THE No 1 UK MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

EPE EVERYDAY PRACTICAL ELECTRONICS

www.epemag.co.uk www.epemag.com

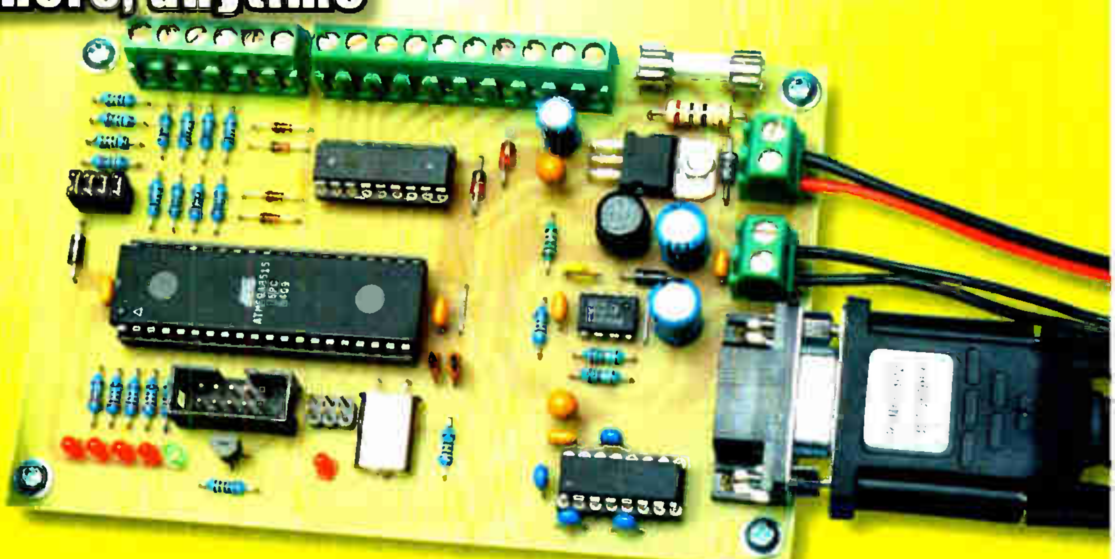
PIC POLYPHONIUM

* Polyphonic musical design
* PC-linked with on-screen musical score
* Create your own music
* LED display interface

SMS CONTROLLER

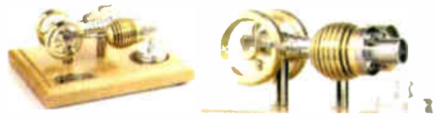
MARCH 2007 £3.50
9 770262 361140 03

Control and monitor appliances, alarms etc. from anywhere, anytime



IR Remote Checker

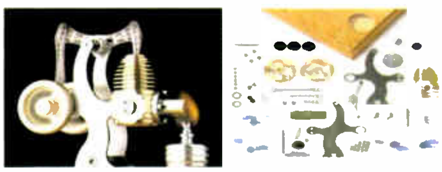
Simply test your remote controls



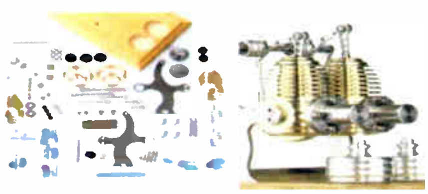
HB7 Stirling Engine
Base measurements: 128 mm x 108 mm x 170 mm, 1 kg Base plate: beech - Working rpm: 2000 rpm/min. (the engine has a aluminium good cooling Cylinder) Bearing application: 10 high-class ball-bearings Material: screw, side parts all stainless steel Cylinder brass, Rest aluminium and stainless steel. Available as a kit £80.75 or built £84.99
www.mamodspares.co.uk

HB9 Stirling engine
Base measurements: 156 mm x 108 mm x 130 mm, 0.6 Kg Base plate: beech Working rpm: approx. 2,000 min Bearing application: 6 high-class ball-bearings Material of the engine: brass, aluminium, stainless steel running time: 30-45 min.
Available as a kit £97.75 or built £101.99
www.mamodspares.co.uk

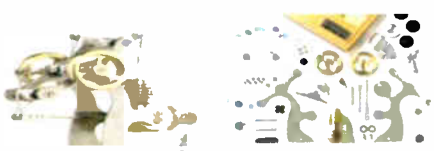
HB10 Stirling Engine
Base measurements: 156 mm x 108 mm x 130 mm, 0.6 Kg Base plate: beech Working rpm: approx. 2,000 rpm Bearing application: 6 high-class ball-bearings Material of the engine: brass, aluminium, stainless steel running time: 30-45 min
Available as a kit £97.75 or built £101.99
www.mamodspares.co.uk



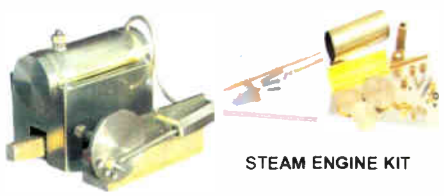
HB11 Stirling Engine
Base measurements: 156 mm x 108 mm x 130 mm, 0.7 Kg Base plate: beech
Working rpm: 2000 - 2500 rpm/min.run Bearing application: 4 high-class ball-bearings Material: screw, side parts total stainless steel Cylinder brass Rest aluminium, stainless steel.
Available as a kit £97.75 or built £101.99
www.mamodspares.co.uk



HB12 Stirling Engine
Base measurements: 156 mm x 108 mm x 130 mm, 1 Kg Base plate: beech Working rpm: 2000 - 2500 rpm/min.Bearing application: 6 high-class ball-bearings Material: screw, side parts total stainless steel Cylinder brass Rest aluminium, stainless steel.
Available as a kit £136 or built £140.25
www.mamodspares.co.uk

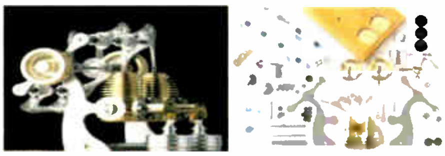


HB13 Stirling Engine
Base measurements: 156 mm x 108 mm x 150 mm, 0.75 kg Base plate: beech Working rpm: 2000 - 2500 rpm/min, Bearing application: 6 high-class ball-bearings Material: screw, side parts total stainless steel Cylinder brass
Available as a kit £97.75 or built £101.99



STEAM ENGINE KIT

Everything in the kit enables you to build a fully functional model steam engine. The main material is brass and the finished machine demonstrates the principle of oscillation. The boiler, uses solid fuel tablets, and is quite safe. All critical parts (boiler, end caps, safety vent etc.) are ready finished to ensure success. The very detailed instruction booklet (25 pages) makes completion of this project possible in a step by step manner. Among the techniques experienced are silver soldering, folding, drilling, fitting and testing. £29.70 ref STEAMKIT Silver solder/flux pack £3.50 ref SSK
www.mamodspares.co.uk



HB14 Stirling Engine
Base measurements: 156 mm x 108 mm x 150 mm, 1 kg Base plate: beech Working rpm: 2000 - 2500 rpm/min, . Incl. drive-pulley for external drives Bearing application: 10 high-class ball-bearings Material: screw, side parts total stainless steelCylinder brass Rest aluminium, stainless steel Available as a kit £140.25 or built £144.50
www.mamodspares.co.uk

HB15 Stirling Engine
Base measurements: 128 mm x 108 mm x 170 mm, 0.75 kg Base plate: beech Working rpm: 2000 rpm/min. (the engine has a aluminium good cooling Cylinder) Bearing application: 6 high-class ball-bearings Material: screw, side parts total stainless steel Cylinder brass Rest aluminium, stainless steel Available as a kit £97.75 or built £102
www.mamodspares.co.uk

HB16 Stirling Engine
Base measurements: 128 mm x 108 mm x 170 mm, 1 kg Base plate: beech Working rpm: 2000 rpm/min. (the engine has a aluminium good cooling Cylinder) Bearing application: 10 high-class ball-bearings Material: screw, side parts total stainless steel Cylinder brass Rest aluminium, stainless steel.
Available as a kit £140.25 or built £144.50

2kW WIND TURBINE KIT
The 2kW wind turbine is supplied as the following kit: turbine generator 48v three taper/ twisted fibreglass blades & hub 8m tower (four x 2m sections) guylines / anchors / tensioners / clamps foundation steel rectifier 2kW inverter heavy-duty pivot tower. £1,499

BULL GROUP LTD
UNIT D HENFIELD BUSINESS PARK
HENFIELD SUSSEX BN5 9SL
TERMS: C/ CARDS, CASH, PO, CHEQUE OR ONLINE ORDERING. PRICES PLUS VAT
UK DELIVERY £5.50
TEL 0870 7707520 FAX 01273 491813
sales@bullnet.co.uk

Solar Panels
We stock a range of solar photovoltaic panels. These are polycrystalline panels made from wafers of silicon laminated between an impact-resistant transparent cover and an EVA rear mounting plate. They are constructed with a lightweight anodised aluminium frame which is predrilled for linking to other frames/roof mounting structure, and contain waterproof electrical terminal box on the rear. 5 watt panel £29 ref 5wnav 20 watt panel £99 ref 20wnav 60 watt panel £249 ref 60wnav. Suitable regulator for up to 60 watt panel £20 ref REGNAV

Solar evacuated tube panels
(20 tube shown) These top-of-the-range solar panel heat collectors are suitable for heating domestic hot water, swimming pools etc - even in the winter! One unit is adequate for an average household (3-4people), and it is modular, so you can add more if required. A single panel is sufficient for a 200 litre cylinder, but you can fit 2 or more for high water usage, or for heating swimming pools or underfloor heating. Some types of renewable energy are only available in certain locations, however free solar heating is potentially available to almost every house in the UK! Every house should have one -really! And with an overall efficiency of almost 80%, they are much more efficient than electric photovoltaic solar panels (efficiency of 7-15%). Available in 10, 20 and 30 tube versions. 10 tube £199, 20 tube £369, 30 tube £549. Roof mounting kits (10/20 tubes) £12.50, 30 tube mounting kit £15

BENCH PSU 0-15V 0-2a Output and voltage are both smooth and can be regulated according to work, Input 230V, 21/2-number LCD display for voltage and current, Robust PC-grey housing Size 13x15x21cm, Weight 3,2kg £48 REF trans2

NEW ELECTRONIC CONSTRUCTION KITS
This 30 in 1 electronic kit includes an introduction to electrical and electronic technology. It provides components that can be used to make a variety of experiments including Timers and Burglar Alarms. Requires: 3 x AA batteries. £15.00 ref BET1803
AM/FM Radio This kit enables you to learn about electronics and also put this knowledge into practice so you can see and hear the effects. Includes manual with explanations about the components and the electronic principles. Req's: 3 x AA batts. £13 ref BET1801
This **40 in 1 electronic kit** includes an introduction to electrical and electronic technology. It provides components that can be used in making basic digital logic circuits, then progresses to using Integrated circuits to make and test a variety of digital circuits, including Flip Flops and Counters. Req's: 4 x AA batteries. £17 ref BET1804
The **75 in 1 electronic kit** includes an nintroduction to electrical and electronic technology. It provides components that can be used to make and test a wide variety of experiments including Water Sensors, Logic Circuits and Oscillators. The kit then progresses to the use of an intergrated circuit to produce digital voice and sound recording experiments such as Morning Call and Burglar Alarm. Requires: 3 x AA batteries. £20 ref BET1806
www.slips.co.uk

ISSN 0262 3617

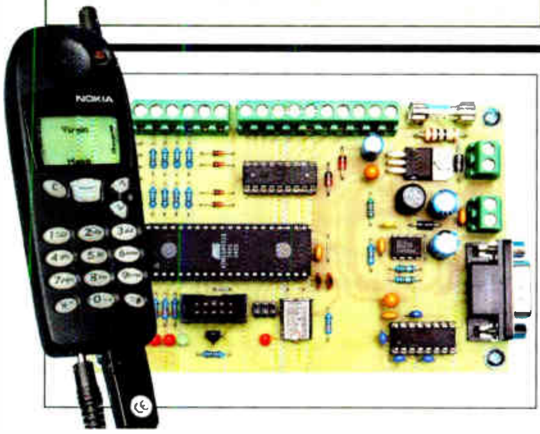
PROJECTS . . . THEORY . . .
NEWS . . . COMMENT . . .
POPULAR FEATURES . . .

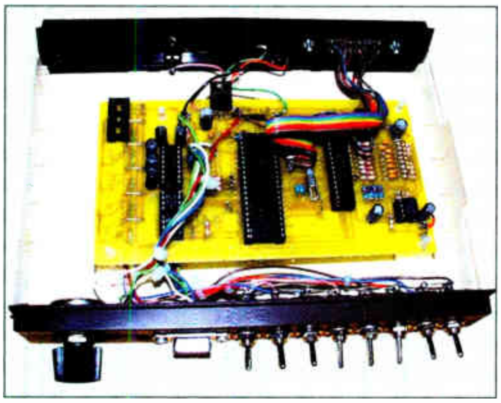
VOL. 36. No. 3 MARCH 2007

EPE EVERYDAY PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS TODAY INTERNATIONAL

www.epemag.co.uk
EPE Online: www.epemag.com





Projects and Circuits

Series and Features

Regulars and Services

Our April 2007 issue will be published on Thursday, 8 March 2007, see page 80 for details.

EPE PROJECT PICs

Programmed PICs for EPE Projects
12C508/9-£3.90; 16F627/8 - £4.90
16F84/71/ - £5.90
16F876/877/ 18Fxxxx - £10.00
All inc. VAT and Postage

1kV/500V Insulation Tester

Super design. Regulated output and efficient circuit. Dual scale meter, compact case. Reads up to 200 Megohms. Kit includes wound ferrite transformer, drilled and punched case, meter scale, PCB & ALL components. (Needs PP3 battery).

KIT 848...£32.95

DUAL OUTPUT *TENS* UNIT

An excellent kit for this project based on the EPE March'97 Design. Our Full Kit includes all components, hardware and an improved Magenta pcb. All hardware and electrodes are included. Designed for simple assembly and testing, providing a high level controlled dual output drive.

KIT 866 .. £32.90
Inc. 4 electrodes

Set of 4 Spare Electrodes £6.50

EPE MICROCHIP P.I. Treasure Hunter

Stable Sensitive Pulse Induction detector. Easy to build and use. No ground effect - works in sea water. Detects Gold Silver, ferrous and non ferrous metals.

Kit Includes Headphones, coil and all Hardware

KIT 847 ... £63.95

Ultrasonic PEsT Scarers

Two Ultrasonic PEsT Scarers. Kit 812 produces regular high level pulses of 32kHz. Kit 867 produces Random pulses and can work with an optional slave unit to give two separate ultrasound sources. Both kits need 9V supply.

Kit 812 ... £14.81 psu . 3.99
Kit 867 ... £19.99 867Slave £12.51

MOSFET MKII Bench PSU 0-25V 2.5A

Based on Mk1 design, with switching pre-regulator for high efficiency. Panel meters for A and V. Toroidal transformer. Variable Volts 0 - 25 AND Variable Current limit from 0 -2.5A
Kit includes punched and labelled case. A classic and essential piece of test gear

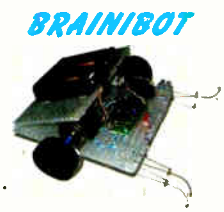
Kit 845 ... £64.95

68000 Trainer Kit 621.. 99.95

Stepping & DC Motors

A range of motors for many applications:
Visit our website for more details
MD100 100 step Unipolar..... £9.99
MD200 200 step Unipolar..... £12.99
MD24 Type '23' size 200 step..£22.95

MAGENTA BRAINIBOT I & II



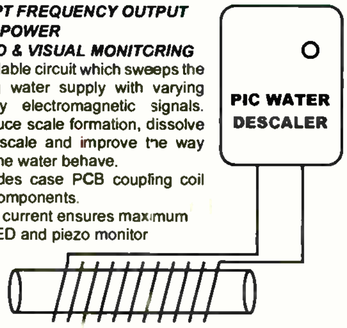
- Full kit with ALL hardware and electronics.
- As featured in *EPE* Feb '03 (KIT 910)
- Seeks light, beeps, and avoids obstacles
- Spins and reverses when 'cornered"
- Uses 8 pin PIC chip
- ALSO KIT 911 - As 910 *PLUS* programmable from PC serial port leads and software CD included.

