ETI

ELECTRONICS TODAY INTERNATIONAL

TOMORROW'S TECHNOLOGY TODAY

THE VIRTUAL WORLD

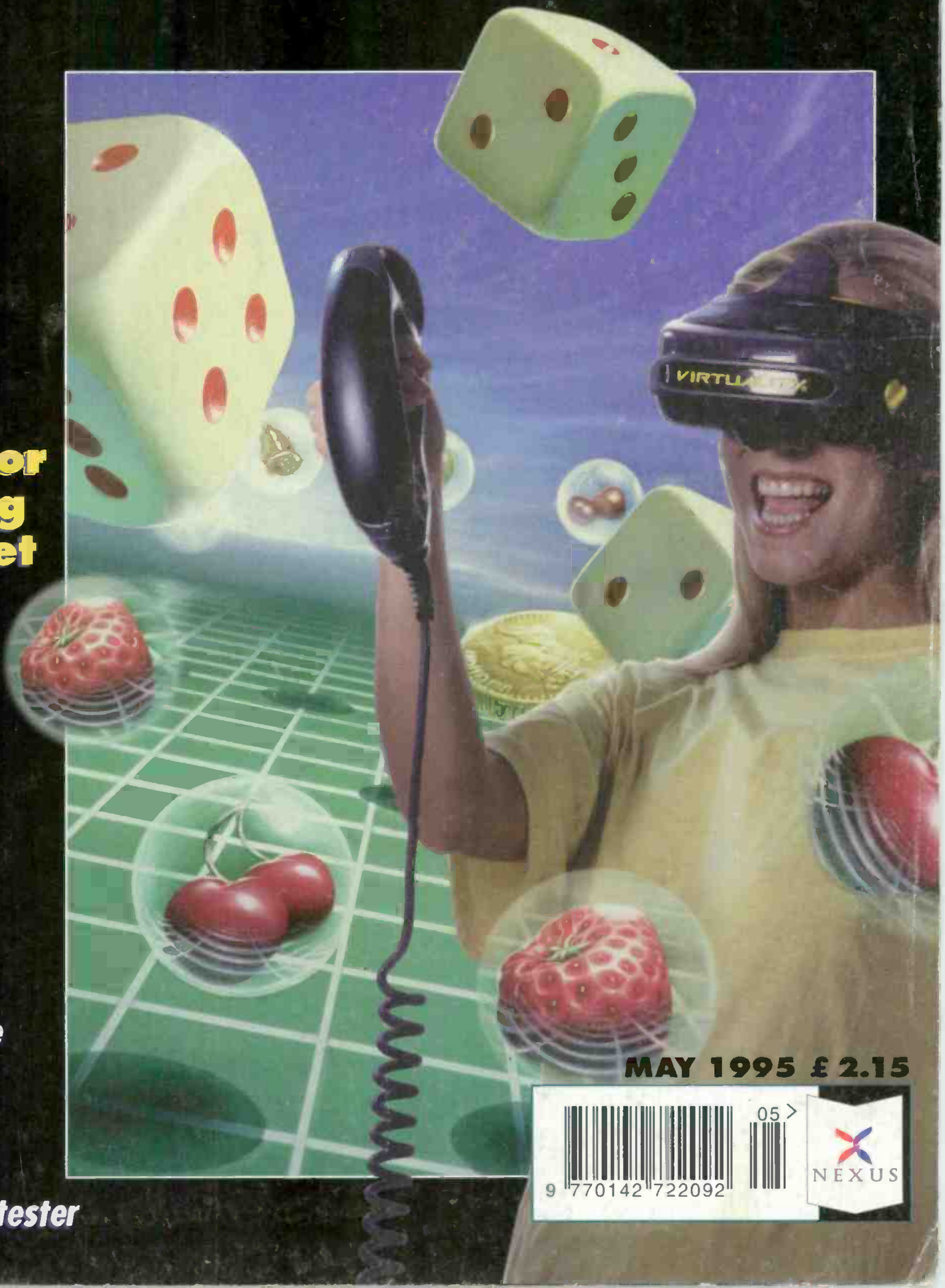
The technology behind and the future ahead for VR

Random number generator for that winning lottery ticket

NiMH battery of the future?

PLUS

- *Bat detector*
- *ETI laser tag base*
- *Servo checker*
- *PIC based timer*
- *Simple continuity tester*



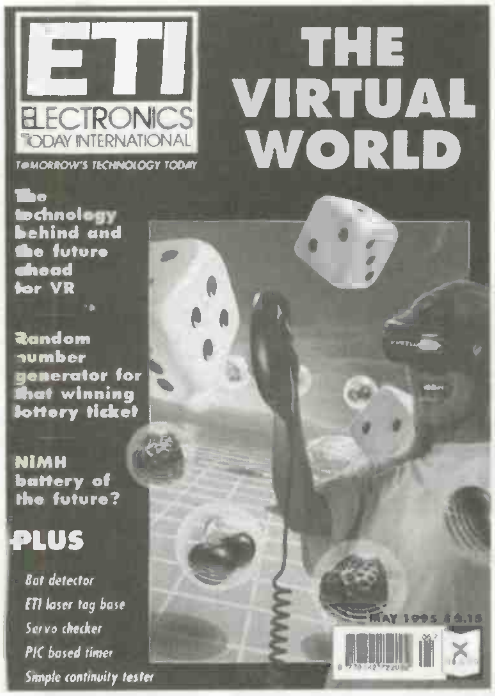
MAY 1995 £ 2.15

05

9 770142 722092

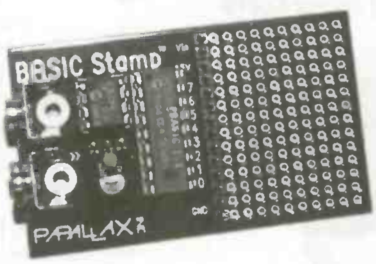
NEXUS

Contents



Volume 24 No.5

& Features Projects



Regulars

MONO VGA MONITORS
Some with slight screen burns but OK at £19.95 Ref EF40 and some without burns at £29.95 Ref EF39.

A4 DTP MONITORS Brand new, 300 DPI. Complete with diagram but no interface details.(so you will have to work it out!) Bargain at just £12.99 each!!!!

OPD MONITORS 9" mono monitor, fully cased complete with rasterboard, switched mode psu etc. CGA/TTL input (15way D), IEC mains. £15.99 ref DEC23. Price including kit to convert to composite monitor for CCTV use etc is £21.99 ref DEC24

PC CONTROLLED 4 CHANNEL TIMER Control (on/off times etc) up to 4 items (8A 240v each) with this kit. Complete with Software, relays, PCB etc. £25.99 Ref 95/26

COMPLETE PC 300 WATT UPS SYSTEM Top of the range UPS system providing protection for your computer system and valuable software against mains power fluctuations and cuts. New and boxed, UK made Provides up to 5 mins running time in the event of complete power failure to allow you to run your system down correctly. SALE PRICE just £119.00.

RACAL MODEM BONANZA! 1 Racal MPS1223 1200/75 modem, telephone lead, mains lead, manual and comms software, the cheapest way onto the net! all this for just £13 ref DEC13.

HOW LOW ARE YOUR FLOPPIES? 3.5" (1.44) unbranded. We have sold 100,000+ so ok! Pack of 50 £24.99 ref DEC16

BRITISH TELECOMM MULTIMETERS SA9083 These are 'returns' so they may have faults but look ok. Complete with new leads and leather case. Price for two meters & 1 case is £10 ref DEC89.

5mw LASER POINTER. Supplied in kit form, complete with power adjuster, 1-5mw, and beam divergence adjuster. Runs on 2 AAA batteries. Produces thin red beam ideal for levels, gun sights, experiments etc. Cheapest in the UK! just £39.95 ref DEC49

SHOP WOBBLERS! Small assemblies designed to take D size batteries and 'wobble' cardboard model signs about in shop windows! £3.99 Ref SEP4P2.

RADIO PAGERS Brand new, UK made pocket pagers clearance price is just £4.99 each 100x40x15mm packed with bits! Ref SEP5.

BULL TENS UNIT Fully built and tested TENS (Transcutaneous Electrical Nerve Stimulation) unit, complete with electrodes and full instructions. TENS is used for the relief of pain etc in up to 70% of sufferers. Drug free pain relief, safe and easy to use, can be used in conjunction with analgesics etc. £49 Ref TEN/1

COMPUTER RS232 TERMINALS. (LIBERTY) Excellent quality modem units,(like wyse 50,s) 2xRS232, 20 function keys, 50 thro to 38,400 baud, menu driven port, screen, cursor, and keyboard setup menus (18 menu's). £29 REF NOV4.

OMRON TEMPERATURE CONTROLLERS (E6C2). Brand new controllers, adjustable from -50 deg C to +1,200 deg C using graduated dial, 2% accuracy, thermocouple input, long life relay output ,3A 240v o/p contacts. Perfect for exactly controlling a temperature, Normal trade £50+, ours £15. Ref E5C2.

ELECTRIC MOTOR BONANZA! 110x60mm. Brand new precision, cap start (or spin to start), virtually silent and features a moving outer case that acts as a fly wheel. Because of their unusual design we think that 2 of these in a tube with some homemade fan blades could form the basis for a wind tunnel etc. Clearance price is just £4.99 FOR A PAIR! (note-these will have to be wired in series for 240v operation Ref NOV1.

MOTOR NO 2 BARGAIN 110x90mm. Similar to the above motor but more suitable for mounting vertically (ie turntable etc). Again you will have to wire 2 in series for 240v use. Bargain price is just £4.99 FOR A PAIR! Ref NOV3.

OMRON ELECTRONIC INTERVAL TIMERS.
Minature adjustable timers, 4 pole c/o output 3A 240v,

HY1230S,	12vDC	adjustable from 0-30 secs.	£9.99
HY1210M,	12vDC	adjustable from 0-10 mins.	£9.99
HY1260M,	12vDC	adjustable from 0-60 mins.	£9.99
HY2460M,	24vAC	adjustable from 0-60 mins	£5.99
HY241S,	24vAC	adjustable from 0-1 secs.	£5.99
HY2460S,	24vAC	adjustable from 0-60 secs,	£5.99
HY243H,	24vAC	adjustable from 0-3 hours.	£8.99
HY2401S,	240v	adjustable from 0-1 secs.	£9.99
HY2405S,	240v	adjustable from 0-5 secs.	£9.99
HY24060m,	240v	adjustable from 0-60 mins.	£12.99

PC PAL VGA TO TV CONVERTER Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/ware. £49.95. Ideal for laptops or a cheap upgrade. We also can supply this in kit form for home assembly at £34.95 ref EF54.

DRINKING BIRD Remember these? hook onto wine glass (supplied) and they drink, standup, drink, standup ETC! £4 each Ref EF1

EMERGENCY LIGHTING UNIT Complete unit with 2 double bulb floodlights, built in charger and auto switch. Fully cased. 6v 8AH lead acid req'd. (secondhand) £4 ref MAG4P11.

GUIDED MISSILE WIRE. 4,200 metre reel of ultra thin 4 core insulated cable, 28lbs breaking strain, less than 1mm thick! Ideal alarms, intercoms, fishing, dolls house's etc. £14.99 ref MAG15P5

300v PANEL METER 70X60X50MM, AC. 90 degree scale. Good quality meter. £5.99 ref MAG 6P14. Ideal for monitoring mains etc.

ASTEC SWITCHED MODE PSU BM41012 Gives +5 @ 3.75A, +12@1.5A, -12@.4A. 230/110, cased, BM41012. £5.99 ref AUG6P3.

TORRODIAL TX 30-0-30 480VA. Perfect for Mosfet amplifiers etc. 120mm dia 55mm thick. £18.99 ref APR19.

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt. £9.99 ea ref AUG10P3.

FLOPPY DISCS DSDD Top quality 5.25" discs, these have been written to once and are unused. Pack of 20 is £4 ref AUG4P1.

ECLATRON FLASH TUBE As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. £9.99 ref APR10P5.

24v AC 96WATT Cased power supply. New. £13.99 ref APR14.

MILITARY SPEC GEIGER COUNTERS Unused anstraight from Her majesty's forces. £50 ref MAG 50P3.

STETHOSCOPE Fully functioning stethoscope. Ideal for listening to hearts, pipes, motors etc. £6 ref MAR6P6.

OUTDOOR SOLAR PATH LIGHT Captures sunlight during the day and automatically switches on a built in lamp at dusk. Complete with sealed lead acid battery etc £19.99 ref MAR20P1.

ALARM VERSION Of above unit comes with built in alarm and pir to deter intruders. Good value at just £24.99 ref MAR25P4.

CARETAKER VOLUMETRIC Alarm, will cover the whole of the ground floor against forced entry. Includes mains power supply and integral battery backup. Powerful internal sounder, will take external bell if req'd. Retail £150+, ours? £49.99 ref MAR50P1.

TELEPHONE CABLE White 6 core 100m reel complete with a pack of 100 clips. Ideal 'phone extns etc. £7.99 ref MAR8P3.

MICRODRIVE STRIPPER Small cased tape drives ideal for stripping, lots of useful goodies including a smart case, and lots of components. £2 each ref JUN2P3.

SOLAR POWER LAB SPECIAL You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor. Superb value kit just £5.99 REF: MAG6P8

SOLID STATE RELAYS Will switch 25A mains. Input 3.5-26v DC 57x43x21mm with terminal screws £3.99 REF MAG4P10

BUGGING TAPE RECORDER Small voice activated recorder, uses microcassette complete with headphones. £28.99 ref MAR29P1.

ULTRAMINI BUG MIC 6mmx3.5mm made by AKG, .5-12v electret condenser. Cost £12 ea, Ours? just four for £9.99 REF MAG10P2.

RGB/CGA/EGA/TTL COLOUR MONITORS 12" in good condition. Back anodised metal case. £79 each REF JUN79

ANSWER PHONES Returns with 2 faults, we give you the bits for 1 fault, you have to find the other yourself. BT Response 200's £18 ea REF MAG18P1. PSU £5 ref MAG5P12.

SWITCHED MODE PSU ex equip, 60w +5v @5A, -5v@.5A, +12v@2A,-12v@.5A 120/220v cased 245x88x55mm IEC input socket £6.99 REF MAG7P1

PLUG IN PSU 9V 200mA DC £2.99 each REF MAG3P9

PLUG IN ACORN PSU 19v AC 14w , £2.99 REF MAG3P10

POWER SUPPLY fully cased with mains and o/p leads 17v DC 900mA output. Bargain price £5.99 ref MAG6P9

ACORN ARCHIMEDES PSU +5v @ 4.4A. on/off sw uncased, selectable mains input, 145x100x45mm £7 REF MAG7P2

GEIGER COUNTER KIT Low cost professional twin tube, complete with PCB and components. Now only £19 REF AUG19.

9v DC POWER SUPPLY Standard plug in type 150ma 9v DC with lead and DC power plug. price for two is £2.99 ref AUG3P4.

AA NICAD PACK encapsulated pack of 8 AA nicad batteries (tagged) ex equip, 55x32x32mm. £3 a pack. REF MAG3P11

13.8V 1.9A psu cased with leads. Just £9.99 REF MAG10P3

PPC MODEM CARDS. These are high spec plug in cards made for the Amstrad laptop computers. 2400 baud dial up unit complete with leads. Clearance price is £5 REF: MAG5P1

INFRA RED REMOTE CONTROLLERS Originally made for hi spec satellite equipment but perfect for all sorts of remote control projects. Our clearance price is just £2 REF: MAG2

200 WATT INVERTER Converts 10-15v DC into either 110v or 240v AC. Fully cased 115x36x156mm, complete with heavy duty power lead, cigar plug, AC outlet socket. Auto overload shutdown, auto short circuit shut down, auto input over voltage shutdown, auto input under voltage shut down (with audible alarm), auto temp control, unit shuts down if overheated and sounds audible alarm. Fused reversed polarity protected, output frequency within 2%, voltage within 10%. A extremely well built unit at an excellent price. Just £64.99 ref AUG65.

UNIVERSAL SPEED CONTROLLER KIT Designed by us for the C5 motor but ok for any 12v motor up to 30A. Complete with PCB etc. A heat sink may be required. £17.00 REF: MAG17

MAINSCABLE Precut black 2 core 2 metre lengths ideal for repairs, projects etc. 50 metres for £1.99 ref AUG2P7.

COMPUTER COMMUNICATIONS PACK Kit contains 100m of 6 core cable, 100 cable clips, 2 line drivers with RS232 interfaces and all connectors etc. Ideal low cost method of communicating between PC's over a long distance. Complete kit £8.99.

MINICYCLOPS PIR 52x62x40mm runs on PP3 battery complete with shrill sounder. Cheap protection at only £5.99 ref MAR6P4

ELECTRIC MOTOR KIT Comprehensive educational kit includes all you need to build an electric motor. £9.99 ref MAR10P4.

VIEWDATA SYSTEMS made by Phillips, complete with internal 1200/75 modem, keyboard, psu etc RGB and composite outputs, menu driven, autodialler etc. £18 each Ref EF88.

BOOMERANG High tech, patented poly propylene, 34cm wing span. Get out and get some exercise for £4.99 ref EF83

AIR RIFLES .22 As used by the Chinese army for training puposes, so there is a lot about! £39.95 Ref EF78. 500 pellets £4.50 ref EF80.

PEANUT TREE Complete kit to grow your own peanuts! full instructions supplied. £3 Ref EF45.

PLUG IN POWER SUPPLYS Plugs in to 13A socket with output lead, three types available, 9vdc 150mA £2 ref EF58, 9vdc 200mA £2.50 ref EF59, 6.5vdc 500mA £3 ref EF61.

VIDEO SENDER UNIT. Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12v DC op. Price is £15 REF: MAG15 12v psu is £5 extra REF: MAG5P2

***FM CORDLESS MICROPHONE** Small hand held unit with a 500' range! 2 transmit power levels. Reqs PP3 9v battery. Tuneable to any FM receiver. Price is £15 REF: MAG15P1

LOW COST WALKIE TALKIES Pair of battery operated units with a range of about 200'. Ideal for garden use or as an educational toy. Price is £8 a pair REF: MAG 8P1 2 x PP3 req'd.

***MINATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range of up to 2km in open country. Units measure 22x52x155mm. Including cases and earp'ces. 2xPP3 req'd. £30.00 pr. REF: MAG30

COMPOSITE VIDEO KIT. Converts composite video into separate H sync, V sync, and video. 12v DC. £8.00 REF: MAG8P2.

LQ3500 PRINTER ASSEMBLIES Made by Amstrad they are entire mechanical printer assemblies including printhead, stepper motors etc etc in fact everything bar the case and electronics, a good stripper! £5 REF: MAG5P3 or 2 for £8 REF: MAG8P3

LED PACK of 100 standard red 5m leds £5 REF MAG5P4

UNIVERSAL PC POWER SUPPLY complete with flyleads, switch, fan etc. Two types available 150w at £15 REF:MAG15P2 (23x23x23mm) and 200w at £20 REF: MAG20P3 (23x23x23mm)

GYROSCOPE About 3" high and an excellent educational toy for all ages! Price with instruction booklet £6 Ref EF15.

FUTURE PC POWER SUPPLIES These are 295x135x60mm, 4 drive connectors 1 mother board connector. 150watt, 12v fan, iec inlet and on/off switch. £12 Ref EF6.

VENUS FLYTRAP KIT Grow your own carnivorous plant with this simple kit £3 ref EF34.

PC POWER SUPPLIES (returns) These are 140x150x90mm. o/ps are +12,-12,+5 and -5v. Built in 12v fan. These are returns so they may well need repairing! £3,50 each ref EF42.

***FM TRANSMITTER KIT** housed in a standard working 13A adapter!! the bug runs directly off the mains so lasts forever! why pay £700? or price is £15 REF: EF62 Transmits to any FM radio. (this is in kit form with full instructions.)

***FM BUG KIT** New design with PCB embedded coil for extra stability. Works to any FM radio. 9v battery req'd. £5 REF: MAG5P5

***FM BUG BUILT AND TESTED** superior design to kit. Supplied to detective agencies. 9v battery req'd. £14 REF: MAG14

TALKING COINBOX STRIPPER originally made to retail at £79 each, these units are designed to convert an ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges. However they can be adapted for their original use or used for something else?? Price is just £3 REF: MAG3P1

TOP QUALITY SPEAKERS Made for HI FI televisions these are 10 watt 4R Jap made 4" round with large shielded magnets. Good quality. £2 each REF: MAG2P4 or 4 for £6 REF: MAG6P2

TWEETERS 2" diameter good quality tweeter 140R (ok with the above speaker) 2 for £2 REF: MAG2P5 or 4 for £3 REF: MAG3P4

AT KEYBOARDS Made by Apricot these quality keyboards need just a small mod to run on any AT, they work perfectly but you will have to put up with 1 or 2 foreign keycaps! Price £6 REF: MAG6P3

HEADPHONES Ex Virgin Atlantic. 8 pairs for £2 REF: MAG2P8

DOS PACKS Microsoft version 3.3 or higher complete with all manuals or price just £5 REF: MAG5P8 Worth it just for the very comprehensive manual! 5.25" only.

GAS HOBS Brand new made by Optimus, basic three burner suitable for small flat etc bargain price just £29.95 ref EF73.

GAT AIR PISTOL PACK Complete with pistol, darts and pellets £12.95 Ref EF82 extra pellets (500) £4.50 ref EF80.

CHRISTMAS TREE KIT Start growing it now! £3 ref EF53.

DOS PACK Microsoft version 5 Original software but no manuals hence only £5.99. 3.5" only.

PIR DETECTOR Made by famous UK alarm manufacturer these are hi spec, long range internal units. 12v operation. Slight marks on case and unboxed (although brand new) £8 REF: MAG8P5

MOBILE CAR PHONE £6.99 Well almost! complete in carphone excluding the box of electronics normally hidden under seat. Can be made to illuminate with 12v also has built in light sensor so display only illuminates when dark. Totally convincing! REF: MAG6P6

ALARM BEACONS Zenon strobe made to mount on an external bell box but could be used for caravans etc. 12v operation. Just connect up and it flashes regularly) £5 REF: MAG5P11

6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. Bargain price just £5.99 ea REF MAG6P12.

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

HEATSINKS (finned) TO220, designed to mount vertically on a pcb 50x40x25mm you can have a pack of 4 for £1 ref JUN1P11.

STROBE LIGHT KIT Adjustable from 1 hz right up to 60hz! (electronic asssembly kit with full instructions) £16 ref EF28.

ROCK LIGHTS Unusual things these, two pieces of rock that glow when rubbed together! belived to cause rain! £3 a pair Ref EF29.

NEW HIGH POWER LASERS

15mW, Helium neon, 3 switchable wavelengths .63um, 1.15um, 3.39um (2 of them are infrared) 500:1 polarizer built in so good for holography. Supplied complete with mains power supply. 790x65mm. Use with EXTREME CAUTION AND QUALIFIED GUIDANCE. £349+Vat.

WE BUY SURPLUS STOCK FOR CASH

FREE CATALOGUE

1995 100 PAGE CATALOGUE NOW AVAILABLE, 45P STAMP OR FREE WITH ORDER.

PORTABLE RADIATION DETECTOR WITH NEW COMPUTER INTERFACE.

£59.00

A Hand held personal Gamma and X Ray detector. This unit contains two Geiger Tubes, has a 4 digit LCD display with a Piezo speaker, giving an audio visual indication. The unit detects high energy electromagnetic quanta with an energy from 30K eV to over 1.2M eV and a measuring range of 5-9999 UR/h or 10-99990 Nr/h. Supplied complete with handbook. Ref. NOV 18.

*SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX BN3 5QT(ESTABLISHED 50 YEARS)

MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £3.00 POST PLUS VAT.

PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY
TELEPHONE ORDERS WELCOME
TEL: 01273 203500
FAX: 01273 323077

ETI News...

ELECTRONICS TODAY INTERNATIONAL

NEC Microcontroller starter kit

NEC Electronics has reduced the cost of designing with its 75X family of microcontrollers by offering a starter kit for only £399. The kit contains everything required to use and evaluate this popular family of 4-bit devices including software, cables and programming board.

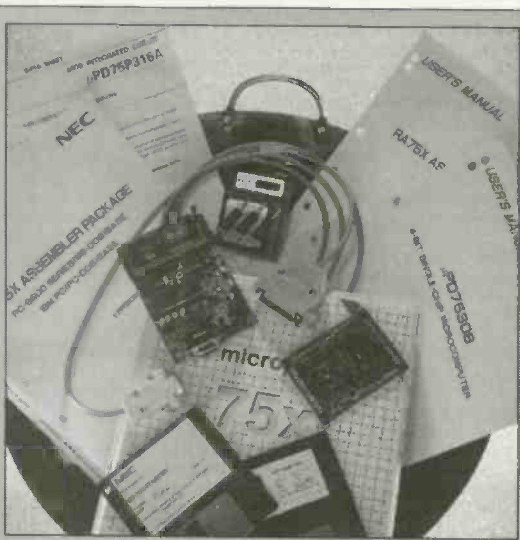
The 75X series of microcontrollers are low cost, low power consumption devices with a wide operating voltage range. The kit is intended for use by small engineering firms, design consultancies in development projects, and by larger firms that wish to evaluate the devices.

In a typical evaluation or development cycle, the user would assemble the source program using the relocatable assembler and then produce a Hex and Symbol file using the linker/Locator. These can be loaded into the simulator for testing and debugging. Once the user is satisfied, the code can be programmed into the target device using the programming board and starter kit programmer software.

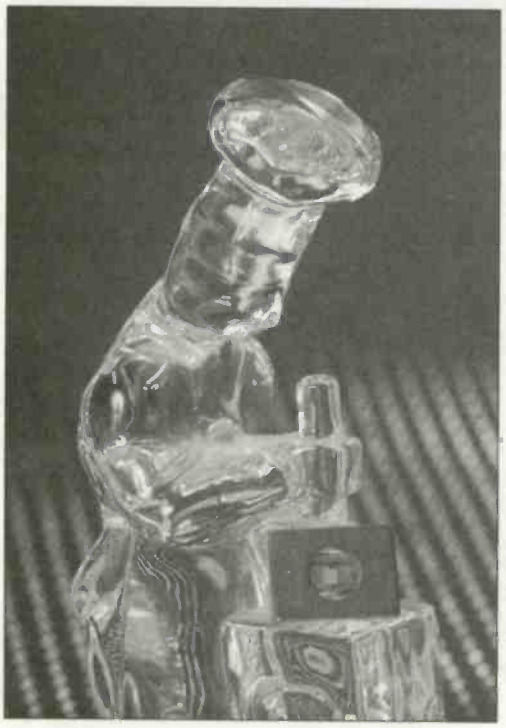
The kit includes a 75X relocatable assembler and simulator package for use on an IBM-compatible PC. The full-screen simulator allows execution, single step operation, multiple break points and watching and modifying memory.

Also included in the kit is a programming board, programming adapter, UV erasable 16K LCD micro, power adapter, all necessary cables and a full set of user manuals. The only additional equipment required is a PC and a UV eraser.

For further information call NEC Electronics of Milton Keynes on 01908 691133.



New 16bit microcontroller



Mitsubishi Electric is announcing the introduction of the M37710 Group of 16bit single chip microcontrollers designed for office, business and industrial controller applications requiring high speed processing for large data volumes.

The new product group devices are available in a range of memory options and include Mask ROM, one time PROM and EPROM versions, as well as with low voltage and packaging options, enabling system integrators to select the optimum microcontroller for their specific design requirements.

M37710 Group microcontrollers feature a large 16Mbytes address space, three instruction queue buffers and two data buffers enabling very high speed program execution. The 16bit parallel CPU is also switchable for 8bit parallel processing. Memory options include 60kbytes ROM/2048 bytes RAM, 32kbytes ROM/1024bytes RAM or ROMless with 2048 bytes of RAM in low voltage or standard voltage devices. Low voltage devices operate at 8MHz from 2.7/5.5V supplies and the standard devices operate at 25MHz from 4.5/5.5V supplies. Instruction execution time is 160ns at 25MHz.

Power dissipation for low voltage versions is 12mW at 8MHz/3V supply, with 95mW for the standard 5V versions. Further power savings can be achieved by using the power conserving STP and WIT instructions.

On-chip features include an eight channel 10bit ADC and two 8bit DACs, eight 16bit multifunctional timers and two fully independent UART or clock synchronous serial I/Os. The devices also incorporate real time ports for stepper motor control, a 12bit watchdog timer and a programmable interrupt controller.

For further information contact Mitsubishi Electric UK Ltd of Hatfield on 01707 276100.

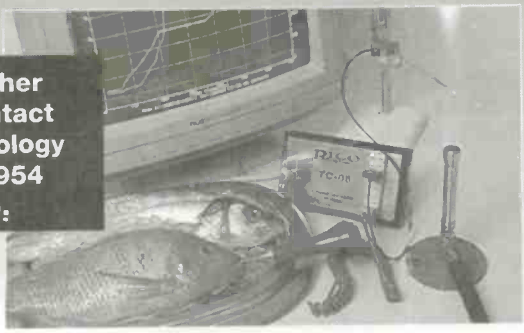
PC Temperature Measurement

Pico's TC-08 is a thermocouple to PC interface. Supplied with PicoLog datalogging software it is designed to allow simple yet accurate temperature recording onto a computer. The unit accepts up to 8 thermocouples (B,E,J,K,R,S, and T types) and connects via the serial port. It requires no power supply.

For type K thermocouples, resolution over the -270C to +1300C range is better than 0.1C and accuracy better than 0.5C. Cold junction compensation is carried out within the unit and linearisation is within the software.

PicoLog can take samples as fast as one per second and as slow as one per hour, allowing recordings to be made for a few seconds or weeks as required. It offers advanced temperature processing functions including filtering, min/max detection and alarms. Data can be displayed in real time, in either graphical or text format or printed out after data collection.

TC-08 comes complete with PicoLog, software drivers, and connecting cable for £199. A range of thermocouples/probes is also available.



For further details contact Pico Technology Ltd on 01954 211716.

Multichannel dynamic signal analysers

Reading based Strategic Test has announced a new range of Dynamic Signal Analysers that combines a measurement capability that exceeds many traditional FFT Analysers, with the report generation quality and flexibility offered by a PC.

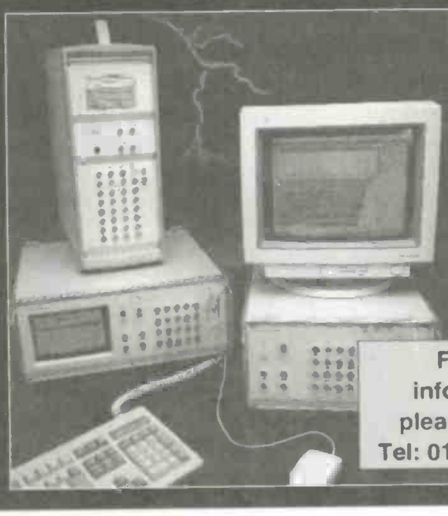
The DSA 200s are expandable from 4 to 32 measurement channels and provide a dynamic range in excess of 90dB for the most sensitive measurements. Each channel includes both analogue and digital filtering with software selectable signal conditioning for AC, DC, ICP accelerometer and microphone inputs. Two independent signal generators offer a wide range of excitation signals which are produced using 18 bit digital to analogue converters. High speed digital signal processors (DSPs) ensure a real-time performance.

The DSA models are complete systems for experimental structural analysis. The multi-channel systems reduce testing time to a minimum by measuring large numbers of FRF functions simultaneously. Modal analysis is handled conveniently by built-in third party Modal software packages.

Sound and acoustic engineers can easily measure the acoustic intensity vector. Further dedicated acoustic functions include narrow band spectral analysis and real-time 1/3 octave analysis, including A, B, and C weighting. Post-processing functions like articulation index and loudness are useful for psycho-acoustic research.

The DSA series Signature software supports order tracking with 3D order ratio diagrams and multi-channel order tracks. Advanced post-processing routines include the ability to create summation diagrams and octave tracks from the 3D diagrams.

Data can be "time-streamed" to the built-in hard disk, replacing tape recorders in many applications. Multi-channel processing capabilities, including order tracking and octave filtering, enable efficient analysis on this throughput data.



For further information, please contact Tel: 01734 575150.

Caretaker solves storage problem

Caretaker Storage Systems of Verwood, Dorset, has developed a unique, space saving, storage system named "The Caretaker".DIY enthusiasts and hobbyists will find "The Caretaker" answers many of their storage problems. It will hold aerosol cans, nuts, bolts, screws, washers, and other numerous bits and pieces that collect around the workshop.

There are two ways of storing; by using the pots supplied or by saving the standard 454 gram jars found in all kitchens that usually end up in the bin. The system fixes to the side or corner of the garage or workshop and is capable, on the two metre system, of holding up to twelve discs; each disc has nine removable pots, giving a total 108 pots or jars. Easy access is gained by rotating the disc, all of which are adjustable in height. For the person with less space, the free-standing system is the answer. In the forthcoming year a tool disc will be added and various accessories. As a modular system, the hobbyists may build up a system to their own requirement.

Fixing kits, free-standing or two metre fixed. (all zinc plated) Individual discs can be purchased as and when required. All discs come with nine removable pots and one fully adjustable centre bearing.

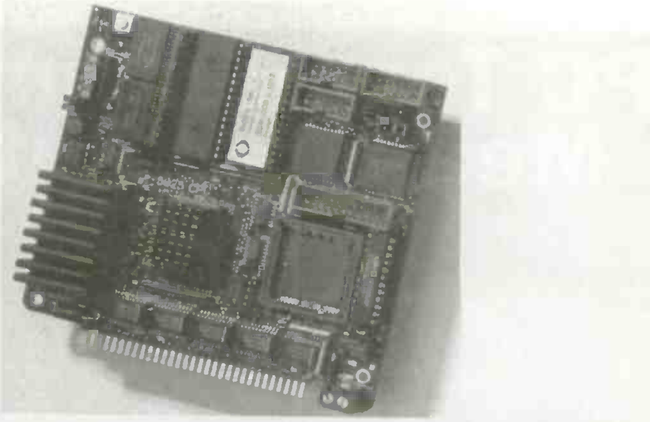
NEC demonstrates gigabit RAM chip

At the recent International Solid State Circuits Conference in San Francisco, NEC shocked the electronics world by unveiling the first sample of a new gigabit DRAM chip. This chip is four times the size of the sophisticated DRAM being developed by IBM, Siemens, and Toshiba, and 16 times the size of the largest DRAM on the market today.

However, the chip is a one-off sample, and NEC expects that it will take at least three years and $1.5billion in investment to reach the stage of supplying samples of this massive chip to computer manufacturers. In fact it could be well past the turn of the century before this chip is in commercial production. Long before then we should see the IBM/Siemens 256Kbit DRAM on the market.

The gigabit DRAM shown by NEC was produced using existing technology to etch lines 0.25microns wide on a chip that measured a massive 26x36mm. Over the next few years NEC expect to be able to etch lines as fine as 0.15 micrometers which should allow them to reduce the overall chip size substantially.

It is widely predicted that DRAM chips with this capacity will be one of the key factors in the development of advanced multimedia and virtual reality systems. Fast, low power consumption, and high capacity memory systems are essential components of systems which handle video data as well as conventional computer data.



New rugged embedded PC

AMC today announced the addition of a powerful new embedded PC - called the 5025A - to the company's Micro PC family of rugged industrial computers. The 5025A has been designed to accommodate a wide range of high performance, embedded control applications. With a rich feature set including multiple solid state disks, wide temperature range, small 4.5 x 4.9 inch form factor and Windows QNX compatibility, the 5025A is ideal for both general-purpose process control and applications where a user interface or real-time operating system is required.

The 5025A is supplied with either a 386CX or a 486SLC processor, up to 50MHz, for use with Windows or real-time operating systems such as QNX. In addition, the 5025A has three solid state disks that can be configured according to customer requirements.

The first solid state disk contains the AT-compatible BIOS with industrial extensions and DOS 6.0 in 512 Kbytes of ROM. The availability of DOS in ROM, or "instant DOS", eliminates uncertainty about how application software will run on the 5025A. QNX or other real-time operating systems can be installed in place of DOS, should the user wish to do so.

The second solid state disk is intended for storage of the application program, and can be configured with either 1Mbyte of EPROM or 512Kbytes of flash memory. The third solid state disk is multi-functional and can be used for data conversion tables, multiple language support or other operating systems. This disk can be configured with the customer's choice of up to 512Kbytes of SRAM, 512Kbytes of flash memory, or 1Mbyte of EPROM.

All three of the 5025A's solid state disks look like floppy disks to the user, and all necessary software is provided.

Other features of the 5025A include a built-in flash memory programmer, two 16C550- compatible serial ports with an RS-232/422/485 interface, and LPT1 bi-directional parallel port, 1-8 Mbytes of DRAM, watchdog timer, and keyboard and speaker ports.

For more information contact Advanced Modular Computers Ltd., of Slough on 01753 580660.

Intel unveil new P6 processor

Despite the problems being faced by Intel over the last few months with respect to the Pentium, the company took the oportunity at the recent International Solid State Circuits Conference in San Francisco to release full technical details of the Pentium's successor, a chip codenamed the P6, a processor which they claim will be able to perform over 1700million instructions per second, making it over twice as fast as the Pentium.

and is the result of over five years of design work. The P6 is being manufactured using the same production techniques as the Pentium but is a much larger chip with over 5.5million transistors, the Pentium having just 3.1million. A lot of the extra speed of the P6 is achieved by using a coded software technique known as 'dynamic execution'. This means that when a processor is waiting for a result or for the arrival of data it is able to make a guess about how the program will proceed, and use that guess to jump ahead and continue operation without having to wait for the necessary data or result.

