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EVERYDAY

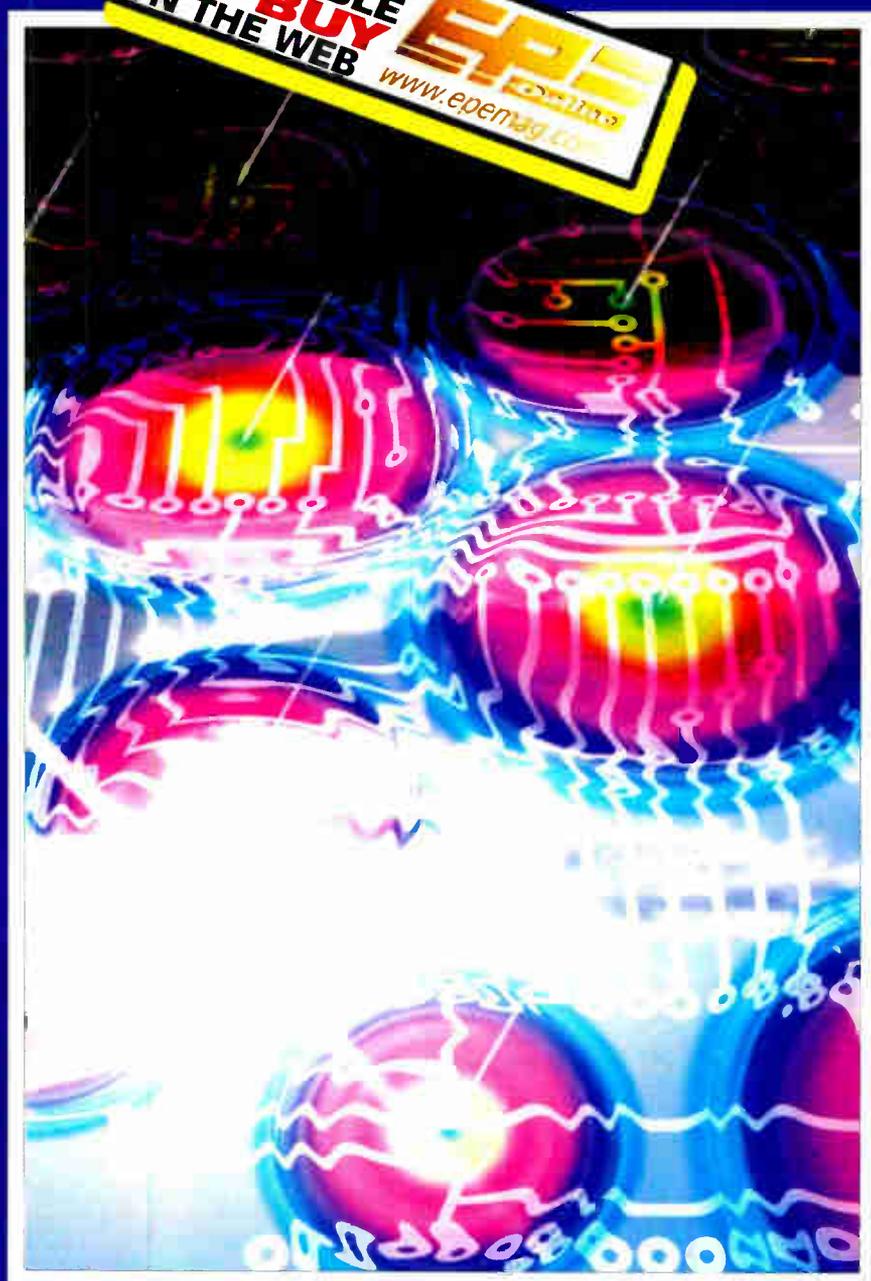
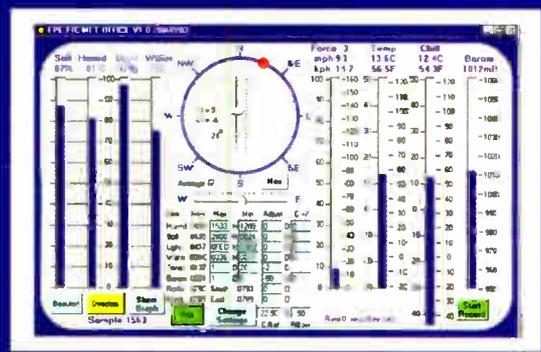
AUGUST 2003

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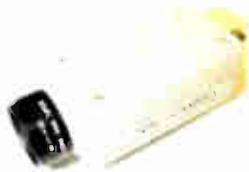
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World Radio History



Colour CCTV camera, 8mm lens, 12V d.c. 200mA 582x628 Resolution 380 lines Automatic aperture lens Mirror function PAL Back Light Compensation MLR, 100x40x40mm. Ref EE2 £69



Built-in Audio .15lux CCD camera 12V d.c. 200mA 480 lines s/n ratio >48db 1v P-P output 110x60x50mm. Ref EE1 £99



Metal CCTV camera housings for internal or external use. Made from aluminium and plastic they are suitable for mounting body cameras in. Available in two sizes 1 - 100x10x170mm and 2 - 100x70x280mm. Ref EE6 £22 EE7 £26 multi-position brackets. Ref EE8 £8



Excellent quality multi-purpose TV/TFT screen, works as just a LCD colour monitor with any of our CCTV cameras or as a conventional TV. Ideal for use in boats and caravans 49.7MHz-91.75MHz VHF channels 1-5, 168.25MHz-222.75MHz VHF channels 6-12, 471.25MHz-869.75MHz, Cable channels 112.325MHz-166.75MHz Z1-Z7, Cable channels 224.25MHz-446.75MHz Z8-Z35 5" colour screen. Audio output 150mW. Connections, external aerial, earphone jack, audio/video input, 12V d.c. or mains, Accessories supplied Power supply, Remote control, Cigar lead power supply, Headphone Stand/bracket. 5" model £139 Ref EE9, 6" model £149. Ref EE10



Fully cased IR light source suitable for CCTV applications. The unit measures 10x10x150mm, is mains operated and contains 54 infra-red LEDs. Designed to mount on a standard CCTV camera bracket. The unit also contains a daylight sensor that will only activate the infra red lamp when the light level drops below a preset level. The infrared lamp is suitable for indoor or exterior use, typical useage would be to provide additional IR illumination for CCTV cameras. £49. Ref EE11



This device is mains operated and designed to be used with a standard CCTV camera causing it to scan. The black clips can be moved to adjust the scan angle, the motor reversing when it detects a clip. With the clips removed the scanner will rotate constantly at approx 2.3rpm. 75x75x80mm £23. Ref EE12



Colour CCTV Camera measures 60x45mm and has a built in light level detector and 12 IR LEDs. 2 lux 12 IR LEDs 12V d.c. Bracket Easy connect leads £69. Ref EE15



A high quality external colour CCTV camera with built in Infra-red LEDs measuring 60x60x60mm Easy connect leads colour Waterproof PAL 1/4" CCD 542x588 pixels 420 lines. 05 lux 3.6mm F2.78 deg lens 12V d.c. 400mA Built in light level sensor. £99. Ref EE13



A small compact colour CCTV camera measuring just 35x28x30mm (camera body) Camera is supplied complete with mounting bracket, microphone and easy connect leads. Built in audio. Colour 380 line resolution PAL 0.2 us +18db sensitivity. Effective pixels 628x582 Power source 6-12V d.c. Power consumption 200mW £36. Ref EE16



Complete wireless CCTV system with video. Kit comprises pinhole colour camera with simple battery connection and a receiver with video output. 380 lines colour 2.4GHz 3 lux 6-12V d.c. manual tuning Available in two versions, pinhole and standard. £79 (pinhole) Ref EE17, £79 (standard). Ref EE18



Small transmitter designed to transmit audio and video signals on 2.4GHz. Unit measures 45x35x10mm. Ideal for assembly into covert CCTV systems Easy connect leads Audio and video input 12V d.c. Complete with aerial Selectable channel switch £30. Ref EE19



2.4GHz wireless receiver Fully cased audio and video 2.4GHz wireless receiver 90x140x30mm, metal case, 4 channel, 12V d.c. Adjustable time delay. 4s, 8s, 12s, 16s. £45. Ref EE20



Colour pinhole cctv camera module with audio Compact colour pinhole camera measuring just 20x20x20mm, built-in audio and easy connect leads PAL CMOS sensor 6-9V d.c. Effective Pixels 628x582 Illumination 2 lux Definition >240 Signal/noise ratio >40db Power consumption 200mW £35. Ref £35



Self-cocking pistol picr002 crossbow with metal body. Self-cocking for precise string alignment Aluminium alloy construction High tec fibre glass limbs Automatic safety catch Supplied with three bolts Track style for greater accuracy. Adjustable rearsight 50lb drawweight 150ft sec velocity Break action 17" string 30m range £21.65 Ref PLCR002 INFRARED FILM 6" square piece of flexible infra-red film that will only allow IR light through. Perfect for converting ordinary torches, lights, headlights etc to infra-red output only using standard light bulbs Easily cut to shape. 6" square £15. Ref IRF2 or a 12" sq for £29 IRF2A NEW 12V 12" SQUARE SOLAR PANEL Kevlar backed, 3watt output. Copper stps for easy solder connections £14.99. Ref 15P42 PACK OF 4 JUST £39.95. REF 15P42SP



Dummy CCTV cameras These motonsed cameras will work either on 2 AA batteries or with a standard DC adapter (not supplied) They have a built in movement detector that will activate the camera if movement is detected causing the camera to 'pan' Good deterrent. Camera measures 20cm high, supplied with rawl plugs and fixing screws. Camera also has a flashing red LED built in. £9.95. Ref CAMERAB

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We also have some used 2.3AH 12V (same as above) these are tested and in good condition and available at an extremely good price for bulk buyers, box of 30 just £49.99. Ref SLB23C



Aiptek Pocket DV Up to 2000 still pics before requiring download! The all new Pocket DV, it's amazing... such advanced technology, such a tiny size - you will be the envy of your friends!! This camera will take up to 3.5 minutes of Video and Audio, up to 2000 digital still pictures or 30 minutes of voice recording! Then just connect it to your PC via the USB cable (Supplied) and after transferring the data you can start all over again!! £69. Ref POCKETDV



The smallest PMR446 radios currently available (54x87x37mm). These tiny handheld PMR radios not only look great, but they are user friendly & packed with features including VOX, Scan & Dual Watch. Priced at £59.99 PER PAIR they are excellent value for money. Our new favourite PMR radios! Standby: - 35 hours Includes: - 2 x Radios, 2 x Belt Clips & 2 x Carry Strap £59.95 Ref ALAN1 Or supplied with 2 sets of rechargeable batteries and two mains chargers £84.99. Ref Alan2



Beltronics BEL550 Euroradarand GATSO detector Claimed Detection Range: GATSO up 400m. Radar & Laser guns up to 3 miles Detects GATSO speed cameras at least 200 metres away, plenty of time to adjust your speed £319. Ref BEL550



Fully Portable - Use anywhere Six automatic programmer for full body pain relief, shoulder pain, back/neck pain, aching joints, rheumatic pain, sports injuries EFFECTIVE DRUG FREE PAIN RELIEF TENS (Transcutaneous Electrical Nerve Stimulation) units are widely used in hospitals, clinics throughout the United Kingdom for effective drug free pain relief. This compact unit is now approved for home use. TENS works by stimulating nerves close to the skin releasing endorphins (natures anaesthetics) and helping to block the pain signals sent to the brain. Relief can begin within minutes, and a 30 minute treatment can give up 12 hours relief or more. TheTENS mini Microprocessors offer six types of automatic programme for shoulder pain, back/neck pain, aching joints, Rheumatic pain, migraines headaches, sports injuries, period pain. In fact all over body treatment. Will not interfere with existing medication. Not suitable for anyone with a heart pacemaker. Batteries supplied. £19.95 Ref TEN327 Spare pack of electrodes £5.99. Ref TEN327X

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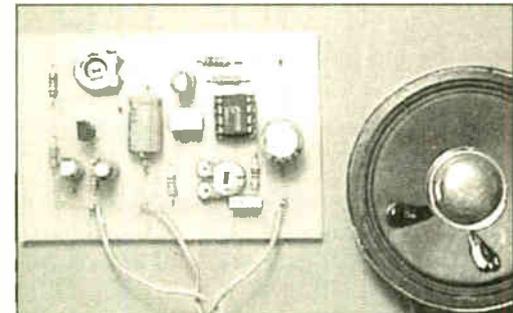
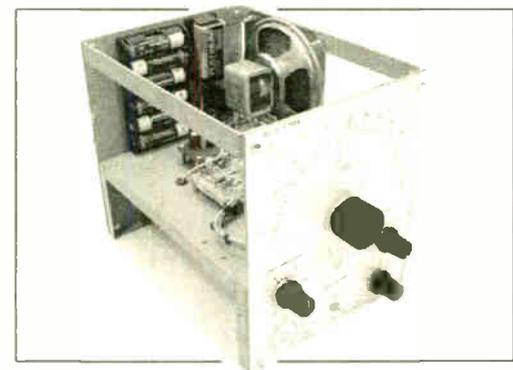
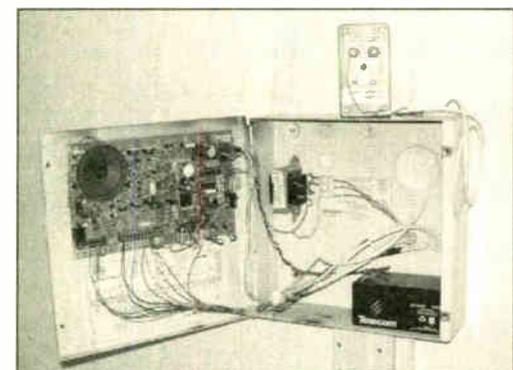
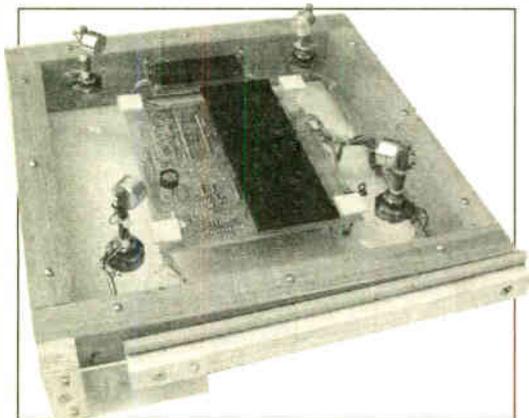
VOL. 32. No. 8 AUGUST 2003

Cover illustration by jgr22

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Our September 2003 issue will be published on Thursday, 14 August 2003. See page 515 for details

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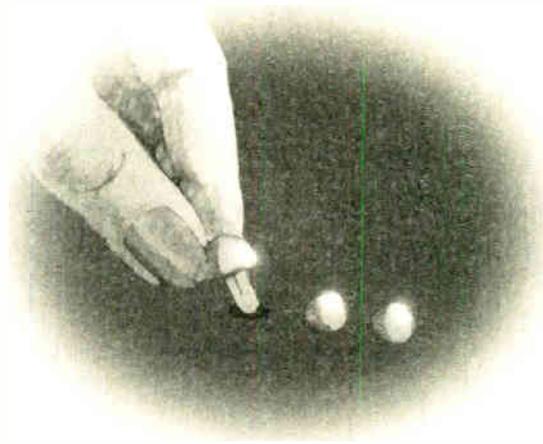
NEXT MONTH

PIC-A-COLOUR

Readers may remember some years ago there was a popular board game called Mastermind – the one with a photograph of a bearded gentleman and an oriental lady on the box. It was a two-player game and the object was for one person to secretly create a colour code using four coloured pegs, the other person then had to try and guess the colours by putting four coloured pegs into a board full of holes.

The original board game is still available and there have been various commercial electronic versions of the game over the years. PIC-A-Colour is an attempt to emulate the principle of the original game using a PIC microcontroller. In this version the player pits their wits against the PIC, which creates a secret random colour code, the player then has ten attempts to try and guess the code. After each guess the PIC gives the player clues as to how close they got to cracking the code using a seven-segment display.

PIC-A-Colour uses four I.e.d.s, each of which can give four colours, providing 256 possible combinations. The game is addictive and now only requires one player. There is plenty of scope for the constructor to modify the program to increase the difficulty, if required, and some ideas for doing this are given in the article.



TWO MORE TOP TENNERS

PRIORITY REFEREE

In so many competitive games, such as 'Snap' and various quizzes, the winner is the person who is the first to respond. Too often, this turns out to be the person who shouts the loudest! This is clearly unfair and the aim of this circuit is to decide which of two players was really the first.

VIBRATION ALARM

Protect your possessions – bike, briefcase, computer etc. – with this easy-to-build versatile alarm.

USING THE PIC'S HIGH COMMAND

On the PIC16Fx series of microcontrollers both program memory and data memory are segmented. Program memory is divided into pages and data memory into banks, and fully accessing them requires the correct use of the PCLATH and STATUS registers.

MPASM and TK3 (from version 1.4 onwards) assemblers provide a feature that greatly simplifies the task of programming PCLATH – the HIGH operator. For those statements that have been assigned a label in a program, the operator HIGH can be used in conjunction with this label to cause the assembler to return the most significant part of the address of the memory location corresponding to the label. This can then be used to automatically set PCLATH without further user intervention.

This technique is recommended wherever possible in any program that could ever conceivably grow to more than 2K program words long, and this article explains how to use it.

PLUS PIC MET OFFICE – PART 2 PRACTICAL RADIO CIRCUITS – PART 4

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PIC & ATMEL Programmers

We have a wide range of low cost PIC and ATMEL Programmers. Complete range and documentation available from our web site.

Programmer Accessories:

40-pin Wide ZIF socket (ZIF40W) £15.00
 Power supply (PSU201) £5.95
 Leads: Parallel (LEAD108) £4.95 / Serial (LEAD76) £4.95 / USB (LEADUAA) £4.95

NEW! USB 'All-Flash' PIC Programmer

USB PIC programmer for all 'Flash' devices. No external power supply making it truly portable. Supplied complete with 40-pin wide-slot ZIF socket, box and Windows Software.

Kit Order Code: 3128KT - £49.95

Assembled Order Code: AS3128 - £54.95



Enhanced "PICALL" ISP PIC Programmer

Will program virtually ALL 8 to 40 pin PICs plus certain ATMEL AVR, SCENIX SX and EEPROM 24C devices. Also supports In System

Programming (ISP) for PIC and ATMEL AVRs. Free software. Blank chip auto detect for super fast bulk programming. Requires a 40-pin wide ZIF socket (not included)

Kit Order Code: 3144KT - £54.95

Assembled Order Code: AS3144 - £59.95

ATMEL 89xxxx Programmer

Uses serial port. No special programming software required. 4 LED's display the status. ZIF sockets not included. Supply: 16VDC.

Kit Order Code: 3123KT - £29.95

Assembled Order Code: AS3123 - £34.95



NEW! USB & Serial Port PIC Programmer

USB/Serial connection makes it ideal for field use. Free 9x/NT/2000 Windows software. Call or see website for PICs supported. ZIF socket not incl.

Kit Order Code: 3149KT - £29.95

Assembled Order Code: AS3149 - £44.95

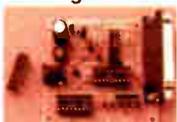
Introduction to PIC Programming

Go from a complete PIC beginner to burning your first PIC and writing your own code in no time!

Includes a 49 page step-by-step Tutorial Manual, Programming Hardware (with LED bench testing section), Win 3.11—XP Programming Software (will Program, Read, Verify & Erase), and a rewritable PIC16F84A that you can use with different code (4 detailed examples provided for you to learn from). Connects to PC parallel port.

Kit Order Code: 3081KT - £14.95

Assembled Order Code: AS3081 - £24.95



ABC Mini Microcontroller Board

Currently learning about microcontrollers? Need to do more than flash a LED or sound a buzzer?

The ABC Mini Starter Kit is based on ATMELs AVR 8535 RISC technology and will

interest both the beginner and expert alike. Beginners will find that they can write and test a simple program, using the BASIC programming language, within an hour or two of connecting it up. Experts will like the power and flexibility of the ATMEL microcontroller, as well as the ease with which the board can be "designed-in" to a project.

The ABC Mini STARTER PACK includes everything you need to get up and experimenting right away. On the hardware side, there's a pre-assembled ABC Mini Board with parallel and serial cables for connection to your PC. Windows software included on CD-ROM features an Assembler, BASIC compiler and in-system programmer. Order Code ABCMINISP - £54.95

The ABC Mini boards only can also be purchased separately at £34.95 each.



ABC Mini Start Pack

Controllers & Loggers

Here are just a few of the controller and data acquisition and control units we have. See website for full details. Suitable PSU for all units: Order Code PSU203 £9.95

Rolling Code 4-Channel UHF Remote

State-of-the-Art. High security. 4 channels. Momentary or latching relay output.

Range up to 40m. Up to 15 Tx's can be learnt by one Rx (kit includes one Tx but more available separately). 4 indicator LED 's. Rx: PCB 77x85mm, 12VDC/6mA (standby). Two & Ten Channel versions also available.

Kit Order Code: 3180KT - £41.95

Assembled Order Code: AS3180 - £49.95



Computer Temperature Data Logger

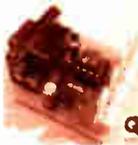
Serial port 4-channel temperature logger. °C or °F. Continuously logs up to 4 separate sensors located 200m+ from board. Wide range of free software

applications for storing/using data. PCB just 38x38mm. Powered by PC. Includes one DS1820 sensor and four header cables.

Kit Order Code: 3145KT - £22.95

Assembled Order Code: AS3145 - £29.95

Additional DS1820 Sensors - £3.95 each



Most items are available in kit form (KT suffix) or pre-assembled and ready for use (AS prefix).

NEW! DTMF Telephone Relay Switcher

Call your phone number using a DTMF phone from anywhere in the world and remotely turn on/off any of the 4 relays as desired.

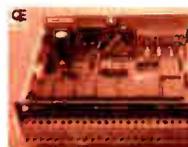
User settable Security Password, Anti-Tamper, Rings to Answer, Auto Hang-up and Lockout. Includes plastic case. 130 x 110 x 30mm. Power: 12VDC.

Kit Order Code: 3140KT - £39.95

Assembled Order Code: AS3140 - £59.95



Serial Port Isolated I/O Module



Computer controlled 8 channel relay board. 5A mains rated relay outputs and 4 opto-isolated digital inputs (for monitoring switch states, etc). Useful in a variety of control and sensing applications. Programmed via serial port (use our new Windows interface, terminal emulator or batch files). Serial cable can be up to 35m long. Once programmed, unit can operate without PC. Includes plastic case 130x100x30mm. Power: 12VDC/500mA.

Kit Order Code: 3108KT - £54.95

Assembled Order Code: AS3108 - £64.95

Infrared RC 12-Channel Relay Board



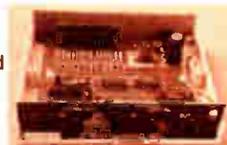
Control 12 onboard relays with included infrared remote control unit. Toggle or momentary. 15m+ range. 112 x 122mm. Supply: 12VDC/0.5A

Kit Order Code: 3142KT - £44.95

Assembled Order Code: AS3142 - £64.95

PC Data Acquisition & Control Unit

Monitor and log a mixture of analogue and digital inputs and control external devices via the analogue and digital



outputs. Monitor pressure, temperature, light intensity, weight, switch state, movement, relays, etc. with the appropriate sensors (not supplied). Data can be processed, stored and the results used to control devices such as motors, sirens, relays, servo motors (up to 11) and two stepper motors.

Features

- 11 Analogue Inputs - 0-5V, 10 bit (5mV/step)
- 16 Digital Inputs - 20V max. Protection 1K in series, 5.1V Zener
- 1 Analogue Output - 0-2.5V or 0-10V. 8 bit (20mV/step)
- 8 digital Outputs - Open collector, 500mA, 33V max
- Custom box (140x110x35mm) with printed front & rear panels.
- Windows software utilities (3.1 to XP) and programming examples.
- Supply: 12V DC (Order Code PSU203).

Kit Order Code: 3093KT - £74.95

Assembled Order Code: AS3093 - £99.95

Motor Drivers/Controllers

Here are just a few of our controller and driver modules for AC, DC, unipolar/bipolar stepper motors and servo motors.

240VAC Mains Drill Speed Controller

Reliable and simple to install project that allows you to adjust the speed of an electric drill or single phase 240V AC motor rated up to 700 Watts. Simply turn the potentiometer to adjust the motors RPM.

Working voltage: 240VAC. PCB: 48x65mm.
Kit Order Code: 1074KT - £11.95
Box Order Code: 2074BX - £7.00



DC Motor Speed Controller (5A/100V)

Control the speed of almost any common DC motor rated up to 100V/5A. Pulse width modulation output for maximum motor torque at all speeds. Supply: 5-15VDC. Box supplied. 60Wx100Lx60H.
Kit Order Code: 3067KT - £12.95
Assembled Order Code: AS3067 - £19.95



NEW! PC / Standalone Unipolar Stepper Motor Driver

Drives any 5, 6 or 8-lead unipolar stepper motor rated up to 6 Amps max. Provides speed and direction control. Operates in stand-alone or PC-controlled mode. Up to six 3179 driver boards can be connected to a single parallel port. Supply: 9V DC. PCB: 80x50mm.
Kit Order Code: 3179KT - £9.95
Assembled Order Code: AS3179 - £16.95



PC Controlled Dual Stepper Motor Driver

Independently control two unipolar stepper motors (each rated up to 3 Amps max.) using PC parallel port and software interface provided. Four digital inputs for monitoring external switches, etc. Provides three run modes and will half-step, single-step or manual-step. Complete unit neatly housed in extended D-shell case. All components, case, documentation and software are supplied (stepper motors are NOT provided). Dimensions (mm): 55Wx70Lx15H.
Kit Order Code: 3113KT - £15.95
Assembled Order Code: AS3113 - £29.95



NEW! Bi-Polar Stepper Motor Driver

Drive any bi-polar stepper motor using externally supplied 5V levels for stepping and direction control. These usually come from software running on a computer. Supply: 8-30V DC. PCB: 75x85mm.
Kit Order Code: 3158KT - £12.95
Assembled Order Code: AS3158 - £27.95



Most items are available in kit form (KT suffix) or assembled and ready for use (AS prefix).

FM Bugs & Transmitters

Our extensive range goes from discreet surveillance bugs to powerful FM broadcast transmitters. Here are a few examples. All can be received on a standard FM radio and have adjustable transmitting frequency.

MMTX' Micro-Miniature 9V FM Room Bug



Our best selling bug! Good performance. Just 25x15mm. Sold to detective agencies worldwide. Small enough to hide just about anywhere.

Operates at the 'less busy' top end of the commercial FM waveband and also up into the more private Air band. Range: 500m. Supply: PP3 battery.
Kit Order Code: 3051KT - £8.95
Assembled Order Code: AS3051 - £14.95

HPTX' High Power FM Room Bug

Our most powerful room bug. Very impressive performance. Clear and stable output signal thanks to the extra circuitry employed.

Range: 1000m @ 9V. Supply: 6-12V DC (9V PP3 battery clip supplied). 70x15mm.
Kit Order Code: 3032KT - £9.95
Assembled Order Code: AS3032 - £18.95



MMTX' Miniature Telephone Transmitter



Attach anywhere along phone line. Tune a radio into the signal and hear exactly what both parties are saying.

Transmits only when phone is used. Clear, stable signal. Powered from phone line so completely maintenance free once installed. Requires no aerial wire - uses phone line as antenna. Suitable for any phone system worldwide. Range: 300m. 20x45mm.
Kit Order Code: 3016KT - £7.95
Assembled Order Code: AS3016 - £13.95

4 Watt FM Transmitter



Small, powerful FM transmitter. Audio preamp stage and three RF stages deliver 4 watts of RF power. Can be used

with the electret microphone supplied or any line level audio source (e.g. CD or tape OUT, mixer, sound card, etc). Aerial can be an open dipole or Ground Plane. Ideal project for the novice wishing to get started in the fascinating world of FM broadcasting. 45x145mm.
Kit Order Code: 1028KT - £22.95
Assembled Order Code: AS1028 - £34.95

25 Watt FM Transmitter

Four transistor based stages with a Philips BLY89 (or equivalent) in the final stage. Delivers a mighty 25 Watts of RF power. Accepts any line level audio source (input sensitivity is adjustable). Antenna can be an open dipole, ground plane, 5/8, J, or YAGI configuration. Supply 12-14V DC, 5A. Supplied fully assembled and aligned - just connect the aerial, power and audio input. 70x220mm.
Order Code: 1031M - £124.95



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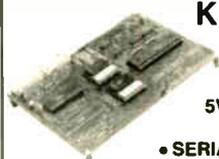
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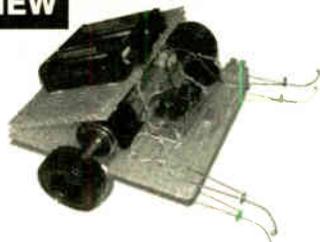
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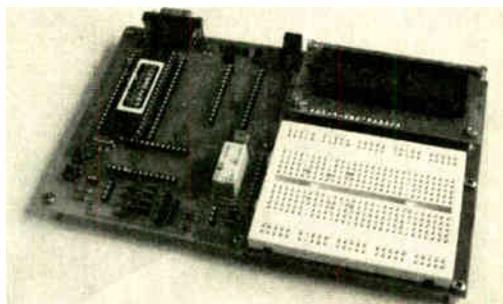
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VOL. 32 No. 8 AUGUST 2003

WEB FEAT

We've been telling you about it for nearly five years now, but it has still to register with some readers. It's the quickest, cheapest method of obtaining *EPE*. At the time of its introduction it was groundbreaking and five years on most other magazines have not yet caught up with us.

Perhaps the regular splash on our front cover, or the numerous mentions in the magazine are not clear enough. Maybe some readers don't understand what we mean. Sure, we can understand why many readers don't want it, but for those that do it's invaluable.

Let me say it again – you can purchase *EPE* from the *EPE Online* Website using a credit card on a secure server and download the latest issue "instantly" to your computer, you can then read it on-screen or print it out to read at your leisure. The cost of this wonderful service that makes *EPE* "instantly" available to readers all around the globe is just \$10.99US for twelve issues – that's about £7, or roughly 92 cents or 60 pence per issue – bargain. Yes, it really is that cheap and that available anywhere in the known universe, provided the Klingons have Web access and a credit card!

Seriously though, it amazes me to find some readers are still not aware. I received an email from a South African reader recently, it basically said "With the low value of the Rand and high print and shipping costs why don't you do a Web edition of *EPE*?" What a great idea, fortunately Clive (Max) Maxfield and Alvin Brown had the same idea and, as our *EPE Online* Editors, they put it into action in November 1998, try it, it is quite a feat. It certainly was when they did it for us. We believe we were the first printed magazine in the world to have a paid for, instantly downloadable version available from the Web. But, of course, we don't like to shout about it!! *Whisper* – it's at www.epemag.com.

STUNNING

Not to be too unkind to some companies there are some pretty awful Websites out there – plus those that never seem to be updated or always seem to fall over. Our own *EPE* Website – the UK one (not the *EPE Online* one) at www.epemag.wimborne.co.uk has grown in rather a topsy-turvy way since its inception in August 1996; yes, it is seven years old now and anyone who has read *The History of EPE* – available on the Website (the one at www.epemag.wimborne.co.uk) – will know that at *EPE* things seem to happen on a seven year cycle.

Because we have continually added to the site over the years, it had become a collection of pages rather than the designed site it started out as when Alan Winstanley first produced it for us all those years ago. It has, of course, served us well but now it has undergone a stunning makeover with various new enhancements, thanks to Alan's hard work. We hope you like it, the basic design comes from Max and Alvin and is in a similar style to the *EPE Online* site (see above if you are not aware of *EPE Online!*), the content, and all the various information pages, search engine, projects listing (going back five years), on-line shop, downloads page, Net Work links, Chat Zone etc., etc., are all down to Alan. Why not take a look? In case you missed them, both the Web addresses are on the front cover, and on this page – in the top right-hand corner, just under our postal address! Alan's *Net Work* column on page 550 will give you a better idea of what it is all about.

With apologies to all those readers who were already well aware of the above.



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Email: enquiries@epemag.wimborne.co.uk

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All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it. A number of projects and circuits published in *EPE* employ voltages that can be lethal. **You should not build, test, modify or renovate any item of mains powered equipment unless you fully understand the safety aspects involved and you use an RCD adaptor.**

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ALARM SYSTEM FAULT FINDER



MIKE RICHARDS

A low-cost fault finder that will find a faulty sensor without the alarm system sounding-off incessantly.

WHEN false alarms occur on domestic and on cheaper/older commercial intruder alarm systems it is often difficult to know which sensor has caused the alarm, and even if this is known, many panels do not have a soak test and log facility to test the would-be faulty sensor.

FINDING FAULT

The usual method of fault finding in this situation, after wiring checks, is either:

- 1) If more than one infra-red, or other sensor is on a single zone it is difficult to know which one is causing the false alarms. The usual method is to sequentially short the intruder contacts out in each sensor, one at a time, and carry on using the system and see when the fault disappears.
- 2) If a single sensor on a zone is causing false alarms, then the normal method is to short that sensor out in the sensor or at the alarm panel, then carry on using the system and see if the fault has disappeared, or just change the sensor for a new one.

Both methods are not very satisfactory for the following reasons:

(a) The false alarm, complete with bells, sirens, and internal sounders, will keep occurring until the faulty sensor is found and shorted out. This could take many attempts if there are a number of sensors on the faulty zone.

Constant repetitive false alarms, especially at night, are not good for your nerves or for your neighbours' tempers. Eventually any alarm will be ignored, as it will be put down to just another false alarm.

(b) If the sensor is just changed for a new one this could well cure the problem, but it may not, as the false alarms may be caused by vermin within the zone (infra-red etc.) or r.f. interference or mains transients occurring and being picked up by the sensor wiring and introduced into the sensor's electronics.

This simple, easy-to-build, low-cost fault finder project will let you find the faulty sensor without causing the complete alarm system to keep going off.

It can be seen that a logic 0 is also applied to IC1c pin 9, which results in a logic 1 output on pin 10, this being fed back to IC1a input pin 6. The flip-flop is now in the SET condition, and will remain so until it receives a logic 1 at the input of the buffer IC1a (pins 12 and 13).

The normally closed (n.c.) contacts of the alarm sensor "under test" are now connected to the test terminals SK1 and SK2, and Reset button S1 is pressed. From the

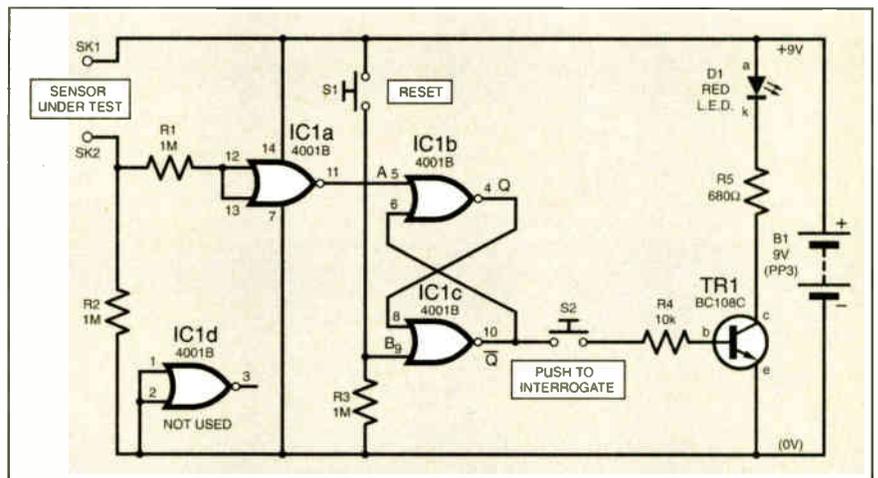


Fig. 1. Complete circuit diagram for the Alarm System Fault Finder.

CIRCUIT DESCRIPTION

The full circuit diagram for the Alarm System Fault Finder is shown in Fig. 1. The circuit is constructed around a CMOS 4001B quad NOR gate.

The first gate, IC1a, is used as an inverting buffer for the input signal from the detector/sensor on test. The second and third gates (IC1b and IC1c) are connected up to form an SR flip-flop. The fourth gate, IC1d, is not used.

It can be seen from Fig. 1 that the inputs to IC1a (pins 12 and 13) on power up are at logic 0 (0V). Thus, the output from IC1a pin 11 is at logic 1 (Vcc or +V).

The output from IC1a pin 11 is applied to pin 5 (Set) of the first gate (IC1b) in the SR flip-flop configuration. From Table 1 it can be seen that any logic 1 applied to a gate input results in a logic 0 output. This logic 0 output from IC1b pin 4 is applied to pin 8 of IC1c, the second "half" of the flip-flop.

Table 1: Truth Table

Inputs		Outputs	
A	B	Q	Q̄
0	0	1	1
0	1	0	0
1	0	0	0
1	1	0	0

truth table and circuit diagram it can now be seen that the input to IC1b is at logic 0, and the output of the second gate, IC1c pin 10, is at logic 0. Therefore, if the Interrogate button S2 was pressed transistor TR1 would be reversed biased and so turned off, thus the l.e.d. D1 would not illuminate.

If the sensor's contacts were to open momentarily then the output of IC1c would be latched at a logic 1, even if the sensor's contacts had closed again. Hence, if the Interrogate button is now pressed, transistor TR1 would be forward biased

and l.e.d. D1 would illuminate with current limiting imposed by resistor R5.

Because the quiescent current drain of the circuit is so small no power supply On/Off switch has been incorporated.

CONSTRUCTION

The Alarm System Fault Finder circuit is built on a small single-sided printed circuit board (p.c.b.) and the component layout, together with a full-size copper foil master and interwiring details, are shown in Fig.2. This board is available from the *EPE PCB Service*, code 404.

Commence construction by soldering in position the 14-pin d.i.l. socket for IC1 followed by the five resistors and transistor TR1. Do not insert IC1 into its socket at this stage.

After this the small flexible lead-off wires can be soldered into place. These are

to provide the connections to the battery, pushswitches, l.e.d. and test connectors SK1 and SK2.

ASSEMBLY AND WIRING-UP

The next job is to mount the pushswitches, l.e.d. and test connectors on the box lid. After this a battery compartment can be made from an old piece of strip-board or p.c.b. and slotted or glued into place in the box, as shown in the photographs.

The various board lead-off wires can now be soldered onto the front panel components, insulating solder joints with plastic sleeves where necessary (see Fig.2). After visually checking the completed tester for any wiring and connection errors, IC1 can now be plugged into its d.i.l. holder. Take the usual anti-static precautions when handling the i.c.

The completed Fault Finder is now ready for testing.

TESTING

Commence testing by connecting up the 9V battery and then press the Interrogate button (S2). This should cause the "memory" l.e.d. D1 to illuminate.

If all is well, apply a temporary shorting link between the test terminals SK1 and SK2 and press the Reset button (S1). Pressing the Interrogate button should not now cause the l.e.d. to illuminate.

Briefly break the short circuit between the test sockets/terminals. Now pressing the Interrogate button should cause the l.e.d. to illuminate.

If the tester does not operate correctly, immediately disconnect the battery and check all wiring and connections for errors. All p.c.b.-mounted components should also be checked for correct orientation.

If no faults have been found reconnect the battery and check the circuit through, preferably using a logic probe, but failing that use a digital multimeter with a high input impedance (10 megohms or above).

COMPONENTS

Resistors

R1, R2
R3 1M (3 off)
R4 10k
R5 680Ω
All 0.25W 5% carbon film

See
**SHOP
TALK**
page

Semiconductors

D1 5mm red l.e.d.
TR1 BC108C npn transistor
IC1 4001B CMOS quad 2-input NOR gate

Miscellaneous

S1, S2 pushbutton switch, push-to-make (2 off)
SK1, SK2 4mm screw terminals (2 off)

Printed circuit board available from the *EPE PCB Service*, code 404; plastic case, type and size to choice; 14-pin d.i.l. socket; l.e.d. clip; 9V battery (PP3 type) and snap connector; multistrand connecting wire; sleeving; solder etc.

Approx. Cost
Guidance Only

£8
excl. case & batts.

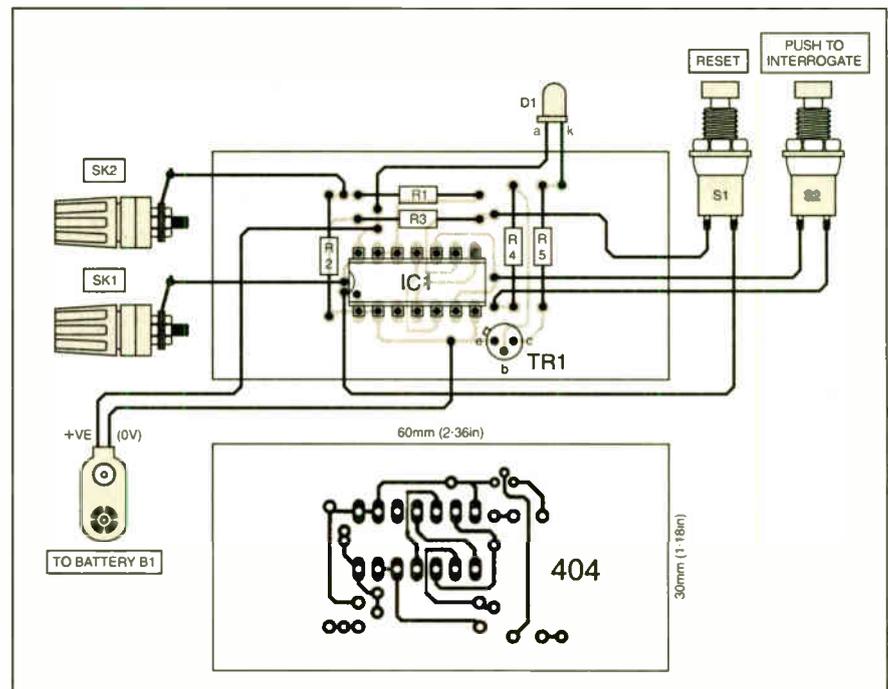
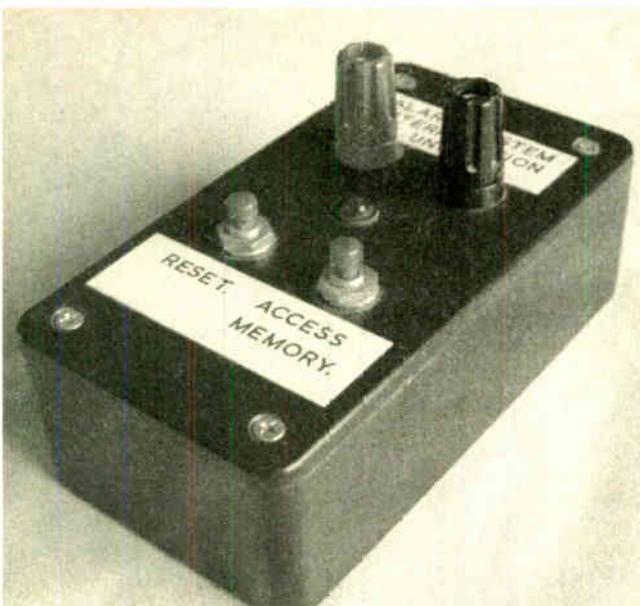
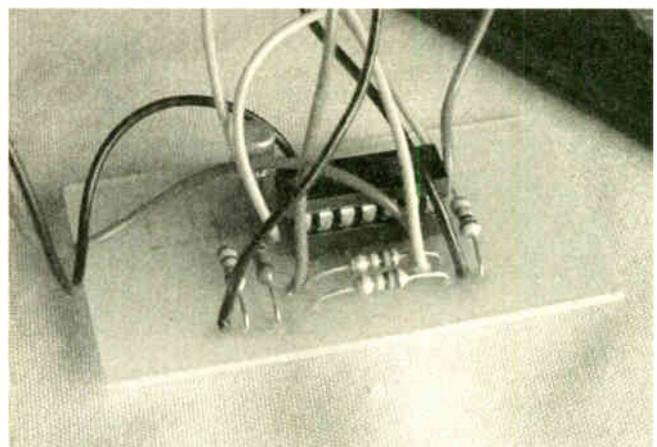


Fig.2. Printed circuit board component layout, off-board interwiring details and full-size copper foil master for the Alarm System Fault Finder. The extra board width is to allow the p.c.b. to slot into the author's plastic box internal "guide rails".

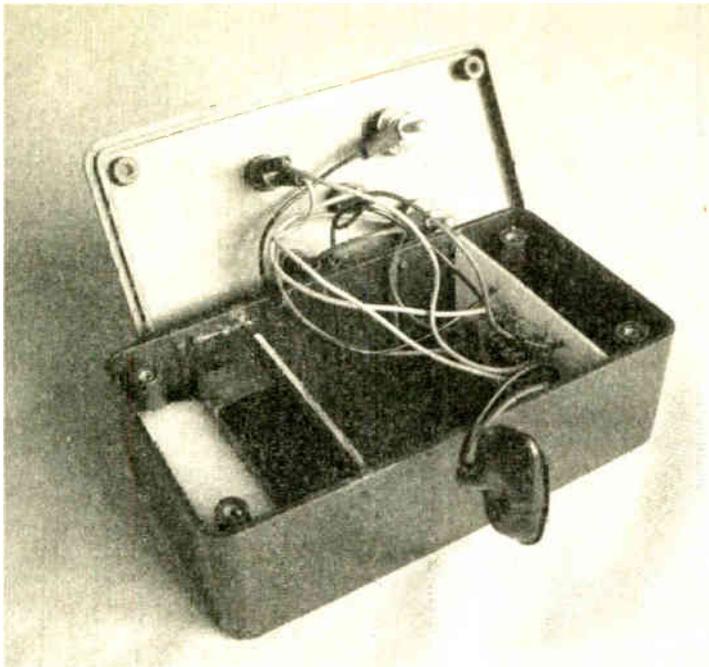


(Left) The finished prototype unit showing general component positioning and lettering on the case lid. Note the "access memory" legend has been amended to "Push To Interrogate" in the final version.



(Above) Completed circuit board removed from its case.

(Left) The finished prototype unit showing general component positioning and lettering on the case lid. Note the "access memory" legend has been amended to "Push To Interrogate" in the final version.



Prototype model showing the p.c.b. and battery compartment divider slotted into the case. The space between boards is to accommodate the lid-mounted components.

USING THE TESTER

Even the most basic alarm panels will usually tell you which Zone has caused the false alarm. Once this is known, how you proceed depends upon how many sensors are connected to the faulty zone.

If one sensor only is fitted, it is necessary to extend the alarm contact wiring temporarily out to the Alarm System Fault Finder input terminals. If the sensor is an infra-red, dual-tech, or ultrasonic device then the tester will have to be located outside the "field of vision" of the detecting device.

After the temporary connections have been made it is also necessary to omit the faulty zone or to short out the zone circuit on the alarm system panel. Then when setting the alarm system also set the alarm system tester unit. This is set by first press-

ing S1 Reset button and then by pressing S2 Interrogate button. The "memory" i.e.d. D1 should stay extinguished, validating the alarm closed circuit through the would-be faulty sensor.

When returning home or getting up in the morning the intruder alarm system should be turned off first. The alarm "fault finder" unit can now be interrogated by pressing switch S2. If the i.e.d. illuminates this indicates a false alarm occurred during the alarm panel set period, and a false alarm would have normally occurred. If no false alarm occurred it is recommended that the test procedure is used for up to a week to validate the tests.

MULTI-SENSORS

If more than one sensor is fitted across the faulty zone then the zone will have to be broken down in a logical order to identify the faulty sensor. On modern systems it is usual to have one sensor per zone but on cheaper or older systems it is possible that each zone could have two, three, or even four sensors fitted to it.

Depending upon how many sensors are fitted to the faulty zone, two approaches can be taken. The first is to split the sensors into two groups and see which group is faulty, then split

POSSIBLE FAULT CONDITIONS

DOOR CONTACT

- Magnet/reed switch out of alignment, and working "just on the edge".
- Old reedswitch whose resistance has increased dramatically.
- Cracked glass reed capsule.

INFRA-RED

- Sunlight falling directly onto the sensor.
- Heat sources within a zone.
- Strong air drafts onto the sensor.
- Animals in a zone.

DUAL-TECH

- Animals in a zone.
- Microwave range not correctly adjusted.

ULTRASONICS

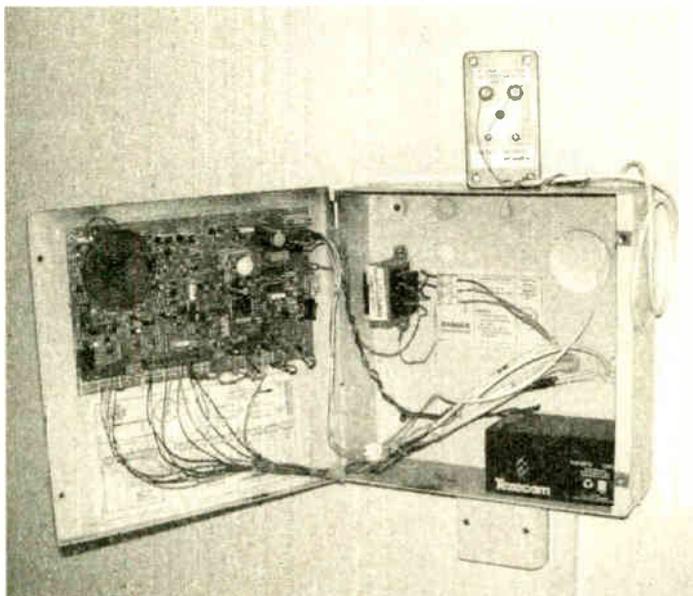
- Animals in a zone.
- Draughts within a zone.
- Heat sources within zone.
- Two sensors "seeing" each other, and are not of the digital crystal controlled type.

these down again and again until the faulty sensor is located.

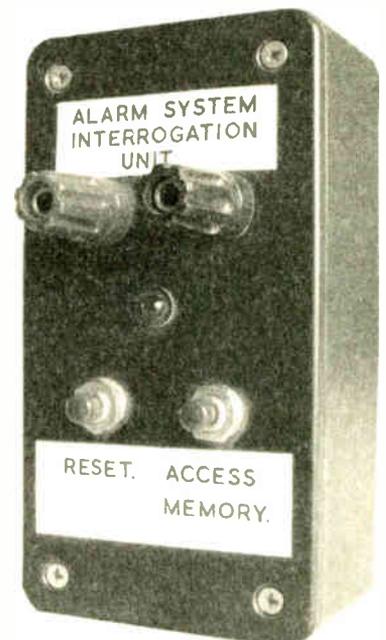
The other method is to test each sensor, one at a time, perhaps using old knowledge or instinct as to where the fault lays. It can be seen that it will take time to locate the fault and the system's security coverage will be reduced during this time, but at least no false alarms will occur and you can sleep soundly at night, as can your neighbours.

Once the faulty sensor is located it can be replaced or relocated depending upon the fault. If the sensor is not faulty then the fault must be found, this could be due to any one of a number of causes, depending upon the type of sensor fitted.

A general guide to other possible "faults" can be found in the accompanying Possible Fault Conditions panel. Let's hope that "silence is golden" is the password for you and your neighbours! □



The Fault Finder connected to the author's Alarm System panel to monitor a suspect zone sensor.



MOBILE VIDEO BATTLES

Will RadioScape's revolutionary, low cost video broadcasting technique challenge the high investment 3G system? Barry Fox reports.

TWO recent demonstrations draw the lines for an imminent battle to create a market and set *de facto* standards for mobile video. DAB and 3G are the opposing contenders.

In the first live demonstration of its kind, British company RadioScape recently joined forces with NTL to show how a DAB digital radio and pocket PC can work like a 3G cellphone to receive video on the move.

"And we have not had to pay billions for a 3G licence", said Radioscape CEO, John Hall.

Video Via Radio

RadioScape had taken over the exhibition area at the top of Tower Bridge in London to show off its new RS 200 DAB/FM/RDS receiver module to the broadcast industry. But shortly before the event RadioScape's engineers succeeded in using the module to squeeze good quality video and sound into a DAB radio channel normally used for mid-fi mono sound.

The Radio Authority waived its usual requirement for ten days advance warning and granted a temporary licence for NTL and RadioScape to broadcast live video by DAB across the bridge.

Flushed with success Radioscape and NTL then joined forces with Microsoft, Texas Instruments and Tandberg to demonstrate the system with news footage from CNN at the National Association of Broadcasters Convention in Las Vegas.

Using Windows Media 9 software, RadioScape converts the pictures and sound into MPEG-4 video, running at just 64Kbps – the rate normally used by radio news stations for mono sound only.

The video is then bundled into Internet Protocol packages and slotted between conventional speech and music radio channels. A DAB module decodes the data for Windows Media Player to play. With a resolution of 176 × 144 pixels, and seven pictures a second, quality on a small screen is surprisingly good. Higher rates give larger, clearer pictures. The inventors claim it even works on a train at 300km/hour.

This is possible because the Digital Audio Broadcast system, developed in Europe as Eureka research project 147, was designed from Day One for mobile use. As a result DAB has already been

adopted by 550 radio stations in 30 countries round the world, including Britain, Australia, Canada, India, China, Israel and Taiwan.

The broadcast signal is spread over many narrow frequency channels, so that each channel is carrying only a slow stream of bits. This helps the receiver filter out unwanted interference and reflections. The broadcast bits can convey either low quality mono speech, high quality stereo music, multimedia data, or a flexible mix of all three.

The new mobile video units have a screen and two chip sets, one working like a conventional cellphone and the other working as a DAB radio. Video is "ordered" by a data or text message, at 9.6Kbps, and then received as a DAB signal.

New Video Broadcast Services

RadioScape envisages new services, probably beginning in the Asia Pacific region, where promotional videos arrive free to view, while premium programming, such as winning goals, horse race finishes and breaking news bulletins are scrambled for viewing in return for subscription or fee payment. The video is either continually streamed, like a live news channel, or short clips are repeatedly broadcast for downloading into the handset. A consortium in Taiwan is now trialling a service. browse www.pc-radio.com.tw/eng/eng_ver.htm.

In the UK there are seven DAB multiplexes, although usually only three are available in any one area. Each multiplex carries 1.2Mbps, of which UK regulations allow 20% to be used for data. In two or three years time, when new frequencies in the L band are freed for DAB, broadcast capacity will double.

This competes head-on with 3G, the third generation mobile phone service. So far the Three networks in Britain and Italy offer the only commercial 3G service outside Japan. Three is 65% owned by Hutchison of Hong Kong, 20% by Japan's Do-co-mo and 15% by Dutch Telecoms company KPN.

Downloading To Handsets

For £60 (or more) a month the owner of a £400 handset (made by NEC and Motorola) can download MPEG-4 sports,

news and comedy clips including Monty Python's Parrot sketch. Each clip lasts about four or five minutes and is downloaded into 32MB of memory in the phone.

The handset has to work either on old 2G or new spread spectrum 3G because the 3G networks are not finished. The leader, Three, can still only claim coverage of 50% of the UK population. When Three handsets move out of range of a 3G base station they will use the Cellnet 02 network for GSM/GPRS reception.

Three says its 3G data speeds range from 120Kbps at the edge of a cell up to 360Kbps, with a theoretical maximum of 384Kbps. Data speed slows with congestion because the wide band fills with signal, which then starts to behave like noise.

Live picture phone video streams at 64Kbps, four to five fps (frames per second). Replay of downloaded video is 7.5fps on the NEC handsets and 15fps on the Motorola. Streaming live video clips will come later. "This is week one of a twenty year project", says 3G's Matt Peacock. Three expects early sales to be conventional early adopters; one thing they will quickly have to get used to is limited battery life, around one hour for video calling and three or four hours for Internet browsing.

Huge Investment

The UK's five rival operators will share 3G sites and towers, but not base stations. So capital investment is huge.

Says Nigel Oakley of RadioScape: "With DAB delivery, startup costs are exceedingly low. There is no licence to buy and no infrastructure to build".

Says Phil Kendall, wireless specialist with industry analysts Strategy Analytics: "There's no escaping the beauty of the idea. As an alternative to blowing around £8 billion on a 3G licence and network, and then being one of five, the logic is compelling. The struggle is not technical, it's to compete with marketing clout of the majors, like Vodafone".

Vodafone paid the UK government a record price of £5.964 billion, just for a licence to run a 3G service. Vodafone's network will be ready by the end of this year. The company's spokeswoman on 3G admitted she was unaware of the DAB system, but assures: "We are committed to 3G. It's in full flow. There's no stopping it now".

TRILOBITE ROBOTIC VACUUM



ELECTROLUX have announced the introduction of the Trilobite, a vacuum cleaner that takes care of the cleaning all by itself. The Trilobite is the first automatic vacuum cleaner in the world. It should be on sale in Sweden by the time you read this and will be exported to other European countries early next year.

The Trilobite has been under development for several years in Sweden. "This has been quite an exiting journey," says Hans Straberg, CEO of the Electrolux Group. "We presented a prototype in 1997 to see if the market was interested. The response was overwhelming."

The vacuum cleaner is 13cm high and has a diameter of 35cm, which means that it can even clean under beds and tables. It "sees" with the aid of ultrasound – just like a bat. The system allows it to quickly detect a dog's water bowl, legs of chairs, walls and other obstacles. Once any of these are detected the Trilobite calculates a new path. Near stairways and other places where there are no natural obstacles, you place special magnetic strips to prevent the Trilobite from passing through.