KIT910..£16.99
KIT911..£24.99

PIC PIPE DESCALER

- *SIMPLE TO BUILD*
- *SWEPT FREQUENCY OUTPUT*
- *HIGH POWER*
- *AUDIO & VISUAL MONITORING*

An affordable circuit which sweeps the incoming water supply with varying frequency electromagnetic signals. May reduce scale formation, dissolve existing scale and improve the way salts in the water behave.
Kit includes case PCB coupling coil and all components.
High coil current ensures maximum effect. LED and piezo monitor



KIT 868 .. £22.95 PSU £3.99

12V EPROM ERASER

A safe low cost eraser for up to 4 EPROMS or other UV erasable windowed devices at a time in 20 minutes. Operates from a 12 Volt supply (400mA). Ideal for mobile work -and in educational applications where mains voltages are to be avoided. Safety interlock prevents contact with UV.

KIT 790 ..... £29.90

PIC LCD DISPLAY DRIVER

16 Character x 2 Line display, pcb, programmed PIC16F84, software disk and all components to experiment with standard intelligent alphanumeric displays. Includes full PIC source code which can be changed to match your application.

- Learn how to drive the display and write your own code.
- Ideal development base for meters, calculators, counters, timers — just waiting for your application
- **Top quality display** with industry standard driver, data and instructions

KIT 860.£19.99

PIC STEPPING MOTOR DRIVER

PCB with components and PIC16F84 programmed with demonstration software to drive any 4 phase unipolar motor up to 24 Volts at 1 Amp. **Kit includes 100 Step Hybrid Stepping Motor** Full software source code supplied on disc. Use this project to develop your own applications. PCB allows 'simple PIC programmer' 'SEND' software to be used to reprogram chip.

KIT 863.........£18.99

8 CHANNEL DATA LOGGER

From Aug/Sept.'99 *EPE*. Featuring 8 analogue inputs and serial data transfer to PC. Magenta redesigned PCB - LCD plugs directly onto board. Use as Data Logger or as a test bed for developing other PIC16F877 projects. Kit includes lcd, programmed chip, PCB, Case, all parts and 8 x 256k EEPROMs

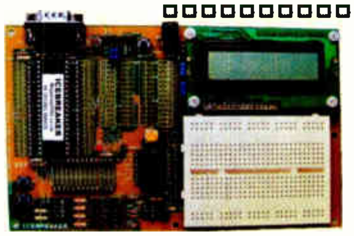
KIT 877.........£49.95

SUPER PIC PROGRAMMER

Magenta's original parallel port programmer. Runs with downloaded WINDOWS 95 - XP software. Uses standard Microchip .HEX files. Read/Prog/Verify wide range of 18,28,and 40 pin PICs. Including 16F84/876/877, 627/8, (Inc. 'A' versions) + 16xx OTPs.

KIT 862. £29.99 Power Supply £3.99

ICEBREAKER



PIC Real Time
In-Circuit Emulator

With serial lead & software disk, PCB, Breadboard, PIC16F877, LCD, all components and patch leads.

KIT 900..£34.99
PSU £3.99

ICEbreaker uses PIC16F877 in-circuit debugger functions.

- Featured in *EPE* Mar'00
Ideal for beginners & experienced users. Windows (95 to XP) Software included

20W Stereo Amp.

EPE May '05 -- Magenta Stereo/Mono Module

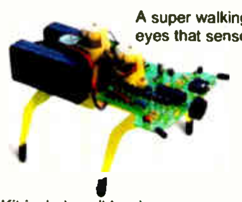
Wide band Low distortion 11W / channel Stereo 20W Mono. True (rms) Real Power

Short Circuit & Overheat Protected. Needs 8 to 18V supply.

Latest Technology - Stable, Reliable, high performance IC with local feedback.

KIT 914 ...... £11.90
(includes all parts & heatsink for stereo or mono)

Magenta BrainiBorg



A super walking programmable robot with eyes that sense obstacles and daylight. **BrainiBorg** comes with PC software CD (*WIN95+ & XP*) with illustrated construction details, and can be programmed to walk and respond to light and obstacles on any smooth surface.
Kit includes all hardware, components, & 3 motor/gearboxes Uses 4 AA batteries (*not supplied*).

KIT 912 ... £29.99 *(Kit with CD Rom & Serial Lead)*
KIT 913 ... £38.95 *(As 912 but Built & Tested Circuit board)*

EPE PIC Toolkit 3

As in EPE Apr/May/Jun '03 and on PIC Resources CD

- **Magenta Designed Toolkit 3 board with printed component layout, green solder mask, places for 8,18, 28 (wide and slim), and 40 pin PICs. and many Magenta extras. Also runs with WinPic800 prog. Software.**
- **16 x 2 LCD, PIC chip all parts and sockets included.**
- **Follow John Becker's excellent 'PIC tutorial 2' series.**

KIT 880 ... £34.99 ***(With 16F84 Chip)***
KIT 880 ... £39.99 ***(With 16F877 Chip)***
OR - Built & Tested £49.99 & £55.99

EPE TEACH-IN 2004

COMPLETE 12 PART SERIES FROM NOV03
All parts to follow this Educational Electronics Course. Inc. Breadboard, and wire, as listed on p752 Nov 03'
KIT920..£29.99

Additional Parts as listed in 'misc.' Section *(less RF modules, Lock, and Motor/g.box)*
KIT921.£12.99
Reprints £1.00 per part.

BAT DETECTORS

Magenta's Super Heterodyne Bat detectors. Our best selling kit 861 now includes a drilled case and front panel label. The MkIIb and digital MkIII are supplied built & ready to go

KIT 861 .. £37.99 *Soft Zip Up Pouch for all 3....£5.99*
MkIIb .. £49.95 MkIII .. £89.95

All Prices Include VAT, Add £3.00 P&P per order, or £7.99 for next day.
Chqs. P.O. & Most major cards accepted.
See our Website for many more kits, products, & Secure On Line ordering.
Mail Order Only.

MAGENTA
ELECTRONICS LTD
135 Hunter Street Burton on Trent Staffs DE14 2ST UK

www.magenta2000.co.uk Tel: 01283 565435 Fax: 01283 546932 email: sales@magenta2000.co.uk

EPE EVERYDAY PRACTICAL ELECTRONICS

THE UK's No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

VOL. 36 No. 3 MARCH 2007

Editorial Offices:
EVERYDAY PRACTICAL ELECTRONICS EDITORIAL
Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND
Phone: (01202) 873872. Fax: (01202) 874562.
Email: enquiries@epemag.wimborne.co.uk
Web Site: www.epemag.co.uk
EPE Online (downloadable version of *EPE*): www.epemag.com
EPE Online Shop: www.epemag.wimborne.co.uk/shopdoor.htm
See notes on **Readers' Technical Enquiries** below – we regret technical enquiries cannot be answered over the telephone.
Advertisement Offices:
EVERYDAY PRACTICAL ELECTRONICS ADVERTISEMENTS
408 Wimborne Road East, Ferndown, Dorset BH22 9ND
Phone: 01202 873872 Fax: 01202 874562
Email: stewart.kearn@wimborne.co.uk

WEEE Must Recycle

The EU Waste Electrical and Electronic Equipment Regulations 2006 (WEEE) came into force at the start of the year. These regulations require that from 1 July 2007 producers of EEE will be responsible for financing the recycling of all equipment which is dependent on electric currents or electromagnetic fields and which has a voltage rating of not more than 1000V AC or 1500V DC, which obviously covers all general equipment from MP3 players to washing machines, plus items like test equipment, soldering irons, light bulbs, toys with flashing lights etc.

From July, if you buy a new kettle in Tesco (for example) then Tesco will be responsible for the disposal of your old one – or at least they must inform you where you can take it locally to be recycled. Producers of equipment will need to be registered with the Environment Agency – for which a fee is charged – and also pay for the recycling of products, usually charged per tonne by approved 'producer compliance scheme' companies. I guess we all know who will eventually foot the bill!

As usual with such regulations there are a number of grey areas. We are told that since the primary function of musical novelty socks is not electronic then they are not governed by the regulations, however, a greetings card with a spoken message, or song, may not be exempt as its primary purpose is to deliver the electronic message!

The area that is of interest to many readers is how the regulations govern the disposal of home-built equipment; basically, because the item has not been provided commercially, it is exempt. However, if it has been built from a kit then it is covered by the regulations and the kit producer should be registered and should comply with the requirements placed on a producer.

Again there are grey areas, for instance, where part of a home built unit uses a ready made module. I guess it is best to play safe and dispose of all electrical and electronic equipment via an approved collection site.

We must obviously wait to see what effect this will have on the retail price of equipment and how much EEE will actually be recycled. We understand that after years of bottle banks only about one third of glass is actually being recycled!

AVAILABILITY
Copies of *EPE* are available on subscription anywhere in the world (see opposite) and from all UK newsagents (distributed by SEYMOUR). *EPE* can also be purchased from retail magazine outlets around the world. An Internet on-line version can be purchased and downloaded for just \$15.99US (approx £9.00) per year available from **www.epemag.com**

SUBSCRIPTIONS
Subscriptions for delivery direct to any address in the UK: 6 months £18.75, 12 months £35.50, two years £66; Overseas: 6 months £21.75 standard air service or £30.75 express airmail, 12 months £41.50 standard air service or £59.50 express airmail, 24 months £78 standard air service or £114 express airmail. To subscribe from the **USA** or **Canada** call Express Mag toll free on 1877-363-1310
Online subscriptions, for downloading the magazine via the Internet, \$15.99US (approx £9.00) for one year available from **www.epemag.com**.
Cheques or bank drafts (in **£ sterling only**) payable to *Everyday Practical Electronics* and sent to EPE Subs. Dept., Wimborne Publishing Ltd. 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872. Fax: 01202 874562. **Email:** subs@epemag.wimborne.co.uk. Also via the **Web** at: **http://www.epemag.wimborne.co.uk**. Subscriptions start with the next available issue. We accept MasterCard, Amex, Diners Club, Maestro or Visa. (For past issues see the *Back Issues* page.)

BINDERS
Binders to hold one volume (12 issues) are available from the above address These are finished in blue p.v.c., printed with the magazine logo in gold on the spine. Price £7.95 plus £3.50 p&p (for overseas readers the postage is £6.00 to everywhere except Australia and Papua New Guinea which cost £10.50). *Normally sent within seven days but please allow 28 days for delivery – more for overseas.*

Payment in £ sterling only please. Visa, Amex, Diners Club, Maestro and MasterCard accepted. Send, fax or phone your card number, card expiry date and card security code (the last 3 digits on or just under the signature strip), with your name, address etc. Or order on our secure server via our UK web site. Overseas customers – your credit card will be charged by the card provider in your local currency at the existing exchange rate.

READERS' TECHNICAL ENQUIRIES
E-mail: techdept@epemag.wimborne.co.uk
We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years' old. Letters requiring a personal reply *must* be accompanied by a **stamped self-addressed envelope or a self-addressed envelope and international reply coupons. We are not able to answer technical queries on the phone.**

PROJECTS AND CIRCUITS
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 than 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.**

COMPONENT SUPPLIES
We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.
We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

ADVERTISEMENTS
Although the proprietors and staff of EVERYDAY PRACTICAL ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or in inserts.
The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture.

TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT
We advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the UK. Readers should check the law before buying any transmitting or telephone equipment, as a fine, confiscation of equipment and/or imprisonment can result from illegal use or ownership. The laws vary from country to country; readers should check local laws.

News . . .

A roundup of the latest Everyday News from the world of electronics

CES Show Las Vegas

Barry Fox tells us a bit about what's happened at this year's CES Show

THE *Consumer Electronics Show* is now in its fortieth year. CES began in New York in 1967, with 100 exhibitors and 17,500 trade visitors. Now in Las Vegas, CES draws 2,700 exhibitors and 140,000 attendees every January. Like all electronics industry shows, CES has been the battleground for a string of format wars, from cassette tape to VHS and Beta, video disc, DAT, DCC and Mini Disc through to DVD-Audio and SACD. 2007 is the year of Blu-ray versus HD-DVD, with the online delivery of video material moving in to outflank both of them.

Terabyte hard drive

Outflanking, has just got a whole lot easier with Hitachi's launch of the world's first terabyte hard drive – of standard size and serial ATA connectors for easy fitting to existing PCs or set-top boxes and home entertainment servers.

Hitachi – which bought IBM's HD business three years ago – prefers to promote it as a drive with 1000 Gigabytes capacity, because consumers are not yet aware of what the term *terabyte* means. One hard drive is equivalent to 200 blank DVDs, at a storage cost of 40 US cents per Gigabyte. Available in March, the new *teradisc* will cost $400.

HD-DVD enhancements

The launch of a dual format blue laser player from LG was pre-hyped as the solution to the big blue format war. So was the dual format disc from Warner. The Super Multi Blue Player from LG – which doubles as a Blu-ray and HD-DVD player – should really be described as 'a one and a half player'. Although the $1200 player is an almost full-featured Blu-ray player, it is a very inadequate HD-DVD player that may well not be entitled to carry the HD-DVD logo.

The player will play DVDs as well as Blu-ray and HD-DVD discs, but not music CDs. The digital connections, called HDMI, follow the now out-dated HDMI 1.2 standard, not the new V1.3. So the player cannot handle the top quality sound systems from Dolby (TrueHD) and DTS (HD Master Audio).

Although the player can play Blu-ray titles with full interactivity, it has no network connection for the Internet interaction and does not support interactivity, which is a promoted feature of HD-DVD. The Super Multi Blue just plays HD-DVD movies with simple menus, admits LG.

Warner's new dual-format TotalHD or THD disc is a dual-sided 'flipper', with a Blu-ray recording on one side and HD-DVD on the other. Impressive demonstrations leave no doubt that it works perfectly. The first THDs will appear at the end of 2007. 'Once we're up and running, this will be the only platform we'll be releasing,' says Ron Sanders, president of Warner Home Video.

Asked whether Warner feels it is commercially viable to expect consumers to pay more for dual discs, Warner reminds that if one format eventually dies, then the consumer will still have discs that play. Also, some homes will have two types of player, HD-DVD in the living room and Blu-ray PS3 in the kid's room, or a Blu-ray player in the living room and Xbox 360 upstairs. Although the cost of replicating dual format discs will be higher and the cycle time slower – because the factory will initially need three lines, one for 0.1mm Blu-ray, one for 0.6mm HD-DVD and one for bonding – Warner's argument is that everyone benefits from single inventory packaging, warehousing, delivery and in-store racking.

Meridian docking

Respected British company Meridian is known for its top end hifi and video equipment. At CES the company unveiled a small docking station for a video iPod that upscales video from small screen iPod quality, to Full Quality HDTV. A demonstration at Meridian's booth used clips from Toy Story, ripped from a DVD and converted to MPEG-4 with 640 × 480 resolution in a file of around 700-800 Mbytes. The dock contains circuitry which analyses the low quality recording, adds extra picture lines and displays a 1080 line picture on a 42-inch Sharp Full HD screen. The quality, with HDMI connection to the TV, was amazing. Meridian will not say what upscaling system it is using, but the company has close ties with Faroudja. The dock is due in April, at around $400.

New mobile phone software

New software coming soon from Kodak will let owners of mobile phone cameras automate the transfer of pictures from the phone's memory to a PC, and from there to Kodak' online Gallery, as soon as they get home or reach the office – thereby releasing the phone's memory for more pictures, and safeguarding pictures in case the phone is lost or stolen. The software offers the option for one-time pairing between a Bluetooth phone and PC with Bluetooth dongle. From then on, as soon the phone comes within range of the PC, inside a distance of around 10 metres, the PC automatically sucks all pictures from the phone's memory, stores them on the PC hard drive and makes a safety copy to the Kodak Gallery.

With so many pictures now being stored, it is hard to find and index them. Kodak's new software will provide facial indexing. If uncle Bill is to be indexed, a shot with head on view of his face is selected. The software then analyses and stores Bill's facial characteristics as a search reference.

Ideally, a couple of shots are used to make the reference more accurate. From then on the software can search through all pictures to find any with faces that match Bill's. The order of pictures is then re-arranged so that all those with Bill's face are at the top of the list.

