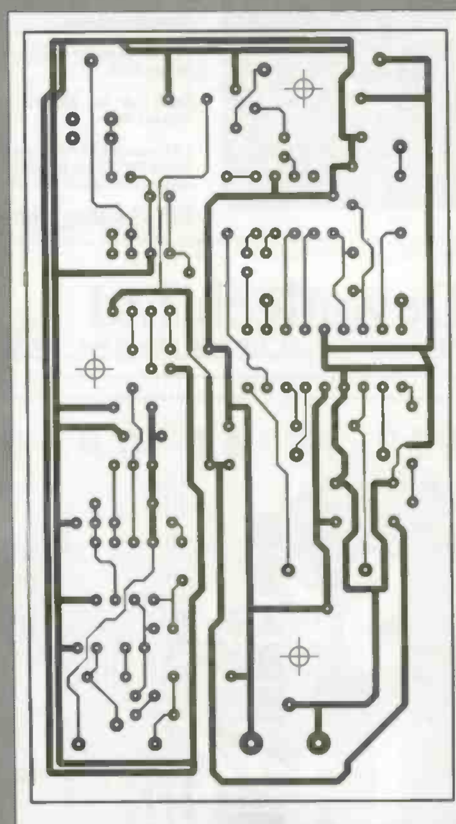
FOILS FOR THIS ISSUE



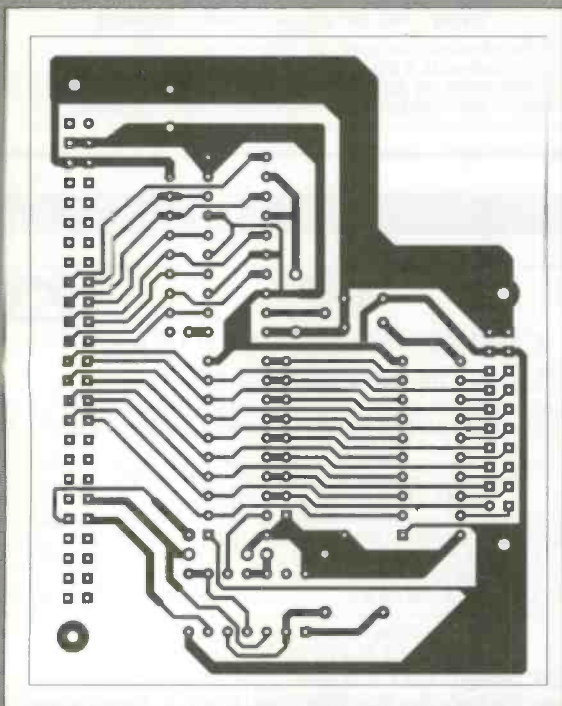
Smart Mains Control



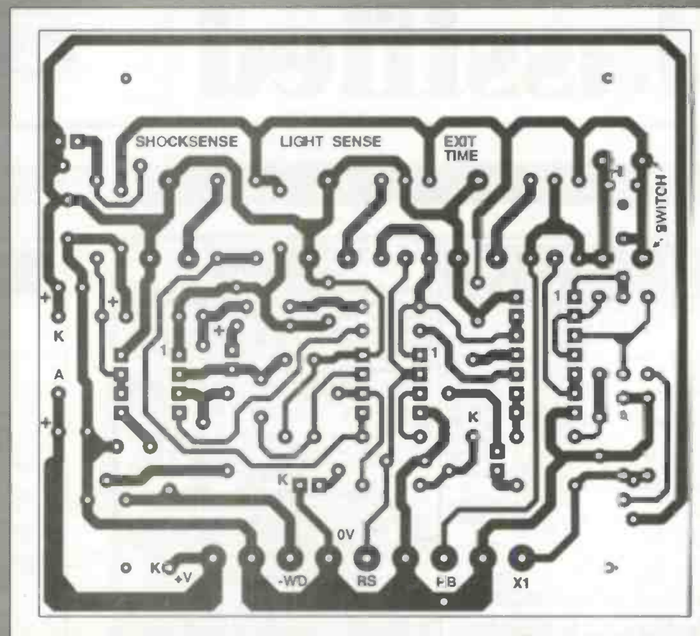
Smart Mains Control



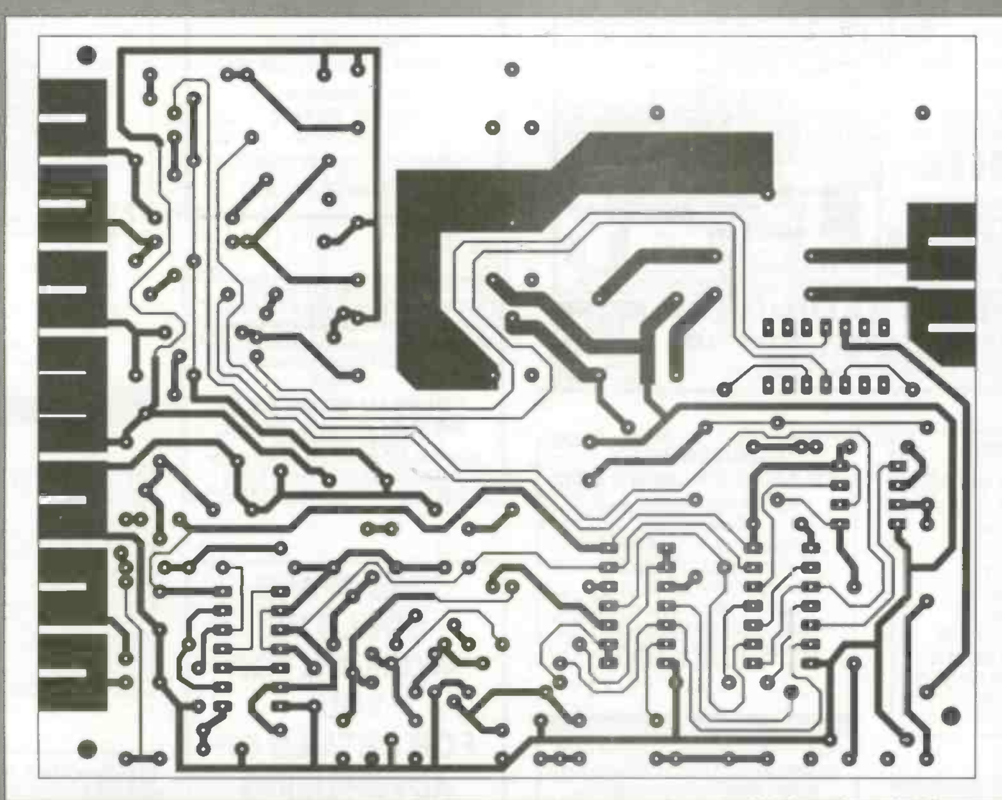
Laser Tag



PCW I/O Port



Garden Shed Alarm



Raydor

ETI Classified

James Gale 01442 66551

Send your requirements to:
ETI Classified Department, Nexus, Nexus House, Boundary Way, Hemel Hempstead, HP2 7ST
Lineage: 70p per word (+ VAT) (minimum 15 words)
Semi display: (minimum 2.5cms)
£9.50 + VAT per single column centimetre

VISA Access

Ring for information on series bookings/discounts.
All advertisements in this section must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

FOR SALE

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220/240V AC 50/60
OUTPUT 0-260V

	Price	P&P
0.5KVA 2.5 amp max	£31.90	£6.00
	£44.53 inc VAT)	
1KVA 5 amp max	£41.15	£7.00
	(£56.58 inc VAT)	
2KVA 10 amp max	£59.40	£8.50