Electrolux say that the Trilobite can easily be left alone to take care of cleaning carpets while its owners are out enjoying themselves. The expected cost of the Trilobite is around £999.

For more information browse:

<http://trilobite.electrolux.se> and <http://news.bbc.co.uk/1/hi/technology>.

CHIP REPAIR

IN this age of throw-away obsolescence, it comes as a surprise to learn that a Scottish microelectronics company is offering repair facilities for integrated circuits.

The Microelectronics Imaging and Analysis Centre (MIAC) has been given funding of more than £200,000 by Scottish Enterprise Edinburgh and Lothian to upgrade its facilities. Part of that upgrading programme will include the introduction of a new technique that will allow the repair of copper based i.c.s which are now increasingly replacing those that use aluminium.

The new technology will mean the Edinburgh based centre will be the only commercially operated facility in Europe capable of carrying out the repairs on copper interconnected devices.

SDRAM ACHIEVES 4-GIGABYTE

SAMSUNG say they have taken memory capacity to the next level by creating the industry's first 4-gigabyte Double Data Rate (DDR) Dual In-line Memory Module (DIMM).

For more information browse www.samsung.com.

WEBBED PRINCIPLES

EPT Software tell us that in order to enable more students and hobbyists to enjoy their Electronics, Mechanics and Computing Principles 8.1 software, they have changed their marketing strategy to one of only supplying via their web site as downloadable installations at substantially reduced prices.

With more than a thousand interactive topics, version V8.1 is a huge interactive resource of technical information, including topics ranging from reading resistor colour codes to PIC programming, mathematics and computer science subjects. EPT say that in fact there are few electronics topics not covered and that many engineers install the software on their laptops in preference to carrying heavy textbooks for reference material.

Clive Humphris of EPT says, "This change of strategy has opened up lots of new opportunities for us and it brings many advantages to our customers, the most significant is being able to make future upgrades available free of charge by simply downloading the latest version."

EPT Software is an authorised Curriculum Online software content provider and retailer.

For more information browse www.eptsoft.com.

PIC Training

MATRIX Multimedia, whose PIC-related products include such renowned CD ROMs as *Assembly for PICmicro* (formerly *PICtutor*), *C for PICmicro* and *Flowlog*, have announced three one-day courses for those who want to learn or teach PIC microcontroller programming.

Each month Matrix is running one-day courses in assembly code programming, C programming and flow chart programming at the company's new training facility in Halifax, West Yorkshire. The aim of each course is to introduce the basics of PIC programming and to give delegates the confidence and all the resources they need to carry on learning at home.

Matrix say that the course is particularly suitable for teachers who have an interest in introducing PIC programming to their school or college.

A full specification of the training days can be browsed at:

www.matrixmultimedia.co.uk.

Science Experiments

PICO Technology ask if you are interested in conducting science experiments? If you are, their new DD103 Oxygen-in-Air sensor will probably appeal to you. It is for use with Pico's popular low cost Dr Daq data logger. The galvanic cell sensor just plugs into one of Dr Daq's external sockets and can measure a full 0% to 100% oxygen level range.

Dr Daq itself simply connects to your laptop/desktop PC, taking power from the PC, so no batteries are required. It runs with the supplied PicoLog data acquisition software and converts the PC into a powerful, yet easy to use, scientific instrument.

This new oxygen sensor broadens the range of biology, physics and chemistry experiments (such as oxygen produced by plants during photosynthesis) that can be conducted in primary and secondary schools. It retails for £99 plus VAT. The Dr Daq data logger and software retails for £59 plus VAT.

For more information contact Pico Technology Ltd., Dept EPE, The Mill House, Cambridge Street, St Neots, Cambs PE19 1QB. Tel: 01480 396395. Fax: 01480 396296. Email: peter@picotech.com. Web: www.drdaq.com.

Distance Learning

OakCAD Training has taken over the whole operation of the National College of Technology Distance Learning Programme, a college which has for many years supported electronic enthusiasts, with courses such as Electronic Circuits, Digital Circuits, and Testing and Fault Diagnosis, all of which offer to the successful student a half or full unit for a BTEC Certificate.

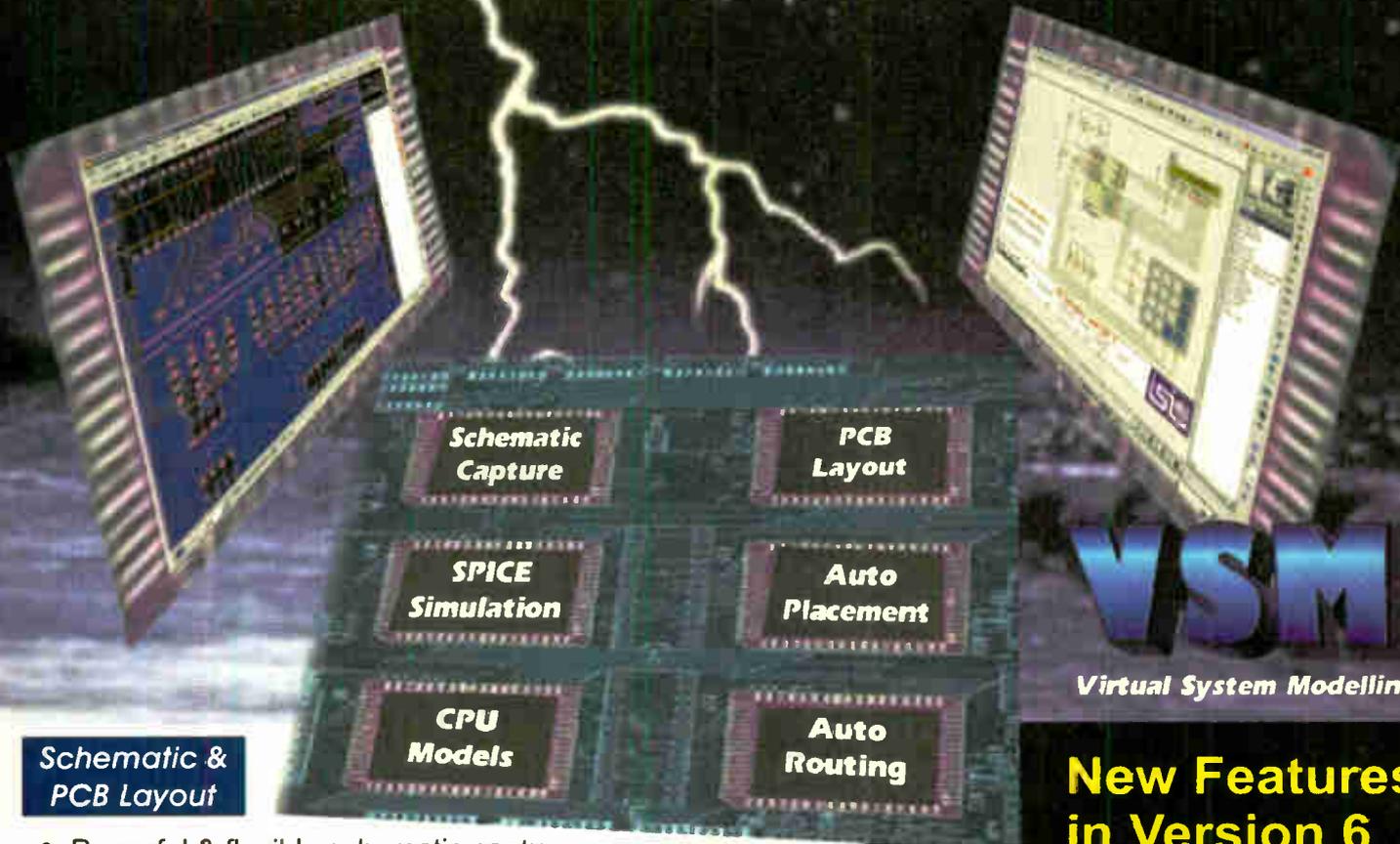
OakCAD Training has over 10 years of engineering and CAD training experience and offers a range of customised engineering courses. Some of these courses are currently being developed in a distance learning format for delivery on CD.

This development will enhance the service offered to anyone interested in learning more about electronics and engineering.

These and other courses can now be booked through OakCAD on their web site: www.oakcad.co.uk/nct.aspx, or telephone 08456 345 445.

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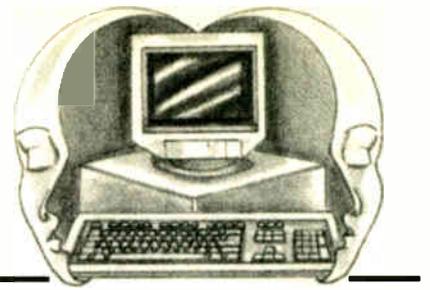
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INTERFACE

Robert Penfold



OPTICAL SENSING HEART-RATE INTERFACE FOR YOUR PC

USING the serial port handshake inputs as general-purpose inputs and for counting pulses at low frequencies has been covered in recent *Interface* articles. In this month's *Interface* article a practical counting application will be described.

The obvious pulse counting application is just that – counting the number of heartbeats per minute. This requires some form of interface to provide the electrical pulses for the computer to count, and there are two common methods of producing the necessary signals. One is to use electrodes on the subject's body to detect the electrical signals generated as each heartbeat occurs, and the other is an optical system.

In many ways the direct electrical method is the more interesting approach, but it does have one or two drawbacks. One of these is that it requires a very large amount of amplification to bring the weak electrical signals in the human body up to a level that will drive the inputs of a PC at suitable levels.

This tends to give problems with pick-up of the electrical noise generated by the PC and the monitor, and with mains "hum" and other electrical noise in the environment. Another problem is that the interface must be electrically isolated from the PC in order to conform to safety regulations.

Shining Through

The second method is simpler and avoids the two main drawbacks of the direct electrical approach. The basic scheme of things is to shine a continuous light through the subject's finger and onto a photocell. Although there is no obvious reason for this generating a signal in sympathy with the subject's heart-beat, it does actually do so.

In order to generate a signal the photocell must be connected in a potential divider circuit across the supply lines of the interface. The variations in blood flow produce small changes in the amount of light passing through the subject's finger. It is possible to use other parts of the body such as an earlobe, but monitoring via the end of a finger is generally the easiest method.

The signal generated by this method is quite small and a large amount of amplification is required in order to drive the serial inputs of a PC. Mains "hum" and other electrical noise is not a major problem with this method because the user is electrically isolated from the interface.

With the direct electrode method the subject effectively acts as an aerial, picking up any electrical noise in the vicinity. This makes it difficult to obtain a "clean" signal, and balancing techniques have to be used to cancel out the electrical noise in the environment. This is unnecessary

with the optical method, which also avoids problems with electrical isolation, since the isolation is an innate part of the system.

Heart-Rate Circuit

For the sake of simplicity the optical method has been adopted for the Opto-Sensing Heart-Rate PC Interface, and the full circuit diagram appears in Fig.1. It is based on the *Heart Rate Monitor* published in the *Ingenuity Unlimited* feature of *EPE* May 2003 circuit, by Tony Lee. R2 is the photocell and R1 is its load resistor.

A cadmium sulphide photocell is a good choice for this application where good sensitivity is an advantage and only very low frequency signals are involved.

An ORP12 light-dependent resistor (l.d.r.) was used for R2, but virtually any cadmium sulphide photo-resistor should work in this circuit. With some alternatives it might be necessary to alter the value of R1 in order to obtain good results.

High-Gain

The output of the photocell circuit is coupled by capacitor C2 to the input of a two-stage high-gain amplifier based on IC1 and IC2. IC1 operates as a non-inverting amplifier having a voltage gain of approximately 30 times. Capacitor C3 rolls-off the high frequency response of

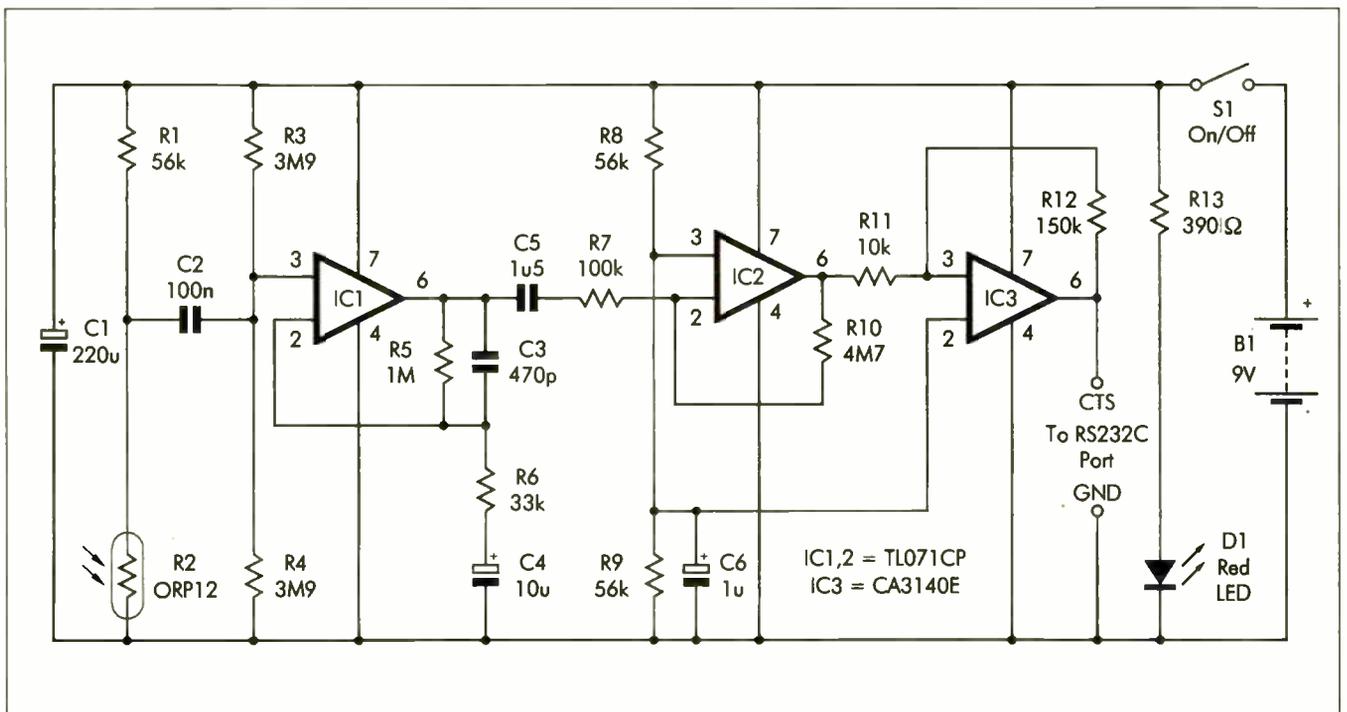


Fig. 1. Complete circuit diagram for the Opto-Sensing Heart-Rate Interface. R2 can be practically any photo-resistor, such as the popular ORP12 light-dependent resistor (l.d.r.). Note that the light source (D1) must be an ultrabright or superbright light-emitting diode (l.e.d.).

the circuit, which helps to avoid problems with instability.

Capacitor C5 couples the output of IC1 to the input of a simple inverting amplifier based on IC2. Feedback resistors R7 and R10 set the voltage gain of this stage at about 47 times, giving an overall voltage gain of approximately 1400. This should be sufficient, but if necessary the gain can be boosted by increasing the value of resistors R5 and (or) R10.

It is important that the signal fed to the computer is reasonably "clean", since any glitches will substantially boost the pulse count and give poor accuracy. The output signal also has to be at voltages that will drive an RS232C input reliably. The output of IC3 is therefore fed to a simple trigger circuit that has a moderate amount of hysteresis provided by resistor R12.

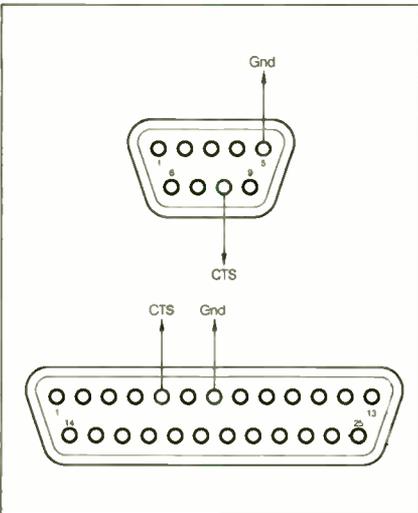


Fig.2. Connection details for 9-pin and 25-pin serial ports.

Although the output signal is not at full RS232C signal voltages, the circuit should drive any normal RS232C port reliably, provided a connecting cable of no longer than two or three metres is used. The output of IC3 could be fed to a proper RS232C line driver if preferred, but there will normally be no advantage in doing so.

Seeing the Light

In order to work properly it is essential for this opto-sensing method of detection to have a reasonably strong light source above the subject's finger, with the photocell on the opposite side of the finger. Also, light from mains powered lighting must be kept away from the photocell as it will tend to produce ripple on the output of IC2 which could produce multiple pulses as the output of the trigger stage changes state.

In days of yore a small light bulb was used as the light source in this type of equipment, but these days an l.e.d. is a better choice. An l.e.d. provides a similar light level but at much lower current consumption. D1 is the l.e.d. used as the light source and resistor R13 is the current limiter resistor. The current fed to D1 is just less than 20mA, which should be enough to provide sufficient light from any ultra-bright or super-bright l.e.d. A "bog standard" l.e.d. is unlikely to give sufficient light output in this application.

Resting Comfortably

It is important that things are arranged in such a way that the user can rest his or her hand comfortably. Any movement of the user's finger is likely to generate spurious signals. For the same reason it is important that the photocell and l.e.d. are fixed firmly in place. Any wobble in either is likely to cause spurious signals.

In all other respects construction of the interface is perfectly straightforward, but bear in mind that the CA3140E used for IC3 requires the usual anti-static handling precautions. Only two connections are made to the RS232C port, and connection details for nine and 25-pin ports are shown in Fig.2. The current consumption of the interface is about 25mA, so it is best to use a fairly high capacity battery such as six AA size cells in a holder.

Software

Regarding the Visual Basic software, the form must be equipped with a label having a suitably large font size to act as the digital readout. Another label component having an appropriate caption such as "Heartbeats Per Minute" is placed above the readout label. The form must also be equipped with MSCOMM and a timer having its Interval value set at 15000 milliseconds (15 seconds).

The following is the code for the heart rate program:

Dim Counter As Variant

```
Private Sub Form_Load()
  MSComm1.PortOpen = True
  Label1.Caption = 0
End Sub
```

```
Private Sub MSComm1_OnComm()
  If (MSComm1.CommEvent = comEvCTS) Then
    Counter = Counter + 1
  End If
End Sub
```

```
Private Sub Timer1_Timer()
  Label1.Caption = Counter * 2
  Counter = 0
End Sub
```

The first line declares a global variable called Counter, which is used to store the pulse count. The subroutine for the form simply switches on the serial port and sets the readout at an initial value of zero.

A simple If...End If routine waits for transitions on the CTS handshake line and increments Counter by one each time a transition is detected. Every 15 seconds the subroutine for the timer sets the caption of the readout label at double the current value in Counter, and then resets Counter to zero so that a fresh count can commence.

Since the count only lasts 15 seconds rather than a minute, the value displayed must be four times the number of input pulses that are counted. However, the count is augmented each time there is a transition (rather than a pulse) on the CTS line. The count therefore increases by two for every complete input pulse, and the value in counter only has to be doubled in order to give a reading in beats per minute. The resolution of the system is therefore two beats per minute.

It can be increased to one beat per minute by using an Interval value of 30000 for the timer and writing the value

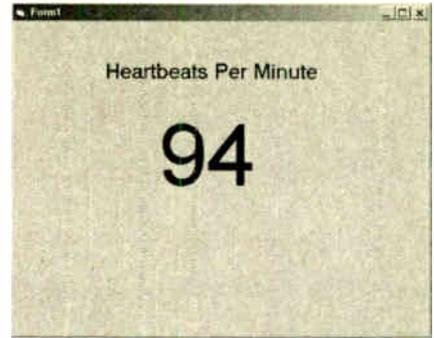


Fig.3. Screen shot showing the heart-rate monitor in operation.

in Counter straight to the readout label. Of course, this has the drawback of updating the readout only twice instead of four times per minute.

In Use

The program in operation is shown in the screen shot of Fig.3. The system works well considering the simplicity of the interface, but it is advisable not to have the interface too close to the PC or the monitor. Keeping the interface reasonably well separated from the computer system helps to minimise any electrical noise from the computer being picked up by the interface's sensitive amplifier.

It is essential to keep light from mains powered lighting from reaching the photocell, and for the subject's finger to remain still relative to the photocell. Displayed pulse rates into the hundreds will occur if noise and spurious pulses are allowed into the system.

Note that the circuit necessarily has an extended low frequency response, and that this results in it taking several seconds after switch-on for the voltages in the circuit to settle down to their normal operating levels. It will also take a few seconds for things to settle down after the subject's finger is placed over the photocell, due to the large initial pulse this produces.

Refinements

There are one or two refinements that can be made to the Visual Basic program. An on-screen indicator could be used to show the transitions on the CTS line. This would be useful when initially setting up the system, and would also make it obvious if there were any problems with glitches.

The pulse counting method used here should guarantee reasonably accurate results, but the display does not update very often. More frequent updates can be obtained by measuring the time taken for (say) four input pulses, and then using some mathematics to convert this time into the equivalent beats per minute. It can be difficult to get consistently accurate results using this method, but it would be an interesting approach to try.



EPE PIC MET OFFICE



JOHN BECKER

Part One

Forget the seaweed and proverbs, let technology cater for your insatiable interest in the weather!

THE EPE Met Office of December '95 and January '96 was the last Weather Centre to be published in these pages. A lot of water has passed under many bridges since then, in more ways one!

One flood has been in the way that readers have taken to PIC microcontrollers during that period. As long as three years ago we recognised that the time was ripe to publish another Weather Centre, this time using a PIC16F877 and its ready capability of monitoring many types of sensor simultaneously.

It was also obvious that this device could easily be used in conjunction with serial memory chips, to perform long-term data recording for subsequent download to a PC-compatible computer for analysis. The technique for such recording had already been proved in the author's *PIC 8-Channel Data Logger* (Aug/Sep '99).

SOLID STATE

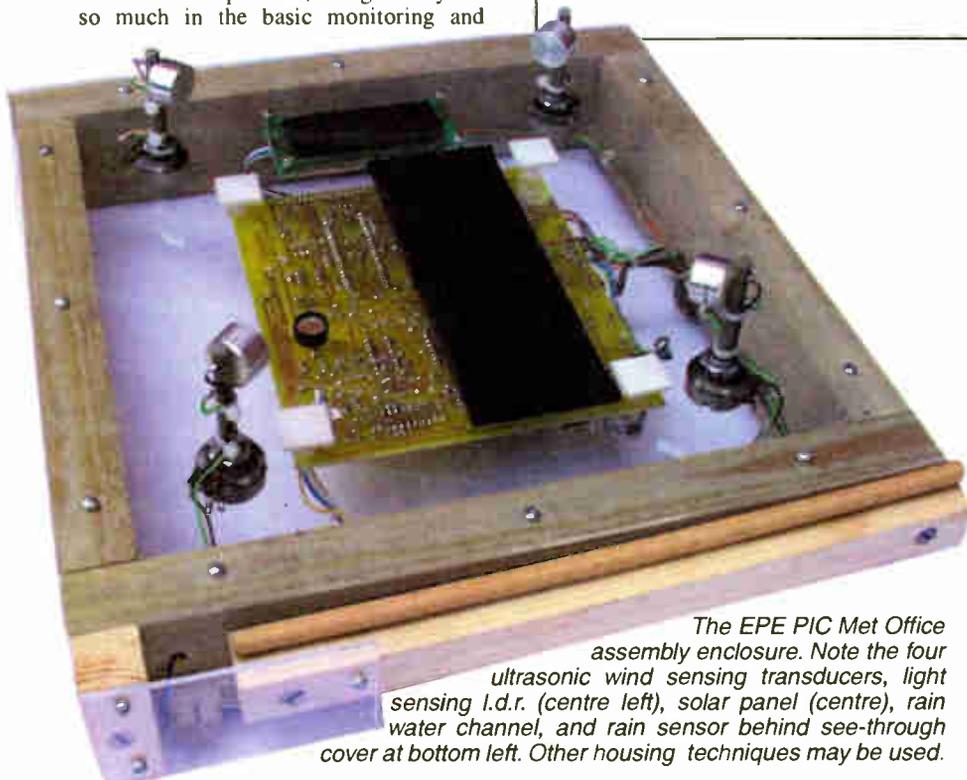
There was a problem, though. It lay not so much in the basic monitoring and

SPECIFICATIONS . . .

The PIC Met Office monitors a range of sensors and processes data for the following conditions:

- Barometric pressure, in millibars
- Temperature, in °C and °F, including sub-zero
- Atmospheric relative humidity, as an RH percentage
- Soil moisture, bone-dry to saturated, as a percentage
- Light intensity, as a relative percentage, full sun to total darkness
- Rain fall, immediate (is it raining *now?*)
- Rain fall, cumulative (by how much has the water barrel filled and over what period?)
- Wind speed, in kph, mph and Beaufort, immediate and averaged

- Wind direction, immediate and averaged, 0° to 360°
- Wind chill factor
- Rainbow alert!
- Recording of all data to non-volatile serial memory (up to 256 kilobytes)
- Selectable data sampling rates, from 1 second to 1 hour intervals
- Serial output (9600 baud) of realtime and recorded data to PC-compatible computer, running under Windows 95/98/ME
- Bargraph and waveform displays on PC
- Data formatted by PC for reading as text file compatible with Excel spreadsheet/graphing software and text editors
- Immediate display of monitored sensor values via alphanumeric liquid crystal display



The EPE PIC Met Office assembly enclosure. Note the four ultrasonic wind sensing transducers, light sensing I.D.R. (centre left), solar panel (centre), rain water channel, and rain sensor behind see-through cover at bottom left. Other housing techniques may be used.

logging, as with the author! He had rashly said that the next weather centre he did should be entirely solid state – no moving parts whatsoever.

As most of you will know, traditionally a weather centre has always had two moving parts, an anemometer for measuring wind speed, and a vane that indicates the direction from which it blows. For readers (and the author), for whom electronics is the chosen technological path to be passionate about, mechanics is the *weakest link – goodbye to all that*, seemed to be the prevailing thought.

So, the reasoning was that electronics by now should be capable of sensing wind speed and direction without resorting to rotational mechanics. There were many ideas of how it *might* be done, but no practical experiments had been performed in Tech Ed's garden. But, after much shilly-shallying and putting off the hard work, he's done it now. As to how, be patient a moment, all will be revealed. First, take a look at the Specifications for what *this* PIC Met Office can do overall!

Note that you do not need to use a PC if you are content to just observe the l.c.d. readout and ignore the data logging option. In this case the serial memory devices and PC interface components can be omitted.

SATELLITE TECHNOLOGY

As will be described presently, a PIC16F877 microcontroller is the brain of the system. In effect, it sits in a commanding position surrounded by several satellites of sensors, variously providing data in response to active control or passive sampling. See block diagram Fig.1.

In turn each of the sensors comes under the attention of the PIC, which acquires that sensor's data and formats it for display on an alphanumeric liquid crystal display (l.c.d.). The full cycle takes about one second to complete.

Secondly, the PIC has been provided with the option to store that data to up to eight on-board serial EEPROM (electrically erasable programmable read-only memory) chips if required. Simultaneously, the PIC constantly outputs data in a serial format for immediate reception via a cable link to a PC if connected.

When requested by the user, the PIC can output all recorded serial EEPROM data to the PC as a block.

The functioning of the control unit will be described presently (Fig.12), but first the sensors are examined in turn.

LIGHT SENSING

One of the simplest sensors in this design is that for sensing light level. Its circuit diagram is shown in Fig.2.

The sensor is an ORP12 (or similar) light dependent resistor (l.d.r.), notated as LDR1. Its resistance is very high (several megohms) in total darkness, falling to just a few tens of ohms in bright sunlight conditions.

Somewhat unusually, it is fed with a digital pulse train provided by the PIC via pin RE2. The l.d.r. is in series with a ballast resistor, R24, and with a capacitor, C13. The rate at which C13 charges between two specific voltage levels in response to the pulses is timed. From this the PIC determines the relative resistance value of the l.d.r. and relates it to the upper and

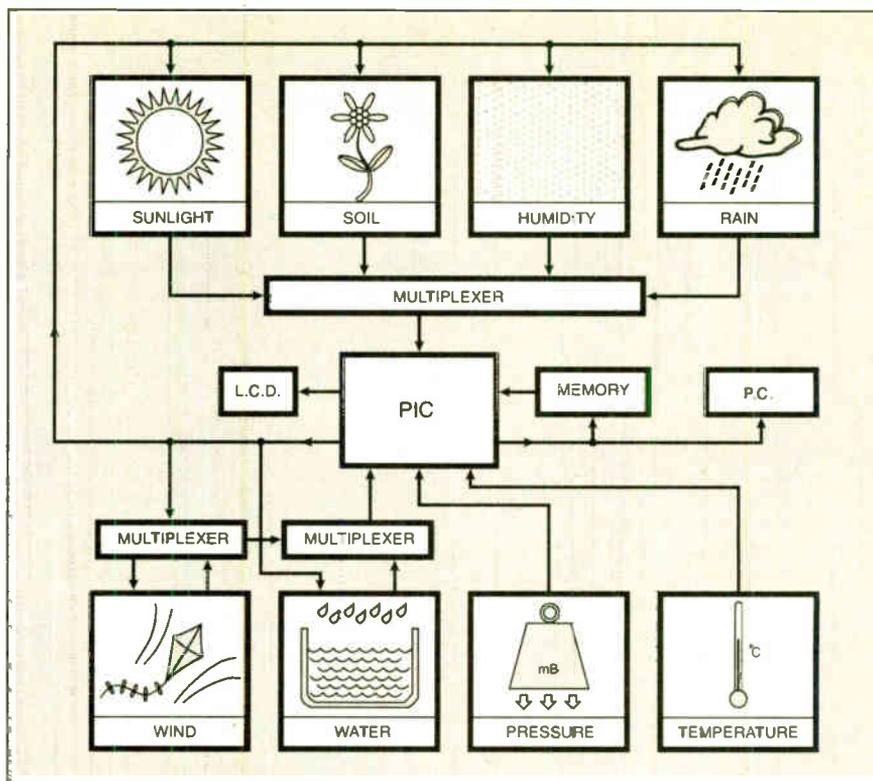


Fig.1. Block diagram of the EPE PIC Met Office.

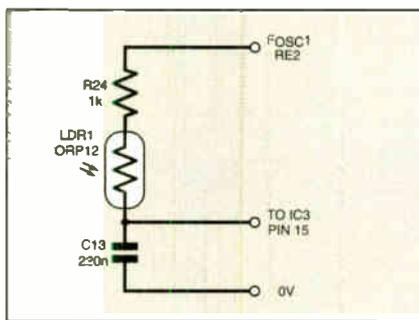


Fig.2. Light sensing circuit.

lower extremes of the l.d.r.'s resistance range, from which a percentage value is obtained.

The junction of LDR1 and C13 is coupled through a multiplexer (IC3, see Fig.3)

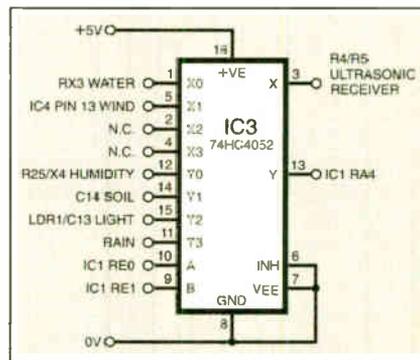


Fig.3. Multiplex circuit through which most of the sensor signals are routed to the PIC microcontroller.

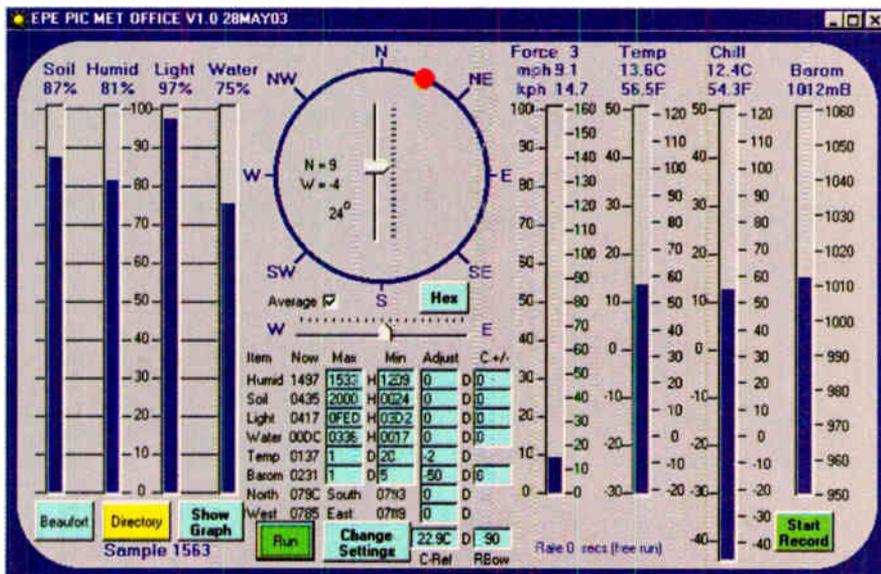
to the PIC's Port A Schmitt trigger input, at pin RA4.

In simple terms, the pulse train from PIC pin RE2 is initially taken low, causing C13 to discharge through LDR1 and R24. As soon as the logic level at RA4 is recognised as being at logic 0, the pulse is taken high to start C13 charging up again. When the PIC recognises that a logic 1 level has been reached, as detected by the upper Schmitt trigger threshold of RA4, it again reverses the pulse logic and starts a timer.

Capacitor C13 starts discharging again. When RA4's logic 0 Schmitt threshold is reached, the timer is stopped and its value read. This is compared with values previously established during the PIC Met Office's initial setting up, and a percentage value relative to maximum light level is calculated.

SOIL MOISTURE SENSING

A similar technique is used to assess the relative moisture content of garden (or pot plant) soil. As discussed in the author's *Earth Resistivity Logger* (Apr/May '03), the resistance that soil presents to a current



Example of the PIC Met Office's main display on a PC-compatible computer screen.

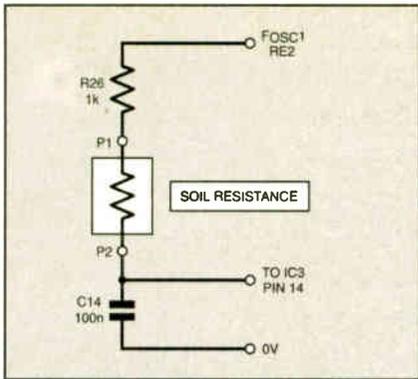


Fig.4. Soil moisture sensing circuit.

fed through it varies depending on its moisture content and general make-up. A very high resistance is present with dry soil, and a very low resistance for wet soil. In this context, the chemical nature of the soil, which may also provide conductivity, has a small effect by comparison to water content.

The circuit diagram for the soil moisture sensor is shown in Fig.4. The circuit is essentially the same as that in Fig.2, except that the l.d.r. resistance is replaced by the soil's resistance. Once again a capacitor, C14, is charged and discharged by the pulse train from RE2, acting via a ballast resistor, R26.

Note that the alternating signal also helps to prevent polarising effects being generated in the soil, and corrosion of the probes, as would happen if a direct current (d.c.) were fed into it. The situation is discussed in the *Earth Resistivity Logger* (and its software contains a text file describing experiments that can be carried out to show the effects).

Physically, two external probes are connected to the soil sensor circuit, one to resistor R26 at point P1, the other to capacitor C14 at point P2.

The voltage level at C14 is fed via multiplexer IC3 (Fig.3) to PIC pin RA4. As with light level sensing, the timings between the logic thresholds are used to determine the soil's relative resistance in relation to preset wet/dry extremes as established during setting-up.

HUMIDITY SENSING

A similar timing technique is used for sensing the relative humidity (RH) of air. The circuit diagram is given in Fig.5.

Here the sensor itself (X4) is the capacitor, in series with two resistances, R25 and preset VR3, the latter setting a basic

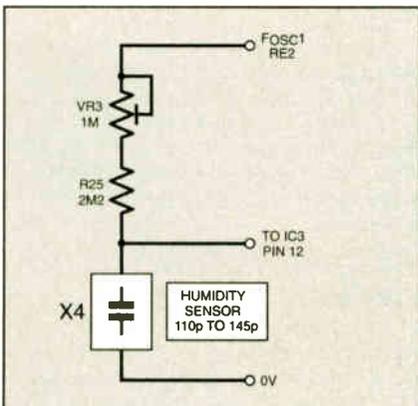


Fig.5. Humidity sensing circuit.

range for the CR (capacitance-resistance) relationship.

The sensor has a capacitance whose value changes with relative humidity. The range is typically 110pF in dry air (RH 0%), to 145pF in saturated air (RH 100%). It is the same sensor type discussed in *Teach-In 2002 Part 3* (Jan '02).

Again the timing factor at the "capacitor" is sensed by PIC pin RA4, via multiplexer IC3. The extremes of the sensing range are established during setting-up, using two "real" capacitors of known value (to avoid a long wait between total air dryness and saturation conditions – which might never occur!).

RAIN SENSOR

The presence of rain is assessed by the simple technique of detecting whether two closely adjacent "probes" are conducting, see Fig.6. They are placed such that rain falling on them accumulates into droplets, growing large enough to periodically cause electrical conduction to take place between them through the water before the drip runs down, breaking contact.

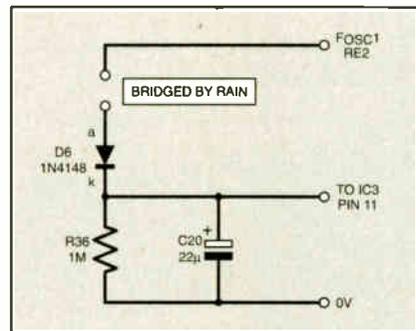


Fig.6. Rain sensing circuit.

One probe is fed with a pulse chain from PIC pin RE2. As with soil moisture detection, the use of an alternating signal reduces probe contamination caused by polarizing currents.

When inter-probe conduction takes place, pulses from the receiving probe cause capacitor C20 to charge via diode D6. The resulting voltage is coupled via multiplexer IC3 to PIC pin RA4. The PIC simply detects whether or not this pin is receiving a voltage above or below its logic threshold levels. If the voltage is at a logic 1 level, then it's raining, or the rain drip has not yet dispersed from the probes.

In the absence of a rain drip, C20 is discharged via resistor R36.

TEMPERATURE SENSING

The temperature sensing circuit diagram is shown in Fig.7. It is essentially the same circuit as used in the author's *PICronos L.E.D. Wall Clock* (May/June '03).

It is based on the type LM35CZ temperature sensor, IC7. The voltage output of this device varies by 0.01V per degree Celsius. It has been configured with two 1N4148 silicon diodes in its ground path in accordance with its manufacturer's datasheet. This allows the device to respond to sub-zero temperatures. Resistor R27 provides a bias path to 0V to suit this role.

The voltage difference between IC7's output and negative pins is processed by the differential amplifier formed by op.amps IC8a to IC8c. Note that the op.amp is a quad rail-to-rail device. A "standard" quad op.amp, such as an LM324 for instance, is unsuitable in this application. A rail-to-rail device *must* be used.

The circuit configuration around the three op.amps provides a gain of $\times 10$, providing an output voltage change at IC8c pin 7 of 0.1V/°C. Some resistors are 1% types in order to provide this gain precision (which is actually $\times 9.99$ – but near enough to $\times 10$ to be acceptable). A span adjustment option is provided by the software but its use should not be needed.

Differential amplifier circuits were discussed in depth in *Teach-In 2002 Part 5* (Mar '02).

The output from this circuit is fed directly to one of the PIC's pins (RA3) configured as an analogue-to-digital-converter (ADC) input. The ADC provides a 10-bit conversion range (1024 values) for voltage inputs of between 0V and the supply rail voltage (5V).

PRESSURE SENSOR

Barometric pressure sensing is performed by the circuit in Fig.8. The pressure sensor itself is notated as X5. It is a compensated temperature bridge device of which two arms, 1 and 3, are used in a current-control configuration between output pin 14 of op.amp IC6a, and the inverting input at pin 13. The resistor values (for R13 to R16) are those recommended in the device's datasheet. Note that R15 and R16 are 1% types, used in series to set a value of 806Ω (the datasheet's value).

The sensor's twin outputs, at pins 2 and 4 are in antiphase, and are fed to the two inputs of another differential amplifier, formed around op.amps IC6b to IC6d. A "standard" op.amp type LM324 is used for IC6, rail-to-rail ability not being needed for this circuit.

Some resistors in the amplifier are also

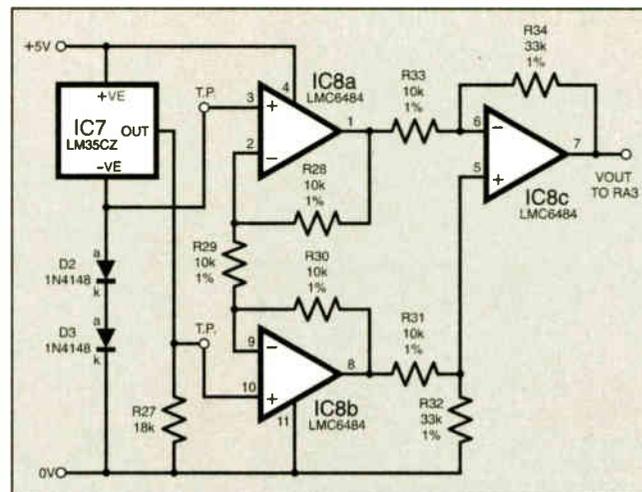


Fig.7 Temperature sensing circuit.

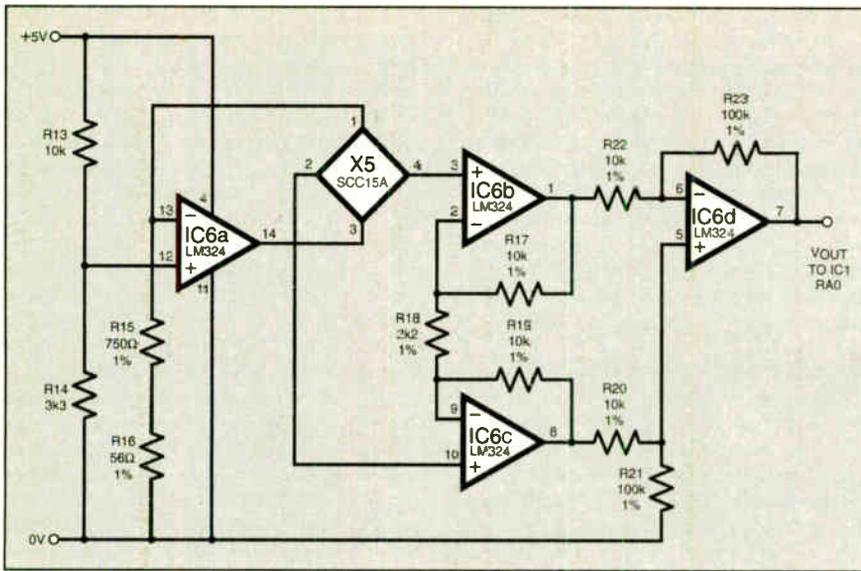


Fig.8. Barometric pressure sensing circuit.

specified as 1%. However, the use of 1% tolerance here is not as crucial as with the temperature circuit. The software provides span alignment to suit individual sensors. The circuit gain is about $\times 30$.

The output voltage at IC6 pin 7 is fed to another ADC pin at the PIC, RA0.

WIND SENSING

In the author's *PIC Wind Speed Meter* (Jan '03), a technique for sensing wind speed by timing the rate at which ultrasonic pulses passed between two ultrasonic transducers was first described in *EPE*. Even though the ultrasonic transducers are sold as matched transmitter/receiver pairs they can in some circumstances be used interchangeably.

In this PIC Met Office, the technique is employed again, but this time four ultrasonic transducers are used, arranged at the four corners of a square. Ultrasonic pulses are exchanged between the transducer pairs at opposite corners. In the

physical construction, these corners are positioned in line with standard compass points, N, S, W, E.

The principle allows not only wind speed to be assessed, but also its direction (with the aid of a bit of maths in the PIC's software!). It works as follows:

Transducer N transmits a couple of ultrasonic pulses towards transducer S. The time it takes for the pulses to cross the short distance (about 25.5cm) is measured. Transducer S now transmits towards N, and again a timing is taken.

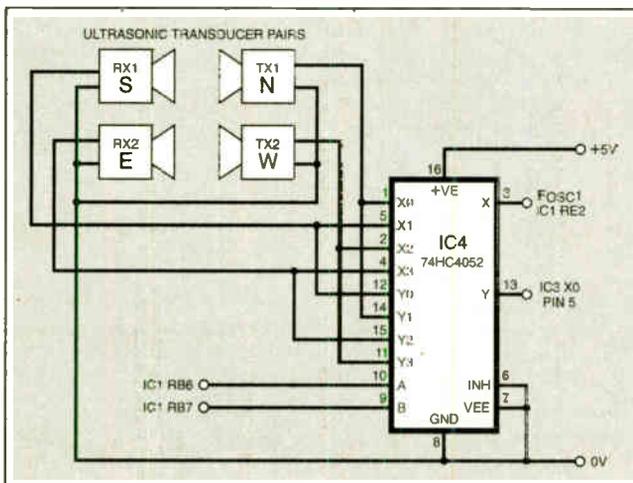


Fig.9. Wind sensing transducer multiplexing circuit.

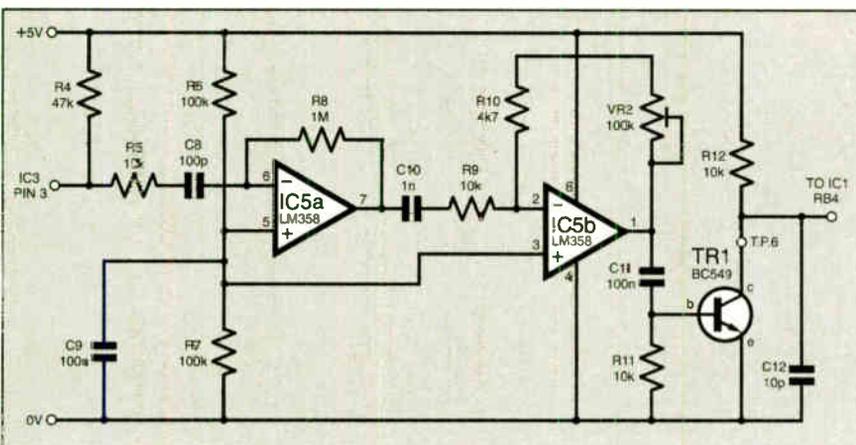


Fig.10. Ultrasonic pulse reception amplifier circuit.

Next transducers W and E exchange pulses and timings are taken. Standard geometry is used to manipulate the four results to provide the dominant angle at which the air is flowing between the transducers' known angular positions. From knowledge of the wind angle, relative wind speed can be established.

Both values are, of course, based on the rate at which sound travels through air (332m/s at 0°C). If the air is moving (there's wind) the rate varies accordingly, faster if the sound is travelling with the wind, slower if it is travelling against it.

Because the transducers alternate between being transmitter and receiver, the effects of temperature change, humidity and barometric pressure can be ignored in this simple application.

Wind by its nature is blustery, constantly changing speed and direction as it swirls passed. Only an average typical rate and direction can ever be established in any low-cost unit (and greater precision is probably very difficult to achieve even in an "expensive" design).

The basic ultrasonic signal routing circuit diagram is shown in Fig.9. PIC pin RE2 is fed to multiplexer IC4 at analogue pin X. The binary code on IC4 pins A and B determines the output path that the signal takes, from X0, X1, X2 or X3.

These four pins are each connected to the signal pin of one transducer. The same transducer pins are also connected to IC4 pins Y0, Y1, Y2 and Y3. According to the code on pins A and B, the selected path is output at IC4 pin Y.

The routing is arranged so that, for example, when transducer N is transmitting the ultrasonic signal from X0, transducer S is receiving the pulses and passing them via Y0 to Y. Conversely, when S is transmitting from X1, N is receiving and outputting via Y1 to Y. Internally, the unselected paths within IC4 are held at high impedance and have no effect on the transducers or the output signal at Y.

PULSE AMPLIFIER

From IC4 pin Y, the output signal is fed via multiplexer IC3 (Fig.3) to the amplification circuit in Fig.10. Here it is amplified by the a.c. coupled circuit around op.amps IC5a and IC5b. The basic gain is $\times 100$ for IC5a, and between approximately $\times 0.5$ and $\times 100$ for IC5b, as set by preset VR2. This allows plenty of scope for the signal amplitude at the output of IC5b, pin 1, to be adjusted to provide clean pulses to the following stage around transistor TR1.

From IC5b, the output signal is a.c. coupled to the base of TR1 via capacitor C11. The base is biased normally-low by resistor R11, so that the collector of TR1 is normally high. Pulses from IC5b that exceed the transistor's turn-on threshold, of about 0.6V, drive the transistor into saturation. The resulting line level (0V to 5V) pulses are fed to the PIC at its RB4 input.

The inclusion of resistor R4 was found necessary to minimise any noise signal from the receiving transducers when their transmitting counterparts are not being pulsed.

Capacitor C12 minimises the transitory effect of received pulses that fall between the transistor's fully on and fully off conditions.

WATER LEVEL SENSING

As with the author's previous weather centres, provision has been made to keep track of the water level in a garden water barrel used for collecting rain. Ultrasonic techniques are also used here. The basic circuit is shown in Fig.11.

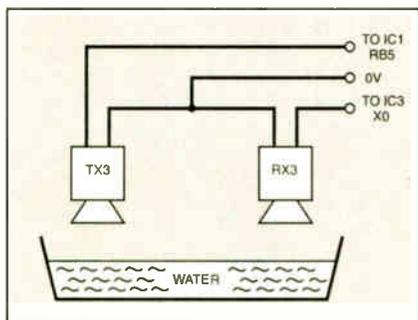


Fig.11. Water level sensing circuit.

A "tapemeasure" principle is used to assess the distance of the water surface. Both transducers, TX3 and RX3, are positioned side-by-side above the water barrel and facing down into it. Transducer TX3 is pulsed by PIC pin RB5, transmitting a signal into the barrel. Transducer RX3 receives the echo pulse and feeds it via multiplexer IC3 to the amplifier in Fig.10.

Having transmitted the ultrasonic pulse, the PIC waits a brief "masking" period to allow RX3 to cease any sympathetic "ringing" while TX3 is transmitting. A timer is then started. It is stopped immediately the PIC receives the amplified and shaped echo pulse from TR1.

During setting-up, timing ranges for a water barrel in both empty and full conditions are established. In "active service", the received echo pulse timings are compared with the empty/full values and a fullness percentage value calculated.

RAINBOW ALERT

The Rainbow Alert is just a bit of a fun gimmick, prompted by some light-hearted banter on the *EPE Chat Zone!* It is based on the logic that **IF it is raining AND the sun is shining, THEN it is worthwhile having a look for a rainbow!**

Of course all sorts of other criteria determine whether or not a rainbow will be seen, such as your viewing angle in relation to the direction of the sun's rays and their refraction by the rain drops.

The Alert is only available via the PC. If it detects that rain is present at the same time as light intensity is above a preset level, then seven concentric circles of "rainbow" colours are displayed on screen. They vanish when the trigger condition has passed.

CONTROLLER CIRCUIT

Since designing the previous Weather Centres, technology has moved on in the

form of PIC microcontrollers coming into widespread use. How did we ever do without them? The simple answer is "with difficulty and ingenuity"! Considerably more complex logic techniques had to be used with the previous designs.

In this design, all the sensor control and monitoring functions are simply performed by feeding a few wires into a few PIC pins, and the software takes care of the rest. (We'll gloss-over the fact that software can take considerably longer to write than the joining of numerous logic chips into a coherent system! This design has around 3600 PIC software commands.)

The circuit diagram in Fig.12 shows the PIC microcontroller, IC1, and its connections. It is operated at 10MHz, as set by crystal X1. The connections are not only those to and from the sensors, but also those to the other functions that give this design flexibility.

Having discussed the sensors, those other functions are now examined. The role of switches S1 to S5 will be discussed when setting-up is described.

SERIAL MEMORY

Data from all the sensors can be stored to a bank of non-volatile serial memory chips for subsequent download to a PC. The size of the memory bank is left to personal choice, but can range from one serial memory chip, to eight. (You may also

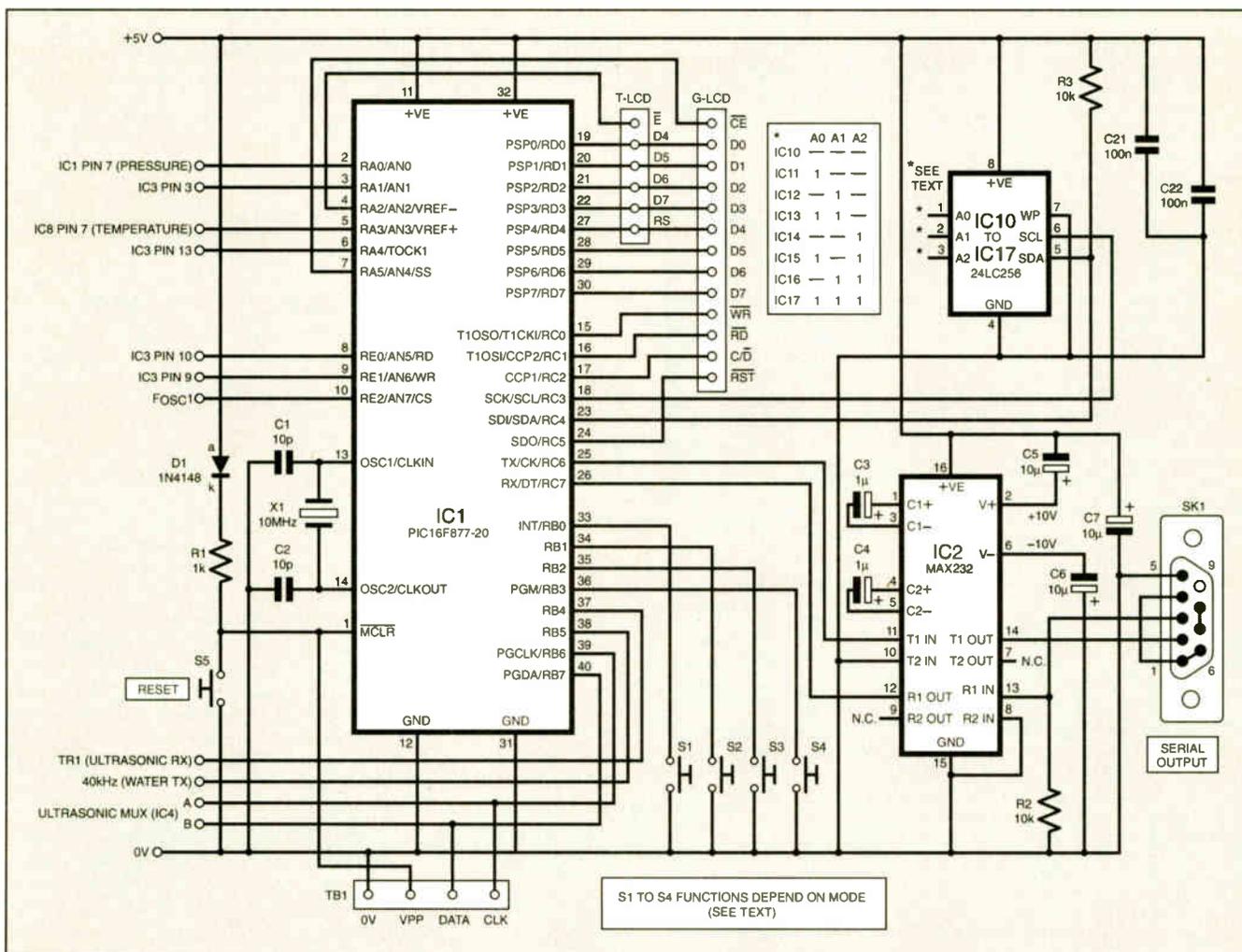


Fig.12. Circuit diagram for the main controller, data storage and output functions.

choose to omit them entirely if you prefer.) They are represented as a single device notated as IC10 to IC17 in the controller circuit diagram, Fig.12.

The serial memory chip type is the same as previously used in the author's data logging designs, the Microchip 24LC256. This has 256 kilobits of memory, used as 32768 8-bit bytes (32K), but using two bytes for storing the data from a single sensor. The use of the 24LC256 was briefly discussed in the author's *PIC Tutorial V2*, Part 3 (May '03).

The memory chips are coupled in parallel and jointly accessed via a single pair of data input and output connections, via PIC pins RC3 and RC4. The chip to be accessed is selected by an identity code transmitted by the PIC. Until another ID code is transmitted, only the selected chip will respond to data being sent or demanded for retrieval.

The eight memory chips have their identity hardwired on the printed circuit board by setting a binary code on their A0 to A2 pins. Internally, the pins are biased normally-low, so it is only necessary to connect the selected pin to the +5V line. The inset block diagram to the left of the IC10 to IC17 symbol shows the logic 1 connections for all eight chip addresses.

Data is transferred between the PIC and the memories via their SDA (serial data) pin, in conjunction with a clock signal applied to pin SCL (serial clock). A single resistor, R3, biases the SDA pins normally high as they are "open-collector".

Any data stored to the memory chips is retained even after the power has been switched off.