Indexing several hundred pictures takes only a couple of seconds. The software will be made available free, as part of the free Easyshare software which Kodak already gives away to encourage people to use the online Gallery – which costs around $25 a year to use.

EOCS

The Electronic Organ Constructors Society (EOCS) have, as usual, sent us their latest magazine, number 200, full of interesting tidbits and news about events and personalities within and around the Society. We've been reporting on it for many years, telling you how worthwhile it is if you are interested in such musical and electronic matters.

Interestingly, they also sent a copy of a newsletter they sent out on 16 May 1960, announcing their first general meeting, at which Alan Douglas would be present, 'bringing his organ'! Some of you will remember how he later also wrote for *Practical Electronics*, presenting another organ for home construction. This News editor recalls it well! (*PE* started in Nov '64.)

Don Bray, who has edited the EOCS magazine for as long as can be remembered here, says he is now retiring. All the very best to you Don.

For further information contact Treasurer/Membership Secretary, Ron Coates, EOCS, 2 Boxhill Nurseries, Boxhill Road, Tadworth, Surrey KT20 7JF. Email: treasurer@eocs.org.uk. Web: **www.eocs.org.uk**.

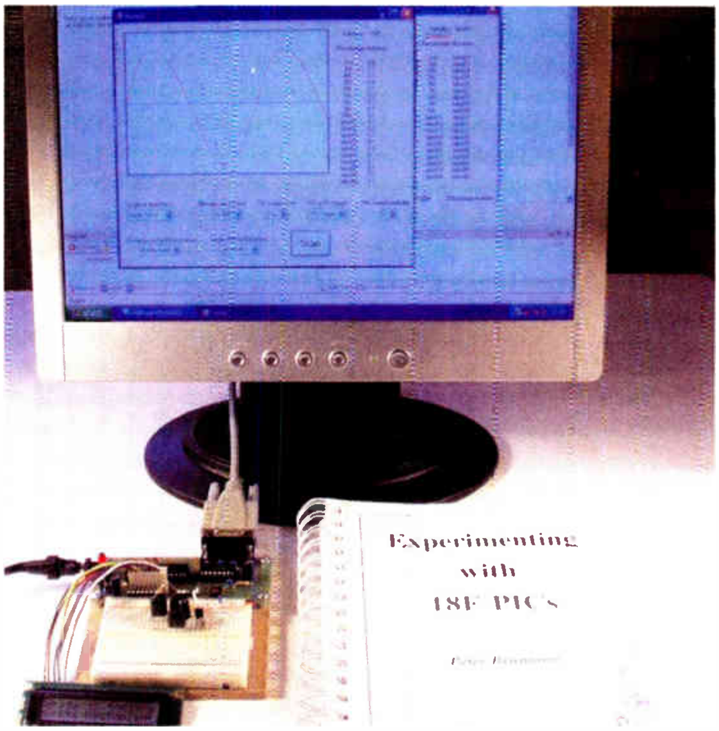
VISUAL C TRAINING COURSE

Brunning Software have just released their latest training course. Writing programs within the Windows environment has always been far too difficult for some, until now. Imagine the problem of designing an interface to connect your own circuits to your PC and the problem of writing a suitable control program to run within Windows. Now with the combination of the latest Microsoft programming aids and the natural teaching method used by Peter Brunning, at last there is an easy way to achieve this.

They start the course by showing the easy way to write Windows programs, studying the design ideas for the latching serial port, building simple circuits, writing control programs, and finish with a sophisticated audio storage oscilloscope.

The course material consists of a 272-page manual, a latching serial port, an LCD assembly and a pack of components for building the experimental circuits (no soldering required), total price £88. (Visual C# express edition needs to be downloaded from the Microchip website – this is a free download and full instructions for doing this are included in the manual.)

For more information browse: **www.brunningsoftware.co.uk** or tel: 01255 862308.



Plastic Electronics

In the news recently has been the story that plastic electronics may replace the silicon in chips. The BBC website (**www.bbc.co.uk/news**) gave a fuller story, of which the following is an extract.

British firm Plastic Logic has announced that it will build the world's first factory, in Dresden, Germany, to manufacture plastic electronic circuits.

Plastic electronics is a branch of electronics that deals with devices made from organic polymers, or conductive plastics, as opposed to silicon. Organic polymers are a class of substances that are used to make everything from bin bags to solar panels. The highly conductive polymers needed for electronic devices were first discovered in the early 1960s. They are already used in some electronic devices.

In 2004, electronics giant Philips announced a concept flexible display, while other companies such as Cambridge Display Technology use them to manufacture organic light-emitting diodes (LEDs). However, plastic electronic devices such as those made by Plastic Logic have never been mass produced.

When the production facility is up and running in 2008, it will manufacture large sheets of flexible plastic. The basic substrate will be polyethylene terephthalate, commonly used to manufacture plastic bottles. Circuits will then be printed on to these sheets. The plastic chips will then be used as the 'control circuits' behind large flexible 'electronic paper' displays.

These devices, currently being developed and sold by firms such as Panasonic and Sony, can hold the equivalent of thousands of books. It is hoped that one day these devices will become as common as newspapers and books. The facility will produce one million sheets every year.

Plastic will not replace silicon in microchips in the immediate future. But other companies are also working on developing plastic chips, such as US firm Lucent, Philips of the Netherlands, Samsung of South Korea and Japan's Hitachi.

MicroPro 26 Beta Update

Quasar Electronics tell us that their MicroPro 26 Beta is available. You can now bring your Quasar USB PIC programmer up to date with the latest release of their programming interface, and they have also added a large number of new devices to the new version. You can download the update from their website at: **www.quasarelectronics.com/micopro.htm**.

This version uses firmware version P018 so if you are currently running MicroPro 24 or 25 then no firmware update is required. If you are running an earlier version of Micropro then you will also need to update the onboard PIC16F628(A) to P018 (hex files can be found in the Micropro 26 installation folder). You will need a spare 16F628 to perform the update (available from the website at: **www.quasarelectronics.com/components.htm#PIC16F628-20/P**). They can also supply ready burnt firmware chips at: **www.quasarelectronics.com/firmware_chips.htm**.

Note that this beta version is supplied without warranty and is intended for testing purposes by experienced users. Please report any findings good or bad to the Support Team at: **support@quasarelectronics.com**.

They hope you find the new range of devices add a significant boost to what is already a very good programmer at a very competitive price. If you are interested in their range of USB PIC Programmers then please see their webpage at: **www.quasarelectronics.com/pic_programmers.htm** or give them a call on 0871 717 7168. They also have a 'wonderful range of goodies' which can be found at: **www.quasarelectronics.com/christ mas_2006.htm**.

Quasar Electronics Limited mail address is: PO Box 6935, Bishops Stortford CM23 4WP. Tel: 08717 177 168. Intl: +44 (0)8702 461 826, Fax: 0871 277 2728. Intl +44 (0)7092 203 496.

New RFID Modules

RF Solutions has introduced a new family of radio frequency identification (RFID) receiver modules, transponder cards and development/evaluation kits. The range, comprising five new basic products, will help engineers develop custom RFID solutions in what is a rapid growth market with a huge and diverse range of applications.

The RF Solutions RFID product range comprises modules that each use a different popular protocol, enabling more and varied applications to be addressed. The protocols include Hitag 1 and 2, EM Marin, Quad Tag and Mifare (all from Philips Semiconductor).

The 125kHz RFID Hitag 1/S receiver module for example, provides a good general-purpose solution with read/write capability, and a communication rate of up to 4K Baud over a distance of 20cm. The accompanying transponder card has a memory of 256 bytes plus a specification that includes data encryption and password support. The Hitag 2 protocol receiver/transponder combination offers a similar specification but with a 32 byte transponder card memory and password exchange capability.

For more information contact RF Solutions, Dept EPE, Unit 21, Cliffe Industrial Estate, South Street, Lewes, East Sussex BN8 6JL. Tel: +44 (0)1273 898000. Fax: +44 (0)1273 480661. Web: **www.rfsolutions.co.uk**. Email: sales@rfsolutions.co.uk.

Control equipment from anywhere, anytime, using SMS and an old Nokia mobile phone! – By Peter Smith

SMS Controller Pt.1

Would you like to be immediately informed when your burglar alarm is activated, as well as which sectors were tripped? What about if you could reset the alarm or even isolate one or more sectors? Well, this is just one of a huge number of possible applications for our new SMS Controller. Other applications include switching home appliances, rebooting a server or locating your car in a car park.

USING THE CONVENIENCE of SMS, this project lets you remotely control equipment by sending plain text messages, such as 'pump on', 'aircon off', 'reset' or 'blast horn' – all of which can be pre-programmed into the controller and easily remembered later. It can control up to eight external devices and report the condition of up to four digital inputs.

Short Message Service (SMS) is defined as a text-based service that enables up to 160 characters to be sent from one mobile phone to another. In a similar vein to email, messages are stored and forwarded at an SMS centre, allowing messages to be retrieved later if you are not immediately available to receive them. Unlike voice calls, SMS messages travel over the mobile network's low-speed control channel. 'Texting', as it's also known, is a fast and convenient way of communicating.

Users have been quick to make use of this technology, with millions of handsets currently in use. As new models with 'must have' features hit the market, older models become virtually worthless and if not recycled, end up in landfill.

With this in mind, we've designed this project to work with several popular (but now outdated) Nokia models. Chances are, you'll already have one of these on the shelf. If not, secondhand units are readily available for a song.

Nokia rebirth

While a number of models would have been suitable for this project, the

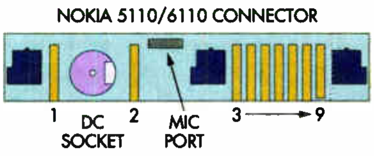


Fig.1: the interface connector on 5110 & 6110 models is located at the bottom of the phone. Here's the pin numbering schematic.

Nokia 3210, 3310, 5110 and 6110 were obvious choices, as they all include a common serial data interface necessary for remote control.

Of these four models, the 5110 & 6110 are preferred for two important reasons. First, Nokia specifically designed the serial interface on these models for user access. In fact, they marketed accessories such as car kits and PC-based software that makes use of the interface. The interface connectors are therefore reliable and easily accessible.

Second, both models include the functions necessary for the SMS Controller to monitor battery level, as well as 'push' the power button should power be lost for any reason.

By contrast, the 3210 & 3310 interface connectors are hidden beneath the rear covers, and in the case of the 3310, beneath the battery! In addition, they lack the battery monitoring and remote power-up functions. It's therefore necessary to manually push the power button if a battery runs flat. Despite these limitations, both models operate satisfactorily with this project. If you don't already have a suitable model, you can often pick one up on eBay for under £10. Look for a unit with a good battery; this will save you money later, as a functioning battery is mandatory, even when connected to a DC power source.

You'll also need a data cable for the phone to controller link. Nokia no longer offers cables for these older phones but after-market equivalents are readily available on the Internet. Alternatively, ask your local mobile phone dealer for advice on suitable suppliers.

Note that some vendors offer cables designed specifically for updating, or 'flashing', phone memory. Some of these will not work with this project! When in doubt, look for a cable that works with 'LogoManager' or 'Oxygen Phone Manager'. Both these PC

Table 1: Connector Pinouts For The Nokia 5110 & 6110 Models

Pin No.	Name	Function
1	V_{IN}	Charger input voltage
2	CHRG_CTRL	Charger control (PWM) signal
3	XMIC	External microphone input
4	SGND	Signal ground
5	XEAR	External earphone output
6	MBUS	MBUS serial receive/transmit
7	FBUS_RX	FBUS serial receive
8	FBUS_TX	FBUS serial transmit
9	L_GND	Charger/logic ground
DC Jack		Charger input (centre positive)

This close-up view shows the interface connector on the Nokia 6110, together with the matching plug from the data cable. The DC jack and the adjacent charger input and control signal pins (pins 1 & 2) are to the left.

System Limitations & Cautions

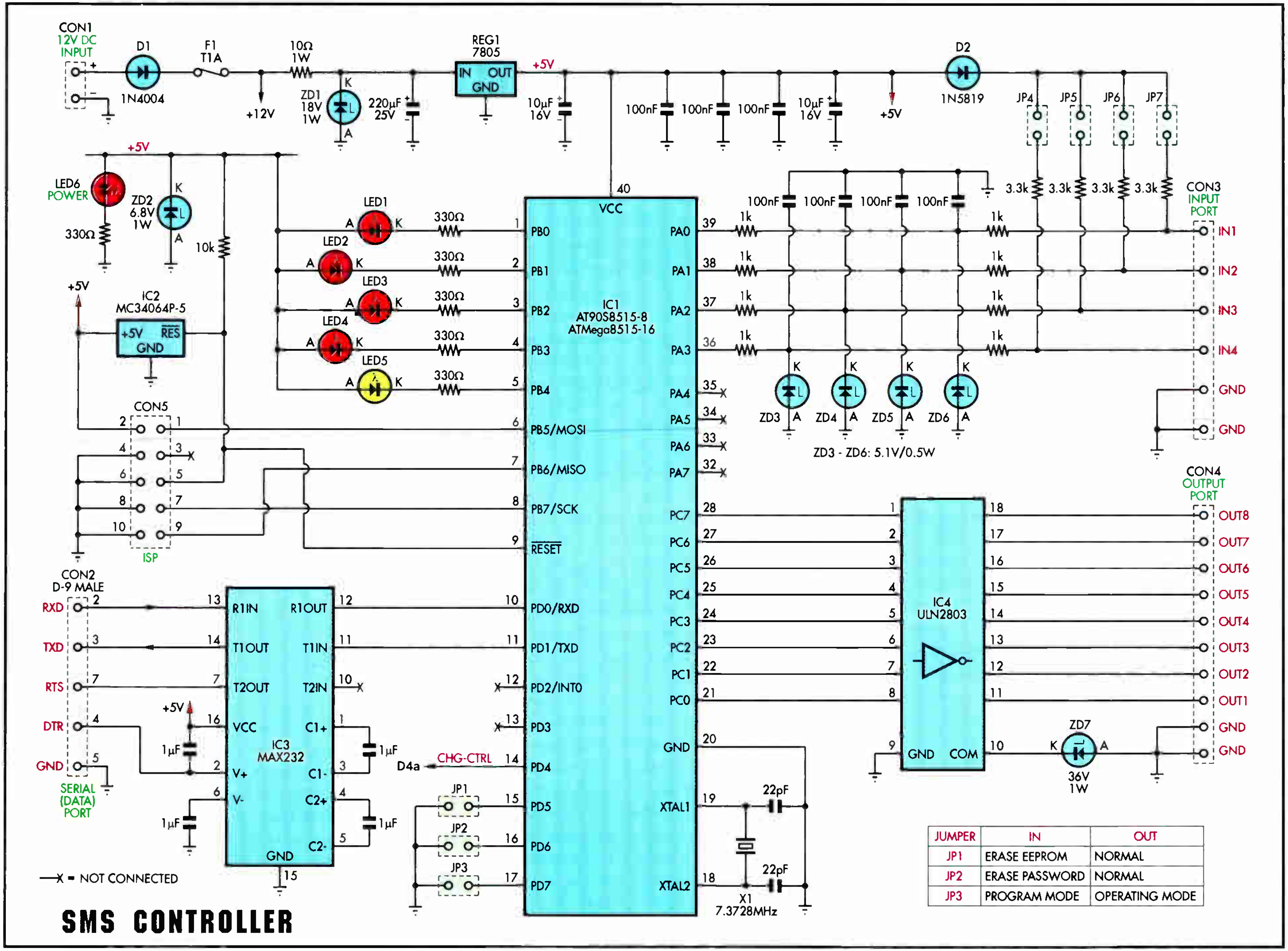
Before building this project, you should first make sure that it suits your intended application. Note that this is not a *real-time* control system. The time taken for a message to be sent by the controller can vary from anywhere between a few seconds to minutes, depending on network load.

This means that rapidly changing inputs will go undetected. Effectively, you will be left not knowing what the real state of the input port is, despite having received a host of state-change messages. In other words, the inputs should only be used to sense signals that change infrequently over time. Alarm signals are a typical example, as they're expected to change only during exceptional conditions.