	(£79.78 inc VAT)	
3KVA 15 amp max	£78.65	£8.50
	(£102.40 Inc VAT)	
5KVA 25 amp max	£139.15	
	(Plus Carriage)	

Buy direct from the Importers. Keenest prices in the country

COMPREHENSIVE RANGE OF TRANSFORMERS–LT–ISOLATION & AUTO
(110-240V Auto transfer either cased with American socket and mains lead or open frame type. Available for immediate delivery

WIDE RANGE OF XENON FLASHTUBES
Write/Phone your enquiries

ULTRA VIOLET BLACK LIGHT FLOURESCENT TUBES

4ft 40 watt £14.00 (callers only)	(£16.45) incVAT
2ft 20 watt £9.00 (callers only)	(£10.58 inc VAT)
12in 8 watt £4.80 + 75p p&p	£6.52 inc VAT)
9in 8 watt £3.96 + 50p p&p	(£5.24 inc VAT)
6in 4 watt £3.96 + 50p p&p	(5.24 inc VAT

230V AC BALLAST KIT
For either 6in, 9in or 12in tubes £6.05 + £1.40 p&p (£8.75 inc VAT)
The above Tubes are suitable for Forged Bank Note detection, security marking etc.
Other Wave Lengths of U.V. TUBE available please telephone your enquiries.