The PIC Met Office can be used without any memory devices if on-board logging facilities are not wanted. Simply omit any memory chips not needed, but resistor R3 must be used whatever the quantity, providing a known bias level to the PIC should it try to read back data from a non-existent chip.

When memory is installed, the PIC constantly writes data to consecutive addresses at a rate preset by the user, as discussed in Part 2. Having reached the end of the available memory, it restarts from the beginning again. When data is downloaded to the PC, the formatting ensures that the samples are saved to disk in the correct time sequence.

PC INTERCONNECTION

Connection between the PIC and a PC is made serially via the RS-232 chip, IC2. Whilst it is often possible to directly connect a PIC to the serial port of a PC, this interface technique is best reserved for situations when only a few bytes of data are to be exchanged at irregular intervals.

Transferring large blocks of data is more reliable if an RS-232 interface chip is used. This ensures that the interface voltage levels are optimised for serial data transfer. Handshaking between the PIC and PC when in block transfer mode also helps to ensure data transfer accuracy.

The interface device used is the commonly available MAX232. In conjunction with capacitors C3, C4 and C6, this device generates logic signals swinging between typically $\pm 10V$ on its output pins T1out and T2out.

Data is transmitted from IC2 pin T1out to the PC via socket SK1 pin 2. Handshake

signals are received by IC2 pin R1in via SK1 pin 3. Resistor R2 biases pin R1in to 0V to ensure stability when the PC link cable is disconnected.

L.C.D. READOUT

In addition to the PC providing readout facilities, the hardware also provides an alphanumeric liquid crystal display (l.c.d.) readout. PIC Port D is used to control the l.c.d., whose connections are shown in Fig.13. The Port D connections to the l.c.d. are notated in Fig.12 within the outline marked T-LCD (text l.c.d.).

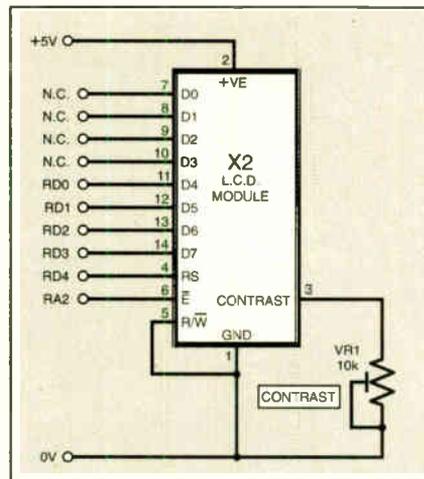


Fig.13. Circuit diagram for the text l.c.d. module X2.

It will be noticed that there is an adjacent outline and connections marked as G-LCD. These connections may be used by the author in some future update to also provide a display using a graphics l.c.d., such as that in his *How to Use Graphics L.C.D.s with PICs* (Feb '01).

If such an update takes place, the display connections shown in Fig.14 will be used, the display being notated as X3. The negative supply inverter required for the graphics l.c.d. is shown as IC18. Its output voltage determines the l.c.d.'s screen contrast, which can be adjusted by preset VR4.

Do note though, that the author offers no assurances that he will ever add this facility, but the connections are already there should he encounter a rainy day and nothing else to do! Of course, you can always write your own program for it!

POWER SUPPLY

The circuit diagram for the power supply is shown in Fig.15. Basically the unit is intended to be powered by a battery source (B1) providing between 9V and 12V. Via diode D5, this supply is regulated down to 5V by IC9.

The option to also use a solar cell/panel is provided (X6), although the unit can be powered by only a battery if preferred. The solar panel generates a voltage related to the amount of sunlight (or other strong light source) falling on its surface. At peak light intensity, the solar panel listed can generate up to

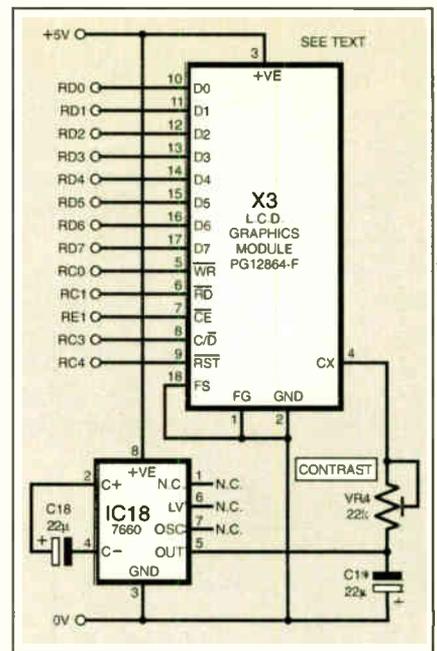


Fig.14. Circuit diagram for controlling a graphics l.c.d. display (see text).

12V, depending on load. At a maximum load of 45mA, the maximum output voltage is around 7.5V. The panel's output voltage is fed via diode D4 to the input of voltage regulator IC9.

The inclusion of diodes D4 and D5 ensures that the two power sources do not conflict with each other. Resistor R35 helps to prevent damage to the solar cell in the event of a short circuit at or following IC9.

Capacitor C15 at the input of IC9 provides preliminary smoothing to the source voltage(s). The one Farad (1F) capacitor, C16, on the output of IC9 is used as a voltage reservoir to minimise fluctuations in power when the solar cell is briefly shaded from the light source and the battery is temporarily removed for replacement. This capacitor has a maximum voltage rating of 5.5V, a limit which must never be exceeded.

Since the current drawn by the complete unit is about 25mA, it is not reasonable to rely only on the solar panel and the capacity of C16 for power. A battery should always be used to keep the circuit correctly powered.

If a rechargeable battery is used, it would be feasible to keep it recharged by the solar panel and a suitable current and voltage limiting circuit. This option will depend on the type of rechargeable battery used and no advice is offered – consult the battery manufacturer's datasheet.

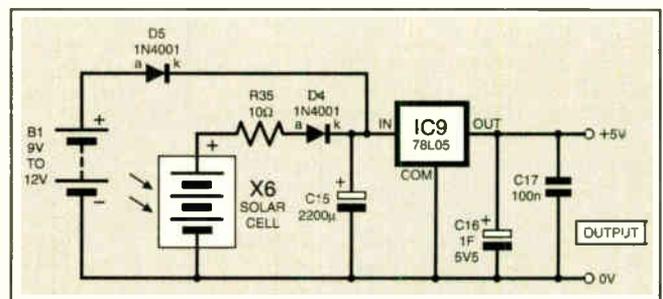
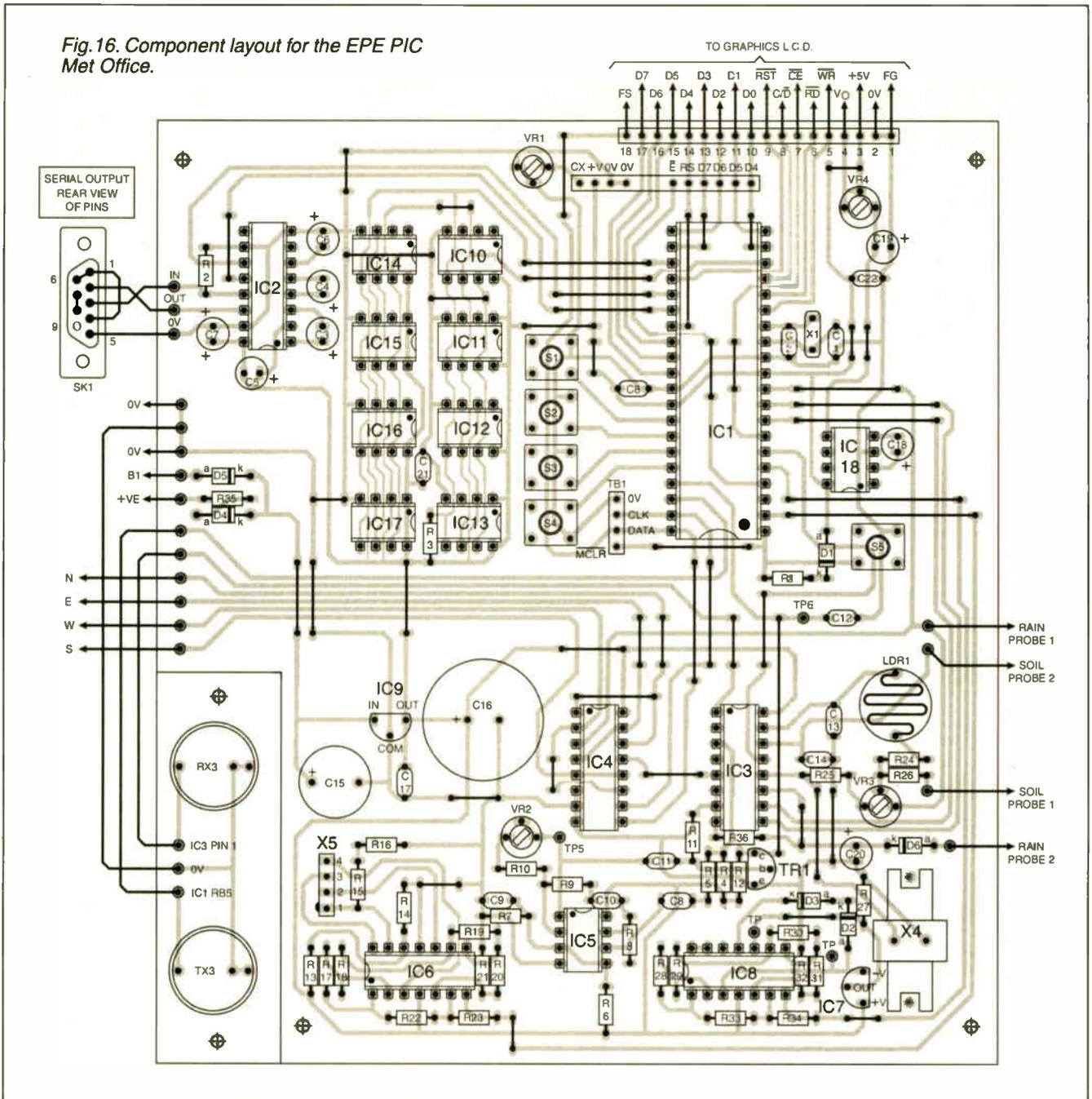


Fig.15. Power supply circuit diagram.

Fig.16. Component layout for the EPE PIC Met Office.



P.C.B. ASSEMBLY

The PIC Met Office is constructed on a single printed circuit board, whose component and track layout details are shown in Fig.16 and Fig.17. This board is available from the EPE PCB Service, code 402.

There is a small area at the bottom left of the board on which the two water level sensing transducers are shown. You have a choice here. One is to cut off this section and mount the transducers on it. Alternatively, the board can be left intact and the transducers mounted on a small off-cut of stripboard.

In either case, the sub-assembly is subsequently mounted on or above the rain water barrel, as discussed later.

It will be necessary to enlarge the two holes for the bolts which secure the humidity sensor (X4) at the bottom right of the board. Do this before starting assembly.

Insert and solder all the link wires, using 24s.w.g. tinned annealed copper wire. A reel of this should be part of any constructor's toolkit. Some links go under i.c. socket positions.

COMPONENTS

Approx. Cost
Guidance Only

£95

excl. solar panel, serial EEPROMS and hardware

Resistors

R1, R24,	
R26	1k (3 off)
R2, R3,	
R5, R9,	
R11 to R13	10k (7 off)
R4	47k
R6, R7	100k (2 off)
R8	1M
R10	4k7
R14	3k3
R15	750Ω 1%
R16	56Ω 1%
R17, R19, R20,	
R22, R28 to	
R31, R33	10k 1% (9 off)
R18	2k2 1%
R21, R23	100k 1% (2 off)
R25	2M2
R27	18k

See
SHOP
TALK
page

R32, R34	33k 1% (2 off)
R35	10Ω
All 0.25W 5% carbon film, or better, unless marked.	

Potentiometers

VR1	10k min. preset, round
VR2	100k min. preset, round
VR3	1M min. preset, round
VR4	22k min. preset, round (see text)
Plus panel-mounting rotary, any value, plastic shaft, flat on one side (4 off, see Part 2 text)	

Capacitors

C1, C2, C12	10p ceramic disc, 5mm pitch (3 off)
C3, C4	1μ radial elect, 16V (2 off)
C5 to C7	10μ radial elect, 16V (3 off)

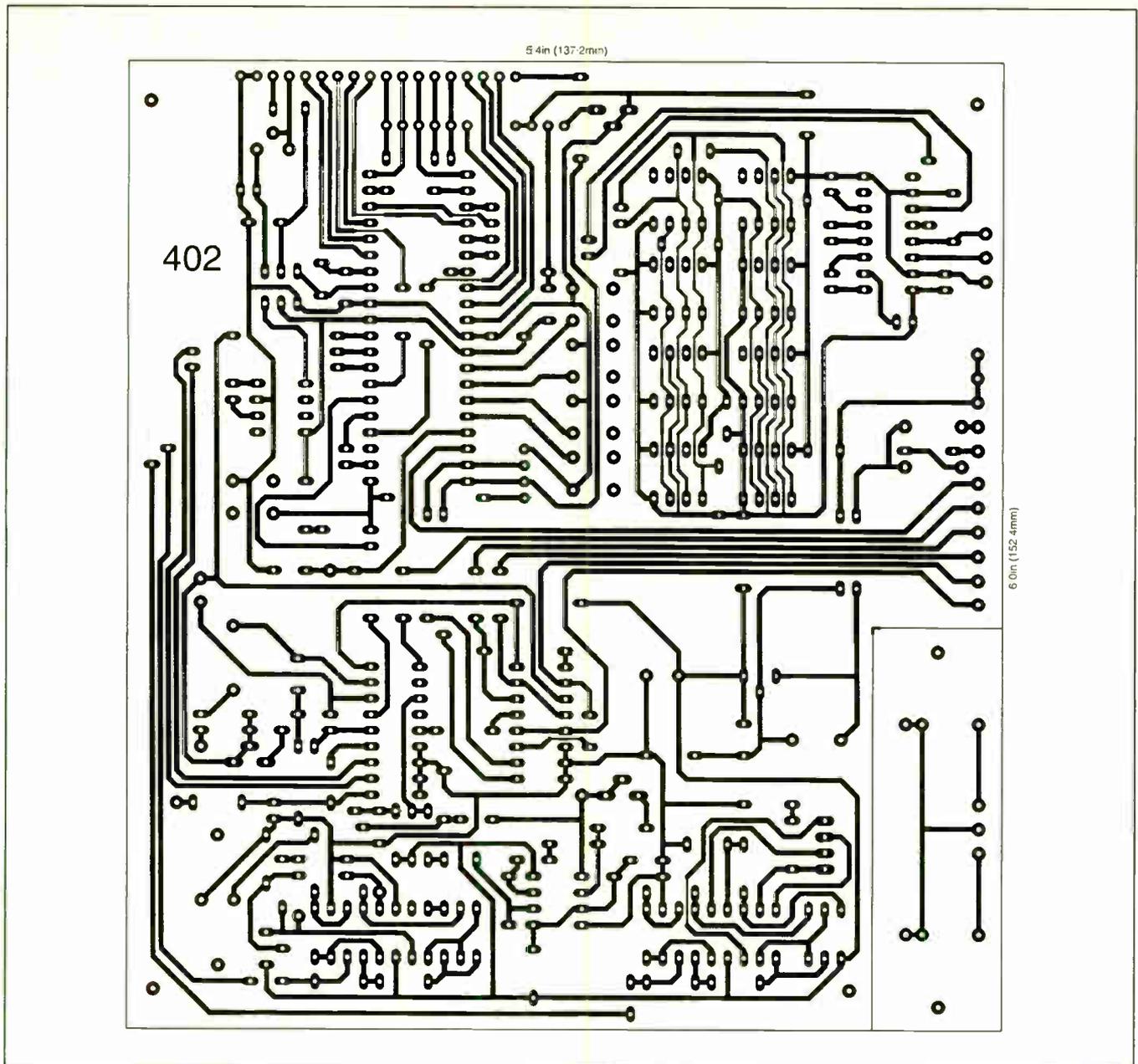
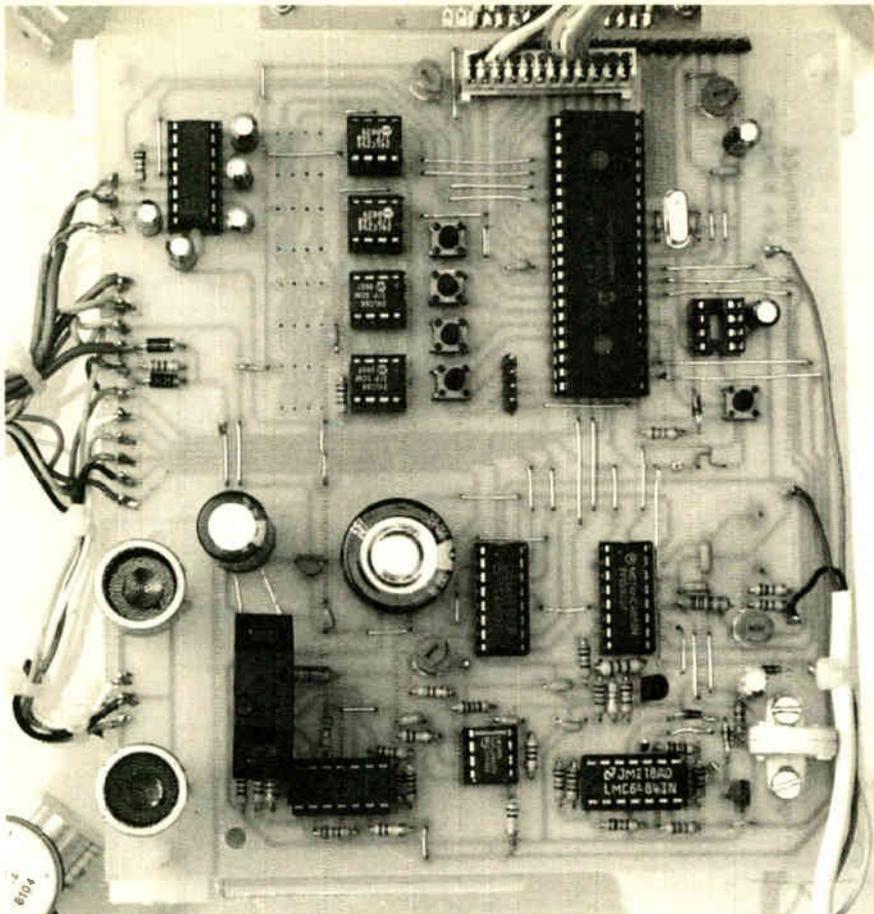


Fig. 17. Copper foil master track pattern for the EPE PIC Met Office.

C8	100p ceramic disc, 5mm pitch	IC2	MAX232 RS-232 interface	X1	10MHz crystal
C9, C11, C14, C17, C21, C22	100n ceramic disc, 5mm pitch (6 off)	IC3, IC4	74HC4052 2-pole 4-way analogue multiplexer (2 off)	X2	2-line, 16 characters per line alphanumeric l.c.d. module
C10	1n ceramic disc, 5mm pitch	IC5	LM358 dual op.amp	X3	PG12864-F graphics l.c.d. (not implemented – see text)
C13	220n, ceramic disc, 5mm pitch	IC6	LM324 quad op.amp	X4	Rapid 61-0960 humidity sensor
C15	2200 μ , radial elect. 25V	IC7	LM35CZ	X5	SCC15A pressure sensor
C16	1F computer back-up, radial, 5.5V	IC8	LMC6484 quad op.amp rail-to-rail	X6	RS 194-098 solar panel (see text)
C18, C19	22 μ radial elect. 10V (see text) (2 off)	IC9	78L05 +5V voltage regulator, 100mA	TX1 to TX3	40kHz ultrasonic transmitter (3 off)
C20	22 μ radial elect. 10V	IC10 to IC17	24LC256 serial EEPROM, 256 kilobit (8 off) (see text)	RX1 to RX3	40kHz ultrasonic receiver (3 off)
Plus 110p and 145p test capacitors (see text)		IC18	7660 voltage inverter (see text)		
Semiconductors		Miscellaneous		Printed circuit board, available from the EPE PCB Service, code 402; 8-pin d.i.l. socket (10 off, see text); 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket (3 off); 40-pin d.i.l. socket; serial cable, length to as needed, connectors to suit PC, and 9-pin D-type serial, male, line mounting; 1mm pin-header strips; 1mm terminal pins, double-sided; materials for enclosure, see text; connecting wire; solder, etc.	
D1 to D3	1N4148 signal diode (3 off)	LDR1	ORP12 light dependent resistor		
D4, D5	1N4001 rectifier diode (2 off)	S1 to S5	mir. push-to-make switch, p.c.b. mounting (5 off) (see text)		
TR1	BC549 npn transistor	SK1	9-pin D-type serial connector, female, chassis mounting		
IC1	PIC16F877-20 microcontroller, pre-programmed (see text)				



See text regarding ultrasonic transducers at the left and the five unused i.c. positions.

Next insert the sockets for all the d.i.l. (dual-in-line) i.c.s, followed by the remaining components in ascending order of size. Do not insert the d.i.l. i.c.s or capacitor C16 until the correctness of the power supply has been proved. Also omit the humidity sensor as setting-up requires two test capacitors to be soldered in its position to establish the range timing factors.

Ensure the correct orientation of the electrolytic capacitors, transistor TR1, IC7, IC9 and the diodes. Note that C15 will need its leads bending to allow space for the pressure sensor.

Initially solder the l.d.r. light sensor to the p.c.b. by short off-board connecting wires. This facilitates testing. Ultimately the l.d.r. should be soldered on the *trackside* of the board, which will be mounted on a transparent cover trackside upwards. It is easiest to solder the pins if the l.d.r. body is held a few millimetres above the board.

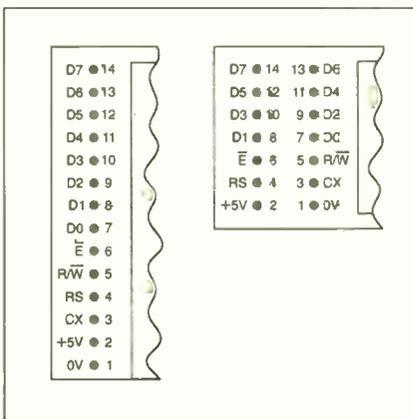


Fig. 18. Typical I.C.D. module pinouts.

Do not connect the l.c.d. until first tests have been made. Typical pinouts are shown in Fig. 18.

SOFTWARE FILES

Software, including source code files, for the PIC unit and PC interface is available on a 3.5in disk (order as PIC Met Office Disk) from the Editorial office (a small handling charge applies – see *EPE PCB Service* page) or it can be downloaded free from the *EPE* FTP site. The latter is accessible via the home page of the main *EPE* web site at www.epemag.wimborne.co.uk. Click on **FTP Site** (downloads) then in turn on **PUB** and **PICS**, in which page the files are in the folder named **PICMetOffice**.

This month's *Shoptalk* page provides information about obtaining preprogrammed PICs.

The PIC program (ASM) was written in a variant of TASM suited for use with *Toolkit TK3*, although the run-time assembly is supplied as an MPASM HEX file, which has configuration values embedded in it (crystal HS, WDT off, POR on, all other values off), plus EEPROM data.

Regarding the PC interface, if you have Visual Basic 6 (VB6) already installed on your machine, you only need to use files **Weather.exe**, **INPUT.DLL** and **WeatherBeaufort.txt**. Unzip (if supplied zipped) and copy them into a new folder named **C:\PIC MET OFFICE**, or any other of your choosing on Drive C (the usual hard drive letter). The software does not require to be "installed".

If you do *not* have VB6, you will need three other files, **comdlg32.ocx**, **Mscmctl.ocx**, and **Msvb60.dll**, held

on our 3.5inch disk named **Interface Disk 1**, and in the **Interface** folder on the **FTP** site (they are also included with the **TK3** software, in **Disk2.zip**). These files must be unzipped and then copied into the same folder as the other **PIC Met Office** files.

For those who have the **TK3** programmer and wish to modify the author's PIC software to suit themselves, on-board programming connections are provided by the pins shown within the **TB1** outline.

Diode **D1** and resistor **R1** are included to protect the 5V power line during programming download.

SOFTWARE NOTES

Note that as the PIC's ASM file is written in TASM, it is necessary to convert it to MPASM if you wish to modify the code via an MPASM-type assembler. **TK3** has the conversion routine built-in. Otherwise, program the PIC with the HEX code, which is already in the MPASM format.

It should also be noted that the **VB6** program contains a serial transfer routine that is subject to copyright restrictions until a forthcoming PIC-to-VB6 serial interfacing facility from Joe Farr has been published. Until then, when certain key files will be released, readers with VB6 facilities cannot modify the author's PIC Met Office VB6 software.

This restriction does not affect the fully compiled and standalone PIC Met Office PC program, **Weather.exe**.

FIRST TESTS

Thoroughly check the assembly for wrongly positioned components and poor soldered connections, using a close-up magnifying glass.

Connect a power supply source of between 9V and 12V d.c. Immediately check that there is +5V present (within a few percent) at the output pin of regulator IC9. If not, disconnect the power and correct the cause of the problem, which could be due to IC9 being inserted the wrong way round (voltage too high), or by a solder short somewhere on the board (no output voltage).

Always disconnect the power before making any changes on the board.

Insert the preprogrammed PIC and connect the l.c.d., typical pinouts for which are shown in Fig. 18.

Re-apply power and adjust preset **VR1** until the display contrast is satisfactory. Initially a message of **PIC MET OFFICE X EEPROM CHIPS** is displayed briefly (which may not be seen unless the contrast has been adjusted), where **X** is replaced by the number of EEPROM chips detected (from 0 to 8).



Typical l.c.d. screen at switch on and Reset.

The screen then cycles through the sensor display modes, in order of humidity, soil moisture, light level, water level, wind speed and direction, temperature,



Example display showing current channel and sample count.

barometric pressure. a display showing all four wind factor counts, followed by CHAN/SAMPLE, showing where data samples are being stored to the serial memory chips. The cycle then recommences from humidity.

Except for the wind factors, on the top line the sensor's title is displayed at the left. At the right is the actual value sensed for that sensor, in hexadecimal. At the left of the bottom line is shown the processed value calculated in relation to various range values (preset by the user into the PIC's non-volatile EEPROM register).

At this time the displayed values will be meaningless until the full complement of i.c.s has been inserted and calibration values have been entered by various switches (see Part 2).

Pressing Reset switch S5 will cause the PIC to restart the program from the beginning. Pressing switch S2 will "freeze" the currently-displayed screen on that mode, allowing values to be observed each time they are updated. Pressing S2 again causes the cycle to continue.

LIGHT TEST

The light sensor can be tested first. Insert multiplexer IC3 and re-apply power. Position the l.d.r. to face the light.

Vary the amount of light falling on its sensitive face and observe how the displayed values change between each occasion that the Light mode screen is displayed. Make a note of the extreme values (in hexadecimal, as on the top line) when the l.d.r. is in complete darkness (cover it with a clump of dark cloth), and in maximum illumination (shine an anglepoise lamp or similar onto it). These values will be used later.

Ultimately, you will take the extreme values in full sunlight and at the light level which you regard as being darkness, and set the PIC's factors accordingly.



Example of light level sensor l.c.d. screen.

SOIL TEST

Initial soil moisture testing can be carried out using the probes of your multimeter and three plant pots, say 12cm diameter. Fill the pots with soil that is really dry, moderately damp and well saturated with water.

Clip the meter leads (without the meter!) to the designated points on the board. In turn, insert their probes at opposite sides of each plant pot. Note the extreme values between dry and saturated, but just observe the value for the moderately damp soil out of interest.



Example of soil moisture l.c.d. screen.

In the final setting-up you need to monitor soil that has the maximum moisture content you regard as satisfactory, and minimum moisture content which indicates that plant watering is required.

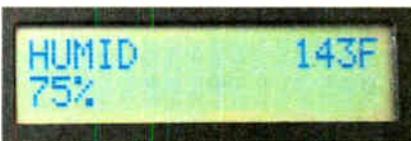
HUMIDITY TEST

As commented earlier, it is not realistic to assess atmospheric humidity content in relation to fully dry and fully saturated. Consequently another technique is used to establish the humidity sensing range.

The humidity sensor used has a stated datasheet capacitance range of 110pF to 145pF, representing a relative humidity (RH) range of 0% to 100%. These extremes are simulated by using capacitors in place of the sensor itself. Ideally they should have the best tolerance specification available, say 1%, although 5% will probably be satisfactory for this application.

First solder a capacitance of 110pF across the sensor's allocated pads on the board. This value may be obtained by using a capacitor of 100pF in parallel with one of 10pF.

Allow time for the temperature of the capacitors to stabilise following the heat of soldering. Then note the sampled value displayed on the l.c.d.



Example of humidity sensor l.c.d. screen.

Next solder a capacitance value of 145pF across the pads. The author used 100pF in parallel with two 22pF capacitors (also in parallel), ignoring the 1pF discrepancy. Allow cooling time, and then note the display reading.

These two readings represent the extreme 0% to 100% RH values. The range will not be precise of course, due to the tolerance and temperature stability of individual humidity sensors, but should be acceptable for this application. Adjustment to the values set into the PIC's data EEPROM can always be made later if you think the range deserves adjustment.

The humidity sensor itself can now be added to the board in place of the capacitors. Be very careful doing this as the sensor's leads are delicate. (In the prototype they actually broke off, requiring rigid wires to be soldered to the remaining stubs.)

Insert the leads into their holes, but do not solder them until the sensor's securing bolts have had their nuts tightened.

When power is re-applied, a value lying between the two extremes produced by the capacitors should be observed on screen.

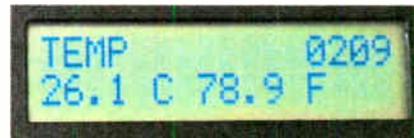
Lightly breathing on the sensor should cause the displayed value to change.

The use of preset VR3 was found to be unnecessary, set it to a midway position and ignore it.

Be aware that the sensor is slightly light sensitive.

TEMPERATURE TEST

The temperature sensor, IC7, can now be tested. First observe the displayed value on the screen. Then hold the sensor between your fingers to warm it. The displayed value should change in response.



Example of temperature sensor l.c.d. screen.

You can also monitor the sensor using a voltmeter. There are two points at which this can be done, across the sensor's output and negative terminals, for which test points have been provided on the board. The sensor's manufacturing characteristic, as said earlier, is a change of 10mV per degree Celsius. The voltage change can also be monitored between IC8c output pin 7 and the 0V line. The change observed here should be 100mV per degree Celsius. Be aware that there is a d.c. bias at the output of IC8c. Software takes care of compensating for this, with your help via the switches during setting up.

In the final setting-up, the displayed temperature display value can be set in conjunction with an accurate mercury-filled thermometer, or by reading the voltage across the sensor's output and -VE pins.

Through the use of 1% resistors at certain points in the amplifier, it is assumed that the output voltage change is linear with respect to temperature change. Consequently, the software should only require correction upwards or downwards, as described later, but the span range can also adjusted through software.

BAROMETRIC TEST

There are no workshop tests that can realistically be done on the barometric pressure sensor at this time. The final setting-up requires values to be read under known millibar pressure conditions. These can be obtained from weather forecasts or via the internet, or from an existing domestic barometer.

They can also be established by observing the readings when the PIC Met Office is taken between locations at known different heights (obtainable from a large-scale ordnance survey map). It is recognised that hills can be few and far between for those who live in East Anglia and Lincolnshire!

Setting-up of the barometer is detailed later.

NEXT MONTH

In the final part next month, testing the other sensors will be described, plus enclosure construction, the PC software and final setting up.

Connected Homes

No, not terraced houses but the notion of homes fully networked for home entertainment, automation and Internet access. Andy Emmerson reports.

PERHAPS it's a sign of the times that Microsoft's botched May announcement of the iLoo, a toilet with a wireless keyboard and extending, height-adjustable plasma screen for surfing the Net while you, er, do your other business, gained far more attention than BT's Home of Possibilities the month previously.

Nevertheless, the fact that both companies chose to make their announcements at about the same time indicates they see fully-wired homes as the way to go. So now is a good time to look at what's happening in this field and check out the trends, which bring together three separate strands – domestic networking, Internet-ready appliances and readily available broadband access.

As yet it is inappropriate to use the word *affordable* as most people will not consider these options to be so, but if the plummeting cost of computers and DVD players is anything to go by, low-cost "wired" living is not far off.

SATURATED

Forget your prejudices and incredulity when you read two years ago about fridges that could re-order food over the Internet, cookers that heated up the food when you email them just as you leave the office, music and the Web in every room of the house. It probably sounded as unlikely as personal helicopters for all, with a landing pad on every garage roof. But there are signs this is going to happen now, if only because the PC market is well-nigh saturated and appliance manufacturers are desperate to create new markets.

There's word of imminent release of ultra-desirable networked products from mainstream manufacturers such as Philips and Sony. More important, the emergence of agreed standards for interconnection of all these gadgets is virtually certain now.

At the *Ideal Home* exhibition this spring BT launched its Home of Possibilities concept, along with a set of new products as part of its vision for a networked home where, through the same broadband connection, every member of the household can work and play whenever they want. It will allow users to connect multimedia devices such as PCs, gaming consoles and media players throughout the house via a central hub, working from the same "pipe" and usable simultaneously and remotely.

BT concedes this is an important component of its strategy to grow the number of its broadband customers from one million this summer to five million in 2006. And BT expects the new products and services to generate sales of more than £100 million in 2004-05. The new products include:

- low-cost home monitoring service, costing £5 a month, which uses the Internet

to alert customers to break-ins and emergencies via phone, text message or email

- home networking solution that links up to ten computers and gaming consoles in the home with no new wiring required
- digital media player allowing you to listen to streamed audio from your PC anywhere in the house
- partnership with Microsoft to launch Xbox live, enabling users to play opponents anywhere in the world in real time.

WIRED TO GO

Big names such as Philips and Sony have "wired" products ready to hook into home networks too, although both use a PC as intermediary. Philips' digital multimedia receiver uses a wi-fi connection to the PC, through which audio and video streaming Internet content is conveyed to audio and video products. Styled like a conventional hi-fi separate, the unit is designed to augment existing A/V systems.

From Sony comes the Network Media Receiver, which connects to a TV or stereo amplifier to deliver broadband content from the Net. A major limitation is the need to use a Sony PC running proprietary software. Sharp and other manufacturers have announced audio products that hook up to the Internet to download MP3 files, whilst Apple's new iTunes service looks like providing a huge choice of legal, low-cost music.

If these hardware products don't sound exactly like the best thing since sliced bread, it's clear nonetheless that more sophisticated and flexible offerings cannot be far off. Bullish comments show these manufacturers are determined to develop this arena with Sony aiming to make the "ubiquitous broadband network" a reality in people's homes.

Let's hope too that Scott Levitan, a brand director with Philips, is not creating a hostage to fortune when he states, "We will succeed in convergence and the connected home by putting the consumer's requirements firmly at the centre of our efforts in this area".

KILLER AP

A mischievous translation of the last statement might be that the killer application for connected homes has not yet materialised but it may not be far off. Horrendous tales of power outages in California remind us how vital energy efficiency is and if networked control of domestic devices could reduce heating and lighting bills significantly, then it will sell itself.

A clear move in this direction comes from a Japanese government-sponsored initiative to promote and standardise home networking and energy management through smart appliances. Energy

conservation is a key objective of this general-purpose system that requires no special rewiring for applying to existing as well as new homes and that can easily control a wide range of devices. It has spawned the largest home networking forum in the world, embracing 120 member companies internationally, and is known as the Echonet consortium (echo as in ecology – you work it out!).

So far so good but is this truly sexy? Well, not really but how about this for the ultimate home of the future? Forget wired-up (or wireless) entertainment delivery for a moment and consider a more radical glimpse of the home of the future. Its name is the Vos Pad (crazy name, crazy place) and it's "a blueprint for future living" according to its exponents, Vos Solutions. The company has integrated the latest technologies within a design framework to create a truly 21st century living space.

LIGHT ENTERTAINMENT

It is, for instance, the world's first apartment lit solely by light emitting diodes, with its ambience controlled via a custom-built computerised system that operates the lighting. The level and colour of the lights in different areas can be changed instantly and the window blinds are also remote-controlled.

The Vos Pad has an integrated home entertainment system with plasma TV screens and surround sound technology, the screens being embedded into the kitchen, bathroom and lavatory walls (no more missing bits of your favourite programme during personal needs breaks!). If that's not your idea of entertainment, then the Vos Pad also features a fully programmable digital grand piano (every home should have one!).

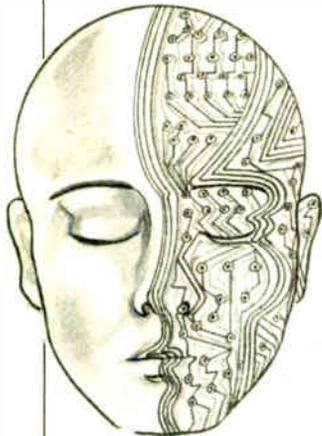
The bathroom features a spectacular i.e.d.-illuminated spa bath and side-lit shower screen that changes colour. The Vos Pad's stainless steel fitted kitchen has integrated appliances, featuring side lit colour changing glass worktops. Limestone flooring is fitted throughout, with all heating under the floor.

Entry is controlled by fingerprint verification system, with the whole thing representing a demonstration of the positive use of technology and an example of the effective integration of design and modern scientific developments in an environmentally conscious manner.

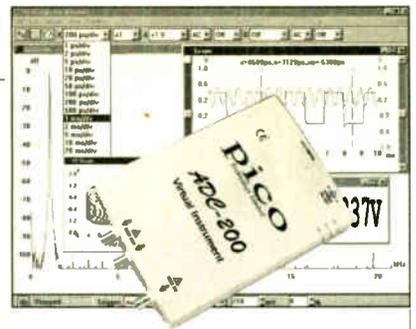
Like BT's Home of Possibilities, the Vos Pad is a statement of concept at the moment, but it does exist, as a luxury apartment adjacent to Chelsea Harbour, London, with riverside views. To save you the journey, you can also visit it on the Web at www.thevospad.com.

More on this next month.

INGENUITY UNLIMITED



Our regular round-up of readers' own circuits. We pay between £10 and £50 for all material published, depending on length and technical merit. We're looking for novel applications and circuit designs, not simply mechanical, electrical or software ideas. Ideas *must be the reader's own work and must not have been submitted for publication elsewhere*. The circuits shown have NOT been proven by us. *Ingenuity Unlimited* is open to ALL abilities, but items for consideration in this column should be typed or word-processed, with a brief circuit description (between 100 and 500 words maximum) and full circuit diagram showing all relevant component values. **Please draw all circuit schematics as clearly as possible.** Send your circuit ideas to: *Ingenuity Unlimited*, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown Dorset BH22 9ND. (We do not accept submissions for *IU* via E-mail.) Your ideas could earn you some cash and a prize!



WIN A PICO PC BASED OSCILLOSCOPE WORTH £586

- 100MS/s Dual Channel Storage Oscilloscope
 - 50MHz Spectrum Analyser
 - Multimeter • Frequency Meter
 - Signal Generator
- If you have a novel circuit idea which would be of use to other readers then a Pico Technology PC based oscilloscope could be yours. Every 12 months, Pico Technology will be awarding an ADC200-100 digital storage oscilloscope for the best IU submission. In addition, a DrDAQ Data Logger/Scope worth £69 will be presented to the runner up.

Audio Noise Generator – Roaring Forté

THE circuit shown in Fig.1 generates an audio noise voltage of between 3V and 5V peak-to-peak, depending on the "noisiness" of Zener diode D1.

The noise voltage produced across the Zener is amplified by the two-stage op.amp circuit, providing a voltage gain of about 1000, which produces an adequate output voltage level. The op.amp used is an LM833, although almost any dual op.amp should do the job.

The choice of Zener diode affects the output amplitude – it was found that 6V8, 7V5 and 8V2 Zeners usually gave a decent output voltage (above 1V p-p) but the few 5V6 Zeners tried were all virtually noise free.

The Zener voltage also affects the d.c. operating point of the op.amps. Too high a voltage (or too noisy an 8V2 Zener) can produce asymmetrical clipping of the output waveform.

P. Tomlinson, Hull, East Yorkshire

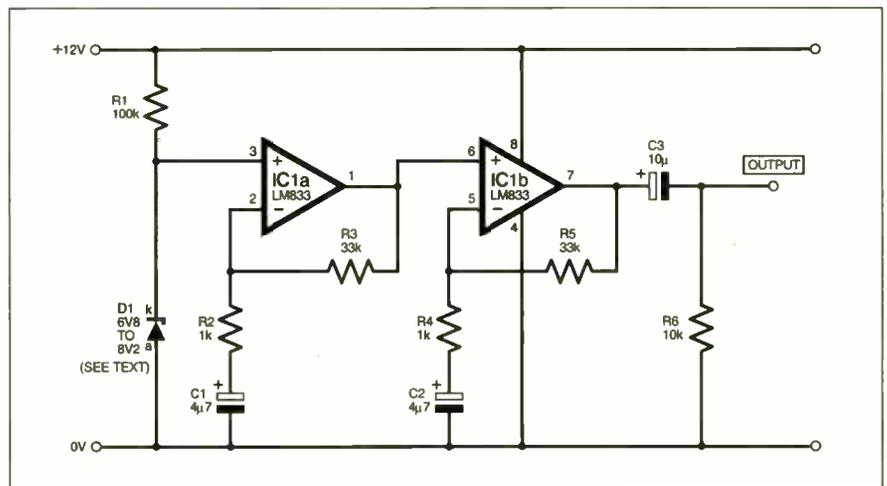


Fig.1. Circuit diagram for the Audio Noise Generator.

Day-Night Switch – Banishing Darkness

THE Day-Night Switch in Fig.2 uses the popular LP2950CZ-5.0 micropower regulator (IC1) to switch a 5V relay as night-time falls. Alternatively, if the light dependent resistor (l.d.r.) R1 and potentiometer VR1 are reversed, this switches the relay when day breaks. Potentiometer VR1 (wired as a variable resistor) is used to set the potential at IC1's adjust (ADJ) pin, and consequently the light level at which switching occurs.

The circuit works on the simple principle that the potential at the ADJ pin tricks the regulator into thinking it should shut down, or alternatively to power up. When in the off state, the regulator (excluding the potential divider formed by R1, R2 and VR1) typically draws 200µA.

Besides being virtually fool-proof, the circuit offers a significant advantage over a standard day-night switch using a transistor to switch a relay. Consider that IC1's ADJ pin has a very low ground current (typically 75µA). This makes it possible to use the circuit with a high value potential divider (up to and exceeding 200kΩ), which opens the possibility for using a thermistor, as well as other devices of a higher resistance, in place of the l.d.r.

In the case of a thermistor, this principle could be used to build a very simple fire alarm or thermostat. Note that the value of VR1 would then need increasing accordingly.

Other three-pin micropower regulators are likely to work in place of IC1. Also, different input voltages may work equally well. The relay's coil resistance should be greater than 50Ω.

Thomas Scarborough, Cape Town, South Africa

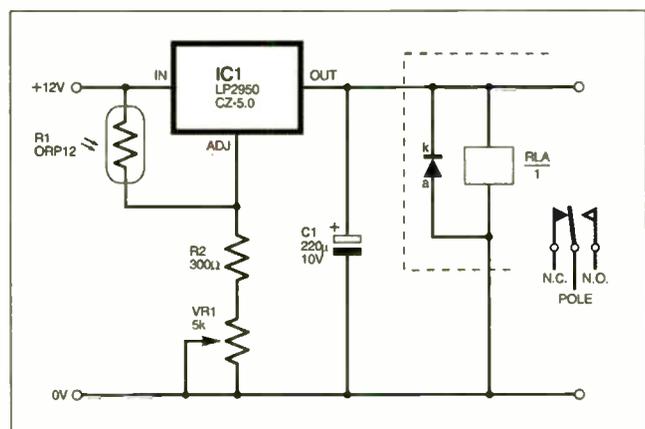


Fig.2. Circuit diagram for the Day-Night Switch.

INGENUITY UNLIMITED BE INTERACTIVE

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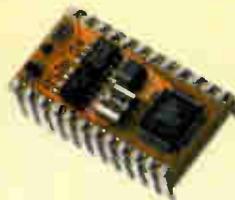
BS2-IC



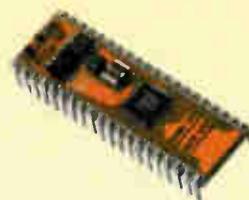
BS2-SX



BS2E-IC



BS2P/24



BS2P/40

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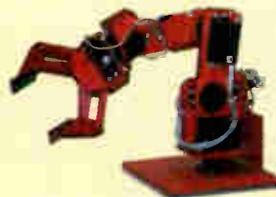
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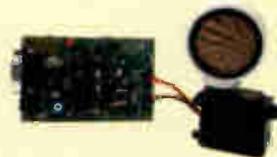
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MASTER/SLAVE INTERCOM



OWEN BISHOP

This short collection of projects, some useful, some instructive and some amusing, can be made for around the ten pounds mark. The estimated cost does not include an enclosure. All of the projects are battery powered, so are safe to build. In a few cases where the project is to be run for long periods, power may be provided by an inexpensive mains adaptor.

AN intercom has many uses around the home and office, including acting as a baby alarm. This simple low-cost circuit operates on the Master/Slave principle. This is a half-duplex system, in which there is communication in both directions, but in only one direction at any one time. This helps to make the circuit simple and cheap, and means that only a single pair of wires is needed to connect the stations.

One station is the Master, and controls the direction in which messages pass. The other station is the Slave and consists of no more than a loudspeaker, which functions as a microphone or as a speaker, depending on how it is switched into the circuit by the Master station.

HOW IT WORKS

The complete circuit diagram for the Master/Slave Intercom is shown in Fig.1. All of the circuit except for loudspeaker LS2 is housed at the Master station.

The circuit comprises two amplifiers, each of which has different characteristics and function. When switch S2 is set as shown, loudspeaker LS1 is acting as the microphone for the Master station, and LS2 is acting as a true loudspeaker for the Slave station. The action of the circuits is as follows:

Input amplifier

The amplifier through which speech is input from the loudspeaker acting as a microphone is configured in what is known as the common base transistor format. It is based on transistor TR1, which has its base (b) terminal held at a fixed voltage of 2.4V, set by the values of R2 and R3. This is held steady by C2.

When someone speaks into speaker LS1, the movement of the speaker coil in the field of the speaker magnet generates a

small signal (amplitude 1mV or less). This passes through capacitor C1 to the emitter (e) of TR1. Thus, the signal is applied between emitter and base. The output is seen as a signal at the collector (c). Here the signal is between collector and base. Because the base is common to both the input and output signals, the amplifier is called a common base amplifier.

Without going into the detailed operation of the amplifier, we can list its characteristics as:

- High voltage and power gain
- No current gain
- Low input impedance
- Medium output impedance

The low input impedance makes it specially suitable for accepting the signal from a speaker which, having a coil

resistance of only a few ohms, has a very low output impedance. In order to get the signal across to the transistor, we need an amplifier with low input impedance. A common base amplifier is specially suited for this purpose.

The amplifier also provides the first stage of voltage amplification, an important function because of the low amplitude of the original signal. Preset VR1 is adjusted so that the voltage at the collector of TR1 is at the mid-point (3V) when there is no signal. This makes it possible for the signal to swing the voltage up and down without distortion.

Low-power audio amplifier

IC1 is a single audio amplifier in an 8-pin package. It is capable of delivering an output of 250mW into an 8Ω speaker when running on a 6V supply. This is

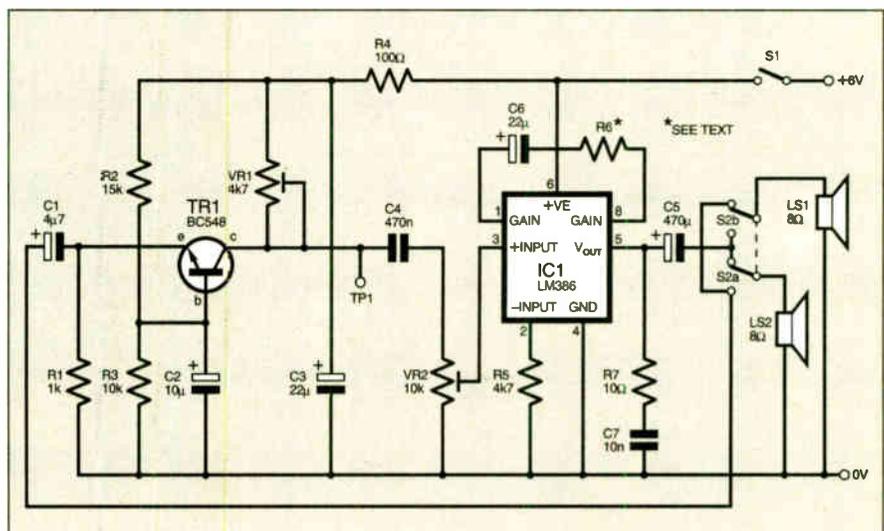


Fig.1. Full circuit diagram for the Master/Slave Intercom.

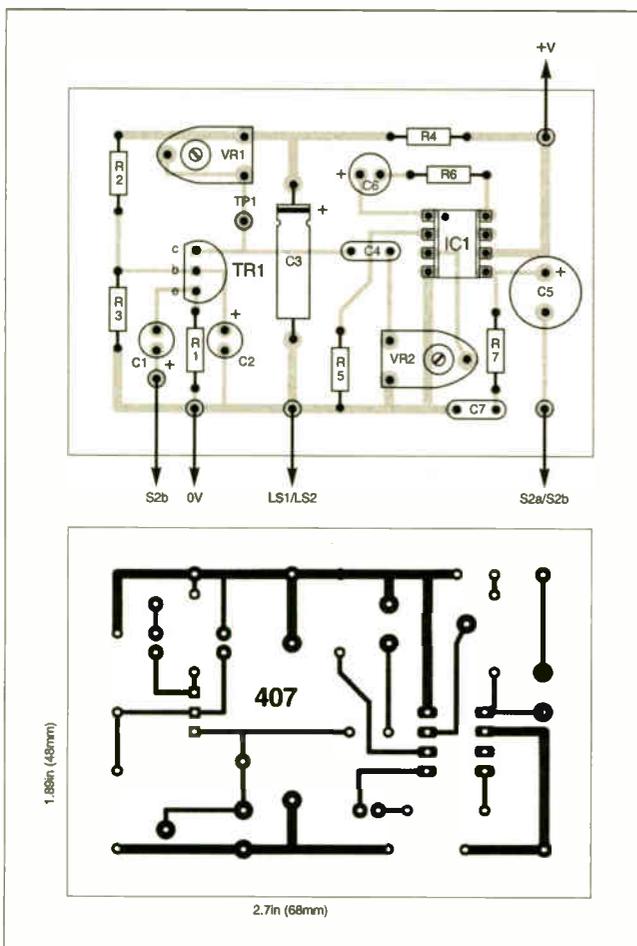
ample output for an intercom system. Its gain is internally set at 20 but can be increased by providing feedback from pin 8 to pin 1 through R6 and C6. Suitable values are:

Gain	R6
20	infinite (omit R6 and R7)
50	680Ω
100	180Ω
200	0Ω (use wire link for R6)

The volume of sound is also controlled by VR2 which can tap off a variable proportion of the output of TR1. The schematic shows this as a preset potentiometer. However, if you prefer to be able to increase and decrease the volume in operation, solder wires to the three pads allocated for VR2 and run these to a rotary potentiometer mounted on the case of the Master Station.

One problem with circuits of this sort is that the large fluctuating current drawn by the sounding loudspeaker can cause appreciable variations in the voltage on the supply rail. These voltage changes affect the operation of the common base amplifier. The circuit goes into oscillation, producing a sound known as "motor-boating" from the loudspeaker.

To prevent this from happening, there is a lowpass filter (R4/C3) on the supply to TR1. A steady supply current passes through R4 with only a slight drop in voltage, while C3 suppresses the variations in the voltage caused by currents through the loudspeaker. If motor-boating gives trouble, try increasing the value of C3. Test point TP is useful when setting up the system.



COMPONENTS

Approx. Cost
Guidance Only
excl. power supply, cases & loudspeakers

£10

Resistors		See SHOP TALK page			
R1	1k	C6	22μ axial elect. 10V (see text)		
R2	15k	C7	10n metallised polyester film		
R3	10k				
R4	100Ω				
R5	4k7				
R6	optional (see text)				
R7	10Ω				
All 0-25W, 5% carbon film.					
Potentiometers		Semiconductors			
VR1	4k7, min. preset, horizontal open skeleton or round (see text)	TR1	BC548 npn transistor		
VR2	10k, min. preset, horizontal open skeleton or round, or panel mounting (see text)	IC1	LM386 audio power amplifier		
Capacitors		Miscellaneous			
C1	4μ7 radial elect. 10V	LS1, LS2	min. loudspeaker, 8Ω, about 57cm dia. (2 off)		
C2	10μ radial elect. 10V	S1	s.p.s.t. min. toggle switch		
C3	22μ axial elect. 10V	S2	d.p.d.t. min. toggle or slider switch		
C4	470n metallised polyester film	Printed circuit board, available from the EPE PCB Service, code 407 (Intercom); plastic case (2 off, see text); 1mm terminal pins (7 off), 8-pin i.c. socket, light-duty single-core connecting wire; light-duty multicore twisted pair for connecting stations; 3.5mm mono jack plug and socket (2 off, see text).			
C5	470μ radial elect. 10V				

CONSTRUCTION

The component positioning and p.c.b. track layout details for the Master/Slave Intercom are shown in Fig.2. This board is available from the EPE PCB Service, code 407 (Intercom).

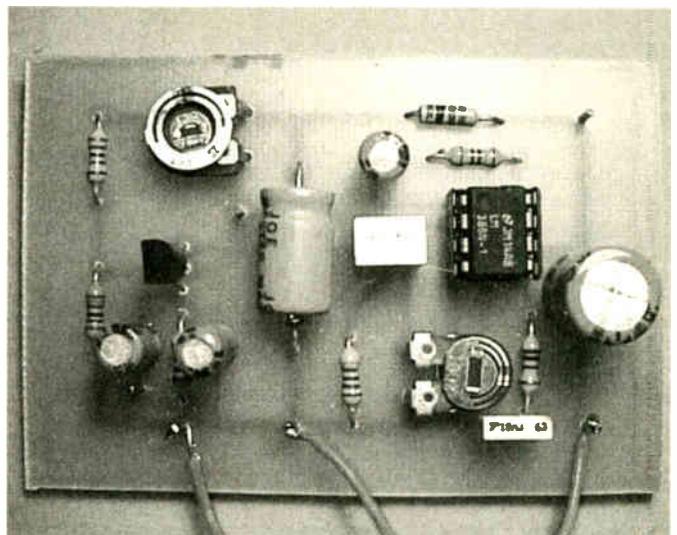
Assemble the board in order of ascending component size, and use a socket for IC1. The board allows for preset VR1 and VR2 to be round or open skeleton types (as just said, VR2 could also be a panel mounting rotary carbon type).

Using a hand magnifier, check the soldered side of the board to see that there are no dry solder joints and no threads of solder bridging between tracks.

ASSEMBLY

The project requires two boxes, each large enough for mounting the speakers. It is essential for the speakers to be firmly attached to their boxes and for the boxes to be closed in at the rear. If this is not done there will be an appreciable loss of volume.

A twisted pair of light-duty wires connects the stations. Fig.3 shows the wiring details. To save costs, it is possible to solder the ends of the wires directly to LS2 and to the terminal pins on the circuit board. However, it is more convenient if



Completed prototype Intercom circuit board.

Fig.2 (left). Printed circuit board component layout and full-size copper foil master for the Master/Slave Intercom.

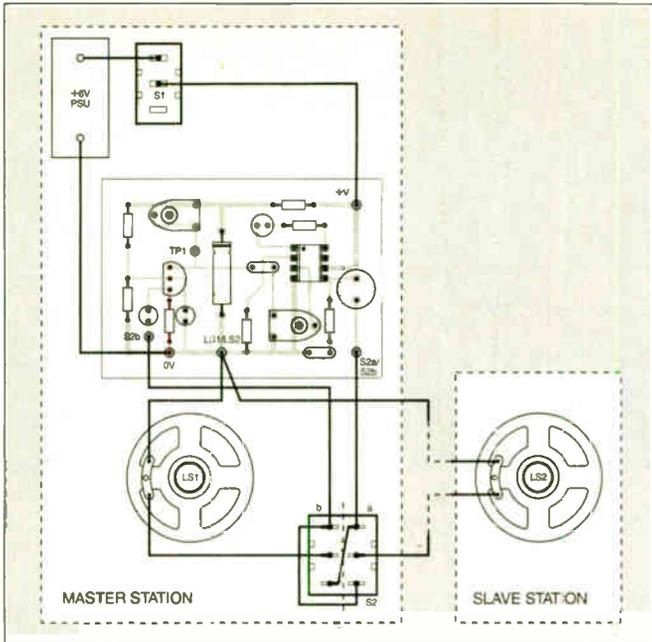
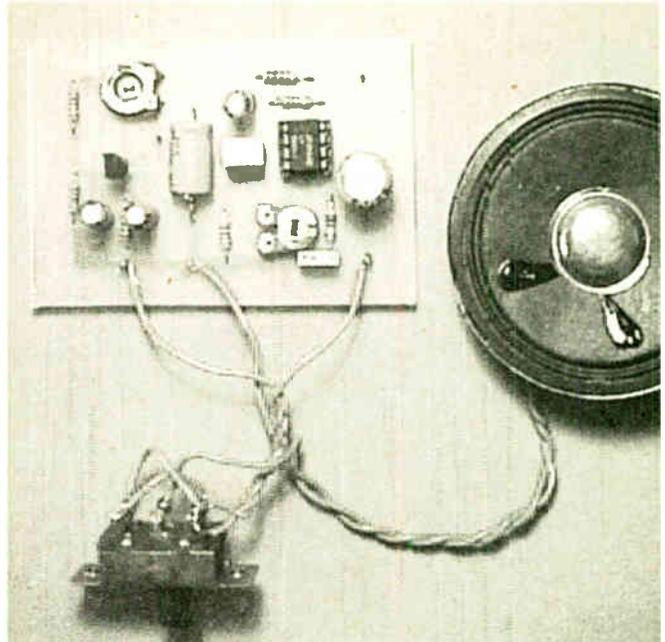


Fig.3. Interwiring from the Master Station to off-board components and Slave Station speaker.