The algorithms which generate the guess have been produced as the result cf careful analysis of tens of thousands of different programs. Their use means that the processor can continue running a program without being held up, indeed it will carry out up to eight speculative branchings before it has to stop and verify the data or calculation result.

Fob size contactless IC cards

Mitsubishi has introduced a new contactless IC card designed specifically to provide fast, easy and reliable access control to mass user systems. Applications range from ticketing to automatic warehousing and even production control, providing authorisation and even proof of payment functions over a transmission range of up to one metre.

At 45x45x4.5mm, the size of a small key fob, Mitsubishi's new contactless MelCard operates in a system comprising a read/write device as a remote, stand-alone terminal or one of several terminals, linked to a computer network for data I/O, read and write operations. In operation, the card is presented near to the reader/writer head which automatically transmits data at up to 455kHz. Exact frequencies can be customised to specific applications, allowing the card to operate a ticket barrier, for example, or read part recognition data in factory automation and CIM.

The simply constructed card operates at communication distances of up to 1m and a typical operation takes less then 0.2s. The mini MelCard features a single chip microcontroller and communicates with the reader/writer via half duplex amplitude shift keying transmission. The Mitsubishi 8bit microcontroller makes for wide ranging,application functions and high security whilst at the same time using little power. Use of SRAM for the user area of memory also enables high speed read and write operations at very low current consumption.

Radio frequency transmission removes the need for electrical connections, avoiding problems of dirty contacts and resultant transmission failure. It provides an ideal solution to the problems of speedily handling mass throughput.

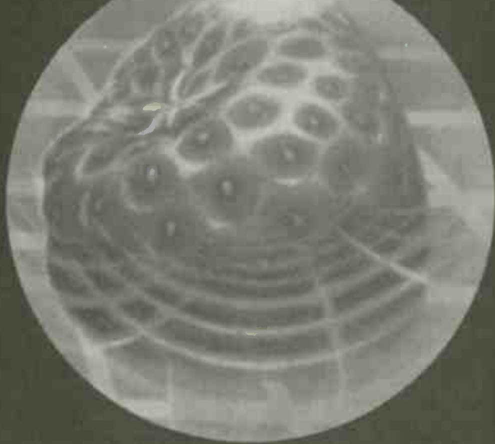
For further information contact Mitsubishi Electric UK Ltd, of Hatfield on 01707 276100.

Event Diary

31 March to 17 April	The Seventh Edinburgh International Science Festival; lots of different events in different parts of the city, for further details contact the organisers on 0131 556 6446.
9-11 April	European Computer Trade Show, Business Design Centre, London. Tel: 0181 7422828
15 April	Spring all Micro Show, Radio Rally & Electronics Fair. Bigley Hall, Staffordshire Showground, Weston Road, Stafford. Tel: 01473 272002.
22 April	International Marconi Day exhibition station at Puckpool Park Wireless Museum, IOW. Tel: 01983 567665
14 May	Drayton Manor Radio and Computer Rally at Drayton Manor Park, Tamworth, Staffs. Tel:0121-443-1189.
20 May	Ipswich Computer Show. Willis Corroon Sports and Social Club, The Street, Rushmere St Andrew, Ipswich. Tel 01473 272002

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.

Virtual reality



Virtual reality is one of those technology-inspired phrases which, every now and then, explodes onto the unsuspecting world. One minute it is only to be encountered in some esoteric literature, and the next it is on everyone's lips. Suddenly there are articles about this new development in Sunday papers; popular TV programmes are made about it, and well known television personalities enthuse and bubble about it.

So what is virtual reality, why the enthusiasm, and why the explosion in popular interest?

The birth of virtual reality

That great sixties guru of psychedelia, Timothy Leary, now a confirmed addict to virtual reality, pointed out that most of us have been living in virtual reality since the proliferation of television. We can perhaps go even further back to the invention of radio and the cinema. This is because virtual reality is concerned with using technology to amplify the imagination of the individual.

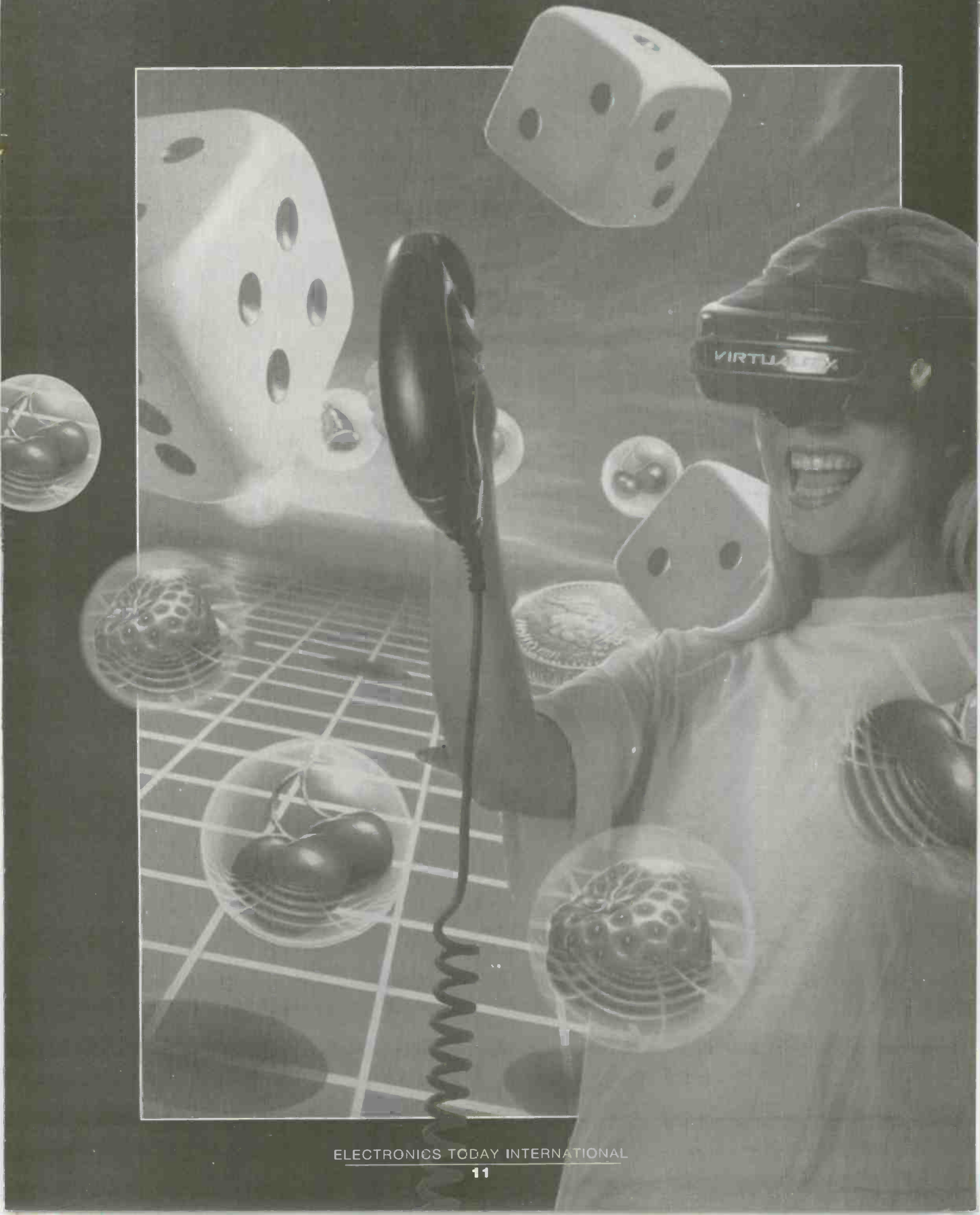
In the distant past history, legend, knowledge, and ritual were transferred from one individual to another as stories. At first transmitted orally and later in written form. Gaps in the description, both physical and temporal, were filled by the imagination, an imagination that was shared by both the teller and the listener, by the author and the reader.

But imagination can only be shared when both parties have had similar experiences in life, seen and known similar things, similar people, similar places. In the imagination an Englishman will see a house that is completely different from the house seen in the imagination of a tribesman in central Borneo. This is one of the problems of literature and is difficult to transfer across widely differing cultures.

However, film does not have this problem since it provides the viewer with a great deal more information than is provided by the written word. There is no need to imagine the house, since there is a detailed image of it. The world that we see on film may be imaginary, but the task of generating that imagination has largely been transferred from the viewer to the director, the cameraman, the actors, etc.

Watching a film or TV is therefore a passive act: there is little or no exercise of the viewer's own imagination despite the fact that the imaginary world which is presented to him is probably far more detailed than any world which he might

Virtual reality is set to change the way that we do a great many things. Nick Hampshire takes a look at the technology behind it



The head mounted display

Sight is our most important sense when it comes to examining the world around us. What we see is a three dimensional, colourful world that exists in every direction in which we look. We can easily create colour images on a standard computer monitor, but the image on such a monitor is two dimensional, there is no stereoscopic depth cueing. Furthermore, the image displayed on the screen is just a small part of the virtual world, it is as if we are looking at that world through a rectangular keyhole.

These factors mean that we can not give someone a true sense of immersion in a virtual world using a conventional monitor. What is needed first of all is a display which will give the user the stereoscopic depth cueing which will allow the user to see the image in 3-D. One way to do this is to use 3-D glasses which have one lens with a blue filter and the other with a red filter. The computer is used to generate two overlapping images on the screen one visible through the red filter and one through the blue. The viewers brain recombines these images to create the impression of a 3-D image.

The problem with this approach is that the image colour and quality is poor although generation of such stereoscopic images is fairly easy and requires no expensive hardware. The other problem is of course that it still confines the user to a 'keyhole' view of the virtual world.

The only way to overcome these problems is to use two displays, one for each eye, thereby generating a stereoscopic 3-D image, and mount these displays on the user's head so that as he moves his head the image displayed is changed to correspond to that viewing angle. This type of HMD equipment is the key component of modern immersion virtual reality, since not only do they provide 3-D images and head tracking, but they also block out an extraneous light from the real world and can also be fitted with headphones to give the user direction sensitive sound as well as sight.

The current generation of commercial HMDs are constructed using colour LCDs. These are directly connected to the computer and behave just like two very small colour monitors, with the software outputting slightly different images to each eye. The light from the small backlit LCDs is focused into the eyes by means of specially designed optics (design of this optical component is very important if the user is not to suffer from serious eyestrain after using the HMD for a short period).

The LCDs used in HMDs currently have about 180,000 pixels. Since the display is colour these are grouped in triads of red, green, and blue, which means that the resolution of the screen is actually only 60,000 pixels. By the end of 1995, however, HMDs should be available with 640x480 resolution and 32K colours. This is sufficient to generate some very high quality images, particularly when techniques such as pixel merging are used to increase apparent resolution.

Another problem with early HMDs is that the image refresh rate was very low, in some systems as low as three or four frames per second. This meant that all movements were very jerky, and quickly led to the user feeling rather nauseous. The problem here, of course was one of having insufficient computer power to generate images at a high enough rate. With the plummeting price of computer power and new display generation technologies this particular problem is rapidly disappearing, and refresh rates of 20 to 30 frames per second, or even more, are now quite common and overcome both the jerky image and nausea (note that standard movie film uses 24 frames per second to achieve smooth movement).

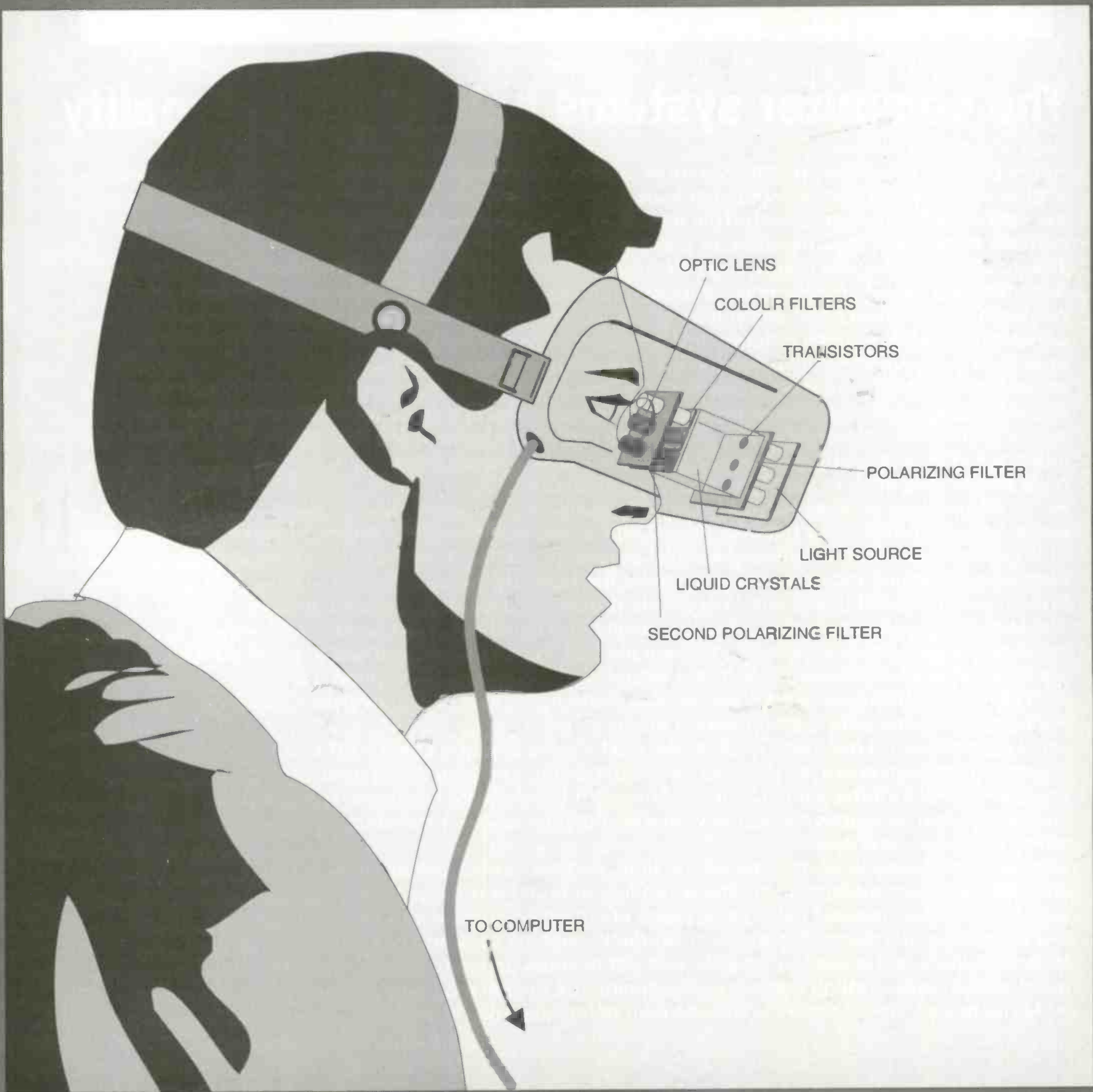
imagine for himself. The degree of imagination involved has been amplified by bringing together the imaginations of many people.

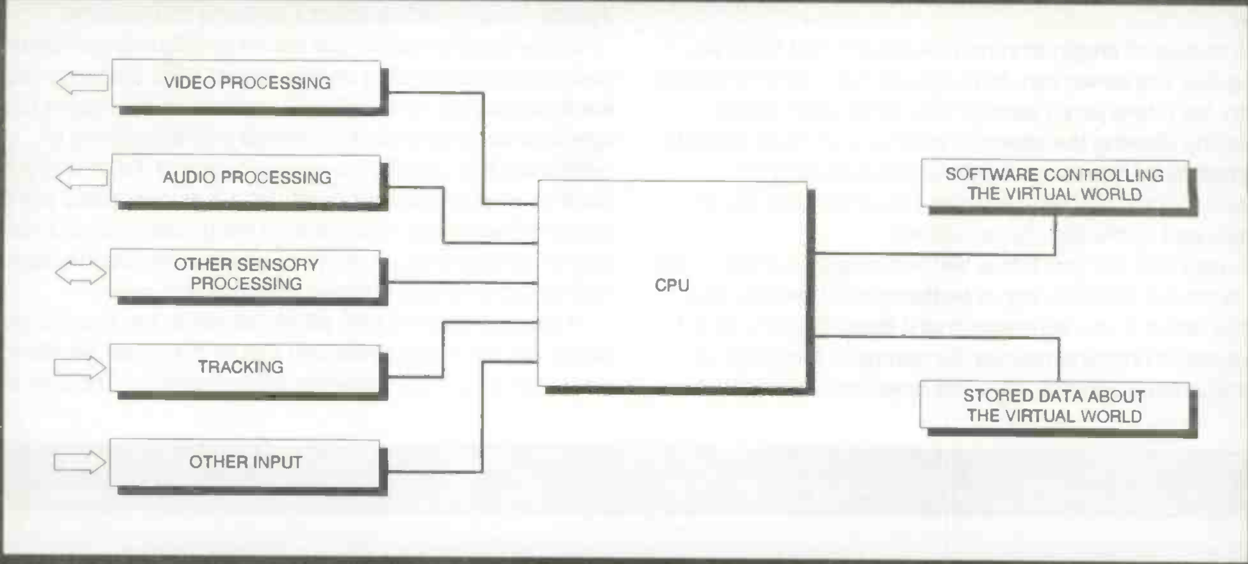
The degree of imagination may be greater, but there is nothing that the viewer can do to change the course of events in a film, his role is purely passive. The elimination of this passivity by allowing the viewer to add his own imagination to that provided by others, accounts for the popularity of computer games. The film becomes interactive, the viewer becomes part of the plot, he is involved.

You may well say that this is fine with respect to fiction, but surely does not apply to, say, a textbook on chemistry. But if you think about it you will realise that it does. Reading about some event, a chemical reaction for example, in a book, or watching a video about it, does not have the same impact on our memory as actually performing the experiment. In most spheres of human knowledge we learn better by doing something than by simply reading about it or being told about it.

In any learning activity the individual will progress faster and have a better grounding on the subject if the learning process involves practical work. After all, one would not expect to be operated upon by a surgeon whose only experience of performing the operation was reading about it in a book. And none of us would feel very safe flying in an aeroplane piloted by someone whose knowledge of flying was solely derived from watching films about flying, however detailed those films may have been, and however attentive the viewer.

It was the need to train pilots that led to the technology which has been combined with that of computer games to create what we now call virtual reality systems. The Link flight ►





The computer systems behind virtual reality

At the heart of any virtual reality system is a special ultra high speed processor known as a reality engine. It is called a reality engine because it is the hardware used to create the virtual world that the user sees and interacts with. This hardware could be a single top end PC or workstation, a network of interacting computers, or perhaps even a super-computer.

The actual structure of a reality engine's hardware depends on factors such as cost, but the one thing it must have is an enormous amount of processing power. To completely generate a 3-D fully rendered image takes most computers a relatively long time even at fairly low display resolutions, generating the two slightly different images for stereoscopy will double the time.

In virtual reality systems such images will need to be generated in less than one twentieth of a second in order to avoid jerky movement. On top of which the computer will also have to generate the appropriate 3-D sounds and perhaps also drive tactile and force feedback systems. Hence the need for lots of processing power, processing power which must also be applied to accessing and interpreting data input by the user. This data consists of such things as head and hand movement, body position, speech recognition, and hand pressure.

At the moment most immersion virtual reality systems use workstation or mini computers based on powerful RISC processors running under UNIX as the reality engine. Although an increasing number of VR systems are now employing parallel processor architecture's similar to those found on super computers. In some multiprocessor systems the tasks performed by the reality engine are usually broken down into sub tasks with a separate processor allocated to each sub task.

The lack of any standardisation in virtual reality, the multitude of different reality engine systems, input and output devices, sensors, etc. means that the software used has to be written for a specific hardware system. However, a lot of the virtual world construction is done using conventional 3-D CAD software running on workstations, this world building process involves construction of wire frame models which are then rendering them.

Once a virtual world has been created the next step is use of a special VR tool kit and simulation manager to assign characteristics to the virtual world, knowing that a door will open, a handle turn, or a switch will turn the lights off or on. These VR tool kits are hardware specific and also allow the addition of user interaction with the virtual world, plus sound generation, and perhaps speech recognition and synthesis.

VR tool kit software is developing all the time, and some versions are now including sophisticated artificial intelligence techniques. These provide in-built knowledge bases that can provide objects with complex behavioural patterns. A piece of virtual equipment can behave in exactly the same manner as the real thing. Designers of products such as cars and consumer electronics are now turning to such techniques in order to test out designs on users prior to building a physical prototype, thereby cutting costs and shortening the design lead time. Some systems are even going as far as having virtual actors with their own behaviour and personality simulator was developed to give pilots the feel of actually flying an aeroplane without risking lives and equipment, a concept that was first developed as a carnival ride by Edwin Link in 1929.

It is a concept which has now been developed to produce the highly sophisticated flight simulators that accurately copy the performance of particular aircraft, cabin layout, views from the windows, etc. and which are used to train most commercial and military pilots. With the use of hydraulic rams to move the cabin pod of the simulator, and massive amounts of computer power to calculate aircraft behaviour, the 'pilot' can feel almost exactly the same types of sensory experience as he would if he were flying a real aeroplane of the same type as that which is being simulated.

So powerful have such flight simulators become that in the recent Gulf War, pilots were trained for bombing missions on simulators which had been loaded with data that allowed the pilot to see the actual terrain he would be flying over. This allowed the pilots to practice their mission before they actually flew it, a factor which considerably improved the pilot's confidence and ability.

The development of virtual reality

The technology behind virtual reality has thus been born out of a fusion of the interactive computer game and the physical simulation systems developed to train pilots. This fusion has produced what some people have described as an imagination amplification system, which is infinitely more powerful than anything developed so far.

This is because virtual reality has turned the imagination delivery process inside out. Instead of the individual sitting in a real world and looking in upon an imaginary world on a TV screen, or within the pages of a book, the individual becomes completely immersed in an imaginary world which has been created by a computer and with which the individual can interact just as he or she would interact with the real world.

This immersion in a computer-generated virtual world is achieved by giving the individual special interfaces for sight, sound and touch which replace the input he would normally receive from the real world. In such a system, the user's view of this virtual world will change as he moves his body; special sensors are used to detect head and body movement. The data derived from these sensors are then used by the computer to generate the appropriate visual and auditory sensations that are appropriate for his current position.

Just as the user can walk and move within this virtual world so he can also interact with that world. He can open and close virtual doors, switch on and use virtual equipment, and even interact with virtual people. In short, anything he can do in the real world, he can (in theory) also do in the virtual world.

But, and this is a very important but, he can also do things in a virtual world which it might well be impossible for him to do in the real world. He could walk on the surface of the Moon, visit the deepest parts of the oceans, develop wings and learn to fly like a bird, roam through the streets of Julius Caesar's Rome on that fateful 15th of March in 44BC, or become infinitely small and walk through the labyrinth of neuronal connections which make up the human brain. One can do all these things and more in a virtual world.

Of course virtual reality technology is very much in its infancy. A lot of these things can only be done in theory. We lack the sophisticated software, sensors, output systems, and of course computing power, to generate virtual worlds which look anything like the real world, and to interact with that world with all the subtlety that we interact with the real world. But achieving this is only a matter of time, of refinement and development of existing technology.

If we compare the development of virtual reality to the development of the games played on today's personal computers, then virtual reality is at about the same stage as Nolan Bushnell's first electronic arcade game, Pong. It has taken twenty years to go from Pong to the Pentium-powered PC. With technological development accelerating, virtual reality should reach the PC stage of development by the end of this decade.

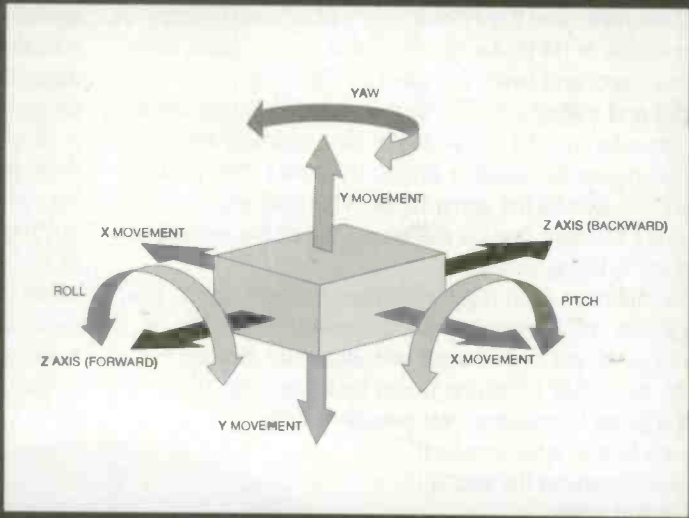
However, just as the origin of the PC can be traced back to the mainframe computers of the early 50s, so virtual reality can be traced back to the early 60s. Indeed virtual reality was probably first conceived in a US patent, number 3,050,870, which was filed in 1961 by Morton L. Helig for a device known as the Sensorama Stimulator. This was an apparatus that was designed as an arcade simulator and gave the user the sights, sounds, motion and smell of riding a motorcycle through the streets of Brooklyn (sensations included pot holes and the smell of pizzas cooking).

What qualifies Helig's Sensorama as being the first virtual reality device is that it was designed to allow the user to interact with the simulator environment in a way which made the user feel as if he was part of that environment. Of course Helig had no computers to aid him, it was all done using film loops, odour canisters, vibrating seat and controls, etc. which were electromagnetically triggered by data encoded onto a track on the film.

Virtual reality with computer generated virtual environments dates back to about 1965, to work that was done at the University of Utah by Ivan E Sutherland, a man who is now regarded as being one of the world's greatest experts in computer-generated graphics. What he developed was a head-mounted computer graphics display which also tracked the position of the wearer's head, the first head mounted display (HMD). It was used to show a topographical map of the US. (Sutherland's company now builds advanced virtual reality simulators for the US Air Force, including those used to train pilots for the Gulf War).

Position sensing

A very important component of any immersion virtual reality system is some means of tracking the individual's movements so that he can navigate and interact with the virtual world, and for this reason they are called interaction devices. The most important being the tracking of head and hand movements. Tracking of hand movements is important since in an immersive virtual reality system the user will interact with the virtual world using his hands, he will pick things up, move them, switch things on or off, in fact do virtually anything that he would do with his hands in the real world. The tracking of head movements is of course a vital part of the visual interaction process whereby the user of the virtual reality system sees different parts of the virtual world as he moves his head.



In both cases tracking needs to be done in three dimensions since the user is interacting with a 3-D virtual world. To do this we need what is referred to as a 6DOF (this stands for 6 Degrees Of Freedom) input device, one for head movements and one for hand movements. In such systems position is measured in terms of X,Y, and Z axis, with orientation being expressed in terms of pitch, roll, and yaw.

Tracking of hand movements can be done using a wide variety of different pieces of equipment, ranging from a conventional mouse to a special position sensing glove known as a data glove. However, a mouse, joystick, or trackerball, is only a 2DOF input device, in other words it can only move in the X and Y axis.

For proper 6DOF hand movement data input we need a device which can sense movement in X,Y and Z axis. The most widely used such device is a wand, or flying mouse. These devices contain either an electromagnetic or an ultrasonic position sensor, together with an array of buttons. They are hand held in an upright position and connected to the computer by a cable.

Other types of hand position data input device include the forceball, a 6DOF version of the common games joystick, and the data glove. The data glove is probably the most sophisticated of all the devices since besides having 6DOF position sensors it also has sensors which can capture the relative movements of each finger as well as the hand in general. This means that the user of a system equipped with a dataglove can interact with the virtual world in a very realistic manner, one can grasp and hold things just as one would in the real world.

The dataglove works by having strain gauges fastened into the glove at all the main finger joints. The only problem with this technique, and with data gloves in general, is that they need to be tailored for each individual, and also need re-calibrating every time they are used. This is necessary because strain gauges are notoriously susceptible to temperature. For this reason many virtual reality system developers are moving away from the dataglove and towards systems which can emulate the performance of a dataglove in a virtual world.

The head mounted position sensors also have to be 6DOF and on most commercial systems use the same type of position sensing as that employed on the hand held units. However, in some applications the system may need to know something about the users physical position and orientation as opposed to simply knowing the position of his head. these are virtual reality systems where the user can roam about within the virtual world. For these applications more sophisticated position trackers are required.

We have so far only considered the use of position sensors on the head and hand, but they can also be attached to any joint and this type of position sensing data input has been put to good use in producing animations of the human body and face. For example this technique was employed to generate highly realistic movement of the characters in Nintendo's Virtual Fighter. In the TV series Virtually Impossible, the computerised fish Codsby was created by having an actor wear a special headset which monitored all his facial features, the data being then interpreted by the computer and converted into the facial movements of Codsby. These are techniques which are both revolutionising, and creating higher quality film animation.

The type of sensor used in all the systems described above are known as active tracking sensors since they use an external signal to create the positional data. This means that both electromagnetic and ultrasonic position sensors require transmitters at three axis positions which can then be used to provide positional reference signals for the mobile position sensors. Here electromagnetic systems are lot more reliable than ultrasonic since they are not prone to problems such as signal reflection. Electromagnetic systems can also be used in a larger area so are also ideal for position trackers as well as interaction devices.

In addition to active tracking systems there are also passive tracking systems which are particularly suited to use on HMDs These need no reference transmitters since they use a small video camera connected to a computer to analyse the HMD wearer's position and orientation. This type of system has the advantage that it can be much more compact and used anywhere.

However, all position tracking and interaction systems do suffer from one great drawback which will only be overcome as computer power increases. With insufficient computer power there is a noticeable lag between the user moving and the computer registering the movement, or action, in the virtual world.

Biomedical uses of VR

Just as flight simulators can be used to train pilots without running any risk to either human life or equipment so virtual reality is starting to be used in the training of doctors in areas such as the teaching of anatomy or surgical practices, training doctors in new techniques, or planning of complex surgery.

The starting point in most of these applications are the two dimensional images generated by CAT (computerised axial tomography) or MRI (magnetic resonance imaging) scans. Successive scans are used by the computer to build up a three dimensional model of the human body. For training purposes these models can be very detailed (in the US a project is under way to create a very high resolution electronic image of the human body).

With a three dimensional computer model of the human body a virtual reality system can be used to generate stereoscopic images which can, in the case of data derived from an actual patient be used to enable the doctor to perform non invasive diagnosis. In other words actually looking under the patients skin without having to cut them open.

With a standard electronic model of the human body students can be trained using virtual reality in a wide range of areas that would previously have involved either just reading about the subject or dissecting actual cadavers. Such electronic models can also be used with virtual reality to train surgeons in new practices. With this type of virtual patient the surgeon can interact with the 'body', cutting, moving, and removing tissue using the standard surgical equipment. They will also be able to monitor all the patient's vital signs, administer anaesthetics, etc.

The interaction of the surgeon with the virtual body is an extremely difficult VR software problem and involves very accurate collision detection between the virtual instruments and the virtual organic model, one can not have a virtual scalpel going into a virtual body without actually cutting it. The system also needs to know how virtual tools behave, after all a scalpel blade will become blunt and will behave differently when blunt to when it is sharp.

Surgeons will also be able to use virtual reality to rehearse very difficult operations before they actually perform them on a patient. Just as the flight simulator reduces the risk of pilots crashing so virtual reality for the surgeon should ensure that many more patients survive complex operations.

Virtual reality is also being used by doctors and biologists to help them visualise and understand complex systems such as the neural networks that make up the brain. At the National Institute of Mental Health in the US, researchers are creating a dynamic set of 3D images of the brain: the Brain Visualisation Project or BVR. The sets of images include not just the normal brain, but also functional maps of different mental disease processes such as schizophrenia, Parkinson's, manic depression, etc.

The BVS allows users to enter a virtual reality environment which enables them to wander around the structures of cifferent types of brain, noting quantitative and electrophysiological changes in different structures with ranges of magnification from individual neurones to the whole brain. The data used being based upon the very latest research findings. This means that the BVS is not just a teaching aid but also a means whereby researchers can visualise the effects of recent discoveries upon the perceived model of brain function.

Virtual Reality and the military

Because virtual reality has to a large degree developed out of military simulation systems for applications such as pilot training it is hardly surprising that the military have adapted this simulation technology to other applications. Applications which range from training tank crews to complete interactive battlefield simulations.

The US military and organisations such as NASA have been, and are, one of the main driving forces behind the development of VR technology. NASA was probably one of the first organisations to realise the potential of VR in training astronauts, and VR is now a regular part of the training schedules for all Shuttle missions, as well as the planning of future missions such as the possible manned trip to Mars.

Military interest in VR is more recent and primarily the result of work by the US military through the US Defence Departments Advanced Research Project Agency, or ARPA. This work was primarily embodied in a project called SIMNET, the goal of which was to integrate an on-line network of more than 200 VR systems into a real time virtual environment. These VR systems could simulate a wide range of different types of equipment, tanks, aircraft, various types of vehicles etc.

By interacting over the network the personnel using these different VR simulators could interact in a virtual battlefield type environment even though the individuals may be located thousands of miles apart. SIMNET was started in 1988 and has now progressed to a stage where it is in everyday use, today it is called the Close Combat Tactical Trainer, or CCTT, just one of a range of battlefield training virtual reality systems.

The CCTT is used in synthetic theatres of war, or STOWs. Currently CCTT technology is supported by the distributed interactive standard, or DIS, which is a protocol for sending data across different types of network to a wide range of different VR simulators. Simulators which are made to resemble as closely as possible actual pieces of military equipment, indeed many soldiers using these simulators say that they have difficulty distinguishing the virtual system from the real system.

To date the VR simulations used by the military have only involved the use of different types of equipment, but work is currently going on to develop what is refereed to as the I-Port. This is a means of inserting individual soldiers into the virtual environment so that he will experience immersion in a networked virtual environment that he shares with other soldiers as well as equipment such as tanks.

The work involved in creation of the I-Port is very complex and involves the generation of completely natural looking and realistic terrains, natural sounds, and the construction of special interfaces that will provide both tactile and force feedback. This is the kind of system that many commercial VR developers dream about, and it has to be admitted that current military systems are probably ten years ahead of any commercial systems.

VR training for astronauts

Putting astronauts into space is an extremely expensive and risky operation, and no activity is more expensive or risky than an astronaut EVA, the so called spacewalk. But with the increasing need to repair and maintain equipment like the Hubble Space Telescope, not to mention the impending construction of an international space station, EVAs are becoming a very important part of the astronaut's job.

The only way to limit the risk of such activity is to very carefully plan the EVA and have the astronaut repeatedly rehearse the procedure, step by step, movement by movement, in special simulators over the months before the mission. Simulating movement within the weightlessness of space is not easy. At NASA they use a range of simulators, the oldest of which is the water tank, where neutral buoyancy is used to simulate weightlessness.

However, NASA faced an enormous problem when attempting to repair the Hubble since a full scale model of it and the Shuttle bay were too big to fit into any existing water tank. The telescope rose 44ft above the bay and on top of this there was the 50ft space shuttle robot arm. A problem which will be compounded one hundred fold when they start training astronauts to build the space station.

The only solution was to slice the model up into sections and deal with one section at a time, not the best solution. However, at this point virtual reality came to the rescue. A three dimensional computer model of the Hubble and shuttle was built on a Silicon Graphics 310 VGX running virtual reality software.
The astronauts were fitted with data gloves, full colour HMDs, and body position sensors, thus allowing them to interact with the virtual models of both the Hubble and the Shuttle, and of course the robot arm. It proved to be enormously successful in planning the EVA mission, resolving geometry problems relating to astronaut position with respect to the equipment being worked upon, and also in working out the critical communication protocols between the EVA astronauts and the robot arm operator.
The Hubble VR training system was able to generate 58,000 polygons at a very slow 3.5Hz update rate on a 320x270 pixel resolution stereoscopic image, the perceived image was thus rather poor and very jerky if the trainee moved too fast. This system has now been updated for current EVA missions and has a much more powerful processor, based upon Silicon Graphics Onyx systems. This means that the update rate is now a more reasonable 20Hz, and by having the software map textures the number of polygons required to map any image has dropped to about 15,000.
However, the VR system which is being planned for space station training is going to be infinitely more powerful with very high resolution and the ability for several astronauts to interact with each other during VR training. Perhaps most importantly, the VR system will have to be fitted with force feedback. They are also looking at using VR within a water tank to give the astronaut the feeling of weightlessness, but within a VR environment, the ultimate in 'virtual reality immersion'.

Touch sense and force feedback

A feature which one will not find on any commercial VR systems, but which is certainly on everyone's wish list is a means of relaying touch sensitivity and muscular force feedback. Ideally, in a virtual world we need to know how hard we are gripping something or pressing against something; we need to know if a surface is rough or smooth, hot or cold.
These are areas where once again military systems development is way ahead of commercial systems development, witness the I-Port project. However, the addition of tactile and force feedback to a VR system is an interesting project for the computer/electronics experimenter.
Tactile feedback devices, or tactors as they are known, consist of arrays of very small actuators which can be made to push into the surface of the users fingers. These very small actuators are individually controlled by the computer and can be used to generate simple temporal and spatial patterns as well as a feeling of applied force and surface texture analysis.
The tactors are constructed using shape memory alloys (we will be featuring a lot more about the uses for these alloys in future issues of ETI) and can be made in very small sizes and quite large arrays. The only real problem which we have to overcome in implementing such tactile feedback is the incomplete knowledge we currently have of our own tactile receptors, their sensitivity, bandwidth etc.
As an example of this incomplete knowledge, note that the feeling generated by pressing a sharp point into the skin is often much the same as the feeling generated by extreme cold. This means that there is an ambiguity between our own pressure sensors and our temperature sensors.
However, this incomplete state of our knowledge makes experimenting in this area all the more interesting and challenging.
Force feedback tells us how hard we need to exert our muscles in order to perform a particular action, after all action and reaction are equal and opposite. Thus lifting a small light object will generate less force feedback than lifting a large heavy object. The problems with adding force feedback to a VR system is really an engineering challenge and has not been added to commercial systems because of the added complexity and the need to tailor the force feedback system to the individual.
To add force feedback we essentially need to provide the user with some form of robotic exoskeleton. If we push against a heavy virtual object the robotic exoskeleton will push back against us with a force that corresponds to that which we would expect from a real object of that weight.