A second pitfall has to do with SMS costs. You *must* use a pre-paid mobile phone account. A malfunctioning system could cost you a fortune on an open-ended plan. In theory, if the controller were to send messages as fast as the network would allow, more than 17,000 messages could be sent in one day alone. This would really be a disaster!

We therefore strongly recommend that a pre-paid account be set up for the controller-connected phone. This ensures that if something goes wrong, you already know how much it's going to cost you.

Finally, do not use the phone connected to the controller to program or test the system by sending messages to yourself. Doing so will confuse the controller, resulting in messages echoing backwards and forwards until your account balance is empty!



JUMPER	IN	OUT
JP1	ERASE EEPROM	NORMAL
JP2	ERASE PASSWORD	NORMAL
JP3	PROGRAM MODE	OPERATING MODE

SMS CONTROLLER

Fig.2: the circuit diagram for the main part of the controller. A 40-pin microcontroller (IC1) handles almost everything, including communications with the mobile phone and control of the input and output ports.

software products communicate with the phone in a similar manner to this project.

Phone power

The controller includes an on-board current-limited power supply for charging the phone's battery. The original plugpack charger (ACP-7A) cannot be used, as it provides no mechanism for disconnecting power once the battery is sufficiently charged.

To connect the controller's power supply output to the phone's DC input, a simple two-wire cable with a standard 1.1mm (3.5mm OD) DC plug on one end is required. You can either make one yourself, or scrounge a ready-made cable from an old in-car charger. All you need to do is disconnect the cigarette lighter plug end and you have the necessary cable complete with a moulded-in DC plug!

Serial interface

The Nokia phones mentioned earlier incorporate two proprietary serial interfaces known as 'MBUS' and 'FBUS'. MBUS is half-duplex, meaning that it provides just one signal line for both sending and receiving data. Data is exchanged over the MBUS at 9600bps (bits per second). This interface is intended primarily for factory test and adjustment, so we won't be using it here.

FBUS, on the other hand, provides separate send and receive lines and operates at the much higher speed of 115.2kbps. Nokia designed FBUS for connection to external accessories, such as their PC Data Suite. However, not all models work with this particular software. Nevertheless, the FBUS interface is present on all these models and ready to do duty in this project.

Note: although earlier model phones also include an FBUS interface, the protocol used is different to that used on the models mentioned here. This project uses FBUS 'version 2' protocol, which according to one source is supported only on the following models: 6110, 6130, 6150, 6190, 5110, 5130, 5190, 3210, 3310, 3330, 3360, 3390 & 3410. However, we've only tested this project with the 6110, 5110, 3210 & 3310 and therefore cannot guarantee operation with other models!

The physical location of the interface pins varies according to the model. In addition, some models provide extra contacts for hands-free adapters and chargers.

Fig.1 and Table 1 show the connector layout and pin assignments for the 5110 and 6110 models. This information is shown for interest only, as the data cable includes all the electronics necessary to interface these signals to a standard PC's serial port. We've designed the controller so that the cable plugs directly into the on-board 9-pin 'D' connector – no PC is required!

Circuit basics

For convenience, we've divided the circuit diagram for the controller into two sections. The main circuit appears in Fig.2, while the phone power supply is shown in Fig.3.

Looking first at Fig.2, you'll note that an Atmel microcontroller (IC1) dominates the circuit, with just a handful of external interface components and a 5V power supply. As first glance, it may seem odd that we've selected a 40-pin micro for the job, as quite a few pins are unused. Wouldn't a

Parts List – SMS Controller

1 PC board, code 609 available from the *EPE PCB Service*, size 130mm x 85mm
4 2-way 5mm terminal blocks (CON1, CON4, CON6)
4 3-way 5mm terminal blocks (CON3, CON4)
1 9-way 90° PC-mount male 'D' connector (CON2)
1 10-way 2.54mm DIL shrouded header (CON5)
1 8-way 2.54mm DIL header (JP4 - JP7)
1 6-way 2.54mm DIL header (JP1 - JP3)
7 jumper shunts
1 40-pin IC socket
1 18-pin IC socket
1 16-pin IC socket
1 220µH ferrite choke (L1)
2 M205 PC-mount fuse clips
1 M205 1A slow-blow fuse
4 M3 x 10mm tapped spacers
5 M3 x 6mm pan head screws
1 M3 x 6mm nut & washer
Nokia mobile phone (see text)
Serial (data) cable to suit phone (see text)
DC power cable to suit phone (see text)

Semiconductors
1 AT90S8515-8 or ATMega8515-16 microcontroller (40 pin) (IC1), programmed with SMS.HEX
1 MC34064P-5 under-voltage sensor (IC2)
1 MAX232 RS232 receiver/driver (IC3)
1 ULN2803 Darlington transistor array (IC4)
1 MC34063 switching regulator (IC5)
1 7.3728MHz crystal, HC49 package (X1)
1 1N4004 diode (D1)
2 1N5819 Schottky diodes (D2, D3)
1 1N4148 diode (D4)
1 1N4746 18V 1W Zener diode (ZD1)
1 1N4736 6.8V 1W Zener diode (ZD2)
4 1N751 5.1V 0.5W Zener diodes (ZD3 – ZD6)
1 1N4753 36V 1W Zener diode (ZD7)
5 3mm red LEDs (LED1 - LED4, LED6)
1 3mm green LED (LED5)

Capacitors
1 220µF 50V PC electrolytic
2 220µF 25V PC electrolytic
2 10µF 16V tag tantalum
4 1µF 50V monolithic ceramic
9 100nF 50V monolithic ceramic
1 1nF 50V ceramic disc
2 22pF 50V ceramic disc

Resistors (0.25W 1%)

1 22kΩ	8 1kΩ
1 10kΩ	6 330Ω
4 3.3kΩ	2 1.5Ω 5%
2 4.7kΩ	1 10Ω 1W 5%
1 10Ω 5W 5% (for testing)	

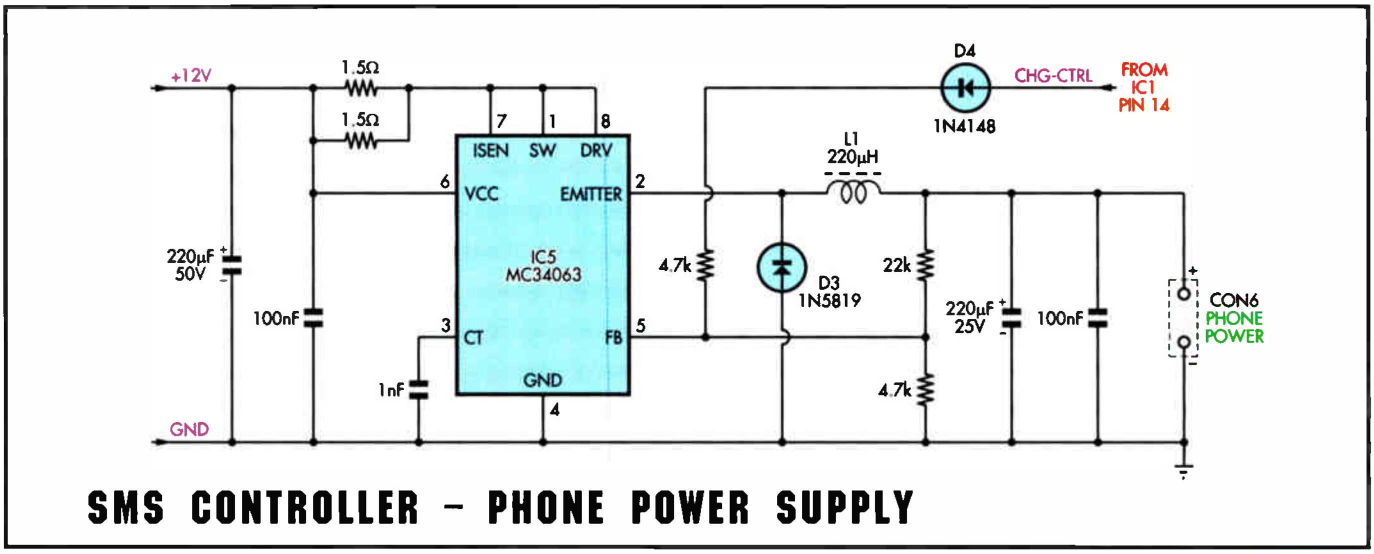


Fig.3: the on-board power supply for the phone is based on a common switchmode regulator (IC5).

smaller, cheaper device have been sufficient? Well, no, because we needed to make use of the generous code and data memory spaces available in this particular device. The AT90S8515/ATMega8515 includes 8192 bytes of code (FLASH) memory, 512 bytes of RAM and 512 bytes of data (EEPROM) memory.

The micro includes four 8-bit input/output (I/O) ports. Ports 'A' and 'C' are used for the external interface, which we'll come back to shortly. Port 'B' drives the five status LEDs (LED1 - LED5) and is also used for in-system programming (ISP) via CON5 – see the panels entitled 'LED Indicators' and 'Microcontroller Programming' in Pt.2 next month.

The upper three bits of Port 'D' (PD5-PD7) are used to read the state of jumpers JP1-JP3. The lower two bits (PD0 & PD1) are programmed as serial transmit and receive lines for communication with the phone. A MAX232 level converter (IC3) transforms the TTL levels on these pins to about ±9V to drive the electronics embedded in the data cable.

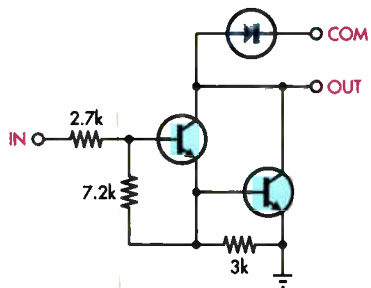


Fig.4: eight open-collector outputs are provided by IC4, a ULN2803 Darlington transistor array. The equivalent circuit for each output channel is shown here.

By way of explanation, electronic circuitry is included in the data cable to convert the logic levels from the phone (0 – 2.8V) into RS232 levels (about ±9V), so that the phone can be plugged into the serial port of a PC. We've therefore included a 'PC-like' interface for use with common types of cables.

The MAX232 also provides simulated 'RTS' and 'DTR' signals to the cable. 'RTS' is used by 'dual mode' cables to switch between the MBUS and the FBUS. In this design, 'RTS' is permanently driven to a negative voltage to select the FBUS connection. Conversely, 'DTR' is permanently driven positive by virtue of the direct connection to the positive output on V+ (pin 2) of IC3. This is used to power the circuits in the cable.

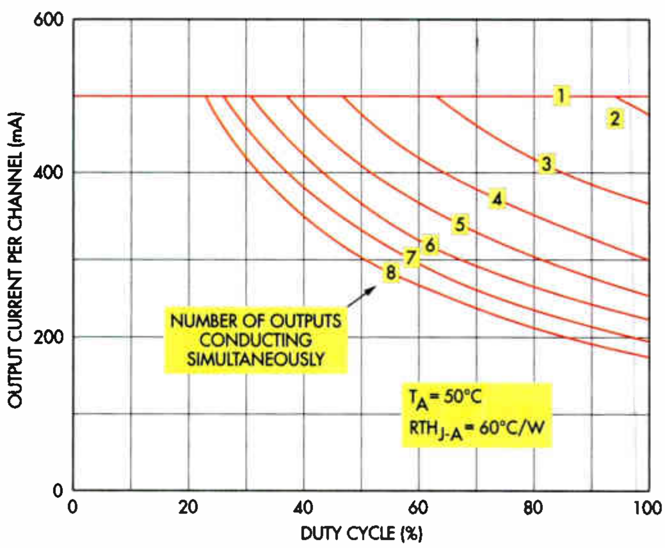


Fig.5: the amount of current the ULN2803 can sink depends on the number of outputs in use. Reproduced from the datasheet, this graph shows the maximum current per channel for 1-8 simultaneously conducting outputs. For most controller applications, a duty cycle of 100% should be assumed.

Power for the micro and its associated circuitry is provided by a 7805 +5V regulator (REG1). The input to the regulator is reverse-polarity protected by D1. Following this, a 10Ω series resistor and Zener diode ZD1 are included to provide transient overvoltage protection.

A 6.8V Zener diode (ZD2) provides limited protection in the case of serious over-voltage transients on the 5V rail. Note that if subjected to a substantial over-voltage, such as might occur during a nearby lightning strike, ZD2 would probably be destroyed. Always check the condition of this Zener if the fuse blows or the 10Ω 1W resistor is found to be open-circuit.

An under-voltage sensor (IC2) is used to reset the micro whenever the power supply voltage drops below about 4.6V.

Output switching

Eight outputs are provided for controlling external devices. Each output line is driven by one open-collector transistor pair in a ULN2803 (IC4). Fig.4 shows the equivalent circuit for one channel of the ULN2803.

All outputs are diode-connected to the 'COM' pin, which is then externally clamped to ground using a 36V Zener diode (ZD7). To allow for plenty of headroom, the open-circuit voltage at any output pin should not exceed +28V.

One ULN2803 output can switch a maximum load current of 500mA. However, when more than one output is used, this must be derated according to the graph in Fig.5. For example, with four outputs in use, the maximum current per channel is slightly less than 300mA.

Note that for this application, a duty cycle of 100% should be assumed. More information is available in the ULN2803 datasheet, which can be downloaded from www.allegromicro.com.

Fig.6(a) shows how to connect a simple relay circuit to any of the eight outputs. Note that a high-speed diode must be soldered directly across the relay coil terminals as shown. This diode limits the flyback voltage that occurs at relay switch-off, thus preventing high-voltage spikes from appearing across the driver output. We've specified UF4001 diodes for the job but of course, the higher voltage UF4002 and UF4003 devices can also be used.

If more current is required than can be provided by the ULN2803, the circuit shown in Fig.6(b) can be used. This circuit will handle at least 500mA, at the same time allowing all eight outputs to be used without overloading the driver. However, by substituting a power transistor and increasing the base drive, the current handling can be increased to over 1A – see Fig.6(c).

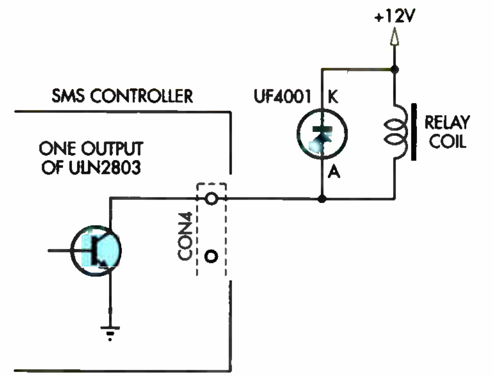


Fig.6(a): here's how to hook up a relay to any of the eight outputs. The diode must be soldered directly across the relay coil terminals. Take particular care that you have the cathode (banded) end to +12V, otherwise the ULN2803 will be destroyed!

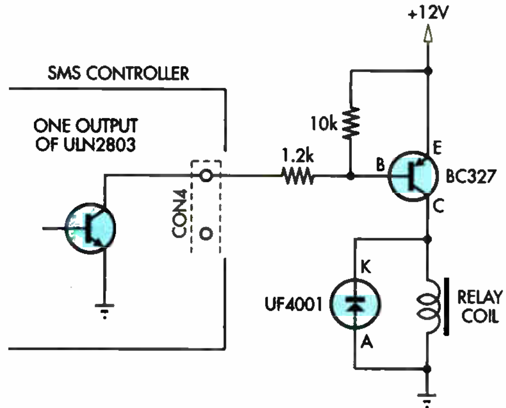


Fig.6(b): if more current is required than the ULN2803 can handle, then a transistor buffer circuit can be added. This circuit will switch at least 500mA.

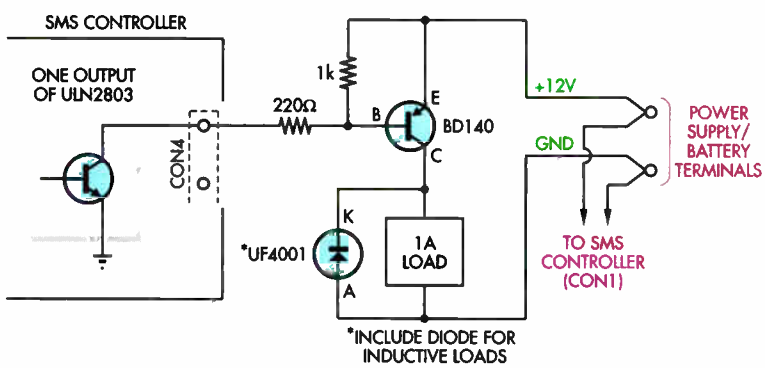


Fig.6(c): a power transistor can be used to boost current handling to over 1A. As shown here, power and ground for all external circuits must be independently wired to the power source.