400 WATT UV LAMP
Only £38.00 + £4.00 p&p £49.35 inc. VAT)
160 WATT SELF BALLASTED BLACK LIGHT MERCURY BULB
Available with BC or ES fitting, price inc VAT & p&p and VAT £25.55

12V D.C. BILGE PUMPS
500 GPH 15ft head 3 amp £19.98
1750 G P H 15ft head 9 amp £34.55
Also now available: 24V D.C. 1750 GPH 15ft head 5 amp £35.55. All designed to be used submerged. PRICES INCLUDE P&P & VAT

SUPER HY-LIGHT STROBE KIT
Designed for Disco, Theatrical use etc.
Approx 16 joules. Adjustable speed £50.00 + £3.00 p&p (£62.28 inc VAT)
Case and reflector £24.00 + £3.00 p&p (£31.73 inc VAT).
SAE for further details including Hy-Light and industrial Strobe Kits.

"BOFFINS SPECIAL" – UNIQUE OFFER
Surplus Precision Medical Unit, internally in excellent condition. Designed primarily to eject a precise controllable amount of fluid from a medical syringe (latter not supplied). Contains the following removable components: Dual Micro Processor Boards and EPROMS. Escap Precision 12V DC Motor with 300:1 Gear Box and optical encoder coupled to a precision threaded drive mechanism. Mains supply with 6 x 1.5V Ni-Cad A.A. cells back-up. L.C.D. Digital read-out 17mm high with legends. Audible warning
These are sold for the dismantling of the exceptional quality components. regret no Circuits available
Ridiculously low price: £20.00 + £4.00 p&p (£28.20 incl VAT)

3.5 KVA ISOLATION TRANSFORMER
New Manufacturers surplus mounted in a solid metal enclosure with a surface mounted MK Residual Current Circuit Breaker, Internally fused 240V AC Input and Output. External SHA. Ground Point. Ideal for work bench isolation etc. Size Width 44cm Depth 44cm Height incl. RCD 47cm.Weight 60 Kilos.
Price EX-WAREHOUSE £120.00 + V.A.T.

240V AC CENTRIFUGAL BLOWER
New Manuf. Surplus Skeleton Blower suitable for mounting inside an enclosure to cool equipment. Overall size 130x110x85mm Outlet 80x35mm. Impellor 60mm dia x 60mm long. £14.10 incl. P&P & VAT

SEWING MACHINE MOTOR
Brand new 220/240V AC/DC SEW-TRIC 2 lead Brush Motor. Size L. 100mm x H. 70mm x W.55mm. Spindle. 1/4in. dia x 1in. long. £14.10 incl. P&P & VAT

GEARED MOTORS
71 RPM 20lb inch torque reversable 115V AC input including capacitor and transformer for 240V AC operation. Price inc VAT & p&p £27.73

SOLID STATE EHT UNIT
Input 230/240V AC. Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, eg supplying neon or argon tubes etc. Price less case £8.50 + £2.40 p&p (£12.81 inc VAT) NMS

EPROM ERASURE KIT
Build your own EPROM ERASURE for a fraction of the price of a made-up unit kit of parts less case includes 12in 8 watt 2537 Angst Tube Ballast unit, pair of bi-pin leads, neon indicator, on/off switch, safety microswitch and circuit £15.00 + £2.00 p&p (£19.98 inc VAT)

WASHING MACHINE WATER PUMP
Brand new 240V AC, fan cooled. Can be used for a variety of purposes. Inlet 1½ in, outlet 1 in. dia. Price includes p&p & VAT. £11.20 each or 2 for £20.50 inclusive

MICROSWITCH
Pye 15 amp changeover lever microswitch, type S171
Brand new price 5 for £7.05 inc VAT & p&p

SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
FAX 081 995 0549 081-995 1560
ACCOUNT CUSTOMERS MIN. ORDER £10
Showroom open Monday/Friday
VISA
Ample Parking Space

VISA

COOKE INTERNATIONAL
SUPPLIER OF QUALITY USED TEST INSTRUMENTS

ANALYSERS, BRIDGES, CALIBRATORS, VOLTMETERS, GENERATORS, OSCILLOSCOPES, POWER METERS. ETC
ALWAYS AVAILABLE

ORIGINAL SERVICE MANUALS FOR SALE
COPY SERVICE ALSO AVAILABLE

EXPORT, TRADE AND U.K. ENQUIRIES WELCOME
SEND LARGE S.A.E. FOR LISTS OF EQUIPMENT AND MANUALS
ALL PRICES EXCLUDE VAT AND CARRIAGE
DISCOUNT FOR BULK ORDERS SHIPPING ARRANGED