Virtual Reality and Health and Safety

Concern has recently been expressed about the health and safety aspects of total immersion virtual reality, in particular the danger of HMDs triggering epileptic attacks. It is a subject about which most of the manufacturers and designers of virtual reality equipment are all too well aware. The Japanese Government has gone so far as to fund research into this potential problem.
However, designers in both the UK and the US are confident that they can eliminate any risk by careful design of the optics, and the display system. To underline this confidence a company like Virtuality points out that more than 26 million people have used their arcade virtual reality systems and not a single health and safety problem has so far been encountered. Having said that, they are not dismissing the potential for problems and are carefully monitoring all existing users.

Another component of virtual reality, the force feedback device which allows the user to feel computer simulated forces directly via a special type of user interface was developed in 1967 by a team under Frederick Brooks at the University of North Carolina.

In 1969 we have the first use of the term 'artificial reality'. This term was coined by an artist called Myron Krueger who was working on a combination of computer and video technology to generate responsive environments. One of these projects, Glowflow, is probably the first known example of projection virtual reality and consisted of minicomputers, sound synthesisers, and a series of tubes filled with multicoloured phosphorescent liquids which created a dynamic visual effect. This environment was designed to immerse and interact with the participant. Since this period Krueger has become a leading voice in the area of virtual reality, art and aesthetics. Virtual reality has grown from these few simple beginnings. A growth which has been fuelled by the increasingly rapid development of electronics, in particular the microprocessor, and by the realisation of the power and versatility of virtual reality by organisations such as NASA and the US military (see box on military development of VR).

Immersion in a virtual world

Virtual reality as it is sold to us in the marketplace comes in different flavours, from navigable 3-D graphic displays on an ordinary PC monitor, to systems which utilise special headsets and position sensors to place the user within a virtual world. It is this latter set-up which constitutes real virtual reality for with it, the user becomes immersed in a virtual world. He becomes oblivious to the real world around him the virtual world becomes the real world in which he lives and with which he interacts.

The type of virtual reality which involves the use of 3-D graphics on a conventional monitor with position input from a standard mouse finds uses within applications such as the modelling of buildings and civil engineering structures. Here the computer model is simply being used to replace the physical models that were, and indeed still are, used to show what an as yet unbuilt structure will look like. Such models are simply designed to help planners, customers, and other interested parties to visualise what the finished structure will look like.

One step beyond this are systems which use simple 3-D stereoscopic techniques with a standard monitor to generate images. Unlike the 3-D graphics used in the simplest systems the use of stereoscopic images gives the user a sense of image depth, and thus greater naturalness. These stereoscopic systems could involve the use of colour separation using red and blue filters (see box on display technology), or they could utilise an optical system that fits over the screen which is displaying two separate images, one for the left eye and one for the right eye.

The problem with such systems is that they limit the user's angle of vision within the virtual world. It is as if one's only view of the world was through a keyhole. Through such a narrow aperture one could not see the world behind one, to the left or right, above or below, however much one moved one's head: a limitation which directly leads us to the next level of virtual reality system, the head mounted display with position tracking.

With a head mounted display, the computer senses which direction one is looking in, and then generates a stereoscopic image on a special display system which fits over the user's head. The image is displayed in front of the user's eyes by means of special optics. With such a system the user is freed from the keyhole image of the virtual world and can, so to speak, enter the virtual world and look all around himself.

In some systems the special optics used to deliver the stereoscopic images cut out any images coming from other sources, but in other systems the optics superimposes the image over the user's view of the real world. This latter technique is familiar to military pilots with head up displays, but is also used in virtual reality systems to produce what is referred to as an augmented reality system. This could be something as simple as a visual system which converted nonvisible radiation, such as infrared, to visible images, or it could be used to provide graphical information about the world.

In this type of augmented reality, visual components are added to the image of the real world. Thus, for example, an engineer attempting to repair a complex piece of equipment could use an augmented reality system to superimpose technical data onto his view of the equipment and thus guide him through the operation.(this type of application is still in the early stages of development but the KARMA project at Columbia University looks promising).

Of course sound is also a very important component of any virtual reality system. This could consist of a descriptive narrative, relevant data turned into speech form by the computer using voice synthesis, or it could be a set of synthesised sounds belonging to a computer generated virtual world. For simple 3-D and augmented reality systems, sound is usually generated by fairly standard multimedia type audio output hardware and software.

Just as the user can enter a virtual world with the aid of a head mounted display, so he can also enter a world of virtual sounds. This is done by equipping the HMD with special earphones that can output computer-generated sounds which have position and intensity within the virtual world. A sound might appear to be behind the HMD user, but as he turns his head 180 degrees, the sound source moves round until it is in front of him. Likewise as he gets closer to it gets louder and as he goes further away it gets softer.

With HMDs that shut out the images and sounds of the real world and replace them with naturalistic 3-D images and sounds from a virtual world, the user is said to be immersed in a virtual world, and this type of system is often referred to as an immersion VR system. With the addition of hand position sensors, or even whole body position sensors, it is possible for the individual using an immersion system to interact with the computer generated virtual world in much the same way as he or she would interact with the real world. Indeed the distinction between existing in a real world and existing in a virtual world start to blur.

From here we go to virtual reality systems which have several users, and where the system senses the position and movement of each user within its virtual world. The system then creates virtual images of each user so that virtual users can interact with each other in the virtual world even though they may be physically located many thousands of miles apart. This is a concept which has been taken up by the military (see box) and has considerable potential in a range of other areas such as education, and teleconferencing.

Into a virtual future

The future for VR technology is exciting. We already have all the basic technologies, it is just a matter of developing them further and reducing the cost so that they can become genuine consumer products. Prices of several key VR system components are already dropping, head mounted displays are now available at under £1,000 compared with about £4,000 only a year ago. And, computing power is dropping in price very rapidly thanks to competition amongst the manufacturers of PCs and workstations.

It has been said by several senior figures in the industry that virtual reality is now at a similar stage in its development to personal computing with the ZX81, and that it will reach a par with today's personal computing within about four years. This implies a rapid development process, and it also implies that somewhere during that period a VR standard will develop in much the same way that the IBM PC has developed as a standard.

Standardisation is the key to the proper commercialisation of virtual reality. Without it, the industry will not achieve either the volume of production to drastically cut prices or a large volume of commercial software, virtual worlds etc., let alone the development of global virtual reality networks along the line of the Internet.

Probably the first true commercial virtual reality systems will be produced by manufacturers of game systems, and we can expect to see the first of these by the end of the year. However, these early commercial systems will not necessarily be the ones from which standards will arise, but they will give a glimpse of some of the possibilities of virtual reality.

They will encourage the development of commercial VR software, primarily games but some educational material, plus the usual array of 'adult' software. It will also lead to the creation of global VR networks through the development of multiplayer games, in much the same way as multiplayer computer games encouraged a lot of people to use global computer networks. This in turn will generate further pressure towards the creation of a global standard for VR.

Once global VR networks are established, thanks to the infrastructure being built for the information super highway, then we will start to see applications with enormous potential for all of us. Applications such as virtual education systems where anyone in the world could attend virtual lectures by the worlds leading experts. Applications such as telemedicine where doctors could perform surgery on a patient located thousands of miles away. Applications such as virtual tourism which would allow us to visit a holiday destination and see what it is like before we physically go there. We will even see the development of virtual work, an application that will allow the individual to be located thousands of miles away from his or her actual workplace.

The range of potential applications for VR is enormous and will grow even bigger as VR technology improves to the stage where the sounds and images we receive from a virtual world are almost indistinguishable from those we receive in the real world. Not only will visual and sound systems improve, but so will other sensory and feedback systems. The dataglove concept will be expanded to create the data suit that will not only register all our smallest movements, but will also feedback all the sensations which we would expect if the virtual environment was real.

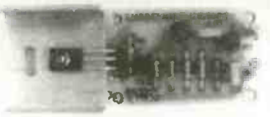
Virtual reality will allow us to do a wide range of things which are currently impossible. As individuals we can go anywhere and do anything in a virtual world, from visiting the deepest oceans to the depths of space. All that is needed is the further development of the technology, the creation of new concepts such as bio-control, and the integration of existing concepts such as artificial intelligence. It is a great challenge and an interesting future.

CONTACT SOURCES:

There are a lot of companies on both sides of the Atlantic which are now producing virtual reality systems, equipment, and software. The following a just a few of them, this is not a definitive list by any means, but simply those companies which have been involved in providing some of the information used in this piece.

Virtuality Entertainment Ltd	**Tel: 01162-337000**
Liquid Image Corporation, 659 Century St, Winnipeg, Manitoba, Canada R3H0L9.	**Tel: 0101 204775 2633**
Virtual Presence Ltd	**Tel: 0171 2522922**
Kaiser Opto-Electrics, 2752 Loker Avenue West, Carlsbad, CA 92008	**Tel: 0101 619 4389255**
Fly It Simulators, 3042, Highland Drive, Carlsbad, CA 92008	**Tel: 0101 619 4341940**
Superscape Ltd	**Tel: 0734 810077**

A mini FM transmitter, very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 Mhz but it is easy to change it to cover 63-130Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £8.22 Kit no 1001.

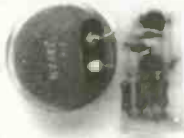


Electronic siren kit with an impressive 5 watt power output. Ideal for car/bike alarms etc. 6-12vdc, max current 1A, tone frequency 1.2khz. £7.05 Kit no 1003.

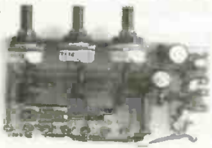
3-30v Power supply, variable, stabilized power supply for laboratory use. Shortcircuit protected, suitable for professional or amateur applications. 24v 3A transformer is also needed to complete the kit. £16.45 Kit no 1007.

Powerful 1 watt FM transmitter supplied complete with piezoelectric microphone. 8-30vdc. At 25-30v you will get nearly 2 watts!. £14.10 Kit no 1009.

FM/AM Scanner, well not quite you have to turn the knob yourself but you will hear things on this radio (even TV) that you would not hear on an ordinary radio!. Receiver covers 50-160Mhz both AM and FM. Built in 5 watt amplifier. £17.62 Kit no 1013.



Mosquito repeller, modern way to keep midges at bay! Runs for about a month on a 1.5v battery. £8.22 Kit no 1015.

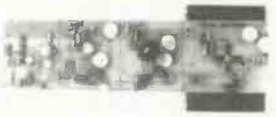


3 channel wireless sound to light system, mains operated, separate sensitivity adjustment for each channel, 1,200 watt power handling. Microphone included. £16.45 Kit no 1014.

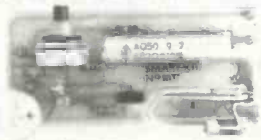
Motorbike/cycle trembler alarm, adjustable sensitivity, preset alarm time, auto reset. Could be connected to bikes horn etc. £14.10 Kit no 1011

0-5 minute timer, adjustable from 0 to 5mins, will switch up to 2A mains. Perfect for alarms, photographic laboratories etc. 12vdc. £8.22 Kit no 1020.

4 watt FM transmitter, small but powerful transmitter, 3 RF stages, microphone and an audio preamp include in kit. £23.50 Kit no 1028.

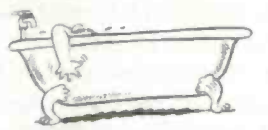


25 watt FM transmitter 4 RF stages, preamp required (our kit 1068 is suitable). Due to the complexity of the transmitter it is supplied in built up form only. £92.82 Kit no 1031.

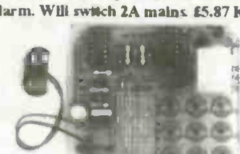


Strobe light, adjustable frequency from 1- to 60 Hz (a lot faster than conventional strobes) mains operated. £18.80 Kit no 1037.

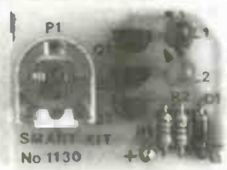
Ultrasonic radar ideal as a movement detector with a range of about 10 metres, automate your cat flap! 12v operation so ideal for cars, caravans etc. £16.45 Kit 1049.



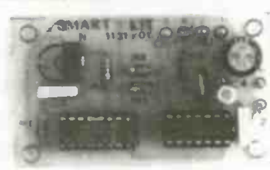
Liquid level detector useful for detecting fluid levels in tanks, fishponds, baths or as a rain or leak alarm. Will switch 2A mains. £5.87 Kit no 1081.



Combination lock 9 key, easily programmable, will switch 2A mains. Complete with keypad. 9v operation. £11.75 Kit 1114.



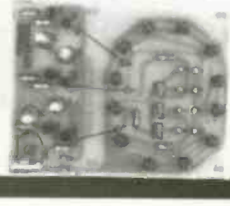
Phone bug detector, this device will warn you if somebody is eavesdropping on your phone line. £7.05 Kit no 1130.



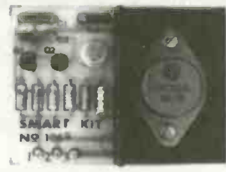
Robot voice, interesting circuit that distorts your voice! adjustable, answer the phone with a different voice! 12vdc £10.57 Kit no 1131.

Telephone bug, small bug powered by the telephone line, starts transmitting as soon as the handset is picked up! £9.40 Kit no 1135.

function generator, produces sinusoidal, saw tooth and square waves adjustable from 20hz-20khz, separate level controls for each shape. Will produce all 3 together. 24vac £17.62 Kit no 1008.



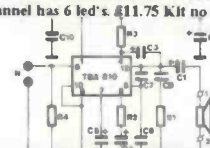
3 Channel light chaser, 800 watts per channel, speed and direction controls supplied with 12 leds and mains triacs, so you can use mains light bulbs if you want. 9-15vdc £19.97 Kit no 1026.



12v flourescent. A useful kit that will enable you to light 4' flourescent tubes from your car battery! (you will also need a 9v 2A transformer, not supplied) £9.40 Kit no 1069.

VOX switch, sound activated switch ideal for turning tape recorders on and off when sounds are heard. Makes the tape last a lot longer! adjustable sensitivity, built in delay. £9.40 Kit 1073.

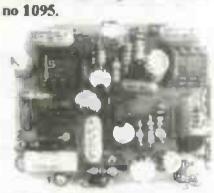
Incar sound to light, Put some atmosphere in your car with this mini 3 channel sound to light. Each channel has 6 led's. £11.75 Kit no 1086.



7 watt HI FI power amplifier useful, powerful, ideal for intercomms, audio systems, car use etc. 12-18vdc 500mA. £8.22 Kit No 1025.

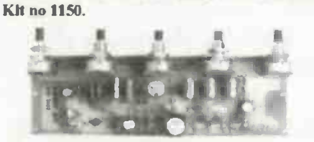
Phone call relay, useful device that operates a relay when ever the 'phone rings, could be used to operate more bells or signalling lights etc. Will switch mains at 2A. £11.75 Kit no 1122.

Lead acid charger, two automatic charging rates, visual indication of battery state, ideal for alarm systems, emergency lighting etc. 100mA 12vdc. £14.10 Kit no 1095.



Car alarm system, works on voltage drop and/or vibration, entry and exit delays plus adjustable alarm duration. Good for cars, caravans etc. £14.10 Kit no 1019.

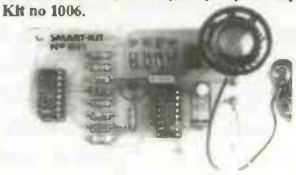
Portable alarm system, based on a mercury switch. The alarm continues to sound until the unit is disabled by the owner. Buzzer included. £12.92 Kit no 1150.



Preamp mixer, 3 input mono mixer, separate bass and treble controls plus independent level controls. 18vdc, input sens 150mv. 100mA. £17.62 Kit no 1052.

Mini metal detector, suitable for locating pipes in walls etc, range 15-20 cm, complete with case. 9v operation. £9.40 Kit no 1022.

800 watt single channel sound to light kit, mains operated, add rhythm to your party for only £9.40 Kit no 1006.



Sound effects generator, produce sounds ranging from bird chips to sirens, complete with speaker, add sound effects to your projects for just £10.57 Kit no 1045.

Guitar preamp with tone controls, small enough to fit inside any guitar, based on TL082 IC, 9-12vdc, 50mA. £9.40 Kit no 1091.

15 watt FM transmitter, 4 stage high power, preamp required. 12-18vdc. Can use either ground plane, open dipole, or Yagi. Supplied in built form only at £81.07 Kit 1021.

Telephone amplifier, Very sensitive amplifier which uses a 'phone pickup coil (supplied) will let you follow a conversation without holding the phone. £12.92 Kit no 1059.

TOP 10 BEST SELLING KITS CORNER

1. Variable speed control kit for 12v DC motors up to 30A! (you may need a heatsink for 30A) £19.97.
2. Composite video kit, converts composite signals into separate H sync, V sync and video £9.40.
3. Geiger counter kit, contains everything you need to build a working counter £22.32.
4. Solar energy kit, contains a solar panel, motor, buzzer and cable for experiments £5.87.
5. Electronic accupuncture kit, may help with migrane, poor circulation, backache etc. £8.22.
6. Electrifying apparatus kit, produces a weak adjustable high tension of 80-300v from a 9v battery, ideal for catching worms etc! £9.40.
7. Adapter bug kit, contains everything you need to build a professional bug built inside a standard 13A mains adapter! the bug is mains powered so it operates all the time the adapter is plugged in. Price is £16.45 for the complete kit including adapter. Hand tools and glue required.
8. Nicad charger kit automatic charger for cells from 1.2v to 15v, 7 settings 50600mA, transformer required 18-20v 600mA. £9.40.

9&10. Inverter kits, produce 240vac from a 12vdc supply, two versions are available a 15w one at £14.10, and an 80w version at £23.50.

EXPRESS COMPONENTS

how to order......

Remember to add £1.50 p&p.
By phone with a credit card.
By post with either a cheque, postal order or credit card details.
By fax with credit card details.

EXPRESS COMPONENTS, PO BOX 517 HOVE SUSSEX BN3 5QZ. DEPT ETI
TEL 01273 771156
FAX 01273 206875

Overseas orders please add £3.50 post and packing.

The Numbers

John Scott Paterson explains how to make a Pocket Random Number Generator to select those winning lottery numbers

The National Lottery is very much in everyone's minds at the moment, and the other night, I was chatting with friends in the pub about how different people select their weekly numbers. Some of them said that they just picked six family birthdays or anniversaries; some chose six house numbers from around their own house, while others picked numbers from bank accounts or PIN numbers. Most said that they stuck to those numbers every week, probably because they would kick themselves if a previous selection came out at later date.

Statisticians tells us that the old technique of using birthdays or anniversaries is not very likely to be successful, as using dates excludes the numbers 32-49 which 1 have noticed, come out quite often in the National Lottery. Similarly, using house numbers can have problems as there are often no odd or even house numbers in any given area.

Because of the many different factors involved in the selection of the numbers in the lottery, i.e. which machine they use, who loads it, who starts it and how long it takes for the numbers to pop out, it might as well be thought of as complete randomness. OK -students of the Chaos Theory will argue that the position of a ball in space, along with 48 others must be determined by external physical factors and so is not strictly random. If its position isn't random, neither is the possibility of its selection - yawn!, yawn!!. As far as we are concerned as punters, we have no physical control over the lottery machine or the selection of numbers and to this end we can regard the process as being totally random.

This being the case, the best way to select your numbers would seem to be to pick six random numbers every time. This sounds very easy, but because we all use numbers daily for such things as bank PIN numbers, account numbers, telephone numbers etc., we nearly always fall into the trap of using numbers that we are familiar with. I usually spend five pounds on tickets every week and it really does become quite

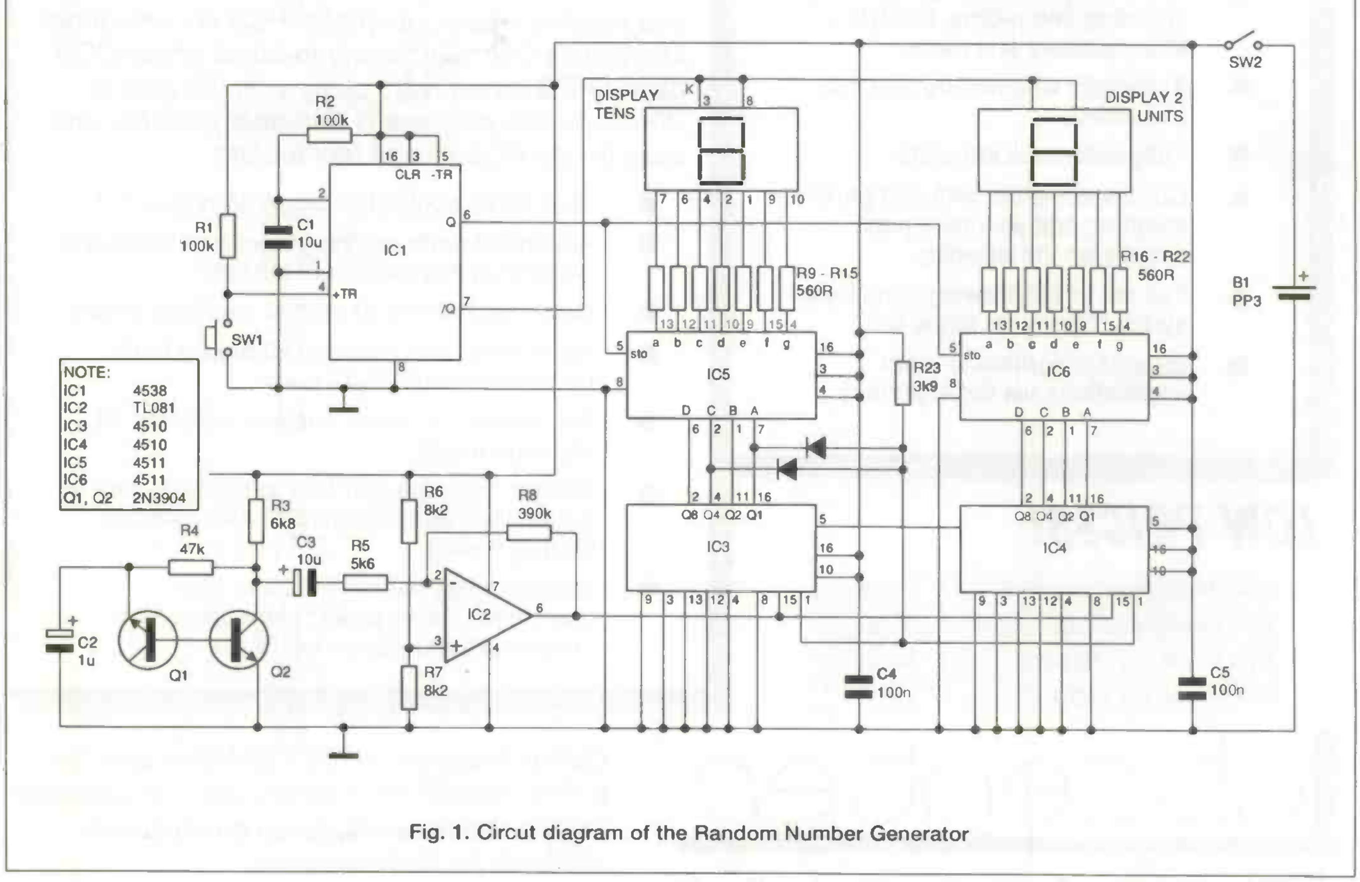


Fig. 1. Circut diagram of the Random Number Generator

Game

difficult to select different sets of six numbers even on the same card. I therefore thought of designing a system that produces 'totally random' numbers between 1 and 49.
The first idea I had was to use a computer to generate a set of six random numbers using the RND function. The program would check if any number generated had already been chosen, and if so, would make a further selection until six numbers had been chosen.
The program was written in OPL on a PSION 3a portable computer and when the program was run and given a seed to start the random function, it seemed to perform well. (Anyone interested in a copy of the program should contact me through the offices of ETI.) However, as everyone knows, computers that generate random numbers are pseudo-random number generators and that at some time, the sequence would repeat. I didn't think this was good enough and decided on a hardware approach to number generation. The design presented here is the result.

The Basic Principle

The concept is simple enough. We have a counter that continuously cycles through the numbers 1 to 49 and we include a means to stop the count and display it before the process repeats. If the clock frequency is high enough the subject pressing the STOP button will have no idea where in the sequence the counter has reached and the number so chosen will, for all intents and purposes, be random. This was tried first and although it worked well, I still wanted some 'natural' element of randomness to take part in the number selection.

Instead of having a single, high frequency clock to drive the counter, it would be much more random, if the counter was driven by multiple, unpredictable frequency clocks and this is the method used here.

A Nice Little "ERNIE".

Unlike the huge ERNIE (Electronic Random Number Generating Equipment) computer used to select the premium bond winners, the device described measures 60 x 100 x 24mm. It has two, seven segment displays to display the number generated.

Figure 1 shows the main circuit diagram which can be broken down into three distinct sections, Input/Select, Counter and Clock Generation.

Counter Section.

The counter section is quite simple using two cascaded synchronous BCD counters which drive two BCD-7-Segment Latch-Decoder-Driver chips, type 4511. The two counters are configured as Up counters by connecting pin 10 of each to the +ve supply. Each can be preset with the Units counter being preset to '1', by setting IC4s parallel load inputs to '0001'. The Tens counter is preset to '0', by setting IC3s parallel load inputs to '0000'.

This is done to ensure that a count of '00' cannot occur as the number '0' does not appear in the lottery numbers. Also, as we do not want numbers greater than 49 to be generated, we need to reset both counters to the initial state on a count of '50'. This is done by diode AND-ing outputs Q4 and Q1 of counter IC3. Only when both these outputs are high, do the LOAD input pins of both counters go momentarily high, presetting to the initial count of '1'. The counter section is always enabled and clocked and so runs ad infinitum, however the display drivers have two store Inputs which when taken to logic '1' store the number currently reached by the counter.

Clock Section.

This is not a regular clock generator as I wanted to have a more natural element of randomness, so I opted for a white noise source. It is easy to build a digital white noise source

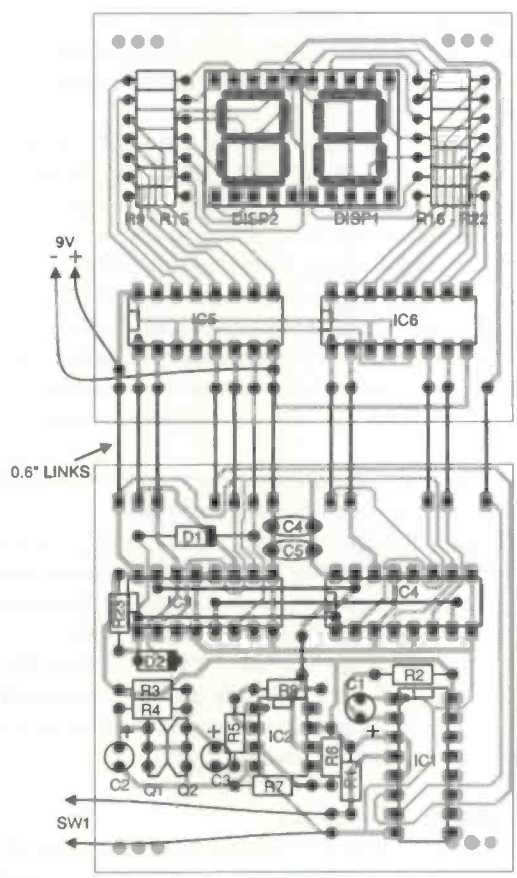


Fig. 2. Component layout for the two boards

from a shift register with some gating, but again, the output produced would not be truely random. So, I chose to use the classic Zener noise generator circuit. Here, the base-emitter junction of Tr1 is reversed biassed through R4 which results in Zener breakdown and the production of 'shot noise' due to the random emission of carriers within the P-N junction of Tr1.

This noise is first amplified by Tr2, then again by a much larger factor in 1C2 to produce a noise signal which, swinging between the supply rails, is suitable for use as a clock signal for the counter section. The output frequencies are unknown and unpredictable and just the job to add that naturally random element to the design. The output of IC2 is used to clock the counters IC3 and IC4 via pin 15.

Input/Select

This section detects a keypress and produces the necessary control signals for the counter section. IC1 is half a section of a dual monostable configured as a +ve edge-triggered mono and when S1 is closed, pin 4 of IC1 is at logic '0' the Q output is at logic '0' enabling the latches of ICs 5 and 6. The not Q output is at logic '1' so blanking the two 7-segment displays.

When S1 is released the monostable is triggered for the period set by R2 and C1. The Q output changes to logic '1' latching the count reached into ICs 5 and 6. The not Q output changes to logic '0', switching on the two displays which show the number generated. After the time-out of the monostable, the display blanks (preserving battery power) and the latch is again enabled. Adjusting the values of R2 and C1 will vary the 'On' time of the display to suit.

The whole circuit is powered by a PP3 battery.

Construction.

To keep the size of the unit down to a minimum, I decided to build it on two small PCBs measuring approx 54mm square which are then sandwiched together. One board contains the displays and drivers, and the second contain all other components.

Figure 2 shows the foil layouts for the two PCBs. Note that these are shown as seen 'through the board' and are twice normal size. This has been done for two reasons: first, it is easier to design a PCB from the top, seeing components in their real position relative to each other before connecting them together. Second, when the artwork is photo-reduced onto film, the emulsion ends up on the side which goes against the copper. This reduces side scatter of light in the exposure unit which would tend to reduce the resultant width of tracks prior to etching. This can be crucial when dealing with very thin tracks.

Figure 3 shows the component layouts for the two boards. It is best to consult this when building the project.

Start by building the display board, fitting resistors R9-R22 first, then ICs5 and 6, and finally fit the two displays and Vero pins for the battery connections. Since it is a bit of a squeeze I don't recommend the use of IC sockets in this project.

On the second board, start by fitting the 4 wire links, three of which are under ICs 3 and 4. Then fit the other components in the order, diodes, resistors, transistors, ICs then capacitors. Finally fit the two Vero pins for switch S1.

Connecting the boards

The easiest way is to perform 12 pieces of insulated wire to the specification as shown in Figure 3. Insert one end of each wire link into one of the boards, then solder in place, cropping off the excess. Then insert the other ends into the second board and solder and crop as before. Test the unit before folding one board over onto the other.

With a meter, check that there are no direct shorts between the supply rails on each board, if not connect a battery and S1. Each time S1 is pressed and released a number should be generated for about a second. If all is well, fold one board over onto the other placing a small thin sheet of Plasticard 54mm x 54mm in between the boards to stop shorts and fix the boards together using two pieces of stiff wire threaded through the holes at the top. The unit is meant to be a push fit inside the case and this method of construction does away with nuts and bolts and holes in your case etc.

A sub-min slide switch was used as the On-Off switch and this along with a sub-min push switch are fitted into opposite sides of the case lid, AFTER the boards have been fitted in place. The lid needs a rectangular cut-out 25mm x l7mm above the display which can be done with a punch or a drill and small saw. A piece of red polarising plastic 35mm x 47mm is cut and superglued onto the top of the case lid; this covers any rough edges you may have had when cutting out your hole.

That completes the Random Number Generator unit and I wish you all good luck with it. I can't guarantee to make you a millionaire, but you never know until you try!

P.S. As yet I have not given up my day job!

PARTS LIST

Resistors

- R1 lOOk
- R2= lOOk
- R3=6k8
- R4=47k
- R5=5k6
- R6,R7=8k2
- R8=39Ok
- R9-R22=56O
- R23=3k9

Capacitors

- C1=10u tant
- C2=1u tant
- C3=lOu tant
- C4, C5=lOOn

Semis

- IC1=4538
- 1C2=TL081
- IC3,4=451O
- IC5,6=4511

Miscellaneous

- S1=sub-min push to make
- S2=sub-min slide switch
- Case type HHI (Maplin ZB17T)
- PP3 battery connector
- Red polarizing filter (Maplin FR34M)

A SAMPLING OSCILLOSCOPE AND LOGIC ANALYSER

IN AN AFFORDABLE PORTABLE PACKAGE

- 10 Mega samples per second single channel DSO
- 1MHz analogue bandwidth
- 0.2v-50v input range
- Various Triggering options
- 10 Mega samples per second 8 channel logic analyser
- 5v TTL/4.5-15v CMOS logic level inputs
- Crisp, clear LCD screen
- Zoom and Scroll facilities (selected ranges only)
- Battery or mains adapter powered
- 12 Months Warranty (Built version only)
- "Get you working" service (kits only)

The Miniscope

MINISCOPE KIT £159
MINISCOPE BUILT £199
MAINS PSU £6.00 P&P £6.00
PLEASE ADD VAT AT 17.5%

Write or phone for a free Information Pack to

AUDON

AUDON ELECTRONICS

36 Attenborough Lane, Chilwell, Nottingham NG9 5JW 01602 259737

High quality stepping motor kits (all including stepping motors) 'Comstep independent control of 2 stepping motors by PC (Via the parallel port) with 2 motors and software.
Kit .... £67.00 ready built £99.00
Software support and 4 digital inouts kit £27.00
power interface 4A kit £36.00
power interface 8A kit £46.00
Stepper kit 4 (manual control) includes 200 step stepping motor and control circuit £23.00
We are now stocking a range of stepping motors and kits to drive them please ask for the stepping motor data sheet for full information.
Invertor toroidal transformers 225VA 10.5-0-10.5 primary 0-260-285 secondary £29.95
LEDs 3mm or 5mm red or green .... 7p each
yellow .... 11p each
cable ties..... 1p each £5.95 per 1000
£49.50 ..... per 10,000
High quality photo resist copper clad epoxy glass boards

Dimensions	single sided	doble sided
3x4 inches	£1.09	£1.23
4x8 inches	£2.75	£2.99
6x12 inches	£6.20	–
12x12 inches	£12.25	–

Rechargeable Batteries
AA (HP7) £0.99
AA 700maH £1.75
C 2AH witl solder tags £3.60
D 4AH with solder tags £4.95
1/2AA with solder tags £1.55
AAA (HP16) 180mAH £1.75
AA 500mAH with solder tags £1.55
C (HP11) 1.8AH £2.20
D (HP2) 1.2AH £2.60
PP3 8.4V 110mAH £4.95
Sub C with solder tags £2.50
1/3 AA with tags (philips CTV) £1.95
Standard charger charges 4 AA cells in 5 hours or 4Cs or Ds in 12-14 hours + 1xPP3 (1, 2. 3 or 4 cells may be charged at a time) £5.95
High power charger as above but charges the Cs and Ds in 5 hours AAs Cs and Ds must be charged in 2s or 4s £10.95
Nickel Metal Hydryde AA cells high capacity with no memory.
100mAH .... £3.50 1200mAH £3.75
Special offers please check for availability
stick of 4 42 x 16mm nicad batteries 171mmx16mm dia with red & black leads 4.8v £5.95
Computer grade capacitors with screw terminals 58000uf 60v £4.95
115v ac 80v dc motor 4mm x 22mm shaft 50mm dia x 60 long body (excluding the shaft) it has replacable thermal fuse and brushes .. £4.95 each £3.95 100+
7 segment common anode led display 12mm .£0.45
LM337k T03 case variable regulator £1.95
£1.44 100+
GaAs FET low leakage current S8873 £12.95 each £9.95 10+ £7.95 100+
BS250 P channel mosfet £0.45, BC559 transistor £3.95 per 100
74LS05 hex invertor £10.00 per 100, used 8748 Microcontroller £3.50
SL952 UHF Limiting amplifier LC 16 surface mounting package with data sheet £1.95
AM27S02 £1.25 each 90p 100+, CD4007UB 10p 100+, 6p 1000+
Sinclair light gun terminated with a jack plug and PP3 clip gives a signal when pointed at 50hz flickering light with output wave form chart £3.95
DC-DC convertor Reliability model V12P5 12v in 5v 200ma out 300v input to output Isolation with data £4.95 each or pack of 10 £39.50
Hour counter used 7 digit 240v ac 50Hz £1.45
QWERTY keyboard 58 key good quality switches new £6.00
Airpax A82903-C large stepping motor 14v 7.5' step 27ohm 68mm dia body 6.3mm shaft £8.95 or £200.00 for a box of 30
Polyester capacitors box type 22.5mm lead pitch
0.9uf 250vdc 18p each 14p 100+ 9p 1000+
1uf 250vdc 20p each, 15p 100+, 10p 1000+
3.3uf 100vdc 30p each, 20p 100+, 15p 1000+
1uf 50v bipolar electrolytic axial leads 15p each, 7.5p 1000+
0.22uf 250v polyester axial leads 15p each, 7.5p 1000+ Polypropylene 1ul 400vdc (Wima MKP10) 27.5mm pitch
32x29x17mm case 75p each 60p 100+
Philips 123 series solid aluminium axial leads
33uf 10v & 2.2uf 40p each, 25p 100+
Philips 108 series long life 22uf 63v axial 30p each 15p 1000+
Multilayer AVX ceramic capacitors all 5mm pitch 100v 100pf, 150pf, 220pf, 10,000pf (10n) 10p each, 5p 100+, 3.5p 1000+
500pf compression trimmer 60p
40 uf 370vac motor start capacitor (dialectrol type containing no pcbs) £5.95 or £49.50 for 10
Solid carbon resistors very low inductance ideal for RF circuits
27phm 2W, 68ohm 2W 25p each 15p each 100+ we have a range of 0.25w 0.5w 1w and 2w solid carbon resistors please send SAE for list
P.C. 400W PSU (Intel part 201035-001) with standard motherboard and 5 disk drive connectors, fan and mains inlet/outlet connectors on back and switch on the side (top for tower case) dims 212x49x149mm excluding switch £26.50 each £138.00 for 6
MX180 Digital multimeter 17 ranges 1000vdc 750vac 2Mohm 200mA transistor Hfe 9v and 1/5v battery test £12.95
AMD 27256-3 Eproms £2.00 each, £1.25 100+
DIP switch 3PCO 12 pin (ERG SDC-3-023) 60p each 40p 100+
Disk drive boxes for 5.25 disk drive with room for a power supply light grey plastic 67x268x247mm £7.95 or £49.50 for 10
Hand held ultrasonic remote control £3.95
CV2486 gas relay 30 x 10mm dia with 3 wire terminals will also work as a neon light 20p each or £7.50 per 100

All products advertised ar new and unused unless otherwise stated. Wide range of CMOS TTL 74HC 74F Linear Transistors kits rechargeable batteries capacitors tools etc. always in stock.
Please add £1.95 towards P&P
vat included in all prices

JPG ELECTRONICS

ETI 276-278 Chatsworth Road,
Chesterfield S40 2BH
Access Visa Orders (01246) 211202
Callers Welcome

SUMMER 1995 CATALOGUE

The Summer '95 edition has 280 pages packed with over 4000 products and now with news and features including a full construction project.