Input sensing

Four digital inputs (at CON3, Fig.2) are available for sensing the state of external trigger devices. Each input is current-limited by a 1kΩ resistor and is then clamped to +5.1V using a Zener diode (ZD3-ZD6). This scheme allows a maximum trigger input of 16V.

As shown in Fig.7(a), an input voltage of between 0 and 1.5V will be sensed as a logic 'low', whereas 3-16V will be sensed as a logic 'high'. Voltages in between these two ranges are considered invalid and may be sensed either 'low' or 'high'.

The micro samples these inputs every 128ms. Any single input change must be present for at least twice that time (256ms), otherwise it will be rejected as noise. If additional inputs change state within this 256ms window, they must remain valid for 500ms or more to be recognised.

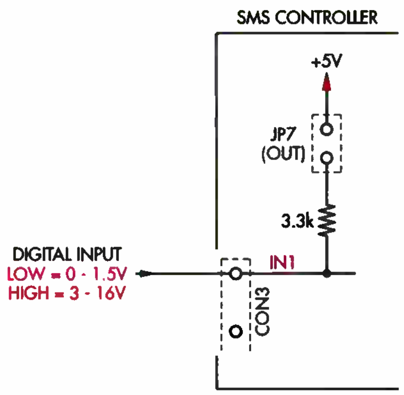


Fig.7(a): any of the four inputs can be used to detect the logic level of a digital signal. An input voltage of between 0 and 1.5V will be sensed as a logic 'low', whereas 3-16V will be sensed as a logic 'high'.

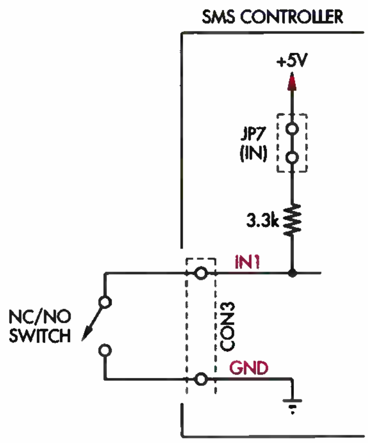
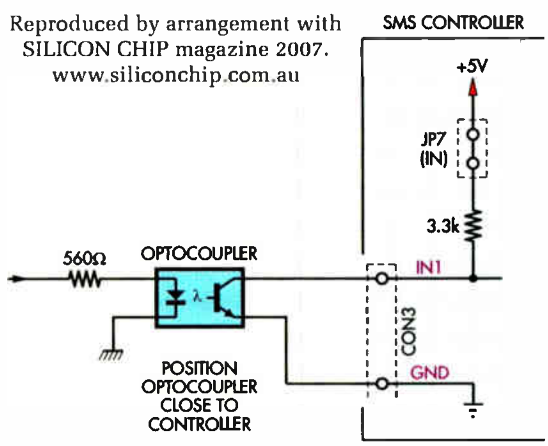


Fig.7(b): with the aid of the SMS Controller's on-board pull-up resistors, the state of a switch is easily sensed.

Fig.7(c): optocouplers can be used when the two systems lack a common ground. This is also an effective means of eliminating false triggering in noisy electrical environments and when using long cable runs. Select a resistor value that limits LED current flow to between 4mA and 20mA.



Jumpers JP4-JP7 allow a 3.3kΩ pull-up to be applied to any of the inputs for use with a switch (Fig.7(b)) or optocoupler (Fig.7(c)). The optocoupler scheme is necessary when the two systems do not share a common ground. It can also be used to eliminate false level sensing in noisy electrical environments and provides an effective isolation barrier against high-voltage transients. Any general-purpose optocoupler (eg, 4N25 or 4N28) would be suitable.

Important: *when using the circuits shown in Figs.7(a) & 7(b), the wiring between the equipment and/or switches and the input terminal block must be kept as short as possible. Do not connect long cable runs directly to the digital inputs! If you need to sense a signal over any significant distance, then use an optocoupler for isolation, as shown in Fig.7(c).*

Phone power supply

A simple step-down switchmode regulator circuit is used to power the phone – see Fig.3. It is based on the well-known MC34063 switchmode controller IC (IC5), which includes an oscillator, PWM controller and switching transistor – ie, most of the elements needed for a step-down design.

In short, the MC34063 regulates the output voltage by varying the amount of time an internal NPN transistor is switched on. The transistor's collector is connected to pin 1 and the emitter to pin 2. When the transistor is conducting, energy is transferred to inductor L1 and a 220µF capacitor. When it turns off, the energy is discharged into the load via D3.

In operation, the MC34063 attempts to maintain the output voltage at 7.0V, as set by the 22kΩ and 4.7kΩ resistors connected to pin 5. However, once the load current reaches about 350mA, internal current-limiting circuits begin to take effect.

The peak current level during each 'on' cycle is determined by the voltage at pin 7, which is developed across the paralleled 1.5Ω resistors. At about 350mA, the MC34063 begins to shorten the transistor 'on' time, thus limiting the output current. This also causes a drop in output voltage.

The result is a current-limited output of between 360mA and 400mA. When charging the phone's battery, the output voltage will typically fall to around 5-6V. This closely follows the performance of the standard ACP-7A plugpack charger.

Battery charging

According to Nokia, the batteries in these models must not be continually charged. In use, we found that the phone's battery charging circuits disconnect the DC input once the terminal voltage exceeds a certain absolute value. Some models also include a thermistor inside the battery pack and will terminate charging after a certain temperature rise. However, neither method eliminates overcharging.

To minimise overcharging, it is therefore necessary for the controller to be able to switch the current-limited supply on and off at the appropriate times. This is achieved in the circuit using diode D4 and a 4.7kΩ resistor between pin 14 of IC1 and pin 5 of IC5. When the micro drives this line high, it pulls the MC34063 feedback signal (FB) above the set point, forcing it to stop switching. In this condition, the internal switching transistor is off, so the input is disconnected from the output and no current flows to the phone.

In operation, the micro adopts one of two charging strategies, dependent on the particular model of phone. For the 5110 & 6110, battery level is monitored over the FBUS. When the level drops to '1', the power supply is switched on. When it reaches '4', the supply is switched off after a short 'top-up' period. To prevent sudden death due to a marginal battery, the supply is also switched on just prior to message transmission if the battery level is less than '3'. These numbers relate to the battery indicator bar on the right-hand side of the display.

As battery level information is not available on the 3110 & 3210 models, a simple timed charge regime is used

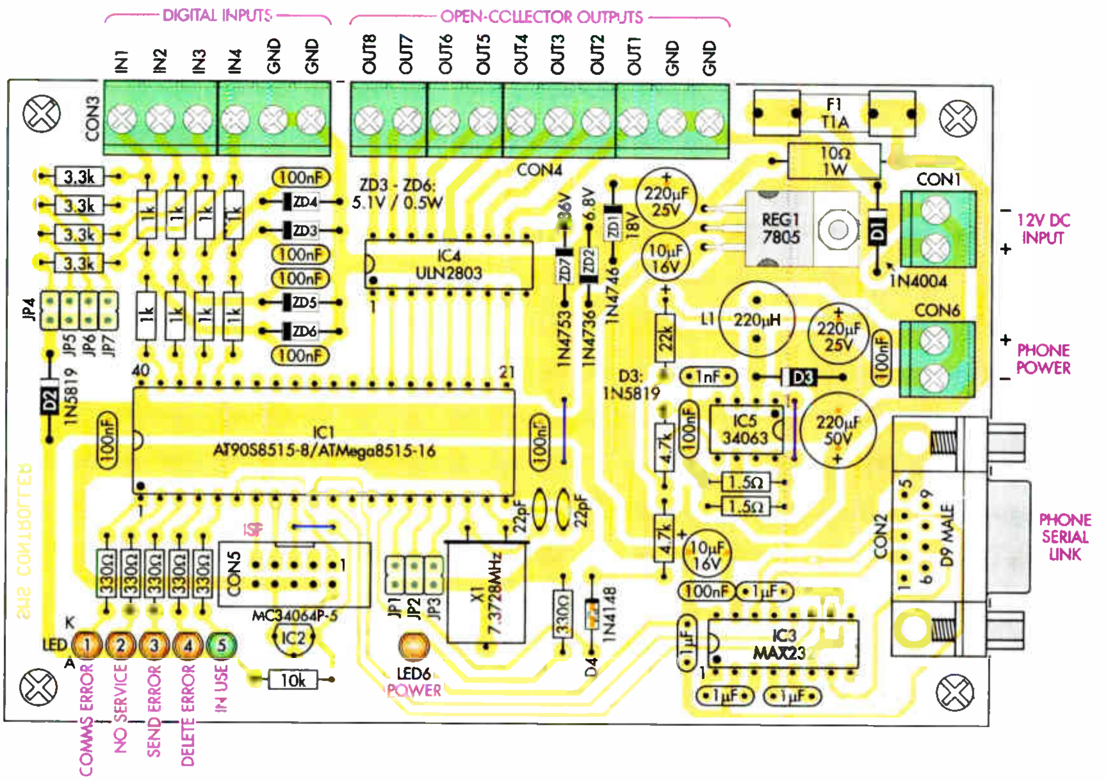
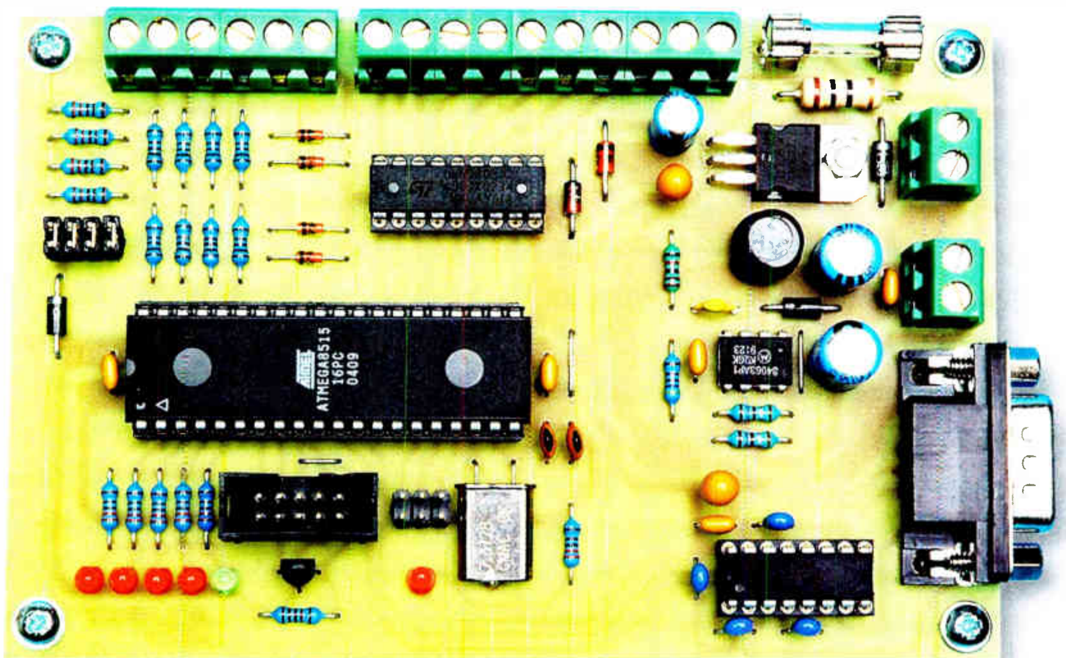


Fig.8: follow this diagram when assembling the controller. The orientation of all the ICs, diodes, LEDs and polarised capacitors is critical, so double-check all of these before applying power.



This is what the fully-assembled PC board looks like. Note that there are a few minor differences between this prototype and the final version depicted in Fig.8.

instead. At switch-on, the battery is charged for 40 minutes. Following this, the power supply is switched off for eight hours and then the cycle repeats over again. As we'll see next month, the default 40-minute charge time can be altered if desired.

This charge-discharge cycling continues indefinitely. Should a marginal battery cause the phone to switch off prematurely or an extended power failure occurs, the controller automatically brings the phone back on-line and resumes charging. Without this feature, you'd

Table 1: Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	22kΩ	red red orange brown	red red black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	4	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	8	1kΩ	brown black red brown	brown black black brown brown
❑	6	330Ω	orange orange brown brown	orange orange black black brown
❑	2	1.5Ω	brown green gold brown	brown green black silver brown
❑	1	10Ω 1W 5%	brown black black gold	not applicable
❑	1	10Ω 5W	not applicable	not applicable

Main Features

- Works with several popular Nokia brand phones
- Eight open-collector outputs
- Four digital inputs
- User-programmable plain text message control
- Communicate from any other mobile
- Password protected
- On-board phone power supply
- Ideal for alarm control panels
- Can be used in vehicles

have to press the power button to restore operation!

Unfortunately, this cannot be achieved with the 3210 & 3310 models, which lack support for remote control of the power button. In other words, a marginal battery or extended power failure will require that you physically press the power button to get the system back on-line.

Assembly

All the circuitry, including the phone power supply, is accommodated on a single PC board measuring 130mm × 85mm and coded 609. This has a row of screw terminals for the inputs (CON3) and outputs (CON4), as well as a 9-pin D socket (CON2) and screw terminals for phone power (CON6) and 12V (CON1). There are also the five status LEDs for the micro.

Fig.8 shows the assembly details. Begin by installing the three wire links using 0.7mm tinned copper wire or similar. Follow up with all the low-profile components, starting with the resistors, diodes (D1-D4) and Zener diodes (ZD1–ZD7). Take care to orient the banded (cathode) ends of the diodes as indicated. Also, double-check the numbers printed on the Zener diodes to ensure you have them all in their intended positions.

Install the IC sockets next, aligning the notched (pin 1) ends as shown. IC5 must be installed without a socket, noting that it goes around the opposite way to the other three DIL-packaged ICs. We also recommend that IC4 be soldered directly to the board (no socket), as in some applications it will have to dissipate considerable power. However, for low-power applications, such as when you'll only be driving one or two relays, an IC socket can be used if desired. Don't plug the micro (IC1) or MAX232 (IC3) into their sockets just yet – that comes later.

All remaining components can now be installed, leaving the connectors until last. Note that the flat (cathode) sides of the LEDs must all face towards the micro (IC1). In addition, the positive leads of the three electrolytic and two tantalum capacitors must be aligned with the '+' markings on the diagram.

To mount the 3-terminal regulator (REG1), first bend its leads at right angles about 5mm from the body. That done, slip it into position, checking that the hole in its metal tab lines up with the hole in the PC board. Adjust as necessary, then secure it to the board using an M3 × 6mm screw, nut and washer and tighten up before soldering the leads.

The leads of the crystal (X1) must also be bent at right angles, this time about 3mm from the body. Once in place, a short length of tinned copper wire can be soldered to the opposite end of the crystal case and to the pad underneath, grounding the case and securing it in position.

Finally, the 10-way and 6-way screw terminal blocks (CON3 & CON4) are made up by sliding 2-way and 3-way sections together, before mounting them on the board. Push them all the way down onto the board surface and hold them in place while soldering. The same goes for the remaining connectors; make sure they're fully in contact with the board surface before soldering their pins.

Controller checkout

The first job is to check out the power supply circuitry. Without IC1 or IC3 installed, connect a 12V DC power supply to the DC input terminals (CON1). A plugpack, 12V SLA battery or bench supply can be used for testing and it must be able to source at least 500mA of current.

Switch on and check that the power LED (LED6) illuminates. If it doesn't, switch off immediately and check that LED6, D1, ZD1 & ZD2 are all correctly installed. Also, check for a possible short circuit between the +5V rail and ground (0V) using your multimeter. Note that a short circuit will probably blow the fuse.