Master Station circuit board and off-board components, except On/Off power switch.

jack plugs terminate the wires, with sockets mounted on the boxes. Also mounted on the box of the Master station are the power switch (S1), and the double-pole double-throw switch Master/Slave Talk switch (S2).

A 6V battery can power the project but this is suitable only if it is switched on for short periods. For longer periods, when used as a baby alarm for example, it is better to use a plugtop mains p.s.u (power supply unit). It should supply 6V d.c. at up

to about 500mA. The unregulated type is suitable and is cheaper.

To set up the system, connect a voltmeter to the 0V pin and to test point TP1. Adjust VR1 until the meter reads 3V. The circuit is then ready for operation. □

ELECTRONIC TWO-UP



Chance your luck with this novel game.

TWO-UP is a traditional Australian gambling game played everywhere from the remote outback to the glitzy casinos of the major cities. The game is played in a Ring, a circular fenced area crowded around by the participants. In the bush, if they are lucky, the players are protected from the burning sun by a corrugated iron roof.

The game is run by the Ringkeeper, who invites one of the participants to be the Spinner. The Spinner holds a wooden device, the Kip, in which are placed two coins. The players lay their bets on the table, then the Spinner flips the Kip. This action projects the coins into the air and they fall to the dusty floor of the outback Ring.

The coins may fall in one of three ways. As might be expected, two heads uppermost is Heads, and two tails uppermost is Tails. One of each is Odds. The probabilities are 25% for Heads and for Tails, and 50% for Odds.

The Spinner wins if they spin three consecutive Heads before spinning either Tails or five consecutive Odds. If the Spinner manages this successfully, they win at seven-and-a-half to one. If the Spinner is unsuccessful, the game continues with someone else volunteering as Spinner.

But this is not all. While the Spinner is trying to throw three Heads in a row, the other players are busily betting Heads or Tails on each spin. They are paid "evens" if they win. If the throw is Odds their bet remains on the table for another spin, but otherwise they lose their stake. After five consecutive Odds all stakes are lost.

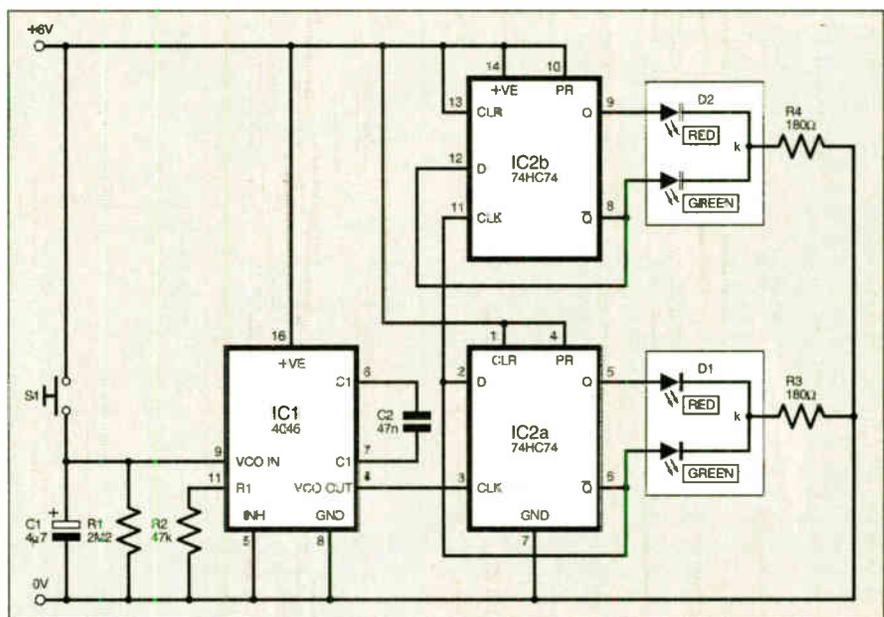


Fig.1. Complete circuit diagram for the Two-Up gambling game

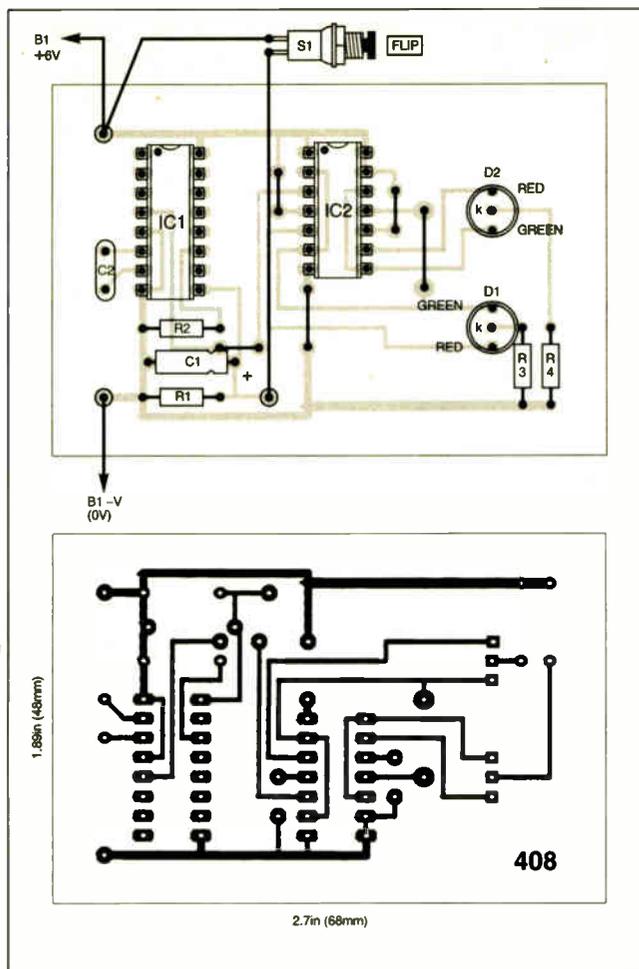


Fig.2. Component layout and full-size copper foil master pattern for the Two-Up guessing game.

BICOLOUR L.E.D.S

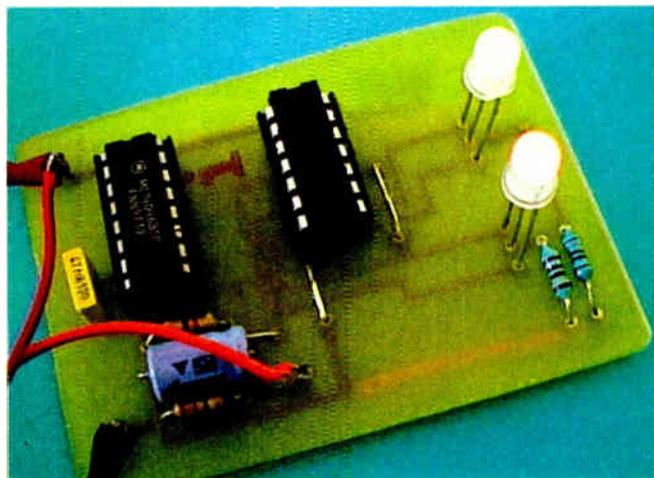
In this electronic version of Two-Up, the coins are each represented by a bicolour l.e.d. This glows red for Heads or green for Tails. The full circuit diagram is shown in Fig.1.

A type 4046 phase-locked loop, IC1, is configured as a voltage controlled oscillator (VCO). To start the l.e.d.s flashing, the Spinner presses and releases switch S1. This charges capacitor C1, so providing a 6V input to IC1 at pin 9. With the values of the timing components, capacitor C2 and resistor R2, specified, the VCO runs at a little over 700Hz.

However, when the switch is released, the charge on C1 gradually leaks away through R1, taking about 10 seconds to fall to zero. During this time the frequency of the output of the VCO slowly falls from 700Hz to zero.

The output signal from IC1 pin 4 is fed to the clock input of IC2a, which is used in conjunction with IC2b to form a 2-bit counting chain consisting of two D-type flip-flops. The outputs from the two counters run through the binary sequence 00, 01, 10, 11, repeating.

The outputs of the first flip-flop, IC2a pins Q and \bar{Q} , are connected to bicolour l.e.d. D1. This contains two l.e.d.s, one red and one green, with their cathodes connected to a common pin. As the flip-flop changes state, the output at \bar{Q} is always the opposite of that at the Q output. The result is that either the red l.e.d. or the green l.e.d. is turned on, but never both together.



Component layout on the Two-Up circuit board. Note the bicolour l.e.d.s are three-pin types.

The \bar{Q} output is also fed to the second counter, IC2b, to give the second digit of the binary sequence, flashing the red and green l.e.d.s of D2 at half the rate of D1.

PLACE YOUR BETS

At first, when capacitor C1 is fully charged, the rate of flashing is so

high that the eye merges the colours and the l.e.d.s appear to glow with a yellowish light. Eventually, as the frequency falls, the l.e.d.s can be seen to be flashing red and green, running through the sequence green-green, green-red, red-green and red-red. In this way the sequence Tails-Odds-Odds-Heads is produced.

As the voltage on C1 drops, the rate of flashing falls more and more slowly, and suspense heightens as the players try to "will" the circuit to stop at a winning combination. At the end, the changes in state come a few seconds apart. Still, there is no telling what the final state will be, so this provides the random element of the game. It also combines the excitement of Two-Up with the suspense of Roulette. Customarily, it is assumed that the game is ended if 10 seconds has passed without a change in the colours, and then the bets are paid or lost.

CONSTRUCTION

The component positioning and track layout details for the Two-Up game are shown in Fig.2. This board is available from the EPE PCB Service, code 408 (Two-Up).

Assemble the board in order of ascending component size, and use sockets for IC1 and IC2. The link wires can be from resistor offcuts. Ensure that the l.e.d.s are the correct way round, as must be the i.c.s, but do not insert them until after the board has been fully checked.

Then insert IC1 in its socket. Check the rise and fall of the voltage at pin 9 as you press and release switch S1. If you have a multimeter with a frequency readout, check the output at pin 4. It should rise almost instantly to just over 700Hz, then slowly fall to zero after S1 is released.

Now insert IC2 in its socket and monitor the signal at pins 1 and 2 (360Hz when S1 is pressed), and pins 12 and 13 (180Hz). If there is no signal at these pins check that pins 1, 4, 10 and 13 are all at +6V. These are the Clear and Reset inputs and the flip-flops do not run if these inputs are not high.

Finally, check that the l.e.d.s shimmer and flash as described. After that, mate, chance your luck in the Two-Up Ring!

COMPONENTS

Resistors		See SHOP TALK page
R1	2M2	
R2	47k	
R3, R4	180Ω (2 off)	
Capacitors		
C1	4μ7 axial elect. 16V	
C2	47n ceramic disc, 5mm pitch	
Semiconductors		
D1, D2	bicolour l.e.d., 3-pin version (2 off)	
IC1	4046 phase-lock loop	
IC2	74HC74 dual D-type flip-flop	
Miscellaneous		
S1	push-to-make switch	

Printed circuit board, available from the EPE PCB Service, code 408 (Two-Up); 14-pin d.i.l. socket; 16-pin d.i.l. socket; 1mm terminal pins; connecting wire; solder, etc.

Approx. Cost Guidance Only
£7

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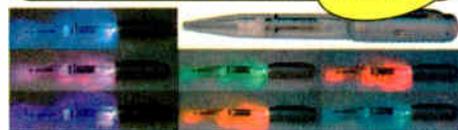


This kit contains a UV mini keylight and invisible ink pen. The UV mini keylight emits ultra violet light which makes the invisible inkpen markings glow brightly. Ideal for security marking valuables, secret messages and UV body art.

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Rainbow Pen

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Now here's a pen with a difference that everyone will want. Simply press a discreet button on the side and the whole pen will light up in a brilliant coloured glow. Press again and the colour changes. Press the button again to cycle through the other colours and one setting cycles continuously through them all! What's more, this great gadget enables you to write in the dark. Ideal when making notes outside at night, or as a passenger in the car.

HLL1090 £3.99

Electronic Stapler

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HLL1084 £14.99

Recording Pen

NEW!!



This high quality ball-point pen is more than it seems. It's also a superb digital recorder that uses no tape. Use it to record and play back reminders or messages. There are 2 channels each offering 10 seconds recording time or one of 20 seconds duration.

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NEW!!



This clever unit will digitally change your voice so that when held to the telephone mouthpiece, you can play tricks on your friends. Comes with six different voices and is complete with battery.

HLL1082 £14.99

Motorcycle Miniature Clock

NEW!!



Ever owned a motorbike? Do you miss it? Remind yourself of what fun it is to be a biker with this terrific metal model, complete with a handy clock built into the rear wheel. Ideal to stand on your desk. Comes in a gift box, with battery included.

HLL1083 £19.99

Roll-Up Calculator



NEW!!

What a great gadget idea. This super flexible roll-up calculator fits neatly into your pocket, handbag or glove compartment. Needs no batteries as it is solar powered and comes complete with handy carry cord.

HLL1089 £9.99

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NEW!!

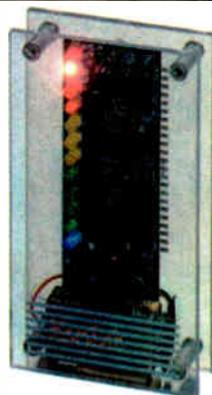


Elegant upright projection clock that will project a clock face onto virtually any flat surface. Ultra fine adjustment means that a sharp image can be seen at a distance of some 15 metres even in daylight.

HLL1077 £69.95

Truth Machine

NEW!!



Never be duped again! This clever little device measures micro tremors in the sounds produced in the vocal chords to determine if someone is telling you less than the whole truth... Great fun in the office or home!

HLL1080 £24.99

Humane Sonic Mole Repellant



**GREENWELD
NEW ITEM
ONLY
£27.99**

Moles or burrowing rodents can ruin your garden, but how do you repel moles without having to resort to traps, harsh chemicals or causing them harm? The ingenious answer could be this sonic Molechaser. Just push the water resistant stake into the ground, switch on, and every 15 seconds it will emit a deep vibrating sound (400Hz frequency) that has been found to remove moles from the vicinity. Safe, waterproof and measures just 38cm long. Uses 4 x D batteries (order code BT0014).

HLL1068 £27.99

Instant Greenhouse Kit



Building your own greenhouse couldn't be easier! This kit has everything you need to create a 15 sq ft tunnel like those used by commercial growers. Perfect for growing early or late in the season as it shields plants from wind and cold. It provides moisture and protects seedlings from birds, insects and other pests. Weather and mildew resistant. The frame and ground stakes are rust resistant. Easy no tools assembly. Measures approximately 59" (L) x 44" (W) x 19" (D) and weight is approx 2lbs.

HLL1050 £14.99

Garden Multi-Tool



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NEW ITEM
ONLY
£9.99**

This lightweight, quality stainless steel multi-tool folds neatly into a handy compact canvas pouch with belt loop. Comprises secateurs with four handy blades which fold away into the handle. Ideal for pruning, taking cuttings, paring and stripping.

TL9111 £9.99

Garden Water Spray



No more dragging around a heavy hose, accidentally blasting soil out of planters, then struggling to rewind the hose. The 24" long spray wand and fitted coiled hose allows easy reach to water hanging baskets and patio plants without bending or stretching. Features an easy on/off finger switch and 5 variation spray shapes from a gradual mist for watering seedlings, to a high pressure water broom effect for cleaning patios, drives, cars, etc.

HLL1067 £29.99

Garden Kneeler/Seat



**GREENWELD
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WAS £45.99
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This clever soft kneeler is a handyman's boon. Made of robust steel tubing designed around a raised, soft, comfortable kneeling platform of polypropylene foam, it also has arms that are just the right height to assist getting up without back strain. And for those jobs where you need a little height - just turn the Kneeler over for a comfy seat or handy step. Folds flat in seconds for easy storage. Was £45.99 - Save £21.00!

HLL1051 Now Only £24.99

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Ensure perfect soil conditions for all plants with the Plant Wizard. Allows you to give your plants, shrubs, vegetables and trees the optimum growing environment. Ensure perfect soil and light conditions for every plant. Prevents overwatering and root rot and saves your plants from unhealthy soil, wet or dark environments. 3 switch positions. No batteries required.

HLL1066 £14.99

Keep Unwanted Animals Out Of Your Garden



**GREENWELD
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ONLY
£39.99**

This portable cat chaser is a cordless ultrasonic repeller that can be placed anywhere. It's built-in PIR motion detector gives a 30ft radius of protection, near the pond, aviary or anywhere in your garden. Single frequency for protection against cats. Runs on 1 x 9V battery (order code BT0015).

HLL1023 £39.99

Twin Speaker Repeller

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HLL1024 £29.99

PIR Motion Sensor



Optional PIR motion sensor for above. Saves power by only triggering sound-waves when it detects movements.

HLL1025 £14.99

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No more flies, mosquitoes or insects to bite and bother you! The ultra-violet light attracts all flying bugs up to 100 sq ft around and on reaching the unit zaps them instantly. Use in any room in the house including kitchen or for barbecues, picnics, camping, caravanning or the beach, etc.

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Every cook knows the benefit of pressure cooking chicken, meat, beans and stews. Now you can pressure cook more quickly and easily with this Microwave Pressure Cooker. Dishwasher safe and with a 10-cup capacity, the cooker comes complete with its own ¾ cup capacity measuring cup and tough, non-scratch spatula for easy stirring. Meals cook faster and your food is tender and tasty, with none of the goodness boiled away! Starter recipes are included for steaming rice, vegetables and more.

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This discreet unit plugs in to any 240V wall socket to give a photo-sensor LED powered night light and bug killer in one! Attracts and kills flies and mosquitos. Ideal for bedrooms, hallways, kitchens, etc. Size 60 (L) x 55 (W) x 100mm (H).

HLL1092 £9.99

Banish Pet Odours



NEW!!

This electronic brush releases deodorising ions that destroys the bacteria that causes doggy smells, leaving your dog or cat smelling fresh and clean. Instead of bathing which removes your pets natural oils, just brush away unpleasant smells in minutes. Large brush head untangles fur, cleans off debris and neutralises odour. Brush plates snap off for easy hair removal. Runs on 9V battery (order code BT0015).

HLL1093 £12.99

Wireless Visitor Alert



NEW!!

This clever unit automatically warns you every time a person or vehicle comes up your drive. Simply put the waterproof detector near your property entrance and mount the wireless receiver up to 400ft away in your house. Receiver requires 3 x AA batteries (order code BT0012). Full user instructions.

HLL1094 £19.99

Solar Garden Light



NEW!!

This new generation solar light uses 50,000 hour superbright LED light to give a warm amber glow to enhance your garden. Totally cordless, it uses sunlight to charge its built-in Ni-Cad battery during the day switching on automatically at night to give up to 8 hours of light. Complete with right angle fitting to attach to your front entrance or spike fitting for lighting flower beds or pathways. Measures approx 7" diameter x 18" high.

HLL1095 £14.99

Desktop Shredder



NEW!!

Keep your private papers private! This powerful desk top electric shredder easily shreds full size A4 paper, credit card receipts, cancelled cheques, etc. Stops them falling into the wrong hands. Press button operation, forward, reverse and stop. Shreds into ¼" strips. Runs on 6 x AA batteries (order code BT0012) or mains adaptor operated (not supplied)

HLL1096 £19.99

Garden Border Edging



NEW!!

Keep your lawn and flower beds neatly separated with this attractive hammer-in edging. Made from strong, flexible, everlasting ABS material, each section locks into the next creating straight or curved shapes around trees, shrubs, lawns or flower beds. Eliminates the need for constant lawn edge trimming and reduces weed transfers. Simply line them up and hammer them in. 20 pieces per pack.

HLL1098 Sherwood Green £9.99

Roll Up & Move Your Jigsaw Puzzle In Minutes



GREENWELD BARGAIN
SAVE £5
NOW ONLY
£19.99

An invaluable problem solver for the puzzle enthusiast. Simply piece your jigsaw together on the Puzzle Roll and both completed and loose pieces cling to the special tabletop acrylic felt mat ensuring that no pieces become lost. When you want to move it, just roll it up! When you unroll it later, you will find that all the pieces have remained in position. Comes with FREE 1000 jigsaw puzzle of Tower Bridge. Size fits up to 2000 piece jigsaw. Was £24.99.

HLL1013 Now Only £19.99

Heavy Duty Paper Shredder



GREENWELD BARGAIN
ONLY
£29.99

Be safe and secure with this heavy duty electric paper shredder. Shred those monthly bills, personal files, private letters, business documents and financial statements. Shreds up to 5 sheets of A4 size paper at the same time into unreadable ¼" strips. Adjustable arm so unit will sit comfortably over any standard size waste paper basket. Mains operated, complete with fitted plug. Speed 8ft per minute. Unit size 33 x 15cms.

HLL1034 £29.99

Eliminate Limescale



NEW!!
Hard water can cost you up to £190 per year in heating and maintenance costs. Your kettle, shower, dishwasher and central heating system all get clogged with calcium deposits that are limescale. The amazing electronic Aquamag is the fast solution to limescale. It plugs into any mains outlet and attaches in minutes to your cold water inlet. Produces an electronic polarising signal that "ionises" the hard water ions, preventing them adhering to the inside of your pipe-work, clearing old limescale and preventing new limescale from forming. The healthy mineral salts remain in solution so there is no taste lost. Costs less than £3 per year to run - pays for itself over and over.

HLL1099 £39.99

Get The Big Picture



NEW!!
 You'll get big screen viewing without spending a fortune when you purchase the TV Magnifier. It will blow even the smallest TV screen up to a massive 26", but will also keep the picture crystal clear. There are no expensive attachments because this is all you need to get an enlarged quality image. You'd pay hundreds of pounds more for a TV with a screen of these dimensions. Installs in minutes. Fits up to and including 24" TV screens. Also ideal for computer monitors.

HLL1103 £29.99

Garden Croquet Set



NEW!!
 Enjoy real English Croquet in your garden, with this high quality set. No longer the preserve of the landed gentry, English croquet is fast growing in popularity as a fun summer sport for the whole family. Our Cottage Croquet Set is hand-crafted from solid hardwood and comprises of: 4 mallets 78cm long with 15cm heads, 4 solid wood balls 7.5cms in diameter, full instructions, 6 steel hoops 2 winning pegs plus **FREE GREEN CARRY CASE**.

HLL1100 £29.99

Never Run Out Of Gas

NEW!!



Ever been caught short with an empty gas cylinder? After all, there's no easy way of telling how much is left and it can so easily run out halfway through a barbecue or much worse on a cold Winters day when you're using your gas heater. Just place the magnetic indicator on the bottom half of the cylinder and once the gas is switched on, the colour of the bar will change below the liquid level telling you how much gas is left. Don't be caught short again!

Q6128 £2.99

Weed Wizard



NEW!!

Easy eco-friendly weeding, no chemicals, just a touch of the Weed Wizard applies a high temperature flame which instantly destroys the weeds internal cell structure causing them to wither and die within a day or two. Eliminates the need for toxic or hazardous chemicals. Ideal for driveways, patios, walls, rockeries, etc. Can also be used for de-icing pavements, frozen pipes, lighting BBQ's, etc. Runs on easy to obtain Butane gas cylinders (not supplied).

HLL1102 £24.99

Multi Neon Wall Clock



NEW!!

Just look at this superb chrome multi neon wall clock, with dual sector Pink/Yellow to Blue/Green. Adjustment of colour change times. Powered by AC adaptor and 1 x AA battery (not included - order code BT0012). 390mm diameter x 96mm. One clock per pack - illustration is to show colour change only.

HLL1070 £39.99

Bright LED Head Lamp



NEW!!

This ultra bright lamp is ideal for biking, camping, fishing, hiking, reading, working under the car and much more. Using 4 super bright LED's instead of normal bulbs, you will have enough light for the darkest of areas. Water resistant and with adjustable light angle, this is ideal for you, or as a gift, or simply if you want another great gadget. Includes 3 x AA batteries.

HLL1107 £17.99

Whistle Keyring Light



NEW!!

This 3-in-1 gadget provides a bright light from its LED and also features an ultra high frequency whistle, capable of being heard from farther away than conventional whistles. It is also a handy keyring.

HLL1108 £9.99

Kara Clip Navigator



NEW!!

The essential outdoor gadget! This smart looking device boasts a digital compass, altimeter, barometer, thermometer, time, date, alarm, countdown timer and stopwatch. Practically the only thing it can't do is pitch the tent! Clips securely to a belt, rucksack, etc. One of the most useful gadgets you can buy whether you are a seasoned hill walker, occasional rambler or just want to work out what the weather's doing!

HLL1109 £54.99

Body & Scalp Massager

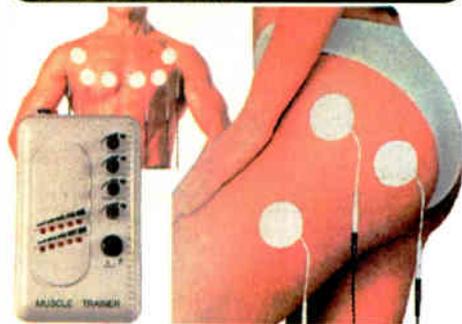


GREENWELD
NEW ITEM
ONLY
£12.99

This compact ultra-vibration travel hair brush and massager vibrates 6,000 times a minute and comes with 4 detachable heads. The hair brush attachment gives you a refreshing, invigorating scalp massage. The facial and body attachments give a deep sensual massage relieving tension and stress and increasing blood circulation. Complete with discreet travel case. Runs on 3 x AAA batteries (not supplied) - order Product Code BT0016.

HLL1059 £12.99

Muscle Trainer



Passive exerciser for the perfect body. Stimulates blood circulation, reduces pain and tension and helps to prevent wrinkles. You can focus on any part of your body and slim down or build up as you want. By placing the pads directly on the problem areas the muscles are gently stimulated. Adjust the strength and frequency to suit yourself and watch your body shape up! Uses 9V battery (not supplied) - order Product Code BT0015.

HLL1060 £29.99

Super Mini Hearing Amplifier



GREENWELD
NEW ITEM
ONLY
£19.99

This marvel of miniaturisation fits comfortably inside the ear to provide a welcome boost to hearing that's not as sharp as it was. Using the integral volume control, you can adjust amplification to the optimum level for every situation, whether you're trying to chat at a noisy party or straining to catch the dialogue from the TV or theatre stage. Discreet and unobtrusive. Complete with 3 size ear pieces and 6 free micro batteries and carry case.

HLL1064 £19.99

Discrete Personal Amplifier



GREENWELD
BARGAIN
ONLY
£19.99

Magic Ear, discrete personal amplifier. The Magic Ear's micro technology is very advanced; it's built-in microphone is extremely sensitive and there's also a volume control to help you adjust to all conditions. In use, Magic Ear is startlingly effective. It'll help you to follow every word of conversations even at a distance. Comes complete with battery. Bargain at under £20.00.

HLL1011 £19.99

Reduce The Risk Of DVT



GREENWELD
NEW ITEM
ONLY
£9.99

Give tired, aching legs the support they need. Reduce the risk of deep vein thrombosis - fits both men and women. These special stirrup stockings are ideal for everyday wear and can be worn under socks or tights and won't add unnecessary bulk around the feet. Perfect in the summer with sandals. Fully washable 85% Nylon, 15% Lycra. Available in small (13"-16" pull) or medium/large (17"-20" pull).

HLL1057 Small £9.99

HLL1058 Medium/Large £9.99

Drug Free Pain Relief



NEW!

TENS (Transcutaneous Electrical Nerve Stimulation) units are widely used in hospitals and clinics throughout the United Kingdom for effective drug free pain relief. This compact unit is now approved for home use. TENS works by stimulating nerves close to the skin releasing endorphins (nature's anaesthetics) and helping to block the pain signals sent to the brain. Relief can begin within minutes and a 30 minute treatment can give up to 12 hours relief or more. The TENS mini microprocessors offer six types of automatic programme for shoulder pain, back/neck pain, aching joints, Rheumatic pain, migranes/headaches, sports injuries, period pain - in fact all over body treatment. Will not interfere with existing medication. Not suitable for anyone with a heart pacemaker. Batteries included.

HLL1104 £29.99

Ab Sonic Electronic Fitness Belt



NEW!

The Ab Sonic firms your body and flattens your stomach by stimulating the nerves that make your muscles contract. Combine the use of the Ab Sonic Fitness Belt with a healthy lifestyle and diet to achieve a firmer and sexier body in just 14 days (depending on your body measurements and fitness). Elasticated velcro fixing to fit tummy, thighs, upper arms, calves, etc. No awkward wiring means that the lightweight Massage Belt is portable and very discreet, no one will know you are wearing it. Six pre-programmed exercise routines with easy to follow instructions. Battery operated (supplied) and includes free bottle of conductive gel.

HLL1105 £19.99

Blood Pressure Monitor



NEW!

Following your doctor's advice on healthy diet and exercise can dramatically reduce high blood pressure. The 64 memory function will monitor your progress as you improve and lower your blood pressure for a healthy long life. Simple, safe and accurate. Automatic large LED blood pressure systolic/diastolic/pulse readout with fuzzy logic. Easy on/off low battery indicator. The best investment you will ever make for your health. Complete with full instructions and 2 year warranty.

HLL1106 £34.99

Talking Pedometer



NEW!

Make jogging fun! This clever talking pedometer clips to your belt or waist and tells you in a clear voice the distance you have walked or jogged. Simultaneously displays number of steps and distance covered. Plays seven tunes to match your walking speed. Also features talking alarm clock with four different sounds. Ideal for ramblers, joggers and golfers. FREE battery included. Measures 6.5 x 5 x 2.5cms.

HLL1110 £12.99

2-In-1 12V Rechargeable Jump Start & Air Compressor

**GREENWELD
NEW ITEM
ONLY
£59.99**



A portable 12V DC rechargeable power supply and boost starter with air compressor in one. An ideal engine starter for cars, power boats and vans and also incorporates a 12V DC power supply for most home, marine and camping applications.

- Provides 400A of starting boost for vehicles with a low battery
- Can be used as a power supply for running 12V DC operated equipment
- Provides up to 50 hours of use with DC appliances including mobile phones, radios and refrigerators
- 260 PSI built-in air compressor as an immediate air supply for tyres, rubber rafts and balls
- Heavy duty booster cables with 400A clamps
- Battery condition and charge level indicators
- Maintenance free sealed battery for safe use and storage
- Supplied with a 230V mains charger and 12V cigar lighter connection for in-car charging
- Weight 8.2kg
- Size 390 x 350 x 160mm

TL9103 £59.99

Paint Beautiful Watercolours



This beautiful artists quality watercolour kit has everything you need to paint your own real watercolour paintings and includes an easy step by step video. 18 permanent watercolour pigments from Burnt Amber to French Ultramarine, Cadmium Red to Alizarin Crimson. Manufactured to European CE Safety Standards. This crafted wooden carry case contains everything you will need to get started and paint beautiful pictures outdoors or inside your own home. Contains 18 Artist watercolours (12ml tubes), 3 quality pig hair brushes, mixing pallet, mixing bowl, water container, eraser, twin sharpener and Artist 2B pencil. 'Learn To Paint' video includes ten of the world's best artists top tips to help you create beautiful pictures to treasure for life and enhance your home. From colour harmony landscapes to still life, set free your creativity. Leading world artists from Alwyn Cremshaw, Roy Camball Smith and Jackie Simmonds.

CDT0233 £34.99

Create Your Own Fridge Magnets

**GREENWELD
NEW ITEM
ONLY
£12.99**



Patented magnetic inkjet paper lets you download any digital photo or image from your camera or computer to make your own birthday cards, holiday greeting cards, photos of the kids or written message. This amazing A4 size inkjet paper is fully flexible and can be cut to any shape to make fridge magnets. Works with inkjet and laser printers. 5 x full size A4 sheets (makes over 100 photo greetings).

HLL1065 £12.99

Light Up The Sky With Night Tracker

**WAS £39.99
SAVE
£10.00**



Possibly the world's most powerful hand-held spotlight. 3.5 million candlepower!

- Ideal security torch
- Used by the M.O.D & Police
- Fully cordless and rechargeable
- Phillips quartz halogen 3.5 million candlepower
- Fully adjustable swivel stands

This must be the world's most powerful hand held torch. Ideal for outdoor activities including camping, fishing, hunting, roadside repairs etc. Dual recharge complete with 12V DC car plug adaptor/charger and mains charger. **Was £39.99.**

HLL1041 Now Only £29.99

Toilet Descaler



**GREENWELD
NEW ITEM
ONLY
£9.99**

No more scrubbing! This chemical free toilet bowl descaler lasts 5 years. Don't waste money on harsh chemical cleaners or spend your time scrubbing. With every flush (up to 50,000) this remarkable cartridge helps loosen and prevent limescale build-up, thus reducing fungus, mildew, bacteria and stains. Hidden in the flow-through cartridge are advanced hydro-mineral magnets and Bact-O-Bane antibacterial fibre. They work without adding anything to the water, or removing anything from it. Measures 4" x 1 1/4" x 1/2". Use two in very hard water. The world's easiest toilet bowl descaler. Just drop it in the tank and it goes to work - preventing mineral build-up and stains.

HLL1055 £9.99

Hidden Wire & Pipe Detector



To avoid the potentially lethal risk of drilling into concealed mains wiring or pipework, a voltage and metal detector is an absolute necessity. This superb detector performs all these functions - and more. With the flick of a switch you can also scan for wooden joists and studs beneath plaster enabling you to locate solid fixing points for shelves and pictures. When metal objects (power cables, wires, nails and pipework) are detected, it will immediately be indicated by a flashing light and a loud buzzer. Uses 9V battery (order code BT0015).

TL9106 £19.99

Spellchecker, Thesaurus & Crossword Solver



**GREENWELD
BEST SELLER
ONLY
£15.99**

This pocket sized Spellchecker, Thesaurus and Crossword Solver can help with words and numbers. The spellchecker has a vocabulary of 160,000 words. Simply type in the questionable word and you'll be instantly told whether that spelling is correct. If incorrect, the checker will advise you of alternatives. The thesaurus feature has 270,000 synonyms based on the 39,000 most commonly used words. Just enter a word to be given a whole range of words with similar meanings. It is also a crossword companion - up to 12 letters per word. It even features a full function calculator with its own protective case. Use it at home, in the office or school and never be stuck for a word. Runs on cell battery (included).

HLL1002 £15.99

Micromagic Cover



This patented microwave food cover is made from a special material that is designed to change colour when your food reaches an even, optimum temperature. No more guesswork or wondering if your food is ready. The specially designed cover will also retain the moisture and food flavour so often lost when cooking or heating food, giving you tastier and thoroughly cooked perfect meals everytime. Generous 26cm fits average dinner plates. Also prevents food splattering the inside of your microwave.

HLL1053 £12.99

Scart Leads

Audio/Video leads. Scart plug to Scart plug, 21 pins connected.

ST0019	0.75m	£1.65
ST0020	1.5m	£1.75
ST0021	3.0m	£2.35
ST0022	5.0m	£3.55
ST0023	10.0m	£4.95

TV/Video Leads

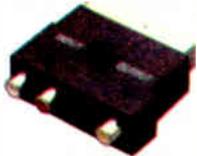
Coaxial plug to coaxial plug. White.

ST0028	1.0m Long	£1.15
ST0029	2.0m Long	£1.35
ST0030	4.0m Long	£1.75
ST0031	10.0m Long	£3.65

Coaxial plug to coaxial plug. Black.

ST0032	2.0m Long	£1.35
ST0033	4.0m Long	£1.75

Handy Scart Adaptor

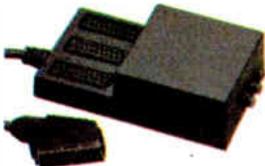


GREENWELD
BARGAIN
ONLY
£4.25

Audio + Video In/Out. Scart plug to 3 x RCA phono sockets and a 4 pin S-video socket, switched for input or output.

ST0024	£4.25
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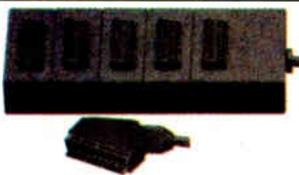
3 Way Scart Switcher



One scart plug to three scart sockets with push button switch to select socket. Lead length 0.5m.

ST108093	£12.95
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Scart Splitter 5 Way



One scart plug to five scart sockets. Lead length 1.5m.

ST108035	£14.50
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2m 4-Way Extension Lead



2m, 4-way extension lead with neon indicator. Bargain at just £4.25.

ST429839	£4.25
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Automatic Night Light



GREENWELD
BARGAIN
ONLY
£4.25

Light up your landing, bedroom, hall or stairs with this plug-in night light. It switches on automatically at dusk and off at dawn. Consumes only 7 Watts when lit and comes with a spare bulb. At this price, you could buy one for all those dark areas around your house.

CDT0152	£4.25
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Spare bulbs for above.

CDT0152B	£0.99
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Telephone Flasher Ringer

GREENWELD
BARGAIN
SAVE £1
NOW ONLY
£6.50



This useful flasher/ringer can be plugged into any telephone socket to indicate incoming calls. Fits straight into the box with a socket on the front for your phone plug. Can be plugged into an extension socket in another room or use an adaptor/extension lead to position it where you want. Ideal for the home or noisy workshops. Was £7.50.

CDT0155	Now Only £6.50
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Temporary Mains Connector



The QuickTest is ideal for electrical shops, factories, laboratories, service and test departments and your home workshop.

- Plugless leads rapidly connected to mains
- Raised lid cuts current for safety
- Tough construction for everyday knocks
- Neon indicator lamp

NB Not suitable for permanent connection to equipment in domestic use.

CDT0154	£12.99
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18' Extension Lead



18 foot (6m), 2-way extension lead.

ST429851	£9.50
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Peace Of Mind With Power Tools



GREENWELD
BARGAIN
ONLY
£12.99

Give yourself added protection against electrocution. Acts as a circuit breaker when earth leakage caused by faulty appliances or damaged cable is detected. Ideal for use with a wide range of household appliances. Particularly recommended for use with electrical gardening and power tools. Simple two button design with prominent indicator window. Easy to use - plugs straight into 13A socket. 3 year guarantee.

CDT0156	£12.99
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Telephone Extension Reel

GREENWELD
BARGAIN
ONLY
£9.99



15m telephone extension lead contained in a white plastic reel. Single socket.

TEL008	£9.99
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Telephone Extension Leads

Telephone extension leads in white with a telephone plug one end and a single low profile socket the other.

TEL016	3m Ext Lead	£2.99
TEL017	5m Ext Lead	£3.99
TEL018	10m Ext Lead	£4.99
TEL019	20m Ext Lead	£6.99

Telephone Extension Kits

Plug-in extension kits consisting of a compact extension socket and double adaptor so you can simply plug in to your existing socket and still use it. Also includes cable clips to make a neat job.

TEL012	10m Ext Kit	£6.49
TEL013	15m Ext Kit	£7.99
TEL014	20m Ext Kit	£8.99
TEL015	30m Ext Kit	£9.99

Watch DVD From Your PC

GREENWELD
BARGAIN
ONLY
£9.99



If you have a computer with an in-built DVD player you can now watch DVD movies on your TV with this neat little kit. As long as your television has a Scart input and the computer an appropriate sound/video card, this Computer DVD to TV kit contains all you need.

AV0002	£9.99
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Just look at this great range of radio equipment new in at Greenweld. Recreate the great days when all the family gathered around the radio with our nostalgic collection. Featuring FM and combining modern technology with elegant design and superb sound, these will be a great investment in listening pleasure.

Dorchester Nostalgic Radio/CD



Relive a bygone age with this superb MW/FM/SW1/SW2 stereo radio receiver/CD player. Rotary volume/on/off, tone and tuning controls. Easy to read illuminated dial scale. Band selection by piano style keys. Motorised lid hiding full-function CD player. Mahogany veneer finish. 275 x 410 x 230mm.

HLL1069 £159.99

Dynamo Torch Radio



Everybody knows about the wind-up radio. But have you actually got one? Now's your chance to own this great invention. Featuring MW and FM, the unit operates by winding to drive the dynamo - this charges the internal Ni-Cad battery store. And that's not all - this great gadget is also a torch! Can be powered by two AA batteries (order code BT0012).

HLL1074 £17.99

Lightweight FM Radio



This scanning FM radio looks the business and doesn't disappoint on performance. The signal is as clear as a bell and the earphones have a curly lead, which helps to stop all those times when you get caught up in your headphone wire! Uses 2 x AAA batteries (order code BT0016).

AV0005 £9.99

MW/LW/FM Nostalgic Radio



This MW/LW/FM nostalgic radio is beautifully finished in a burr walnut effect and really looks great with its illuminated dial scale. Powered by AC mains electricity, this will grab the attention of all who visit your home. Dimensions 200 x 278 x 150mm.

HLL1071 £44.99

MW/LW/FM/Air/Marine/SW1-2

NEW!!

GREENWELD BARGAIN SAVE £30.00



A multi-band radio with automatic frequency control for improved FM performance. MW, LW, FM, air band and SW1-2 reception. AM direction finder. Sockets for microphone, line in and earpiece. 1m, 360° telescopic antenna. Mains or battery power (requires 4 x D batteries - order code BT0014). Size 380 x 265 x 160mm. Normally £99.99.

HLL1008 Now Only £69.99

Airband Radio & Book



This excellent Airband radio from Steepletone is ideal for those who want to take up the hobby of listening to aircraft transmissions, or just for general interest. Priced at an absolutely amazing £14.99, this bargain radio receives airband on 108-136MHZ and FM on 88-108MHZ and even has MW too! And that's not all - this great offer also includes an aircraft radio frequencies and guide book with aircraft recognition section and a free pair of headphones. Offers like this rarely come along and certainly not at this price. Can you believe it - all this for just £14.99. Requires 1 x D battery (order code BT0014). And why not order our super In-Car Audio Adapter featured on the right of this item. Simply plug it into the headphone socket of your airband radio, plug the cassette into your car cassette player and hear aircraft transmissions clearly through your car's speaker system.

AV0006 £14.99

Thirties Style Radio/CD Player



Just look at this thirties style radio/CD player. If you miss the look of your radio receiver of years gone by, why not treat yourself to this beautiful reproduction. Not only does it feature 3 wavebands (MW/LW/FM) but it comes complete with a built-in CD player. Finished in a smart medium oak veneer, the unit features rotary controls for on/off, volume, tuning and band selection. The dial is illuminated and the set is mains powered. Great for you or as a special gift. Dimensions 275 x 200 x 156mm.

HLL1073 £139.99

Replica MW/FM Valve Radio



This replica MW/FM valve look radio looks really good. Complete with 3 LED light-up 'replica look valves'. Rotary controls for on/off, volume and tuning. A particularly nice touch with this super item is the use of burr walnut effect side panels. Powered by 4 x AA batteries (order code BT0012). Dimensions 155 x 95 x 96mm.

HLL1072 £14.99

In-Car Audio Adaptor



Allows you to listen to your MP3 player while you are in your car. Hear your favourite MP3 or CD music while on the move. Connects to your car cassette player and requires no external power supply. Also ideal for use with pocket PC's or even play DVD's on your laptop and listen to the sound through your car stereo. Amazing price! As featured in 'New Scientist' magazine.

ST0017 £8.95

The Alarm That Phones You If There's A Problem



GREENWELD
NEW ITEM
ONLY
£79.99

This new alarm provides protection to your home or office in minutes. No complicated wiring or other installation is required. The alarm features a built-in siren, PIR movement sensor, control panel and built-in auto dialler. If the alarm is triggered, it automatically dials 3 pre-programmed telephone numbers of your choice, alerting you that your home, business or holiday home is possibly being intruded. The in-built microphone enables you to listen to what is going on in your home through the telephone. You can receive messages whilst at work, on holiday or your mobile phone. The unit will need to be placed near to a mains socket and a standard telephone point. The alarm features a battery back-up facility in the event of mains power failure. Anyone entering the room will trigger the alarm (unless the alarm is disarmed by the keyfob). Once activated, the loud 110dB siren will sound for one minute before re-arming itself. Any further movement will repeat the alarm cycle. The alarm is armed and disarmed by the keyfob. **This also has a 'panic' button that will activate the alarm instantly if pressed.**

AL001 £79.99

See And Talk To Callers Before You Open The Door



This system allows you to monitor callers at your front door and see and talk to them before allowing entry. Incorporates a clear black and white 2.5" display. Ideally suited for residential dwellings, sheltered housing, offices, reception areas and any sensitive areas where entry has to be restricted, with the unit allowing for two-way communication. Easy to install and including it's own mains power supply.

AL002 £149.99

Flashing Chimer & Door Button

GREENWELD
NEW ITEM
ONLY
£29.99



Wireless door chime - installs without cables or mains power. Chimer sounds a choice of three chimes/melody when triggered by the door button. Other transmitters can be added to trigger different chimes, emit a paging tone or sound its internal siren. Special flashing strobe option, with mode switch for sound only, sound and flash or flash only settings. Features 50 metre operating range and one year battery life. Chimer stands or is wall mounted.

AL003 £29.99

Personal Alarm & Flasher



GREENWELD
NEW ITEM
ONLY
£5.99

Combined attack alarm and flasher provides a greater protection than regular models. Loud (115dB) siren if hand strap is pulled from unit. Bright flashing beacon is also activated with the siren to show others the whereabouts of the alarm. Can also function as just a flashing beacon for joggers, cyclists, etc. Operates on 1 x 9V PP3 battery. Belt clip. Compact design measures 60 x 80 x 30mm.

AL004 £5.99

Alarm Any Door Or Window

GREENWELD
TWIN PACK
ONLY
£9.99



Alarm any door or window. Pack of 2 tiny alarm units to protect doors, windows, drawers, cupboards, medicine cabinets or any other openings. Uses magnetic sensor aligned alongside each other. Shrill siren sounds immediately until sensor is realigned. Simple on/off switch. Operates from 3 button cells included. Comes complete with window warning stickers. Measures 60 x 30 x 20mm.

AL005 £9.99

Door Phone System



Operates as a regular door chime in everyday use but also lets you talk to any caller before opening the door. The weatherproof bell push mounts outside a door and when pressed triggers the chimer unit (cable is provided to link the units). The chimer can hang from a wall or stand on a surface. Picking up the handset allows you to communicate with the caller outside - the caller does not need to press any buttons to talk back. (The door release button automatically opens the door when fitted with an appropriate lock and power supply - not included).

AL006 £29.99

Window Alarm - Installed In Seconds - Instant Deterrent



GREENWELD
TWIN PACK
ONLY
£12.99

For windows, patio windows or doors with windows. Uses shock/glass breakage sensor and simply mounts to inside of window. Siren sounds immediately upon detection. Two electronic vibration sensors self-adhere to the inside of windows and patio doors. When a window has been struck or broken by a force outside, the window alarm will immediately activate its siren for a duration of 30 seconds. Simple on/off switch on side and takes only a few seconds to install. Supplied with window warning stickers. Each alarm measures 60 x 60 x 20mm. Operates on 3 button cells supplied.

AL007 £12.99

Plug-In Smoke Detector

GREENWELD
BARGAIN
SAVE £3
NOW ONLY
£19.99



Handy smoke detector that can be fitted in seconds. Smoke detectors don't work when the batteries are missing or dead. The new Fire Angel plug-in alarm doesn't have this problem. It simply plugs into any suitable bayonet light fitting above the bulb and the integral battery charges automatically every time you turn the light on and powers the alarm when the light is off. This smoke alarm can be fitted so easily that you could even take it with you on holiday. Was £22.99.

HLL1046 Now Only £19.99

Light Activated Switch

GREENWELD BARGAIN ONLY £4.99



Compact waterproof electronic unit ideal for switching on external lights at dusk (for security) and off again when it gets light (to save electricity). Just install in series with any light bulb rated up to 150W maximum. Not suitable for fluorescent or discharge lights.

ALLSS1 £4.99

Vibration Detector



GREENWELD BARGAIN ONLY £2.40

A surface mounting vibration detector with normally open contacts and adjustable sensitivity. The white plastic box, size 60 x 22 x 15mm is secured with an anti-tamper screw.

ALSS15 £2.40

Security Switches

Reed switch/magnet pairs in various forms designed to be fitted to windows or doors or in many other applications. The switches have Normally Open contacts which are kept closed while the opposing magnet is in place.

GREENWELD BARGAIN ONLY £1.85



Flush mounting NO reed switch/magnet contacts (25mm diameter hole required). 4 wires (2 for the switch + 2 security loop).

AL25W £1.85



GREENWELD BARGAIN ONLY £1.85

Surface mounting NO reed switch/magnet blocks in white plastic with fixing holes. 2 wire connections with 3 spare screw terminals. OA size 62 x 12 x 13mm.

ALA35W £1.85

GREENWELD BARGAIN ONLY £1.10



Flush mounting door switch with a spring loaded ball catch actuator which when depressed slides an internal magnet over a Normally open reed switch to close it. Fitted with 30cm flying leads. Requires a 20mm diameter hole.

ALRBDS1 £1.10

Pressure Mats



Flexible pressure mat for use in alarm systems and designed to be concealed under carpets, etc. Floor mat 720 x 390mm.

ALPMF £5.90

Stair mat 595 x 170mm.

ALPMS £4.60

Alarm Junction Boxes



White plastic junction box - 8 way, size 112 x 13 x 10mm.

ALATB8W £0.45



GREENWELD BARGAIN ONLY £0.45

Creamy yellow plastic junction box - 5 way box secured with an anti tamper screw, size 80 x 22 x 18mm.

ALATB8C £0.45

Window Tape Kit

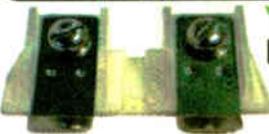
GREENWELD BARGAIN ONLY £6.85



Self adhesive aluminium foil tape 9mm wide supplied on a 45m roll to create a circuit across/around windows. To join wires to the tape use self adhesive twin screw terminals. One 45m roll of tape and three terminals.

ALWT £6.85

Window Tape Terminals



GREENWELD BARGAIN ONLY £1.30

Additional terminals to join wires to the window tape.

ALWTT £1.30

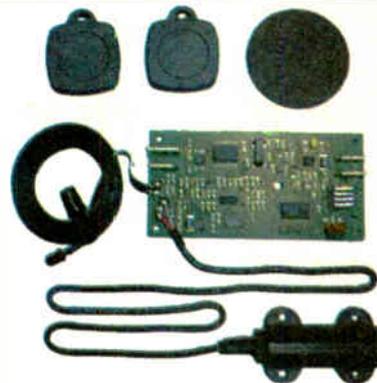
Security Cable

6 core cable suitable for wiring up your alarm system and other low voltage/ low current applications. The six 7/0.2 tinned copper conductors are colour coded within a white PVC sheath. Rated 60V rms, 1A per core. Supplied by the metre or buy a 100m reel for extra savings.

CB5002 £0.40 Per Metre

CB5002/100 £22.95 Per 100m

No Keys Required With This RF System



No more fussing around with keys! Just hold up the radio frequency key fob to the reader and you could open the door, turn on the lights or get access to your computer. The pack consists of 1 RFID assembly of Tag Reader Board with LED and external Antenna, 1 Programming Plate and 2 Key Fobs with unique codes together with a plug-in 240/12V Power Supply (not shown) and full operating instructions. The reader board is mounted in a black plastic enclosure but the picture shows the board unboxed.

*Additional fobs can be purchased separately. The system is also available without the power supply if you have 12V - 15V DC available. OEM and bulk enquiries welcomed. Complete pack as above with 2 key fobs. Please Note: Some wiring is required for the power supply - see our website for details.

Q9200 £34.95

Additional fob.

Q9201 £2.50

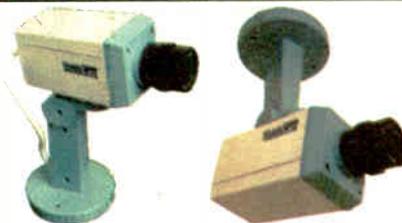
Pack of 10 additional fobs.

Q9201/10 £19.00

Reader assembly pack with 2 key fobs without the power supply.

Q9202 £32.50

Dummy CCTV Camera With PIR Swivel Motion Sensor



Worried about intruders and would like to protect your property? Have peace of mind with this affordable authentic looking surveillance system replicating a closed circuit TV camera. It has a flashing LED light and built in passive motion detector which senses movement and activates a flashing light and monitor movement. Made of high quality weather proof materials. Requires 2 x AA batteries (order code BT0012). The camera measures approximately 13 x 5 x 5cm. Bracket approximately 15cms long.

HLL1011 £14.99

Great Value Batteries & Chargers



Button Cells



A range of popular, long life, alkaline manganese button cells. Nominal voltage 1.5V. Used extensively in calculators, cameras, clocks, etc.

Code	Type	Size (Dia x H)	Price
BT0031	L621	6.8 x 2.1mm	£0.89
BT0032	L726	7.9 x 2.6mm	£0.89
BT0033	L736	7.9 x 3.6mm	£0.89
BT0034	L754	7.9 x 5.4mm	£0.89
BT0035	L1131	11.6 x 3.1mm	£0.89
BT0036	L1142	11.6 x 4.2mm	£0.89
BT0037	L1154	11.6 x 5.4mm	£0.89

EQUIVALENTS

L621	LR60
L726	196, LR59
L736	192, LR41
L754	193, LR48
L1131	189, RW89, LR1130, V10GA
L1142	186, RW84, LR43, V12GA
L1154	A76, RW82, LR44, V13GA

Rechargeable Battery Packs

Rechargeable Ni Cad battery pack 7.2V. 1600mAh.

CDT0077 £9.99

9.6V, 600mAh rechargeable Ni-Cad battery pack. Suitable for ready made cars such as Nikko.

CDT0078 £9.99

2000mA capacity Ni-Cad battery pack, 7.2V. Suitable for fast charging. Fitted with standard connector. Top quality and excellent value.

CDT0100 £12.99

Alkaline Batteries

AA size. Pack of 4.

BT0012 £1.95

'C' size. Pack of 2.

BT0013 £2.30

'D' size. Pack of 2.

BT0014 £2.95

'PP3' size. Pack of 1.

BT0015 £2.45

'AAA' size. Pack of 4.

BT0016 £2.30

12 Pack Alkaline Batteries

How about this for a power packed deal! 12, yes 12 high power alkaline AA size batteries for the amazing price of just £3.99. AA batteries are the most popular size, fitting everything from TV and audio remotes to digital cameras. Save £'s on these super concentrated power cells. Order from Greenweld today.

BT0038 £3.99

Ni-MH Batteries



Rechargeables without the memory effect.

'AAA' size, 1.2V, 550mAh. Pack of 4. Was £8.99.

UN0011 Now Only £7.99

'AA' size, 1.2V, 1300mAh. Pack of 4. Was £7.99.

UN0012 Now Only £6.99

'C' size, 1.2V, 2200mAh. Pack of 2. Was £9.99.

UN0013 Now Only £8.99

'D' size, 1.2V, 2200mAh. Pack of 2. Was £9.99.

UN0014 Now Only £8.99

'PP3' size, 8.4V, 150mAh. Pack of 1. Was £5.99.

UN0015 Now Only £4.99

Ni-MH & Ni-Cad Charger



GREENWELD BARGAIN ONLY £14.99

Charges Ni-MH and Ni-Cad batteries. Will charge 'AAA', 'AA' and 'PP3' type batteries. Fast charger (depending on type). Automatic cut-off. Complete with 4 'AA' Ni-MH batteries.

UN0016 £14.99

Lithium Button Cells



GREENWELD BARGAIN ONLY £0.99

Type CR1220.

BT0004 £0.99

Type CR2016.

BT0005 £0.99

Type CR2025.

BT0006 £0.99

Type CR2032.

BT0007 £0.99

Type CR2430.

BT0030 £0.99

Ni-Cad Batteries



Uniross RechargePlus Ni-Cads suitable for Fast Charging.

'AAA' size, 1.2V, 240mAh. Pack of 4.

UN0001 £3.99

'AA' size, 1.2V, 650mAh. Pack of 4.

UN0002 £3.99

'C' size, 1.2V, 1500mAh. Pack of 2.

UN0003 £3.99

'D' size, 1.2V, 1500mAh. Pack of 2.

UN0004 £3.99

'PP3' size, 8.4V, 110mAh. Pack of 1.

UN0005 £3.99

High Power Chargers & Torch Offers

If you have a digital camera or camcorder you'll know how great they are but you'll also know how they use up batteries. Rechargeables are the answer and these high capacity rechargeables are designed especially for digital cameras and camcorders. With a capacity of 1700mAh they'll keep you going for longer and, because they use Ni-MH technology, **without the memory effect.**

Ultra Fast Charger

**GREENWELD
BARGAIN
SAVE
£5.00**



Just look at this superb charger for car and home. It will recharge Ni-Cad or Ni-MH batteries in just 1 to 2 hours, using either mains electricity or, if you happen to be out and about, from your vehicle's cigar lighter. If you are too busy to hang around waiting for conventional chargers to work overnight, then this is just what you've been waiting for. Look at all these great features:

- Ideal for frequent and intensive use, like digital cameras
 - Plugs into 240V mains or 12V car cigar lighter socket
 - Lightweight and compact
 - Charges in less than 2 hours
 - Comes complete with 4 FREE 1700mAh Ni-MH batteries, which offer over 240% more capacity than standard 500mAh Ni-Cad rechargeables
 - No memory effect
- Was £34.99.