- The computer section is greatly increased with new ranges of equipment and accessories for PCs including:

  Mother boards, CPUs and SIMMs
  CD ROM drives and hard drives
  Sound cards, I/O cards, disc drive cards and video cards
  Mice, trackerballs and joysticks
  Power supplies and cases

£1.95 + 30p p&p

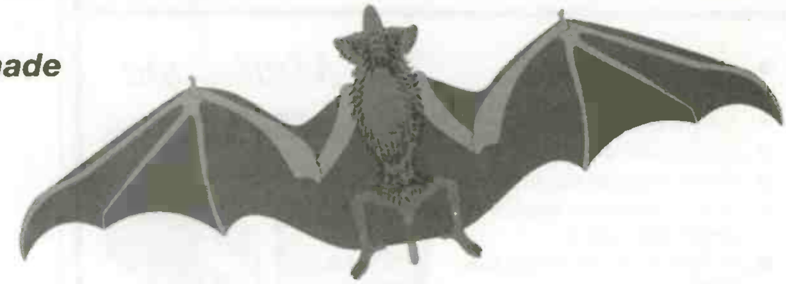
- Feature project for an EPROM programmer
- New 20MHz 'scope from Leader, training systems from Flight and an extended range of mobile phone batteries and accessories from Uniross
- Latest addition from Velleman kits including a video digitiser card
- 280 pages, 26 sections, over 4000 products from some of the worlds finest manufactures and suppliers
- Available at most large newsagents, from 13th April, or directly from Cirkit
- **Send for your copy today!**

Cirkit — Access — VISA

Cirkit Distribution Ltd
Park Lane · Broxbourne · Hertfordshire · EN10 7NQ
Telephone: 01992 448899 · Fax: 01992 471314

BAT SIMULATOR AND BAT SOUND DETECTOR

This project designed by E. Chicken allows the user to hear the sounds made by bats in flight, and an even simpler unit that electronically simulates bat sounds for testing it.



Bat-watching is a fascinating and interesting adventure, but without a bat sound-detector it can be like watching television without the audio! Whilst sunset is perhaps the best time of day to see and hear bats as they leave their dwelling places for nocturnal activities, there may be times during the hours of darkness when it is not possible to see the bats in flight. Listening to their sound-emissions becomes the only way to detect their presence and follow their flight patterns.

However, without the help of electronics their sounds cannot be heard by humans because the sound-waves they emit are at frequencies very much higher than those audible to human ears. Although a very young ear might respond to perhaps 20kHz, the average healthy adult person can only discern sound-waves up to a frequency of about 15kHz, but even that upper frequency limit decreases with age.

It is therefore feasible that an infant might just be able to hear some impression of sound from say a Serotine bat, believed to use frequencies as low as 20kHz. As most bat sound-waves are in the supersonic range 30-100 kHz the use of an electronic aid becomes mandatory.

Unlike most other animals, bats use sound for more than defining territorial boundaries and attracting mates. Bat-sound is used as a very efficient form of sonic-radar to map out obstacles and insects in the bat's flight path. Repetitive short pulses of sound-waves are transmitted by the bat in its direction of flight, and the return-echoes from objects in the line of fire are heard by the bat whose brain converts them into locational data such as distance, direction and size.

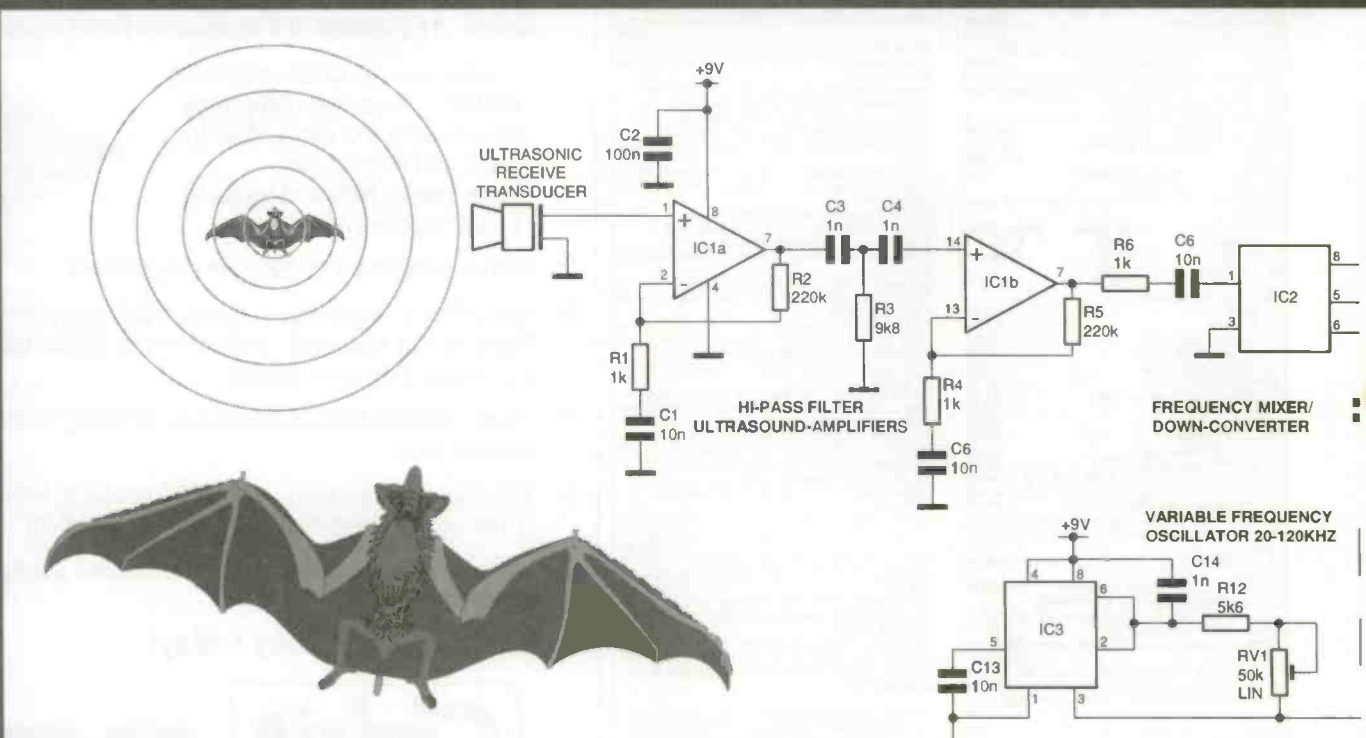


Fig.1. Circuit diagram for heterodyne bat-detector

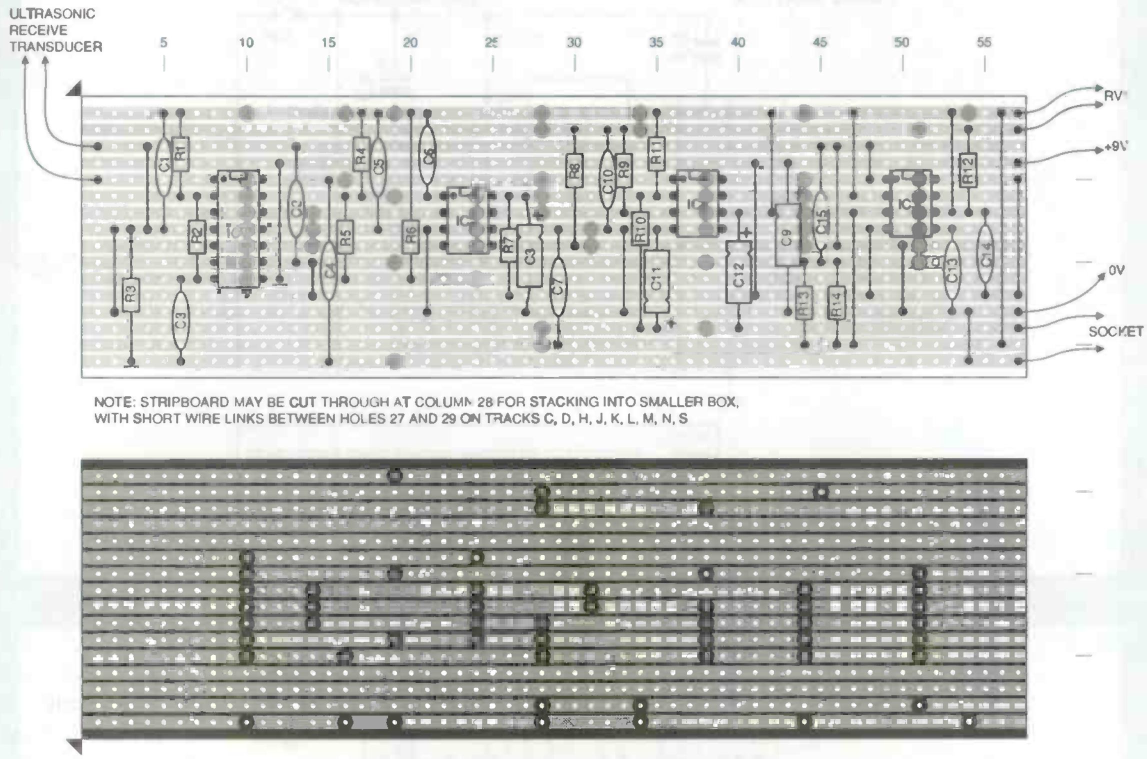
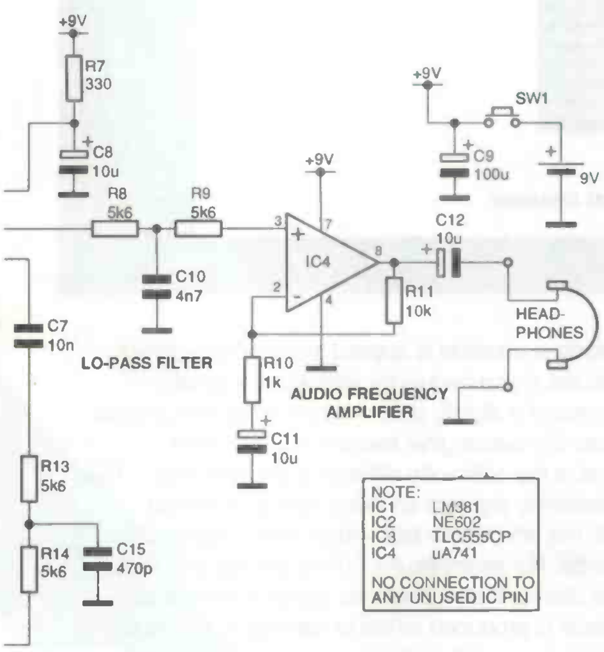


Fig.2. Bat-detector component layout and wiring



The seemingly erratic flight pattern of a bat in the vicinity of trees and hedgerows is in fact being precisely determined by echoes from its own sonic emissions, so its flight pattern far from being erratic is truly an extremely well controlled wonder of nature!

For a bat in normal flight, the pulse-rate of its emissions is typically 8-10 per second, and because of the short time-duration of each pulse, the sound heard by an observer using a bat sound-detector is more like the tapping of a pencil on a table-top rather than a pulsed tone. The pulse-rate tends to increase in the vicinity of an obstacle and can rise to 100-200 pulses per second, so the tapping sound changes into a low-pitched buzz, which increase in pitch as the bat approaches the obstacle.

The increase in pulse-rate when approaching an object gives the bat a more detailed 'radar-display' by which to sharpen up its navigational accuracy.

Not all bats or even species of bat use the same exact frequency, otherwise a flock might suffer from serious jamming of their various radar signals and controlled flight could be impossible. Each different species of bat tends to confine its sonic signals to a particular band of frequencies within the range 20-110kHz. For example:

Serotine	approx	20-60kHz
Pipistrelle	approx	40-50kHz
Brown Long-eared	approx	35-60kHz
Greater/Lesser		
Horseshoe	approx	80-110kHz

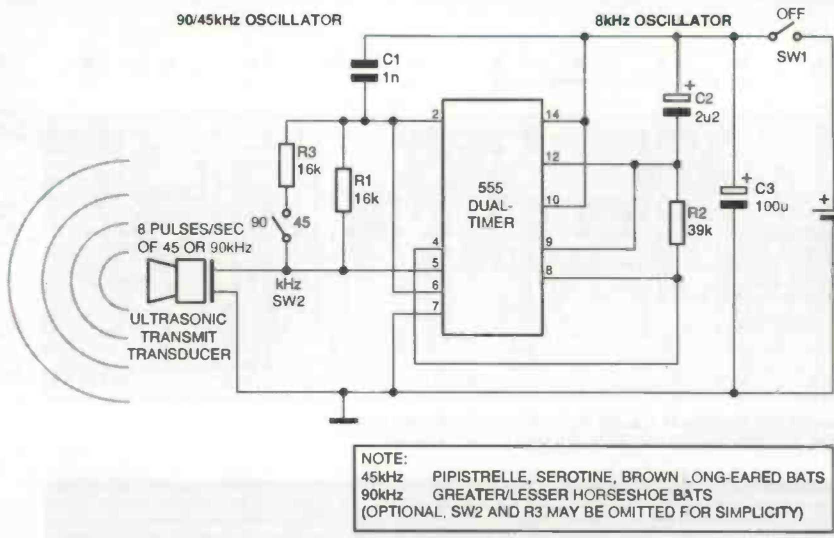


Fig.3. Circuit diagram for bat simulator

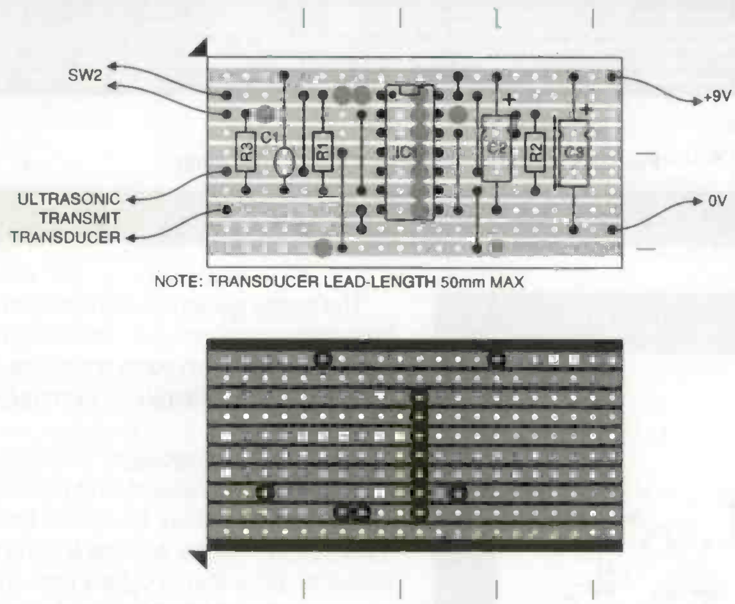


Fig.4. Component layout and wiring for bat simulator

Because there is so much overlapping of frequency-bands used by the several species of bat, the bat sound-detector can only indicate whether the particular sound comes from say a Horseshoe bat at the higher-frequency end of the band (80-110kHz), or from the lower to middle frequency part of the band (20-60kHz) used by more than one species.

Electronics Chat

This unit down-converts the supersonic bat-frequencies such that they fall within the audible range of human hearing, hence to be heard in headphones. It is designed for portability with its own battery, and can be tested at home using the bat-simulator without having to await the right conditions for its intended use.

The heterodyne principle is applied in the sound-detector by mixing the bat-signal frequency with another locally generated signal of a slightly different frequency, in a process which replaces the two original frequencies by a third frequency that is the arithmetic difference between them. This difference-frequency signal is an exact replica of the bat sound-signal, but which now falls within the human audio-frequency range. For example, if a 50kHz bat signal is mixed with a 47kHz electronically generated signal, a 3kHz audio-frequency signal is produced which is identical in format to the original bat-signal except that it can now be heard by humans.

It should be noted that the heterodyne process also produces a fourth, but unwanted frequency - i.e. the arithmetic sum (as opposed to difference) of the two original frequencies. This sum-frequency is deliberately suppressed by the circuit design.

A special ultrasonic microphone is used which is sensitive to the sound-frequencies from the bat, but not to those from human activities. The microphone is the 'receive' unit from a pair of ultrasonic transmit/receive transducers such as are used in remote-control systems. These transducers have a sensitivity maximum at about 40kHz, but are also quite sensitive across the whole ultrasonic frequency range. They are somewhat insensitive to audio-frequency sound-waves, which makes them even more attractive as a sensor for bat-sounds.

Referring to the circuit diagram as given in Figure 1, bat-signals from the microphone are amplified in two successive stages by a dual pre-amp IC type LM381. Each amplifying stage has a voltage gain of x220 determined by the resistor combinations R2÷R1 and R5÷R4, to give an overall voltage amplification of almost 50,000.

The possibility of interference with the bat-signal from any voice-frequency signals picked up by the microphone, is further reduced by the high-pass filter formed by C3, R3, C4 in the signal path between the two microphone-amplifier stages IC1a and IC1b. This filter allows the bat-frequencies to pass unhindered, but inhibits lower frequencies such as those from human voices and noises produced by handling of the sound-detector housing.

Interference from radio-frequency signals is minimised by the choice of amplifier IC, because the type LM381 is unable to amplify signals at frequencies much higher than those used by bats.

After amplification, the bat-signal is ac-coupled by C6 into one input terminal (pin 1) of the mixer IC2. Resistor R6 is used as a simple form of impedance matching between the IC1b output and IC2 input. IC2 is a double-balanced mixer device type NE602 or the slightly lower cost alternative NE612, which electronically mixes the bat-signal with the signal from a local-oscillator whose frequency is only a few kHz different from that of the bat.

IC3 which serves as the local oscillator, is a type 555 timer device configured as a variable-frequency oscillator with a square-wave output voltage. A low-pass filter formed by R14, C15, R15 rounds off the square-wave output from pin 3 of IC3 to feed a pseudo sine-wave into the second input terminal (pin 6) of mixer IC2 via capacitor C7.

The oscillator frequency is given approximately by f (kHz) = 710/Cr where C = C14 in nF and R = (R12+RV1) in kohm, to provide a frequency swing of about 20-120kHz which adequately covers the bat frequency-range. RV1 is externally accessible so allows the frequency to be manually adjusted to be within a few kHz of the bat-signal frequency, for whatever species of bat. In other words, the bat sound-detector is 'tuned' by RV1 for optimum audio-control and calibrated in kHz, or bat-species, or both.

The mixer output signal at the difference-frequency as determined by adjustment of RV1 actually falls within the audio-frequency range of human hearing, but it needs to be divorced from the unwanted sum-frequency signal before it alone can be amplified and fed to headphone as audible bat-sound. Components R8, C10 and R9 form a low-pass filter between the mixer output and the IC4 audio amplifier input, which allows unhindered passage to the low difference-frequencies whilst blocking the much higher frequencies of the sum-signal.

This filter also provides further protection against interference from unwanted radio-frequency signals such as broadcast.

Amplification of the now filtered audio-signal is provided by IC4, a standard 741 operational amplifier. Resistor combination R11÷R10 gives the af amplifier a voltage gain of x10, which is sufficient to produce an acceptable sound level

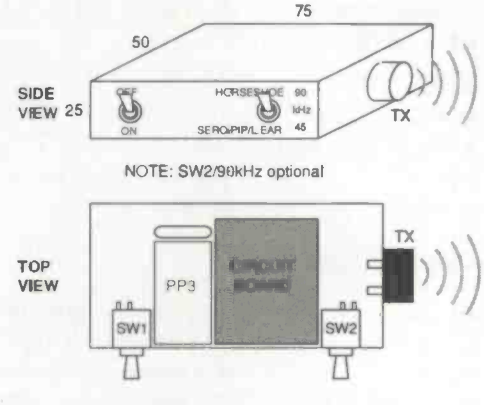


Fig.5. Bat simulator housing

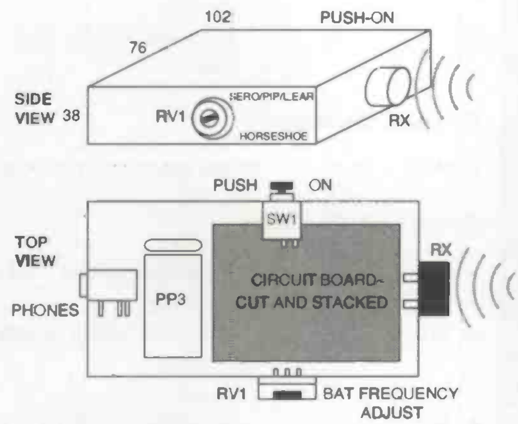


Fig.6. Bat detector housing

in headphones from dc, and a stereo-type socket with its two tip-terminals strapped allows the use of either stereo or mono phones.

Power supply is from a PP3 9volt battery at a current drain of about 25mA. Whilst the push-button on-off switch gives some control of battery-life, the use of a high-power type of PP3 battery is advisable.

Bat-Simulator

This is a separate small portable unit of simplistic design, with its own battery. Current drain from the battery is minimal. The simulator provides a signal with which to test/calibrate the bat sound-detector. It uses the 'transmit' transducer from the transmit/receive pair mentioned earlier, to radiate a pulsed-train of ultrasonic waves at bat-frequencies with a sound power-level similar to that from a bat in flight.

Whilst the simulated signal does sound like that from a real bat, the pulse time-duration has been designed to be much longer than normal. This results in a pulsed whistle-tone being heard while adjusting the bat-tuning control RV1 of the bat sound-detector, which helps in the calibration of that control.

A choice of two frequencies is available at the touch of a switch. One at 45kHz is centred on the 20-60kHz band used by the Serotine, Brown Long-eared and Pipistrelle bats, and another at 90kHz centred on the 80-110kHz band used by the Horseshoe bat. This dual frequency facility is again useful in calibrating the frequency/bat-tuning control of the sound-detector unit.

The bat-simulator has a transmission-range similar to that of a live bat, so the unit can be placed some 20-30 metres distance from the bat sound-detector to check its sensitivity

PARTS LIST

Resistors or 1/3W — Carbon Film 1/8W

R7	330
R1, 4, 6, 10	1k
R3, 8, 9, 12, 13, 14	5k6
R11	10k
R2, 5	220k

Capacitors

C15	470p ceramic disc, 100V
C3, 4, 5	1n ceramic disc, 100V
C10	4n7 ceramic disc, 100V
C1, 5, 6, 7, 13	10n ceramic disc, 100V
C2	100n ceramic disc, 63V
C8, 11, 12	10µ electrolytic, 25V axial lead
C9	100µ electrolytic, 25V axial lead

Potentiometer

RV1	50k linear, cermet preset

Semiconductors

IC1	LM381 low-noise dual pre amplifier
IC2	NE602 or NE612 double balanced mixer
IC3	TLC555C or ICM7555 timer
IC4	µA741 operational amplifier

Miscellaneous

Qty 1 pair	Ultrasonic transducers transmitter/receiver
Qty 3	DIL socket, 8 pin, low profile
Qty 1	DIL socket, 14 pin, low profile
Qty 1	Box, 102x76x38mm, plastic
Qty 1	Switch, miniature push to make, panel mounting
Qty 1	Battery PP3 Alkaline 9volt
Qty 1	Battery clip, dual miniature PP3 with leads
Qty 1 metre	4-wire telephone cable
Qty 1	Stripboard 39 strips x 62 holes
Qty 1	Stripboard track-cutter
Qty 1	Headphones, low-cost 3.5mm stereo
Qty 1	Socket, 3.5mm stereo, chassis mounting or plastic line mounting

Bat Simulator

Resistors	Carbon Film 1/8W or 1/3W
R1, 3	16k
R2	39k

Capacitor

C1	1n ceramic disc 100V
C2	2µ2 electrolytic, 25V axial lead
C3	100µ electrolytic, 25V axial lead

Semiconductors

IC1	TLC556 or NE556 dual timer

Miscellaneous

Qty 1	DIL socket, 14 pin, low profile
Qty 2	Switch, ultra-min toggle, SPST
Qty 1	Box, 75x50x25mm, plastic
Qty 1	Battery PP3, zinc chloride
Qty 1	Battery clip, dual miniature PP3 with leads
Qty 1	Stripboard 10 strips x 20 holes offcut from above
Qty 1	Ultrasonic transmitter transducer from pair above

and directivity.

Figure 3 gives the circuit diagram of the simulator. A dual-timer IC type 556 is configured as two free-running oscillators, the outputs of which combine to produce the pulsed ultrasonic tones. Each of the two oscillators uses a circuit similar to that of the local-oscillator in bat sound-detector unit, except that their frequencies are not variable and no attempt is made to round-off their square-wave shapes.

One oscillates in the ultrasonic frequency region, while the other oscillates at the very low pulse-rate frequency of 8Hz. The square-wave voltage-output from the low-frequency oscillator is used to switch on and off the ultrasonic oscillator at the rate of eight times per second, so producing an 8Hz pulsed wave-train in the bat-frequency range.

The ultrasonic oscillator has two frequencies preset at 45kHz and 90kHz, and selected by switch SW2. Frequency is determined by C1&R1 for 45kHz, or by C1&R1&R3 for 90kHz, using the formula f(kHz) = 710÷(CxR) where C is in nF, and R is in kohm. With switch SW2 open only R1 is in circuit, to give a frequency of 45kHz. Closing SW2 connects R3 in parallel with R1 hence doubling the frequency to 90kHz.

However, the 45/90kHz can only function when its 'reset' pin4 is connected to a positive voltage, and the 8Hz oscillator serves that purpose. The low-frequency oscillation is preset at 8Hz by means of C2 and R2, given by the formula f(Hz) = 0.71÷(C2xR2) where C2 is in microfarad and R2 is in kilohm. The 8Hz output signal from pin 9 is a square-wave whose amplitude varies periodically between 0V and +9V. This is connected to the reset terminal pin4 of the ultrasonic oscillator, thereby switching its 45/90kHz oscillations on and off at the rate of 8 times per second.

The resultant pulsating 45/90kHz signal from output pin5 of the ultrasonic oscillator is fed to the 'transmit' transducer of the transmit/receive pair, which acts as a mini-loudspeaker to radiate a continual string of ultrasonic pulses at 8 per second, hence simulating a bat-signal. The pulses are radiated in a highly directional conical beam from the central aperture of the transducer in very much the same directional pattern as those from a bat. Again, they can not be heard by the human ear, but are fully audible when received by the bat sound-detector.

Because the pulse time-duration of the bat-simulator signal is relatively long compared to that from a real bat, it produces in the bat sound-detector a discernible heterodyne-whistle tone that can be varied to zero-beat by adjustment of bat-tuning control RV1. These zero-beats allow the rotation of RV1 to be calibrated at its 45kHz and 90kHz positions, so to identify the bat-sound in the phones as being from either the Serotine, Pipistrelle, Brown Long-eared group of bats, or the Horseshoe species respectively.

Construction

Copper stripboard of 0.1inch grid is used for each unit, with the component layout and wiring shown in Figures 2 and 4. The use of stripboard rather than printed-circuit means that these units can be constructed simply and economically.

DIL sockets are used for the ICs, and inter-wiring is simplified by using the given layouts with cuts in the copper tracks as shown. These cuts can be made by hand using a sharp 3mm drill, or better still by means of proper track-cutting tool. They are not expensive, and really are to be recommended as a long-term investment. All components are horizontally mounted. Wiring is by single-core pvc of different colours such as from a short length of internal telephone cable. The colours help in checking the finished assembly.

This type of wiring layout results in a circuit-board a little larger than would be the case if point to point wiring were adopted, but the sound-detector board layout allows for it to be cut in two and folded for fitting into a smaller box if required. Referring to Figure 2, the cut would be made at hole column 28, with short wire-links soldered between holes 27 & 29 on tracks C, D, H, J, K, L, M, N, S.

A 3.5 stereo headphone socket is used with the bat sound-detector to accommodate stereo phones, although of course the sound is not in stereo. As an alternative to being panel-mounted, a stereo 3.5mm line-socket on the free-end of a short flexible cable would save box-space, but in either case only the two tip-terminals of the socket must be used, with the common-terminal left unconnected. This connects the two earpieces in series.

The bat-simulator does not really need a box. The frequency switch and transducer could be soldered directly to the board, and for further simplicity the switch and R3 could be omitted, so giving only the 45kHz signal as used by most bat species. Even the on/off switch could be dispensed with, by disconnecting the battery when not in use.

A low-cost plastic box with a removable lid makes a suitable housing for either unit. The battery and strip-board whether cut and folded or not, can be fixed securely into place using pieces of plasticine, Blu-Tak, or double-sided adhesive pads.

For the bat-tuning/frequency control RV1 of the sound-detector, a rotary preset potentiometer of the cermet type with a finger-adjustment or dust cover is ideal, being smaller and cheaper than a miniature rotary potentiometer plus knob, and easier to install. It can very simply be inserted into the side wall of the box by drilling three small holes for the pins, and gently bending-over the pins on the inside to hold the control in place. Pointed-nose pliers or tweezers should be used to protect the plastic box when soldering the connecting wires to the potentiometer.

Two small holes in the end face of the sound-detector and/or simulator box allow the transducer pins to be inserted, and again the pins may be bent slightly but carefully on the inside to hold the transducer in place.

The push-button on/off switch for the sound-detector should be mounted on the side panel opposite the bat-tuning control, and positioned for most comfortable thumb-access.

Connecting wires between circuit board and external components should be as short as possible to minimise radio-frequency pick-up.

Box dimensions given in Figures 5&6 are for guidance only. It is always worth a reconnaissance of the kitchen cupboards before buying a box!

Before connecting the battery, each finished stripbaord should be carefully checked for correctness of wiring and track-cuttings, and for solder-splashes across the tracks.

Use of Bat Sound-Detector and Simulator

When the sound-detector battery on/off switch is pressed, a hissing sound will be heard in the headphone. No other sound should be heard even while speaking. To test the sound-detector quickly and easily, rub together one's fingers in front of the receive transducer. The ultrasonic content of the rubbing process should be distinctly audible in the phones, much more pronounced than that heard by the ear without the phones.

A better test is to position the bat-simulator at some 10-20 metres distance but within view, with the unit switched on and set for 45kHz, and with the transducer-face pointing towards the sound detector. A strong pulsating/tapping sound should be heard in the phones. By rotating the bat-tune control on the sound detector the tapping should change to a pulsating whistle-tone.

The control should then be adjusted until the musical pitch of the tone decreased towards zero-beat in the phones. The panel should be marked at the zero-beat position of the control, with the legend Pipistrelle/45kHz. With the simulator now switched to 90kHz, the bat-tune control should be re-adjusted for another zero beat of the pulsating tone, and the panel marked Horseshoe/90kHz at that new position of the control.

The bat-tune control should then be adjusted for maximum audible signal, and the detector moved in a wide circular-sweep to give a sense of the receive-transducer's highly directional properties. Similarly, the detector is kept stationery while an assistant walks about with the simulator, so to observe the directivity and detection-range of the simulator's transmit-transducer.

Now that the sound-detector has been proven and calibrated, it is ready to be tested in earnest. Between sundown and the onset of darkness is the best time to see and hear the bats as they fly towards their night-time feeding areas.

With the bat-tune control set to its mid-position and the on-button pressed, the detector-transducer is pointed skywards towards the anticipated flight-path of the bats. It should be possible to hear a bat upwards to 20-30m distance, when strong tapping sounds will be heard irrespective of the position of the bat-tune control. Once a bat-sound is heard, the bat-tune control is adjusted for best results in the headphones whilst following the bat's line of flight with the transducer. No further adjustment is necessary.

It would of course be possible to tape-record the sounds for later demonstration to family and friends, by fitting a two-way adaptor to the headphone socket and taking a separate lead to the recorder.

Good hunting Batman!

Surplus always wanted for cash!

THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

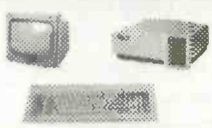
LOW COST PC's - ALL EXPANDABLE - ALL PC COMPATIBLE

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 mother-board, 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 3½"- 8"

5¼" from £22.95 - 3½" from £24.95

Massive purchases of standard 5¼" and 3½" 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 3½" supported on your PC).

3½" **Panasonic** JU363/4 720K or equivalent	£24.95(B)
3½" **Mitsubishi** MF355C-L. 1.4 Meg. Laptops only *	£36.95(B)
3½" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop	£29.95(B)
5¼" **Teac** FD-55GFR 1.2 Meg	£29.95(B)
5¼" **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)**

3½" **FUJI** FK-309-26 20mb MFM I/F RFE	£59.95(C)
3½" **CONNER** CP3024 20 mb IDE I/F (or equiv)RFE	£69.95(C)
3½" **CONNER** CP3044 40mb IDE I/F (or equiv.)RFE	£89.00(C)
3½" **RODIME** RO3057S 45mb SCSI I/F (Mac & Acorn)	£99.00(C)
5¼" **MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE	£49.95(C)
5¼" **SEAGATE** ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5¼" **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*

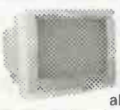
IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

5,000,000 items EX STOCK

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

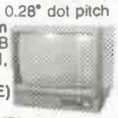
VIDEO MONITOR SPECIALS



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 modern 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 13½" x 12" x 11". **Only £125 (E)** Good used condition. 90 day guarantee.
KME 10" as above for PC EGA standard £145.00 (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with standard composite **15.625 Khz video** input via **SCART** socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested with a 90 day guarantee. In attractive square cream plastic case measuring W10" x H10" x 13½" D. Mains powered **Limited Quantity - Only £79.00 (D)**

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

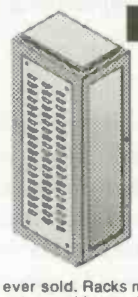
10,000 Power Supplies Ex Stock
Call for info / list

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. Dims 13" x 5" x 2½". 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. 6¼" x 4" x 1¾" 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
KNS EMC / Line interference tester **NEW**	£1200
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
COMPONEDEX T1000 Portable **TELEX** tester **NEW**	£250
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: 77½" H x 32½" 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)

SIMM OFFERS

1 MB x 9 SIMM 9 chip 120ns	only	**£19.50** (A1)
4 MB 70ns 72 pin SIMM module	only	**£125.00** (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 **Densel. 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-

ESTABLISHED 25 YEARS

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

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

Nickel Metal Hydride BATTERIES

NiMH battery technology is now one of the prime contenders in the race to provide an economical and practical power storage device for electric vehicles. Douglas Clarkson takes a look at the technology and future uses for MiNH batteries

Battery technology has a very direct impact on the development of a wide range of equipment, particularly mobile phones and laptop computers. Also, as battery technology advances, so new ranges of electronic and electrical equipment become practical to design and develop.

It is perhaps significant that the bulk of the initial production of NiMH batteries has been secured by large multinational companies in the mobile phone sector. This indicates a strong demand for the emerging product.

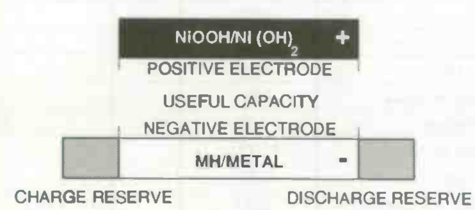


Figure 1: Basic electrode configuration of NiMH cell.

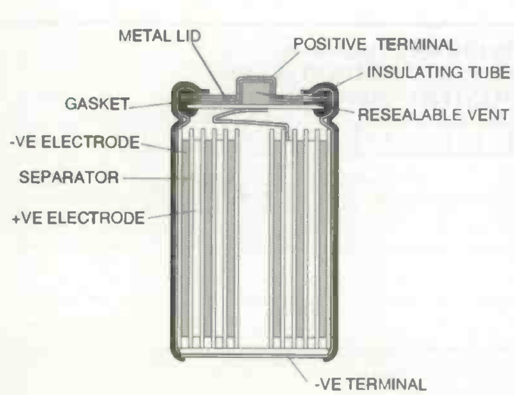


Figure 2: Construction of cylindrical NiMH cell. (Courtesy Varta Ltd.)