Assuming all is well, set your meter to read volts and measure between pins 20 & 40 of IC1's socket and pins 15 & 16 of IC3's socket. Both readings must be close to 5.0V (±5%). Any problems here must be rectified before continuing with the testing procedure.

Next, measure the voltage across the phone power supply output terminals (CON6). With nothing connected to these terminals, you should get a reading of about 7.0V.

If this is correct, switch off and install a 10Ω 5W resistor across the '+' and '-' terminals of CON6 to act as a load. This resistor will get quite warm

Cutting Corners: Using A Homemade Data Cable

Some readers will already be familiar with the Nokia FBUS/MBUS and software such as LogoManager and Oxygen Phone Manager. These products enable you to upload and download phone books and ring tones, create logos and more, using a PC.

Some may even have made up their own cables for connection to a PC. Making your own cable can save a few pounds but it's risky. A wrong connection and your phone or project may not survive. The results may also not be completely reliable. We'd therefore strongly recommend that you use a commercially made data cable for this project.

Having said that, we know that some diehards will want to have a go at making their own cable for the phone to controller connection, so here are the basics – use them at your own risk!

Commercial data cables include electronics for conversion between the FBUS/MBUS signal levels (0 - 2.8V) and RS232 levels (about ±9V) so that you can plug the phone into your PC. However, when using the phone with a microcontroller, a much less complicated level conversion scheme can be employed.

To modify the standard layout for direct phone to controller connection, leave out the MAX232 (IC3), the four 1µF capacitors and 100nF capacitor and install three resistors instead, as shown in Fig.9(b). The transmit (TXD), receive (RXD) and ground (GND) pins from the on-board D9 connector are then wired to the FBUS_RX, FBUS_TX and L_GND pins of the phone using shielded data cable. The length of this cable should be 550-600mm and the cable shield must be connected to ground.

We note that some circuits published on the Internet join MBUS to FBUS_RX and use a diode to connect back to the serial transmit line. This may work but it provides no protection for the microcontroller or phone signal lines.

The method used here translates the 5V logic levels from the micro's serial data output to about 2.7V for the FBUS serial input using a simple 2.7kΩ and 3.3kΩ resistive divider. On the return side, data transmitted on the FBUS is connected directly to the micro's serial data input via a 2.7kΩ current-limiting resistor.

The 2.8V logic levels from the FBUS mean that this scheme is running right on the margin and is not noise-immune. However, if you make the cable as we've described, you should find that it works reliably.

For the 5110 & 6110 models, an old hands-free set is a cheap source for the phone-side connector. For other models, you're on your own! Pinouts for the Nokia 3210 and 3310 models are readily available on the Internet.

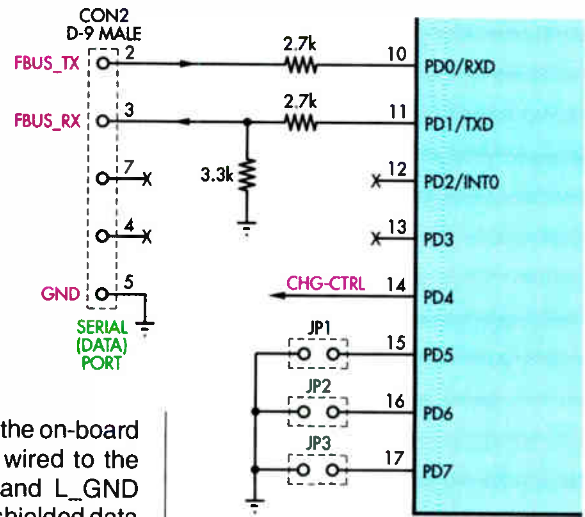


Fig.9(a): use this modified circuit if you intend using a homemade data cable (see text).

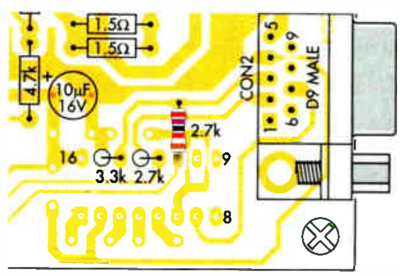


Fig.9(b): the modified board layout – just leave out the MAX232 (IC3) and five associated capacitors and install three resistors instead (note: the pads are numbered in line with IC3's original pin positions). Two resistors mount vertically between pads 15 & 14 (3.3kΩ) and pads 13 & 12 (2.7kΩ), while the third (2.7kΩ) goes between pad 11 and the spare pad directly above.

in operation, so make sure that it's not touching anything. Now power up again and measure the voltage across the 10Ω load resistor – it should be between about 3.6V and 3.9V.

In some cases though, this voltage may be higher than specified due to tolerances in the MC34063 and the 1.5Ω resistors. If it's 4.7V or less, it can be safely used as is. Alternatively, you can reduce the voltage to the specified level (3.6V - 3.9V) by increasing one of the 1.5Ω resistors to 1.8Ω.

If the voltage is still out of range, the first step is to make sure that the DC input voltage on CON1 is between 12.0V and 14.5V. If so, there is a problem somewhere in the switching regulator section shown in Fig.3. In particular, check that D2 is oriented correctly and that you've installed the wire link that goes between pins 1 & 8 of IC5.

Once the power supply checks out, disconnect the 10Ω test resistor and connect your phone's power cable leads. Be particularly careful that you have the polarity correct. This can be verified by measuring the voltage directly at the DC plug tip. With the black (-) probe on the barrel (outer) surface of the plug and red (+) probe on the inner contact, your meter should display a positive (not negative!) voltage.

That's all for this month. In Pt.2, we'll show you how to check out the remainder of the circuit, including the microcontroller and serial interface, and describe how it's used.

TECHNO-TALK MARK NELSON

Watery Wireless

Water and electricity don't mix, unless you want a dead short. You'd think the same would apply to radio too, but this is not always the case. This month Mark Nelson looks at sub-sea wireless and catches up with an important time change in March.

MURPHY'S Law is not the only reason why radio doesn't always behave the way you'd expect it to. I have read enough articles about buried radio antennas to realise they were not all April Fool jokes and the same applies to sub-sea transmission.

Radio is in fact the only way of keeping in touch with submarines below the surface and there are obvious political and tactical reasons why the frequencies and transmitter sites used were for many years kept something of a secret.

At the end of the Cold War the so-called 'peace dividend' defences were lowered somewhat and more information was released. Britain's own involvement was discussed four years ago in our sister publication *Radio Bygones*, when an article was devoted to the radio station at Criggion (Shropshire), which had been the contact point for Britain's nuclear submarines across the world and a 'Category A' target during the Cold War.

The same year, a book by Peter Hennessey, *The Secret State,* blew away further secrets with the statement, 'Among [the Russians'] military targets were the very low frequency signals installations at Rugby and Criggion, whose purpose was and is to relay the Prime Minister's instructions to the commanders of the deterrent-bearing submarines.'

Since then it was announced that the VLF services provided formerly from Criggion and Rugby had been replaced by a new service to Royal Navy submarines under a public finance initiative (PFI) contract managed by the Ministry of Defence. Alert Communications, a consortium led by Merlin Communications, now provides the service through a new transmitter site at Skelton and the updated standby site one at Anthorn. Under the contract, the consortium also provides the receivers on board all submarines.

Borderline radio

Leaving politics aside, how does wireless work under water and more important, how can you get an electrical signal to propagate in what is a conductive medium? The answer is that one uses a special kind of wireless, in the Low (LF) and Very Low Frequency (VLF) bands, between about 20 and 50kHz.

The lower end of this range is immediately above the audio spectrum, meaning you could say this is borderline radio, and in fact VLF radio shares many of its characteristics with audio signals. Seawater does indeed cause considerable attenuation, this is chiefly to the electric field component of the signal. Electromagnetic waves also contain a magnetic component and the water has far less direct effect on this. This is a gross oversimplification but it does provide a clue to how radio can work under water.

At these low frequencies the signal penetrates water well and can, in some cases, provide global coverage to sub-surface vessels. Digital signals are sent at the very slow rate of 50 Baud (in this case 50 bits per second), providing robust reception at a few characters per minute under all conditions. Transmitter power ranges from around 100 watts to a kilowatt, on spot frequencies such as 21.4kHz and 40.75kHz.

Leading developer

A British company with a lot of experience in undersea radio is Wireless Fibre Systems Ltd, based in Livingston, near Edinburgh. Its innovative research has resulted in filing more than 10 patent applications in Europe and the USA, and it claims to be the world's leading developer of radio-based underwater communications, sensing and navigation systems. Although some of its developments have defence applications, most of its work is for oil and gas exploration, also environmental monitoring.

One of its latest research projects has been with wireless modems that work in the salt-water environments encountered by remote-controlled sensors and video cameras. For underwater exploration devices, kilowatt transmitters are completely out of the question and the company believes it has scored a first in a battery-powered modem that sends 16kbit/s over a distance of 300 metres in seawater. Communication with a shore-based transceiver out of the water is also possible.

Not all applications of VLF radio are underwater. VLF systems are also used for lightning research and for examining the physical and electrical properties of the Earth's ionosphere that can affect our military and civilian communication and navigation systems. There are entirely natural transmissions too, such as 'whistlers', a type of electromagnetic wave that results from lighting strikes. The actual frequency of whistlers is around 20kHz but by playing back the signals at a lower frequency, humans can hear them at an artificially lower frequency. An Internet search engine will find you plenty of descriptions and sound samples. Entire CDs have been issued of this ghostly 'symphony of the skies' too.

MSF moving

One other major user of the low frequency spectrum is the timecode transmitters that enable radio-controlled clocks and watches to operate. In point of fact, the signals are not only used by timepieces but also synchronise mobile phone billing systems, cash machines and the major computer systems that control airport and railway operations. Best known of these transmitters in Britain is MSF, which broadcasts the National Time Standard for the UK on 60kHz and is accurate to within one millisecond (one thousandth of a second) of Universal Time. This service is funded by the Department of Trade and Industry, with maintenance and development of the actual time standard carried out by the National Physical Laboratory (NPL).

Since inception in 1950, MSF's transmitter site was always located at British Telecom's Rugby radio station, but with the ending of its defence-related VLF activities this is coming to an end. On 1st April 2007 Rugby is moving to Anthorn, Cumbria, or more accurately, the MSF signal will from that date be transmitted from a new transmitter at Anthorn. NPL has reassured most users that they need take no action to continue receiving the signal but at a few locations clocks will receive a worse signal and may need to be repositioned or provided with a remote antenna.

In case you are wondering, the letters MSF are the radio callsign of the timecode transmitter. 'M' is one of Britain's international 'country code' prefixes that goes back to the time that all Marconi wireless stations had a callsign beginning M. The S and F relate to 'standard frequency'.

And finally

Earlier, I mentioned that 50 baud was equivalent to 50 bits per second (bit/s) in that particular case. Many people confuse bauds with bit/s but there is a difference. In fact, bit/s is a measure of data rate, whereas the baud is a measure of signalling speed, the number of signal events per second. The baud is therefore the same as bits per second only if each signal event represents exactly one bit, which it often does not. Take analogue modems for instance, the sort we had to put up with until broadband and other digital line systems came along. A 9600bit/s operated at 2400 baud, because each event represented four bits. I knew you were desperate to know this and please do not forget this now, as there will be a test afterwards!

PIC N' MIX

MIKE HIBBETT

Our periodic column for your PIC programming enlightenment

PIC Timers

What is the difference between a microcontroller and a microprocessor? is a common interview question for engineers. There are many answers, and a good one would be 'A microcontroller is a microprocessor with built-in memory and peripherals'. *Peripherals* refers to the circuitry added to the chip to provide useful external interfaces and support functions. Timers, serial ports, analogue-to-digital converters and so on.

The Microchip range of microcontrollers provide a wealth of different peripherals on their parts and it is probably the vast range and mix of them that makes the PIC such a popular choice with hobbyists. By carefully studying the product line-up one can find exactly the right part, one that provides just the right combination of on-chip electronics and memory to match our latest project.

Microchip for their part has done an excellent job in documenting their microcontrollers in a clear and ordered manner, especially with the way in which they have kept to a common format across the range of products. Thanks Microchip – thats one less problem to worry about!

Diverse peripherals

Providing such diverse features does of course have its downside. What do all these peripheral features do, and how can we make the right choice? Over the next few months we will take a look at some of the more widely available features and try to make some sense of them, hopefully adding a few useful programming tricks to our toolbox.

We start this month with one of the most important of peripheral features, and probably the most confusing for the novice programmer: timers. Timers are simple, versatile and without them programming anything beyond the most trivial application would become a nightmare.

A timer is a small logic circuit that holds a binary value (like a variable) that can be incremented by a clock signal. The circuit is configurable so that the source of the clock and the speed at which the clock runs can be selected from a number of different options. An application can configure these various options, read and write to the timer's value and react to special events that occur such as the value overflowing.

The timer's count value appears very much like a variable. It consists of a number of 'bits' of data (eight or sixteen, depending on the timer in question) and so can count up to 255 or 65535 before 'overflowing' back to 0 on the next clock. This overflow can cause a bit to be set in an SFR (special function register) or even cause an interrupt to occur.

Incremental

By far the most important feature of a timer is that the process of value increment, SFR flag bits being set and interrupt generation are all handled by electronics on the chip rather than software – you configure the various options in the timer, start it and then forget about it. When the desired time has elapsed an interrupt occurs and your program can perform the necessary action.

Being an independent circuit, a timer is very accurate – its operation is unaffected by whatever your program is doing. Its accuracy is limited only by the accuracy of the clock signal that is driving it. If that clock signal is an external crystal oscillator then it is possible to use a timer as the basis of a real-time clock program, such as a watch or a central heating timer.

As a timer can generate an interrupt when it expires, it can be used to trigger software to be called in an interrupt routine, software that runs outside of your 'normal' application. For example, to cause software to periodically scan a keyboard to look for keypresses. It can be thought of as a 'background' process, that can do anything you wish.

Timers are also used to help handle 'timeouts' in programs. Say you send a message out of the serial port, and expect a response back within 300ms. Rather than sit in a software loop waiting for the message to arrive, you can set a timer to run for 300ms and then check the timer flag from time to time. Your main program can continue doing other things, and if the message has not arrived when the flag is set, you know a timeout has occurred.

Timers can be configured to run with periods from a few hundred nanoseconds up to hundreds of milliseconds. Operating timers with very short periods can have downsides, however, as the time taken to call and return from the interrupt may add a significant time to the 'background' processing. Just take care if your timer has a period of less than a millisecond or so.

Terminology

Before we go under the hood, let's cover some of the terminology involved with configuring timers. There is quite a lot of it:

16/8 bit Mode: At the core of any timer is a register (a kind of variable) that holds the count value. Like any variable, it consists of a number of 'bits' that determine the maximum value it can store. Some timers are 8 bits wide, and some are 16. An 8-bit timer will count up to 255, then roll over to 0. A 16-bit timer will count up to 65535 and then roll over to 0. As the PIC has an 8-bit wide data bus, 16-bit timers use two registers to store the value, usually indicated by an L at the end of the name for the lower, least significant byte and an H for the upper byte. We will see this when we examine one of the more complicated timers later on.

Clock Source: Each timer has an input clock signal that causes the value of the timer to increment by one each time the signal changes from a zero to a one. Where this signal comes from can be selected for each timer. Normally it would be a divided down version of the main system clock, but most timers can also accept a signal on an input pin. This means the timer can be used to 'count' zero to one transitions on a pin, useful for measuring frequency or pulse counting.

Prescaler: As the clock source may be running at a very high speed it is often desirable to 'divide down' the frequency before it reaches the timer register. This can be done with the prescaler, which provides a small number of programmable division constants.

Postscaler: This is very similar to the prescaler, but divides down the output of the timer rather than the input. The combination of a prescaler, timer and postscaler enables a huge range of timeout periods to be selected.

Overflow: When a timer register has reached a value of all 'ones' (255, or 65535 for a 16-bit timer) the next clock signal will cause the register to clear back to all zeros – i.e. to overflow. At this point the output (if no prescaler is enabled) will set the timer flag and trigger an interrupt, if enabled.