OPEN MONDAY TO FRIDAY 9AM - 5PM
COOKE INTERNATIONAL
ELECTRONIC TEST & MEASURING INSTRUMENTS
Unit Four, Fordingbridge Site, Main Road, Barnham, Bognor Regis, West Sussex, PO22 0EB Tel (+ 44) 0243 545111/2 Fax + 44) 0243 542457

LIVERPOOL
PROGRESSIVE RADIO
87/93 Dale Street
Tel: 051 236 0982 051 236 0154
47 Whitechapel
Tel: 051 236 5489
Liverpool 2
'THE ELECTRONICS SPECIALISTS'
Open: Tues-Sat 9.30-5.30

LEN COOKE ENTERPRISES
For the best value in Used Electronic Test Instruments
We buy, sell and service oscilloscopes, signal generators, frequency counters, spectrum Analysers, Power meters, logic testers, etc.
Spare parts available for most Textronix scopes.
Tel: 081-813-9946
Fax: 081-574-2339
Mobile: 0374 759984
Mail order address: Unit 5, Southall Enterprise Centre, Bridge Road, Southall, Middx. UB2 4AI
We engineer what we buy, we support what we sell.

TURN YOUR SURPLUS TRANSISTORS, ICS ETC INTO CASH immediate settlement.
We also welcome the opportunity to quote for complete factory clearance
Contact:
COLES-HARDING & CO.
Unit 58, Queens Road, Wisbech, Cambs PE13 7PQ
BUYERS OF SURPLUS INVENTORY
ESTABLISHED OVER 20 YEARS
Tel: 01945 584188 Fax: 01945 475216

SWC SCIENTIFIC WIRE COMPANY
ENAMELLED COPPER WIRE
TINNED WIRE SILVER
PLATED COPPER WIRE
SOLDER EUREKA WIRE
NICKEL CHROME WIRE.
BRASS WIRE LI TZ WIRE
BIFILAR WIRE MANGANIN
WIRE TEFZEL WIRE NICKEL
SAE BRINGS LIST 18 RAVEN RD LONDON E18 1HW
FAX 081 559 1114

NEWMARKET TRANSFORMERS LTD
Mail Order Transformer Specialists.
Toroidal and Laminated Transformers, 3VA to 1kVA.
Fast delivery. Competitive prices. Quality guaranteed.
Phone: Michael Dornan on 0638 662989 for Immediate Quote

THIS SPACE COULD BE WORKING FOR YOU!
FOR DETAILS OF ADVERTISING RATES CALL JAMES ON 01442 66551

P.C. I/O CARD Manual 24 pages detailing I/O port addresses parallel, serial and joystick port data. Ideal for inputting and outputting data to and from a P.C. £3.20. E W Lofthouse, 155 Main Street, Scholes, Leeds LS15 4DP. Tel: 0274 390011.

PROJECTS FOR IBM-PC & LAPTOP PCS
Controlled by Printer or RS232 ports
Versatile 24-line I/O card, Data logging system sound sampler/playback, EPROM emulator, Stepper motor board (+A/D+I/O ports), 8031 development system. Z80 and 80535 single board computers, etc.
INNOVATIVE INTERFACING
58 Lamport Court, Manchester M1 7EQ
U.K. Phone/Answer/Fax: 061-272-8279

SOFTWARE

SCIENTIFIC SHAREWARE
Discover the true wealth of PD & shareware for the PC. Since 1982 PDSL have supplied the best and latest programs covering all interests *Business, Leisure, Engineering, CAD, DTP, Maths, Stats, Chemistry, Education, Electronics, Ham Radio, Esoteric, Meedical, Raytracing, Programming & languages, Tools, Utilities, WP, Editors, Comms, Special applications, Esoteric, Novelty, Astronomy & hundreds more.*

All software can be provided on Floppy disc or CD ROM.