A proprietary nickel metal hydride battery technology developed and patented by the Ovonic Battery Company (Troy:Michigan) - a subsidiary of Energy Conversion Devices (ECD) is attracting considerable interest as a direct replacement for Nickel Cadmium re-chargeable batteries in a wide range of portable equipment. A range of battery manufacturers are now developing or manufacturing NiMH batteries under licence from ECD. These include Varta Batterie (Germany), Gold Peak (Hong Kong), Matsushita (Japan) and Hitachi Maxell (Japan).

The NiMH battery was initially intended as an 'interim technology' solution for portable and electric vehicle applications. The good progress with the current versions of NiMH battery technology and the prospects for extending the energy density characteristics in Wh/Kg and Wh/l have resulted in NiMH technology being recognised as potentially the best long term rechargeable battery technology available.

Also, the NiMH battery is 'greener' than the NiCd cell. It can be safely recycled or committed to landfill and poses no problems during manufacture.

With NiCd cells, manufacturers have made available a range of product types - standard, high discharge current, high capacity, high temperature and fast charge. It is likely that as the market for NiMH develops, a broader range of application specific types of batteries will become available.

Various independent groups in the former Soviet Union are also developing NiMH batteries. This could help to lower the relatively high price of NiMH batteries from their current levels. ECD has independently granted a licence to Solvux (Russia) for NiMH battery development/production.

Development Path

When the first commercially available NiMH batteries appeared in 1987, this was only after several decades of development by a range of companies. Initially effort was focused on La:Ni (Lanthanum:Nickel) and Ti:Ni (Titanium:Nickel) systems for the negative electrode material. These compounds suffered, however, from poor ability to absorb hydrogen and were prone to oxidation and corrosion. The solution to this problem which was discovered by the Ovonic Battery Company was to introduce a disordered approach by the development of a range of complex alloys for the La:Ni and the Ti:Ni systems. The 'cocktail' of compounds for each family is indicated in table 1.

Table 1:

Component elements of La and Ti families of metal hydride alloys for negative electrode.

LaNi Family	TiNi Family
La:Lanthanum	V:Vanadium
Ce:Cerium	Ti:Titanium
Pr:Praeseodymium	Zr:Zirconium
Nd:Neodymium	Ni:Nickel
Ni:Nickel	Cr:Chromium
Co:Cobalt	Co:Cobalt
Mn:Manganese	Mn:Manganese
Al:Aluminium	Al:Aluminium
	Fe:Iron

While previously the mix of metal was derived from a mixture of naturally occurring rare earth elements that can include Ce, La and Nd these form of alloys tended to degrade in performance relatively rapidly. This type of materials is commonly referred to as 'mischmetal'. Using a so called 'disordered' materials approach, the alloy compositions have been configured to optimise performance.

The multicomponent, multiphase materials used favour the creation of compositional and structural disorder which increases the number of chemically active sites - leading to increased hydrogen bonding possibilities.

The complex chemistry of the multicomponent multiphase hydride alloys can be configured to produce specific battery characteristics. The series of elements Mg, Ti, V, Zr, Nb and La are associated with increasing the number of hydrogen atoms stored per metal atom. The strength of the metal-hydrogen bond is influenced by the elements V, Mn and Zr. Catalytic properties which ensure adequate charge and discharge reaction rates and gas re-combination are provided in turn by Al, Mn, Co, Fe and Ni. A range of desirable surface properties such as oxidation and corrosion resistance, improved porosity and electron and ionic conductivities are imparted by the elements Cr, Mo and W.

Key factors in the manufacture of such complex 'cocktail' alloys are the purity of the component metals and the accuracy with which the various metals are mixed and fabricated. The elements which play a catalytic role will have a critical effect on battery function.

Thus by adjusting the relative composition of the alloy, batteries with specific performance features such as high charge rates or good charge holding function can be configured.

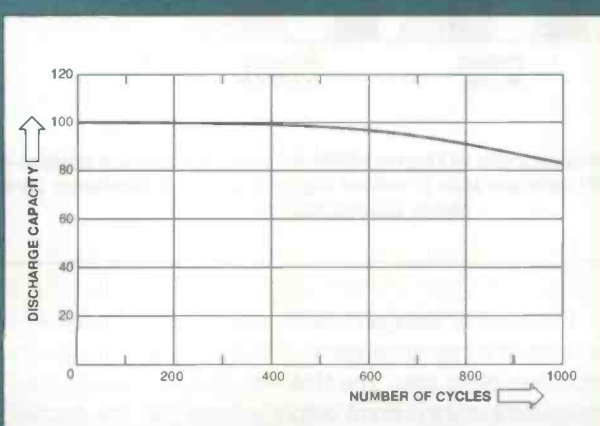


Figure 3: Life expectancy of standard NiMH cell for 0.25 CA charge and 0.25 CA discharge conditions. (Courtesy Varta Ltd.)

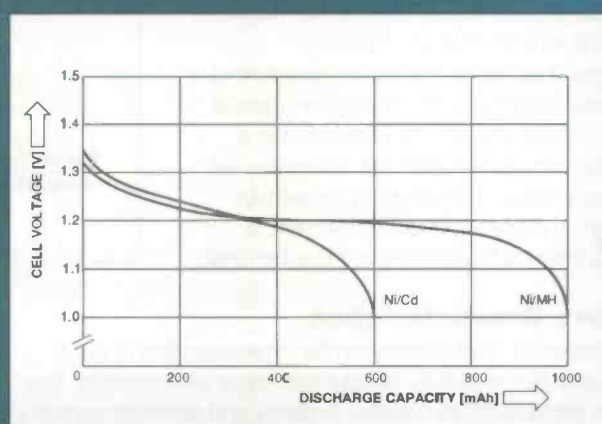


Figure 4: Discharge curve of Varta AA cells compared with conventional NiCd AA cell. (Courtesy Varta Ltd.)

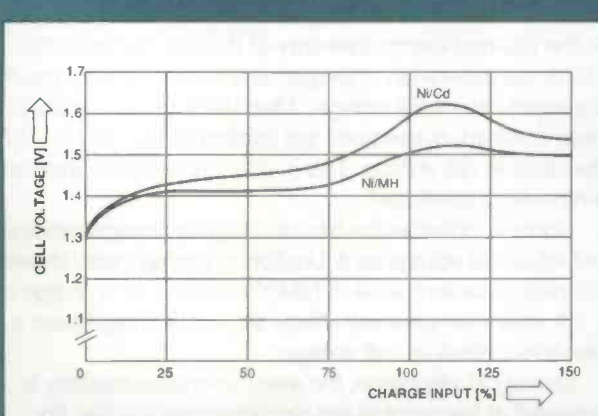


Figure 5: Typical charging characteristics of individual cell voltage as a function of charge input showing relative performance of NiMH and NiCd cells for a charge rate of 1 CA. (Courtesy Varta Ltd.)

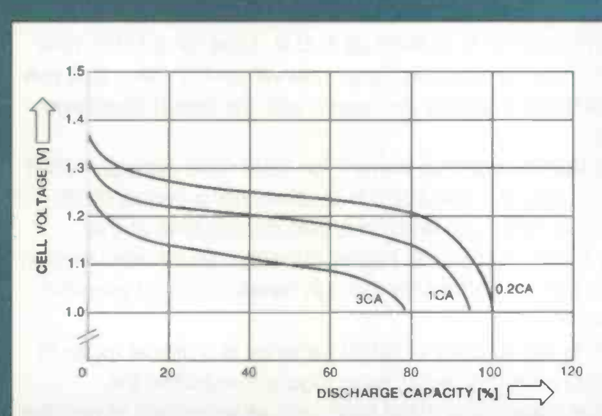


Figure 6: Discharge characteristics as a function of discharge rate. (Courtesy Varta Ltd.)

The first generation of NiMH cells at AA size, for example, had a nominal capacity of 1000 mAh, a specific energy of 56 Wh/Kg and energy density of 180 Wh/l. Recent advanced types such as 'Gold Peak' cells provide a capacity of up to 1500 mAh, a specific energy of around 80 Wh/Kg and an energy density of around 250 Wh/l.

Battery Construction

Figure 1 indicates the basic configuration of the NiMH cell. The positive electrode consists of mainly NiOOH in the charged state and Ni(OH)2 in the discharged state. The negative electrode consists mainly of Metal in the discharged state and Metal-Hydride in charged state.

The charging process therefore transfers hydrogen from the Nickel positive electrode to the metal negative electrode. The electrolyte used is KOH, Potassium Hydroxide. In the conventional NiCd cell, the negative electrode is formed from Cadmium. Up to 20% of the weight of typical NiCd cells is accounted for by Cadmium content.

In prismatic cells of square or rectangular cross section, the electrodes are layered as flat plates interspaced by separator sheets.

In order to protect the cell from oxygen which is released at the end of charging and to protect against end of discharge, the negative cell is over dimensioned. It is therefore the net size of the positive electrode which determines the cell capacity.

Figure 2 indicates the typical structure of a cylindrical NiMH cell. The separator material which is impregnated with electrolyte is a synthetic non-woven material. While the cell will operate over most of its cycle without build up of pressure, a resealable vent is typically included under the positive terminal.

Battery Characteristics

NiMH batteries have broadly similar characteristics to NiCd batteries in terms of their charge/discharge performance. The various terms such as nominal capacity and available capacity are carefully defined within a wider framework of definitions. A range of parameters for first generation types are referenced.

The nominal capacity (C) in Ah denotes the minimum amount of capacity which can be withdrawn in 5 hours when discharging at the nominal rate (defined as 0.2 CA). The end of discharge voltage is defined as 1 .0 V. Thus for a 1000 mAh capacity, the nominal discharge rate will be 0.2 CA = 200 mA. The discharge capacity decreases with increased discharge current.

The standard charge current for 1000 mAh capacity NiMH cells is usually 0.1 CA which is applied over a period of 15 - 16 hours. The maximum recommended charge time at this charge rate is 100 hours. Higher currents can be used though this can reduce battery life through development of elevated temperatures.

The life expectancy of NiMH batteries is a critical factor in assessing a battery technology. Figure 3 indicates the discharge capacity of 1000 mAh cells as a function of number of charge/discharge cycles for standard NiMH cells at 0.25 CA charge and 0.25 CA discharge conditions.

Charging at accelerated rates is 0.3 CA is possible. It is advised that temperature cut off devices or time limitation of 5 hours are utilised if currents of eg 0.3 CA are used. Fast charge at constant current of 0.5 CA to 1 CA requires charge termination primarily due to temperature cut out and monitoring of rates of rise of cell temperature. In this mode, software can predict temperature end points during charge phases and so provide an added element of protection.

Standard NiCd cells provide nominal charging rates of 0.3 CA - so the 1000 mAh NiMH cells are slower to charge. Some fast charge NiCd types provide charge rates of at least 2 CA.

Trickle charge levels with standard NiMH are typically in the region 0.03 CA to 0.5 CA, which for a 1000 mAh cell equates to between 30 mA and 50 mA.

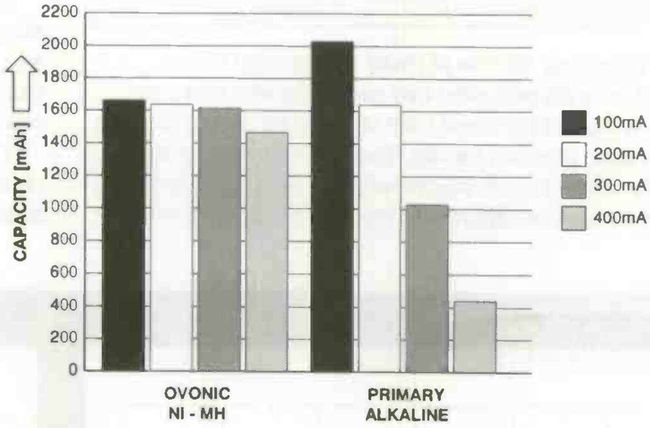


Figure 7: Relative capacity of Ovonic NiMH AA cells and primary alkaline AA cells. The NiMH cells are able to deliver higher capacity at discharge levels above around 200mA.

The nominal voltage of NiMH cells is 1.2 V. Figure 4 indicates the discharge curve of Varta AA cells compared with equivalent NiCd cells. The NiMH discharge characteristic maintains a more uniform output voltage over the discharge process.

Charging Characteristics

During the charging cycle up to around 75% of capacity has been reached, the cell voltage increases to around 1.43 V due to the planned electrochemistry of the cell. Between 75% and 100% the generation of oxygen at the positive plate results in a steeper rise of cell voltage. After 100% of cell capacity has been reached, subsequent self heating of the cell results in a decrease in cell voltage. This is due to the cell's negative temperature coefficient.

Figure 5 indicates the typical charging characteristics of individual cell voltage as a function of charge input, showing the relative performance of NiMH and NiCd for a charge rate of 1 CA where temperature effects above full charge have a significant effect on cell voltage.

During cell discharge, the rated discharge capacity is achieved at the nominal cell discharge rate 0.2 CA. For discharge at higher currents, the discharge capacity is reduced as indicated in figure 6. Thus at around 3 CA, only 80% of the discharge capacity is available and the cell voltage is considerably reduced.

The higher capacity NiMH cells now available can actually provide higher capacity at high discharges than high performance alkaline cells as indicated in figure 7. When making comparisons of cell capacity, it is essential to relate this to rates of current discharge.

The discharge capacity of the NiMH cell with temperature behaves in a similar way to that of the NiCd cell for discharge currents around 1 CA as indicated in figure 8. There is slightly improved performance at lower discharge rates. At 0.2 CA, for example, the discharge capacity is reduced to around 95% at -20 C.

Table 2:

Typical recommended figures of charge, discharge and storage temperatures of standard NiCd, high temperature NiCd and NiMH batteries.

	charge recommended temp range	discharge recommended temp range	store recommended temp range
NiCd (standard)	+10 to +35	-20 to +45	0 to 45
NiCd (high temp)	+10 to +40	20 to +45	0 to 45
NiMH	0 to +45	-20 to +60	-20 to +35

Temperature Characteristics

While NiCd and NiMH batteries can be used over a wider range of permissible temperatures, table 2 indicates some typical recommended temperature ranges for charge, discharge and storage.

Thus, NiMH can be charged on a broader range of temperature, both at low and high ranges. NiMH can be discharged at higher temperatures. In storage, NiMH can be stored at lower temperatures but at slightly lower upper temperatures compared with NiCd. It is more than likely that the temperature tolerance of NiMH batteries in electric vehicle applications will be a critical factor in electric vehicle developments.

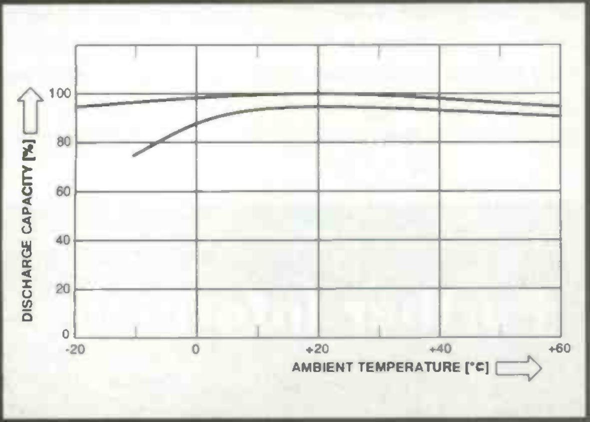


Figure 8: Discharge capacity as a function of temperature for NiMH cells

Figure 9: General Motor's Impact car (slide)

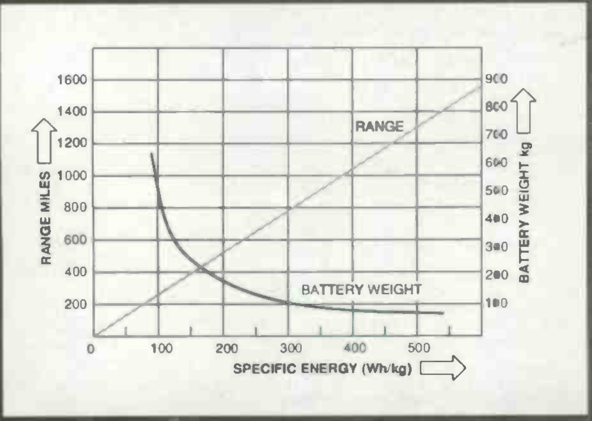


Figure 10: Dashed line: range of 'Impact' type EV with NiMH batteries as a function of specific energy of the batteries. Solid line: Mass of battery for equivalent range capacity of 250 miles for 'Impact' type car as a function of specific energy of batteries

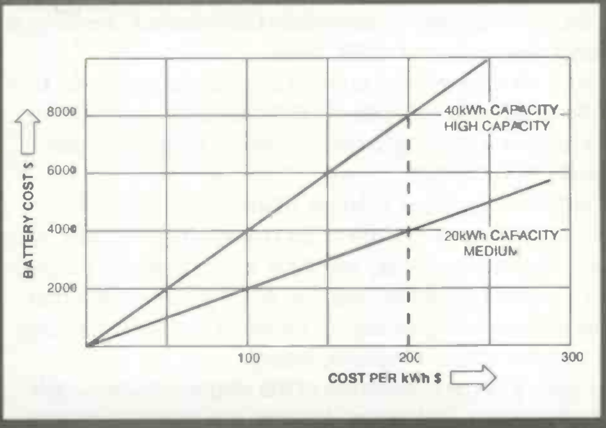


Figure 11: Estimate of range of costs for a range of battery capacities in kWh as a function of cost per kWh (20 kWh medium range/capacity :40 kWh high range/capacity).

Future Developments of NiMH Cells

While other well established battery technologies such as Zinc Carbon (AA capacity 1100 mAh), Alkaline Manganese (AA capacity 2300 mAh) and standard NiCd (AA capacity 700 mAh) have remained relatively static in their nominal capacity, researchers are confident that there exists considerable potential for significant extension of the NiMH capacity. Second generation AA NiMH capacity batteries are already available with AA capacity of 1500 mAh. It is anticipated by researchers at the Ovonic Battery Company developing thin film fabrication techniques that specific energy densities of 120 Wh/kg are achievable - suggesting that NiMH AA capacity of 2250 mAh could be commercially available in a few years. This is approaching three times the capacity of standard NiCd cells.

Already advanced battery materials and configurations are being considered which have the potential for storage of 500 Wh/kg. This capacity in an AA cell would be in the region of 9000 mAh. There are clearly some interesting times in store.

Use in Electric Vehicles

The Ovonic battery Company has produced and tested a range of NiMH batteries for use in electric vehicles. 1.2 kWh (12 V 100 Ah) modules have been used to construct battery units between 10-30 kWH. This corresponds approximately to a battery mass of 125 kg to 375 kg for an energy density of 80 Wh/kg.

The pioneering 'Impact' vehicle being developed by General Motors (figure 9) uses advanced engineering design to achieve high energy efficiency. Using state-of-the-art lead acid batteries providing 16.7 kWh, a range of between 70 to 100 miles of urban driving can be attained. A set of NiMH batteries of the same weight (490 kg) could be used to propel the Impact between 200 to 292 miles and provide 39 kWh of energy storage. The NiMH battery is able to utilise a greater percentage of its stored capacity compared with a lead acid type.

Assuming a conservative total of 500 charge cycles could be achieved, a total battery life of 100,000 miles for NiMH EV batteries should be possible. Currently, the lead acid batteries used with the Impact would have to be replaced every 20,000 miles. With development of energy densities of 120 Wh/kg, this would allow the range of such a vehicle to be increased to 375 miles for the same battery weight or the battery weight being reduced to around 320 kg for a range of 250 miles.

There is clearly scope for progressively reducing the size and volume of electric vehicle NiMH batteries but providing a standard range of around 250 miles.

Figure 10 (dashed line) outlines some details of range as a function of specific energies of NiMH batteries. A sensible upper limit for a town type electric vehicle would probably, however, be 300 miles.

The solid curved line in figure 10 indicates the battery weight equivalent to a range of 250 miles for an 'Impact' type car. At present, the battery weight is a significant percentage of the weight of an electric vehicle. It is likely, however, that the percentage will gradually fall as NiMH battery technology attains higher values of specific energy.

As ever, it is the economics of the electric vehicle which still dominates the present and future. It is estimated that the cost for an average electric car of NiMH batteries in large volume production will be around $4,500 based on a cost of around $200 per kWh. Figure 11 indicates estimated costs for a range of vehicle capacities in kWh as a function of cost per kWh.

Where small cars in the USA sell for around $9,000, electric vehicles will come into their own where the cost of the battery is around $2,000. The radical new technology of the electric vehicle, however, does present some deeper issues. Is it likely, for example, that such vehicles should be easier to manufacture and require a reduced labour force? Also, when in use, are they likely to require reduced maintenance compared with a conventionally powered vehicle?

There is also the aspect of the cost of the electricity against the cost of fuel. In the UK, the cost of petrol for a vehicle with 50 mpg petrol consumption which has travelled 100,000 miles is £5,000. The equivalent cost of electricity based on 39 kWh being equivalent to 250 miles of travel is around £1,100 - giving a ratio of costs of petrol/electricity of around 4.6. In the USA the ratio of costs of petrol/electricity is around 6 though petrol and electricity are both less expensive.

Based on such simple economics, there is every indication that even for a battery costing £5,000 initially, the additional outlay will be recovered through time with reduced running costs using electricity. The high initial cost of the battery may be a red herring.

Summary

The drive towards development of higher energy capacity batteries for a range of technologies is certainly underway. At present, the NiMH rechargable battery looks like the front runner although a range of parallel technologies are also being researched. While this will bring benefits to users of a wide range of portable electric and electronic equipment, It is likely to have most impact in the development of efficient and cost-effective electric vehicles and possibly also in applications to store energy from photovoltaic systems.

Further Information:

Dr. Paul R. Gifford,
Ovonic Battery Company,
1707 Northwood Drive,
Troy, Michigan,
48084 -2702, USA.
tel 0101 810 362 1750
fax 0101 810 362 0332
Nanette M. Wiatr,

GM Electric Vehicle Program,
Mail Code: 22,
1450 Stephenson Highway,
Box 7083 - M.C. #22
Troy, MI 48007-7083,
USA.
tel 0101 810 528 5987
fax 0101 810 528 6414

Making servos work for you

Control pulse-width proportional servos and measure the pulse width of other servo drivers with this project based on the versatile Parallax BASIC Stamp computer

Servos of the sort used in radio-controlled aircraft are finding new applications in home and industrial automation, movie and theme-park special effects, and test equipment. They simplify the job of moving objects in the real world by eliminating much of the mechanical design. For a given signal input, you get a predictable amount of motion as an output.

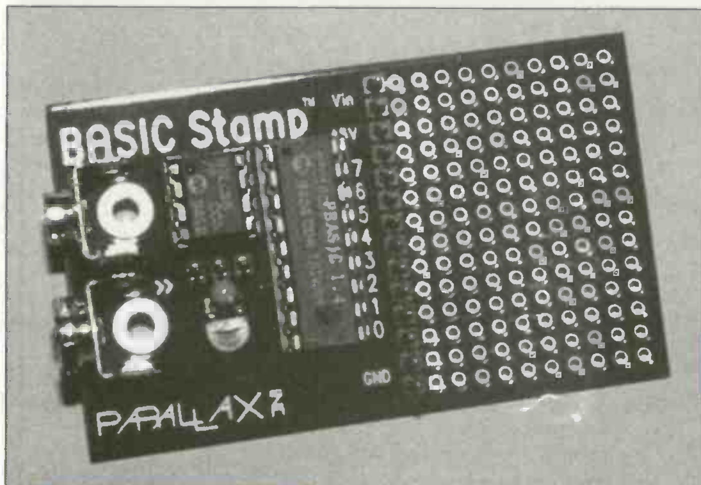
Figure 1 shows a typical servo. The three wires are +5 volts, ground, and signal. The output shaft accepts a wide variety of prefabricated disks and levers. It is driven by a geared-down motor and rotates through 90 to 180 degrees. Most servos can rotate 90 degrees in less than a half second.

Torque, a measure of the servo's ability to overcome mechanical resistance (or lift weight, pull springs, push levers, etc.), ranges from 20 to more than 100 inch-ounces.

To make a servo move, connect it to a 5-volt power supply capable of delivering an ampere or more of peak current, and supply a positioning signal. The signal is generally a 5-volt, positive-going pulse between 1 and 2 milliseconds (ms) long, repeated about 50 times per second.

The width of the pulse determines the position of the servo. Since servos travel can vary, there is not a definite correspondence between a given pulse width and a particular servo angle, but most servos will move to the centre of their travel when receiving 1.5-ms pulses.

Servos are closed-loop devices. This means that they are constantly comparing their commanded position (proportional to the pulse width) to their actual position (proportional to the resistance of a potentiometer mechanically linked to the shaft). If there is more than a small difference between the two, the servo's electronics will turn on the motor to eliminate the error. In addition to moving in response to changing input signals, this active error correction means that servos will resist mechanical forces that try to move them away from a commanded position. When the servo is unpowered or not receiving positioning pulses, you can easily turn the output shaft by hand. When the servo is powered and receiving signals, it won't budge from its position.



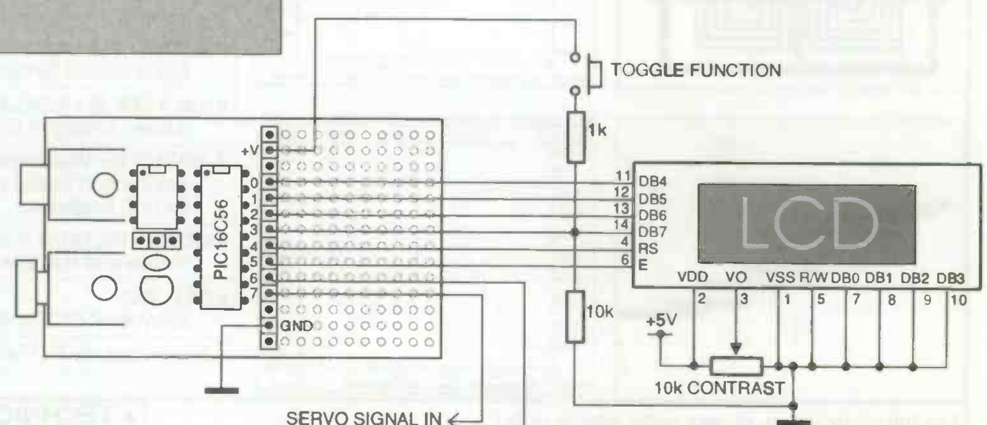
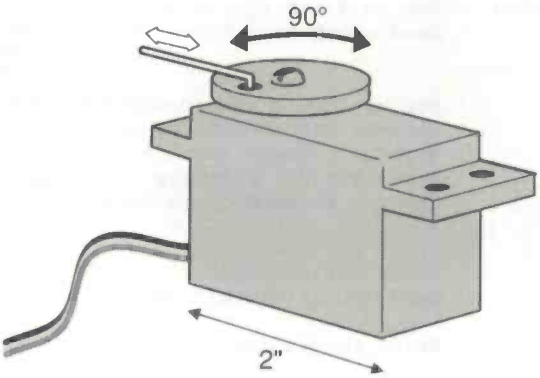


Fig.1. Circuit diagram for STAMP based servo checker



Application

Driving servos with the BASIC Stamp is simplicity itself. The instruction pulse out pin, time generates a pulse in 10-microsecond units, so the following code fragment would command a servo to its centered position and hold it there:

```
servo:                    pulse out 0,150
      pause 20
      goto servo
```

The 20-ms pause ensures that the program sends the pulse at the standard 50 pulse-per-second rate.

The program listing is a diagnostic tool for working with servos. It has two modes, pulse measurement and pulse generation. Given an input servo signal, such as from a radio-control transmitter/receiver, it displays the pulse width on a liquid-crystal display (LCD). A display of

```
Pulse Width: 150
```

indicates a 1.5-ms pulse. Push the button to toggle functions, and the circuit supplies a signal that cycles between 1 and 2 ms. Both the pulse input and output functions are limited to a resolution of 10μs. For most servos, this equates to a resolution of better than 1 degree of rotation.

The program is straightforward Stamp BASIC, but it does take advantage of a couple of the language's handy features. The first of these is the EEPROM directive. EEPROM address, data allows you to stuff tables of data or text strings into EEPROM memory. This takes no additional program time, and only uses the amount of storage required for the data.

After the symbols, the first thing that the listing does is tuck a couple of text strings into the bottom of the EEPROM. When the program later needs to display status messages, it loads the text strings from EEPROM.

The other feature of the Stamp's BASIC that the program exploits is the ability to use compound expressions in a LET assignment. The routine BCD (for binary-coded decimal) converts one byte of data into three ASCII characters representing values from 0 (represented as '000') to 255.

To do this, BCD performs a series of divisions on the byte and on the remainders of divisions. For example, when it has established how many hundreds are in the byte value, it adds 48, the ASCII offset for zero. Take a look at the listing. The division (/) and remainder (//) calculations happen before 48 is added.

Unlike larger BASICs which have a precedence of operators (e.g., multiplication is always before addition), the Stamp does its math from left to right. You cannot use parentheses to alter the order, either.

If you're unsure of the outcome of a calculation , use the debug directive to look at a trial run, like so:

```
let BCDin = 200
let huns = BCDin/100+48
debug huns
```

When you download the program to the Stamp, a window will appear on your computer screen showing the value assigned to the variable huns (50). If you change the second line to

```
let huns = 48+BCDin/100
```

you'll get a very different result (2).

By the way, you don't have to use let, but it will earn you Brownie points with serious computer-science types. Most languages other than BASIC make a clear distinction between equals as in:

```
huns = BCDin/100+48
```

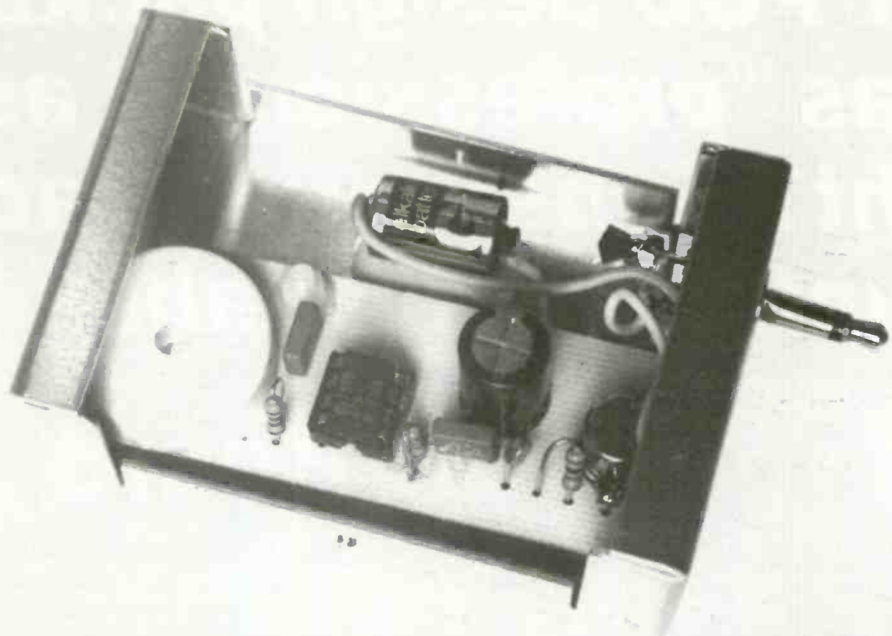
and

```
if BCDin = 100 then...
```

Program listing:

```
' PROGRAM: Servo.bas
' The Stamp works as a servo test bench. It
provides reliable servo
' signals for testing, and measures the pulse
width of external
' servo signals.

Symbol    E      =  5  ' Enable pin,
                       1 = enabled
Symbol    RS     =  4  ' Register     select pin,
                              0 = instruction
Symbol    char   =  b0 ' Character sent to LCD.
Symbol    huns   =  b3 ' BCD hundreds
Symbol    tens   =  b6 ' BCD tens
Symbol    ones   =  b7 ' BCD ones
Symbol    BCDin  =  b8 ' Input to BCD
                      conversion/display routine.
Symbol    buttn  =  b9 ' Button workspace
Symbol    i      =  b10' Index counter

'Load text strings into EEPROM
'EEPROM 0,("Cycling... Pulse Width: ")

' Set up the Stamp's I/O lines and initialize the
                       LCD.
begin:    let pins = 0 ' Clear the output lines
          let dirs = %01111111' One input,
                       7 outputs.
          pause 200    ' Wait 200 ms for LCD to
                              reset.

' Initialize the LCD in accordance with Hitachi's
'instructions
' for 4-bit interface.

i_LCD:    let pins = %00000011' Set to 8-bit
                                operation.
          pulsout E,1          ' Send above data
                                three times
          pause 10     ' to initialize LCD.
```

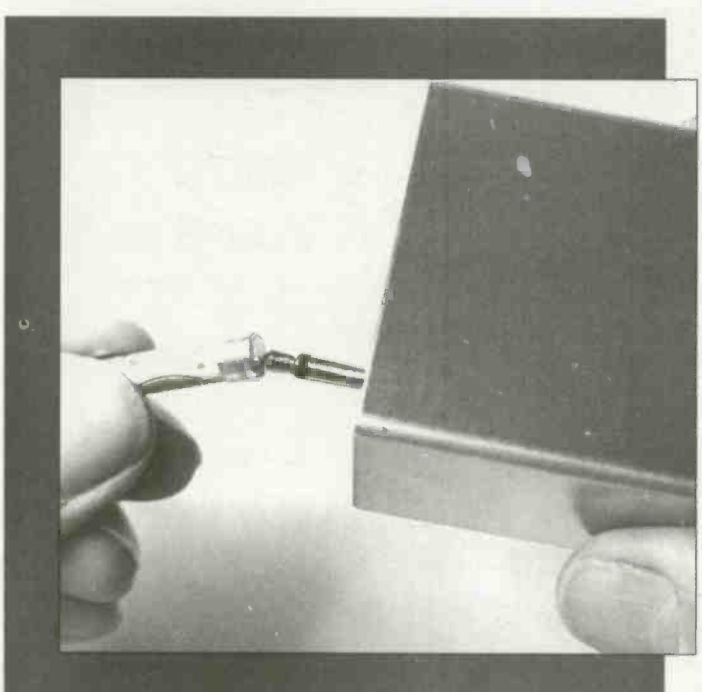
```
                pulsout E,1
                pulsout E,1
                let pins = %00000010    ' Set to 4-bit operation.
                pulsout E,1             ' Send above data three times.
                pulsout E,1
                pulsout E,1
                let char = 12           ' Set up LCD in accordance w/
                gosub wr_LCD            ' Hitachi instruction manual.
                let char = 6            ' Turn off cursor, enable
                gosub wr_LCD            ' left-to-right printing.
                high RS                 ' Prepare to send characters.

mPulse:         output 3
                gosub clear             ' Clear the display.
                for i = 11 to 23        ' Read "Pulse Width:" label
                  read i, char
                  gosub wr_LCD          ' Print to display
                next
                pulsin 7, 1, BCDin      ' Get pulse width in 10 us units.
                gosub BCD               ' Convert to BCD and display.
                pause 500
                input 3                 ' Check button; cycle if down.
                button 3,1,255,10,buttn,1,cycle
                goto mPulse             ' Otherwise, continue measuring.

' Write the ASCII character in b3 to LCD.
wr_LCD:         let pins = pins & %00010000
                let b2 = char/16        ' Put high nibble of b3 into b2.
                let pins = pins | b2    ' OR the contents of b2 into pins.
                pulsout E,1             ' Blip enable pin.
                let b2 = char & %00001111     ' Put low nibble of b3 into b2.
                let pins = pins & %00010000   ' Clear 4-bit data bus.
                let pins = pins | b2    ' OR the contents of b2 into pins.
                pulsout E,1             ' Blip enable.
                return

clear:          low RS                  ' Change to instruction register.
                let char = 1            ' Clear display.
                gosub wr_LCD            ' Write instruction to LCD.
                high RS                 ' Put RS back in character mode.
                return

' Routine to convert a byte into three ASCII digits for display
' on the LCD. ASCII 48 is zero, so it calculates hundreds, tens
' and ones, and adds 48 to each for display on the LCD.
BCD:            let huns= BCDin/100+48        ' How many hundreds?
                let tens= BCDin//100    ' Remainder of #/100 = tens+ones.
                let ones= tens//10+48   ' Remainder of (tens+ones)/10 = ones.
                let tens= tens/10+48    ' How many tens?
                let char= huns          ' Display three calculated digits.
                gosub wr_LCD
                let char = tens
                gosub wr_LCD
                let char = ones
                gosub wr_LCD
                return

' Routine to cycle a servo back and forth between 0 and 90 degrees.
' Servo moves slowly in one direction (because of 20-ms delay between
' changes in pulse width) and quickly in the other. Helps diagnose
' stuck servos, dirty feedback pots, etc.
cycle:          output 3
                gosub clear
                for i = 0 to 9          ' Get "Cycling..." string and
                  read i, char          ' display it on LCD.
                  gosub wr_LCD
                next i
reseti:         let i = 100             ' 1 ms pulse width.
cyloop:         pulsout 6,i             ' Send servo pulse.
                pause 20                ' Wait 1/50th second.
                let i = i + 2           ' Move servo.
                if i > 200 then reseti        ' Swing servo back to start
                                              position.
                input 3                 ' Check the button; change function if
                                              1.
                button 3,1,255,10,buttn,1,mPulse
                goto cyloop             ' Otherwise, keep cycling.
```



TOUCH TEST

A simple go/no-go continuity tester by Terry Balbirnie

This single-point continuity tester will be found useful for checking many electrical devices found around the house. Such items include fuses, switches, light bulbs, plugs and sockets, audio connectors and lengths of wire. In general electronics work, it can be used to test transformer windings for continuity and to perform a basic check on diodes and transistors. The amateur car mechanic will find it handy for identifying breaks in bulbs, fuses, motor windings, ignition components, heated rear windscreens and pieces of wire.