Sync: All activities within the CPU (even the processing of external interrupts) are synchronised to the main system clock. This way, events occur in a predictable manner. If a timer is using an external signal as its clock then this signal has to be delayed slightly to ensure it increments the timer at the correct system clock edge. On the block diagram this will be shown as a 'sync' or 'synchronise' block. In reality, it will only delay the clock signal by two clock periods – not an issue if you are using an internal clock signal to drive your timer, but it may be worth noting if you are using a slow external signal.

Capture: Timers can be put to uses other than just providing periodic interrupts. In capture mode, an input pin can be used to trigger the recording – at a precise instant in time – of the current value of a timer. This is an extremely powerful feature. Imagine if you wish to record the exact time an external event occurred. If you tied the signal to an interrupt input then when the event occurs there would be a variable delay between the signal being detected and your interrupt code being executed. In capture mode a timer will record a copy of its timer value at the instant the event occurs, and your software can come along later at its leisure and read the value.

Compare: Compare mode is the opposite to capture; when the timer reaches a preprogrammed value, the timer will cause the level on a pin to change (go high, low or toggle) without any software being called. This is ideal for generating fixed frequency signals like audible tones from a PIC without needing any software to be involved. Generating tones under software control would consume a large amount of the PIC's processing power otherwise.

PWM: PWM stands for Pulse Width Modulation and refers to a mode of operation of some timers used predominately for controlling motors. It's a complex subject that we will have to leave for another article, but we should note that PWM operation can also be used for generating tones or variable voltages.

PIC	Timers Implemented
10F202	Timer0: 8-bit, no interupt capability
12F672	Timer0: 8-bit
16F628/ 16F877	Timer0: 8-bit or 16-bit
	Timer1: 16-bit, 32khz Oscillator
	Timer2: 8-bit with auto reload
18F2420	Timer0: 8-bit or 16-bit
	Timer1: 16-bit, 32khz Osillator
	Timer2: 8-bit with auto reload
	Timer3: 16-bit

Fig.1. A selection of PICS and their timers

Timer variants

Microchip has four standard timers called Timer0, Timer1, Timer2 and Timer3. The number of these timers that are actually present on a PIC will depend on the type of processor. The smaller products such as the 10F and 12F may only have one or two, while the larger 18F devices may have all four.

There are some subtle differences in the implementation of each timer on different products, for example Timer0 on the 10F devices does not generate an interrupt. In general, however, once you understand how a particular timer works on one processor, you will understand how it works on any. Fig.1 shows which timers are implemented on a selection of different PIC types.

Timer0

The simplest way to comprehend a timer is by studying its block diagram. These diagrams are very concise but include some logic symbols that probably require some explanation. Fig.2 is an annotated block diagram of Timer0 on a simple PIC, the 12F672. Let's go through some of the symbols.

The square with a cross inside it at position 'A' indicates an actual pin on the device, in this case pin PORTA4/T0CKI. The symbol at 'B' is an exclusive-or gate. Depending on the level of the line T0SE, the output of the gate is either a copy of or the inversion of the signal on the pin. And what is T0SE? It's a single bit within one of the special function registers, T0CON. The symbol at 'C' is an unusual one – a multiplexer. It's like a relay, the signal on the thin edge of the symbol (T0CS) selects one or other of the inputs on the left and passes it out to the right. You can look up the definition of T0CS in the T0CON register if you are unsure of what it is doing.

The block at 'D' is a *black box* that implements a prescaler (divider) that can be selected via the PSA bit. After synchronising the signal with the system clock at 'E', the signal goes into the clock input of the actual timer register at 'F'.

The arrow head below the timer register indicates that an 8-bit bus connects the register to the internal data bus – i.e. we can read or write to it like a variable in our software.

Timer0 is a fairly simple timer. To use it, simply select the clock source required, write a value into the timer register, enable it and wait for the interrupt to occur. Calculating the value to write to the register for a particular delay is quite complicated, and we will come back to that shortly.

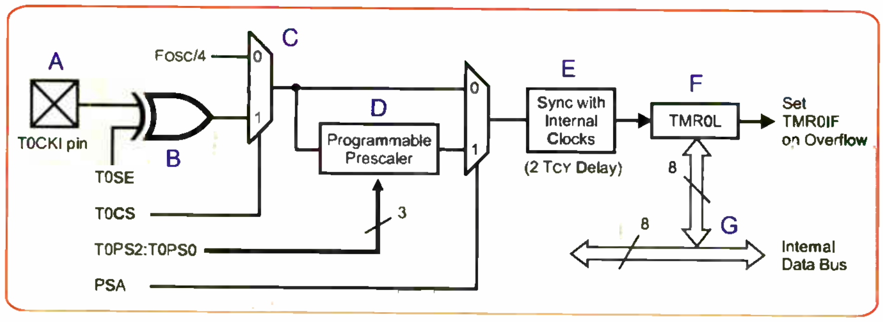


Fig.2. Timer0 internal Architecture

Timer1

With only 256 unique values available, Timer0 is somewhat limited. Let's take a look at a more capable timer, Timer1. An annotated version is shown in Fig.3.

Note the inclusion at position 'A' on the block diagram of an oscillator driver circuit. It's designed for a 32kHz 'watch' style crystal. The datasheet shows the external components required to use the oscillator – just two capacitors and the crystal.

This oscillator is designed for low power operation and opens up some very interesting possibilities. If the timer is set to run on this oscillator then the main CPU oscillator can be powered down with the SLEEP instruction. The PIC will draw mere microamps of current until it wakes up as a result of the timer expiring (overflowing). On waking up it powers up its main clock and continues running at full speed, until put back to sleep again. This is ideal for an 'always on' battery powered real time clock or data logger device.

Note how the timer register, shown at position 'B', is 16 bits long and is stored in two registers. This makes reading the contents of a running timer rather tricky, as you have to read the timer's value in two operations. It's perfectly possible that between the two reads an increment to the high byte can occur, resulting in some significantly wrong values being read. For example, consider the following sequence:

timer value: 00FF
read low byte (FF)
timer increments: 0100
read high byte (01)

Your software will think that the timer had a value of 01FF, when it should be more like 00FF or 0100. Oh dear.

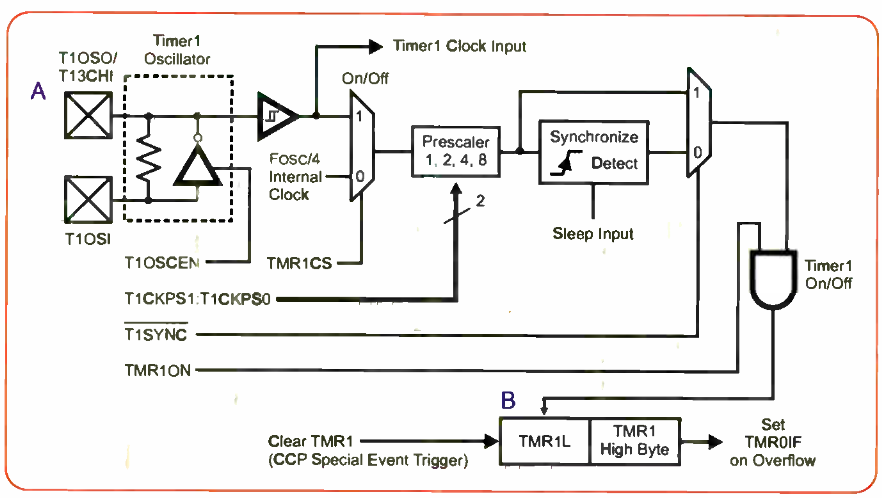


Fig.3. Timer1 Internal arhitecture

There are two solutions to this problem. The first, the one we have had to use over the years, involves repeating the read of the high byte to make sure it didn't change:

1) get high byte
2) get low byte
3) get high byte again
4) if high byte has changed, goto step 1

This is an acceptable process, but in later versions of PICs, such as the 18F, Microchip have corrected this little problem by introducing a '16-bit read mode'. When enabled, the timer module will hold a 'latched' copy of the timer high byte whenever you read the low byte. It saves a byte of user RAM, so if you need to read a 16-bit timer, enable this feature and use it.

Timer values

One of the big challenges to actually using a timer is working out what value to write into the register to achieve a desired timeout.

Let's take a real example and work through it. We have a PIC18F2420, running at 20MHz, and we would like to create a timer that runs for 100ms. That's quite a long delay for a timer, so we look to one of the bigger 16-bit timers. Let's use Timer1, as shown in Fig.3.

To keep the component count down we will use the main system oscillator as the clock source, as shown by the text Fosc/4 on the diagram. The text Fosc/4 clearly means our input clock is 20MHz/4, or 5MHz. As we are looking for a timeout of 100ms (or 10Hz), we need to divide that 5MHz signal down a further 500,000 times. That's still quite large, so let's enable the prescaler to divide by 8, which will further reduce the timer clock signal down to 625kHz.

To work out what value we want to put into the timer for a 100ms timeout, it's convenient to convert the input clock frequency into its period, by inverting it. 1/625000 is 0.0000016, or 1.6μs. So every 1.6μs, the timer will increment by 1. If we want to count 100ms, then the number of timer 'counts' required is 100ms/1.6μs which equals 62500.

So, we want the timer to count 62500 and then generate an interrupt. Remember that the interrupt occurs when the timer rolls over from FFFF (hex) to 0000. So we just need to subtract 62500 (decimal) from FFFF (hex) and then add 1. In decimal this is 65535 - 62500 + 1, which equals 3036 or 0BDC in hexadecimal. Just load 0B into the high byte, DC into the low byte, enable the timer and in 100ms the timer will expire, and generate an interrupt, if enabled. Assuming that you want the interrupt to occur every 100ms just reload the value 0BDC into the timer at the start of your interrupt routine.

There is a small problem with this technique – as the interrupt processing may be delayed by other software (already being in an interrupt when the timer expired, for example) there will be some 'jitter' on this periodic interrupt. If you require a rock steady periodic interrupt then we must turn to another feature of some timers – auto reload.

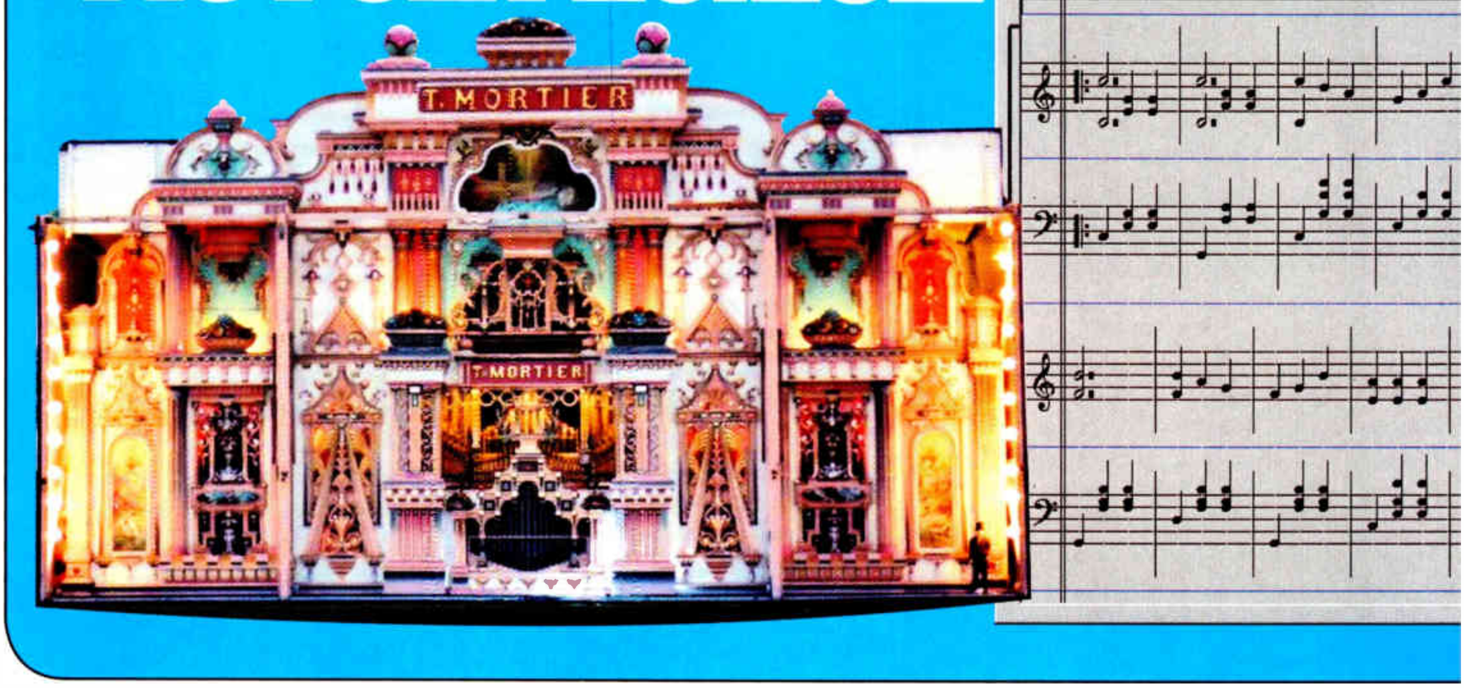
Auto reload

Auto reload is a feature implemented by a small circuit that can be used to reload your desired timer value every time the timer expires. Being under hardware control it is very accurate, as accurate as the source of the input clock. You would want to implement auto reload on features such as a real time clock, or an audio tone generator.

Timer2 on the PIC2420 has a reload feature, which you can see from its block diagram in its datasheet. The second 8-bit register on the diagram, PR2, hints at this feature, which can be confirmed by reading the appropriate section in the datasheet. The timer counts up from 0 until it reaches the value in PR2. When this occurs the timer resets to zero, a timer interrupt flag is set and the timer starts incrementing again on the next clock transition. This is very useful for creating accurate, periodic interrupts. One simply sets up the control register, writes the desired delay value into PR2 and enables the timer. Your interrupt routine will then get called periodically, with no further software activity required.

Timers are probably the most important peripheral on a processor; writing anything other than the most trivial program will benefit enormously from their use. The PIC is equipped with some very flexible timers and it is worth taking the time to experiment with them to better understand their capabilities. With time, you will find them as flexible and diverse as the venerable 555 timer itself!

PIC POLYPHONIUM



A novel polyphonic musical design inspired by the glorious sounds of the showmans' fairground organs of the bygone steam engine era.

By JOHN BECKER

Part 1: Master Control Unit & Note Generator

VISITING VARIOUS steam fairs, such as the Great Dorset, over the last ten years or so, the author has been fascinated by the grandeur of the sights and sounds of the superb showmans' fairground organs there in abundance. He has long wished to commemorate them in some electronic musical way.

Such organs were perhaps in their heyday for 30 years or so either side of 1900. Possibly Italian in origin, judging by the names of some of them, Cavioli, Marenghi, Mortier (see above), they were magnificent examples of craftsmanship and ornateness, with sounds to match, generated by steam suction or pressure through a variety of organ pipes and percussion instruments, frequently with moving manikins playing triangles or seemingly conducting the performance.

Museum piece

As well as at steam fairs, there are numerous museums around the UK where they may be seen (variously browse the web on such phrases as steam or fairground organ). It is believed that they may still be made in Holland and Belgium.

The organs are controlled by continous strips of punched card cycling through mechanical detector switches, causing the music to be generated and the movement of the manikins etc. These cards were perhaps the forerunners of the Hollerith punched card system, originally designed in 1890 to analyse the data from the US Census. Hollerith later founded the company that was to become IBM.