UNRC 01691 Now Only £29.99

Now the better weather's on the way you'll be wanting to use your digital camera and your camcorder. Imagine how frustrating it would be to be miles from anywhere and find your camera battery is flat. Avoid this happening by treating yourself to a handy second battery. Greenweld offer a range to suit virtually every make and model of digital cameras and camcorders. Go to www.greenweld.co.uk and use our powerful search facility to find the battery that you need.

Power Lamp c/w Batteries



Small torch - big power! This handy torch is made from soft rubber. Takes 2 x 'D' type batteries (included).

UN0010 £3.99

Fast Charger With Batteries

This unit will charge Ni-MH and Ni-Cad batteries. Takes AA, AAA and PP3 sizes and comes complete with 4 AA high capacity 1700mAh batteries.

UNRC101678 £23.99

High Capacity AA Batteries

1700mAh rechargeable Ni-MH batteries in a pack of 4. Absolutely excellent value at only £11.99.

UNRB101677 £11.99

Universal Adaptor

Fed up with power hungry devices gobbling up batteries like there's no tomorrow? Save yourself a fortune with this great new high power, 2000mA adaptor. Plug in to any available 240V mains supply and it's ready to use. Ideal for:

- Digital Cameras
- Mobile Scanners
- IT Equipment

Comes complete with 6 connector types. Output voltages 3, 4.5, 5, 6, 6.5 and 7V.

UNRC101708 £19.99

Rechargeable Multi-Function Lamp

This is a truly great torch and especially at this truly bargain price! Just look at all its features:-

- 2 Bright fluorescent tubes
- Flashing red and amber lights
- Spotlight
- Rechargeable battery
- AC/DC adaptor

This tough, ABS lamp is ideal for camping and caravanning, around the home or workshop and as an emergency light in the car. The sealed lead acid battery gives plenty of power and is charged from the mains using the mains charger supplied (fitted with UK plug).

UN0021 £14.99

Mini Lamp c/w Batteries



These excellent mini lamps are ideal for glove compartments, handbags or pocket. Made from soft rubber. Takes 2 x 'AA' type batteries (included).

UNL009 £3.25

Camping Lantern

ABS plastic construction camping lantern. Krypton bulb, 4.8V, 0.75A. Requires 4 x 'D' type batteries (not supplied).

UN0017 £9.99



Digital Camera Li-Ion Batteries

See our website www.greenweld.co.uk for bargain prices on Li-Ion Batteries for Canon, Nikon, Fuji and Sony digital cameras and power tool batteries for Bosch and Makita, or call 01277 811053 for details.

Ideal For:

- **CAMPING**
- **BARBECUES**
- **SUMMER EVENINGS**
- **BOATING**
- **NIGHT FISHING**



WIN THIS SUPERB CYBER CD PLAYER WORTH £99.95!

- PLAYS CD's/CD-R's & CD-RW's
- AM/FM PLL RADIO
- EQ PRESET
- TEMPERATURE FUNCTION
- CLOCK/CALENDAR/ALARM
- ELECTRONIC CD DOOR

GREAT COMPETITION!



All you need do to enter our competition is to answer the following three questions, then fill in your name and address and send this coupon to Greenweld Limited, Unit 14, Horndon Business Park, West Horndon, Brentwood, CM13 3XD. The closing date for this competition has been extended to 31st July 2003. The first correct entry drawn will win the Cyber CD Player worth £99.95. Please use BLOCK CAPITALS.

Name.....
 Address.....

 Post Code.....
 Tel.....
 Email.....

Q1. How much is Greenweld's electronic Digital Caliper - code TL9121?

Q2. How long in inches are our amazing Micro Radio Controlled cars?

Q3. On which page do we feature a complete PicBasic Compiler special offer?

PRIZE DRAW RULES

The closing date for this competition has been extended to 31st July 2003. The first correct entry drawn will win the Cyber CD Player worth £99.95. One entry per household. Employees or associates of Greenweld Limited are not eligible for entry. No cash equivalent is available. No purchase necessary. The judges' decision is final. The winner will receive notification in writing. No correspondence will be entered into. Promoter: Greenweld Limited.
 If you don't want to cut into your catalogue, simply send us the answers and your details on a postcard. Photocopied forms are also accepted.

clocks

GREENWELD

Quartz Movements For Clocks



These quartz clock movements are complete with top quality, dust free cases and integral hanging points. Front and rear plates are held by through screw fixings. The hands can be adjusted from the rear and the side. Central fixing point. Size 55 x 55 x 15mm. Quartz movement for clocks with a face up to 5mm thick.

CL001 £3.55

Quartz movement for clocks with a face up to 12.5mm thick.

CL002 £3.55

Metal Clock Hands



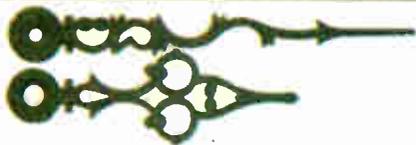
Black finish to suit quartz movement. Minute hand 65mm, hour hand 45mm long.

CL008 £1.99



Black finish to suit quartz movement. Minute hand 80mm, hour hand 60mm long.

CL009 £1.99



Black finish to suit quartz movement. Minute hand 103mm, hour hand 73mm long.

CL010 £2.75



Black finish to suit quartz movement. Minute hand 80mm, hour hand 55mm long.

CL011 £2.25



Second hand to suit quartz movement. Radius 80mm.

CL012 £1.25

Clock Face



Metal, brass anodised. 120mm diameter.

CL013 £3.50

Quartz Pendulum Movement



Quartz pendulum movement for clocks with a face up to 5mm thick. Takes the pendulum bob below or make your own novelty one.

CL003 £6.95

Brass Pendulum



Adjustable brass pendulum 300mm long.

CL004 £4.25

UNIROSS

RECHARGE YOUR BATTERIES



See Pages 12 and 13

The Rechargeable Specialists

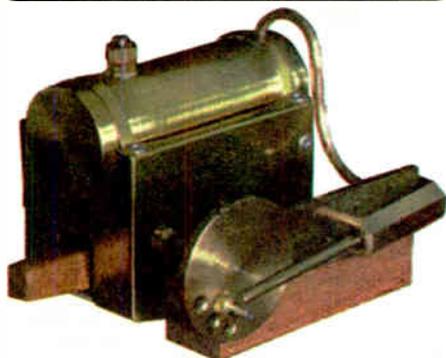
Hot Air Motor Project Kit



Make your own Stirling motor with this kit. The pack contains all the materials needed to produce a fully functional hot air motor. This is NOT a clip together kit! All the most critical parts are prepared but there is a considerable amount of work to be carried out including silver soldering and you will require a few tools. This kit was originally designed for pupils of 15+ but makes an excellent and satisfying project for all ages.

CDT0093 £29.50

Steam Engine Project Kit



This kit requires a considerable input from the constructor and uses various metalworking techniques including silver soldering, folding and drilling to produce a fully functional steam engine in brass. The very detailed instruction booklet shows you how, step by step and includes practical tips for working with metal. Uses solid fuel tablets CDT0095.

CDT0094 £26.50

Solid Fuel Tablets

Solid fuel tablets (ESBIT) for use with the above steam engine kit. Two tablets are required for each heating cycle. Supplied in packs of 20.

CDT0095 £3.75

Soldering Flux

25gm bottle of flux for silver solder. Effective range 500-800°C.

CDT0097 £5.99

Silver Solder

40% silver for all hard soldering on steel, brass and copper. Working temperature 610°C. 1.5mm diameter x 250mm long.

CDT0096 £2.99

Years ago, 'apprentices' were employed to learn the craft of building wooden boats and were instructed by the masters of the trade. Now you too can learn the joy of assembling scale reproductions of the nautical past with your own hands! These are COMPLETE kits, including many pre-cut parts plus a complete fittings set.

Wooden Dinghy Kit



This model is an Amesbury Style Skiff, a type of dinghy designed for use as a yacht tender. It is easily built using the same parts and techniques as the full size boat. It makes an excellent project for those interested in small boat construction. Experience cutting and fitting parts required. Length 10", beam 4", scale - 1" = 1'. Hull construction - die-cut frames, bottom plank, garboard, middle and top planks.

CDT0230 £29.99

Fantail Launch II Kit

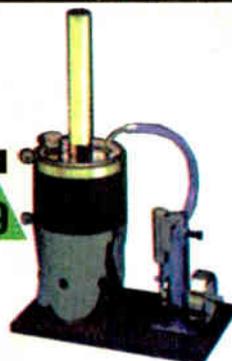


Suitable for R/C and now including the Running Hardware Kit. This model is designed for use with the Model VI Steam Engine (see below - order code CDT0232). The Fantail Launch II is a model of the small open steam launch that is typical of the small yachts used at the turn of the century. Length - 19", beam - 7 3/4", scale - 1" = 1'. Hull construction - die-cut frames and keel, balsa side planking.

CDT0231 £69.99

Model VI Steam Engine Kit

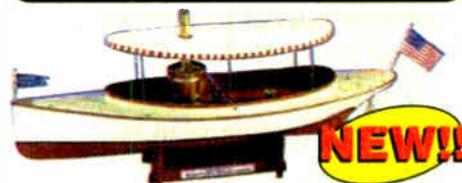
GREENWELD BARGAIN ONLY £75.99



Discover live steam with this single cylinder oscillating engine and vertical boiler. The engine will run for 10 - 15 minutes at a realistic 3 - 4 knot speed. Operation is as simple as spinning the flywheel to start the engine and the 3" x 5" mahogany base is included with kit. Also suitable for use with the Fantail Launch II above.

CDT0232 £75.99

Elliott Bay Steam Launch Kit



Recreate the age of elegance when you build this simple but rewarding model of a steam launch. Suitable for R/C and including running hardware, this kit has a vacuum formed hull, deck and canopy and a wooden interior with mahogany planking and metal fittings. Illustrated with the Heritage Steam Engine shown below. Length 25 1/4", beam 67/8".

CDT0240 £124.99

Heritage Pre-Assembled Steam Engine



As a model on its own or as the power for the steam launch above this engine is pre-soldered and easy to complete in under an hour. Pre-assembled bronze main frame. Pre-soldered copper vertical boiler with pressure relief valve. Complete with all fittings.

CDT0241 £109.99

Building Simple Model Steam Engines - Book 1



GREENWELD BOOK OFFER ONLY £4.95

Tubal Cain. There is a fascination about the simple oscillating steam engine. It may be their sheer simplicity of mechanism, it may be memories of childhood days or may be just the fun of seeing the machine work. This book describes the making of four such models. Designs and methods of construction are clearly detailed, with instructions that even a beginner will be able to follow.

BK9996 £4.95

Building Simple Model Steam Engines - Book 2

Tubal Cain. Since the publication of the first book dealing with these fascinating little engines, the author has designed and built several more. These are now described in this second volume and as in the first book the methods of construction are fully detailed, all being written with the beginner in mind.

BK9997 £5.95

Catapult Launched Rocket

The Saturn rocket is a catapult launched rocket that may be used again and again! At the top of its trajectory a parachute opens and gently takes it back to the ground.



ORDER CODE
DPR3156
ROCKET
ONLY
£4.25

Parafoil Kite (Pocket Size!)

Size 70 x 60cm but soft and portable fits in your pocket! Includes colourful tails, nylon stuffable pouch bag and control handle with flying line.



ORDER CODE
DPRK004
KITE
ONLY
£14.99

Hand Launched Insect Coptors

These fun flying toys are for all children from 5 to 95! Each foam insect is equipped with a helicopter type rotor which is spun by a string and pulley in the hand grip supplied. The models then rise into the air and will fly over 20m. One model per order.



ORDER CODE
DPR2140
INSECTS
ONLY
£9.49

Radio Control Indoor Airship

Enjoy amazing indoor flying action with this multifunction radio controlled indoor airship. 51" (1275mm) long. Incorporating powerful micro motor jet thrusters for complete control over speed and direction; even 360° turns. The easiest way to learn to fly ever...! Includes everything you need to get going.

Please Note:

Helium is required for this Airship, available from florists, party shops, etc.

WARNING:

Helium is an inert gas. Under no circumstances use the highly flammable gas Hydrogen. Not suitable for outdoor use.



ORDER CODE
TY0055
AIRSHIP
ONLY
£69.95



Big, bold and beautiful, these amazing **Aeroplane Kites** are made of tough Rip-Stop nylon and are easily put together in just a few minutes. These fantastic 5' **Airshow Aeroplane Kites** include a Tornado Tailspinner to provide a spectacular air display wherever flown. Designed to be easy to fly using a single line, simple aerobatics may be performed by following the instructions supplied in the Flight Manual enclosed.

ORDER CODE
DPRK002
SAVE £5
NOW ONLY
£19.99



Shark Attack - 5' Wingspan Kite

Brightly coloured 5 wingspan kite. Feel the power of the wind in your hands and impress everyone with this superb kite. Was £24.99.

Bi-Plane - 5' Wingspan Kite

Recreate a bygone era with this lovely 5 wingspan bi plane kite. Much more fun than any ordinary kite. Great gift idea. Was £29.99.



ORDER CODE
DPRK003
SAVE £5
NOW ONLY
£24.99

ORDER CODE
DPRK001
SAVE £10
NOW ONLY
£24.99



Airshow Triplane

Stunning 5' wingspan kite. Bright red in colour. Comes complete with flight control handles, line and informative flight manuals. Excellent gift idea for all the family. Was £34.99.

Amazing Micro Radio Controlled Cars - Just 2" Long!



TY0043 £14.99 TY0044 £14.99 TY0045 £14.99

Yes, we've got them! You may have seen these unbelievably tiny radio controlled cars in shopping malls. They certainly are the latest craze to be sweeping the country. They are not easy to get hold of, but we're happy to say that we've got plenty. Whether you want to race around the office, have fun at home or to give as this year's hottest new present, you won't go wrong. At just over 2" long, they come packaged in a super plastic dome, containing the car and the controller - no wires, no fuss, just hours of fun. Buy several and race each other. Each car has it's own frequency so they can be raced together. Why not buy all three for the great price of just £39.99? Batteries not included - order product code BT0012 (AA) and BT0016 (AAA) - see page 12 for full details of alkaline batteries.

TY0048 All 3 Cars £39.99

Radio Control Cessna Aircraft



An ideal introduction to radio controlled flight. Changeable crystals allow the use of 6 wavebands. Powered by a 4.8V (110mAh) Ni-Cad rechargeable power pack (supplied). The Ni-Cad is recharged via 6 'D' cells inserted into the battery box ('D' cells not included). The plane is controlled directly from the transmitter which requires 4 x 'AA' cells (not included). Fuselage length 480mm, wingspan 640mm. Suitable for 10 years and over.

TY0012 £109.99

Radio Control Mini Tanks



Take a look at these radio-control mini tanks. At just 5cm long, these are ideal for desktop or tabletop combat. Ideal for the stressed executive, or for a quick shoot 'em up at home, these tanks fire an infrared beam, which, if it hits the opponents tank, disables it for five seconds! Complete with audio for extra realism, they are controllable through left and right, forward and reverse, with a 180 degree turret turn. The two tanks are on different frequencies and come complete with their own chargers. You just have to add these to your big boys toys collection - or think what a great gift they'll make.

TY0054 £39.99 Per Pair

Micro R/C Motorcycles



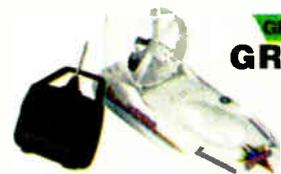
Ever owned a motorbike? Whether you have or not, you can't fail to be impressed and amazed at this latest gadget. This radio controlled micro motorcycle is shorter than a cigarette and a lot longer on fun. Now you needn't be stuck for what to buy for yourself, your friends or your family. Be ahead of the game with this fantastic new item. Needs just 2 x AA batteries (Order product code BT0012 - 4 x AA high power alkaline). Available in two frequencies so they can be raced together.

TY0046 Red £19.99

TY0049 Blue £19.99

TY0050 Both Bikes £35.98

Hawaii Air Boat



GREENWELD GREAT BUY ONLY £85.99

Ideal for shallow water, this great radio-controlled boat is sure to provide hours of fun. With a speed of 2 metres a second, it's pretty fast. Comes complete with 2 channel radio, 7.2V battery and charger and is fully assembled. Fully charged, the boat will run for up to 20 minutes. Ideal gift.

TY0040 £85.99

Sea Royal R/C Boat



GREENWELD BARGAIN ONLY £33.99

Made by Nikko this superb value radio control boat features forward, reverse, left/right turn and stop. Includes safety device to prevent uncontrolled driving as the boat automatically stops when out of range of the transmitter. Also includes handy stand for storage. Complete with hand-held transmitter.

TY0001 £33.99

Air-Tech Stealth & Burner R/C Electric Powered Aircraft

New into the country, the amazing Air-Tech Stealth and exciting Red Hot Burner are made from super tough, lightweight durable foam and look spectacular in the air. Inherently stable, these radio-control aircraft are so easy to fly that you'll be in control right from the start. If you've always promised yourself a radio-control plane, but were always put off by the high cost or complexity, these are just what you need. The aircraft are steered simply by moving the transmitter stick left or right. Just think what super gifts these will make and if you like big boys toys, you've just got to get one on order right away! 680mm wingspan. Includes flight battery and charger.

Needs 8 x AA (order code BT0012) and 6 x D cell (order code BT0014) alkaline batteries.

- ALMOST READY-TO-FLY
- OUT OF THE BOX AND IN THE AIR IN HALF AN HOUR

NEW!! ORDER CODE TY0053 STEALTH ONLY £79.99

NEW!! ORDER CODE TY0052 BURNER ONLY £79.99

SIMPLE TO FLY ELECTRIC RADIO CONTROL AIRCRAFT

30x & 60x Microscope Kit



**GREENWELD
NEW KIT
ONLY
£9.99**

The large world of small things with this superb microscope with 30 and 60 times magnification. To observe the things that are hardly noticeable with the human eye. This new optical design project can also be used in science: Physics - magnification by using combination of lenses; Technology - how optical devices are made; Biology - practical observation of leaves, pollen, insects, bird feathers, etc. Special features include adjustable microscope arm, adjustable mirror, object table with holding springs, stable wooden base and practical storage drawer for lenses. Spare lens and lens carrier plus covering foil are also included.

CDT0224 £9.99

My First Clock Kit



**GREENWELD
NEW KIT
ONLY
£9.99**

Based on the first mechanical clock, developed by the Italian scientist Danti E in 1350. This educational model is made from plastic. A complete mechanical clock with step by step printed instructions. 33 parts to assemble - no tools are necessary!

CDT0225 £9.99

Solar Photopaper

**GREENWELD
NEW ITEM
ONLY
£10.99**



A special paper based on the early days of photography. Lay an object on the paper and place it in the sun for a short time and it will leave behind an outline like a papercut design. Developing and fixing without water or a dark room! Totally safe, made from recycled paper. 20 sheets A5 with instructions.

CDT0228 £10.99

Short Wave Radio Kit



Build your own Short Wave radio with this solderless kit. The baseboard, components and an earphone are included with an illustrated instruction manual. The only extra to add is one 9V PP3 battery. Receives from 6-8MHz (SW1) & 12-18MHz (SW2). Suitable for ages 8 and up.

CDT0235 £9.99

Electronic AM/FM Radio Kit



Build your own AM/FM radio with this solderless kit. The baseboard, components and an earphone are included with an illustrated instruction manual. The only extra to add is one 9V PP3 battery. Receives from 520-1650 KHz (AM) & 88-108MHz (FM). Suitable for ages 8 and up. Educational and fun.

CDT0236 £9.99

Metal Detector



**GREENWELD
BARGAIN
ONLY
£19.99**



Introduce children to the amazing world beneath their feet with this great value metal detector. It's adjustable length means it is suitable for all ages from 7 up and it features an adjustable base plate. Easy to use, lightweight and using just a 9 volt battery, it's both simple to operate and lots of fun for kids (adults might care to have a go, of course!). Complete with LED display and audible warnings. Needs 1 x 9V battery (not included - order code BT0015).

CDT0218 £19.99

Grow Your Own Crystals



NEW!!

Explore the appealing science of crystals! Complete and absorbing activities to see how crystal structures are formed and learn about their importance in nature. Grow your own crystals as well as Stalactites and Stalagmites.

EK025 £12.99

Electric Hovercraft Kit



NEW!!

Everything required to build a working electric hovercraft. Emulate the great Sir Christopher Cockerill in the comfort of your own home! Age 8+.

EK016 £12.99

Inventor Centre Vehicles Kit



NEW!!

This tremendous bumper kit is a combination of popular Techno Kits and examines three different aspects of motion. When the different projects are completed you can use the principles learnt to 'invent', modify and customise your own vehicles! Age 8+.

EK017 £19.99

Electric Paddle Boat Kit



NEW!!

From the building board to the bath in one hour! Construct an electric paddle boat that moves quickly on any flat stretch of water. This is a special purchase item that we have managed to acquire as an end of line product, so stocks are limited - order now to avoid disappointment. Great gift idea. Age 8+.

EK018 £7.50

Visit www.greenweld.co.uk For More Educational Toys And Kits

Bubble Machine



A whimsical machine to construct from simple components which will delight for hours as it churns out thousands and thousands of bubbles! Age 10+.

EK019 £19.99

Electric Buggy Techno Kit



Build a working electric buggy that incorporates a magnetic switch to kill the engine when the vehicle crashes! This simple, educational kit is fun to build and use. Age 8+.

EK015 £14.99

Buzzwire Game



A real best seller! Combines the basics of electronics with the creativity of building a fun game that tests hand-eye co-ordination. Age 8+.

EK020 £12.99

Electric Propellor Car



Using the simple electronic components in this kit you can build your own propeller driven car! Once again great fun and educational too! Age 8+.

EK021 £9.99

Fun To Build Wooden Motorised Kits

Absolutely **NEW** in this catalogue - a great collection of easy-to-build wooden motorised kits. These will make ideal experimental and educational gifts for children and at these bargain prices, you'll be spoilt for choice and value. Kits contain pre-punched boards, pulleys, gears, shafts, switch, motor, battery holder and all parts. Tools required: knife, screwdriver and long-nosed pliers.

Tyrannomech Motorised Kit



Tyrannomech is a new mechanical motorised kit. Gear drive mechanism with swinging arms and mechanical movement of feet. Requires 2 x AA batteries (Greenweld Part No. BT0012).

EK009 £14.99

Stegomech Motorised Kit



Stegomech features gear drive operating mechanical movement of both sets of feet. Gear drive mechanism with mechanical movement of feet. Requires 2 x AA batteries. (Greenweld Part No. BT0012).

EK012 £14.99

Trainmech Motorised Kit



Trainmech features gear drive operating running wheels. Size 220 mm long x 150mm high. Requires 4 x AA batteries. (Greenweld Part No. BT0012).

EK014 £16.50

Coptermech Motorised Kit



Coptermech features pulley drive operating running wheels and rotating propellor. Requires 2 x AA batteries. (Greenweld Part No. BT0012).

EK011 £14.99

Automech Motorised Kit



Automech dragster style car features pulley drive operating running wheels. Requires 2 x AA batteries (Greenweld Part No. BT0012).

EK010 £14.99

Robomech Motorised Kit

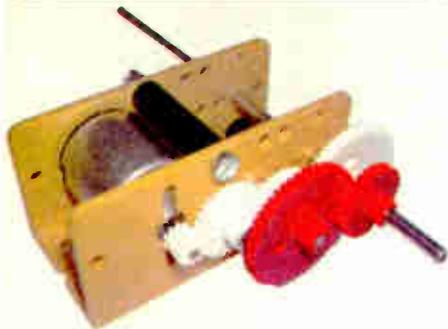


Robomech features gear drive operating swinging hands and mechanical movement of feet. Also with LED flashing eyes. Gear drive mechanism with swinging arms and mechanical movement of feet. Requires 2 x AA batteries. (Greenweld Part No. BT0012).

EK013 £14.99

EVERY CATALOGUE IS DIFFERENT. DON'T MISS OUT ON THE BARGAINS - PHONE, FAX OR EMAIL US NOW TO MAKE SURE YOU GET YOUR FREE COPY OF THE NEXT ONE

Gearbox & Motor Kit

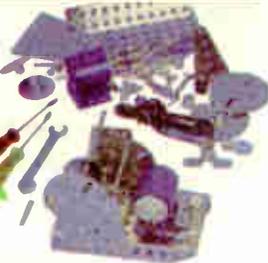


A multi-ratio gearbox supplied in kit form which allows eight different transmissions from 5:1 to 1125:1. Included in the kit is a medium torque motor which will operate from 1.5V to 4.5V DC. The gearbox is easy to mount to any surface with the slots that are provided in the mounting plates. Output shaft is 3mm diameter. Ideally suited to many projects within education. Supplied with full instructions on assembly and gearbox ratios.

CDT0021 £5.50
CDT0021/10 £43.99 For 10

Build Your Own Generator

GREENWELD BARGAIN ONLY £10.95



Here's another fun and educational project designed to show how a small DC motor can be used to convert movement into electricity. This kit contains 65 pieces with metal side frames, gears, the motor and a bulb which lights up when you turn the handle. Everything you need is here including a spanner and a screwdriver.

CDT0092 £10.95

Reversible DC Motor



Geared 16V DC, reversible motor (works well on 12V). Size 61 x 33mm diameter, 10mm diameter gear on spindle. Final drive speed 200RPM.

XB330 £3.00
XB330/2 £5.00 For 2

Motor & Gearbox

GREENWELD BARGAIN ONLY £3.99



A motor and gearbox ideal for modelling projects. The motor operates on 3-6V DC and is connected to the 3mm diameter axle by gears giving a 42 to 1 ratio. The motor, gearbox and axle are mounted in a black plastic cradle with holes for easy fixing. Axle length 125mm.

CDT0160 £3.99

High Torque Motor



3-9V DC motor. High torque. 37mm long x 27mm diameter with flats on both sides. 2mm shaft fitted with 16 tooth, 10mm diameter brass gear. Body has 2 tapped fixing holes.

CDT0009 £1.00
CDT0009/2 £1.75 For 2
CDT0009/10 £7.50 For 10

FOR A RANGE OF GEARS & MECHANICAL ITEMS PHONE FOR INFORMATION OR VISIT www.greenweld.co.uk

Motor



4.8V - 9V motor. A high quality, high speed model motor originally manufactured for use in rechargeable electric drills. Shaft size: D=3mm, L=11.5mm. Body size D=38mm, L=65mm. DC voltage: 4.8V 1.7A @ 8500rpm, 6V 1.9A @ 12,000rpm, 7.2V 1.9A @ 13,500rpm, 9V 2A @ 20,000rpm.

Q0636 £2.95

Cassette Motor



Cassette motor 12V @ 7,000rpm with three mounting lugs. Body dimensions: D = 38mm, L = 35mm. Shaft dimensions: D = 2mm, L = 6mm. Comes complete with pulley 12mm diameter.

Q0637 £1.50

DC Motors

A range of 4 small motors operating on 1.5 to 4.5-6V and one 3-9V with many applications including models, robotics and educational demonstrations. All with 2mm shafts.



30mm long x 20mm diameter with flats on both sides. Speed 14,000RPM at 3V. I=110mA. Stall torque 26g/cm.

CDT0005 £0.40

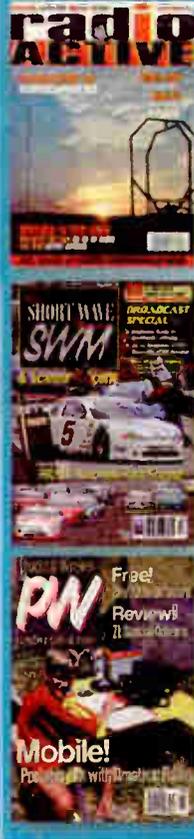
30mm long x 24mm diameter. Higher torque than above. Speed 6,300RPM at 3V; I=110mA. Stall torque 44g/cm.

CDT0007 £0.50

34mm long x 24mm diameter. High torque model. Speed 8,300 at 3V; I=170mA. Stall torque 56g/cm.

CDT0008 £0.60

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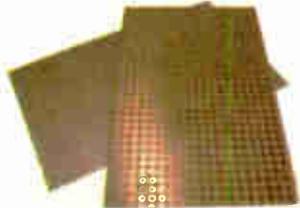
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Prototyping Materials For Circuit Construction

We use these boards in our Kitmaster Kits - because they can be easily cut to size and there are no tracks to cut. Simply use the copper tape to create the tracks where you want them. These SRBP (synthetic resin bonded paper) boards have a matrix of holes for the easy mounting of components and copper pads to solder to and are ideal for prototyping and development purposes. We offer three varieties, all on boards 100 x 160mm with 1mm holes.



Round Pad Cards

With individual round copper pads on one side. Hole spacing 2.54 x 2.54 (0.1"), 38 holes x 61 holes.

CDT0137 £3.65

Hole spacing 5.08 x 5.08 (0.2"), with larger pads, 19 holes x 31 holes.

CDT0138 £2.75

Tripad Board

Similar to the above boards but with rectangular pads covering three holes at a time. Hole spacing 2.54 x 2.54 (0.1"), 39 strips x 20 (3 hole pads).

CDT0139 £3.65

Copper Tape

Self adhesive tape to make conducting tracks on the above boards or for many other uses. 5mm wide x 33 metres long.

CDT0140 £6.59

Test Tubes

Small heat resistant test tubes, 3" x 3/8". Made by Monax.

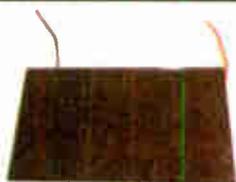
Q1565 £2.49 For 10

Plastic Specimen Tubes

Round bottomed polystyrene test tubes complete with push on caps. Not heat resistant but ideal for transport and storage.

Q1567 £2.49 For 10

Solar Panel



Solar panel. 60 x 100mm glass panel with 60mm flying leads. Unmounted. Output 3V.

CDT0141 £2.90

CDT0141/3 £6.50 For 3

Peltier Element



This thermo element enables you to produce electricity from the temperature difference between the two sides of the element. Alternatively apply an electric current and produce the cooling/heating effect. You'll be amazed at the results from just a 1.5V battery. Fascinating for all. Size 30 x 30 x 4.75mm.

Technical Data
 Used as a Peltier element for cooling/heating:
 Maximum Cold Performance: 17 Watt
 Maximum Temperature Difference: 67 Degrees
 Maximum Output: 8V
 Maximum Current: 3.5 Ampere
 Maximum Working Temperature (Constant): 70 Degrees
 for short time experimental purposes: 110 Degrees
 Resistance: 1.8 Ohm
 Heat Value: 140 mW/K
 Weight: 15gm
 For use as a Thermo element:
 Thermo power: 27 mV/K

CDT0098 £9.75 Each

CDT0098/2 £17.50 For 2

CDT0098/3 £25.00 For 3

Matchbox Crystal Radio Kit



The original was built into an old style matchbox and was probably the smallest commercial radio until Sinclair introduced a transistor version in the 1960's. The kit contains all the parts to build a radio in a matchbox - and includes aerial and earth wires. The components are connected together in a terminal block for which a special screwdriver is provided.

EK022 £12.95

One Valve Radio Kit



Several low-cost one valve radios were manufactured in the 1920's - but needed a high voltage power supply - e.g. an expensive battery. The kit needs only four 1.5V AA batteries (order code BT0012) and either one or two 9V PP3 batteries (order code BT0015). Although the kit uses a later valve, it is laid out and looks like one of the originals. The components, including an authentic ceramic valve base, are pre-soldered onto the main board. Aerial and earth wires are included.

EK023 £14.95

Postcard Crystal Radio Kit



Postcard radios were made to imitate real postcards - but were slightly thicker. The kit comprises a ready to use 2mm thick radio board manufactured using printed circuit technology. Like the many radios of the period, it is tuned by moving a metal plate over its flat coil. (Sometimes coins were used!) Aerial and earth wires are included.

EK024 £11.95

Look at these great new products, just in at Greenweld. Compressed air motors - renewable energy source - just pump them up and watch them go. Just think of all the uses - ideal for car kits, experiments, boats, aircraft and much more.

High Power Propeller Drive



This is a very powerful motor and comes complete with a fixing harness. It has a fantastic power to weight ratio and is capable of taking off vertically if fully pressurised. Can also be used for powering wheeled vehicles.

CDT0242 £8.95

Direct Drive Motor



This is a single cylinder motor designed to drive the axle of a model car. It can be linked directly to driving wheels (or gear train/gearbox) either by the gear supplied on the motor or via a modification to this gear, e.g. a plastic flywheel drilled out to fit over the gear.

CDT0243 £8.95

Air Motor Pump



This all-plastic pump has a tapered connection designed to plug into either air motor.

CDT0244 £3.95

240V Mains Power From Your 12V Or 24V Car, Caravan Or Boat

ATTENTION ALL CAR DRIVERS - MAINS POWER WHEN AWAY FROM HOME!

A complete range of regulated inverters to power 220-240V AC equipment from a car, lorry or boat battery. Ideal for camping, caravanning, boats, motor caravans and of course cars. Power up your desktop or laptop computers, TV's, lamps, recharge your mobile phone - dozens of uses! Due to their high performance (>90%) the inverters generate very little heat, and the high stability of the output frequency ($\pm 1\%$) makes them equally suitable to power sensitive devices. These inverters generate a modified sine wave which, although not perfect, is considerably superior to the square wave produced by most other inverters. This means they are capable of powering electrical equipment such as TV's, videos, electrical equipment, lamps, pumps, battery chargers, etc. INCORPORATES STANDARD UK 3 PIN SOCKET.

Low Battery Alarm

The inverters give an audible warning signal when the battery input voltage is lower than 10.5V (21V for the 24V versions). The inverter automatically shuts off when the battery voltage drops below 10V to stop you completely draining your battery (20V for the 24V versions). Fuse protected input circuitry.



Ideal For:

- Camping
- Caravanning
- Boats
- Cars
- HGV
- Market Stalls
- Fetes
- Renewable Energy Systems
- Airshows
- Picnics
- Amateur Radio
- Laptops
- TV's
- Lighting
- Phone Chargers
- Microwave Ovens
- Video Battery Chargers
- Etc., Etc.

Use With:

Code	Input	Power		Price	Code	Input	Power		Price
		Continuous	Peak				Continuous	Peak	
ST651581	12V	150W	450W	£45.95	ST651578	24V	150W	450W	£45.95
ST651582	12V	300W	1000W	£59.95	ST651585	24V	300W	1000W	£59.95
ST651583	12V	600W	1500W	£109.95	ST651593	24V	600W	1500W	£109.95
ST651587	12V	1000W	2000W	£182.50	ST651597	24V	1000W	2000W	£182.50
ST651602	12V	1500W	3000W	£352.00	ST651605	24V	1500W	3000W	£352.00
ST651589	12V	2500W	5000W	£552.00	ST651599	24V	2500W	5000W	£552.00

Exclusive Offer From Greenweld - Complete PIC Programming And Development Package!!!

L.E.T. PIC BASIC COMPILER



Absolutely new in and exclusive to Greenweld, we are delighted to be able to open up the world of programming computer chips to our customers. We are offering the opportunity to purchase a complete package to get you started. Provided you have a grasp of programming in BASIC, you will have no trouble getting to grips with writing and programming your own chips. There's almost no end to what you can do, from designing and operating a simple flashing LED, to producing a commercially viable data logger - and because the package is licence free, you'll have no worries about royalties.

Greenweld's great value package makes it so easy - not only do you get a super Professional edition compiler on CD, you also get the fantastic L.E.T. PicBasic Compiler Unleashed book.

Normally you would need to buy a book like this separately, but you will receive this highly informative, illustrated book absolutely free in the package. This book is not a tutorial on BASIC, as it assumes you have at least a simple understanding of programming using the BASIC language. What it does offer, superbly and clearly written, is a collection of circuit ideas, building block routines and working projects using the

PicBasic language, which will enable you to gain a better insight into the PICmicro.

It also shows you how to interface with more exotic peripheral devices such as LCD modules, serial eeproms and so on.

Our great package also includes a super PicBasic Programmer with ZIF socket, 5 PIC devices to get you started, a power supply and a parallel cable. All this for just £99.95 - an unbeatable offer!!

Whether you are a seasoned veteran, or a beginner to the world of PIC microcontrollers, the LET PicBasic Compiler has something in it for you.

LOOK AT THIS SPECIAL INTRODUCTORY OFFER!!

To make things nice and easy for you to get started, we have bundled together all the items that you will need.

When you order your L.E.T. PicBasic Compiler you will also receive the following:

- L.E.T. PicBasic Unleashed book
- Users guide
- PicBasic Programmer with ZIF socket
- 5 programmable PIC devices (16F84)
- Power supply
- Interconnecting cable

ALL THIS FOR AN AMAZING £99.95 ONLY FROM GREENWELD

Dallas i-Buttons

We have acquired a quantity of Dallas i-Buttons together with readers.

But what is an iButton?

The iButton is a computer chip enclosed in a 16mm stainless steel can. Because of this protection, up-to-date information can travel with a person or object anywhere they go. The steel button can be mounted virtually anywhere because it is rugged enough to withstand harsh environments, indoors or outdoors. It is durable enough to attach to a key fob, ring, watch or other personal items and used daily for applications such as access control to buildings and computers. Data is transmitted over the 1-wire interface just by touching the button to two contacts on the reader. The DS1990A iButton has a factory programmed 48 bit code which provides each button with its unique identity. Take a look at the website www.ibutton.com for more information.



Dallas DS1990A-F3 64 bit ROM identifier with a 48 bit unique serial number.

Q1612 £1.99

i-Button Metal Key Ring Tag

Metal key ring tag to hold the iButton (glue the iButton on).

Q1613 £0.75

i-Button Reader Device

Reader device to make contact with the iButton. This is just the housing with the mechanical connections. It needs to be connected to a computer or other programmable device to collect the information. Design may vary.

Q1614 £2.00

Diecast Metal Box



Ideal for projects needing a more robust enclosure or screening. Size 171 x 121 x 55mm. Lid secured with six screws.

Q1605 £3.99

Q1605/10 £30.00 For 10

Yuasa 6V Batteries



NP7-6 sealed lead acid battery, 6V, 7Ah. 151 x 34 x 101mm. New and unused.

Q1607 £8.99

Q1607/10 £70.00 For 10

Heavy Duty Geared Mains Motor



This motor has a final output speed of 12RPM from the geared shaft but you also have access to the full speed shaft. 50% duty cycle but if you put a fan on the main shaft you could uprate this. 240V AC. Size (excluding shafts) 64 x 69 x 69mm. Geared output shaft: 8mm dia x 20mm long with flat. Direct shaft: 5mm dia x 18mm long.

Q1606 £9.95

12V DC Solenoid



Medium duty solenoid with spring return. 12V supply. Size 35 x 25 x 20mm. Actuator: 8mm dia x 36mm long. Body has two mounting holes.

Q1608 £1.20

Q1608/10 £10.00 For 10

12V DC Stabilised PSU



A fully stabilised power supply manufactured by Advance providing 5.5A at 12V. The list price on these is over £80 plus VAT. Our special price this month only is £39.99 including VAT. This is new and boxed stock and at this price they are likely to sell out very quickly.

Q1609 £39.99

Neon Test Screwdriver



Standard electrical neon test screwdriver.
Q1611 £1.49

Buy one, get another half price.
Q1611/2 £2.23 For 2

Anti-Static Grounding Cable



A curly anti-static cable 1 metre long with 4mm banana plug at each end. The cable has a resistance end to end of 1 Megohm. The whole assembly is bright yellow. Sealed in original MOD packing.

Q0960 £1.99

Beep Tone PCB



This small PCB (45 x 45mm) produces a 'beep' or 'engaged tone' when connected to an 8 ohm speaker. Runs on 12V DC. The tone is adjustable via a small potentiometer on the PCB.

Q0645 £3.95

Warble Tone PCB



This small PCB (45 x 45mm) produces a 'warble' tone or, by moving a floating plug, a continuous tone, when connected to an 8 ohm speaker. Runs on 12V DC. The tone is adjustable via a small potentiometer on the PCB.

Q0647 £3.95

Round Speaker

2 1/4" diameter speaker. 8 ohm, 0.25W with 9" flying lead.

X8326 £1.00

Special Oval Speaker



5" x 2 1/4" overall, 2" deep. 8 Ohms impedance. This speaker is unusual for an oval speaker in being 5" long but only 2 1/4" high compared to the normal 3".

Q5104 £2.00

Bargain Packs

Greenweld mixed packs are a great value for money way to stock up on those items that you can use on all sorts of projects. The workshop equivalent of the cook's store cupboard basics. Here's a list of some of the packs currently available.

K532	Relay Pack. 20 assorted relays.	£6.95
K611	Pots Pack. 30 various. Log and lin, some switched.	£3.99
K582	Polystyrene Caps. 200 various values.	£4.00
K520	Switches. 20 assorted. Rocker, slide, toggle, etc.	£2.50
K572	Resistor Networks. 100 SIL and DIL. 6 to 16 pin.	£4.50
K712	Crystals. 20 mostly HC60 and HC18U.	£4.95
K603	Small Mixed Hardware. Screws, nuts, washers, spacers, etc. 1Kg.	£4.95
K612	IEC Sockets. 30 panel mounting IEC connectors.	£2.50
K604	Fuse Mix. 100 fuses. 20mm, 1" and 1.25". 100mA - 20A.	£2.95
K528	Electrolytic Caps. 100 axial and radial.	£4.50
K602	Transformers. 15 small-medium including PCB mounting.	£3.95
K616	Large Spring Pack. 20 large springs, tension and compression.	£3.99
K618	Special Washers. Large number spring, shakeproof, crinkle, etc.	£2.49
K610	Assorted Knobs. 12 round knobs and rectangular sliders.	£2.00
K921	Broken Meters. 5 panel meters, damaged or odd values.	£5.00
K607	Lead Pack. 25 leads - audio, computer and power leads.	£2.95
K609	Terminal Strip Pack. 30+ terminal strips, connection blocks and fanning strips.	£2.95
K916A	Small Heatsinks. 30 small heatsinks of various shapes and sizes.	£3.00
K623	LCD's. 10 assorted LCD's from 0.5" x 2" upwards. New but no data.	£4.99
K628	Self Tapping Screws. Small - medium, mostly cross head. Approx 500.	£1.99
K922	PCB's. 5 unpopulated PCB's in various sizes for educational or craft use.	£1.00

Bargain Boxes

As you can imagine we have collected an enormous variety of surplus stock, some of which is difficult to catalogue. To make space for new parcels coming in we are packing some of it in special bargain boxes. These large boxes contain a variety of goodies and may include motors, enclosures, mobile phone accessories, connectors, hardware, and so on. Hours of fun and bargains galore!

BB0001 £9.50 Per Box

BB0001A £16.00 For 2

MR25 Metal Film Resistor Kit



A pack containing a total of 1,000, 0.25W 1% 50ppm precision metal film resistors ranging in value from 1R through to 1MR. A total of 70 different values including many selected from the E24 range to provide a comprehensive spread of resistances.

CDT0145 £19.99

CR25 Carbon Film Resistor Kit



A pack containing a total of 1,000, 0.25W 5% carbon film resistors ranging in value from 4.7R through to 10MR. A total of 63 different values.

CDT0144 £13.99

Interested In Surplus?

Well so are we, and we get lots of interesting surplus that doesn't make it into the catalogue because the quantities are too low to justify the space.

So how can you find out about it? One answer is to keep looking on our website on a regular basis but the other way is to sign up for "SurplusMail".

"SurplusMail" is our regular email newsletter which includes a list of the latest surplus goodies to arrive in our warehouse. This gives you first pick of the new surplus, sale offers and many items which won't make it into the catalogue.

If you don't already receive our emails and want to be added to the list just send an email to surplusmail@greenweld.co.uk with **SUBSCRIBE ME** in the subject line.

Speaker Connections



Spring loaded, 4 red, 4 black for mounting through panel. Also suit low voltage supply or test connections.

X6605 £0.50

Socket



SPCB mounting phono socket. 4-up, colour coded (white, red, blue, yellow). Suitable for audio and video equipment. Was £1.00 each.

Q0384 £1.00 For 2

BA Fasteners



Nuts, Screws, Washers and Solder Tags all supplied in packs of 100.

Steel Nuts

Code	Type	Price
HW2680	2BA Steel Nuts	£1.30
HW2685	4BA Steel Nuts	99p
HW2690	6BA Steel Nuts	89p
HW2695	8BA Steel Nuts	£1.10

Cheesehead Screws

Code	Type	Price
HW2605	2BA x 2	£3.45
HW2615	2BA x 1/2"	£2.39
HW2620	2BA x 1/4"	£2.69
HW2625	4BA x 1"	£2.19
HW2630	4BA x 1/2"	£1.67
HW2635	4BA x 1/4"	£1.47
HW2645	6BA x 1/2"	£1.29
HW2650	6BA x 1/4"	£1.31
HW2660	8BA x 1/4"	£1.37

Steel Plain Washers

Code	Type	Price
HW2700	2BA	49p
HW2705	4BA	49p
HW2710	6BA	49p
HW2715	8BA	49p

Hot Tinned Brass Solder Tags

Code	Type	Price
HW2720	2BA	£1.99
HW2725	4BA	£1.99
HW2730	6BA	£1.99
HW2735	8BA	£1.99

ISO Metric Steel Screw Kits

A range of kits of bright zinc plated slotted pan head screws and full nuts and washers. All sizes of screw and nut are individually packed in resealable plastic bags.



M2.5 kit contains: 100 x 6mm screws, 100 x 12mm screws, 100 x 20mm screws, 300 nuts and 300 washers (total 900 items).

HWPK0001 £9.99

M3 kit contains: 200 x 6mm screws, 100 x 12mm screws, 50 x 20mm screws, 50 x 25mm screws, 400 nuts and 400 washers (total 1200 items)

HWPK0002 £10.49

M4 kit contains: 100 x 6mm screws, 100 x 12mm screws, 50 x 20mm screws, 50 x 25mm screws, 300 nuts and 300 washers (total 900 items).

HWPK0003 £10.99

Brilliant Component Analyser!



**GREENWELD
NEW ITEM
ONLY
£59.99**

Got a box of components you can't identify? Can't lay your hands on the data sheet you need? Forgotten the pin-outs? The Atlas is a new generation of intelligent component analyser which brings a world of component data to your fingertips. Just connect the three colour coded test leads and press the button! The Atlas features:

- Automatic component identification of: Bipolar and Darlingtons transistors Enhancement and Depletion Mode MOSFET's Junction FET's Triacs and Thyristors Standard and Bicolour LED's Diodes and Diode networks
 - Automatic pinout identification for all the above component types.
 - Special feature identification such as diode protection and resistor shunts.
 - Gain measurement for transistors.
 - Gate threshold measurement for Enhancement Mode MOSFET's.
 - Semiconductor forward voltage measurements for diodes, LED's and transistors.
 - Semiconductor test current measurement.
- The Atlas analyser will save you hours of wasted time. Just what the well equipped workshop needs.

TG0001 £59.99

Replacement battery for above.

BT0011 £0.99

LCR Tester



**GREENWELD
NEW ITEM
ONLY
£79.00**

The Atlas LCR is an advanced instrument that greatly simplifies the testing of passive components. Traditional LCR bridges are inherently complex and very time consuming to use. The Atlas LCR automatically identifies the type of component (Inductor, Capacitor or Resistor) as well as its value together with further component data, such as the DC resistance of an inductor. Just clip the universal test leads to your component and press the test button. It automatically selects the best signal level and frequency for the test component. Ranges: 1uH to 10H, 1pF to 10,000uF, 1R to 2MR. Basic accuracy is 1%. Universal test probes are detachable, allowing use of many different probe types including SMT tweezer probes.

TG0002 £79.00

(If you want to read the comprehensive user guides on the two testers before you buy just visit our web page www.greenweld.co.uk/data.)

Computer Microscope

NEW - QX3™ Plus Computer Microscope - view objects at up to 200x magnification on your computer screen.

No more peering through a small lens. Now all the family can see what's under the microscope. This superb microscope magnifies anything from 10x all the way to 200x. You can view everything from the pre-prepared slide of a honeybee leg to a close up of your own tongue.

Much More Than Just Slides

The most impressive thing about this microscope is the fact you can take it out of its slide-viewing cradle. As long as it's still plugged into the computer, you can magnify anything with it: the hairs on your arm, your eyeball, flowers, or even the hidden microscopic text on money. While it is harder to focus using the microscope in handheld mode, it allows children to interact with a moving and alive world, rather than the pre-prepared, dead, flat world of the traditional microscope.

Movies Of The Microscopic

Another great feature of the microscope is that it's not just a stills camera, it's a movie camera too. Carpet fly-overs, centipede's leg articulation or flies digesting their food can all be captured. You can even create a time-lapse movie. Photographing a sprouting seed over hours and then playing the images back as a movie is an amazing leap forward from the static view of a traditional microscope.

System Requirements:

Available USB port • Intel Pentium, Celeron 200MHz or processor that is comparable or faster • 32MB of RAM • Minimum 150MB hard drive space CD-ROM Drive (to load software) • 800 x 600 display, 16bit colour Windows compatible sound device • Works on Microsoft Windows 98/98SE/Me/2000/XP



**ORDER CODE
TG0003
MICROSCOPE
ONLY
£89.99**

NEW!!

- See the image on your computer screen
- 10x, 60x and 200x magnification
- Save images on your computer
- As supplied by Intel to UK schools
- Works with Win98, ME, 2000 and XP
- Plugs straight into your PC's USB port

Sound Level Meter



NEW!!

This versatile analogue sound level meter will measure sound levels in just about any environment. Ideal for factories, schools and airports as well as domestic applications such as studios or home cinema installations, etc. Powered by a 9V PP3 battery (included) the unit is completely portable and easy to use.

Specification:

- 7 Sound level ranges from 50dB to 126dB
- 2 Frequency weightings
- Fast and slow response settings
- Battery condition monitor
- Phono output for connection to other test equipment
- Tripod bush

ST952422 £59.99

Membrane Keypads



A selection of 5 keypads. Each has 8 tactile keys with a 9 way connector cable. Some have LED and display areas but this can be cut away to leave the keypad. Basic keypad 107 x 39mm.

Q1590 £1.95 For 5

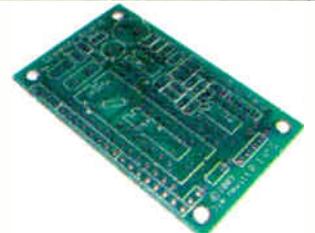
Speech Chip



The speech chip is back in stock. The SP0256-AL2 produces all 59 phonemes of the English language plus 5 pauses of different lengths. Each of the phonemes are individually addressable which makes the SP0256 capable of saying anything which can be said in the English language. This is the easiest approach to universal speech synthesis and the speech quality is that of a good robot voice. Search the net and you will find loads of reference to the use of this chip in robots, etc., with masses of circuit ideas and chip specification.

Z733 £9.50

Speech Chip PCB



We now have a PCB measuring 38 x 63mm for the speech synthesis chip circuit. Supplied with construction details.

Q1604 £10.99

SPECIAL OFFER! Buy the speech chip and PCB above at the special combined price of just £19.50 (price separate £20.49).

Q1604SP £19.50

Pocket Sized Digital Multitester



SPECIAL OFFER ONLY £7.50

A compact pocket sized, 3.5 digit multitester with 19 ranges and six functions. Selectable by rotary control, which includes diode test and hFE test.

DC Volts	200mV - 1000V ($\pm 0.5\%$)
AC Volts	200V - 700V ($\pm 1.2\%$)
DC Current	200 μ A - 10A ($\pm 1.0\%$)
Resistance	200R - 2MR ($\pm 0.8\%$)

ST600006 £7.50

Digital Multimeter



WAS £17.95 SALE PRICE NOW £15.95

Digital multimeter, DMT-1030. 3½ digit, 13mm high LCD display. DC volts up to 1000V, AC volts up to 750V, DC Amps up to 10Amps, resistance range up to 10Meg. Diode test, continuity buzzer, test signal output for signal tracing and transistor tester. Works off a 9V DC PP3 battery (included). Includes test leads and manual. Was £17.95 originally.

X8391 £15.95

Power Supply



UK plug-in power supply. 13.5V DC @ 700mA. With 2 metre of cable and DC power plug.

Q0386 £2.50

12V DC Power Supply

GREENWELD BARGAIN ONLY £6.99



This handy plug-in power supply simply plugs into the mains to give you 12DC @ 800mA via a built in cigar lighter socket. You can now use your 12V car equipment (mobile phone chargers, mini vacuums, etc) in the house. Also ideal for testing equipment in the workshop without worrying about running your battery down.

ST660430 £6.99

Digital Multimeter



GREENWELD BARGAIN ONLY £9.95

Don't struggle on without a meter. For less than a tenner you can have this excellent digital model, DMT1005. 3½ digit 12mm LCD display. 9V PP3 battery, test leads and manual.

DC Volt	200M, 2000M, 20, 200, 1000V
AC Volt	200, 750V
DC Amps	200 μ , 2000 μ , 20mA, 200mA, 10A
Continuity	200R, 2000R, 20k, 200k, 2M
Diode & Transistor Tester	

X8478 £9.95

Digital Clamp Meter



Features data hold and continuity test with buzzer. Supplied in a leather carry case.

DC Volts	1V - 1000V ($\pm 0.5\%$)
AC Volts	1V - 750V ($\pm 0.6\%$)
AC Current	0.1A - 1000A ($\pm 2\%$)
Resistance	200R - 2000MR ($\pm 2\%$)
Maximum Display	1999
Power	9V

ST600616 £19.99

9-18V DC Switch Mode PSU

GREENWELD BARGAIN ONLY £19.99



Compact, light and energy efficient switch mode power supply with regulated output voltage range from 9-18V DC. Features short circuit protection, automatic thermal cut off, automatic overload cut off and small ripple current. Output current 800mA (9/12V), 1200mA (15/18V). Complete with 7 different adaptor plugs for various appliances. Accepts input voltage from 100-240V AC 50/60Hz. 3 interchangeable plugs for UK, USA and European (Shuko) operation.

Input Voltage	100-240V AC
Output	9/12/15/18V DC
Max Current	1200mA
Adaptor Plugs	2.5mm/3.5mm/5.0 x 2.1mm/5.5 x 2.5mm 3.5 x 1.35mm/4.1 x 1.7mm/2.35 x 0.75mm

ST661010 £19.99

Analogue Multitester



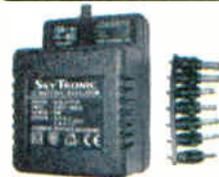
GREENWELD BARGAIN ONLY £9.25

Good quality analogue multitester with 18 ranges and 5 functions including continuity and battery test. Large, easy to read mirrored scale and LED for continuity test.

DC Volts	250mV - 100V
AC Volts	10V - 100V
DC Current	0.25mA - 500mA
Resistance	500R - 5MR
Battery Test	0.8 - 1.6V

ST600439 £9.25

300mA Power Supply 3-12V



GREENWELD BARGAIN ONLY £5.50

Power up all your battery operated gadgets with this useful dual polarity mains power adaptor. Regulated universal power supply. 300mA. Selector switch for 7 different output voltages between 3V and 12V. Fitted with an on/off LED indicator and 7 adaptor plugs. Switchable polarity by reversing the plug.

Input	230V AC/50Hz
Output Voltages	3, 4.5, 6, 7.5, 9, 12V DC
Switchable Max Current	300mA

ST0004 £5.50

Bench Type Power Supply



GREENWELD BARGAIN ONLY £16.95

Bench type, regulated universal power supply with selector switch for 6 different output voltages between 3V and 12V. Fitted with an on/off LED indicator and red and black terminal posts. On/Off switch on the rear. Fully protected for thermal, short circuit and overload plus a current limiter.

ST0005 £16.95

30W Soldering Iron For Just £5.50



Budget soldering iron ideal for the hobbyist and many small domestic or electrical soldering applications.

ST700744 £5.50

60/40 Solder

TL9991	22 SWG, 100gm reel.	£2.00
TL9954	22 SWG, 500gm reel.	£7.90
TL9953	18 SWG, 500gm reel.	£7.50
TL9955	18 SWG, 17gm tub.	£1.50

Low Voltage Digital Soldering Station



**GREENWELD
NEW ITEM
NOW
£59.99**

This high-quality soldering station controls the tip temperature between 150°C and 480°C. The digital read-out allows you to set the desired temperature on the LED display and the sensing system in the heating element allows the station to control the temperature within +/- 6°C via a 24V transformer. Earthed tip for soldering static sensitive circuits with auxiliary grounding terminal. Overheat protection. Soldering iron rest can be placed on the left or right hand side of the base to suit your requirements. The balanced soldering iron has a fine point tip, ceramic heating element, a special non-slip grip and a 1.1m heat resistant silicone cable. Spare tips available - ask for details.

ST703050 £59.99

500W Hammer Drill



**GREENWELD
NEW ITEM
ONLY
£19.99**

Look at this for a deal! Variable speed hammer drill with forward and reverse. Drills wood, metal and plastic. Ideal for the DIY enthusiast. A bargain at just £19.99.