On the other hand

In use, Touch Test is held in one hand and one end or terminal of the component to be tested held or touched by the other. The test probe on the unit is then applied to the other end of the component (see photographs). If there is a finite resistance, the buzzer emits a bleep. If the resistance of the test item is infinite (open circuit), the buzzer will remain silent. Deaf readers could easily substitute an LED for the buzzer and the method for doing this is described later. The single-point operation is made possible because the circuit operates through the user's body resistance which exists between one hand and the other through the metal case.

There is no conventional on-off switch fitted to this circuit. Instead, there is an internal mercury-loaded vibration sensor of the type used in certain intruder alarms. Thus, when Touch Test is picked up for use, there will be sufficient vibration to allow a capacitor to charge and provide a supply for tests to be made. When the device is put down, no current is drawn. By avoiding an on-off switch, there is no possibility of leaving the circuit switched on and so drain the battery accidentally. It also ensures that the minimum current is required in the course of use. The power supply consists of a miniature 6V camera-type battery although it would be possible to use a 9V PP3 unit if a slightly larger case was used. In occasional use it is thought that the battery will last almost as long as its shelf life. It would not be a good idea to store the device in a drawer or similar place where there would be unnecessary movement and a consequent drain on the battery.

Circuit description

The complete circuit for the Touch Test is shown in Figure 1. When moved from its rest position, vibration switch, S1, operates randomly. This allows a series of current pulses to flow to capacitor C3 through resistor, R4. The capacitor charges to virtually full supply voltage in a second or two and this provides a smooth supply for the rest of the circuit. Resistor, R4, limits the charging current to prevent possible damage to the switch.

Integrated circuit timer, IC1, together with external components, form a monostable. Thus, when triggered by a low pulse applied to the trigger input (pin 2), the output (pin 3) will go high for a certain time then revert to its original low state. While high, current will flow to the solid-state buzzer WD1 which will emit a bleep. The time period is set by the values of fixed resistor, R3, connected to IC1 pins 6 and 7 and capacitor, C2. With the values specified, this will be about 0.2 seconds and since this timing is not thought to be particularly critical, no adjustment is provided. For a longer timing, R3 could be increased in value and vice-versa.

Coupling

The low triggering pulse referred to above, is applied to IC1 pin 2 through the user's body resistance Rx and the resistance of the component under test. This comes about because the metal case of the finished device is connected to supply negative and is held in one hand. The other hand makes contact with one terminal of the component and the test probe makes contact with the other one.

The value of body resistance will depend on the area of contact made between the various parts and the hands. It is also affected by the tightness of the grip and the dampness and salt content of the skin. It will also depend to some extent on the individual making the test. Using a mains plug fuse as an "average" test component, measurements made under actual conditions showed a typical value of 100kW. This body resistance plus the resistance of the component appear in series and form the lower arm of a potential divider. The upper one consists of fixed resistor, R1. This arrangement is connected across the nominal 6V supply appearing across capacitor, C3. The voltage across the lower arm of the potential divider is applied to the left-hand side of capacitor C1 and during a test will be a small fraction of that of the supply. Since it will be less than the required criterion of one-third supply voltage (this figure is "built into" IC1) it will be sufficiently low to trigger the i.c. and its state is transferred briefly to pin 2 via C1.

The reason for using "a.c. coupling" (that is, via a capacitor instead of being applied direct) is so that only one brief trigger pulse will be delivered, even if the test probe is applied continuously to the component. If direct triggering were used, a continuous trigger pulse would be given and the buzzer would sound constantly. This would be unnecessary and would waste the battery. With the probe removed from the component under test, capacitor C1 discharges rapidly through fixed resistors R1 and R2. Resistor R2 keeps IC1 pin 2 high in the absence of a trigger pulse and this prevents false operation. If there is an open circuit between the probe and supply negative line, the triggering criterion will not be met (that is, IC1 pin 2 will remain high) and the buzzer will be silent.

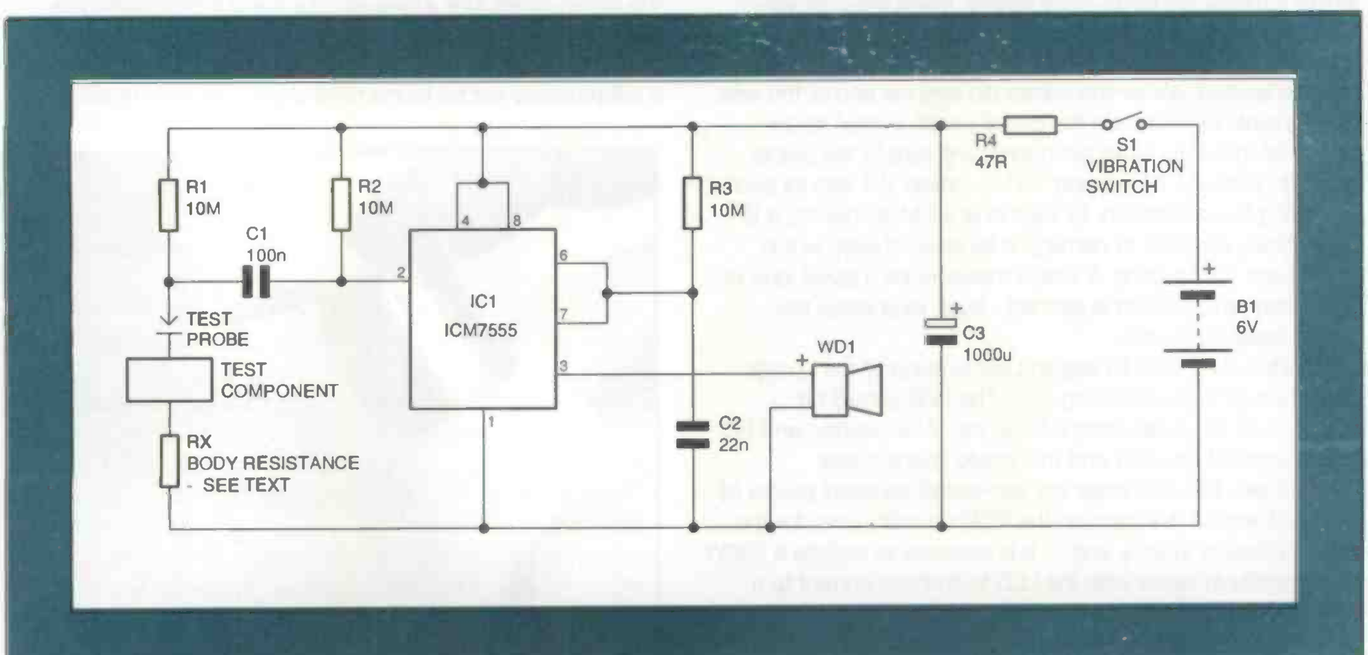
Construction

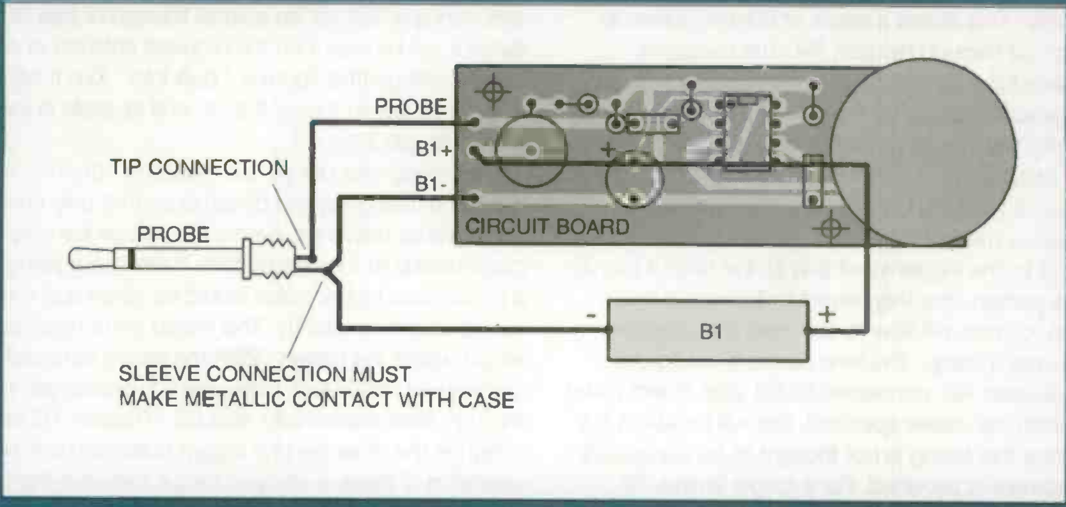
Note that this project must be built in a metal box. This is because it relies on conduction between the hand holding it and the case.

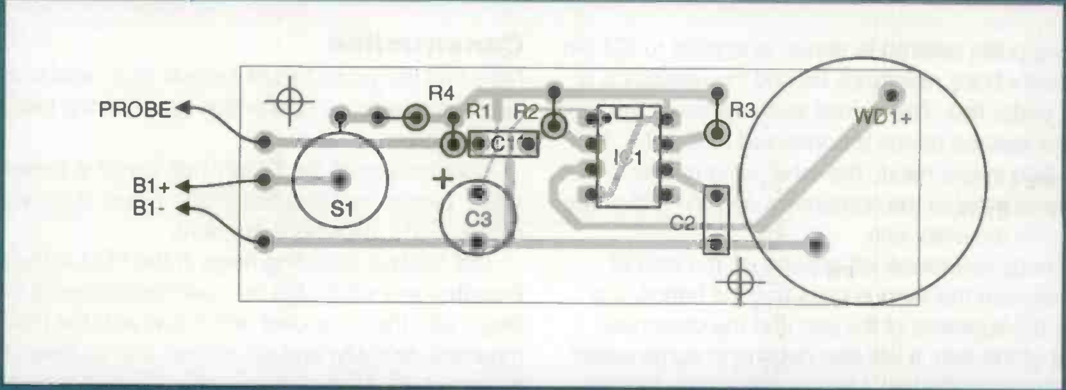
Construction of the Touch Test circuit is based on a single-sided printed circuit board (PCB). Figure 2 shows the topside details (parts placement diagram).

Drill the two mounting holes in the PCB in the positions indicated and solder the on-board components into position. Begin with the i.c. socket and follow with the resistors (all mounted vertically) and capacitors. Do not insert the i.c. into its socket yet. Note that capacitor C3 and the audible warning device, WD1, are polarity-sensitive so must be connected with the correct orientation. In the case of WD1, the polarity is marked on the underside.

The connections to the vibration switch are made between the centre pin and metal body. Do not attempt to make a





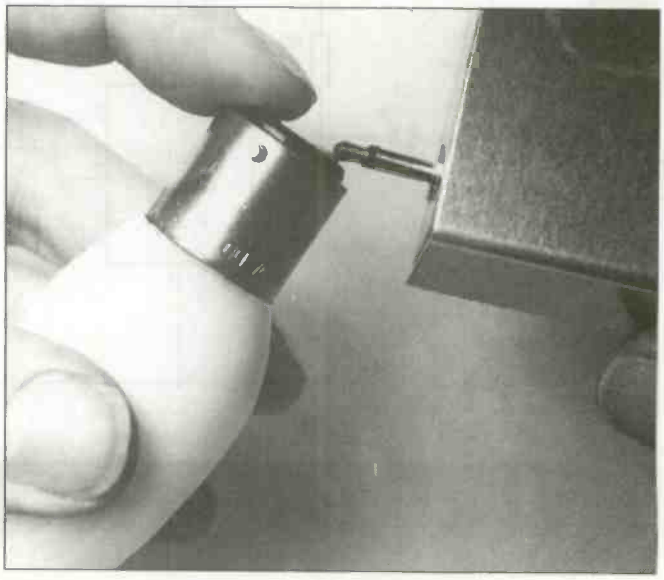


soldered connection direct to the side. Instead, twist a piece of bare connecting wire tightly around it and apply a little solder where it meets the body. Alternatively, make the connection using a small spring clip - a short piece of wire should be soldered to this before it is clipped on to the switch. Whichever method is used, solder the centre pin and the end of the wire to the points indicated on the circuit panel. Solder 6 cm pieces of light-duty stranded connecting wire to the points labelled "probe", "B1+" and "B1-". Insert IC1 into its socket observing the orientation. Since this is a CMOS device, it is theoretically possible to damage it by static charge which might exist on the body. It would therefore be a good idea to touch something which is earthed - such as a water tap - before handling its pins.

Readers who wish to use an LED in place of the buzzer should do so in the following way. The LED should be mounted on the case using a fixing clip. Alternatively, an LED indicator could be used and this would give a better appearance. The end wires are connected via short pieces of stranded wire to the pads on the PCB normally used for the buzzer (labelled WD1 + and -). It is essential to include a 390W fixed resistor in series with the LED to limit the current to a safe working value. This may be placed in-line at the LED end or at the PCB and in either lead. Note that the LED is polarity-sensitive and should be connected in the correct sense - the shorter lead is the negative one.

A good tip

Drill holes in the base of the box to correspond with those in the circuit panel. Drill a hole also for the 3.5 mm mono jack plug which will be used as the probe. Other types of probe could be used but must be electrically isolated from the case. It will probably not be found necessary to provide holes for the



sound to pass through. If tests show that the buzzer is not loud enough, holes may easily be drilled in the top section above WD1 position at the end of construction.

Attach the internal components as shown in the photograph. The circuit board should be mounted on short plastic stand-off insulators or plastic washers so that the copper track side remains a few millimetres clear of the metalwork. A piece of cardboard could be placed underneath as an additional precaution. Using the specified box, the circuit board will need to be manoeuvred between the flanges but this is possible providing it is no more than 68 mm long. If necessary, the flanges could be cut off or filed down to provide more clearance.

Threaded ring

Refer to Figure 3 and complete the internal wiring. The connection between the battery negative terminal, the "batt -" wire leading from the circuit panel and the case is conveniently made using the outer (sleeve) connection on the jack plug. However, some jack plugs have totally isolated terminals - that is, the sleeve connection will not end up connected to the metalwork. In this case, a separate connection will need to be made using a solder tag and a small fixing. The tip connection of the jack plug is soldered to the wire leading from the circuit panel "probe" position. The plastic top of the jack plug is cut down to make a threaded ring about 5mm long. This is then used to secure the body in the hole.

The connections to the battery may be made by soldering them quickly into position. It should then be secured to the base of the box - in the prototype unit this was done by means of an adhesive fixing pad. The battery will only need to be replaced infrequently so soldering is an acceptable method for connecting it. Do not be surprised if the buzzer gives the occasional bleep during this work. Stick plastic feet on to the base of the box to prevent scratching the work surface.

Testing is simply a matter of checking for correct operation. Lift the device from the table top - again, sometimes the buzzer gives a single bleep and this is of no consequence. Hold the case in one hand and any small metallic object in the other. Now touch the tip of the probe with the object. The buzzer should bleep. If this test works, try a few other items such as fuses and filament bulbs. You may need to shake the unit slightly after a few tests to maintain the supply. Note that the test works best when sudden metallic contact is made with the probe - this provides efficient a.c. coupling. Simply touching the probe with a finger will not necessarily produce a bleep since the contact is not sudden enough. Under very dry conditions it may be necessary to moisten the finger holding the test object. This was never found to be needed in the prototype with any of the objects tested.

Component testing

Most of the time, Touch Test will be used for checking components which conduct in both directions such as fuses and filament bulbs. However, it may be used to provide a basic test on certain polarity-sensitive devices used in electronics. Diodes should conduct when the anode end is touched on the probe with the cathode held between the fingers - but not the other way round. Note that this test will probably fail to work with light-emitting diodes. Transistors may be regarded as two diodes back to back with the base common to both. With an npn transistor, the buzzer should sound when the base is touched on the probe with either of the other leads (emitter or collector) held between the fingers. If the base is held, there should be no conduction when either emitter or collector is touched on the probe. If the transistor is a pnp type, the effect is opposite - that is, it should conduct when the base is held between the fingers and either of the other pins is touched on the probe.

A very low value capacitor will cause one bleep when tested. It will now be fully charged and will not cause a further bleep until discharged again. A higher value capacitor (up to, say, 1mF) will cause further bleeps when the probe is re-applied but eventually, this too will become fully charged. Tests on electrolytic capacitors and resistors are not meaningful. The polarity of some button cells is not immediately obvious - the probe will quickly determine the negative one.

If all is well, Touch Test may be put into permanent service. Do not store the device where it will experience movement such as in a frequently-used drawer or in the car. This would run the battery down needlessly.

PARTS LIST

Resistors

- R1, R2, R3 — 10M (3 off)
- R4 — 47R

Fixed resistors are 0.25W 5%

Capacitors

- C1 — 100n min. metallised polyester - 5mm lead spacing.
- C2 — 22n min. metallised polyester - 5mm lead spacing.
- C3 — 1000mF 16V PCB elect.

Miscellaneous

- S1 — Vibration switch - see Shop Talk.
- B1 — 6V battery type GP11A - see text.
- WD1 — Solid-state buzzer 5mA 3-12V operation
- Aluminium box size 76 x 51 x 25 mm
- 8-pin d.i.l. socket

3.5mm mono jack plug for probe - see text.
Small fixings (2 off); stand-off Insulators; adhesive fixing pad. Self-adhesive plastic feet (4 off).
Connecting wire, solder etc.

Buy Lines

Most of the components for the Touch Test are freely available. The vibration switch used in the prototype is stocked by Maplin (order code UK57M). The battery was also obtained from Maplin (order code ZB53H).

PROGRAMMABLE POCKET TIMER

3-D

This project by Bart Trepak shows how a PIC microcontroller chip can be used to easily solve a particular design problem.

Ask any electronics engineer to design a timer and the first thing he will think of is almost certainly a 555 ic. Tell him that a time delay of over half an hour is required and he will probably change his mind and choose a chip such as the ZN1034E to enable more reasonable values of capacitor and resistor to be used. Add the requirement that the time is to be variable in one minute intervals and he will change the design to use CMOS counters, thereby avoiding the need to calibrate potentiometers and enabling the required time delay to be set using switches.

To save on extra decoding chips the time delay would, of course, need to be set in binary. But if you now tell him that the timer is for your grandmother then he will probably decide that BCD switches and counters would be the answer. That is until he comes to look at the cost of the project and realises that these would cost more than the rest of the electronics put together.

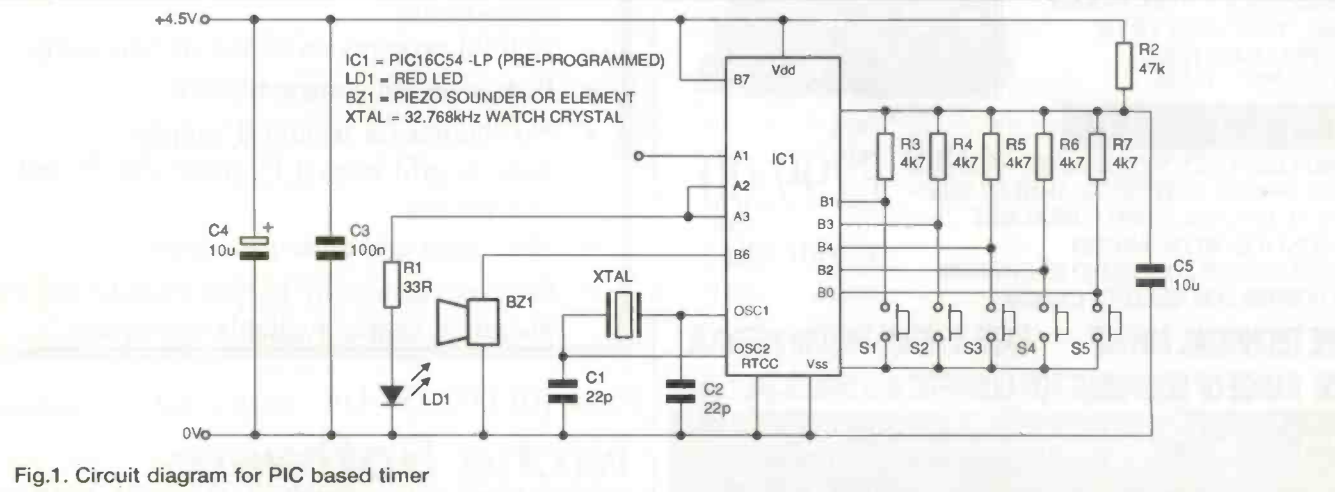


Fig.1. Circuit diagram for PIC based timer

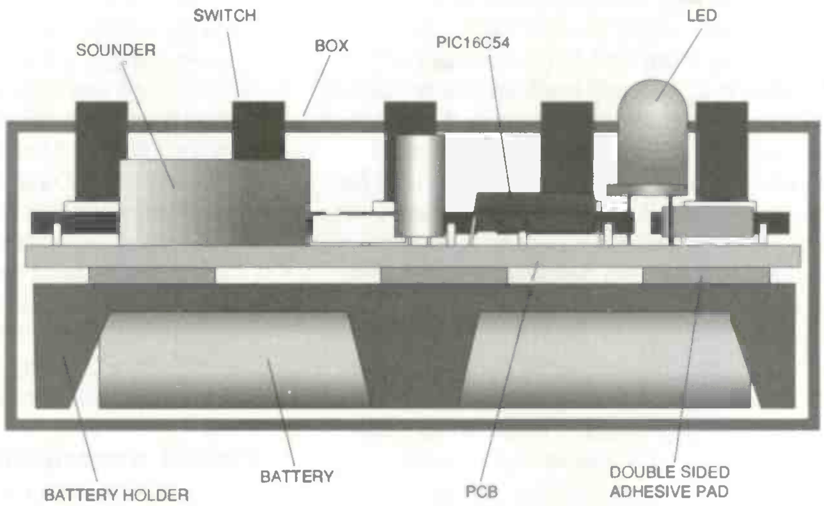


Fig.2. Suggested method of mounting the battery on the PCB

GIT

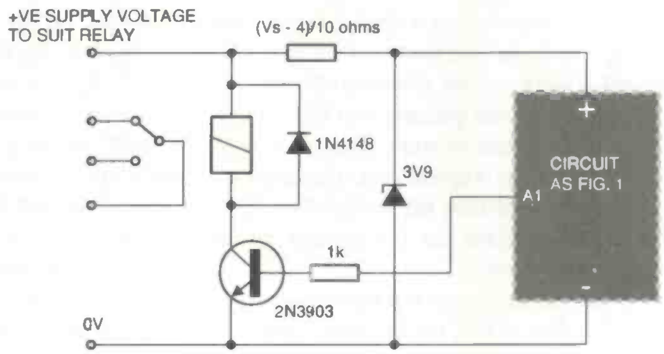


Fig.3. Circuit diagram from relay output

At this stage he may think of using a display instead, but the thought of wiring all these chips would probably lead him to suggest that you go and buy a commercial timer. Not a bad idea! Many countdown timers are available which sound a buzzer or even play a tune at the end of the timing cycle. However, if a relay output is required, for say charging NiCad batteries, then there is a problem. Timers of this kind seem to be rather thin on the ground unless you have a very deep pocket.

This chain of reasoning led me to design a 3 digit timer with an LED display which could be easily set to switch a relay on for a time of up to 9 hours 59 minutes without having to fiddle about with dil switches. While trying to think in binary and having done the sums, the obvious answer was to replace all these chips with a micro-controller, bringing the cost down to more reasonable level.

A PIC16C54 microcontroller was pressed into service and soon the project began to grow with more and more features being added as I thought of them, ending up with a device which could count up or down in two ranges to 9 hours 59 minutes or 9 minutes 59 seconds, switch a relay, pause, sound a buzzer and do everything except play a tune.

While working on this, it occurred to me that in many circumstances a simpler timer would suffice. A relay output, for instance, would serve no useful purpose if the timer were required to remind you that it was time to return to your car and put some more money into the parking meter or that you were to ring someone back in ten minutes. The timer would still need to be easily set but preset times of say one or two hours in fifteen minute intervals would not be good enough.

Although accuracy is not of prime importance for such applications it was decided to use a crystal as a timebase. Since this device only costs about 20p there would not be a great saving to be made by using an RC oscillator and it would save having to calibrate the finished unit. Battery operation however, would be a must and since the microprocessor is a CMOS device, low current consumption could be guaranteed, especially if the device were "put to sleep" at the end of a timing sequence.

The PIC processor has an instruction (called - not suprisingly - SLEEP) which, when excecuted, stops all operations,by disabling the clock oscillator. In this state the processor draws a mere 0.6uA which means that a battery would last for virtually its shelf life. To "wake up" the microcontroller, the device needs to be reset and there is even a special bit in the STATUS register which is cleared to zero if the device wakes up when it was in the sleep mode but is set to one if the reset occurred at power up so that the two states can be differentiated if this is required.

The problems start, however, when the actual time setting is considered. In the original mains powered timer, push buttons were used to set the time. This was not a problem as the LEDs were also used to display the time set but even miniature LED displays would require an appreciable current making them unsuitable for a battery powered timer.

Commercial timers use Liquid Crystal Displays to get around this problem but these tend to be expensive unless bought in production quantities and because they are dificult to multiplex, they require the use of many more I/O lines to drive them than the PIC has, since each segment would require its own line. For use as a parking timer, the LCD has another disadvantage in that it does not generate light and is therefore virtualy impossible to see in poor light. Anyone who has tried to read the time from his digital watch under street lighting conditions will know what I mean.

This can be a problem in winter when it can be quite dark even at 4.00pm in London (or even earlier if you live further north) while traffic wardens still ply their trade until 6.00pm or even later. As if this were not reason enough for not using them, LCDs also require an AC drive voltage to avoid damaging the display and, much as I enjoy writing programmes, I did not relish the prospect of doing this.

3 digit timer without a display

The solution chosen turned out to cost much less than an LCD and use no current - simply by not having a display at all! After all, the display is only required to set the time and is more or less redundant after that because we are only interested in being alerted when the set period has elapsed and this is best done by a buzzer. It may be desirable to know how much time there is left and, for this reason, the unit has been designed to give a warning when there is ten minutes left so that the user can begin to make his way back to the car. For periods of less than 10 minutes, no warning is given.

By now many readers will be turning to the front cover to check if this is not the April issue of ETI, for what has been described so far is a pushbutton programmable 3-digit timer with no display and no apparent way of seeing what time has been set! The answer is quite simple and relies on the way the pushbuttons operate and a piezo buzzer.

The original timer used three buttons to set the hours, tens of minutes and minutes and these buttons have been retained. Each push button, when pressed, increments the relevent digit by one and there is no overflow from one digit to the next, so to set a time of, say, one hour and fifty three minutes, the hours button would be pressed once, the tens of minutes button five times and the minutes three times, assuming all the digits were at zero to begin with.

To aid in this process, the microcontroller has been programmed to generate a short low, medium or high frequency tone each time the hours, tens of minutes or minutes digit is incremented respectively, and two short bleeps of that frequency when that digit is set to zero. It is therefore a simple matter to set the required time by counting the bleeps for each digit making this perhaps the only programmable pocket timer which can also be programmed in the pocket! It also makes the device useful for the blind or partially sighted (hopefully not as a parking timer) or for use in a darkroom where the difficulty of reading an LCD display could present a problem. It could also be used as a kitchen timer.

The original LED timer also had two further pushbuttons and these have been retained although their functions have been changed. Since this timer will mostly be used for timing long periods of hours and minutes, it was not considered worthwhile to retain the MODE button to select between hours/minutes and minutes/seconds mode and although this possibility has been retained, this is set using a different method.

The function of the mode button has therefore been changed to RESET and pressing this will reset all the digits to zero. As a check, the buzzer sounds the tone for each digit in turn. Because one is unlikely to want to stop or pause a parking timer (traffic wardens, like time and tides, wait for no man) the function of the START/STOP button has also been modified to START only so that the timing sequence, once started, cannot be stopped except by pressing the RESET in which case all the digits will also be reset to zero.

The PCB has been made small and even when powered by AA cells the whole circuit will fit into a box measuring only 65x50x30 mm. No box has been suggested as much will depend on the batteries, pushbuttons and buzzer used but there are plenty of plastic boxes available to choose from.

Circuit description

The full circuit diagram is shown in Fig 1 and, as can be seen, consists of very few components with the microcontroller performing all the functions ,from reading the switches, generating the tones and flashing the LED to indicate that it is timing. The time base and the clock for the microcontroller is provided by the 32.768kHz watch crystal XTAL1.

Resistor R2 and capacitor C5 provide the power on reset delay with the values carefully chosen in conjunction with R3 to R7. The processor begins operation when the voltage on the MCLR pin is logic 1, while a logic 0 or low voltage generates a reset. When the battery is first connected, this pin will be low until the capacitor C5 has charged via R2 to a suitable level thus providing the initial reset. The LED is a dual-function indicator which lights when the processor is "awake" as during programming and flashes at 1Hz during timing to show that the circuit is working. During the "sleep" mode, the LED remains off.

Following a reset pulse, the circuit "wakes up", switching on the LED and setting port B output 5 to a logic low or 0 volts and lines B0 to B4 as inputs. An internal timer is also started and if this times out before another key is pressed or the timer has been put into the timing mode, the circuit will shut down switching the LED off and cancelling any time set. This remains the condition when the processor excecutes a SLEEP instruction and switches off its oscillator to enter its low power mode. In addition, all the I/O pins retain their status (i.e. input or output) and maintain the logic level (high or low) which they had when the SLEEP instruction was excecuted and the

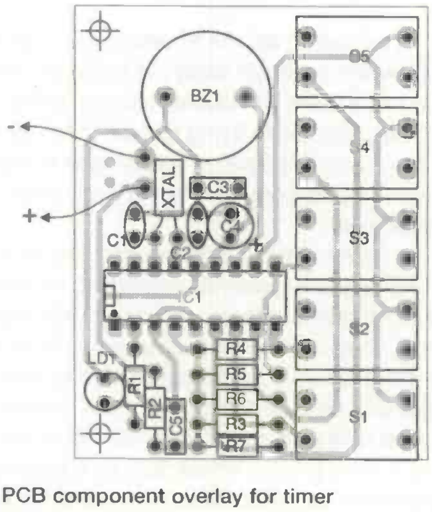


Fig.4. PCB component overlay for timer

programme is written so that port B pin 5 is at logic 0 or 0 volts when this happens.

Once the circuit is in the "sleep" mode, any depression of a key will cause C5 to rapidly discharge through one of the resistors R3 to R7 and port B5, causing the MCLR pin to go low and the circuit to "wake" up again when the key is released. The first instruction that the microcontroller excecutes is to take port B5 high preventing C5 discharging (even if the key continues to be depressed) thus allowing the circuit to continue operating. In operation, the keys are scanned by taking port B5 low and checking which, if any, of the inputs B0 to B4 are low and setting B5 high again whether or not an input is detected. This takes such a short time that C5 does not have time to discharge via the resistors R3 to R7 so that the processor is not reset again when a key is pressed, allowing operation to continue.

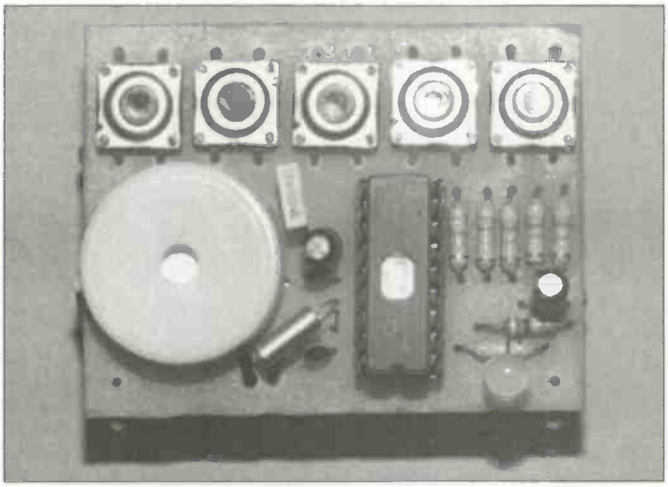
Each key depression generates a different frequency tone on output port A1 which is reproduced by the piezo sounder BZ1. Note that this is just a piezo element and not one with an internal oscillator which would be unsuitable for this circuit. Pressing S1 causes a relatively high frequency to be heard for each depression and increments the units (of minutes) counter. Following a reset or a depression of the RESET button S4, all counters are set to zero so pressing S1 three times will set the counter to three while pressing it ten times will set it back to zero again which would be indicated by two beeps instead of the usual one generated when the switch is depressed.

Switches S2 and S3 operate in the same way except that the tones which are generated have a lower frequency and they set the tens (of minutes) and hours counters respectively. The counters are separate and no overflow occurs from one digit to the next during setting so that if you make a mistake and press a button three times when you only meant to press it twice, simply keep pressing it until you hear two bleeps and then press it twice. Since the tens of minutes counter only counts to 5, before reaching zero again, two bleeps will occur after six depressions of S2.

As mentioned, the RESET button S4 resets all the digits to zero and generates each tone in turn. It also stops the timer and resets it if it is in the timing mode. The final switch S5 is the RUN button and is used to start the timer when you have set a time. Depressing this switch will causes the LED to start flashing at 1Hz to indicate that timing is in progress. It also disables the internal timer to prevent the unit from powering down. In this mode, all the other switches are disabled so that the set time cannot be altered and only the RESET switch is scanned.

If the RUN button is pressed before a time has been set, or the time set is zero, an error signal consiting of three bleeps is sounded and the LED flashes once and remains on until further entries are made or the unit powers down. At the end of the timed period, assuming that it has not been terminated by pressing the RESET, the circuit will generate three groups of five bleeps and the LED stops flashing to indicate this to the user. Since in this state the counters will be at zero, a new time must be entered if another timing run is required or the circuit simply left until it goes to sleep when the internal timer counts out.

The circuit will operate from any voltage in the range of 3 to 5 Volts so that two or three AA or even AAA cells would be ideal. Since the circuit draws so little current, it is not worth using rechargeable NiCad types but, if you decide to, bear in mind that since the voltage of these is lower, a 3 cell battery holder should be fitted.



Construction

The circuit is best built on a printed circuit board as this will make for the smallest sized unit which is important if you don't want to to have pockets bulging with electronics. No special precautions need be taken but remember that the chip is a CMOS device so it is best to mount this in an 18-pin dual in-line socket and double check that it has been inserted in the correct way around when the rest of the assembly is finished. The only other polarity sensitive components are the LED and the electrolytic capacitors.

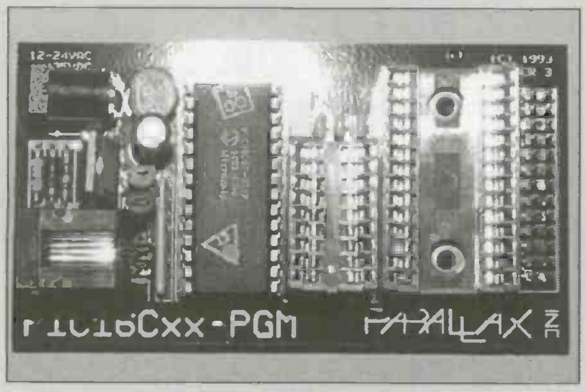
There are no details given for mounting the circuit in a box as much will depend on the particular box chosen to house the project. This will obviously need to be large enough to fit both the unit and the battery holders and again these are available in various styles housing one, two or three batteries. The printed circuit board has been designed so that it occupies the same space as three single AA size holders, enabling these to be mounted on the track side of the board thereby minimising the amount of space required. Alternatively, a single 3V button cell would probably suffice as the current drain, even during operation, is still very small. This would make the unit even slimmer.

The switches used on in the prototype may also be changed for panel mounted components if preffered, which could also serve to secure the module to the box. With so many possibilites, these details are best left to the ingenuity of the reader.

Testing

The circuit has so few components that mistakes are very unlikely to occur and any non-operation of the circuit will, almost certainly, be due to poor soldering. However, even if the circuit appears to be working and making all the right noises at the expected times, it would still be useful to be able to check that the timing is correct. After all, you could find out the hard way by paying a hefty parking fine!

To check the timing even over one hour would not be very convenient - unless you enjoy watching an LED flash for one hour - so a test mode has been programmed into the chip. This changes the timer into a minutes/seconds timer so that the operation of the timer is identical in all respects except that it runs faster. This mode is selected by depressing S1 and keeping it depressed while the unit is powered up (ie. when the battery is being connected). Provided that a time is set and the unit put into the RUN mode before the internal timer times out and the timer switches off, the unit will count at the faster rate enabling it to be checked in a reasonable time. Once the



Programming PIC chips

If you want to programme your own PIC chips, a good idea if you intend making use of this versatile chip, then you will need to either buy or make a PIC programmer. There are a wide range of PIC programmers on the market at prices ranging from about £70 to several hundred. Alternatively, readers could wait until next month's ETI when we will be publishing a project to build a PIC programmer.

Most of these programmers are designed to interface to a PC, with the PIC code being written, assembled, and debugged using a simulator, on the PC, and then the actual object code being downloaded into the PIC programmer and blown into the PROM or EPROM on the chip. If you got last month's ETI then you will already have a copy of the PIC assembler and simulator programmes for running on a PC; they were contained as part of the code on the cover disk.