Whatever your interest we probably have it. Send today for our PC Shareware reference guide. It runs to more than 250,000 words and is probably the most comprehensive catalogue currently available Send £2.50 (voucher provided refundable on first order) or phone/fax using Access/Visa/MC to:
PDSL, Winscombe House, Beacon Rd, Crowborough, East Sussex, TN6 1UL Tel 0892 663298 Fax 0892 667473

ASTRA *Desk Top Accounting™*
Overture - Invoicing, Sales, Purchases, Nominal, VAT, etc
Premier - plus Stock, Jobs, EPOS, Barcodes, Serial No, etc
Professional - plus Multi-Currency/Depts/Location, etc

S&S Systems Ltd, Bretton Court, Manor Road, Wales Sheffield, S31 8PD, UK (Software distributors and Apple dealers)
Tel: (01909) 773399 • Fax: (01909) 773645 • Int Code: (+44 1909)

PANELS

PANELS
ALUMINIUM OR STEEL
cut to size

SAE to P.M.S.
320C High Road,
Benfleet
Essex SS7 5HB
Tel: 0268 793381

BOOKS & PUBLICATIONS

"THE BUG CONSTRUCTORS MANUAL"
All you'll ever need to know about bugs & bugging. Over 40 bug circuits for every application, including high power & crystal controlled bugs. Many Hitherto unavailable circuits. This is the very latest book and the only book of its kind available in the UK.. An invaluable asset for the professional & hobbiest. Price £9.95 incl p&p. For immediate despatch send cheque or PO payable to:
GAINSFORD ELECTRONICS
at 71 Gainsford Road, Bitterne, Southampton SO19 7AW

PLANS

ELECTRONIC PLANS, laser designs, solar and wind generators, high voltage teslas, surveillance devices, pyrotechnics and computer graphics tablet. 150 projects. For catalogue. SAE to Plancentre Publications, Unit 7, Old Wharf Industrial Estate, Dymock Road, Ledbury, Herefordshire, HR8 2HS.

COMPONENTS

EPROMs,PLDs + microcontrollers copied or programmed. We supply devices/convert discrete logic to PLDs. PLDs for ETI PC POST card supplied at £10. PO Box 1561 Bath 0225 444467.

KITS

FREE 10 Watt amplifier + controls + catalogue + samples!! £1.00 postage & packing!! K.I.A. 1 Regent Road, Ilkley...... 60 watt amplifiers £5.00!!

COURSES

Start training now with the specialists for the following courses. Send for our brochure — without obligation or Telephone us on 0626 779398 ETI 3/95

Name ______________________

____

____

____

- ☐ **Telecomms Tech C&G 2710**
- ☐ **Radio Amateur Licence C&G**
- ☐ **Micro-processor**
- ☐ **Introduction to Television**

Radio & Telecommunications Correspondence School
12 Moor View Drive, Teignmouth, Devon TQ14 9UN

TO PROMOTE YOUR BUSINESS IN THE NEXT ISSUE OF ETI CALL JAMES ON 01442 66551

TO ADVERTISE FILL IN THE COUPON BELOW. IF YOU DO NOT WISH TO CUT YOUR MAGAZINE PLEASE SEND A PHOTOCOPY

ETI

ELECTRONICS TODAY INTERNATIONAL, CLASSIFIED ADVERTISEMENT DEPARTMENT, NEXUS HOUSE, BOUNDARY WAY, HEMEL HEMPSTEAD HP2 7ST

Rates: Lineage 70p per word + VAT minimum 15 words.
Semi-display £9.50 per single column cm plus VAT. No reimbursements for cancellations.
All ads must be pre-paid.

Name ....

Address ....

.... Daytime Tel. No: ....

Signature .... Date ....

PLEASE DEBIT MY ACCESS/BARCLAYCARD No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Expiry Date ....

FOR SALE **COMPONENTS** **PLANS** **OTHER - PLEASE STATE**

Open Forum

Ten years ago robots were all the rage and there was much discussion about them taking over the more menial jobs in manufacturing and service industries. New car factories were being built at the time, full of robot welding lines that could do the job better and quicker than any human. A great deal of press and TV coverage was given to events such as the Micromouse robot competition.

There were several companies manufacturing kits which allowed enthusiasts to build mobile robots and robot arms. There were even a couple of magazines devoted to practical robot building, plus quite a stack of books on the subject; even ETI carried a build your own robot project.

Then suddenly all interest seemed to disappear, the magazines ceased publication, the companies went out of business and the press were no longer bothered about robotics. It is difficult to say why this happened, though it was probably the result of media overkill. Too much hype for a subject which failed to deliver what the media and the enthusiast wanted.

The science fiction image of robots, the metal men, turned out to be in realty just rather sophisticated but otherwise boring pieces of factory automation.

But just because the media and the general public lost interest in robotics that does not mean to say that all research and development in robotics also ceased. Indeed, quite the opposite. Now in the mid 1990s we are beginning to see renewed popular interest in the subject.