TL9100 £19.99

19 Piece Power Tool Set

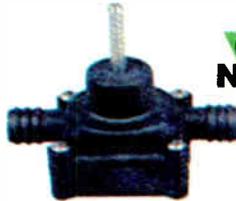


**GREENWELD
PRICE CRASH
SAVE £15
NOW ONLY
£24.99**

Don't spend money on new tools for every job - this super value 19 piece power tool set does the lot! Sands, saws, sharpens, drills, polishes, grinds, cuts and shapes. You can use it on metal, ceramics, wood, plastic and glass. Contains super hard multi-adjustable wrenches, eight piece drill set including saw drill, two multi-rotor discs, super wire cutter, versatile glass cutter and blade sharpener. Was £39.99.

TL9110 Now Only £24.99

1/4" Shaft Drive Drill Pump



**GREENWELD
NEW ITEM
ONLY
£7.99**

A compact, lightweight pump capable of pumping 500 litres per hour when used in conjunction with a drill set at 2000 RPM. The pump is ideal for emptying flooded rooms, ponds, fish tanks, etc. Manufactured to be used with 1/2" piping.

HLL1005 £7.99

12V DC Impact Wrench



**GREENWELD
NEW ITEM
ONLY
£39.99**

Electrically removes wheel nuts using the car's own 12 volt supply. Built in LED for night use. Total torque developed over 250 ft/lbs. Removes even the most stubborn of wheel nuts. Complete with four Chrome Vanadium sockets. Removes wheel nuts in around 3-4 seconds. Fully reversible in order to re-fit the wheel nuts.

TL9107 £39.99

Micro Gas Blow Torch



Turbo flame micro gas blow torch. At under 75mm long this super little metal butane torch offers big torch power in the size of a cigarette lighter. Windproof, reliable Piezo ignition, refillable and adjustable.

CDT0237 £6.99

Electronic Digital Caliper In Plastic Storage Case



NEW!!

Measuring range 0-150mm and 0-6 inches with an accuracy of ±0.001". Measurement readings can be switched from metric to imperial (and vice-versa) at the touch of a button.

TL9121 £29.99

Illuminated Magnifier



**GREENWELD
BARGAIN
ONLY
£46.00**

A superb magnifying light for home, academic or commercial use. This light with a 5" diameter, scratch resistant magnifying glass on a cantilevered stand comes complete with a 22W fluorescent tube, a strong table clamp and cable fitted with a UK plug. The lens has a focal length of 33cm (3 x dioptries). Hands free operation and shadowless illumination from the circular tube make the ideal light for many applications. So whether you are trying to paint OO gauge engines, sewing delicate embroidery, examining specimens or checking for dry solder joints this is the light for you.

ST700015 £46.00

Hacksaw



**GREENWELD
SALE
SAVE £2
NOW ONLY
£3.99**

This general purpose hacksaw with a comfortable moulded plastic handle is made by Eclipse in the UK and takes standard 12" blades. It comes with one 24 TPI blade suitable for metal and plastics. Was £5.99.

Q0799 Now Only £3.99

2 In 1 Saw Drill



Does more than drills holes, it also cuts, reams and saws difficult odd shaped apertures in most materials. Coated with ultra-hard titanium nitride it cuts faster and cooler. Suitable for woods, plastics and metals. Fits any 6.3mm or larger drill chuck.

TL9102 £6.95

7.2V Drill



**GREENWELD
BARGAIN
ONLY
£19.99**

7.2Volt drill with rechargeable Ni-Cad battery, fast charger and 11 piece accessory set. On/off switch. Keyless chuck.

TL9109 £19.99

Computing For The Older Generation

- Especially written for the older generation, using plain English and avoiding technical jargon
- Large clear type for easy reading
- Topics covered:
 - ~ Choosing, setting up and understanding your computer
 - ~ Writing letters, leaflets, invitations, etc
 - ~ Keeping track of your finances
 - ~ Using databases
 - ~ Using the Internet to find information
 - ~ Using email to keep in touch
 - ~ Making copies of your work
 - ~ How to use Windows XP to help people with impaired vision, hearing or mobility



BK9862 £7.99

The Internet For The Older Generation



This book explains how to use your PC on the Internet and covers, amongst other things:

- Choosing and setting up your computer for the Internet
- Getting connected to the Internet
- Sending and receiving emails, photographs, etc
- Searching for and saving information
- On-line shopping and home banking
- Setting up your own simple web site

BK9865 £7.99

Sorry, Wrong Number - The Abuse Of Measurement

The world is driven by numbers and many of them are misleading or just plain wrong. In this book John Brignell (Professor of Industrial Instrumentation at the University of Southampton for 20 years) examines some of the tricks and deceit practised by politicians, bureaucrats, quasi-scientists (junk, pseudo or just bad) and SIFs (Single Issue Fanatics) who manipulate numbers to persuade us to do what they want.

BK9994 £14.00

Royal Armoured Corps Video - Battle Day

The Royal Armoured Corps put their powerful tanks to the test in this exciting video of the Battle Day at Bovington Camp. Action packed, this video will appeal to all military enthusiasts. 30 minutes.

VID016 £10.99

Babani Computer Books

Computers are undoubtedly wonderful and powerful tools that have transformed the way we live and work. People of all ages are learning to get to grips with CD-ROMs, RAM, hard-drives, peripherals, the Internet and so on. However, not everyone knows what to do when and if computers go wrong, or want to add a new printer, or even link up more than one PC. That's where the Babani Computer Books come into their own. Well written, clear and ideal for beginners to experts, this selection of books will help you, no matter what you need to know about computers. Add them to your shopping list today.



Code	Title	Price
BK9845	Windows XP Explained	£6.99
BK9847	Easy Windows XP Troubleshooting	£7.99
BK9848	MS Works Suite 2002 Explained	£7.99
BK9849	Getting The Most From Windows XP	£7.99
BK9853	How To Use MS Frontpage 2002	£7.99
BK9854	Controlling Windows XP The Easy Way	£7.99
BK9855	Using Flash MX	£7.99
BK9856	How To Use MS Powerpoint 2002	£6.99
BK9857	Internet Explorer 6 And Outlook Express 6 Explained	£6.99
BK9860	Easy PC Upgrading	£7.99
BK9861	How To Use XML	£7.99
BK9916	How To Expand & Upgrade Your PC	£6.99
BK9917	Web Site Construction Simplified	£6.99
BK9919	Using MS FrontPage 2000	£6.99
BK9920	Easy PC Troubleshooting	£6.99
BK9921	Simple Networking With Windows 98	£6.99
BK9923	How To Create Pages For The Web Using HTML	£6.99
BK9924	Fun Web Pages With JavaScript	£6.99
BK9925	Understanding Windows 98 Registry	£5.99
BK9955	The Internet & World Wide Web Explained	£5.95
BK9956	Web Pages Using MS Office 2000	£6.99
BK9957	Internet Explorer 5 Explained	£6.99
BK9958	Email On The Internet	£6.99
BK9959	Using FrontPage 98	£6.99
BK9960	Windows 98 Explained	£6.99
BK9961	Tune Up Windows 98	£6.99
BK9962	Windows 98 Hard Disk & File Management	£6.99
BK9963	MS Office 2000 Explained	£6.99
BK9964	A Practical Introduction To MS Works 2000	£6.99
BK9965	MS Works 2000 Explained	£6.99
BK9966	Multimedia Explained	£6.99
BK9967	Troubleshooting Your PC Printer	£6.99

Wings Of World War Two



One hour of unique, full colour action-packed sequences never seen before. Features: THE SPITFIRE, HURRICANE, LANCASTER, MOSQUITO, BLENHEIM, FLYING FORTRESS, LIBERATOR, MITCHELL, MUSTANG, HELLCAT, CORSAIR and AVENGER. Was £7.99.

VID012 Now Only £5.99

Battleships At War

The battleship reigned supreme in naval warfare from the start of the century to 1945. This video shows most of the worlds naval forces in action throughout the globe. Was £7.99.

VID003 Now Only £5.99

Military Aircraft Video

Sit back and turn up the volume as we take you on a trip through time with a potted history of military and jet powered aircraft. Vampire, Venom, Harrier, Vulcan, Chinook, Black Hawk, Phantom, Tomado, F111 and F16. 40 minutes.

VID014 £10.99

D-Day - Assault On Fortress Europe



D-Day, four years in the planning, two in the organising and one day in the execution - the landing in Normandy was easily the largest and most extraordinary combined military operation ever attempted. Was £7.99

VID001 Now Only £5.99

Sound Recording Module



**GREENWELD
BEST SELLER
ONLY
£7.95**

Originally destined for greetings cards which spoke your personalised greeting to the recipient, we have been fortunate to acquire a large parcel of these modules. They consist of a small PCB (56 x 46mm) with a micro-chip, battery, power supply and microphone with wires to a low profile 1½" diameter moving-coil speaker. A simple switch operated when the card was opened. The module records up to 10 seconds of speech and plays it back when turned on. The message is retained even when the power is removed and can be played back an unlimited number of times. We understand a new message can be recorded at least 500 times. You could use them as they were originally intended in a special greetings card or build an audible warning annunciator or even a personalised bell push. With a suitable time delay you could build a circuit to remind you to close the fridge door or turn the car lights off when you stop.

- Q0231 £7.95 Each**
- Q0231/4 £21.00 For 4**
- Q0231/6 £27.00 For 6**

Make Your Own Joystick



**GREENWELD
SALE
ONLY
£1.00/3**

4 switches with centre-off position. Moving the joystick in any direction will activate one or two of the switches depending on direction. Centring the joystick opens all switches Was £1.00 for 2.

- Q2408 £1.00 For 3**
- Q2408/20 £5.00 For 20**

FM Dipole Aerial



T piece style FM aerial designed to hang on the wall. Measures 2m high and 2m across the top. Two different connections.

- Q0923 Spade Connectors £1.50**
- Q0924 3 Pin Plug (Shown) £1.50**

Solenoid



Solenoid with 5V DC coil. Body size 30 x 20 x 17mm. Steel plunger has a nylon hook screwed into it (easily removable) 5mm travel. Tapped fixing holes. 190mm long leads terminated in 2 way IDC type socket.

Z38Q2/A £1.20

Fibre Optic Cable Assemblies



**SALE ITEM
20% OFF
ORIGINAL
PRICE**

These assemblies were manufactured by Schott in Germany. Each cable comprises a bundle of optical fibres encased in a black plastic sheath. The fibre-optic bundle is approximately 1mm dia and the overall sheath diameter is 2mm. Both ends of the fibres have been crimped into brass shouldered ferrules approx. 3mm dia and 8mm long and glued and polished. (These ferrules are a push fit into a 3mm hole.) Use for railway signals, cold illumination of microscope specimens, photo detection in inaccessible places, a twinkling star-spangled ceiling or illuminated clothing!!!!

- Q6406 750mm £2.40 For 10**
- Q6407 730mm £2.36 For 10**
- Q6408 700mm £2.32 For 10**
- Q6409 660mm £2.28 For 10**
- Q6410 550mm £2.24 For 10**
- Q6411 500mm £2.20 For 10**
- Q6412 480mm £2.16 For 10**
- Q6415 330mm £1.96 For 10**
- Q6413 220mm £2.00 For 10**

Special 5 Legged Unit

One combined ferrule approx 8mm dia x 15mm long with 5 fibre-optic leads 130, 220, 290, 460 and 690mm long.

Q6414 £1.40

Mains Toggle Switch



**GREENWELD
NEW ITEM
ONLY
£1.49**

Mains toggle switch with chrome lever. 2 NC and 2 NO pairs of contacts rated 2A @ 250V AC. Panel mount with two nuts. Switch body size 25 x 23 x 17mm. Solder connections

Q0991 £1.49

Miniature Extension Speaker



**GREENWELD
BARGAIN
ONLY
£2.50**

Mylar cone speaker rated at 8 ohm, 2W. Only 56 x 50mm.

Q0789 £2.50

Waterproof Speaker



**GREENWELD
BARGAIN
ONLY
£3.50**

Entirely submersible. having a clear plastic sealed cone. Have music in your bath.... literally! 88mm diameter (3.5"), rated 12W, 8R, 60mm diameter magnet. Super quality and fantastic value!

Q0164 £3.50

6VA Transformer 15V Output



6VA transformer with 15V output for 240V AC.

Q0300 £0.75

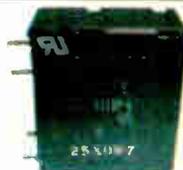
DPDT 250V AC Toggle Switch



Toggle switch with a long plastic paddle. DPDT, 250V AC, 5A. Made by Swan. Panel mounting (under panel?) with holes for fixing

Q0323 £1.00 For 3

Omron Relay



9V Omron relay G2L measuring 28 x 25 x 11mm with a 150 ohm coil. SPM 8A contact.

- X3265 £1.00**
- X3265/10 £6.00 For 10**

Crocodile Clips



32mm long with soft plastic insulation cover.

ST779350	Red	£0.90 For 10
ST779351	Black	£0.90 For 10
ST779352	Green	£0.90 For 10
ST779353	Yellow	£0.90 For 10
ST779354	White	£0.90 For 10

2 of each colour 32mm crocodile clip (total 10).

ST7793MX	£0.90 Pack
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Handy Crocodile Lead Set



10 crocodile leads (370mm long) in 5 colours, red, black, blue, yellow and white (2 of each) connected to soft plastic insulating clips. Dozens of uses.

CDT0010	£2.50
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CDT0010/10	10 Sets For £20.00
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Crocodile Clips



67mm length with plastic handles. For cables up to 5mm diameter. Screw fixing for cable.

ST779266	Red	£1.00 For 4
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ST779267	Black	£1.00 For 4
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Crimping Pliers



Useful crimping pliers for insulated red, blue and yellow crimp terminals. Includes wire cutter and stripper and bolt cutter.

ST710270	£3.99
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Ratchet Action Terminal Pliers



A substantial pair of pliers with heavy ratchet action for insulated red, blue and yellow crimp terminals.

ST710278	£15.99
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Terminal Blocks



Terminal blocks (12 way strips) in see-through polyethylene insulation. Heat resistant up to 80 degrees. Brass contacts and screw clamp fixing in chrome-plated steel.

Cable diameter 3-4mm². Maximum current 3A. Strip length 9cm.

ST786401	£0.25
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ST786401/10	Pack Of 10 £1.95
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Cable diameter 3.2-6mm² Max mum current 5A Strip length 10.5cm.

ST786402	£0.30
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ST786402/10	Pack Of 10 £2.45
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Cable diameter 4.2-10mm². Maximum current 10A. Strip length 13cm.

ST786403	£0.40
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ST786403/10	Pack Of 10 £3.45
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Cable diameter 4.8-12mm². Maximum current 15A. Strip length 13.5cm.

ST786404	£0.50
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ST786404/10	Pack Of 10 £4.45
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Cable diameter 5.8-16mm². Maximum current 30A. Strip length 16.5cm.

ST786405	£0.70
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ST786405/10	Pack Of 10 £5.90
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Gaffa Tape



Good Quality Gaffa tape on 50M rolls. Tape Width 50mm.

ST0001	Black	£3.99
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ST0001/5	5 Rolls Black	£15.99
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ST0002	Silver	£3.99
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ST0002/5	5 Rolls Silver	£15.99
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ST0002W	White	£3.99
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ST0002W/5	5 Rolls White	£15.99
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One of each colour above - save over £1.00.

ST00123	Mix Pack Of 3	£10.70
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Crimp Terminals



A selection of 100 crimp terminals in a handy compartmented plastic storage box. Ring terminals, male and female spade connectors and butt splicers for cables 0.5mm to 2.5mm diameter.

ST785408	£3.99
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Cable Clips

Tough cable clips in both round and flat profiles for easy routing of cables. Supplied in bags of 100 pieces.

ST782051	Round, 5mm	£1.00
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ST782052	Round, 7mm	£1.00
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ST782053	Flat, 2 x 4mm	£1.00
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ST782054	Flat, 3 x 6mm	£1.00
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One pack of each type above 400 clips in all

ST782MIX	£3.50
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Electrical Insulation Tape



British Standard (BS3924, BS3887) approved insulation tapes in a range of colours.

Suitable for electrical insulation with flame retardant qualities. Width 19mm on 20m rolls.

ST710305	Black	£1.15
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ST710305/10	10 Rolls Black	£8.90
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ST710307	Blue	£1.15
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ST710307/10	10 Rolls Blue	£8.90
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ST710308	Red	£1.15
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ST710308/10	10 Rolls Red	£8.90
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ST710309	Green/Yellow	£1.15
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ST710309/10	10 Rolls Grn/Yell	£8.90
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ST710310	Brown	£1.15
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ST710310/10	10 Rolls Brown	£8.90
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ST710311	Yellow	£1.15
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ST710311/10	10 Rolls Yellow	£8.90
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Pack of six colours - one of each of the above.

ST710MIX	Mix Pack	£5.99
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Cable Ties

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ST782015	100mm x 3mm	£0.50
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ST782018	150mm x 3mm	£0.75
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ST782021	220mm x 4mm	£1.30
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ST782024	250mm x 4mm	£2.50
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Pack of each length above - 400 cable ties in total - save over 10%.

ST782TIES	£4.49
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P Clips



Black plastic P clips for cable up to 6mm diameter.

Q0982	£1.50 For 100
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Why not visit our stand at the Northampton Radio, Electronics & Computer Fair to be held at Northampton County Cricket Ground on Sunday 13th July 2003, 10.30am to 4.30pm. The County Ground is at Wantage Road/Abington Road, Northampton, NN1 4JT. See www.radiorally-nrc.co.uk for more details.

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New Year Essentials Catalogue

Mr D Machin of Kettering, wins an outstanding 2-in-1 Rechargeable Jump Start and Air Compressor, also worth £59.99. Our congratulations go out to both lucky customers. Don't forget, there's always a prize to be won in your super FREE 32 page Greenweld Catalogue – so make sure you fill in your entry form on page 14 and send it to: Greenweld Limited, 14 Horndon Business Park, West Horndon, Brentwood, Essex, CM13 3XD.

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AV0004 £99.95

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These walkie-talkie watches are just in and are brilliant as a gift or for your own use. With a range of over 250 ft, they are ideal keeping in touch in different rooms, at the supermarket or if you are out cycling together. The

kite contains two watches, earphones and interchangeable fascias. Also makes an ideal present for kids. **Was £29.99 - Price now £19.95 a pair.**

HLL1075 £19.95

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See Page 23 Code Q1611 For Details

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DC AC Electrical Semi-Conductors Op-Amps Testing Maths Equation Editor Digital Computi...

direction of velocity

Conductor L

Flux

Armature rotates on X - X axis.

MAGNETISM: Attraction and Repulsion

Flux = 10mWb
Area of pole = 40cm²

DC VOLTAGE: Loading a Voltage Divider

$I = 2.27\text{mA}$

Loaded $V_{out} = 7.27\text{V}$
Load = 10k
 $R2 \parallel \text{Load} = 3.20\text{k}$

$V_{out} = V_{in} \times \frac{R2}{R1 + R2}$

Effect of connecting
a load across R2.

$V_{out} = V_{in} \times \frac{R2 \parallel \text{Load}}{R1 + (R2 \parallel \text{Load})}$

Contents

- Circuit Theorems
- Complex Numbers
- DC Power
- AC Power
 - Amplifier Power Gain/Loss
 - Power Levels Expressed in Decib
 - RC Series Power
 - RL Series Power
 - Capacitance Reactive Power
 - Inductance Reactive Power
 - Power Factor Correction
- Silicon Controlled Rectifier
- Power Supplies
- Voltage Regulation
- Magnetism
 - Attraction and Repulsion
 - Magnetic Field of a Straight Cond

Mechanical

$M = \frac{2 \times \pi \times \mu \times I^2 \times N^2 \times A}{P \times r}$

$B = \frac{\Phi}{A}$

Magnetic flux density
 $B = \text{flux density}$
 $A = \text{cross section}$

Load = 1 f for

Attraction and

Pitch = 1.50

Voltage Divider

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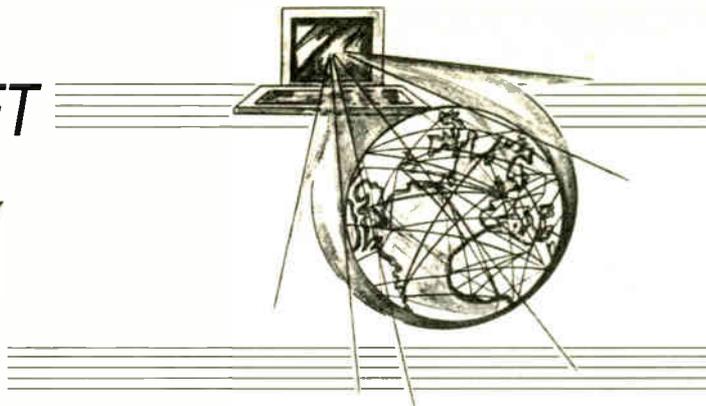


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SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY



New web site

USERS of our UK web site at www.epemag.wimborne.co.uk will have noticed a radical change in the last few weeks, with the launch of a brand new design. It is intended to co-ordinate with *EPE Online*, our Internet-only edition (www.epemag.com), and it has been completely redesigned from the ground up. This month's *Net Work* is a walk-through of the new site and what it has to offer.

Each page contains a simple navigation panel that carries a series of buttons:

- Monthly Features
- Subscribe Now
- Online Shop
- Project Index
- Chat Zone
- Net Work
- More Info
- Contact Info

Additionally there are separate clickable links for a forthcoming new *Downloads* page, and also there's the *Resources* page as before. Probably the most important page for regular constructors will be the *Projects Index* page. This is a chronological listing of

Downloads Page

One of the most important functions that our Internet presence has is to make available our comprehensive listing of PIC micro-controller source codes for download. *EPE* was the first magazine in the world to do this for free, and a large number of files have accumulated over time on our FTP server (type <ftp://ftp.epemag.wimborne.co.uk/pub> into your web browser). However, it would be true to say that, in spite of FTP being a common enough protocol, many readers have struggled to access these files, sometimes due to inexperience (as reflected in the often intemperate emails received!), or possibly due to browser compatibility problems. Often there has been nothing wrong that decent FTP freeware wouldn't cure.

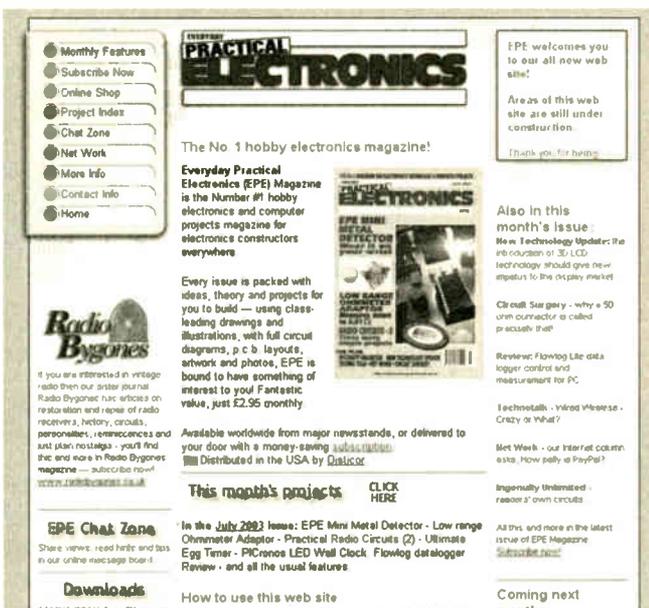
Although the technical issues seem to have eased somewhat, a new *Downloads* page is currently under development, which will form a web-based front-end of all our downloadable PIC source files. At last, you will be able to download files directly onto your machine through a web page, though you can still use FTP as usual if preferred. There will still be a link to the PIC Mirror site kindly maintained by Thomas Stratford, available as a second source of our files.

Over at the *Chat Zone* message board, this has had a minor makeover and hopefully the technical problems associated with the navigation panel will be resolved by the time you read this. The "Acceptable Use Policy" has also been reinforced in some areas, in line with our desire to ensure that the forum remains a friendly, tolerant and welcoming place to help electronics enthusiasts of all age groups from around the world. Once again, our thanks go to all those regulars who help out with the message board.

There are also links to the *EPE Online Shop*, which is the UK-based service that provides back issues, project p.c.b.s, books, CD-ROMs, videos and more. This too is being updated shortly. Further developments are in the pipeline including a site-wide Search facility and the introduction of banner adverts for a select number of electronics suppliers.

We are all very proud to be able to bring you this much-improved online resource, so why not click over to our web site now and see what's happening?

In next month's *Net Work*, it's back to the topic of broadband, when I look at what's available to bandwidth-hungry users who find themselves beyond the reach of mainstream broadband services. You can email me at alan@epemag.demon.co.uk.



Part of the Home Page of the new *EPE* web site – note the navigation panel (top left). The *Project Index* page replaces the "Recent-Issue" page and contains any Please Take Note for projects, dating back five years (no less!)

each issue, with a brief outline of contents. The *Projects* main page shows the current year, and there are links for the previous five years as well. Use either the nav-panel button or the separate link in the body of the home page to launch the *Projects* Main Page.

By clicking on an individual month, a pop-up window opens that contains colour photos of each month's projects. In response to popular request, any corrections or updates to projects are now added to the web site as soon as they arise. A small icon against a project name highlights the fact that a *Please Take Note* amendment has been published, details are also given in the pop-up window.

The *Resources* page contains the *Basic Soldering Guide* which will be redesigned and brought up to date. Other useful articles that we published over the years are also linked on the *Resources* page; we hope to expand this range in due course.



Each month's magazine projects are summarised in a pop-up window, available from the *Projects* Main Page. Click a month to view.

We can supply back issues of *EPE* by post, most issues from the past three years are available. An *EPE* index for the last five years is also available at www.epemag.wimborne.co.uk or see order form below. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photocopy of any *one article* (or *one part* of a series) can be purchased for the same price. Issues from Nov. 98 are available on CD-ROM – see next page – and issues from the last six months are also available to download from www.epemag.com.

DID YOU MISS THESE?

APR '02

PROJECTS • Electric Guitar Tuner • PIC Controlled Intruder Alarm • Solar Charge and Go • Manual Stepper Motor Controller.
FEATURES • Teach-In 2002 – Part 6 • Interface • Programming PIC Interrupts-2 • Circuit Surgery • Ingenuity Unlimited • New Technology Update • Net Work – The Internet Page • *FREE* Giant Op.Amp Data Chart.

MAY '02

PROJECTS • PIC Big-Digit Display • Simple Audio Circuits – 1 • Freezer Alarm • Washing Ready Indicator.
FEATURES • Teach-In 2002 – Part 7 • Ingenuity Unlimited • Practically Speaking • New Technology Update • Circuit Surgery • Net Work – The Internet Page.

JUNE '02

PROJECTS • Biopic Heartbeat Monitor • Frequency Standard Generator • Simple Audio Circuits – 2 • World Lamp.
FEATURES • Teach-In 2002 – Part 8 • Interface • New Technology Update • Circuit Surgery • Ingenuity Unlimited • Net Work – The Internet Page.

JULY '02

PROJECTS • EPE StyloPIC • Infra-Red Autoswitch • Simple Audio Circuits – 3 • Rotary Combination Lock.
FEATURES • Teach-In 2002 – Part 9 • Practically Speaking • Using The PIC's PCLATH Command • Ingenuity Unlimited • Circuit Surgery • New Technology Update • Net Work–The Internet Page.



AUG '02

Photocopies only

PROJECTS • PIC World Clock • Pickpocket Alarm • Big-Ears Buggy • Simple Audio Circuits – 4.
FEATURES • Teach-In 2002 – Part 10 • Using Square Roots with PICs • Ingenuity Unlimited • Evolutionary Electronics • Interface • Circuit Surgery • Net Work – The Internet Page.

SEPT '02

Photocopies only

PROJECTS • Freebird Glider Control • Portable Telephone Tester • EPE Morse Code Reader • Vinyl to CD Preamplifier.
FEATURES • Circuit Surgery • New Technology Update • Practically Speaking • Net Work • Flowcode for PICmicro • Logic Gate Inverter Oscillators • Net Work – The Internet Page.

OCT '02

Photocopies only

PROJECTS • EPE Bounty Treasure Hunter • IC Tester • Headset Communicator • PIC-Pocket Battleships.
FEATURES • Circuit Surgery • New Technology Update • Logic Gate Inverter Oscillators – 2 • Interface • Network – The Internet Page • Using TK3 With Windows XP and 2000.

NOV '02

Photocopies only

PROJECTS • EPE Hybrid Computer – 1 • Tuning Fork and Metronome • Transient Tracker • PICAXE Projects-1 (Egg Timer – Dice Machine – Quiz Game Monitor).
FEATURES • Practically Speaking • Ingenuity Unlimited • Circuit Surgery • New Technology Update • Net Work – The Internet Page.

DEC '02

PROJECTS • Versatile PIC Flasher • EPE Hybrid Computer – 2 • Door Defender • PICAXE Projects – 2 (Temperature Sensor – Voltage Sensor – VU Indicator).
FEATURES • Electronic Paper • Alternative Uses for Transistors • Interface • Circuit Surgery • New Technology Update • Ingenuity Unlimited • Net Work – The Internet Page • 2002 Annual Index.



JAN '03

PROJECTS • EPE Minder • F.M. Frequency Surfer • Wind Speed Meter • PICAXE Projects-3 (Chaser Lights).
FEATURES • Who Really Invented The Transistor • TechnoTalk • Circuit Surgery • Practically Speaking • New Technology Update • Computer GOTOs • Ingenuity Unlimited • Net Work – The Internet Page.

FEB '03

PROJECTS • Wind Tunnel • Brainbot Buggy • Back To Basics-1 (Hearing Aid, Audio Power Amplifier) • Tesla High Voltage Transformer.
FEATURES • In The Bag • Techno Talk • Circuit Surgery • New Technology Update • Interface • Ingenuity Unlimited • Net Work – The Internet Page.

MAR '03

PROJECTS • Wind-Up Torch Mk II • 200kHz Function Generator • Driver Alert • Back-To-Basics-2 (Metal Detector, Simple Timer).
FEATURES • Ingenuity Unlimited • Practically Speaking • Techno Talk • New Technology Update • Circuit Surgery • Peak LCR Component Analyser Review • Net Work – The Internet Page.

APR '03

PROJECTS • Atmospheric Monitor • Intelligent Garden Lights Controller • Back-To-Basics-3 (Touch Light, Plant Watering Reminder) • Earth Resistivity Logger-Part 1.
FEATURES • Ingenuity Unlimited • Techno Talk • New Technology Update • Circuit Surgery • Interface • Network – The Internet Page • *SPECIAL SUPPLEMENT* – EPE PIC Tutorial V2-Part 1.

MAY '03

PROJECTS • Super Motion Sensor • Earth Resistivity Logger – Part 2 • Door Chime • Back-To-Basics-4 (Live Wire Detector, Medium Wave Radio).
FEATURES • Ingenuity Unlimited • Techno Talk • Practically Speaking • Circuit Surgery • Net Work – The Internet Page • *SPECIAL SUPPLEMENT* – EPE PIC Tutorial V2 – Part 2.



JUNE '03

PROJECTS • Fido Pedometer • PICronos L.E.D. Wall Clock-Part 1 • Back-To-Basics-5 (Mini Theremin, Twilight Switch) • Radio Circuits-1 (Crystal Set, MK484 TRF Receiver, Headphone Amplifier).
FEATURES • Ingenuity Unlimited • Techno Talk • Interface • Circuit Surgery • New Technology Update • Net Work – The Internet Page • *SPECIAL SUPPLEMENT* – EPE PIC Tutorial V2 – Part 3.

JULY '03

PROJECTS • EPE Mini Metal Detector • Low Range Ohmmeter Adaptor Mk2 • Radio Circuits-2 (Q-Multiplier, MW Reflex Radio, Speaker Amplifier) • Ultimate Egg Timer • PICronos L.E.D. Wall Clock – Part 2.
FEATURES • Ingenuity Unlimited • Circuit Surgery • Techno Talk • Practically Speaking • Flowlog Lite Review • Net Work–The Internet Page.

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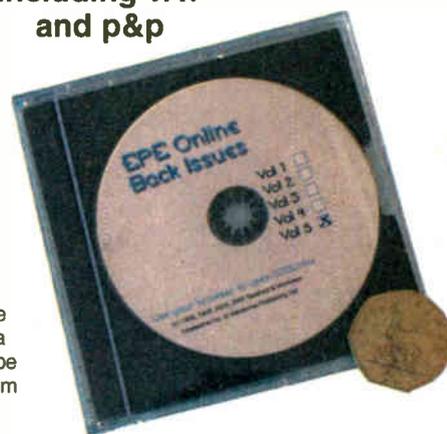
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BACK ISSUES – July 2000 to Dec. 2000

VOL 5 CONTENTS

BACK ISSUES – January 2001 to June 2001

VOL 6 CONTENTS

BACK ISSUES – July 2001 to December 2001

VOL 7 CONTENTS

BACK ISSUES – Jan 2002 to June 2002

VOL 8 CONTENTS

BACK ISSUES – July 2002 to December 2002

WHAT IS INCLUDED

All volumes include the full editorial content of every listed issue, plus all the available PIC Project Codes for the PIC projects published in those issues.

Note that no advertisements are included in Volumes 1 and 2; from Volume 5 onwards the available relevant software for *Interface* articles is also included.

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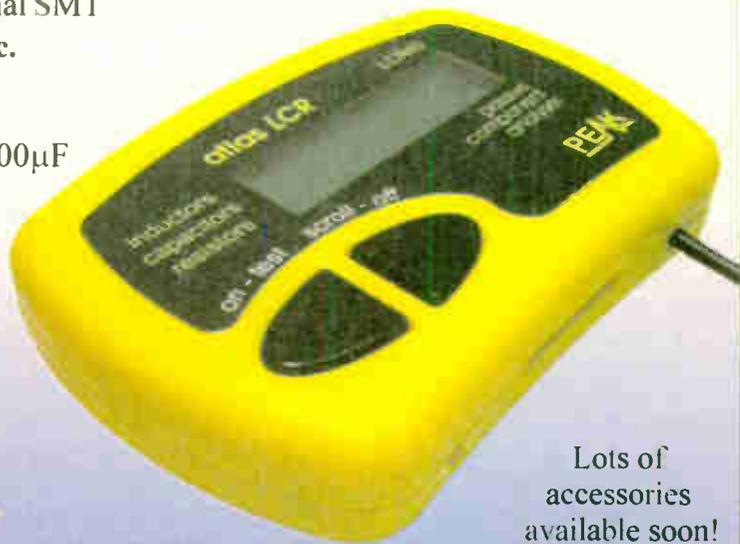
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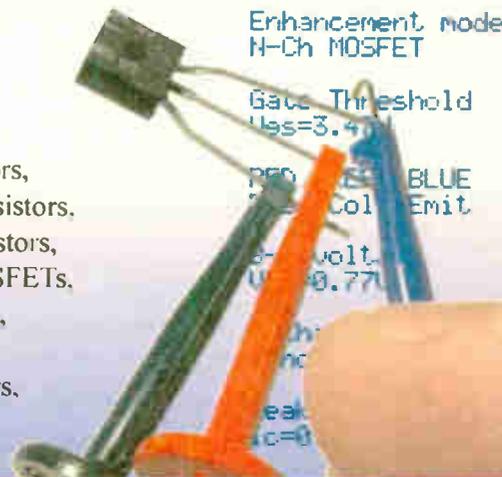
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READOUT

Email: john.becker@wimborne.co.uk

John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

All letters quoted here have previously been replied to directly.

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★ LETTER OF THE MONTH ★

FLOW CHARTS AND PICS

Dear EPE,

I have recently finished reading Part 3 of your excellent *PIC Tutorial V2* and would just like to offer some comments on the Programming and PICs vs. Hardware sections.

With regard to Programming, flowcharting has not been "in vogue" for quite some time for a number of reasons:

1. It is just as difficult to write as a program, so why not write the program?
2. It was used to document programs, however it was/is difficult to include in "normal" documentation (i.e. text files or in early versions of Word documents) so it tended to be ignored. Diagramming tools are starting to make a comeback with the latest PC capabilities but they tend to have moved on to UML and DFD (Unified Modelling Language and Data Flow Diagram) etc.
3. They were extremely difficult to update to match changes in the program so people maintaining systems tended to distrust them (or use them only to get an idea of the original program concept).
4. Most importantly they simply give a different view of the program, but did not document the context or system view which tends to be more meaningful to give the "why" rather than just the "how" (this is probably why UML and DFD are preferred).

Regarding Hardware, if replacing lots of i.c.s was the sole aim, then we would use FPGAs a lot more. The MCU style of chip does provide functionality and allows complex interactions with data inputs which would be difficult with "normal" chips. However, MCU do have the drawback of relatively slow responses (although, they are reasonably fast and the speed is rarely an issue for hobbyist/semi-professional work). If you want both quick immediate response to inputs, complex responses and minimal chip count then a Programmable System on a Chip (PSoC) may be the answer (I have not played with one yet but they look interesting!).

As a last comment, in production systems chip/device count is very important as it impacts on size, power needs, cost of manufacture etc, and can have a real impact on the profitability of the device. Most of these considerations are not that relevant for hobbyists, but reducing cost and complexity (= chance for mistakes) is always of benefit.

**Jon Rigter,
Canberra, Australia**

Thank you Jon, you confirm my beliefs! Thanks too for the beneficial information you have been giving me about Visual Basic through our private email chats.

PIC-O-MANIACS

Dear EPE,

I am an avid reader of *EPE* and have been so since 1978. I look forward each month to receiving the new edition. I have also been involved with PICs for the past seven years. I noticed a revamped version of the *PIC Tutorial* was coming and eagerly awaited my April issue, which takes eight weeks to hit the bookshops here in New Zealand. Imagine my delight when I opened the article to find you had converted the files to the industry standard MPASM. It's such a fantastic piece of work putting the *Tutorial* together and getting people started in this easy way.

I have learned Assembler, then Basic and latterly C programming. However, I often revert from the higher level languages to verify things in Assembler. I firmly believe that a thorough understanding of Assembler is the key to success with more complex firmware designs.

Of all the published magazines you are doing the best job supporting us PIC-O-Maniacs. There is a very good publication out of Australia which is starting to catch up but *EPE* definitely leads the way. One request, how about a few designs using the 12F675 in its conventional form as opposed to the PIC-AXE version?

Many thanks for years of motivating and rewarding projects and articles.

**Mark Weir, Wellington,
New Zealand, via email**

Many thanks for your kind comments, Mark – I am well pleased how readers have taken to my PIC Tuts, both V1 and V2. It's interesting that you revert from high level to low level to check your logic. If I'm developing something complex I sometimes write it first in Basic and then translate to Assembler. Error checking using a PC's screen for readout with Basic is far easier than setting up a PIC to output via an I.c.d., to fully check logic, although this method too has great merits.

Incidentally, we have an excellent PIC debugging tool coming up, Richard Hinkley's PIC Breakpoint, which a group of us have been helping Richard to field-test and finalise. It is scheduled for the November issue.

As you may gather I am PIC-addicted (and thankfully there's no known cure)! One day I'll look into the 12Fx (or a reader might), so keep reading us!

PRACTICALLY SPACED

Dear EPE,

Practically Speaking in July '03, which included notes about spacers, brought to mind my method of doing this.

I use model aircraft fuel tubing of a suitable diameter and cut to an appropriate length. This has a number of advantages:

It is an insulator against the p.c.b. tracks. It is a push fit onto the bolts so that they are held in place while fitting the p.c.b. Because the bolts can move a bit, it doesn't matter if the holes are not exactly lined up. You can't overtighten the nuts as the tubing simply compresses. It is cheap.

Peter Hardy, via email

Thanks Peter, that sounds useful!

FISH FINDING

Dear EPE,

I take Kyaw Swa Thant's *Readout* question seriously (*Babel Fish?* April '03) – as I do SONAR.

If he wants to build from scratch then he is really serious and several questions need to be answered:

1. Is the fishing going to take place on: (a) a lake, (b) the sea or (c) a river bank?
 - If (c) then I do not think anyone has sorted this problem, unless the river is as wide as a lake in which case it is an (a) problem! Hunter fish normally use electro-sensing to detect prey and I do not think we humans have developed sufficiently sensitive equipment thus far! If searching takes place at sea or on a lake (i.e. from a boat) then matters get simpler perhaps.
 2. What size are the fish? This might dictate the sounding frequency – the smaller the fish the higher the frequency needed to detect it/them. But as a qualification to this, I have just read a WW2 account of *HMS Warrior* where the destroyer encountered a shoal of fish and a U Boat. The search frequency was, I gather, 15kHz.
 3. What kind of indicator is called for? Is it: (a) directional only, or (b) plan position (usually used by submarines).
- I am quite happy to provide info as and where I can help.

David McCloy, via email

Thank you David. If Kyaw cares to contact us at EPE via email I'll send it on to you.

PORTABLE PIC PROGRAMMER

Dear EPE,

As a regular *EPE* reader I get to see what the latest ideas are in the electronics field. I saw in the March edition *Readout* a short discussion about a mobile PIC programmer. You also said that if there were enough requests then you would look at this as a project. It would be ideal for the school that I run. We teach hardware and software and also analogue. There is also a small side-line business for the kids who often do small production runs of some of the projects they are requested to look into and develop.

As a source for the data which is used for the programmer why not use a smart card EEPROM? It could be loaded with the hex file via a simple adapter using the serial port. This way if more of these products were ever to be needed, this smart card is simply taken from a manual rolodex containing the cards and loaded into the programmer. I brought this up in class and all responded with a clear yes, but no one considered themselves good enough to tackle this project. Are you still thinking about this?

Harry, South Africa, via email

Thanks Harry, I had not considered the type of application you envisage but can see that the idea does have merit. However, if I do ever do one I would not be using a smart card, about which I know nothing, but probably use an EEPROM chip. These devices have been demonstrated in use in several of my PIC projects. Although not so "portable" as a smart card, they have the advantage of being a "known" product to readers.

ORG-ANIC PICS

Dear EPE,

I have built your *Toolkit TK3* and am trying to run programs from various books, such as Robert Penfold's *Intro to PIC Micro* and D. Smith's *PIC in Practice*. In each case I get an error message "No ORG found" when I try to assemble. I am no expert, this is my first foray into PICs and have tried different permutations without success. Can you help or point me in the right direction, before it all ends up in the bin.

**Anthony Coen,
Thetford, Norfolk, via email**

Don't bin it Anthony! ORG simply says where the start of the program is to be placed, usually ORG 0 or ORG 5 (although it does have other uses). Try putting ORG 5 immediately prior to the first command. ORG is explained more fully in Part 1 of my PIC Tutorial V2 in the April issue. I suggest you read and experiment with the whole three-part series.

CRYSTALISED FRUITS

Dear EPE,

As a radio amateur I'm pleased to see your new series of radio projects from Raymond Haigh. You might be interested to know that my upper 6th Electronics "A" level group all built crystal sets and found that *outstanding* results were obtained by simply connecting the output to a pair of cheap amplified PC speakers. Logical really, as I suspect the input impedance is probably at least 10kΩ, offering better selectivity due to lower damping. Try it and see!

Also, it's been a while since you did any PIC/RC servo projects. How about a "trainable" servo controller to scan a small camera back and forth, up and down, with the ability to have presets, scan between set points etc. 360 degree coverage could be arranged by stacking two servos on top of each other, then having the tilt servo on top of that lot, if you see what I mean.

**Gareth Evans,
via email**

Thank you Gareth, yes Raymond's series is very welcome, and we are pleased to hear of your interesting results at school. Successfully building radio receivers, crystal or otherwise, has always been a fruitful pursuit, going right back to the days of Marconi even!

We do not have anything on PIC/RC servo in the pipeline, but someone might be encouraged to offer us something useful after reading your letter.

SIMPLER GLCD CODING

Dear EPE,

Thank you for running your *PIC Tutorial V2*, it has lots more useful information and is well worth reading over and over. Under the I²C section I notice you haven't used this format on PICs other than the 16F87x. In the 16F84 to g.l.c.d. routine I sent you and which you put on your ftp site, there is an I²C routine that should run on most PICs, but may need tidying.

Also, a long while back, I read John Becker's *How to Use Graphics L.C.D.s with PICs* (Feb '01) and experimented with another g.l.c.d. device. I also sent John an ASM listing for running a graphics l.c.d. (g.l.c.d.) via shift registers and said I would apply my findings to a normal glcd hook-up. I have found that status checks are not necessary on g.l.c.d.s and simple timing delays work even at a 20MHz PIC clock. This means a large-ish saving in code space and eases the learning curve a bit.

Part of getting to grips with g.l.c.d.s was learning more about "normal" text l.c.d.s. Using a shift register interface, I ended up with a routine that will setup an alphanumeric l.c.d., with timing, S/R, command, character and number sub-routines, in 35 PIC commands. This too will run at 20MHz. As it only uses any three I/O pins (two of which could be used as inputs when no l.c.d. work is in progress) you might find it useful in program development when I/O pins are in short supply.

I include here my "timing" routine for g.l.c.d.s based around John's SENDCMD subroutine. I had a little trouble understanding the original SENDCMD and particularly OUTDATA subs, but then I realised that any change to D0-D7, CD, RD and WR had no effect until CE is clocked low. This simplistic view was applied to the following subs in which CE is the key. Finding the timing was simply a matter of counting passes through BTFSC in the CHECK subs in his GEPE456 prog.

The T6963 chip (as in John's g.l.c.d. example) is a lot faster than the HD4470 used in some other l.c.d.s and approximately 8μs delay is used with a built in safety margin and only applied to command data. PICs don't appear to run fast enough to "overload" on autowrite data input. Interestingly, the first call to PAUSIT isn't needed! I didn't even change INTCON settings.

I appreciate John's efforts in getting g.l.c.d.s to work, especially with the limited data available, and understand any reluctance to change tack. It gave me something to tune (I don't make engines, I rebuild, modify and tune them). Here's my code for the 20MHz g.l.c.d. version, which will also work with any slower crystal rate. Change CLKCNT BSF values if time is at a premium. Replace the existing SENDCMD and OUTDATA subroutines with the following. Also rem out all calls for CHECKS 3, 6, 8, and replace all calls to AUTOWRITE with CALL OUTDATA.

```
SENDCMD: movwf PORTD ; place word on D0-D7
          bsf CLKCNT,5 ; value is nearest Xtal whole number * 1.5
SC:       decfsz CLKCNT,f ; rough timer to give over 8μs
          goto SC
          movlw %00011010
          movwf PORTC ; set CE, WR low
          goto DWELL ; wait for port to stabilise
OUTDATA: movwf PORTD ; place word on D0-D7
          movlw %00010010 ; 1 0 0 1 0
          movwf PORTC ; set CD, CE, WR low
DWELL:    bsf CLKCNT,3 ; use bsf temp,3 above 15MHz, 2 above 10MHz, 1 above 5MHz & 0 under 5MHz
TIME:     decfsz CLKCNT,f ; rough timer to give about 2μs
          goto TIME
          bsf PORTC,2 ; data and control line words "clocked in"
          return
```

Graham Card, via email

Interesting that you've got round the Check situation - well done Graham. I have put your above code into PIC Tricks on our ftp site, together with the longer example program you sent, and its additional notes.

Of course, using a timing delay will be familiar to anyone using alphanumeric displays as this is the only technique in use with these devices in EPE projects. Regarding PAUSIT, have you checked that the g.l.c.d. will initialise immediately power is switched on, even with a power supply that has a slow rise-time for its final regulated voltage?

I haven't yet had the need for I²C on an F84 but I'll keep your previous code in mind should I do so, thanks for it. Continue enjoying your PICing!

PIC ASM COLUMNS

Dear EPE,

Having built the Magenta version of the *Toolkit TK3* board and tested it out ok I proceeded to your *PIC Tutorial V2* of Apr-Jun '03, but haven't got far! When I tried to assemble the code for Tutorial 2, I was greeted with a multitude of errors. As the code "looked correct" I began to comment out lines to try and trace my fault.

It seems that the assembler does not like the GOTO command. If I just leave in the first GOTO 5 the error produced is "5 command unfound at line 2". Both GOTO 5 statements produce "5 command unfound at line 2", "5 command unfound at line 4", and "GOTO duplicate labels at Prog Counts 0004 & 0000". GOTO is a valid command. I have very limited knowledge on assembly programming and to have been stopped short so early on in the Tutorial has given me some cause for concern. Any help at all would be most gratefully received.

Bryan Keane, via email

I assume Bryan that you mean you are typing in the commands, and I suspect you are not following the layout of the listings in my Tutorial. Commands like GOTO etc have to be in column 2 (i.e. at least one space character from the left of the screen page before the statement. If you are doing what I think you are, you are putting your GOTO in column 1, but column 1 (starting hard left of line) is where PIC assembly programmers expect to find such things as labels, not commands.

So to take the first part of program TK3TUT3 as an example, note the separation of columns 1 and 2:

```
STATUS      EQU 3
PORTB       EQU 6
ORG 0
GOTO 5
ORG 4
GOTO 5
ORG 5
CLRF PORTB
BSF STATUS,5
CLRF PORTB
BCF STATUS,5
BSF PORTB,0
LOOPIT
```

In fact the assembly program looks for more than just two columns, depending on the nature of the commands. Just a single space or tab key can separate the columns, and where appropriate commas also are taken as separators. Taking LOOPIT BSF PORTB,0 as an example, the assembler splits the line into four columns as follows, taking appropriate action depending on the information in each:

```
Col 1      Col 2      Col 3      Col 4
LOOPIT     BSF        PORTB      0
```

So you will see that putting your GOTO 5 at the left of the screen page resulted in the assembler seeing things as:

```
Col 1      Col 2
GOTO       5
```

and so treating GOTO as a label, and 5 as a command, which of course it is not.

AVR PROGRAMMER

Dear EPE,

I have just one wish - if EPE can come up with a similar *Toolkit* for both programming and development for Atmel's AVR microcontrollers (e.g. AT90S2313, AT90S8515, etc) as you have for PICs with *TK3*, that will be great!

Davis (aka techy fellow), via email

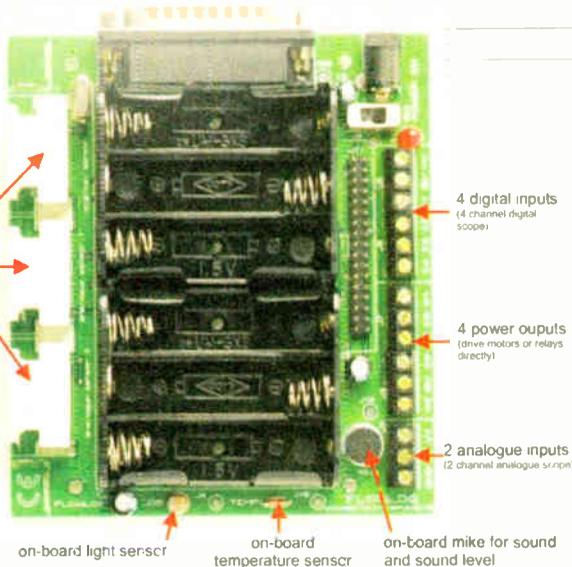
Well Davis Techy Fellow, we tried readers on Atmel chips some years back but there was a very poor response, so we are sticking with PICs (although we could reconsider AVRs if enough of you twist our arms!).

FLOWLOG

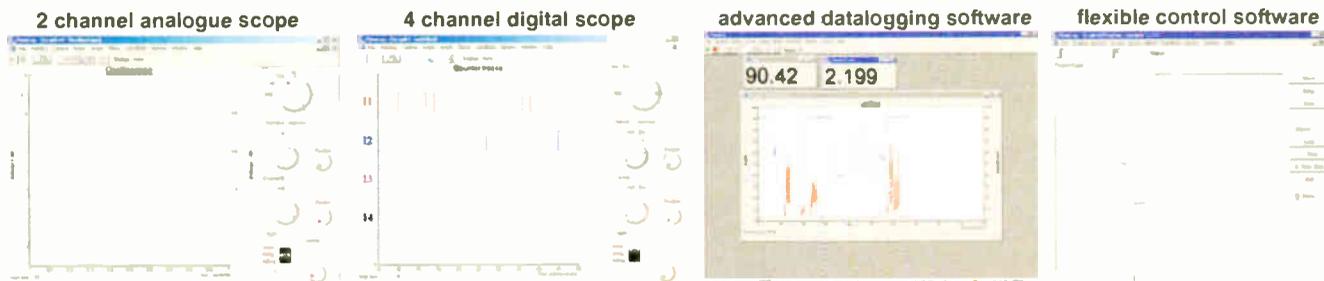
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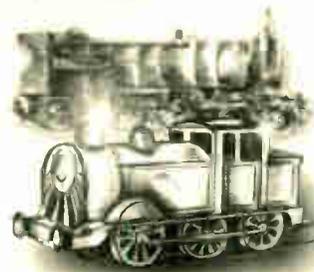
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DIGITAL COMMAND CONTROL FOR MODEL TRAINS



JOHN WALLER

How the computer age has caught up with controlling model trains

EARLY model trains used steam or clockwork as the energy source for their locomotives. Indeed, some of the earliest steam locomotives were tested in model form.

Between 1920 and 1930, electric energy sources with analogue control were introduced. Some early examples used batteries, although trains operating off transformers soon followed.

Until recently, full-size ("real") electric traction motors were nearly all of the series-wound commutator type, which have a very favourable torque-speed characteristic for traction use. These motor types have a field winding and armature in series, and have the useful property that reversal of the current does not affect the direction of rotation.

This property allows the motor to operate off alternating current (a.c.) as well as direct current (d.c.), provided that the a.c. frequency is not too high. This type of motor is still common in mains-powered hand tools, where 50Hz or 60Hz is tolerable for power outputs which are a fraction of a kilowatt.

In "real" a.c. locomotives, 50Hz is too high in frequency for the much larger motor size. Frequencies around 20Hz were introduced, and are still in use in some places.

But, for model trains which use a.c. and series-wound motors, 50Hz to 60Hz is quite satisfactory. Such trains, exemplified by manufacturers Lionel and Märklin, used variable transformers to control train speed. A special relay was fitted to the locomotive to reverse direction, which was activated by sending it a high voltage pulse.

TWO-RAIL RUNNING

Early electrically powered model trains mostly used a three-rail system. Sometimes the third rail was disguised as a series of small posts between the running rails.

This evolved into the two-rail concept, which is now ubiquitous. The two running rails, to which the track voltage is applied, are electrically isolated from each other. All wheel sets in the train must have electrically isolated wheels. Some or all of the locomotive wheels are designed to pick up track current, as well as the wheels on any car which requires current.

Traction motors are separately-excited d.c. motors, with permanent-magnet field. Train reversing simply means reversing the track current. Speed control, before the advent of solid-state electronics, was usually by rheostat. In terms of locomotive operations, a rheostat is a somewhat retrograde step compared with the variable transformer.

ANALOGUE CONTROL

Solid-state technology spawned a spate of d.c. train controllers from series regulators to pulsed methods. Model train buffs still argue over the relative merits of smooth d.c. and pulsed d.c. A common method of using pulses is shown in Fig.1, wherein the d.c. controller generates a series of pulses, which are effectively smoothed by the locomotive motor, although the motor will chatter if the pulse frequency is too low.

Advocates of the pulsed method claim that the high voltage improves slow speed

running in the presence of poor contact between wheel and track, although the author has never seen the results of a controlled comparison.

Nearly all electric motor types also act as generators. In the case of the d.c. motor, the generator effect is called *back electromotive force*, or *back-e.m.f.* for short. If the locomotive motor is spun it will generate a voltage proportional to the rotational speed, and this is the back-e.m.f. In practice, the motor adjusts its speed until the impressed voltage, back-e.m.f. and torque out to the load are in balance.

The latter is conditional, of course, upon the motor being able to generate the necessary torque. Also, if the load torque is too low, the motor speed could increase until it destroyed itself. In a model locomotive, the motor usually has too much self-friction for this to occur.

Smart pulsed controllers soon emerged which measured the back-e.m.f. by sensing the track voltage between pulses, as shown in Fig.1. The back-e.m.f. as seen by the controller is "noisy" as it is subject to varying contact resistance between wheel and rail.

A smoothed version of the back-e.m.f. is compared with a control voltage set by the user, with the difference used to control pulse width. The peak pulse voltage of 14V shown is typical for small scale model trains.

SIMULATED INERTIA

A real train, if left with its brakes released, will run away (without the help of any traction) on a very small gradient in the track. A model train with locomotive coupled will never run away, as the friction in the motor is too high. Many model locomotives will jerk to a sudden stop if power is removed, although very good locomotives, with a large

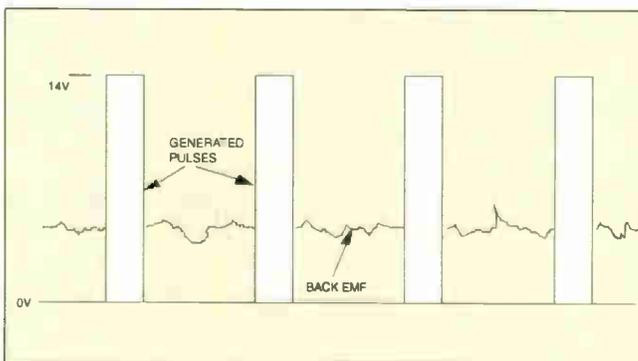


Fig.1. Locomotive pulsed power with feedback.

fraction of their interior devoted to fly-wheels, will coast several centimetres.

The obvious remedy is to vary the control voltage to simulate inertia, and this is now commonly done.

FORMS OF MULTIPLEXING

The limitations of the "analogue" train control systems described so far are that a given locomotive needs its own dedicated section of track to operate. To operate several trains, the track layout must be divided into electrically isolated sections, each with its own control switch. In addition, without some auxiliary power system, train lights, for example, extinguish when the train stops; not very realistic.

Various forms of providing multiplexed signals to the locomotive have been developed, using power split up into frequency bands, with each locomotive assigned a specific frequency, or using time slots in a waveform. In any case, the signal also provides power, which then becomes common throughout the layout, obviating the need for isolated track sections.