A typical example of a low cost PIC programmer is the PIC16Cxx from Parallax. This is just a small PCB with all the appropriate electronics plus ZIF sockets to take the popular PIC 16C5x, 16C64/74, 16C71, and 16C84 series microcontroller chips. Included in the programmer package is an assembler, simulator, cables to connect to a PC and documentation. All the software runs on a standard PC AT or compatible with parallel port, 3.5 inch disk drive and DOS 2.0+. To get the system running you will also need a 12-24VAC power supply.

With this simple little programmer system, one can easiliy write software for, and programme, most of the 18 and 28 pin PIC chips, and with the addition of an optional extra extender socket all 40 pin devices. Since PIC chips are available in both OTP and reprogrammable versions a standard EPROM eraser is an useful additional purchase.

Included with the Parallax PIC programmer is a collection of useful application notes and PIC data sheets. The application notes cover such areas as driving LCDs, sending/receiving serial data, using DRAMs, and reading rotary encoders. Any software can be be debugged by running it on the PC based simulator programme prior to programming a chip.

The Parallax PIC 16Cxx Programmer is available from Milford Instruments, priced £89 (inclusive of VAT and shipping). Milford Instruments can be contacted at Milford House, 120, High Street, South Milford, Leeds LS25 5AQ. or Tel: 01977 683665.

unit is allowed to go to sleep however, this mode will be reset and all subsequent timing runs will be in the hours/minutes mode.

If the timer is required for timing shorter intervals up to 9 minutes 59 seconds, then this mode can be selected by pressing S2 during the power up period. If this is done, the condition will be permanent (until the battery is disconnected) and will not be affected by the timer entering the sleep mode. To differentiate this from the hours/minutes mode, the programme has been modified to produce a short high tone when the RUN button is pressed.

To reassure the user that the device is timing (for those who don't trust or cannot see the LED) the programme can be modified to produce a "ticking" sound by pressing S3 during the power up period.

Finally, although it is not used in this application, the output port A1 has been programmed to go to a logic 1 (i.e. supply voltage) during a timing period, enabling a relay to be connected to the circuit if required. A suitable circuit is shown for this in Fig 3. By using a relay with change-over contacts, an item of equipment could be switched on or switched off for the duration of the timed period. For this application a battery supply would probably not be very practical due to the large current consumption of the relay so a mains supply is necessary. The supply voltage should be chosen to suit the relay and the supply for the microcontroller derived from this using a zener diode as shown.

This would enable the chip to be used and perhaps built into other pieces of equipment such as multimeters or radios to prevent batteries from running down. In this case, a relay would not be required and the equipment switched by an external transistor.

Software overview

There are many ways of writing a program to perform the function of this timer and this is one of them. The program listing for this is shown and is best understood by studying it in conjunction with the accompanying simplified flowchart for the timer.

After initial power-up, the INITIALISE routine is executed which checks if the timer has been woken from the SLEEP mode or not. This is done by checking the PD (power down) bit in the STATUS register and setting up the registers and reading the keys as required. The keys are then scanned by the SCAN routine which detects if any keys are pressed and carries out the required function such as incrementing the hours or minutes registers. It also calls the appropriate BEEP routine to generate the required tone.

The tones are generated by the subroutine beginning at the label BP1 which decrements a counter (CTR2) and complements port B6 when it reaches zero. The counter is re-loaded and the sequence repeated which results in a square wave appearing at the output pin. The number that is loaded determines the delay and hence the frequency which is generated.

Another counter (CTR1) is used to count the number of cycles generated so that each tone lasts for approximately the same period of time which of course means that a different number of cycles of each frequency must be generated. These counters are loaded at the lables BEEP, BEEPL, BEEPM and BEEPH and different frequencies and durations will result depending on which point the subroutine is entered. NOBEEP is basically a delay routine which, although executing the beep program, does not generate a tone because B6 is designated as an input.

Only the first key closure detected is acted upon and no further action is taken until the pressed key is released. This, together with a delay caused by generating the beep, prevents key bounce from upsetting the operation. If the timer is not in the timing mode (i.e. FLAG register bit 1 cleared) then the time-out delay timer is decremented and if it is not zero, the SCAN routine is excecuted again resetting the time-out delay if a key is pressed. Once the time-out timer reaches zero, the SLEEP instruction is excecuted and the unit shuts down until a key is pressed to wake it up again.

If the unit is in the timing mode, the time-out timer is disabled and the program tests the RTCC register which is incremented by the internal crystal oscillator until it overflows to zero which occurs every 0.5 seconds. Because the PIC16C54 does not support interrupts, the RTCC register must be tested continuously for zero to ensure that this state is not missed. When a zero is detected, the LED flashes and is further counted in the Time Base Counter (TBCTR) to decrement the seconds, minutes and hours counters.

The TBCTR is loaded from the Time Base Register which is initially loaded with 2 (decimal) if the unit is in the minutes/seconds mode, and 120 if it is in the hours/minutes mode. This is then used to decrement the main counters which count in Binary Coded Decimal (BCD), hence the BCDADJ routine.

If these counters have not reached zero, the SCAN routine is called again and the process repeats. This happens until either the reset switch is pressed or the counters reach zero when the sounder sounds five bleeps and the timing flag is reset. The SCAN routine is now excecuted and the program continues on the right hand branch of the flow chart until the time-out timer times out and the device goes to sleep or the timing mode is re-entered.

PARTS LIST

R1	33R
R2	47K
R3-R7	4K7
C1,C2	22pF Ceramic
C3	100nF Ceramic
C4,C5	10uF/16V
IC1	PIC16C54-LP (containing program)
LD1	Red LED
XTL	32.768KHz Watch crystal
S1-S5	Push to make switches
BZ1	Piezo sounder or element

- 18 pin DIL socket, PCB, battery holder, and box to suit.

A preprogrammed PIC chip for this project is available from the author price £9.50 including P&P and VAT (Mail Order Only)
Please send cheque or postal order to:
B. TREPAK,
20 The Avenue,
London W13 8PH.

The general purpose registers used in the program are defined at the beginning of the listing using the "equ" statements and eleven of the available 25 registers are utilised. The special function registers such as the program counter, status register etc. are defined in the "PIC.H" file which is called using the INCLUDE statement. This is simply a file consisting of a list of "equ" statements defining these registers and saves having to type out the list each time when developing new applications.

The "ORG" statement at the end of the listing tells the assembler to start the assembly from address 1FF hex as this is the value of the program counter when the PIC16C54 is reset so that the first instruction to be excecuted is at location 000 which is "goto START".

Pocket timer software

```
;This program is for a count down timer which
counts in mins/hrs or
;sec/mins if switch S2 is pressed during the power
up sequence.

;S1, S2 & S3 set UNITS TENS and HOURS counters
without any overflow
;from one digit to the next. When the START switch
                          S5 is pressed the
;counter counts down to zero and activates the
                          sounder. S4 RESETs the
;counters to zero. The timebase is derived from a
                          32.768kHz crystal.
;Switches connected between B0-B4 & B5, sounder -
                          B6, LED - A2/A3,
;A1 - relay o/p if used.
FLAG equ 07h  ; Flag register
HSCTR equ 08h ; Half Second CounTeR - counts down
                         from 64 to provide
      ; 0.5 sec timebase
TBCTR equ 09h ; TimeBase CounTeR - counts down
                         from 2 for 1sec or 120
      ; for 1min timebase
TBREG equ 0Ah ; TimeBase REGgister for reloading
                          TimeBase CounTeR
TMCTR1 equ 0Bh ; TiMer CounTeR 1 - holds tens and
                          units time which is
        ; decremented as count progresses
TMCTR2 equ 0Ch ; TiMer CounTeR 2 - holds hundred
                          time which is
        ; decremented as count progresses
CTREG2 equ 0Dh ; CTREG2 register stores frequency
                         for BEEP
CTR1 equ 0Eh ; counter used for BEEP
CTR2 equ 0Fh ; counter used for BEEP
DLY equ 10h ; counter used in DELAY routine
DLY1 equ 11h ; counter used in DELAY routine
LIST P=16C54;f=inhx16
INCLUDE "PIC.H"
goto START
; *****SCAN KEYBOARD
SCAN  movlw 9Fh              ; ie 1001 1111
  tris PORTB                 ; make B5 &  B6 o/p, all
                                 others i/p
 movwf PORTB                  ; make B5 and B6 low
;
 btfss PORTB,2               ; test B2
 goto RESET                  ; S4 pressed *RESET
 btfsc FLAG,1                ; RUN mode? FLAG,1 set?
 goto SCNEND                 ; yes - do not test other
                             switches
;
 btfss PORTB,0               ; test B0
 goto RUN                    ; S5 pressed  *RUN
;
 btfss PORTB,1               ; test B1
 goto SET_UT                 ; S1 pressed  *SET UNITS
;
 btfss PORTB,3               ; test B3
 goto SET_TN                 ; S2 pressed  *SET TENS
```

```
;
 btfss PORTB,4              ; test B4
 goto SET_HR                ; S3 pressed *SET HOURS
SCNEND      movlw 0BFh ; ie 1011 1111
 movwf PORTB                ; switch B5 high if no
                                 switches pressed
 bcf FLAG,0                 ; clear FLAG 0 if no
                                 switches pressed
 retlw 00
RUN   nop                   ; start count down timer
 movlw 0BFh                 ; ie 1011 1111
 movwf PORTB                ; switch B5 high
;
 movf TMCTR1,same
 btfss STATUS,2             ; test if TMCTR1 is zero
 goto RUN1                  ; not zero
 movf TMCTR2,same           ; TMCTR1=0 - test if
TMCTR2 =0
 btfsc STATUS,2
 goto ERROR                 ; no time has been set
;
RUN1  bsf FLAG,1            ; set RUN mode
 bcf FLAG,0
 movlw .240
 movwf RTCC                 ; load 240 dec into RTCC
 bsf PORTA,1                ; switch on relay o/p
 btfsc FLAG,4
 call BEEP
 retlw 00
;
ERROR call BEEP
 call NOBEEP
 call BEEP
 retlw 00
;
RESET movlw 0BFh            ; ie 1011 1111
 movwf PORTB                ; switch B5 high
 btfsc FLAG,0
 goto KEYPRS                ; if switch still pressed
 call BEEPH
 call BEEPM
 call BEEPL
 bsf FLAG,0
 bcf FLAG,1                 ; clear RUN mode flag
 bcf PORTA,1                ; switch off relay
 clrf TMCTR1                ; clear counters
 clrf TMCTR2                ;
 movlw 0Ch                  ; ie 0000 1100
 iorwf PORTA                ; switch on LED
 retlw 00
;
SET_UT                      movlw 0BFh  ; ie 1011
1111
 movwf PORTB                ; switch B5 high
 btfsc FLAG,0
 goto KEYPRS                ; if switch still pressed
 call BEEPH                 ; high beep
 bsf FLAG,0
 incf TMCTR1
 movlw 0Fh
 andwf TMCTR1,w             ; mask out low order bits
 xorlw 0Ah                  ; test if units=10 dec
 btfss STATUS,2
 retlw 00                   ; not = 10
 movlw 0F0h                 ; ie 1111 0000
 andwf TMCTR1,same          ; clear units to zero
 call BEEPH
 retlw 00
;
SET_TN                      movlw 0BFh  ; ie 1011
1111
 movwf PORTB                ; switch B5 high
 btfsc FLAG,0
 goto KEYPRS                ; if switch still pressed
 call BEEPM                 ; mid beep
 bsf FLAG,0
 movlw 10h
 addwf TMCTR1               ; add 1 to high order
                                 nibble
 movlw 0F0h
 andwf TMCTR1,w             ; mask out high order
                                 bits
 xorlw 60h                  ; test if tens=6
 btfss STATUS,2
 retlw 00                   ; not = 6
 movlw 0Fh                  ; ie 0000 1111
 andwf TMCTR1,same          ; clear tens to zero
 call BEEPM
 retlw 00
;
SET_HR                      movlw 0BFh  ; ie 1011
1111
 movwf PORTB                ; switch B5 high
 btfsc FLAG,0
 goto KEYPRS                ; if switch still pressed
 call BEEPL                 ; low beep
 bsf FLAG,0
 incf TMCTR2
 movlw 0Fh
 andwf TMCTR2,w             ; mask out low order bits
 xorlw 0Ah                  ; test if hours=10
 btfss STATUS,2
 retlw 00                   ; not = 10
 movlw 0F0h                 ; ie 1111 0000
 andwf TMCTR2,same          ; clear hours to zero
 call BEEPL
 retlw 00
;
KEYPRS                      movlw .20
 movwf DLY
 retlw 00
;
DELAY movlw 00Fh            ; *DELAY SUBROUTINE
 movwf DLY1                 ; D1 loop excecutes in
.300uS
D2    movlw 0FFh
 movwf DLY
D1    decfsz DLY,same
 goto D1                    ; if not zero
 decfsz DLY1,same
 goto D2                    ; if not zero - excecute
loop 4  times
 retlw 00                   ; if zero end of delay
;
NOBEEP    movlw 0FFh        ; *NO BEEP
                              SUBROUTINE
 movwf CTR1                 ; Determines no of cycles
 movlw 0DF                  ; ie 1101 1111
 tris PORTB                 ; make port B6 an input
 movlw .1
 movwf CTREG2               ; determines frequency
 goto BPLOAD
;
BEEP  movlw 040h            ; *BEEP SUBROUTINE
 movwf CTR1                 ; Determines no of cycles
 movlw .1
 movwf CTREG2               ; determines frequency
 goto BPLOAD
;
BEEPL movlw 20h             ; *LOW BEEP SUBROUTINE
 movwf CTR1                 ; Determines no of cycles
 movlw .8
 movwf CTREG2               ; determines frequency
 goto BPLOAD
;
BEEPM movlw 40h             ; *MID BEEP SUBROUTINE
 movwf CTR1                 ; Determines no of cycles
 movlw .4
 movwf CTREG2               ; determines frequency
 goto BPLOAD
;
BEEPH movlw 80h             ; *HI BEEP SUBROUTINE
 movwf CTR1                 ; Determines no of cycles
 movlw .2
 movwf CTREG2               ; determines frequency
;
BPLOAD                      movf CTREG2,w
 movwf CTR2                 ; load CTR2 from CTREG2
BP1   decfsz CTR2,same
 goto BP1                   ; if not zero
 movlw 40h                  ; ie 0100 0000
 xorwf PORTB                ; complement B6
 decfsz CTR1
```

```
 goto BPLOAD              ; CTR1 not zero ie. not
                           all cycles done
 bcf PORTB,6              ; switch B6 low
 movlw 9Fh                ; ie 1001 1111
 tris PORTB               ; restore B6 to o/p if it
                            was made an i/p
 retlw 00
;
START nop                 ; *INITIALISE ROUTINE
INTLSE      movlw 9Fh     ; ie. 1001
                            1111
 tris PORTB               ; make PORTB i/p except
                                B5 & B6
;
 btfsc STATUS,3           ; if bit 3 is set (PD
                                bit)
 clrf FLAG                ; clear FLAG register if
                                power on reset
;
 movlw 00h                ; ie 0000 0000
 tris PORTA               ; make PORTA o/p
 movwf PORTA              ; load all
 movwf TMCTR1             ; these
 movwf TMCTR2             ; registers with zero
 btfss STATUS,3           ; test PD bit to see if
reset or wake up
 bcf FLAG,3               ; wake-up - clear TEST
mode
 movlw 07h
 option                   ; set option with
                           prescaler /256 internal
 movlw 0Ch                ; ie 0000 1100
 xorwf PORTA,same         ; compliment LED
;
 movlw 9Fh                ; ie 1001 1111 - B5 and
                                B6 low
 btfss PORTB,1
 bsf FLAG,3               ; S1 key pressed - select
                                TEST mode
 btfss PORTB,3
 bsf FLAG,4               ; S2 key pressed - select
                                MIN/SEC mode
 btfss PORTB,4
 bsf FLAG,2               ; S3 key pressed - select
                                TICKING mode
;
Xmovlw 0BFh               ; ie 1011 1111
 movwf PORTB              ; make B6 low and B5 high
 movlw .120
 btfsc FLAG,3
 movlw .2                 ; move 2 into w if S1 was
                                pressed
 btfsc FLAG,4
 movlw .2                 ; move 2 into w if S2 was
                                pressed
 movwf TBREG              ; load TimeBase REGister
                                with 120 dec.
 movlw .20
 movwf DLY                ;
 movlw 0FFh               ;
PROG1 movwf DLY1
PROG  call SCAN           ;
ENDTM btfsc FLAG,1
 goto TIME                ; RUN Mode - do not go to
                                sleep
 decfsz DLY1              ;
 goto PROG                ;
 decfsz DLY
 goto PROG1
 btfsc FLAG,1
 goto TIME                ; RUN Mode - do not go to
                              sleep
 movlw 0Ch                ; ie 0000 1100
 xorwf PORTA,same         ; switch off LED & relay
                           - no keys pressed
 movlw 9Fh                ; ie. 1001 1111
 tris PORTB               ; make PORTB i/p except
                              B5 & B6
 movwf PORTB              ; switch off B5 & B6
 sleep
;
TIME  movlw .240
```

```
 movwf RTCC               ; load RTCC with 240 dec
TIME3 movf TBREG,w        ; load TBREG into w
 movwf TBCTR              ; load TBCTR with 120 dec
TIME2 call SCAN
 btfss FLAG,1
 goto ENDTM               ; FLAG 1 clear - end
timing
TIME1 movf RTCC,w
 btfss STATUS,2           ; skip if RTCC = 0
 goto TIME1               ; RTCC is not zero -
                               check RTCC again
 movlw .240               ; RTCC=zero
 movwf RTCC               ; reload RTCC with 240
                                dec
 movlw 0Ch                ; ie 0000 1100
 xorwf PORTA,same         ; FLASH LED at 0.5 Hz
 movlw 40h                ; ie 0100 0000
 btfsc FLAG,2
 xorwf PORTB,same         ; if FLAG,2 (tick enable)
                                set
 decfsz TBCTR
 goto TIME2               ; TBCTR not zero - SCAN
                                keys
 movf TBREG,w
 movwf TBCTR              ; reload Time Base
                              CounTeR
 decfsz TMCTR1,same
 goto XX
 goto FINISH
XX    movf TMCTR1,w
 xorlw 10h
 btfsc STATUS,2           ; test if count = 10
 goto XY                  ; see if TMCTR2 = 0
 movf TMCTR1,w
 xorlw 0FFh
 btfss STATUS,2           ; has TMCTR1 overrun to
                                0FFh?
 goto  BCDADJ             ; no - check if units
                           have overrun to Fh
 decf TMCTR2,same         ; no - decrement TMCTR2
 movlw 59h
 movwf TMCTR1             ; change next two digits
                                to 59
 goto PROG
;
XY    movf TMCTR2,same    ; yes
 btfsc STATUS,2           ; is TMCTR2=0
 call BEEP                ; yes - 10 to go - BLEEP
;
BCDADJ   movf TMCTR1,w    ; this adjusts the BCD
                                count
 andlw 0Fh                ; ie 0000 1111 - mask out
                                units
 xorlw 0Fh                ; compare to 0000 1111
 btfss STATUS,2           ; are units=F
 goto PROG                ; no
 movlw .6                 ; yes - Subtract
 subwf TMCTR1,same        ; subtract 6 (dec) from
TMCTR1
 goto PROG
;
FINISH  movf TMCTR2,same  ; test if
 btfss STATUS,2           ; TMCTR2 is zero
 goto XX                    ; no
 bcf FLAG,1               ; yes - sound alarm
 bcf PORTA,1              ; switch off relay o/p
 call BEEP
 call NOBEEP
 call BEEP
 call NOBEEP
 call BEEP
 call NOBEEP
 call BEEP
 call NOBEEP
 call BEEP
 goto ENDTM
;
 ORG 1FFh
;
 END
```

Light Gun Central

This third part of the light gun project covers the central renewal station. The station provides the capability to organise different game types, to adjust the length of the games and to automatically provide scores for individual players and for the teams. It also allows light guns to be programmed with their Identities which are stored in EEPROM in the light gun micro-controller

The central renewal station consists of two pieces of equipment: the central and the external display. The central provides the processing capability for the game and has a keyboard and LCD display for game control and reporting. It also has a serial port which drives either the external display or a printer.

The external display is optional; it is a 3", four-digit, seven-segment display (or even larger if you can afford it). It can be mounted up to 5 metres from the central and can be fixed to any convenient tree, lamppost, gutter etc. using the strap attached to its case, preferably as high up as possible so that it can be easily seen. During the game it displays either the passing time or the Identity of secret agents or warriors in certain game types. At the end of the game it displays all the users' Identities, their overall score and their position. The LCD display on the central duplicates this information, but it is very hard to see when 16 players are crowding round trying to see their end of game scores! Two displays may be driven mounted in separate locations.

The external display may also be used for displaying numbers and text for any equipment such as a PC. It will be described in the final part of the project.

If a printer is used, then it will print out score sheets with information for each player and for the teams at the end of the game.

Description of the central

The central is constructed in a small plastic case. At the front of the case is a 2 line x 20 character LCD display. On top of

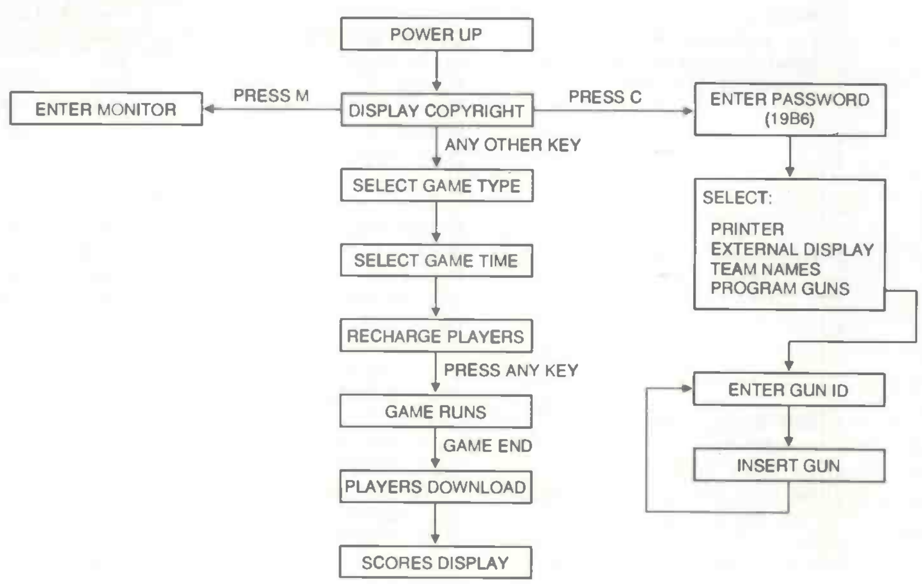


Fig.1. Operation of the central

the case is a 20 key touch-sensitive keyboard. The keyboard allows the user to enter numbers or characters.

On either side of the case, there are green and red LEDs which flash to indicate operation of the central. There are also two 3.5" jack sockets which are used to connect to the coiled cables which are used to renew the guns.

On the back of the case are two power sockets for connection of a 12v supply, and to power the external display. There is also a 9-pin RS232 socket for connection of the external display, or a printer. There are two phono sockets for communicating with the bases, and a reset button.

The central operates from an external 12V supply. We used a sealed Lead acid battery. Power consumption is about 150mA for the central and about 250mA if the external display is used, so a small 2Ah battery is sufficient to power the base for a good number of games; alternatively a small mains driven supply can be used.

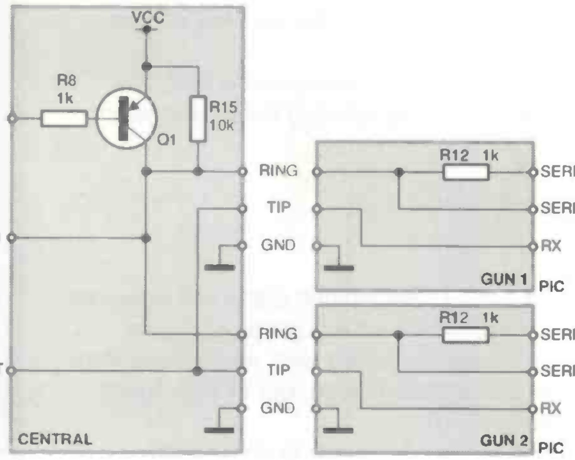


Fig.4. Serial protocols

Operation of the central

When power is first applied to the central, or when the reset button is pressed, the display will show the copyright message. Pressing any key will enable the game selection menu. There are six game types :

1. Light 6-20
2. Warrior 4-20
3. Indy 20-50
4. Highlander 10-50
5. Special Agent
6. Light 10-50

The detailed operation of each game is described below. The name of the game shows the game type and the number of lives and shots on each renewal. For example, Indy 20-50 offers players 20 lives and 50 shots each time that they renew. To select the game type, the up and down arrow moves between game types and the enter key selects the game.

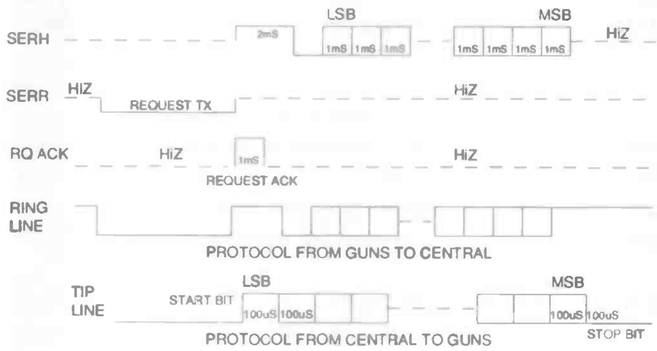


Fig.3. Simplified renewal circuit

The next prompt will request the game time in minutes and this must be entered between 1 and 99. The display will show the default game time; however, the delete key and the number keys may be used to select a new game time. We usually found 15 minute games to be about right; however, games such as Highlander, which do not allow players to renew during the game, should be much shorter. The enter key selects the game time.

Now the players may renew to start the game. At this point the red and green LEDs on the side of the case will be flashing. Each player inserts the renewal plug into the light gun front case, the gun LEDs will flash in sequence, steady, and then the renewal plug may be removed. Players are advised to go to their bases for a team game, or to scatter across the playing field before the game starts. During this period the ID of the last player to renew is displayed on the LCD display. This is especially useful during development to check that the gun IDs have been programmed properly.

When all players are renewed, the game can be started by pressing any key. All game types except the Highlander type allow players to renew during the game, even if they didn't renew during the renewal period before the game started.

During the game, the LCD display on the central displays the following information:

1. Game time remaining in minutes and seconds
2. Red team Score (team games only)
3. Green team Score (team games only)
4. Identity of last player to renew
5. Identity of the last player to hit a base
6. Identity of warriors or secret agents.

An example of the screen format is shown below:

```
08:24 R:100  G:-75
R4 WR7G3 BASE : R6
```

This example shows that the remaining game time is 8 minutes 24 seconds, that the red team have scored 100 points, whilst the green team have -75 points. The last player to renew was Red 4, and the current warriors are Red 7 and Green 3. Finally, the last player to hit a base was player Red 6.

At the end of the game all the guns will "die" simultaneously - all the LEDs on the guns and packs will go out. One of the more impressive features of a night game is to see a field full of red and green lights all extinguish within about one second of each other at the game end! At this point the guns must be renewed one last time to get the final count of lives for each player. During this period the central will display the IDs of all the users who need to finally renew; however, if players are in a hurry then the enter key may be pressed to display scores directly.

Scores are shown on the external display and the LCD display. The LCD display has the following format (shown as an example) :

```
R1     R:1200 G:-12
290    3 (B2 L27/6)
```

This shows that player Red 1 scored 290 points and came 3rd on his team. The red team scored 1200 points, whilst the green team scored -12 points (the red team won!). Player Red 1 hit the opposition's base (green) twice, lost 27 lives during the game, and renewed 6 times.

The display will change every 4 seconds to show all the players in the game.

If an external display is in use it will display the player scores as well. For the first two seconds it will show the ID and the position of the player. Thus:

```
R1 3
```

Showing that Red one came third. For the next two second period it will display the score of the player :

```
290
```

It is much easier for all players to see their scores if an external display is used strapped 10 feet up a tree than to crowd round the small 2-line display on the central!

To start again (at the end of the game, or at any time during the game) then the reset button is pressed at the back of the case.

Figure 1 shows the operation of the base.

Printer

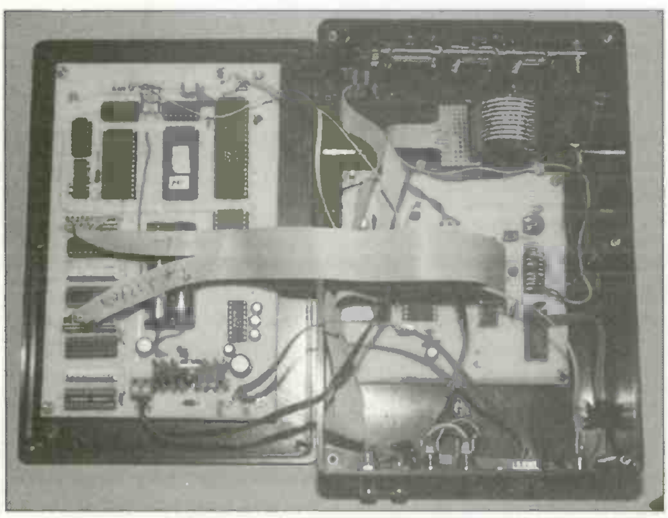
If a printer is in use it will print a score sheet for each team at the end of the game.

Game types

The game types are as follows:

Light 6-20, Light 10-50

This is a team game, each team has to defend its own base against attack, whilst trying to trigger the oppositions base.



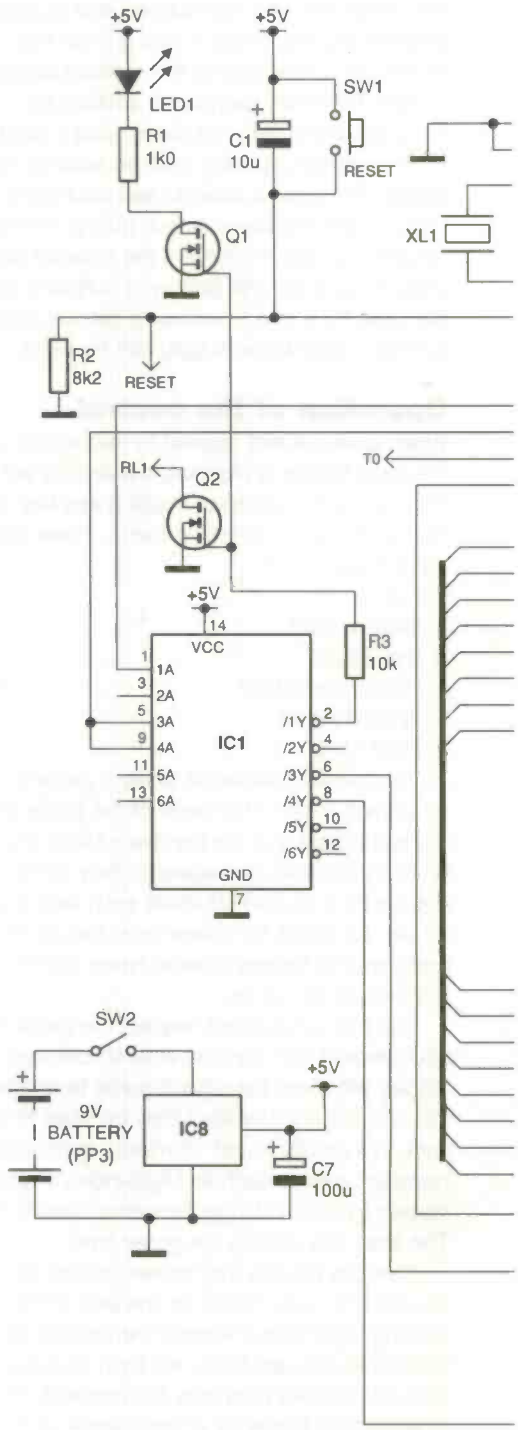
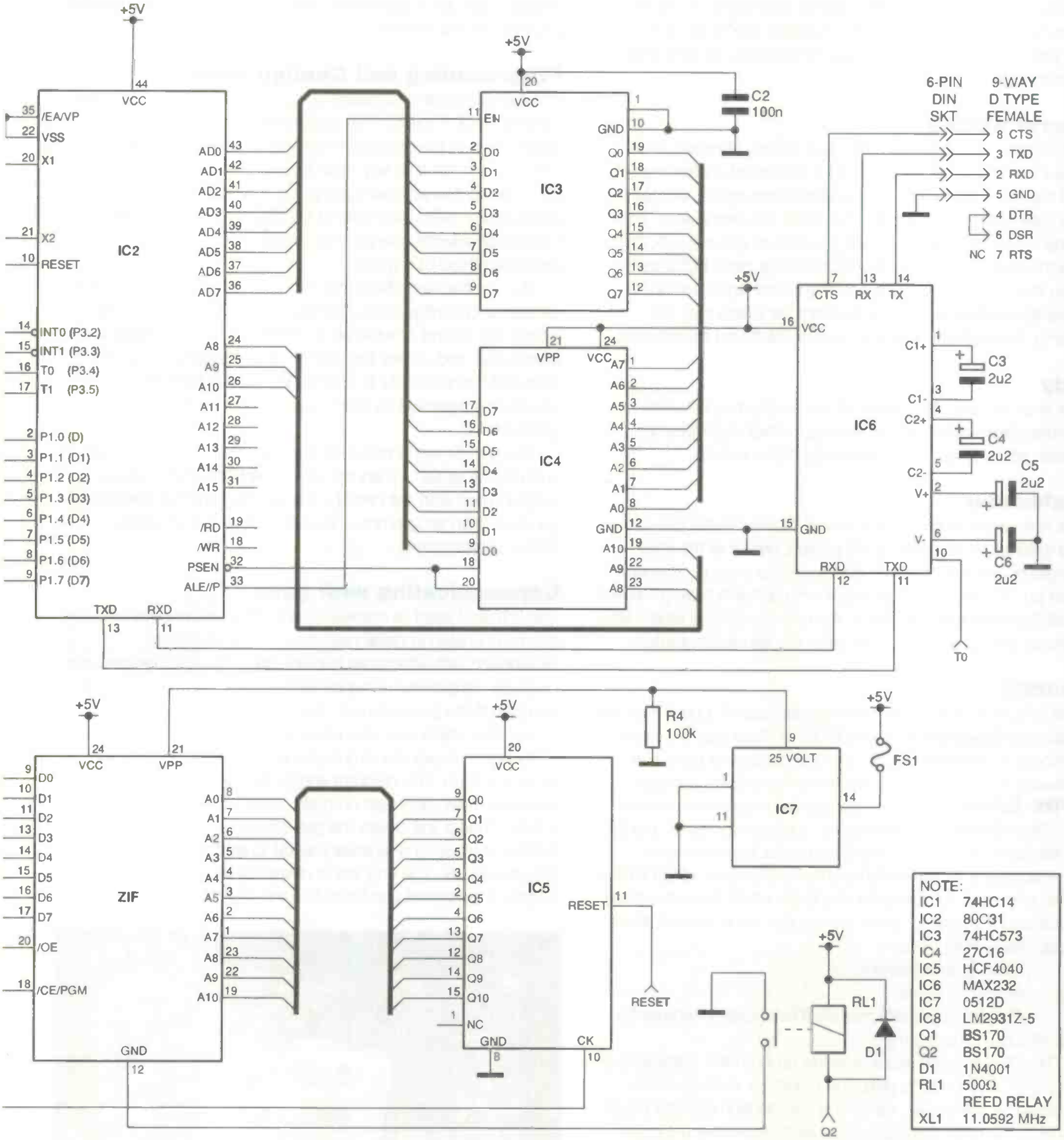


Fig.7. Circuit diagram of main processor



+5V
IC2
VCC
/EA/VP
VSS
X1
X2
RESET
INT0 (P3.2)
INT1 (P3.3)
T0 (P3.4)
T1 (P3.5)
P1.0 (D)
P1.1 (D1)
P1.2 (D2)
P1.3 (D3)
P1.4 (D4)
P1.5 (D5)
P1.6 (D6)
P1.7 (D7)
AD0 AD1 AD2 AD3 AD4 AD5 AD6 AD7
A8 A9 A10 A11 A12 A13 A14 A15
/RD
/WR
PSEN
ALE//P
TXD
RXD
IC3
EN
GND
D0 D1 D2 D3 D4 D5 D6 D7
Q0 Q1 Q2 Q3 Q4 Q5 Q6 Q7
C2
100n
IC4
VPP
VCC
A7 A6 A5 A4 A3 A2 A1 A0
A10 A9 A8
6-PIN DIN SKT
9-WAY D TYPE FEMALE
8 CTS
3 TXD
2 RXD
5 GND
4 DTR
6 DSR
NC 7 RTS
IC6
CTS RX TX
C1+ C1- C2+ C2- V+ V-
C3 2u2
C4 2u2
C5 2u2
C6 2u2
T0
ZIF
/OE
/CE/PGM
A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 A10
IC5
Q0 Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10
NC
CK
R4
100k
25 VOLT
IC7
FS1
RL1
D1
Q2
NOTE:
IC1 74HC14
IC2 80C31
IC3 74HC573
IC4 27C16
IC5 HCF4040
IC6 MAX232
IC7 0512D
IC8 LM2931Z-5
Q1 BS170
Q2 BS170
D1 1N4001
RL1 500Ω REED RELAY
XL1 11.0592 MHz

Warriors

This is also a team game with each team having its own base. At any time, only one player (the "warrior") from either team is able to hit the opposition's base. The two warriors are chosen at random, and their IDs are shown on the central and the external display. The warriors must renew, at which point all the gun lights will flash in sequence, the warrior is then able to hit the opposition's base. The warrior only needs to be hit once to return to normal operation where the base cannot be hit. The warrior IDs change every 60 seconds, or whenever a warrior renews.