The press and TV are once again curious to see what the designers of metal monsters are up to. Enthusiasts tired of playing with their personal computers are also rediscovering the intellectual challenge that is robotics. The only difference is that this time the robot developers have a lot more to show.

Robots of today are not just building cars, they are carrying out surgical operations. Neither are they blindly bumping their way around a maze; instead, six-legged metal insects are purposefully scuttling around labs, robot fish are swimming in a giant test tank and robot security men are guarding buildings and warehouses.

The robots that are being designed today are not the clunking metal men of films, but the explorers of distant planets and ocean bottoms, mankind's helpers for the future. This may all sound over-optimistic, and fanciful, but the technology behind both robotics and machine intelligence is advancing in leaps and bounds. Who knows what might be possible in another decade?

However, although both robotics and machine intelligence studies are advancing rapidly, they are still areas where big research and development funds are not always essential and where the individual researcher, perhaps even a knowledgeable amateur, can still make a major breakthrough.

This brings me to the main point, the fact that this magazine is breaking new ground with our proposals for the First ETI Amateur Robot Competition which will be held in London in January 1996. This may seem like a long way off but we want to give potential competitors plenty of time in which to work on good designs for what will be a difficult competition.

But do not be deterred from taking part simply because it is going to be difficult, we do not want this to be a competition where winning is all important, we want it to be one where taking part is the important thing. A competition where, hopefully, all the participants will learn from each other as well as from taking part, and where these new ideas can be applied in building better entries for the following year's competition.

Nick Hampshire, Editor of ETI.

Next.Month...

In the April 1995 issue of ETI we will be continuing our laser tag game project and Neil Birtles will be showing how to construct the light gun base unit. We will also be looking at the first of Richard Grodzik's add-on boards for his 80188 single board computer project.

If you have ever fancied the idea of building a computer controlled 'turtle', then the next issue of ETI has a project for such a robot which has been designed by Dr Pei An. From Richard Tanfield there is a design for a versatile Ni-Cad battery charger, and from Douglas Clarkeson there is an interesting project on the measurement of light.

We will also be examining the world's smallest computer programmable in Basic, the Parallax Stamp. Furthermore we will be describing the first of a series of applications projects based around this very useful little device.

Next month's Tomorrow's Technology feature will examine the current and future use of electronics in the film industry. PC Clinic will look at audio adapters and the FREE cover disk will contain more useful software for the electronics and computer experimenter.

ETI
ELECTRONICS TODAY INTERNATIONAL

EDITORIAL
Editor ***Nick Hampshire***
Sub Editor ***Eamonn Percival***
Editorial Assistant ***Wendy Butler***

CREATIVE
Designer ***Nadia Ahdout/Jeff Hamblin***
Technical Illustration ***John Puczynski***
Photography ***Manny Cefai***

ADVERTISEMENT SALES
Display Sales
Eric Thompson
Advertisement Copy Control
Marie Quilter
Classified Sales
James Gale

MANAGEMENT
Managing Director
Terry Pattisson
Circulation & Promotions Manager
Debra Stupple
Production Manager
Tony Dowdeswell
Group Editor
Stuart Cooke
Group Advertisement Manager
Claire Jenkinson

ABC CONSUMER PRESS
ISSN 0142-7229

ETI is normally published on the first Friday in the month preceding the cover date.

Subscription rates-UK £23.40 Europe £30.30 Sterling Overseas £31.50 US Dollars Overseas $52.00

Published by Nexus Special Interests, Nexus House, Boundary Way, Hemel Hempstead HP2 7ST. Telephone (0442) 66551. UK newstrade distribution by SM Distribution Ltd, 6 Leigham Court Road, London SW16 2PG. Telephone 081-667 8111. Overseas and non-newstrade sales by Magazine Sales Department, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST. Telephone (0442) 66551. Subscriptions by Nexus Subscription Services, ETI, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS. Telephone (0737) 768611.
US subscriptions by Wise Owl Worldwide Publications, 4314 West 238th Street, Torrance, CA90505 USA. For Visa/Mastercard orders in USA - Telephone (310) 375 6258 Fax (310) 375 0548. Pacific Time: 9am-9pm Weekdays. 10am-6pm Weekends. Typesetting and origination by Ebony, Liskeard, Cornwall. Printed by Wiltshire Ltd. Bristol.

NEXUS Special Interests

Nexus House, Boundary Way,
Hemel Hempstead HP2 7ST
Telephone (0442) 66551
Fax (0442) 66998