Power is applied to the track whether trains are moving or not, so lights can be on all the time.

Obviously, any multiplexing system requires the locomotive to be fitted with a decoder. The system which has come to the fore is called Digital Command Control (DCC).

BRIEF HISTORY OF DCC

In 1980 Lenz Elektronik of Germany started marketing a system called Digital Plus. In 1990 the National Model Railroad Association (NMRA) in the USA formed a working group to survey all the multiplexed command control systems on the market. The Digital Plus system stood out as having a high signal-to-noise ratio, and the flexibility necessary for expansion.

The NMRA then defined the standards and recommended practices for DCC, using Digital Plus as a starting point, but moving far beyond it. Lenz has two patents in Germany for the technology, but relinquished the rights outside of Germany. The DCC group is now a separate entity within the NMRA structure, and may be visited at www.nmra.org.

The whole philosophy with DCC is to specify the minimum standard which will allow a locomotive decoder from any manufacturer to work with a control system from any other manufacturer. This basically means any signal connected to the track running rails must follow the standard. Signals elsewhere in the system, such as what is done with the output of the decoder in the locomotive, or inputs from the user into the control system, are the individual manufacturer's prerogative.

This approach is taken to encourage innovation. Items which meet the NMRA standard carry their stamp of approval. In all respects DCC is more revolutionary than evolutionary, and offers a degree of realism to the modeller not previously attainable.

Although DCC is primarily aimed at locomotive traction functions, decoders may also be used in ancillary equipment, such as level crossing gates, signals, and points (turnouts in North America).

Table 1. Bit Details of a Typical Data Packet

Preamble	Address byte	Instruction byte	Error detection byte
1111111111	OAAAAAA	01DUSSSS	EEEEEEEE
Always all ones	Contains the address of the intended recipient of the packet	The 'D' bit is direction; the 'U' bit is undefined; the 'S' bits are speed	Each bit is the exclusive OR of the corresponding bits in the address and instruction bytes

Table 2. Bit Timing and Tolerance

One bit	Zero bit
Nominal cycle duration 116µs	Each half nominally ≥ 100µs, but maintained nominally equal to each other
Each half duration between 55µs and 61µs	Each half duration between 95µs and 990µs, but total duration ≤ 12000µs

DCC PROTOCOL

Digital Command Control is an asynchronous serial protocol. It is unusual among such protocols in that the control signal itself also contains all the power necessary to operate all the receivers (locomotives and ancillary items) connected to the system.

DCC is only applicable to two-rail electrification, but, in principle, is independent of the track gauge or scale of the train. Typical track voltage for HO scale trains is 14V, with a current capacity of 10A or more. The DCC controller sends power to the track continuously.

The power form is described as "alternating d.c.", meaning the voltage on the track is constant, but switches polarity about 1500 times each second. Of course, the system has finite bandwidth, and the transition from one polarity to the other takes a finite time, but this does not adversely impact operations.

The switching protocol contains asynchronous serial data as a series of zeros and ones denoted by the time interval between successive polarity switches.

Each locomotive in any train contains a decoder which is set to recognise an address in the serial data, which precedes instructions, such as a change in speed, for that particular locomotive. Details of the data packet format are shown in Fig.2, which shows how zeros and ones are transmitted at different spacings, and Fig.3, which shows a complete packet. Further information is shown in Tables 1 and 2, which are based on the NMRA standards; see www.nmra.org and www.tttrains.com for complete details.

The decoder also enables ancillary functions so that, for example, the train lights may be turned on or off from the DCC

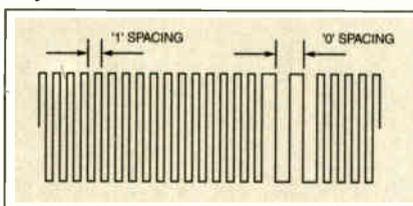


Fig.2. A small snippet of DCC protocol packet.

controller. Other ancillary capabilities include simulated steam exhaust noise, firebox flickering light, whistles, diesel engine rumble, and many others. The essential differences between analogue control and DCC are shown in Table 3.

A consequence of the high current available from DCC track power sources is that short-circuit currents must be interrupted very quickly. Typically, a power source will have fold-back protection so that all trains will stop suddenly in the presence of a short. Unless corrected, a prevalent source of shorts is the "frog" on points, the frog being the place where two running rails of opposite polarity cross.

Special points are now available where the check rail on the frog is insulated to reduce the possibility of shorts. Existing points may be modified by inserting an insulating section in the check rail.

SIGNAL ENCODING

The DCC signal is typically encoded as shown in Fig.3. The aim is to keep the d.c. level of the signal close to zero, to allow

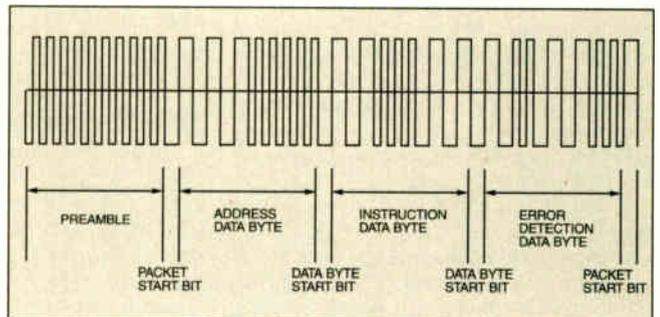


Fig.3. A typical data packet.

the decoder to measure the time between zero crossings, much the same as where digital data are transmitted by radio.

Each "packet" is preceded by a preamble, which is just a string of square waves, at "1" spacing, to allow the decoder to synchronise or re-synchronise in the presence of dirty track. Beyond the preamble, each part of the packet is preceded by a start bit at "0" spacing.

The NMRA standards allow for 9999 locomotive addresses. Naturally, they cannot all be used at one time! The DCC controller has means of placing locomotive addresses, and their action orders, on a queue, with other addresses and orders. The contents of the queue are then transmitted in the packet as just described. The length of time taken to send the packet is clearly dependent mostly on the number of

Table 3. Differences Between Analogue Control and Digital Command Control

Analogue	DCC
Each train must operate on its own electrically isolated section of track	The whole track is connected to a single source of power, there are no electrically isolated sections, and all trains receive the same power
The train speed is determined by the track voltage within its own section	The track voltage is constant and train speed is determined by the track voltage pattern; each train being controlled has its own address
There are no universal standards	The NMRA sets DCC standards. A DCC controller by a particular manufacturer, which has been approved by the NMRA, must operate correctly with a decoder from any manufacturer, which has been likewise approved
Train ancillaries, such as lights, must have their own power supply if they are not to be dependent on track voltage (the lights go out when the train stops)	Constant lighting, and other ancillary features, specified in the DCC standards, are supplied from the track voltage and can be activated at will by the user
The overall control system characteristics must be a compromise among the various locomotives in use	DCC allows each individual locomotive to have its own control settings; no compromising is necessary

locomotives in the queue, with a limit of 30 being typical.

SIGNAL DECODING

A baseline decoder is shown in Fig.4, which is based on an illustration in the EasyDCC manual from CVP Products. The locomotive wheels pick up current from the running rails to power the decoder.

This is a critical part of electric model train operations, and DCC is no exception. The track running rails must be clean, as well as the locomotive wheels and the brushes which collect current from the wheels.

The decoder is looking for its address in the packet protocol of Fig.3. If found, the subsequent bits are decoded and action taken accordingly. For the simple decoder shown, the actions comprise setting speed and direction, and turning the lights on and off. As already mentioned, other decoder functions are often included, and there are decoders designed for static ancillary functions.

The decoder controls motor speed and direction, using a closed-loop system, but without the complication of wheel to rail contact resistance being present within the loop. Furthermore, the decoder can be programmed to provide inertia. As mentioned earlier, this is available in advanced analogue systems, but there is always a

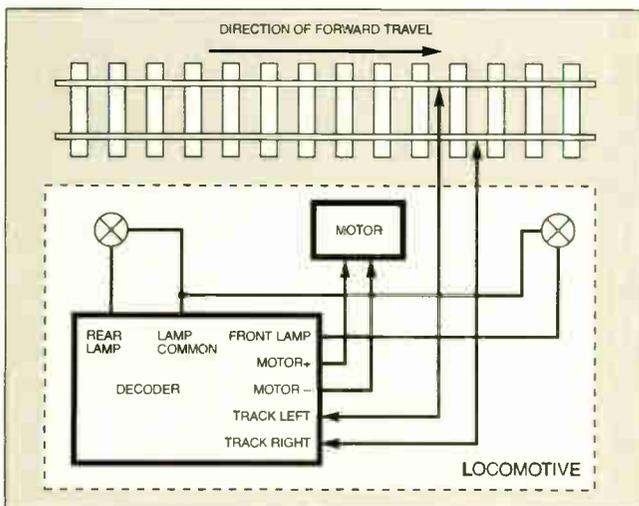


Fig.4. A Baseline locomotive DCC decoder.

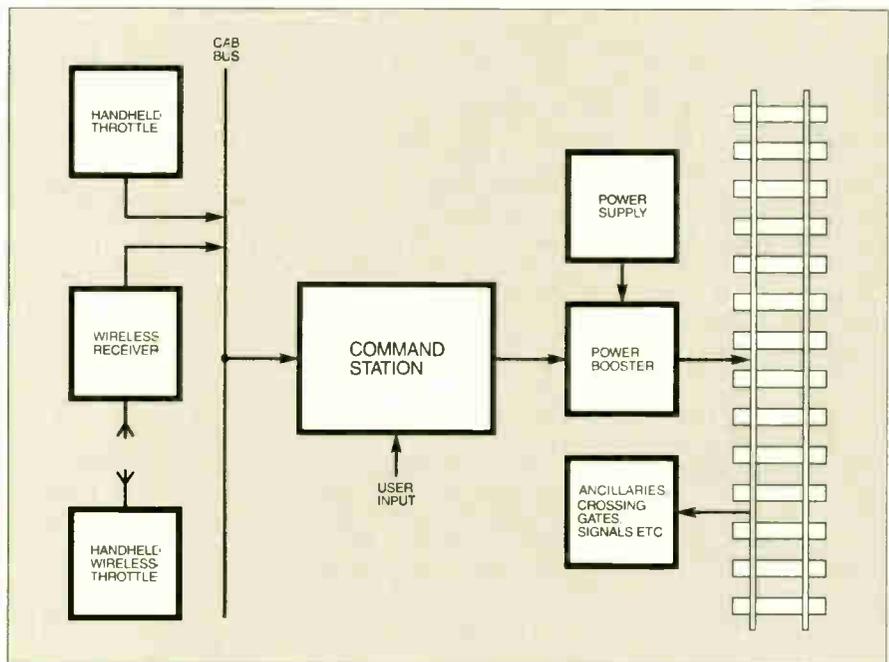


Fig.5. Representative elements of Digital Command Control.

compromise in setting the amount of inertia to suit all the locomotives on the layout.

Performance differs markedly among individual locomotives. With DCC decoders, each locomotive may be given inertia appropriate to it and it alone. Acceleration and deceleration may be set to different values from each other.

Additionally, friction requires that the locomotive motor receives some minimum current before it will move from a standstill. Again, the DCC decoder allows the user to program each individual locomotive with its own starting current, to obtain a more realistically smooth start.

REPRESENTATIVE DCC SYSTEM

The heart of the DCC system, shown in Fig.5, is a Command Station (CS), which generates the serial protocol shown in Fig.3. The output from the CS is boosted to the power level necessary to run all the trains on the system (an HO loco typically requires about 0.5A), together with any ancillaries drawing power from the rails.

The CS has its own user interface, in addition to the "cab bus" shown. A cab, in DCC parlance, refers to the locomotive driver's compartment, or engineer's compartment in North America.

The cab bus allows several users to be controlling trains simultaneously, through hand-held throttles (regulators) connected to the cab bus, either directly or through a wireless link.

The CS provides facilities for controlling trains, setting locomotive and ancillary decoder parameters, and matching these parameter settings with those for the CS. For example, DCC standards provide three speed step values, covering the range from

slowest speed to maximum speed in 14, 28, or 128 steps, respectively.

For a given locomotive, a throttle, whether hand-held or on the CS, must match the speed step setting for that locomotive. Depending on the CS configuration, a locomotive decoder's parameter values are set by placing the locomotive on a special programming track, on the main track, or either. Any attempt to control a locomotive or train from more than one throttle simultaneously produces erratic (and sometimes hilarious) results.

DRAWBACKS OF DCC

Although Table 3 lists the impressive advantages of DCC, the system of Fig.5 suffers from a potential drawback. Particularly in large layouts, where trains can disappear from view, maybe for minutes at a time, users can lose track of which train has which address, and where it is.

In an analogue system, a user, out of sight of other users, will be in charge of a particular section of track, and can prevent collisions by adjusting that section's track voltage. This is not a satisfactory method for DCC, as the principle of track voltage being the same everywhere is violated.

The out-of-sight user must be furnished with a list of trains, and their addresses, identify the train at risk, adjust a throttle to the correct address, and set the train speed for safety. But this will not be successful unless other users do not have that train's address selected on their throttles.

PIC CONTROL

The author has been working to overcome this problem, and has designed and built a PIC-based Smart Throttle, which keeps track of trains and resolves conflicting speed orders. The prototype, whose block diagram is shown in Fig.6, uses a PIC16F877 with RS232 interface to an EasyDCC CS.

Track sensors allow the Smart Throttle to track trains, always matching a train's position to its decoder address, and reducing train speed as required to avoid hazards. The user still has control over trains, but the user-set speed is

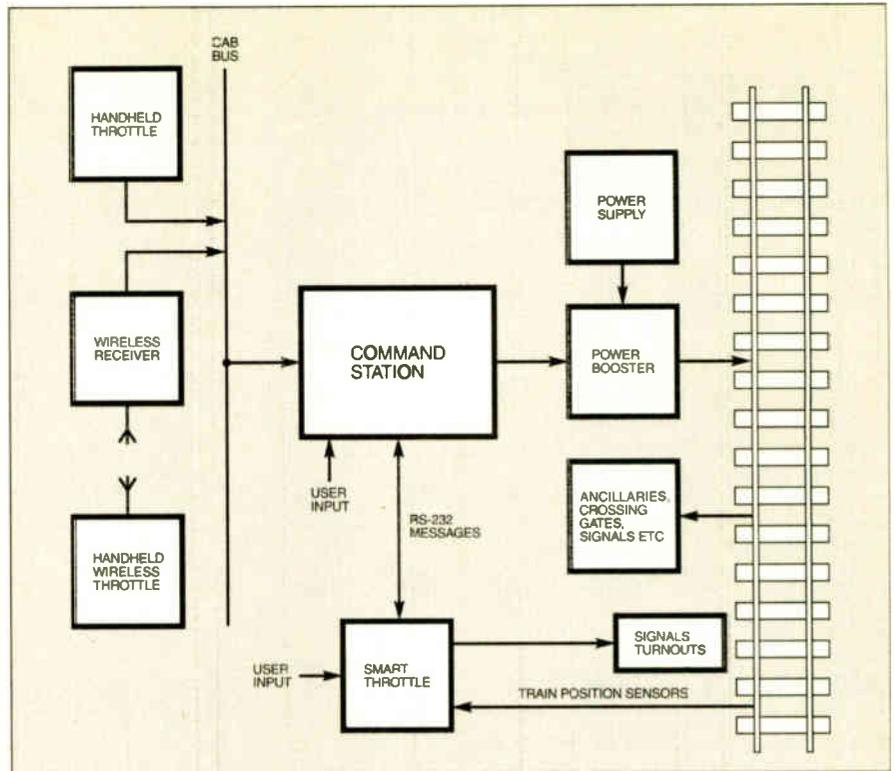


Fig.6. Adding a Smart Throttle to Digital Command Control.

overridden by the Smart Throttle, where appropriate, in a block and signal control system.

Again, if the Smart Throttle is controlling a given train, all other throttles must deselect that train. But, within the Smart Throttle environment, conflicting speed orders are resolved by rules, such as always selecting the slower (slowest) speed to send to the CS.

The prototype Smart Throttle controls a small layout to demonstrate the effectiveness of sensor inputs, and the various control algorithms. Signal values (colour or semaphore position) are output directly to user-visible signals, but they are for information only.

Potentially, points can also be controlled. Unlike most "real" trains, but universally so in models, the signals do not directly con-

trol train speed. In principle, the signal values could be sent from the Smart Throttle to the CS, and thence to ancillaries. The Smart Throttle divides the track layout up into sections or blocks, and no train may enter a block, unless it is declared vacant.

The Smart Throttle prototype is specifically configured for the simple track layout used for development.

For the concept to be viable, it must be adaptable to any layout, and preferably work with a variety of DCC systems. The author continues to work on these aspects.

DCC MANUFACTURERS

A list of some manufacturers of DCC Command Stations is given in Table 4. There are other manufacturers who make decoders and ancillary equipment. There are 12 manufacturers listed, of whom five report currently having an RS232 interface, with one more (ZTC) scheduled for completion in September 2003.

Those manufacturers listed as "not known" in the third column did not answer correspondence on the matter. The author has been using CVP Products for all work so far, but intends to add a ZTC product, as soon as the interface is made available, to give the project an international flavour.

CONCLUSION

The advantages of DCC for the serious railway modeller are considerable. Any hobbyist, whether beginner or otherwise, is well advised to take them into account when starting or modifying a model train layout. Improvements to DCC, including those by the author, will continue to occur.

ACKNOWLEDGEMENT

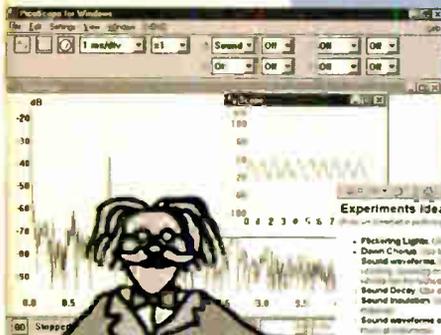
The author is indebted to Brian Barnt, the DCC Manager for the National Model Railroad Association, for the history of DCC model control. □

The author may be contacted at john.waller@snet.net.

Table 4. DCC manufacturer's web sites

Manufacturer	Web address	RS232 Link
Arnold Digital, Germany	www.arnold-digital.de	Not known
CVP Products, Texas, USA	www.cvpusa.com	Yes
Digitrax, Inc., Georgia, USA	www.digitrax.com	Yes
Ernst Paul Lehmann Patentwerk LGB, Germany	www.lgb.com	Not known
Lenz Elektronik GmbH, Germany	www.lenz.com	Yes
Model Rectifier Corporation, New Jersey, USA	www.modelrectifier.com	No
North Coast Engineering, New York, USA	www.ncedcc.com	Yes
ROCO Modellspielwaren GES. M. b. H. & Co. KG, Austria	www.infodellbahan.de	Not known
TRIX Modelleisenbahn GmbH & Co.KG, Germany	www.modellbahanhersteller.de	No
Wangrow Electronics, Inc., Illinois, USA	www.wangrow.com	Yes
ZIMO Elektronik, Austria	www.zimo.at	Not known
ZTC Systems, UK	www.ztcccontrols.co.uk	Sept. 2003?

DrDAQ Data Logger



- Output
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- Voltage
- Light level
- Temperature
- pH
- Microphone

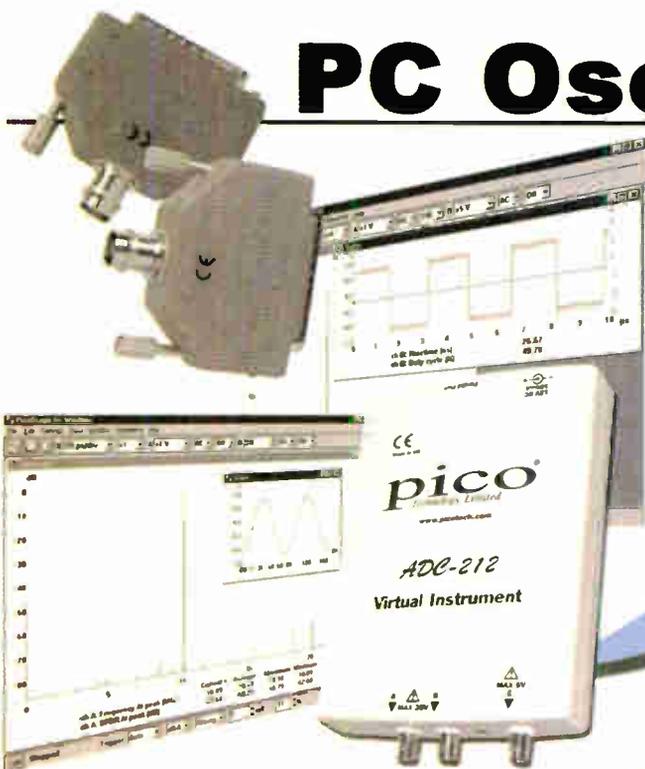
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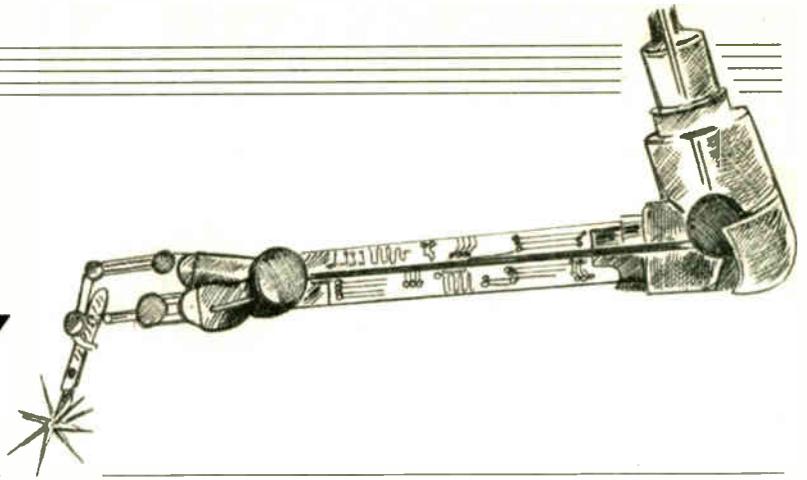
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CIRCUIT SURGERY



**ALAN WINSTANLEY
and IAN BELL**

Our surgeons offer a brief introduction to SPICE during the process of trying to unravel some mysteries of a reader's inverter circuit.

The SPICE Boys

Muhammed Abdallah Saif from Uganda emailed about his inverter circuit.

I am designing an inverter using a 555 timer, with the output at pin 3 fed to a 4013 dual D-type flip-flop. The 4013 outputs (Q and \bar{Q}) are connected through a 1k Ω resistor to BC558 transistors with collector resistors of 330k Ω . Their outputs are connected to two 2N3055 power transistors.

The timer has frequency of 200Hz, which should give 50Hz from the 4013. The supply is 12V d.c. The output from one transistor is higher than the other, why? Also, can the 4013 really produce bi-phase outputs?

We'll try to answer the question shortly, though from your written description it is difficult to work out exactly what circuit you are using. This is often the case with the written circuit descriptions that we receive, as in general it is very difficult to describe circuits in prose form.

If you do manage, the description will inevitably be very long and complicated. For this reason it is always better to include a schematic diagram when corresponding with us (or anyone else) about a circuit.

When using email you can scan a drawing or create a drawing on the computer using an image editor and attach it to the email. There are of course packages that are specifically for drawing circuit schematics, but these may have their own formats, which cannot be read by other software.

It is often better to use standard image formats (e.g. jpeg or PDF) that don't require very specialist programs to read them. If you email images, make sure the file sizes are as small as possible whilst being legible. It is bad netiquette to send people large images unless they are expecting them!

If you are restricted to using plain text for any reason (e.g. if posting into an online forum) it is possible to draw "ASCII-matics" using symbols from a non-proportional font such as Courier, but this can be hard work done by hand. A great program that creates ASCII pictures or

drawings by converting image files is available at <http://go.to/asgcn>.

Netting a List

An alternative way of describing circuits is to write a *netlist*. This is a defined format for writing a wiring list in text. There are a number of formats in use, but perhaps the best known is that employed by the industry standard analogue simulator known generically as SPICE. We will describe a simplified form of the SPICE netlist as it will be of use to many readers.

Each line of a SPICE netlist has the following format:

ComponentName Connections [model] Parameters

The component name identifies an individual component in the circuit. The first letter of the component name identifies the component type as follows (for basic analogue devices). Obviously this can be extended for other components.

C	Capacitor
D	Diode
I	Independent Current Source
J	Junction Field Effect Transistor (JFET)
K	Mutual Inductor
L	Inductor
M	Metal-Oxide-Semiconductor FET (MOSFET)
Q	Bipolar Junction Transistor (BJT)
T	Transmission Line
V	Independent Voltage Source

A different *ComponentName* must be used for each component. The component type determines the number of connections and the order in which they are listed

The *Connections* are lists of nodes or "wires" in the circuit. So each interconnection must be given a name, as well as the components. The nodes may be numbered or given meaningful names such as input1 or control. Node zero is always the ground node if numbering is used. The order of the connections is not important for some components such as resistors, but is obviously so for transistors.

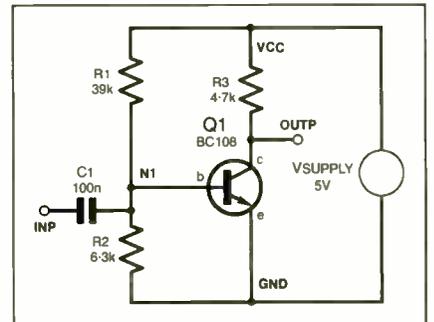


Fig.1. Circuit diagram for a netlist example.

The *Parameters* are component values for passive devices and data such as gain for transistors. They may be listed in a pre-defined order or listed by name.

The *Model* is optional and typically used for transistors and diodes. For our purposes it is simply the name of the transistor or diode type used (e.g. 2N3055).

It is best to illustrate the idea of a netlist by example, so here it is for the circuit in Fig. 1. The transistor connections are listed in the order base, emitter, collector. Note that the "wires" are named INP, N1, VCC, OUTP and GND.

```
Q1 n1 gnd outp bc108
C1 inp n1 100n
R1 n1 vcc 39k
R2 gnd n1 6.3k
R3 outp vcc 4.7k
Vsupply vcc gnd 5V
```

Inverted Views

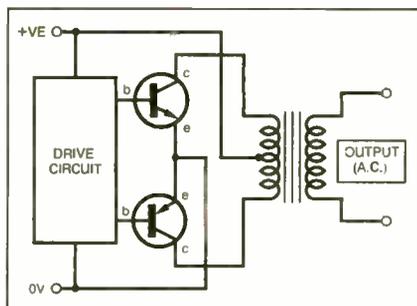
Next month we'll discuss the use of SPICE in more detail. Returning now to the main subject of Muhammed's letter, the basic form of the circuit we assumed is being used, is shown in Fig. 2. This can be described as a "driven push-pull inverter" (self oscillating push-pull inverter circuits are also possible). The drive circuit (in this case the 555 oscillator, 4013, and BC558s) provides two 180 degrees out of phase waveforms to the drive transistors' bases.

The problem of different voltages on the transistors outputs is difficult to evaluate. We do not know the specific circuit, and the reader does not say exactly what was

measured (r.m.s. voltage, peak current, d.c. offset etc.). However, transistors vary quite widely in gain between individual devices and this may account for measured differences. Another possibility (hinted at by the second question) is that the drive may not be fully symmetrical.

The signals at the two drive transistor bases may have different rise and fall times and the two pulse trains may overlap or have a gap in times when both are high. This could happen due to uneven loading on Q and \bar{Q} in the circuit used, or simply be due to the different timing characteristics of these two outputs.

This may not be a major problem at the low frequencies used, but the exact switching characteristics of inverter drive signals can be of critical importance in high speed,



high power, or high efficiency inverters and similar power switching circuits. In general, in some circuits specifically overlapping or non-overlapping two-phase clocks are required.

The bi-phase drive waveform can be obtained from a D-type flip-flop (e.g. 4013) wired as a "toggle" flip-flop as

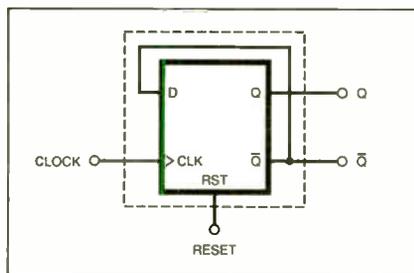
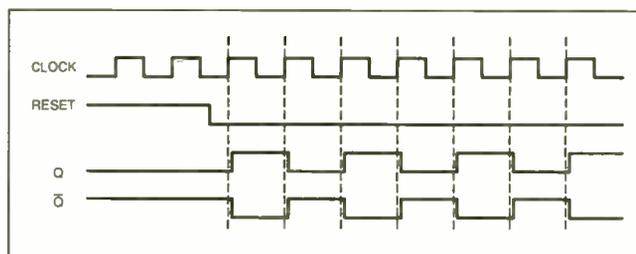


Fig. 3. Toggle flip-flop to produce bi-phase drive waveform.

Fig. 2 (left). Block schematic diagram for a typical push-pull inverter circuit.

Fig. 4. (right). Toggle flip-flop timing diagram.



shown in Fig. 3. The timing diagram is given in Fig. 4. Notice that when the flip-flop is not being reset the output is a square wave at half the clock frequency.

The output square wave will be symmetrical (the signal will be at 0 for the same duration as it is at 1). The Q and \bar{Q} outputs will always be at opposite logic levels, apart from perhaps a short period after the clock edge if the Q and \bar{Q} propagation delays are different.

A further thought – if the 330k Ω resistors described in the reader's circuit are in the current supply path for the 2N3055's bases then it is quite possible that the power transistors are being under-driven. Less than 40 μ A base current (330k Ω and 12V) in a 2N3055 will result in a few milliamps collector current at the most. This may account for poor performance of the circuit. I.M.B.

SHOP TALK

with David Barrington

EPE PIC Met Office

As to be expected with a multi-sensor design that makes up the *EPE PIC Met Office* project, some of the component parts are going to be "specials" and not your everyday stock items.

To start with, the Sensym pressure module SCC15AN and Microchip's 24LC256 serial EEPROM memory chip were purchased from **Farnell** (☎ 0113 263 6311 or www.farnell.com), codes 179-275 and 300-1696 respectively.

The 40kHz ultrasonic transducers must be the moisture proof, "sealed for external use", types. These were purchased as pairs from **Rapidelectronics** (☎ 01206 751166 or www.rapidelectronics.co.uk), codes 35-0182 (Tx) and 35-0184 (Rx). They also supplied the capacitive type humidity sensor, code 61-0960.

Next in line is the rail-to-rail LMC6484 quad op.amp. This was supplied by **RS Components**, code 310-925, and can be ordered through any *bona-fide* stockists, including some of our advertisers. You can order direct (credit card only) from RS on ☎ 01536 444079 or rswww.com. Expect to pay a handling charge. They also supplied the optional solar cell panel, code 194-098.

The rest of the semiconductor devices should be straightforward, including the LM35CZ temperature sensor chip. However, it must be the CZ type as this version will detect/monitor temperatures down to -40°C and up to +110°C.

For those readers unable to program their own PICs, a ready-programmed PIC16F877-20 (20MHz) microcontroller can be purchased from **Magenta Electronics** (☎ 01283 565435 or www.magenta2000.co.uk) for the inclusive price of £10 each (overseas add £1 p&p). They also supplied the 2-line 16-character (per line) alphanumeric i.c.d. module.

The software is available on a 3.5in. PC-compatible disk (PIC Met Office) from the *EPE Editorial Office* for the sum of £3 each (UK), to cover admin costs (for overseas charges see page 579). It is also available for free download from the *EPE* ftp site, which is most easily accessed via the click-link option when you enter the main web site at www.epemag.wimborne.co.uk. On entry to the ftp site take the path *pub/PICS/PICMetOffice*, downloading all files within the latter folder.

The large printed circuit board is available from the *EPE PCB Service*, code 402 (see page 579).

Finally, due to the vagaries of the environment, it is imperative that constructors treat the finished circuit board with a moisture protection agent. This comes in the form of a plastic/acrylic spray ("conformal coating") in 110ml and 200ml cans. Readers might like to contact: **ESR Components** (☎ 0191 251 4363 or www.esr.co.uk) code 251-950; **Rapidelectronics** (see above), code 87-1210; and **RS** (see above), code 290-9476.

Practical Radio Circuits – 3

This month's *Practical Radio Circuits* instalment majors on the construction of a single-band *High Performance Regenerative Radio* project. Only a couple of items need highlighting, the rest of the parts should be readily available.

The polythene dielectric tuning capacitor will normally be found listed as a miniature "transistor radio" type and usually consists of an antenna and oscillator section, plus trimmers. The favoured value is 20pF to 126pF range

and the two sections should be wired in parallel to give the required 260pF upper range. The miniature tuning capacitor is currently stocked by **ESR Components** (☎ 0191 251 4363 or www.esr.co.uk), code 896-110 and **Sherwood Electronics** (see ad. on page 584), code CT9.

The author claims almost any polyvaricon variable capacitor designed for a.m. or a.m./f.m. portable sets should work in the Regen. circuit. The one in the author's model came from **Maplin** (☎ 0870 264 6000 or www.maplin.co.uk), code AB11M. Again, you will need to parallel the a.m. sections to give the correct coverage.

The tuning coil is hand-wound from 24s.w.g. (23a.w.g.) enamelled copper wire. A 50g (2oz) reel is stocked by **JAB Electronic Components** (☎ 0121 682 7045) or www.jabdog.com. Most suppliers only sell "large" reels.

The two printed circuit boards are available from the *EPE PCB Service*, codes 405 (Regen.) and 406 (T/Cap), see page 579. The optional Wave Trap was covered last month.

Master/Slave Intercom (Top Tenner)

The first of our *Top Tennes* this month is a simple *Master/Slave Intercom* project that can also be used as a "baby alarm".

The article suggests the use of a "plug-top" mains adaptor power supply unit for running the Intercom for prolonged periods of time. It should be capable of delivering up to about 500mA at 6V d.c. and most of our components advertisers should be in a position to offer a suitably rated 3-pin mains plug-top regulated battery eliminator at a reasonable price. You can also use an unregulated type if you wish.

Miniature 8 ohm 40mm (1½in.) to 57mm (2¼in.) diameter loudspeakers seem to be widely stocked and are usually of the paper or Mylar cone types. The LM386 audio power amp i.c. also seems to be a stock item. The author used a 2-pole slider switch for the call/listen function on the Master unit.

The printed circuit board is available from the *EPE PCB Service*, code 407 (Intercom) – see page 579.

Electronic Two-Up (Top Tenner)

The bi-colour l.e.d. used in the *Electronic Two-Up* guessing game, the second of this month's *Top Tennes* projects, is the three-pin version and readers will have some difficulty finding one. We believe the author used an old **Maplin** (☎ 0870 2263 6000 or www.maplin.co.uk) device, code CZ45Y (round). We suggest readers use a 3-pin tri-colour 5mm l.e.d. as these are widely stocked and should not cause any problems.

The 4046 phase-locked loop and the 74HC74 dual D-type flip-flop i.c.s should be easy to come by. The printed circuit board is obtainable from the *EPE PCB Service*, code 408 (Two-Up) – see page 579.

Alarm System Fault Finder

All components listed for the *Alarm System Fault Finder* project are standard "off-the-shelf" devices and should not cause any local sourcing problems. The 4001B CMOS quad 2-input NOR gate is certainly found listed in all our component catalogues.

The small printed circuit board is available from the *EPE PCB Service*, code 404 (see page 579).

PLEASE TAKE NOTE

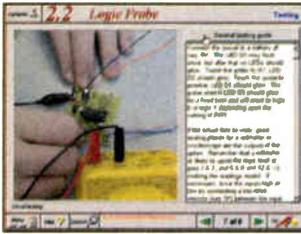
Ultimate Egg Timer

The 74HC4017 counter specified for IC2 in the *Ultimate Egg Timer* (*Top Tenner*) project has a maximum voltage limit of 6V and could be damaged by the 9V supply shown. To run this circuit at 9V a "standard" CMOS 4017 should be used.

(July '03)

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ELECTRONICS PROJECTS

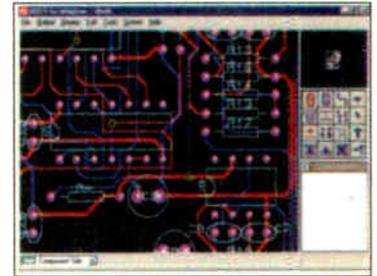


Logic Probe testing

Electronic Projects is split into two main sections: **Building Electronic Projects** contains comprehensive information about the components, tools and techniques used in developing projects from initial concept through to final circuit board production. Extensive use is made of video presentations showing soldering and construction techniques. The second section contains a set of ten projects for students to build, ranging from simple sensor circuits through to power amplifiers. A shareware version of Matrix's CADPACK schematic capture, circuit simulation and p.c.b. design software is included.

The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

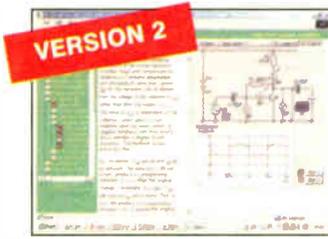
ELECTRONICS CAD PACK



PCB Layout

Electronics CADPACK allows users to design complex circuit schematics, to view circuit animations using a unique SPICE-based simulation tool, and to design printed circuit boards. CADPACK is made up of three separate software modules. (These are restricted versions of the full Labcenter software.) **ISIS Lite** which provides full schematic drawing features including full control of drawing appearance, automatic wire routing, and over 6,000 parts. **PROSPICE Lite** (integrated into ISIS Lite) which uses unique animation to show the operation of any circuit with mouse-operated switches, pots, etc. The animation is compiled using a full mixed mode SPICE simulator. **ARES Lite** PCB layout software allows professional quality PCBs to be designed and includes advanced features such as 16-layer boards, SMT components, and an autorouter operating on user generated Net Lists.

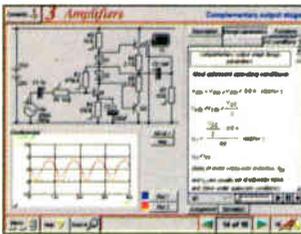
ELECTRONIC CIRCUITS & COMPONENTS V2.0



Circuit simulation screen

Provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Version 2 has been considerably expanded in almost every area following a review of major syllabuses (GCSE, GNVQ, A level and HNC). It also contains both European and American circuit symbols. Sections include: **Fundamentals**: units & multiples, electricity, electric circuits, alternating circuits. **Passive Components**: resistors, capacitors, inductors, transformers. **Semiconductors**: diodes, transistors, op.amps, logic gates. **Passive Circuits**. **Active Circuits**. *The Parts Gallery* will help students to recognise common electronic components and their corresponding symbols in circuit diagrams. Included in the Institutional Versions are multiple choice questions, exam style questions, fault finding virtual laboratories and investigations/worksheets.

ANALOGUE ELECTRONICS



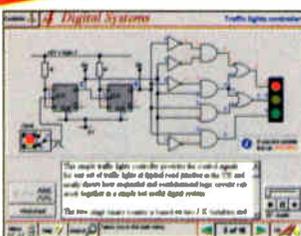
Complimentary output stage

Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.

Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections), Transistors (4 sections), Waveshaping Circuits (6 sections). **Op.Amps** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. **Systems** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

DIGITAL ELECTRONICS V2.0

Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen. Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units. Sections on Boolean Logic and Venn diagrams, displays and chip types have been expanded in Version 2 and new sections include shift registers, digital fault finding, programmable logic controllers, and microcontrollers and microprocessors. The Institutional versions now also include several types of assessment for supervisors, including worksheets, multiple choice tests, fault finding exercises and examination questions.



Virtual laboratory – Traffic Lights

ROBOTICS & MECHATRONICS

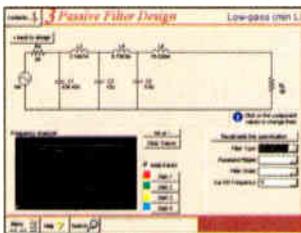


Case study of the Milford Instruments Spider

Robotics and Mechatronics is designed to enable hobbyists/students with little previous experience of electronics to design and build electromechanical systems. The CD-ROM deals with all aspects of robotics from the control systems used, the transducers available, motors/actuators and the circuits to drive them. Case study material (including the NASA Mars Rover, the Milford Spider and the Furby) is used to show how practical robotic systems are designed. The result is a highly stimulating resource that will make learning, and building robotics and mechatronic systems easier. The Institutional versions have additional worksheets and multiple choice questions.

- Interactive Virtual Laboratories
- Little previous knowledge required
- Mathematics is kept to a minimum and all calculations are explained
- Clear circuit simulations

FILTERS



Filter synthesis

Filters is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed. It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev op.amp filters.

PRICES

Prices for each of the CD-ROMs above are:

(Order form on third page)

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Institutional (Schools/HE/FE/Industry).....	£99 plus VAT
Institutional 10 user (Network Licence).....	£199 plus VAT
Site Licence.....	£499 plus VAT

PICmicro TUTORIALS AND PROGRAMMING

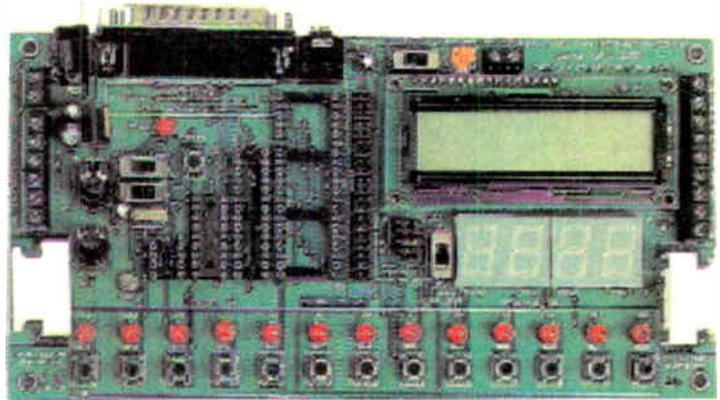
HARDWARE

VERSION 2 PICmicro MCU DEVELOPMENT BOARD

Suitable for use with the three software packages listed below.

This flexible development board allows students to learn both how to program PICmicro microcontrollers as well as program a range of 8, 18, 28 and 40-pin devices. For experienced programmers all programming software is included in the PPP utility that comes with the development board. For those who want to learn, choose one or all of the packages below to use with the Development Board.

- Makes it easier to develop PICmicro projects
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- Supports PICmicro microcontrollers with A/D converters
- Fully protected expansion bus for project work
- All inputs and outputs available on screw terminal connectors for easy connection



£145 including VAT and postage
12V 500mA plug-top PSU (UK plug) £7
25-way 'D' type connecting cable £5

SOFTWARE

Suitable for use with the Development Board shown above.

ASSEMBLY FOR PICmicro V2 (Formerly PICtutor)

Assembly for PICmicro microcontrollers V2.0 (previously known as PICtutor) by John Becker contains a complete course in programming the PIC16F84 PICmicro microcontroller from Arizona Microchip. It starts with fundamental concepts and extends up to complex programs including watchdog timers, interrupts and sleep modes. The CD makes use of the latest simulation techniques which provide a superb tool for learning: the Virtual PICmicro microcontroller. This is a simulation tool that allows users to write and execute MPASM assembler code for the PIC16F84 microcontroller on-screen. Using this you can actually see what happens inside the PICmicro MCU as each instruction is executed which enhances understanding.

- Comprehensive instruction through 39 tutorial sections
- Includes Vlab, a Virtual PICmicro microcontroller: a fully functioning simulator
- Tests, exercises and projects covering a wide range of PICmicro MCU applications
- Includes MPLAB assembler
- Visual representation of a PICmicro showing architecture and functions
- Expert system for code entry helps first time users
- Shows data flow and fetch execute cycle and has challenges (washing machine, lift, crossroads etc.)
- Imports MPASM files.



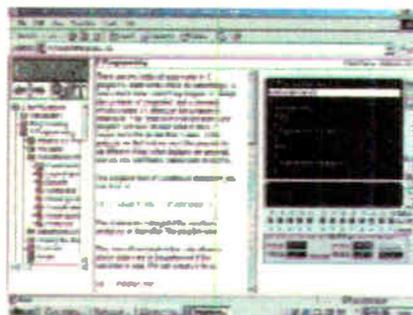
Virtual PICmicro

'C' FOR PICmicro VERSION 2

The C for PICmicro microcontrollers CD-ROM is designed for students and professionals who need to learn how to program embedded microcontrollers in C. The CD contains a course as well as all the software tools needed to create Hex code for a wide range of PICmicro devices – including a full C compiler for a wide range of PICmicro devices.

Although the course focuses on the use of the PICmicro microcontrollers, this CD-ROM will provide a good grounding in C programming for any microcontroller.

- Complete course in C as well as C programming for PICmicro microcontrollers
- Highly interactive course
- Virtual C PICmicro improves understanding
- Includes a C compiler for a wide range of PICmicro devices
- Includes full Integrated Development Environment
- Includes MPLAB software
- Compatible with most PICmicro programmers
- Includes a compiler for all the PICmicro devices.



Minimum system requirements for these items: Pentium PC running Windows 98, NT, 2000, ME, XP; CD-ROM drive; 64MB RAM; 10MB hard disk space.

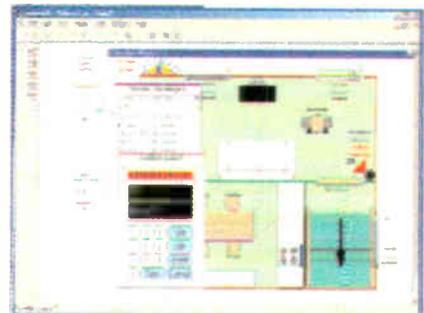
FLOWCODE FOR PICmicro

Flowcode is a very high level language programming system for PICmicro microcontrollers based on flowcharts. Flowcode allows you to design and simulate complex robotics and control systems in a matter of minutes.

Flowcode is a powerful language that uses macros to facilitate the control of complex devices like 7-segment displays, motor controllers and I.c.d. displays. The use of macros allows you to control these electronic devices without getting bogged down in understanding the programming involved.

Flowcode produces MPASM code which is compatible with virtually all PICmicro programmers. When used in conjunction with the Version 2 development board this provides a seamless solution that allows you to program chips in minutes.

- Requires no programming experience
- Allows complex PICmicro applications to be designed quickly
- Uses international standard flow chart symbols (ISO5807)
- Full on-screen simulation allows debugging and speeds up the development process
- Facilitates learning via a full suite of demonstration tutorials
- Produces ASM code for a range of 8, 18, 28 and 40-pin devices
- Institutional versions include virtual systems (burglar alarms, car parks etc.).



Burglar Alarm Simulation

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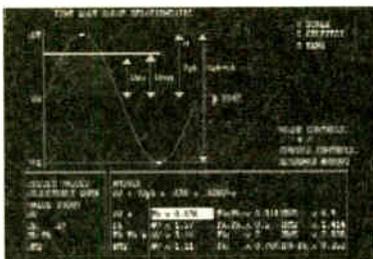
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 Institutional (Schools/HE/FE/Industry)
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TEACH-IN 2000 – LEARN ELECTRONICS WITH EPE

EPE's own *Teach-In* CD-ROM, contains the full 12-part *Teach-In* series by John Becker in PDF form plus the *Teach-In* interactive software covering all aspects of the series. We have also added Alan Winstanley's highly acclaimed *Basic Soldering Guide* which is fully illustrated and which also includes *Desoldering*. The *Teach-In* series covers: Colour Codes and Resistors, Capacitors, Potentiometers, Sensor Resistors, Ohm's Law, Diodes and L.E.D.s, Waveforms, Frequency and Time, Logic Gates, Binary and Hex Logic, Op.amps, Comparators, Mixers, Audio and Sensor Amplifiers, Transistors, Transformers and Rectifiers, Voltage Regulation, Integration, Differentiation, 7-segment Displays, L.C.D.s, Digital-to-Analogue.



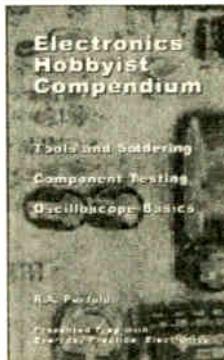
Sine wave relationship values

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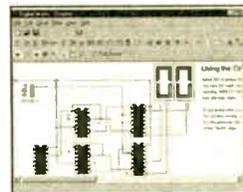
£12.45 including VAT and postage. Requires Adobe Acrobat (available free from the Internet – www.adobe.com/acrobat).

FREE WITH EACH TEACH-IN CD-ROM – *Electronics Hobbyist Compendium* 80-page book by Robert Penfold. Covers Tools For The Job, Component Testing, Oscilloscope Basics.

FREE BOOK WITH TEACH-IN 2000 CD-ROM



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Counter project

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New Technology Update

Super-cool diamonds may be a major milestone in the development of superconducting technology, reports Ian Poole.

SUPERCONDUCTORS have been known about for many years. They were first discovered in 1911. Despite the "hype" in the news they have not been adopted into as many areas as might have been expected. One of their major drawbacks is the fact that superconductors usually have to be operated at very low temperatures.

Some of the first superconducting materials that were discovered needed to be within a degree or so of absolute zero to exhibit the effect. Above this temperature the effect totally disappeared. Even some of the more recently discovered materials still require to be operated at very low temperatures and this requires that highly sophisticated cooling plants have to be used.

Despite this, the technology is still used in some areas of technology where very high levels of performance are required. One example of this is within the Maglev high speed train in Japan. This magnetically levitated train achieved a speed of 552km/hr in April 1999.

The technology also has applications in the electronics arena as well. Here it finds uses in microwave components where its use enables designers to considerably reduce the level of surface resistance in conductors.

Although superconduction can give significant improvements in performance over standard technologies, the costs of the refrigeration units have often meant that they are not viable for many applications. However, a recent development may mean that the vacuum above a diamond may be able to superconduct at room temperature.

This development at the University of Pretoria is as yet not fully proved, but if it is shown to work then it will certainly be a major milestone on the development roadmap of superconducting technology. It could even lead to the development of room temperature superconductors.

In Theory

The new discovery can be explained by certain aspects that are common with superconducting technology. To understand how superconductors work it is first necessary to investigate how a normal conductor operates.

A conducting material consists of a lattice of nuclei from which electrons are able to break free. These free electrons normally move in a totally random fashion. If a potential is applied across the material then they will drift in a particular direction as a result of the fact that the electrons are attracted by an opposite charge.

However, the electron movement is hindered by the nuclei in the lattice of the material and the impurities in the conductor. This causes the electrons to scatter and not flow in an orderly fashion. This impedes the flow of the electrons and gives rise to resistance.

In the case of a superconductor there is an interaction between the nuclei and electrons but in this case the effect results in electrons being able to flow unimpeded through the lattice. What happens is that as one electron flows through the lattice it distorts the lattice. When a second electron approaches the first, it is attracted by the greater density of the positive charge where the nuclei have been pulled together.

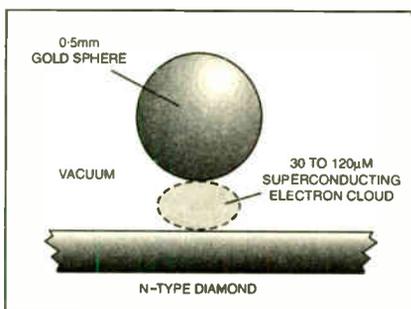


Fig.1. Details of the layout used for the diamond superconduction experiment.

This effect overcomes the repulsive force that would normally exist between two electrons and they travel together as a pair known as a Cooper pair. These pass through the lattice with no obstruction and as a result there is no resistance. It is found that these pairs of electrons each have an opposite spin, and this enables them to be attracted together despite the fact that they have the same charge and would normally repel one another.

As the temperature increases the nuclei start to vibrate more and eventually a point is reached where the Cooper pairs start to break up and the material rapidly reverts to its normal state, along with the associated resistance. This effect can also occur if the level of current becomes too high. This is known as the critical current.

New Discovery

The discoverer of the potentially new phenomenon is Professor Johann Prins at the University of Pretoria. He said that he was researching properties associated with an *n*-type doped diamond surface. In the experiments that he was undertaking he placed a 0.5mm gold sphere within a few

micrometers of the surface whilst it was held in a vacuum.

Under these conditions it should have been possible for a current to flow, only under the presence of a large voltage that would cause a breakdown in the gap between the diamond and the gold sphere. As predicted a current flowed when a voltage of 500 volts was applied, but it was also found that current flowed when a very much lower voltage was applied.

One explanation for the current flow under low voltage conditions was that it was caused by some contamination. This was extensively investigated and no trace of contamination was found.

The explanation that is being proposed is that the electrons must exist in pairs. The only way that this can happen without them repelling one another is for them to be in the same macro quantum state as they are in superconductors. Here each electron in the pair has an opposite spin. It also appears that this can only occur in *n*-type doped diamond.

From the observations that have been made so far, the best explanation appears to be that the electrons appear as a cloud of electron pairs in a wave function with zero velocity in the gap between the diamond surface and the small gold sphere – see Fig.1. Electrons that enter the gap from one side do not drift across but become part of the wave, and correspondingly electrons emanate from the other side.

Possibilities

This research is at its very earliest stages. As a result, the theory is developing and new ideas and explanations are being proposed.

It has been mentioned by one party that a related discovery some years ago turned out to be the result only of the impurities that had been introduced into the diamond. Nevertheless, this could still be a very exciting development because it demonstrates the possibility of superconduction at room temperature.

Whilst diamond may be an expensive base to use it is quite possible that the same phenomenon may be able to be replicated on another cheaper base, thereby giving the possibility of true superconducting technology at everyday temperatures for the first time. This would undoubtedly be a major breakthrough and one that could change the whole face of electrical and electronics technology as we know it today.

More information about the latest in radio and electronics technology can be found at www.radio-electronics.com.

PRACTICAL RADIO CIRCUITS

RAYMOND HAIGH



Part 3: Regenerative Receivers – A modern-day version of Armstrong's 1913 circuit.

Dispelling the mysteries of Radio. Circuits for the set builder and experimenter.

IN Part Two we reviewed the history and theory of regeneration and used the technique to improve the performance of two, portable, radio receivers. This month a regenerative receiver designed for serious listening on the long, medium and short wave bands will be described.

BASICS

For a regenerative receiver to perform well, three basic requirements have to be met. (1) Its regeneration control must be smooth, completely free from backlash, and have a minimal effect on tuning.

(2) The tuned circuit to which the Q enhancing positive feedback is applied must be isolated from the aerial: failure to do this will result in reaction dead spots on frequencies (or harmonics) at which the aerial is resonant.

(3) Provision must be made, at the receiver input, for the attenuation of powerful signals, otherwise the regenerative circuit will lock onto strong carriers and it will not be possible to receive weak transmissions on adjacent channels.

ARMSTRONG UPDATED

A modern, transistor version of Armstrong's circuit, patented in 1913, is shown in Fig.3.1. In the original, the feedback coil (tickler coil in the USA), L3, was connected in place of the radio frequency choke, L4, and regeneration controlled by adjusting its proximity to tuning coil L2. This was eventually superseded by the variable capacitor system shown here, where increasing the capacitance of VC1 increases feedback through L3.

Choke L4, in the drain (d) circuit of TR1, acts as a load for the radio frequency component of the amplified signal, controlled amounts of which are fed back through L3 to overcome losses in the tuned circuit (L2/VC2) and increase its efficiency or Q factor.

Armstrong discovered that the technique permits the amplification of weak signals by a factor of more than 1000.

Further, because tuned circuit Q is raised, there is also a dramatic improvement in selectivity.

Source bias is developed across resistor R3, which is bypassed by capacitor C2, and signal detection occurs by way of rectification at the gate/source junction of transistor TR1. (In the original valve versions, diode rectification between grid and cathode resulted in detection or demodulation). Low value blocking capacitor C1 prevents the audio voltage developed across gate resistor, R1, being shorted by the tuning coil.

AUDIO SIGNAL

The amplified audio signal is developed across drain load resistor R2 and coupled to the audio amplifier stages via d.c. blocking capacitor C3. Residual radio frequencies are bypassed by capacitor C4.

In some versions of the circuit, a transistor type audio transformer (e.g., an LT44) is substituted for the resistive load in order to maximize signal transfer. However, even with this arrangement, the audio output is very low, and at least one additional stage of pre-amplification will be required ahead

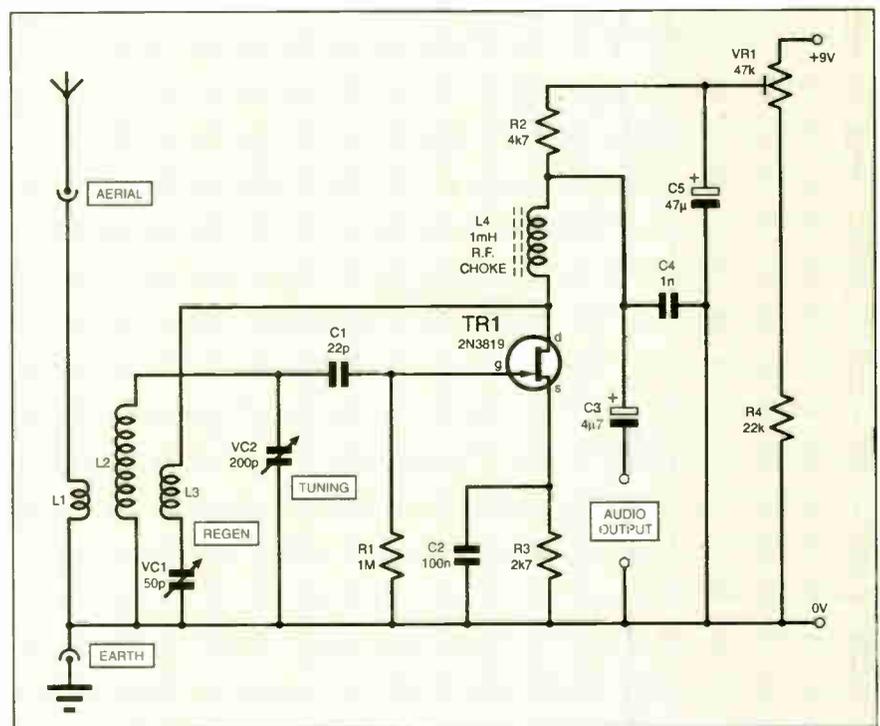


Fig.3.1. Circuit diagram for a modern transistor version of Armstrong's Regenerative Detector. In Armstrong's circuit, patented in 1913, feedback coil L3 is connected in place of r.f. choke L4 and its proximity to L2 is adjusted to control regeneration. VR1 presets regeneration control range.

of the headphone or speaker amplifiers described in Parts 1 and 2.