Secret Agents

In this game type there are also two teams. However, one player from each team (whose ID is displayed on the central and the external display) swaps teams throughout the game and acts with the other team to attack his own colour. This game is most effective at night because all players look similar and the secret agent has the same colour pack LEDs as the team that he is trying to attack. The secret agents should make themselves known to the team for which they are playing, although the game is open to bluff and double bluff.

Indy

This is an independent game where bases may be used, or disconnected. All players attack each other regardless of colour, and attempt to hit the bases if connected.

Highlander

This is an independent game where bases are disconnected and ignored by the central. All players renew at the start of the game, and are then not able to renew once all lives are used up. The winner is the player who remains having finished off all the other players. This is the only game type where late entrants are not able to renew after the game has started.

Scoring

As it is not possible to tell which player has hit a pack then the scoring is dependant on the number of lives lost, the number of renewals, the team score, and the number of base hits achieved by a player. As a result scoring is quite complex.

The team scores in team games are made up as follows :

- Each life lost, or a renewal by, a player scores 10 points for the other team, and loses 5 points for his own team.
- Each base hit scores 50 points for the team which hit the base, and loses 25 points for the team which owns the base.

Individual scores for team games are made up as follows:

Score=(Base Hits)*100+
(Team Score)/(Number of
players on team)
-(Player's Lives+Recharges)/(Total Lives+Renews for team)*(Score other team)

Thus, the player's score is made up from the average score per player on the team, plus 100 points for each base hit achieved by the player, minus the contribution that the player made to the other team's score. Negative scores are quite possible! Player positions are shown relative to the rest of their team.

Individual scores in individual games are made up as follows:

Score= (((Max.lives for any player)+(Min. lives lost by any
player)/2-player lives)*10
+(Base Hits)*100

Thus the score is made up from the number of lives lost relative to other players, plus 100 points for each base hit achieved by the player. Player positions are shown relative to all other players regardless of colour.

In reality, different games have different scores for hitting a base or losing lives. For example, individual players gain 200 points for hitting a base in the warrior game because it is so much harder to hit the base in this game. Details of the full scoring table are supplied with the EPROM holding the control program for the central.

Programming and Configuration

The central holds information about its configuration in battery backed RAM. To enter the configuration menu, the key 'C' is pressed when the copyright message is being displayed. To enter 'C' the left shift key must be pressed followed by the 'C' key. The central will then prompt for a "password". The password is 19B6, and cannot be changed. It is intended to prevent accidental changing of configuration, or reprogramming of a gun ID.

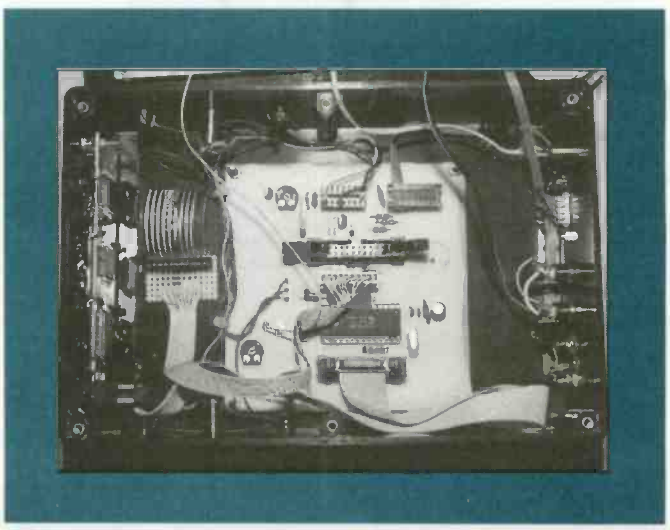
The central then offers the choice of programming gun IDs or changing configuration. Configuration change is used to inform the central of whether a printer or external display is connected, and allows the user to change the team names from RED and GREEN to "HEROES" and "JUMPERS" or whatever is selected by team captains each time a game starts.

The gun ID menu requests that the user enter a new gun ID such as RA or G7. When the gun is renewed then it will be programmed with the new ID, the central confirms that the gun has been programmed successfully and then offers further programming.

Communicating with guns

The protocol used to communicate between the guns and the central is shown in detail here for those who wish to experiment with alternative implementations. (For instance, we seriously considered using an IBM PC as a central, but total non-portability prevented us, however notebook style computers which can take expansion cards may be utilised.)

Figure 3 shows the circuit of the central and the guns in simplified form. The diagram shows two guns renewing simultaneously, although normally there will only be one gun at a time. The tip line drives the gun directly and is used by the central to transmit a renewal packet to both guns simultaneously. The ring line is driven by the gun into the central. The central can force this line high by pulling the base



LSB															MSB
1	X	X	X	X	X	I	I	I	I	I	Y	Y	Y	Y	Y
	NUMBER OF LIVES LEFT					USER ID					INVERSE USER ID				

Fig.5. Message from gun to central

of TR1 low. Remember that the PIC can make any of its port pins outputs or inputs and note that the gun can provide a resistive drive by driving serr, and can then monitor serh, or can provide a low impedance drive by driving serh.

The serial protocol operating from the guns is a simple bus protocol. A gun wishing to transmit requests transmission, waits for acknowledgement from the central, and then transmits. The transmission request is seen by the other gun as a denial for its own transmission, and it waits until the first gun has finished before requesting its own transmission.

The central only transmits on the tip line once every 1/8th of a second, and so this line is normally held at a low level - ground (Vdd). The gun uses this low level to infer that it has been plugged in to the central.

The serial protocol is illustrated in figure 4. The ring line is normally pulled high by R15. The gun requests transmission by pulling serr low and monitoring serh. However, if the ring line (monitored on serh) is already low, then the gun waits until it is high for a period of 20mS before it attempts to request transmission. This will occur if another gun is requesting transmission.

When the central is ready to receive a transmission, it forces the ring line high for 1mS by pulling TR1 base low, the drive from TR1 is of much lower impedance than R12 so that the ring line goes high. When the gun sees this high state on serh it turns off the drive on serr and drives serh high for 2mS so that the central has time to release the drive to TR1. After this time the gun starts a serial transmission with a low start bit followed by the bits it wishes to transmit at a 1mS rate per bit. After transmission, the gun returns serr and serh to a high impedance state and the ring line is pulled high by R15 once again ready for another gun transmission.

Should both guns attempt to transmit simultaneously then this will be detected by serr, and both guns wait a random time which is between 20ms and 21mS before trying again - the gun which chose the shorter time will "win". This is a crude form of the CSMA protocol used on local area networks.

For transmission from the central to the guns the protocol is much simper. There is no request and acknowledgement, the gun simply repeats the same message every 1/8th of a second. The tip line is normally low, the start bit is high, followed by 8 bits and a low stop bit. This is also shown in figure 4. Each bit is 100uS long.

Note on bit times

The protocol was designed to work with PICs with 4MHz clocks. In practice, due to the slightly higher frequency clock used, the serial bit times are actually 954uS instead of 1mS for the transmission from the guns to the central, and 95uS from the central to the guns.

Packet Format

Renewal of a gun operates in two phases. The first action is taken by the gun which attempts to transmit a message to the central informing it of the number of lives the user has left, and the user's ID. This enables the central to count the total number of lives used, and to count the number of renewals taken by each player. The format of the message which is 16 bits long is shown in figure 5. The inverse user ID must match the user ID for the message to be accepted, this is intended to provide a simple check against spurious messages sent when the renewal lead is inserted into or removed from the gun. Red IDs have the top bit of the ID set to 0, green IDs have the top bit set to 1.

The renewal packet from the central to the gun consists of 10 bytes and is shown in figure 6. Renewal of the gun is only complete when the gun sees its own ID in the bytes MRC or MRCBUT1 in the renewal packet. This is an acknowledgement from the central to the gun. The checksum byte is the 8 bit remainder from the sum of all the bytes from byte 2 to byte 9, and is used by the gun to check that the received packet is valid.

Next Month...

we will continue with a look at the processor board, its construction and software.

Byte	Name	Value (Hex)	Notes
1	Start flag	AA	Always has the value AA, shows start of packet
2	Type	00-01	00 for a renewal packet 01 to program the gun ID For ID packets bytes 4 to 9 are set to 00
3	Shots	00-FF	Number of shots per life For an ID packet this the ID of the gun to program For ID packets bytes 4 to 9 are set to 00
4	Timelo	00-FF	Lower byte of game time left in seconds
5	Timehi	00-FF	Upper byte of game time left in seconds
6	Game type	00-07	Type 0 is normal Type 1 is warriors All other types are spare
7	Lives	00-7F	Number of lives for user Note numbers greater than 1F(Hex) are used only for special purposes, as the number of lives transmitted from the gun to the central is limited to 5 bits
8	MRC	00-9F	ID of the most recently renewed user used to acknowledge the gun BIt 7 if set shows that this user is a warrior
9	MRCBUT1	00-9F	As MRC for the most recently renewed user but one
10	Checksum	00-FF	8 bit checksum - lower 8 bits of the additive sum of bytes 2 to 9 (does not include start flag)

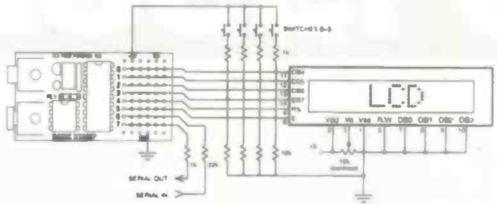
Fig.6. Renewal packet from central to guns

BASIC Stamp -Stamp sized Computer runs BASIC

The Basic Stamp by PARALLAX measures only 40x60mm yet is a true microcomputer that runs BASIC programmes written on your PC. Its size, ease of use and extensive I/O features make it an ideal tool for both educational and industrial applications as well as for the serious hobbyist.

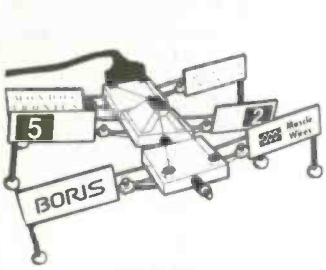
Writing programmes for the Stamp is easy. A 3-pin cable connects the Stamp to your PC printer port. One piece of software is used to enter,debug and download your programme. Features include 8 I/O lines, non-volatile memory, serial comms, pulse measurement and PWM; all achieved with a minimum of external components.

Typical Application



The BASIC Stamp Development Kit at £99 includes; 1 BASIC Stamp, Instruction manual, PC cable, software and extensive application notes. Further Stamps are available from £29.

Muscle Wires -wires that contract when heated!



Fascinating, highly processed Shape Memory Alloy wires that actually contract when electrically heated producing a useful amount of force.

Low cost linear actuators at last!
Their light-weight makes them excellent for use in models, robots and many other types of project. Low voltage and power allows simple control by computer or electronics (eg The BASIC Stamp).

Detailed Data and Project Book (128 pages) plus Muscle Wire kit suitable for 13 projects including BORIS the walking, six-legged robot; only £44.95.

All prices excl VAT and £3 postage per order. For further details of the Stamp, Muscle Wires and other products please call for our NEW colour catalogue.

MILFORD INSTRUMENTS

24hr Answerphone · 01977 683665, Fax 01977 681465
Milford House, 120 High Street, South Milford LEEDS LS25 5AQ

BHA TRADING

Tel: 01438 816474
Fax: 01438 812569

Open Chassis Monitors	
Panasonic 12" Colour	£50.00
Panasonic 12" Green	£25.00
Panasonic 9" Green	£15.00
2m Euro Power Leads -2m	£ 2.00
Mains Leads -Euro/3 Pin	£ 2.00
PCB Mount Buzzer (IMO)	£ 0.50
Quality Min, Toggle Switch	£ 4.50
48v DC Fan 119 x 119 x 38	£20.00
Heat Sink - 120 x 115 x 140	£ 5.00
UHF TV Tuner Head Module	£ 7.50
Mitsubishi 5.25" 1.4Mb Drives	£15.00
Mitsubishi 5.25" 360Kb Drives	£ 7.50
Mains Filter Panel mount -3A	£ 4.50
Mains Filter P. Mount 3A Fused	£ 7.50
Fuse holder - P. Mount Bayonet	£ 0.75
115v AC Fan 119 x 119 x 38	£12.50

Quantity of Data and Design Manuals - SAE for List.
All prices include VAT
Post and packing Free for orders of less than £2.00.
£0.50 for orders up to £10.00 and £2.50 for all orders over £10.00

Payment With Order

15 Oakwell Close, Stevenage, Herts, SG2 8UG

the new

CRICKLEWOOD Electronics

Very Interesting CATALOGUE

ASTRONOMICAL RANGE AT DOWN TO EARTH PRICES

- TRANSISTORS+ICs+SEMICONDUCTORS
- RESISTORS+CAPACITORS+INDUCTORS
- SURVEILLANCE+SECRECY+SECURITY
- PLUGS+SOCKETS+LEADS+CONNECTS
- TV & VIDEO SPARES (inc Video Heads)
- HIFI+DISCO+HIFI GADGETS+SPEAKERS
- AUDIOPHILE COMPONENTS (inc Capacitors)
- IN CAR AUDIO+SPEAKERS (inc Bass tubes)
- COMPUTER ACCESSORIES+BOARDS
- TOOLS+TEST EQUIPMENT+BENCHWARE

& much much much more (over 10,000 lines).

SEND TODAY FOR *THE VERY INTERESTING CATALOGUE*
Pay by PO, Cheque, Credit Card or tape Coins to Paper

Please send me ......copies of the 1995 Cricklewood Catalogue.
I enclose £2.50 per copy (UK & Europe). £5.00 overseas
Name..
Address..
....
....
....
Please Charge my Credit Card.no..
Expiry Date......................Tel no..............................ETI

Cricklewood Electronics Ltd, 40-42 Cricklewood Broadway London NW2 3ET Tel 0181 450 0995 Fax 0181 208 1441

WE HAVE THE WIDEST CHOICE OF USED OSCILLOSCOPES IN THE COUNTRY

TEKTRONIX 7000 SERIES OSCILLOSCOPES
Available from £200 - PLUG-INS SOLD SEPERATELY

TEKTRONIX 2246A 4 Channel 100MHz Cursors/Voltmeter etc	£1250
TEKTRONIX 2245A 4 Channel 100MHz Cursors etc	£1000
TEKTRONIX 475 Dual Trace 200MHz Delay Sweep	£500
TEKTRONIX 465 Dual Trace 100MHz Delay Sweep	£400
TEKTRONIX SC504 Dual Trace 80MHz in TM503B	£500
IWATSU SS5711C 4 Channel 100MHz Delay Sweep with DMM	£500
TRIO CS2070 4 Channel 70MHz Delay Sweep	£450
TEKTRONIX 2215A Dual Trace 20MHz Delay Sweep	£300
TEKTRONIX 2213 Dual Trace 60MHz	£350
HITACHI V650F Dual Trace 60MHZ Delay Sweep	£350
PHILIPS PM3217 Dual Trace 50MHz Delay Sweep	£400
GOULD OS1100 Dual Trace 30MHz with Delay	£240
HITACHI 412 Dual Trace 20MHz trig to 40MHz Delay	£225
BECKMAN 9020 Dual Trace 20MHz Delay Sweep	£240
TEKTRONIX 1922 Dual Trace 15MHz	£200
GOULD OS250B Dual Trace 15MHz	£125
IWATSU SS5702 Dual Trace 20MHz	£200
TRIO CS1566A Dual Trace 20MHZ	[illegible]
LE CROY 9400 Dual Trace 125MHz Digital Storage	£1000
HITACHI VC6045 2 Channel 40 MS/s Digital Storage Cursors	£1100
TEKTRONIX 466 Dual Trace 100MHz Analogue Storage	£400
GOULD OS4000 Dual Trace 10MHz Digital Storage	£200

THIS IS JUST A SAMPLE - MANY OTHERS AVAILABLE

HEWLETT PACKARD 1740A OSCILLOSCOPES
100MHz Dual Trace, Delay Sweep..........For Only £350

MARCONI 2019 Synthesized AM/FM Sig. Gen 60KHz-1024MHz	£1900
MARCONI 2018 Sythesized AM/FM Sig Gen 80kHz 520MHz	£700
H.P. 8620C Sweep Oscillator with 86245A 5.9012 4GHz	£400
SYSTRON DONNER 1702 Synth AM/FM Sig Gen 100Hz-1GHz	[illegible]
RACAL 9081 Sythesized Sig Gen 5-520MHz	£500
FARNELL SSG520 Synthesized AM/FM Sig 10MHz-520MHz	[illegible]
MARCONI TF2015 AM/FM Sig. Gen. 10kHz-510MHz	£200
MARCONI TF2015 With Synchronizer TF2171 (lock box)	£350
MARCONI TF2016 FM Sig Gen 10kHz-120MHz	£250
MARCONI TF2016 With Synchronizer 2173 (lock box)	£375
MARCONI TF2337 Automatic Distortion Meter	£200
RACAL 9104 RF Power Meter 1MHz-1GHz 10mW-300W	[illegible]
RACAL 9100 Absorption Wattmeter 1-5MHz-520MHz 300mW	£100
TEKTRONIX CPS250 Trip. Output PSU 2x20 VO-5A Var, 5V2A Fxd	£225
TEKTRONIX CFG250 Function Gen. o-2Hz-2MHz Sine/Sq/Tri etc	£225
TEKTRONIC CDM250 Digital Multimeter 3½ digit LED	£180

BRUEL & KJOER EQUIPMENT AVAILABLE PLEASE ENQUIRE

SPECTRUM ANALYSERS

H.P. 8565A 0.01-22GHz	£5000
H.P. 3580A LED 0.5MHz-50KHz	£1000
POLARAD 641-1 10MHz-18GHz	£1500
ANDO AC8261 with AC8211 1700MHz	£1500
H.P. 182 with 8558B 100KHz-1500MHz	£1500
H.P. 141T with 8554B & 8552B 500kHz-1250MHz	£1200
H.P. 141T with 8553B & 8552A 1kHz-110MHz	£800
MARCONI TF2370 30Hz-110Mhz	£1000
H.P. 141T Main Frames Only. Good Tubes	[illegible]

H.P. 3456A DMM 6digit DC/True RMS/AC/RES HP18	[illegible]
H.P. 5341 Frequency Counter 50MHz-1.5GHz LED	£300
MARCONI 2435 Digital Frequency Meter 2GHz	£400
RACAL 1998 Freq. Counter 1.3GHz (options GPIB & High Stab)	£900
RACAL 1991 Universal Counter/Timer 160MHz 9 digit	£150
MARCONI 2437 Universal Counter/Timer DC - 100MHz 8 digit	£175
MARCONI 2431A Frequency Counter 10Hz-200Mhz 8 digit	£150
MARCONI 2430A Frequency Counter 10Hz 520Mhz 9 digit	£200
RACAL 9918 Frequency Counter 10Hz-520Mhz 9 digit	£200
DATRON 1061A 6.5 digit Autocal Multimeter True RMS AC/Current	£750
H.P. 3490A 5 digit Multimeter AC/DC/Ohms	£200
H.P. 3435A 3.5 digit Multimeter AC/DC/Ohms/Current LED	£100
PHILIPS PM2534 Multi Function DMM 3.5-6.5 digit GPIB/IEEE	£400
SOLARTRON 7150 6.5-3.5 digit DMM with IEEE	£400
SOLARTRON 7045 4.5 digit Multimeter Volts/Amps/Ohms	[illegible]
WAYNE KERR B905 Automatic Precision Bridge 0.05%	£600
MARCONI TF2700 Universal Bridge. Battery Operated	from £150
MARCONI TF1313A Universal LCR Bridge 0.1%	£125
HEATHKIT IB RLC Bridge	£80
BRADLEY 192 Oscilloscope Calibrator	£600
WILTRON 560 Scaler Network Analyser with Detectors	£1000
FARNELL H30/100 0-30V, 0-100A Metered	[illegible]
FARNELL TVS70 Mk2 70V 5A/35V 10A, Metered.	£200
FARNELL B30/10 30V, 10A Variable	£200
FARNELL L30E 0-30V; 0-5A Metered	£125
THURLBY PL320OMD 30V2A Twice Digital	£250
THURLBY PL320 30V 2A Digital	£120
MARCONI (WEIR) TF2154 0-30V 1A; 0-15V 2A; 0-7.5V 4A Metered	£60
H.P. 6516A 0-3Kv; 0-6mA Metered	£150
BRANDENBURG 472R PSU +/- 2Kv	£200
BLACK STAR Meteor 100-100MHz Frequency Counter	£70
BLACK STAR Jupitor 500 500KHz Fun Gen Sine/Sq/Tri/TTL	£70
FEEDBACK FG600 Sine/Sq/Tri 0-01Hz-100kHz	[illegible]
LINDON LA1 Mk 2B Audio Analyser	[illegible]
UNAOHM EP501 Audio Analyser	£350
PHILIPS PM5518 Colour TV Pattern Generator	£1000
RADFORD LD04 Low Distortion Oscillator	[illegible]
RADFORD LDMS2 Low Distortion Measuring Set	£300
MARCONI TF2163 Attenuator DC-1GHz	£100
MARCONI TF893B Audio Power Meter Sinad	£250
H.P. 1630D Logic Analyser 43ch	£750
H.P. 4275A Multi Freq LCR Component Meter	[illegible]
THANDAR TG501 Fun Gen 0.0005Hz-5MHz Sine/Sq/Tri/Ramp/Pulse etc	£200
MARCONI TF2331 Distortion Factor Meter 20Hz - 20KHz 0.05%	£150
H.P. 8405A Vector Voltmeter 1-1000MHz from	£300

NEW EQUIPMENT

HAMEG OSCILLOSCOPE HM1005 Triple Trace 100MHz Delay Timebase	£847
HAMEG OSCILLOSCOPE HM604 Dual Trace 60MHz Delay Sweep	£653
HAMEG OSCILLOSCOPE HM303 Dual Trace 30MHz Comp. tester	£392
HAMEG OSCILLOSCOPE HM205-3 Dual Trace 20MHz Digital Storage	£653

All other models available - all oscilloscopes supplied with 2 probes

BLACK STAR EQUIPMENT (P&P all units £5)

APOLLO 10 100MHz Counter Timer Ratio/Period/Time int etc	£222
APOLLO 100 100MHz (as above with more functions)	£325
METEOR 100 FREQUENCY COUNTER 100MHz	£119
METEOR 600 FREQUENCY COUNTER 600MHz	£145
METEOR 1000 FREQUENCY COUNTER 1GHz	£189
JUPITOR 500 FUNCTION GEN. 0.1Hz-500kHz Sine/Sq/Tri	£119
ORION COLOUR BAR GENERATOR Pal/TV/Video	£229

All other Black Star equipment available

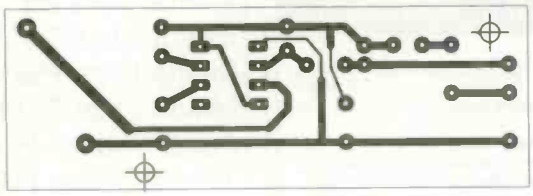
OSCILLOSCOPE PROBES Switched X1 X10 (P&P £3)	£12

Used Equipment - Guaranteed. Manuals supplied if possible.
This is a VERY SMALL SAMPLE OF STOCK. SAE or telephone for lists. Please check availability before ordering. CARRIAGE all units £16. VAT to be added to Total of Goods and Carriage.

STEWART OF READING

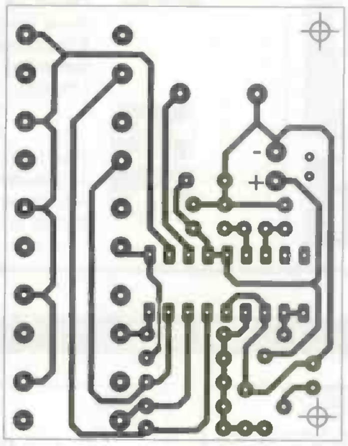
110 WYKEHAM ROAD, READING, BERKS RG6 1PL
Tel: 01734 268041 Fax: 01734 351696 Callers welcome 9am to 5.30pm MON-FRI (UNTIL 8pm THURS)

FOILS FOR THIS ISSUE

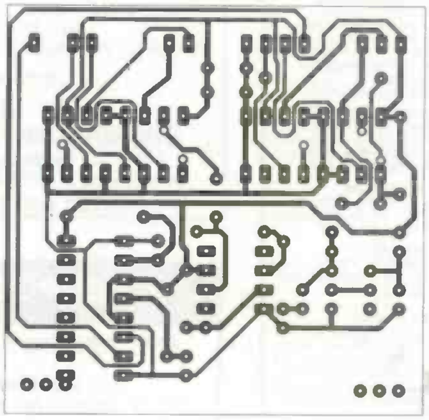


Touch Test

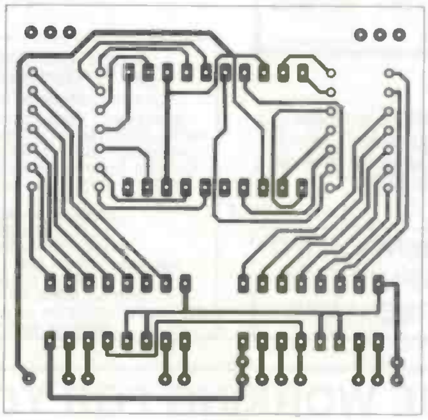
Light Gun Central



Pocket Timer



Random Number Generator



Random Number Generator

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

VISA

Access

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 of open frame type. Available for immediate delivery.

WIDE RANGE OF XENON FLASHTUBES
Write/Phone your enquires

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES
4ft 40 watt £14.00 (callers only) (£16.45 inc VAT)
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 GPH 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
Desiged for Disco, Theatrical uses 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 + VAT

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..3

SOLID STATE EHT UNIT
Input 230/240V AC, Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20sec, 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 1½in. 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

Access

SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
FAX 081-995 0549 081-995 1560
ACCOUNT CUSTOMERS MIN, ORDER £10

BARCLAYCARD VISA

Showroom open Monday/Friday
Ample Parking Space

VISA ACCESS

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 (50p)
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) 01243 545111/2 Fax (+44) 01243 542457
WANTED TEST EQUIPMENT & MANUALS TO PURCHASE

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

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

KINDLY MENTION ETI WHEN REPLYING TO ADVERTISEMENTS

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

COMPLETE GUIDE to building a P.C. details send SAE D. Bryan, IMAY, 19 Acle Gardens, Bulwell, Nottingham NG6 8NY.

KINDLY MENTION ETI WHEN REPLYING TO ADVERTISEMENTS

LEN COOKE ENTERPRISES
For the best value in Used Electronic Test Instruments
We buy, sell and service ocsilloscopes, signal generators, frequency counters, spectrum Analysers, Power meters, logic testers, etc. Spare parts available for most Textronic 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.

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, Medical, 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)

THIS SPACE COULD BE WORKING FOR YOU! FOR DETAILS OF ADVERTISING RATES CALL JAMES ON 01442 66551 OR FAX YOUR ADVERTISEMENT ON 01442 66998

READERS PLEASE NOTE that some telephone dialling codes may recently have changed. If you experience any difficulty in contacting advertisers, ring our advertising department 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

All the great developments in what we loosely call media technology have brought in their wake massive cultural changes. Waves of cultural change which wash across the years and erode the very foundations of the society in which we live. As a result some old institutions have crumbled, but at the same time new ones are arising and pointing the way to the future.

Cinema, radio, television, telephones, personal computers, and the information superhighway have shrunk the world. It seems today that nowhere is 'lost', remote or inaccessible. No culture, no social system, no political dogma or religious creed can hide from the influence of 'mass communications'.

But although we may be losing some of the world's cultural diversity, we are at the same time building a world where the dogmas and intolerance born of ignorance are hopefully a thing of the past. Dictators and fanatics can not exist in a world where the free flow of information means that their lies and evil doings are exposed for all to see.

It is not surprising therefore that the governments of some more intolerant states have attempted, usually with little success, to control the technology which allows this free movement of information. Or that some fanatical sects have sought to hound, using every possible legal or illegal means, ex members who are using information technology to tell the world about the dangers of these self same fanatics.

This is of course Marshall McLuhan's 'Global Village', but in spite of all its enormous benefits it is a global village with a major flaw. The information technology has separated us from experiencing the world, it has denatured our vision of the world. It is a vision in which we as individuals have no control.

Given information from a multitude of media sources we have the ability to cast out our own politicians, and in limited areas change the way that our society is run. But although we might witness famine, poverty, ignorance, and disease in other parts of the world on our TV screens there is little we can do apart from give a donation to some aid charity. Similarly we may witness the adrenalin pumping excitement of flying a supersonic jet, or being part of a military operation but solely from the standpoint of an uninvolved observer, we can not share the adrenalin rush.

The result is in many cases frustration, but frustration soon gives way to either inertia or antisocial anger. This is where the danger sets in, for we look at what is happening in the world, a world about which we have information from every remote corner, and finding ourselves uninvolved simply shrug our shoulders and turn to other things. Society becomes alienated and divided, with increasing numbers losing themselves in drink, drugs, and mindless violence. For without activity, the ability to physically take control, we have lost the world, activity for mankind is everything.

Enter virtual reality, telepresence and teleoperator technologies, the latest in media technology, and the first to offer the user the potential to be in control, to interact with real and imaginary worlds. A technology which does not narrow the human spirit, but instead frees it and perhaps even amplifies it.

This means that virtual reality offers us a way in which everyone can participate, either for their own benefit or for the benefit of others. It offers us a way to reduce the dangerous elements of human nature, such as aggression, by letting the individual work them out in a virtual world.

This technology allows the positive side of human nature to be emphasised. Doctors will be able to remotely operate on patients thousands of miles away, teachers will be able to take classes of students who are scattered across the globe, and the disabled, or those living in remote districts, will be able to work normally in a virtual workplace.

Virtual reality will be commercialised as a new entertainment medium, but we must not allow this to obscure its potential. No more than we must allow television to be conceived of as a purveyor of game shows and soap operas, as opposed to documentaries and educational programmes.

However, if virtual reality is to achieve this potential there is an enormous amount of work which needs to be done in developing and exploiting the technology. Already in the US literally hundreds of small companies are springing up to exploit new VR ideas, a pattern which to a limited degree is being copied in the UK. The virtual reality market is wide open, we have yet to see the Microsoft, Compaq, or Apple of the VR market. We have yet to see the new billionairs of VR.

Virtual reality has enormous potential, it already has individuals with visions of a VR future. It is a future which can not be extrapolated by looking at the past, technology is opening up uncharted territory. We must now remember that the past is simply history, no more and no less, the future is where we are destined to spend the rest of our lives. It is up to us what kind of future we make for ourselves.

Next Month...

In the June 1995 issue of ETI we will continue our laser tag game project, Robin Abbott will conclude the construction of the light gun central. We will also look at another of Richard Grodzik's add-on boards for his 80188 single board computer project, a 4 channel touch switch. Plus a bicycle loop alarm from Terry Balbyrnie, and Dave Bradshaw takes a look at building simple switch regulators

We continue our new series of projects built around the Parallax Stamp computer with a look at building a remote analogue signal measurement system that will connect to your PC. We will also be continuing our series of projects using the PIC microcontroller. Plus a project to build your own PIC programmer (can be used with the development software in April ETI's free disk)

The main feature will delve into the technology behind, and the amazing uses for, shape memory metals. PC Clinic will have a new Q & A look.

ETI
ELECTRONICS TODAY INTERNATIONAL

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

CREATIVE
Designer ***Nadia Ahdout***
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

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

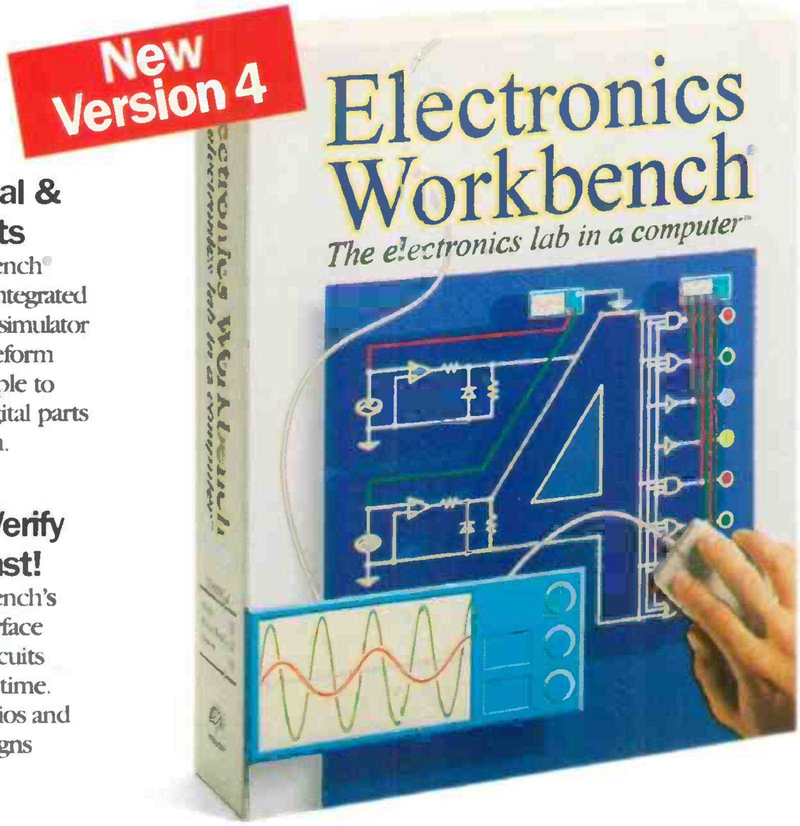
Published by Nexus Special Interests, Nexus House, Boundary Way, Hemel Hempstead HP2 7ST. Telephone (0442) 66551. UK newstrade distribution by SM Distribution Ltd, 6 Leigham Court Road, London SW16 2PG. Telephone 081-667 8111. Overseas and non-newstrade sales by Magazine Sales Department, Argus House, 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

MIXED-MODE SIMULATION. THE POWER OF VERSION 4.



Analog, Digital & Mixed Circuits

Electronics Workbench® Version 4 is a fully integrated schematic capture, simulator and graphical waveform generator. It is simple to mix analog and digital parts in any combination.

Design and Verify Circuits... Fast!

Electronics Workbench's simple, direct interface helps you build circuits in a fraction of the time. Try 'what if' scenarios and fine tune your designs painlessly.

More Power

Simulate bigger and more complex circuits. Faster. On average, Electronics Workbench Version 4 is more than 5 times faster than Version 3.

More Parts

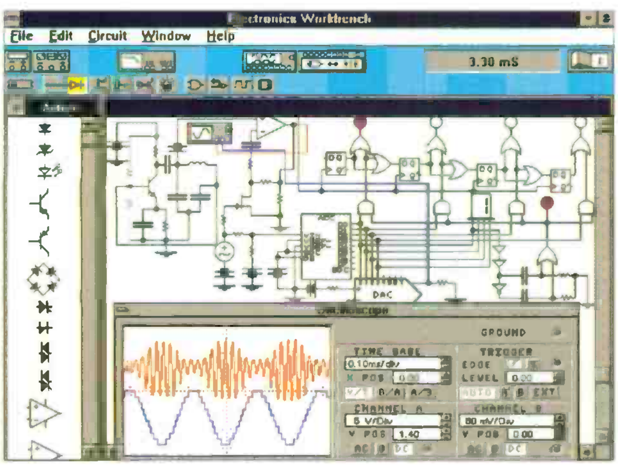
Multiple parts bins contain over twice the components of Version 3.

More Models

Over 350 real world analog and digital models are included free with Electronics Workbench. And, if you need more, an additional 2,000 models are available.

Incredibly Powerful. Incredibly Affordable.

If you need mixed-mode power at a price you can afford, take a look at this simulator and graphical waveform generator that mixes analog and digital with ease.



True mixed-mode simulation: Simultaneous AM transmission, digitization and pulse-code modulation of a signal.

With over 20,000 users world-wide, Electronics Workbench has already been tried, tested and accepted as an invaluable tool to design and verify analog and digital circuits. With Version 4 true mixed-mode simulation is now a reality with incredible simplicity.

Electronics Workbench™
The electronics lab in a computer™

Order Now! Just £199*

44-(0)1203-233-216

Robinson Marshall (Europe) Plc

**Nadella Building, Progress Close,
Leofric Business Park,
Coventry, Warwickshire CV3 2TF
Fax: 44 (0)1203 233-210
E-mail: rme@cityscape.co.uk**

Shipping charges UK £5.99. All prices are plus VAT.

* 30 Day money-back guarantee.

Australia: 2-519-3933 • Brazil: 11-453-5588 • Cyprus: 2-62-1068 • Denmark: 33-25-0017 • Finland: 0-297-5033 • France: 14-908-9000 • Germany: 711-62-7740 • Greece: 1-524-9981 Hungary: 1-215-0082 • India: 11-544-1343 • Israel: 3-647-5613 • Italy: 11-437-5549 • Japan: 3-3382-3136 • Malaysia: 3-774-2189 • Mexico: 5-396-3075 • Netherlands: 18-031-7666 New Zealand: 9-267-1756 • Norway: 22-16-70-45 • Portugal: 1-814-6609 • Singapore: 462-0006 • Slovenia: 61-317-830 • South Africa: 331-6-8309 • South Korea: 2-2-222-3431 Spain: 1-553-3234 • Sri Lanka: 1-86-5970 • Sweden: 8-740-5500 • Thailand: 66-2-398-6952 • United Kingdom: 203-23-3216

INTERACTIVE