The gain of TR1, and hence its willingness to regenerate, is determined by preset potentiometer VR1, which adjusts the drain voltage. By this means the circuit can be optimized for different transistors and coil feedback winding ratios.

POPULARITY

Using gradually improving versions of Lee de Forest's triode valve as the amplifying device, Armstrong's circuit, followed by a one or two valve audio amplifier, remained popular as a domestic receiver until the end of the 1920s in the USA and well into the 1930s in the UK. Regenerative receivers were still being manufactured by Ever-Ready (their Model H) as late as the 1950s, and they were constructed by amateurs up to the close of the valve era.

It is not easy to use low impedance, current amplifying bi-polar transistors in this circuit. However, it saw something of a revival in amateur circles following the introduction of the field effect transistor (f.e.t.), with its more valve-like characteristics, in the late 1960s.

IMPROVED CIRCUITS

Smooth regeneration can be obtained more readily, and with simpler coils, by configuring the Q multiplier, or regenerative detector, as a Hartley oscillator. A typical circuit is given in Fig.3.2, where feedback from the source(s) of the dual-gate MOSFET, TR1, is connected to a tapping on the tuning coil L2.

The level of feedback is controlled by VR1, which varies the gain of the transistor by adjusting the voltage on its gate g2. Preset potentiometer VR2 (wired as a variable resistor) determines the source bias and optimizes the action of the regeneration control for individual tuning coils and transistors.

Audio output is developed across drain load resistor R3. The stage is decoupled from the supply rail by resistor R2 and capacitor C5, and the filter network formed by C4, R4 and C6 removes radio frequencies from the output.

SEPARATION

During the valve era, the functions of signal detection and Q multiplication or regeneration were invariably carried out by a single device. This combining of functions can make it more difficult to obtain the smooth, backlash-free control of regeneration which is crucial to the efficient operation of a receiver of this kind. Best modern practice uses separate transistors.

The dual-gate MOSFET circuit illustrated in Fig.3.2 can be used just as a Q -multiplier by increasing the value of capacitor C4 to 100nF. Filter components, R4, C6 and coupling capacitor C7, can be omitted when the stage is configured in this way.

The "hot" end of the tuned circuit must, of course, be connected to gate g1 of the transistor, and resistor R1 is best retained to hold gate g1 at 0V during coil changing.

DETECTORS

A field effect transistor (f.e.t.), biased into the non-linear region of its

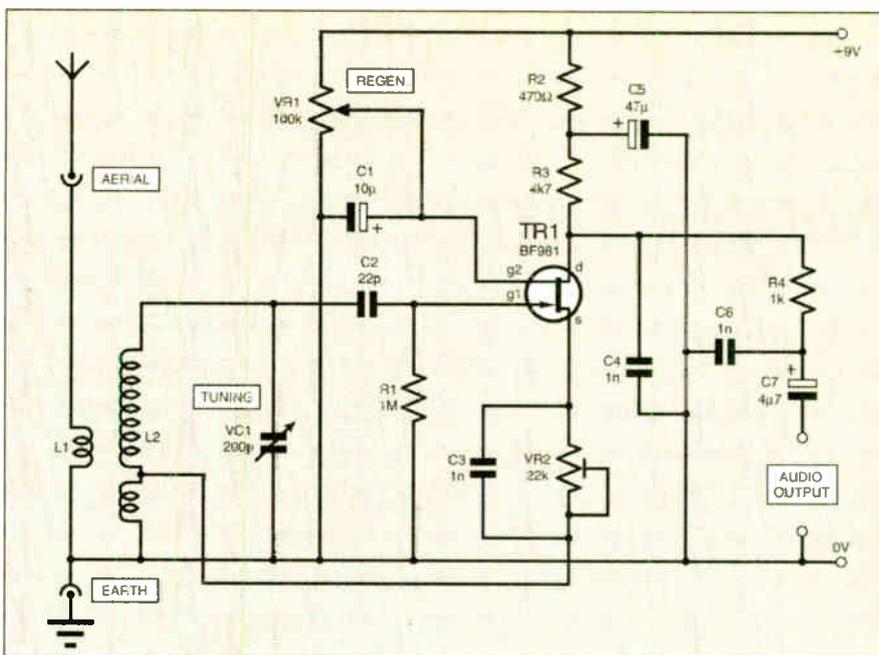


Fig.3.2. Circuit diagram for an improved Regenerative Detector based on a Hartley oscillator. VR2 presets regeneration control range. This circuit forms an excellent Q -Multiplier for use with a separate detector, in which case increase capacitor C4 value to 100nF and delete C6, C7 and R4.

characteristic curve, forms an excellent detector stage. The "drain bend" version (the transistor equivalent of the valve "anode bend" detector) is included as TR3 in the Regenerative Receiver design illustrated in Fig.3.4. This arrangement is discussed later.

Alternatively, the audio output can be taken from the source of the f.e.t. We then have the transistor equivalent of the valve "infinite impedance" detector. The modified circuit, using the component numbering of Fig.3.4 for ease of comparison, is shown in Fig.3.3.

High-value source bias resistor R9 is bypassed only at radio frequencies by capacitor C10 (C9 is omitted), and C13 is increased to 47uF to decouple the stage which is now in the common drain mode. The r.f. filter components, R8 and C15, and the original decouplers, R6 and C11, are not required.

There is little to choose between the two detectors: both work well, imposing very little damping on the tuned circuit. In theory there is some gain with the drain bend version whilst the gain of the source follower is slightly less than unity.

In practice, the need to ensure non-linearity over a range of f.e.t. characteristics results in the drain bend circuit providing very little gain. If the value of r.f. bypass capacitor C10 in Fig.3.3 is reduced, the source-follower detector may become unstable when the regeneration control is critically set.

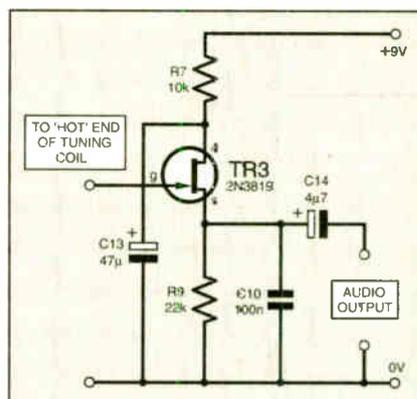
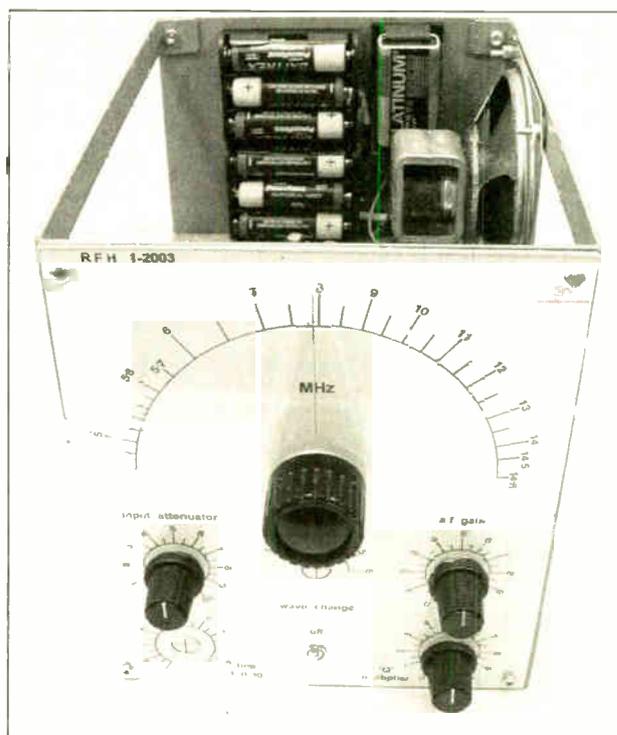


Fig.3.3. Source-follower detector circuit. Transistor equivalent of the valve "anode-bend" detector.



HIGH PERFORMANCE

REGENERATIVE RADIO

A modern-day update of a 1913 circuit

The full circuit diagram for a High Performance Regenerative Radio incorporating the essential features described here is given in Fig.3.4. It is easy to set up and performs well.

Grounded base stage, TR1, isolates the tuned circuit L2/VC1 from the aerial and TR2 functions as the *Q*-Multiplier. Field effect transistor TR3 is a drain bend detector and transistor TR4 an audio preamplifier.

Although excellent *Q* multipliers can be designed around dual-gate MOSFETS (metal-oxide semiconductor field effect transistors), devices of this kind are becoming more difficult to obtain. For this reason a j.f.e.t. (junction field effect transistor) is used in the *Q* multiplier stage.

Performance is not compromised and these simpler devices are widely available. The circuit in Fig.3.2 should assist any readers who might wish to experiment with dual-gate MOSFETS as an alternative.

INPUT CIRCUIT

Some readers may be plagued by a medium wave transmission which is powerful enough to swamp the receiver, and L1 and C1 act as a Wave Trap, blocking out the offending signal. Wave trap circuits were discussed in Part 2 last month, and component values and a printed circuit board design were also given.

Potentiometer VR1 connected as the emitter resistor for transistor TR1, controls signal input, and resistors R2 and R3 fix the base bias. The base of TR1 is "grounded" at radio frequencies by capacitor C5; and R1, C3 and C4 decouple the stage from the supply. Blocking capacitor, C2, prevents the grounding of TR1 emitter when aerials are connected to the receiver via a balun transformer and coaxial cable.

The grounded base configuration results in a low input impedance and a high output impedance, and the stage can be coupled directly to the tuned circuit without imposing excessive damping. Because TR1 is a *pnp* transistor, its collector (c) can be connected to the 0V rail via coil L2, eliminating the need for a coupling winding.

STABILITY MATTERS

Stability is ensured by stopper resistor R4 and by maintaining a low level of base bias on TR1. Constructors may wish to try reducing the value of resistor R3 (not less than 47 kilohms) to improve performance when low gain transistors are used in the aerial input circuit.

However, if this is overdone the stage will no longer be unconditionally stable,

and control of regeneration will become erratic, especially when tuning capacitor VC1 is set at a low value.

It could be argued that using a field effect transistor, with its near square law characteristics, in the TR1 position, would reduce the receiver's susceptibility to cross-modulation.

Cross-modulation occurs when a powerful signal drives the input stage into non-linearity. It then begins to function as a modulator, imposing the strong signal on adjacent weaker signals and spreading it across the dial.

The regenerative circuit of Fig.3.4 will lock onto a powerful signal long before it is strong enough to make TR1 non-linear. The measures taken to avoid this (wave trap and input attenuator) will, therefore, also prevent cross-modulation. Moreover, *p*-channel field effect transistors are not so widely available, and this militates against their use.

TUNING

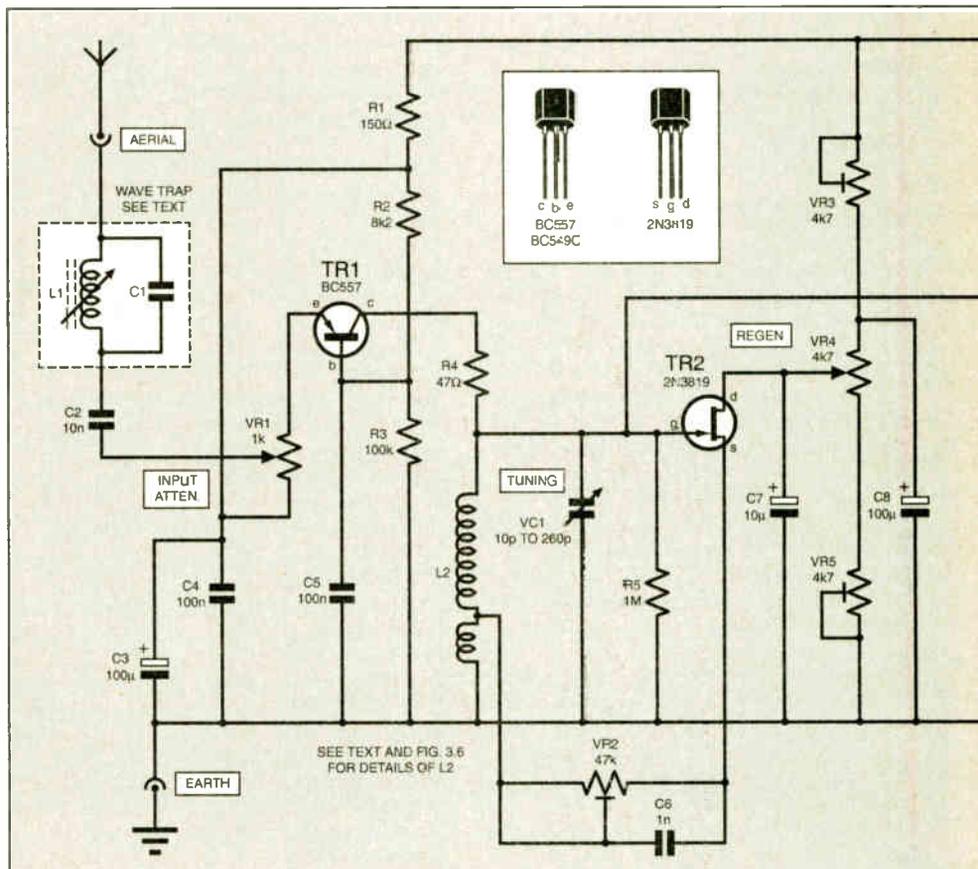
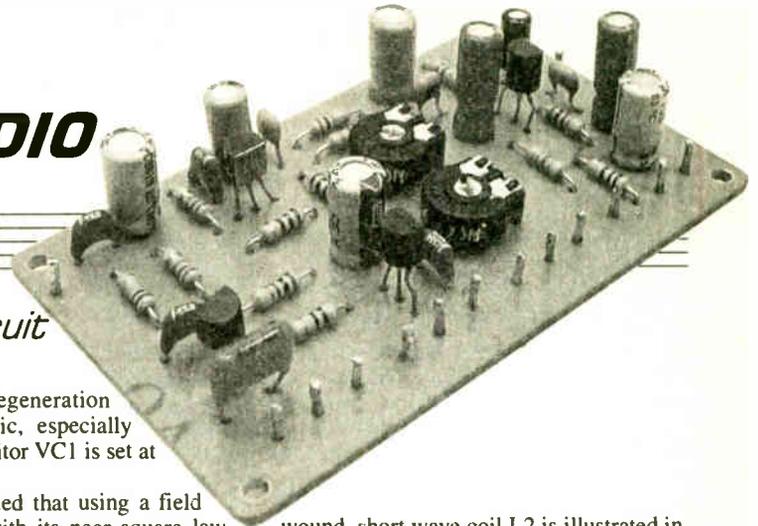
The simplest possible tuning arrangement is depicted in Fig.3.4. and the hand-

wound, short wave coil L2 is illustrated in Fig.3.6.

The tuning capacitor VC1 is a 10pF to 260pF unit formed by connecting both a.m. gangs of a polyvaricon (polythene dielectric) capacitor in parallel. Typical connection details are shown in Fig.3.7, and the copper track side of a printed circuit board suitable for mounting most screw or tag fixed variable capacitors of this kind is also shown.

REGENERATION

Regeneration, or *Q* multiplication, is provided by TR2, a field effect transistor configured as a Hartley oscillator. Feedback is taken from TR2 source (s) to a tapping on coil L2 via preset potentiometer VR2 and its bypass capacitor C6. This arrangement enables the control of regeneration to be optimized for different coil and transistor combinations.



REGENERATIVE RADIO

Resistors

- R1, R6, R11 150Ω (3 off)
- R2 8k2
- R3 100k
- R4 47Ω
- R5, R10 1M (2 off)
- R7 10k
- R8, R13 470Ω (2 off)
- R9 22k
- R12 4k7

All 0.25W 5% carbon film

Potentiometers

- VR1 1k rotary carbon, lin.
- VR2 47k carbon preset, horizontal
- VR3, VR5 4k7 carbon preset, horizontal (2 off)
- VR4 4k7 rotary carbon, lin.
- VR6 4k7 rotary carbon, log.

Capacitors

- C1 only required if Wave Trap fitted (see Part 1)
- C2 10n disc ceramic
- C3, C8, C11, C12 100μ radial elect. 25V (4 off)
- C4, C5, C10 100n disc ceramic (3 off)

See
**SHOP
TALK**
page

- C6 1n polyester
- C7, C9 10μ radial elect. (2 off)
- C13, C15 1n polyester or ceramic – see text and Table 3.1 (2 off)
- C14, C17 4μ7 radial elect. – see text and Table 3.1 (2 off)
- C16 47μ radial elect. – see text and Table 3.1
- C18 10n polyester or ceramic – see text and Table 3.1
- VC1 10p to 260p polythene dielectric variable capacitor

Semiconductors

- TR1 BC557 pnp small signal transistor
- TR2, TR3 2N3819 n-channel field effect transistor (2 off)
- TR4 BC549C npn silicon transistor

Miscellaneous

- L1 only required if Wave Trap fitted (see Part 1)
- L2 tuning coil, hand-wound (see Fig.3.6)
- S1 d.p.s.t. toggle switch

Printed circuit boards available from the *EPE PCB Service*, codes 405 (Regen) and 406 (T/Cap); diecast or aluminium box for chassis, at least 200mm x 150mm x 75mm (8in. x 6in. x 3in.), or aluminium sheet to fabricate a base and front panel; aerial and earth screw terminals; one large and three small plastic control knobs; audio type screened leads; 50g (2oz) reel of 24s.w.g. (23a.w.g.) enamelled copper wire for tuning coil; plastic tube, 20mm (3/4in.) outside diameter (o/d) for coil former; 9V battery (PP3) and clip; connecting wire; nuts, bolts and washers; solder pins; solder etc.

Feedback is adjusted by regeneration control VR4, which varies the voltage on the drain (d) of TR2 thereby altering its gain. The range of adjustment is fixed by presets VR3 and VR5, and the action of the regeneration control can be made very gentle and smooth when the swing of VC1 is not too great. Potentiometer noise is eliminated by capacitor C7.

DETECTOR PREAMPLIFIER

Drain bend detector, TR3, is biased into non-linearity by resistor R9, which is bypassed at audio and radio frequencies by capacitors C9 and C10. Audio output is developed across drain load resistor R7, and R6 and C11 decouple the stage from

Table 3.1. Capacitor Values for a Wide or Narrow Audio Frequency Response

Part No.	Wide Response	Narrow Response
C13	1n	10n
C14	4μ7	100n
C15	1n	10n
C16	47μ	4μ7
C17	4μ7	100n
C18	10n	330n

the supply rail. Residual radio frequencies are filtered out by R8, C13 and C15, and the signal is coupled to transistor TR4 through d.c. blocking capacitor C14.

Audio preamplifier stage, TR4, is necessary in order to boost the weakest signals. Emitter bias is provided by resistor R13, which is bypassed by C16; R10 is the base bias resistor, and R12 is TR4's collector load.

Supply rail decoupling is effected by R11 and C12. The output signal is taken from TR4 collector, via blocking capacitor C17, and the audio output level is set by Volume control VR6.

AUDIO RESPONSE

Speech signals, especially when they are overlaid by noise, can be greatly clarified by reducing the response of the system to low and high audio frequencies. Telephone companies throughout the world operate on this principle, and heavily attenuate frequencies below 300Hz and above 3000Hz (3kHz). Narrowing the response leaves speech intelligible while removing parts of the spectrum that carry a good deal of the noise.

The values of the capacitors in the receiver's audio signal path, i.e. from the collector of TR3 onwards, can be chosen to tailor the

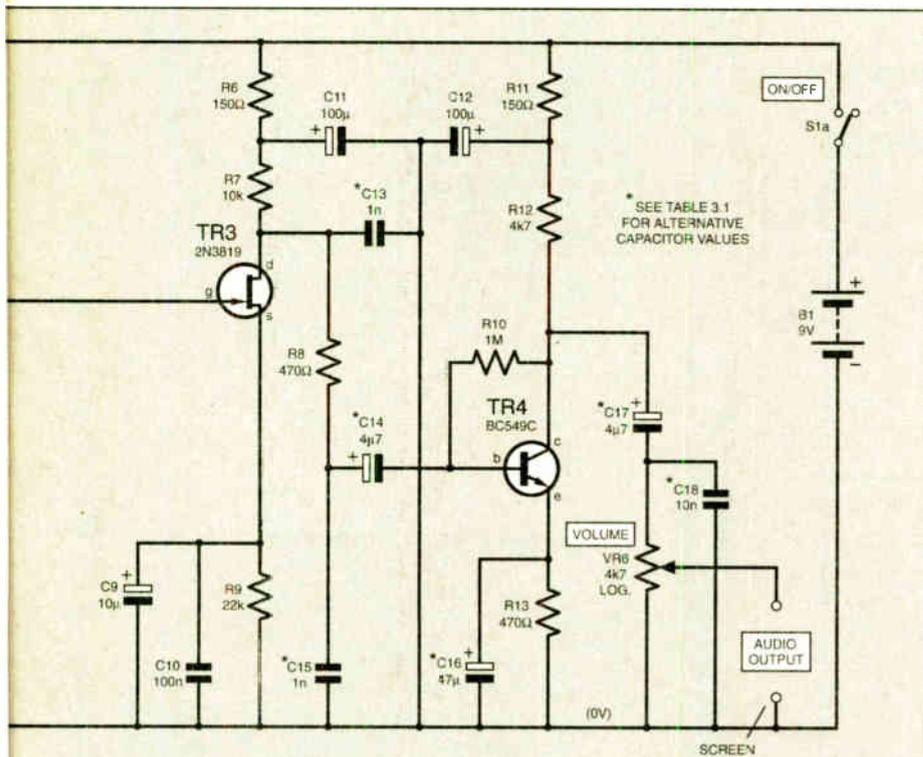


Fig.3.4. Complete circuit diagram for the High Performance Regenerative Radio. See Table 3.1 for alternative capacitor values. Note the Wave Trap is optional – see text and Part 2 (July '03).

audio response. Increasing the value of shunt capacitors C13, C15 and C18, will reduce response to high frequencies.

Reducing the value of coupling capacitors, C14 and C17, will attenuate low frequencies. Reducing the value of bypass capacitor C16 introduces selective negative feedback which also inhibits response at the lower audio frequencies.

Suggested alternative values for these capacitors are given in Table 3.1. Readers will no doubt wish to experiment until the audio response meets their needs.

POWER SUPPLY

Even small power amplifiers induce large voltage variations in the supply rail, and the four transistors in this circuit must have their own battery supply (or a supply isolated by an electronic regulator and ample smoothing).

Voltage fluctuations on a common supply will cause erratic regeneration, problems with electronic tuning systems (described next month) and low frequency oscillation or "motor boating". The receiver battery is switched by S1a. The other half of the toggle switch, S1b, can be used to control the supply to the Speaker Amplifier (described last month) or other audio amplifiers.

SEMICONDUCTORS

The *pn*p, bipolar transistor used as the r.f. amplifier, TR1, is not particularly critical. Any small signal device with an f_T of at least 100MHz and an H_{fe} of 200 or more should perform well. The audio preamplifier, TR4, can be almost any small signal *n*p*n* silicon transistor, but low-noise, high gain (H_{fe} at least 400) devices are to be preferred.

Most *n*-channel field effect transistors should function in the detector (TR2) and *Q* multiplier (TR3) stages. In addition to the specified 2N3819's, the BF244A, BF245B, J304, J310, TIS14, K168D and MPF102 have all been "in circuit" tested and found to be satisfactory.

Note that base connections for all of these devices vary and should be checked.

CONSTRUCTION

Most of the receiver components are assembled on a compact printed circuit board (p.c.b.). The topside component layout, together with the full-size underside foil master pattern and off-board wiring are illustrated in Fig.3.5. This board is available from the EPE PCB Service, code 405 (Regen).

The tuning coil L2 and variable capacitor VC1 are mounted separately. This gives greater freedom in the choice of tuning arrangements. A small p.c.b. which will take most miniature screw or tag fixing polythene dielectric variable capacitors is shown in Fig.3.7. This board is also obtainable from the EPE PCB Service, code 406 (T/Cap).

Solder pins inserted at the lead-out points ease the task of off-board wiring. They should be inserted into the printed circuit board first. Follow these with the resistors, then the capacitors, smallest first; and, finally, the semiconductors. It is good practice to use a miniature crocodile clip as a heat shunt whilst soldering the field effect transistors in place.

On completion, the p.c.b. should be examined for poor soldered joints and

bridged tracks, and the orientation of semiconductors and electrolytic capacitors should also be checked.

It is a good idea to wire the printed circuit board to the controls and tuning components on the work bench, and test it before mounting it in an enclosure. Current consumption of the receiver should be in the region of 4mA.

COIL WINDING

Details of the tuning coil L2 are given in Fig.3.6. It is wound on an off-cut of 20mm (3/4in.) outside diameter plastic electrical conduit and preset VR2 and its bypass capacitor C6 are located at one end of the former. Solder tags are used to anchor the windings and the preset potentiometer.

Plastic electrical conduit for the hand-wound coil is retailed at most DIY outlets. Suppliers of enamelled copper wire and tuning capacitors are mentioned in the *Shoptalk* column. The remaining components are widely available.

The specified variable capacitor (VC1) will tune coil L2 from 4.8MHz to 14.6MHz. This covers the 20, 30 and 40 metre amateur bands, and the 25, 31, 41, and 49 metre broadcast bands.

Details of hand-wound coils covering 150kHz to 30MHz will be described next month, together with switched coil packs, incorporating commercial coils, for general coverage and amateur bands receivers.

Constructors who like to experiment with their own coils should tap longwave inductors at 5 per cent of the total turns, and all other coils at 10 per cent. The short-wave coil covering up to 30MHz may require a 15 per cent tapping point to secure regeneration when the tuning capacitor is set at maximum. Commercial coils in spares boxes can be pressed into service by adding turns to form the source tapping point.

ASSEMBLY AND WIRING

Construction of the set must be rigid and robust or the receiver will not perform well, especially on the short-wave bands. Diecast boxes are best for chassis or enclosures, but receivers assembled on or in aluminium boxes are acceptable. A metal front panel is essential for screening purposes.

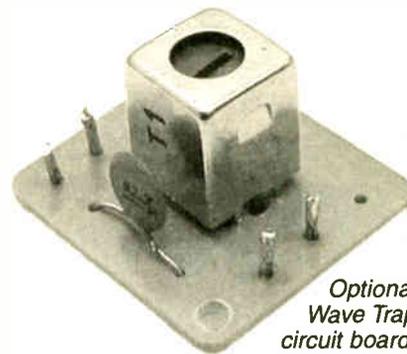
Layout is not particularly critical, but locate the tuning components close to the relevant solder pins on the receiver printed circuit board. Keep signal input leads away from output leads. The regeneration potentiometer VR4

can be located in any convenient position (it is decoupled from the signal circuits).

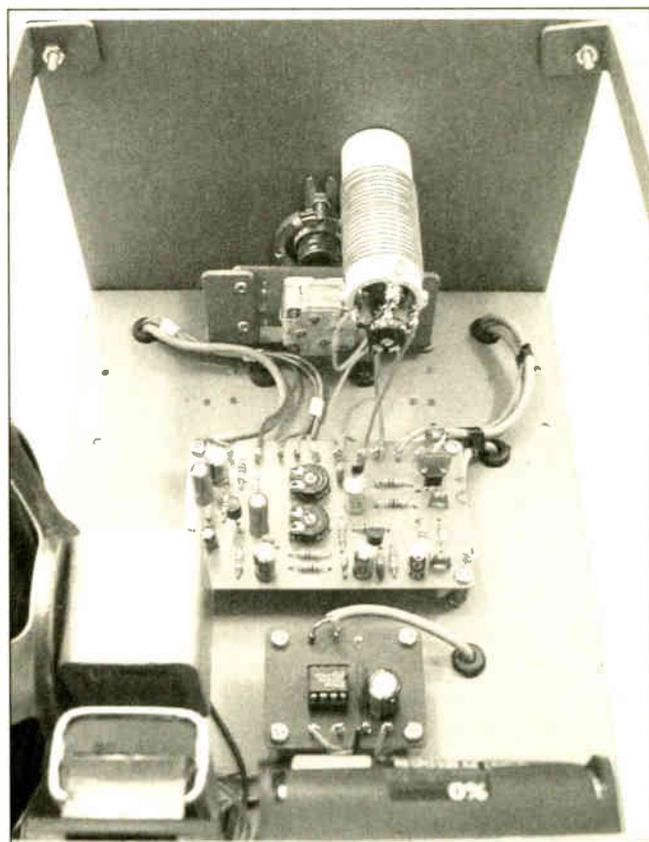
The general interwiring from the p.c.b. to the off-board components is shown in Fig.3.5. Some variable capacitors are secured by screws driven into their front plates. Check the length of the screws to ensure that they do not project too far and foul the capacitor vanes.

Metal potentiometer cases should be connected to the 0V rail. Leads between the aerial terminal, the input attenuator, VR1, and the receiver printed circuit board, should be screened, as should the leads between the volume control, VR6, the power amplifier and the receiver board. The screening must, of course, be connected to the "ground" or 0V rail.

Most polyvaricon capacitors designed for a.m. or a.m./f.m. portable receivers will be suitable. The calibrated dial reproduced (half-size) in Fig.3.8 should be reasonably accurate if the tuning capacitor mentioned in the Components List is used and the coil is wound in accordance with Fig.3.6.



Optional Wave Trap circuit board, not shown in the author's model below.



General layout inside the metal case. The speaker amplifier module is in the foreground. The wave trap is mounted on the underside boxed chassis.

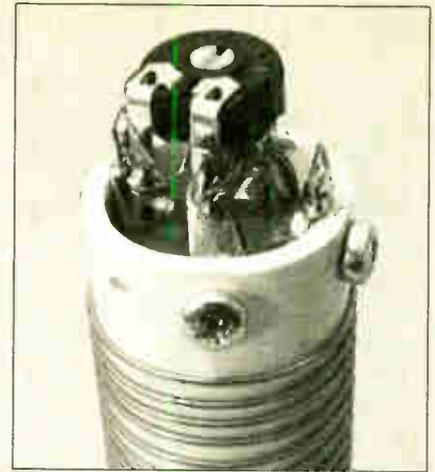
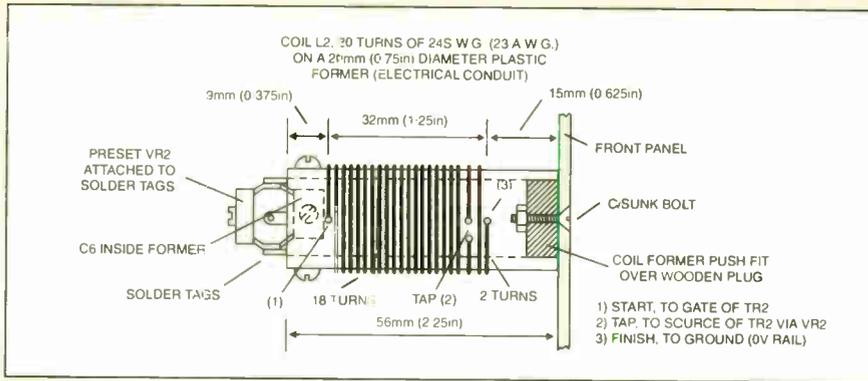


Fig.3.6. Coil winding details for the tuning coil L2. The coil former also carries preset VR2 and capacitor C6 – see photo opposite.

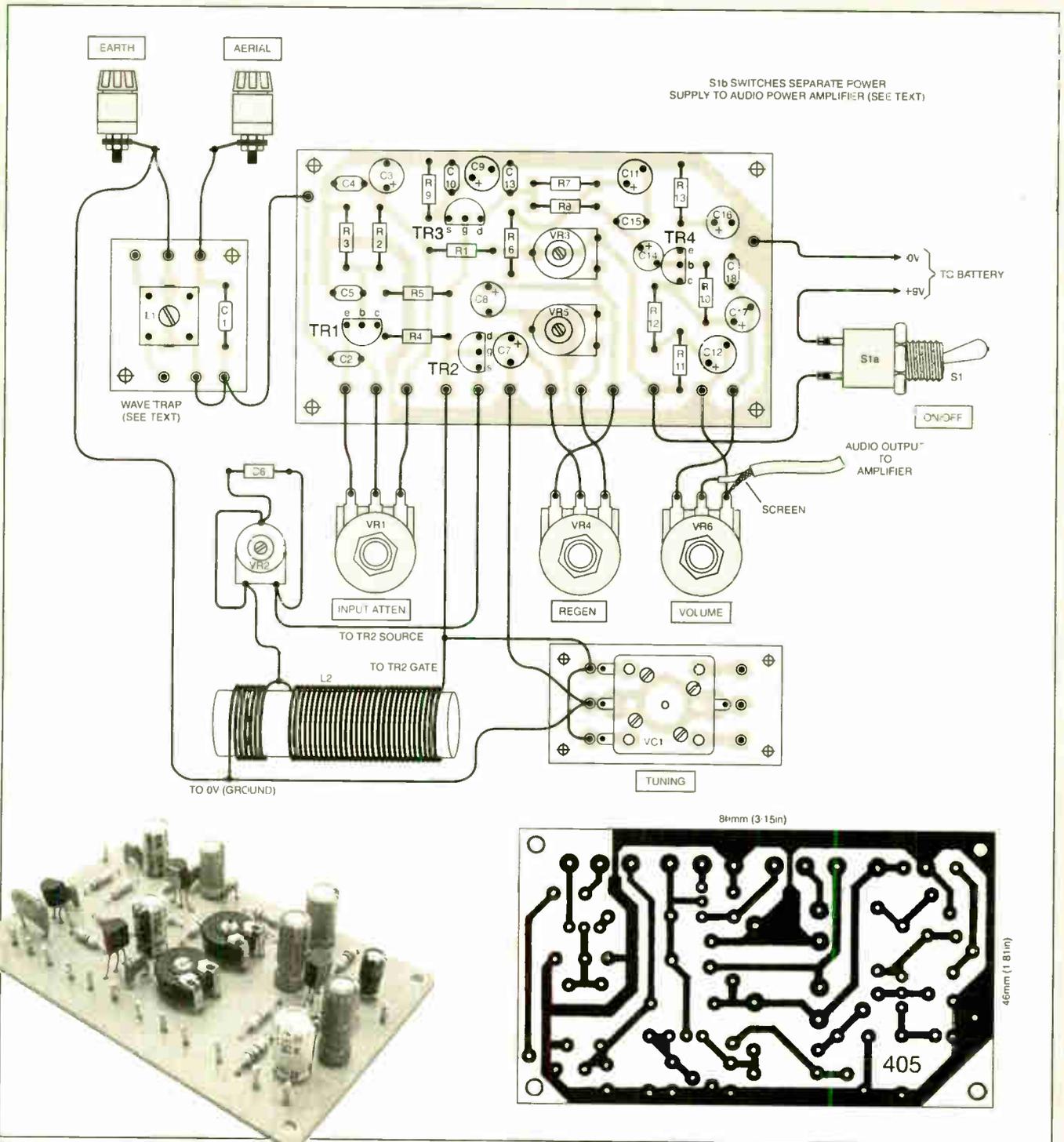
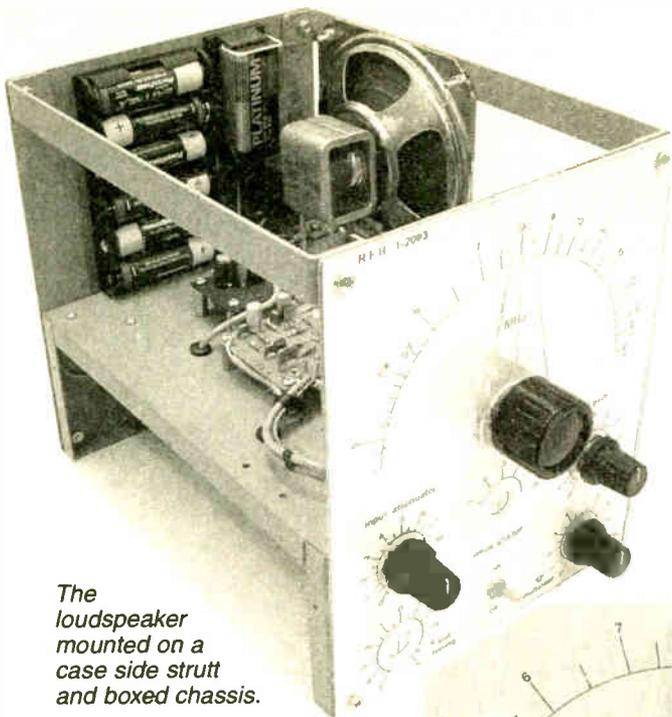


Fig.3.5. Printed circuit board component layout, interwiring details and full-size copper foil master for the Regenerative Receiver. Note you will need an additional VR2 preset and capacitor C6 for each waveband coil.

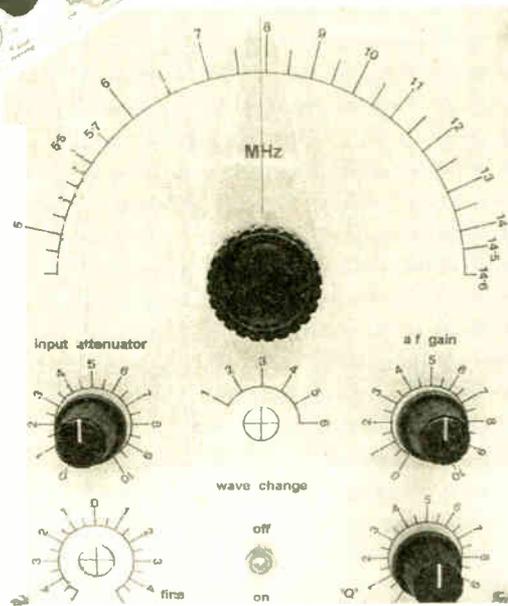


The loudspeaker mounted on a case side strutt and boxed chassis.

Polyvaricons intended for inexpensive 'hi-fi' systems often have 300pF or larger a.m. gangs. These capacitors have a deeper case, around 20mm (3/4in.) compared to the 10mm (3/8in.) or so for the lower value units. Only one gang should be connected if a capacitor of this kind is fitted.

The accompanying photographs show this simple version of the receiver assembled on the metal chassis used to test and evaluate the circuits. A 6:1 reduction drive is fitted to the spindle of the tuning capacitor but this is not adequate for easy tuning over the shortwave bands.

Further, the value of the tuning capacitor, whilst it gives good coverage with the single coil, is too high and regeneration becomes difficult to adjust at the high frequency end of the range. These questions are addressed next month when more refined tuning systems are discussed.



Front panel fascia of single band version showing general layout.

Readers may wish to try connecting only one of the capacitor gangs into circuit. This gives a swing of 5pF to 130pF and coverage with the specified coil is around 6.5MHz to 15.5MHz. Coverage is reduced but control of regeneration, at the higher frequencies, is easier.

SETTING UP

Connect the receiver to the Speaker

Amplifier described in Part 2. Connect an aerial comprising at least 30 feet (10 metres) of wire located as high as possible and well clear of any telephone or power lines and earthed objects.

Set preset VR2 to maximum, and presets VR3 and VR5 to minimum resistance. Rotate the slider of Regen. control VR4 to put the maximum voltage on the drain (d) of TR2. Set the other potentiometers to half-travel.

Now connect a fresh 9V battery and tune in a weak signal with variable capacitor VC1, set close to its maximum value.

Reduce the resistance of preset VR2 until the Q multiplier begins to oscillate (indicated by a rushing sound or faint whistle). Turn down Regeneration control VR4. The receiver should slide gently out of oscillation.

When regeneration is set close to oscillation, the perceived strength of signals will be greatly increased and tuning much sharper.

Turning down VR1 to attenuate input signals, as necessary, gradually open the vanes of VC1 to tune the receiver up in frequency. Less regeneration will be required to maintain sensitivity as the tuning capacitance is reduced, and VR4 will have to be progressively turned down. When VC1 is fully open, increase the value of preset VR5 until regeneration can be set just below the threshold of oscillation when VR4 is at minimum.

Refine the adjustment of preset potentiometers VR2, VR3 and VR5 until the action of the regeneration control VR4 is as gentle as possible across the entire tuning range. Because of the wide swing of the tuning capacitor, VC1, in this simple version of the receiver, presets VR3 and

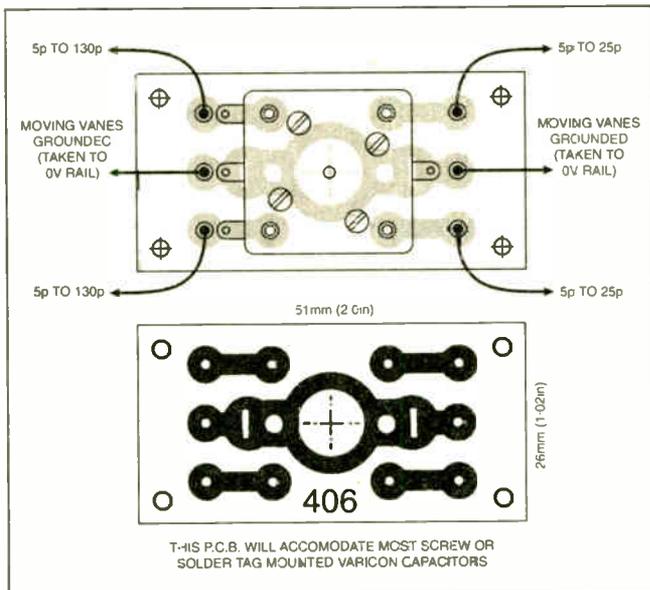


Fig.3.7. Tuning capacitor mounting p.c.b. details. Connections to a typical a.m./f.m. four-gang polythene dielectric variable capacitor. Capacitance values and connections may vary and should be checked.

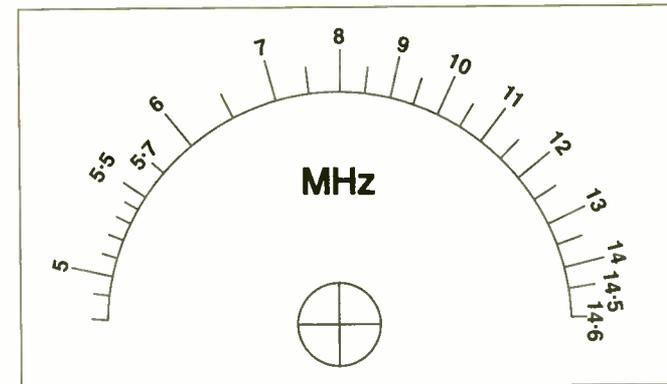
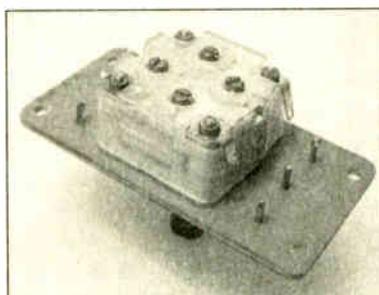
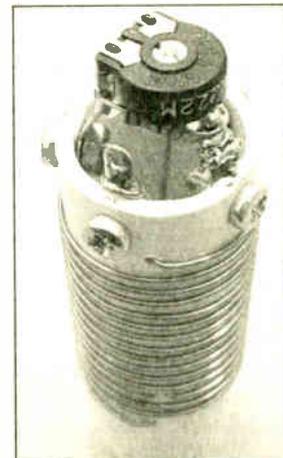


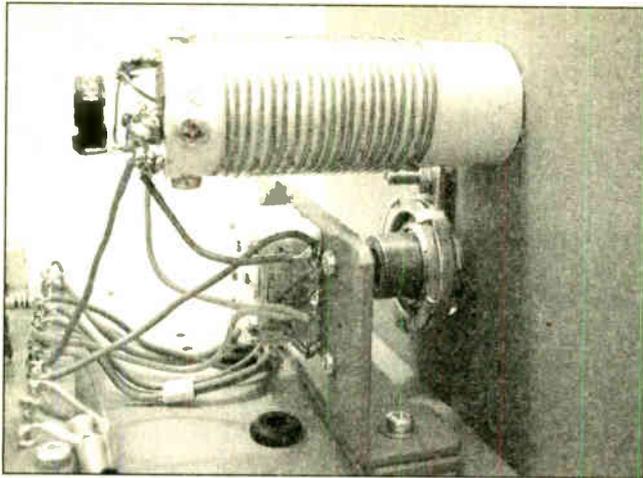
Fig.3.8. Half-size calibrated dial (MHz). Calibration with the specified tuning capacitor and coil L2. Receivers will vary, but it is a good guide to coverage.



(Above) The tuning capacitor mounted on the p.c.b.



(Right) Completed tuning coil showing preset soldered to tags bolted on one end of former.



Close-up view of the mounting arrangement for the tuning coil and variable capacitor. Note the reduction drive fitted to the tuning capacitor spindle.

VR5 will have to be set close to minimum resistance to give VR4 sufficient control.

OPERATION

Best results will be obtained if the Regenerative Radio is operated with VR1 set to attenuate the input as much as possible and the audio frequency gain (Volume) control turned up to ensure adequate sound output. This is good practice with complex sets and essential with this simple receiver. If this procedure is not followed it will be impossible to hear weak signals close in frequency to powerful ones.

For best reception of a.m. (amplitude modulated) signals the Regeneration control VR4 must be adjusted, as the receiver is tuned across the band, to keep the *Q* multiplier circuit close to oscillation. When regeneration is correctly set, rocking the tuning control should produce a faint whistle on either side of the station.

A useful technique when searching for very weak signals is to advance the

regeneration control until the stage is just oscillating in the absence of a carrier signal. When a station is tuned in its carrier will suppress the oscillation and the weak signal will become audible.

PUBLIC WARNING

This practice was widely adopted when regenerative receivers were popular for domestic listening. Unfortunately there was usually no radio frequency stage to isolate the detector from the aerial, and an oscillating valve with up to 100V on its anode forms a good transmitter.

Reception was, therefore, marred by whistles and howls propagated by neighbouring receivers. The problem became so acute that, in 1928, the BBC issued a handbook guiding the public on the correct operation of the regeneration control. During that year so many complaints were received that listeners were warned that their licenses would be withdrawn if they didn't exercise more restraint.

With this modern transistor design, the grounded base radio frequency stage isolates the very low powered oscillator and interference problems do not arise.

AMATEUR BAND RECEPTION

For the reception of amateur s.s.b. (single-side-band) transmissions, the regeneration control must be advanced until the *Q* multiplier is oscillating. The locally generated oscillation replaces the

carrier suppressed at the transmitter so that the signals can be demodulated in the usual way (more about this later).

Very precise tuning is required to clarify these signals, and the simple slow motion drive fitted on this version of the receiver is completely inadequate. Fortunately, the operation of the regeneration control produces a very slight shift in the *Q* multiplier's frequency of oscillation, and this can be used to fine tune and clarify these transmissions (increasing the drain voltage produces a very slight reduction in the gate to source capacitance).

The signals will still be difficult to resolve, however, and next month a tuning system dedicated to the three most popular amateur bands will be described.

An "earth" connection may improve reception. Guidance on constructing an earth system was given in Part 1.

PERFORMANCE

The Regenerative Radio described here is a modern evocation of the 1913 circuit that made man's dream of long distance radio reception a reality. However, it should not be regarded as a historical novelty. Correctly built, connected to a decent aerial and skillfully operated, it will permit the reception of at least 90 per cent of the signals receivable on a modern, high performance communications receiver.

Skilful operation is the key to unlocking its performance. The need for this is, perhaps, the main reason why it was replaced by the more easily controlled superhet receiver.

It lacks automatic gain control, automatic input attenuators and pushbutton tuning. It does, however, offer a standard of performance out of all proportion to the minimal outlay of money and effort involved in its construction.

Next month's article, dealing with more refined tuning systems and general coverage and amateur bands coil packs, will help readers to get the best out of the receiver.

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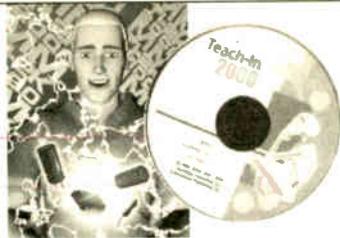
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167 pages

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This book offers a number of power supply designs, including simple unregulated types, and variable voltage regulated designs, the latter being primarily intended for use as bench power supplies for the electronics workshop. The designs provided are all low voltage types for semiconductor circuits. The information in this book should also help the reader to design his own power supplies. Includes cassette PSU, Ni-Cad charger, voltage step-up circuit and a simple inverter.

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This book explains the basic function of an oscilloscope, gives a detailed explanation of all the standard controls, and provides advice on buying. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits, plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulser and crystal calibrators.

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Also included are techniques for connecting a PC to a remote control system, the use of a microcontroller in remote control, as exemplified by the BASIC Stamp, and the application of ready-made type-approved 418MHz radio transmitter and receiver modules to remote control systems.

160 pages

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Bill Mooney

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RADIO

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I. D. Poole

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Topics covered include: The equipment that is needed; Setting up the shack; Which aerials to use; Methods of construction; Preparing for the licence.

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86 pages

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H. C. Wright

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Although primarily a practical book with text closely supported by diagrams, some formulae which can be used by straightforward substitution and some simple graphs have also been included.

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THEORY AND REFERENCE

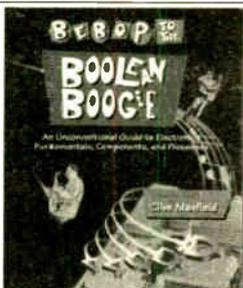
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Contents: waves and pulses, passive components, active components and ICs, linear circuits, block and circuit diagrams, how radio works, disc and tape recording, elements of TV and radar, digital signals, gating and logic circuits, counting and correcting, microprocessors, calculators and computers, miscellaneous systems.

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Since *Foundations of Wireless* was first published over 60

years ago, it has helped many thousands of readers to become familiar with the principles of radio and electronics. The original author Sowerby was succeeded by Scroggie in the 1940s, whose name became synonymous with this classic primer for practitioners and students alike. Stan Amos, one of the fathers of modern electronics and the author of many well-known books in the area, took over the revision of this book in the 1980s and it is he, with his son, who have produced this latest version.

400 pages **Order code NE27** £21.99

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96 pages **Temporarily out of print**

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Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

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Ian Waugh

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The projects covered in this book include: Four channel audio mixer, Four channel stereo mixer, Dynamic noise limiter (DNL), Automatic audio fader, Video faders, Video wipers, Video crispener, Mains power supply unit.

109 pages **Order code BP356** £5.45

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R. A. Penfold

Whether you wish to save money, boldly go where no musician has gone before, rekindle the pioneering spirit, or simply have fun building some electronic music gadgets, the designs featured in this book should suit your needs. The projects are all easy to build, and some are so simple that even complete beginners at electronic project construction can tackle them with ease. Stripboard layouts are provided for every project, together with a wiring diagram. The mechanical side of construction has largely been left to individual constructors to sort out, simply because the vast majority of project builders prefer to do their own thing in this respect.

None of the designs requires the use of any test equipment in order to get them set up properly. Where any setting up is required, the procedures are very straightforward, and they are described in detail.

Projects covered: Simple MIDI tester, Message grabber, Byte grabber, THRU box, MIDI auto switcher, Auto/manual switcher, Manual switcher, MIDI patchbay, MIDI controlled switcher, MIDI lead tester, Program change pedal, Improved program change pedal, Basic mixer, Stereo mixer, Electronic swell pedal, Metronome, Analogue echo unit.

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Robert Charles Alexander

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Alan Dower Blumlein led an extraordinary life in which his inventive output rate easily surpassed that of Edison, but whose early death during the darkest days of World War Two led to a shroud of secrecy which has covered his life and achievements ever since.

His 1931 Patent for a Binaural Recording System was so revolutionary that most of his contemporaries regarded it as more than 20 years ahead of its time. Even years after his death, the full magnitude of its detail had not been fully utilized. Among his 128 patents are the principal electronic circuits critical to the development of the world's first electronic television system. During his short working life, Blumlein produced patent after patent breaking entirely new ground in electronic and audio engineering.

During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H2S' - blind-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirtieth birthday.

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R. A. Penfold

Written by highly respected author R. A. Penfold, this book contains a collection of electronic projects specially designed for video enthusiasts. All the projects can be simply constructed, and most are suitable for the newcomer to project construction, as they are assembled on stripboard.

There are faders, wipers and effects units which will add sparkle and originality to your video recordings, an audio mixer and noise reducer to enhance your soundtracks and a basic computer control interface. Also, there's a useful selection on basic video production techniques to get you started.

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Just a few of the questions you've probably asked. Well, you'll find the answers to all these questions, and many more, in this book. It will show you what can be done, what it all means, and what you will need to start creating your own music on your PC. It's an easy read, it's fully illustrated and it will help you understand how a computer can be used as a creative music tool.

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AN INTRODUCTION TO PIC MICROCONTROLLERS

Robert Penfold

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The PIC processors have plenty of useful features, but they are still reasonably simple and straightforward to use. This book should contain everything you need to know.

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A. Filnd

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Various circuits using inductors and capacitors are covered, with emphasis on stable low frequency generation. Some of these are amazingly simple, but are still very useful signal sources.

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PRACTICAL ELECTRONICS HANDBOOK – Fifth Edition. Ian Sinclair

Contains all of the everyday information that anyone working in electronics will need.

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Contents: Passive components, Active discrete components, Circuits, Linear I.C.s, Energy conversion components, Digital I.C.s, Microprocessors and micro-processor systems, Transferring digital data, Digital-analogue conversions, Computer aids in electronics, Hardware components and practical work, Micro-controllers and PLCs, Digital broadcasting, Electronic security.

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B. B. Babani

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R. M. Marston

A useful single-volume guide to the optoelectronics device user, specifically aimed at the practical design engineer, technician, and the experimenter, as well as the electronics student and amateur. It deals with the subject in an easy-to-read, down-to-earth, and non-mathematical yet comprehensive manner, explaining the basic principles and characteristics of the best known devices, and presenting the reader with many practical applications and over 200 circuits. Most of the i.c.s and other devices used are inexpensive and readily available types, with universally recognised type numbers.

182 pages **Order code NE14** £20.99

OPERATIONAL AMPLIFIER USER'S HANDBOOK

R. A. Penfold

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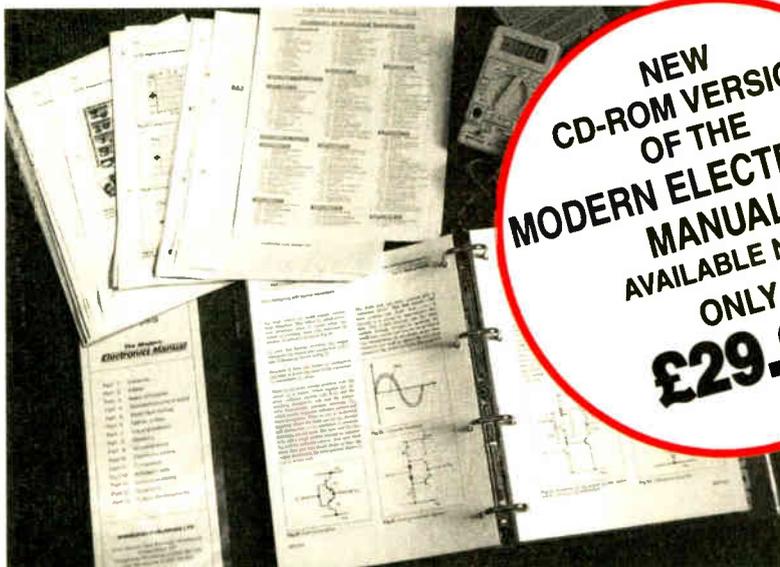
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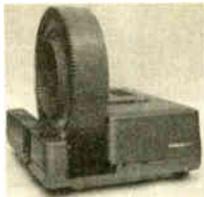


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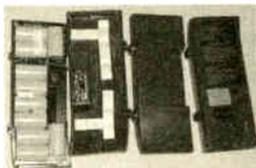


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Published on approximately the second Thursday of each month by Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Printed in England by Apple Web Offset Ltd., Warrington, WA1 4RW. Distributed by COMAG Magazine Marketing, Tavistock Rd., West Drayton, UB7 7QE. Subscriptions INLAND: £15.50 (6 months); £29.50 (12 months); £54 (2 years). OVERSEAS: Standard air service, £18.50 (6 months); £35.50 (12 months); £66 (2 years). Express airmail, £27.50 (6 months); £53 (12 months); £101 (2 years). Payments payable to "Everyday Practical Electronics", Subs Dept, Wimborne Publishing Ltd. Email: subs@epemag.wimborne.co.uk. EVERYDAY PRACTICAL ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

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