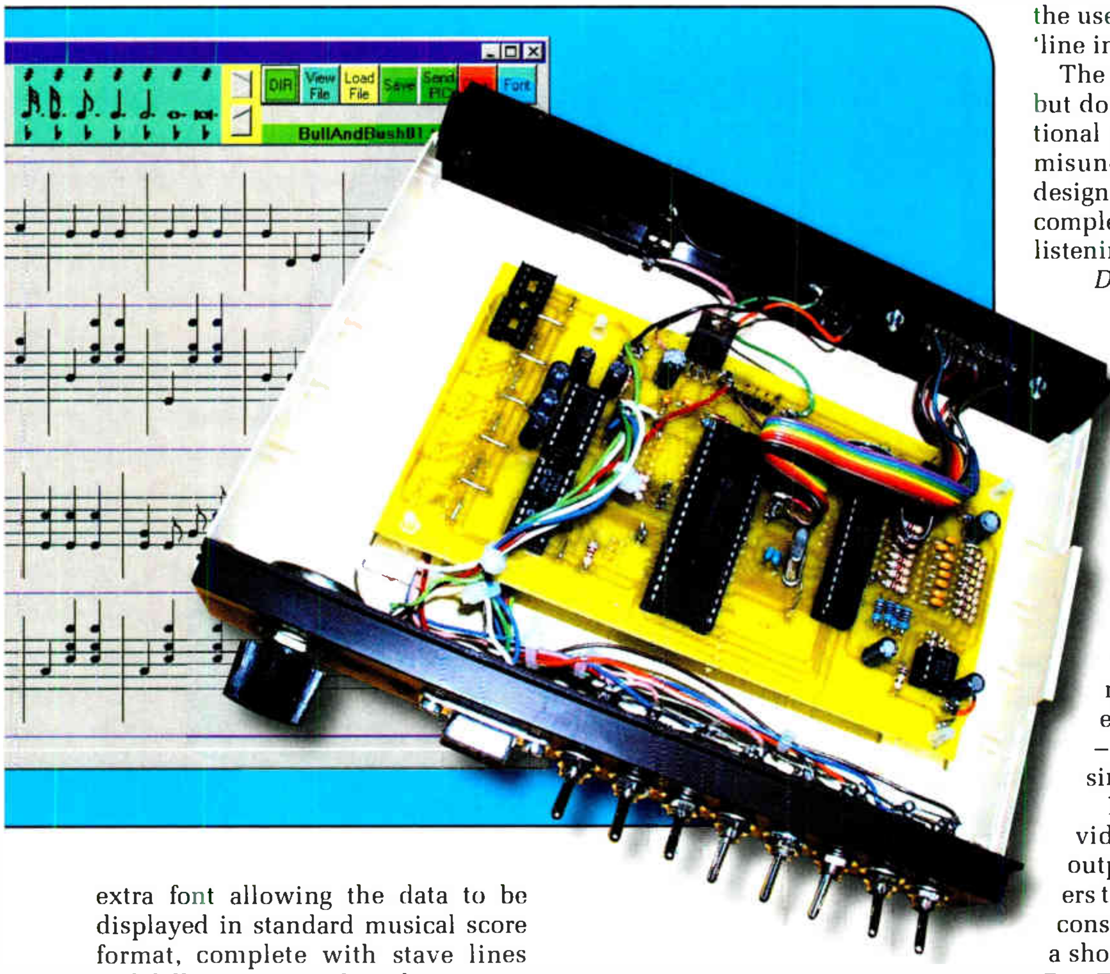
Dawn of an idea

It was at the steam fair at Detling in Kent during August last year that the author recognised that the punched cards used by the organs could be readily replaced by electronic memories and their retrieved data used to control electronically generated notes, a topic that he has explored several times in his published designs in the past, *Magic Music*, *Musical Sundial* and *Stylo-PIC* for instance.

As he sat in the garden on the evening of visiting the steam fair, contemplating how one could design a tribute to these musical masterpieces of a bygone era, it was realised that he could also probably write software that would enable the musical data to be entered on a PC screen and downloaded to the memories accessed by a PIC microcontroller, which would then control the music generation. So began five months of development!

Polyphonium

The result is the PIC Polyphonium presented here. Data is entered via a PC's keyboard onto a screen display, aided by a readily available freeware



extra font allowing the data to be displayed in standard musical score format, complete with stave lines and different note styles. Sheet music scores of any chosen themes can be keyed onto the screen. Musical users can also be creative and write their own scores.

The data is saved to disc as numerical values and can be sent to the PIC via a serial data link. The PIC then causes the data to be stored in up to eight on-board serial memories, each holding a different tune, which can be selected by switches. Each memory can typically store 32768 bytes (32K) of data, representing 21845 notes (three bytes per two notes).

The PIC then reads data from the chosen memory, sending it to a master Top Octave Generator and octave divider based on a second PIC, and which can generate all twelve notes in an octave (including sharps/flats) across seven octaves (84 different notes). Up to eight notes can be generated simultaneously (it is a truly polyphonic instrument), with their duration determined by the codes – quavers, minims, breves etc. The rate at which the music is played is controllable via a panel-mounted potentiometer.

Sound generation

Thought was given to what type of sound should be generated. It was decided that it should be reminiscent of the somewhat harsh sounds of the fairground organs being commemorated. Consequently, a simple square wave frequency is generated for each note, avoiding the more flute-like sounds that would be produced by sine waves. The notes are mixed in a simple op amp mixer and output to the user's own audio amplifier via its 'line in' connector.

The resulting music sounds superb, but do not expect hifi in the conventional sense – anyone expecting hifi misunderstands the nature of this design. It sounds rather like a great complex barrel organ said one listener, listening to such 'tradional' themes as *Down at the Old Bull and Bush* (1903) and *I do like to be beside the seaside* (1909) and others that had been keyed in as test pieces from some ancient scores inherited from the author's mother.

His wife has even had a good 'singalong' with it, obviouly enjoying it! During development, the author has often just switched it on as pure entertainment. (How he recalls the War-time years, travelling to the seaside at Skeggy – Skegness, Lincs – everyone singing along to such tunes.)

Facilities have also been provided so that basic data can be output and used by inventive readers to control their own mechanical constructions such as those befitting a showman's organ. More on this in Part Two.

How it works

First we describe the basic PIC-controlled Master circuit, as shown in Fig.1. The PC aspect will be described later (the design is believed to be compatible with PCs running under W95, W98, ME and XP).

The musical data having been stored in a serial memory, up to eight, selected by the combination of switches S1 to S3 on PORTE and biased by resistors R33-R35, is input by the master PIC,

IC2. This takes the data and outputs it to the master tone generator, IC3, via PIC PORTD, at a rate controlled by potentiometer VR1 on PORTA,0. It also makes it available to the outside world via PORTB. Users who can write their own PIC software may also make use of the rest of PORTA and half of PORTC for similar purposes (see later).

Top octave generator

Top octave generator IC3 generates the notes, their octaves and individual durations from the data received from IC2 via PORTC, and outputs up to eight different frequencies from PORTB. The amplitude of the square wave notes is basically 0V to +5V, but is reduced to about a fifth of that by the combination of resistors R4-R19.

The attenuated signal is AC-coupled by capacitors C4-C11 to resistors R20-R27, jointly feeding into the inverting input of op amp IC5, configured as a unity gain mixer. Its bias is set by the potential dividers R30, R31 and R28, R29, with capacitors C23 and C25 providing stability.

The single mixed signal, which can peak just below the op amp's amplitude clipping limits, determined by the 9V supply from which it is powered, is AC-coupled by C24 to the line input of the user's own audio amplifier. The use of level control VR2 is optional – typical amplifier systems having their own level control.

The overall duration of the notes can be selected by switches S4, S5 and S8, as described shortly. Short durations give a staccatto effect, longer ones give a more 'melodic feel'. The overall octave range can be selected as normal, plus one or minus one by switches S6 and S7, on PIC pins RA2 and RA3, where 0 = off and 1 = on:

S6	S7	Octave range
0	0	normal
0	1	minus one octave
1	0	normal
1	1	plus one octave

Serial link to PC

Data is output from the PC in a serial stream at 9600 Baud via one of its COM ports, a choice of COM 1 or COM 2 (the unit has not been designed to accept data from a PC's USB port). An RS232 link from the PC connects to the serial interface chip IC4 in Fig.1. This is used in the standard way with IC2 pin RC7 receiving input data from IC4, and IC2 pin RC6 transmitting handshake data back to the PC via IC4. The PC connection is via connector SK1 and any standard serial lead (such as used with a modem).

IC4 generates its own signal voltage levels as required by the RS232/PC protocol. The use of this chip was discussed by Joe Farr in his *EPE Serial Interface for PICs and VB6* of October 2003, and it will not be discussed here.

Serial memories

In Fig.1, the block of eight serial EEPROMS (electrically eraseable programmable memories) is represented as a single block outline, IC6 to IC13. The choice of memory quantity and capacity used is up to the constructor. Data stored in these devices is permanent even after the power has been disconnected. They can be overwritten with new data if required.

Each memory has a data line (SDA) and clock (SCL) line, under control of IC2 pins RC3 and RC4. There are also three address lines, A0, A1 and A2. The address code, between 0 and 7, is determined by which pins are connected to the positive line or left unconnected (they are internally biased to 0V in unconnected mode). The connection logic is shown in the insert table in Fig.1 and is an inherent part of the printed circuit board (PCB) design.

Microchip manufacture several serial EEPROMS with different 8-bit memory byte capacities. In the prototype, the 24LC64 (64 kilobits or 8KB) and 24LC256 (256 kilobits or 64KB) were used. The test themes keyed in ranged in size from 5KB to just under 8KB. The former was just one score page, the latter was eight pages.

The playing time depends on the setting of VR1, but at a reasonable play rate the latter theme took about two and half minutes to play through once. (The Polyphonium has also been designed to play through a theme over and over again, indefinitely until stopped or a different theme is chosen.)

Which EEPROM the data is written to or played from is controlled in software by IC2, as determined by which switches (S1-S3) are selected.

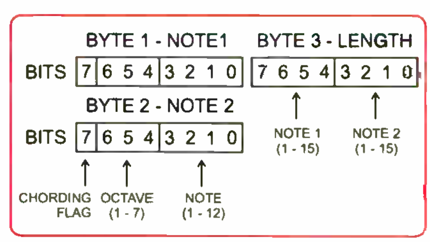
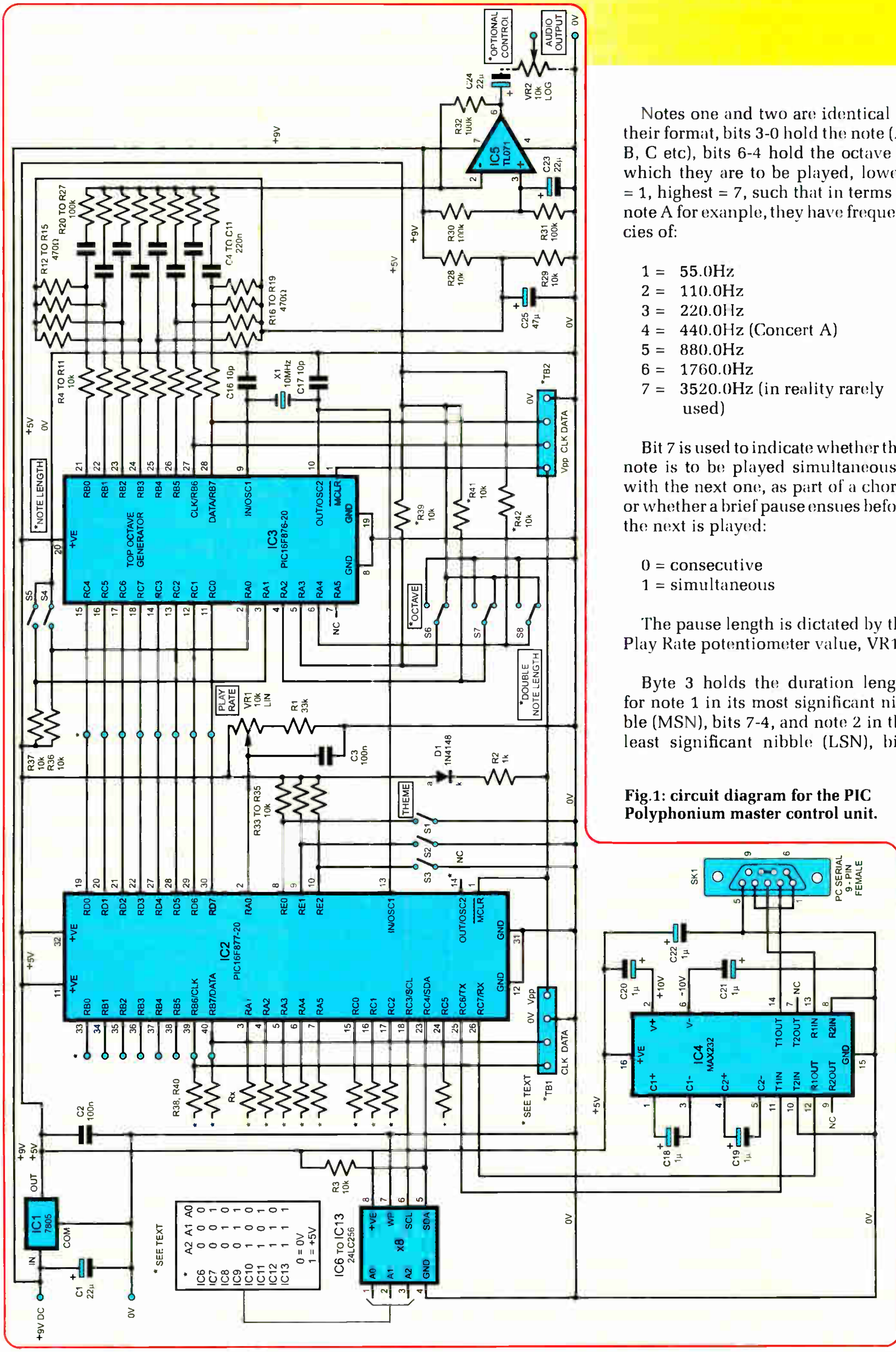


Fig.2: how data is arranged in the three consecutive music data bytes

Data format

The music data is formatted into three data bytes for each two notes, stored as shown in Fig.2. transmitted and retrieved in consecutive bytes. note 1, note 2, note length for each.



Notes one and two are identical in their format, bits 3-0 hold the note (A, B, C etc), bits 6-4 hold the octave at which they are to be played, lowest = 1, highest = 7, such that in terms of note A for exanple, they have frequencies of:

1 = 55.0Hz
2 = 110.0Hz
3 = 220.0Hz
4 = 440.0Hz (Concert A)
5 = 880.0Hz
6 = 1760.0Hz
7 = 3520.0Hz (in reality rarely used)

Bit 7 is used to indicate whether that note is to be played simultaneously with the next one, as part of a chord, or whether a brief pause ensues before the next is played:

0 = consecutive
1 = simultaneous

The pause length is dictated by the Play Rate potentiometer value, VR1.

Byte 3 holds the duration length for note 1 in its most significant nibble (MSN), bits 7-4, and note 2 in the least significant nibble (LSN), bits

Fig.1: circuit diagram for the PIC Polyphonium master control unit.

3-0. The values set the durations, or note lengths, in terms of note type as follows:

Note Code	Basic Length
0 nil	(not used)
1 demisemiquaver	2
2 semiquaver	4
3 quaver	8
4 crotchet	16
5 minim	32
6 semibreve	64
7 breve	128
8 dotted demisemiquaver	3
9 dotted semiquaver	6
10 dotted quaver	12
11 dotted crotchet	24
12 dotted minim	48
13 dotted semibreve	96
14 dotted breve	192
15 continuous	(prototype tuning purposes only)

The actual duration of the notes is not according to any conventional musical timing, but is changeable by the user in multiples of twice the basic rate, as determined by the main structure of the software routine in relation to the PIC's clock rate. As will be seen, the lengths are in multiples and sub-multiples of 2.

The basic note length can also be changed by the binary setting of switches S4 and S5, monitored by IC3 pins RA0 and RA1, where 0 = off, 1 = on.

S5	S4	Multiplier
0	0	× 1
0	1	× 2
1	0	× 4
1	1	× 8

The note length value when received for any note triggers that note to start and is placed into a counter, which decrements for each cycle of the main program loop. When any counter reaches zero, the respective note is turned off again.

Note generation

Recently on the *EPE Chat Zone* (access via **www.epemag.co.uk**), there was a discussion about how musical notes could be generated in software. There are various methods and the one favoured by the author in several designs is an additive technique, which is worth discussing here:

When a given value between 1 and 255 is added to an 8-bit byte, that byte eventually rolls over beyond 255, leaving the remainder of the addition, if any, in the byte. That byte then counts up again from the remainder value until again it rolls over, and so on indefinitely until stopped.

Each rollover of the byte can be monitored by the Status register of a PIC as the Carry flag (Status bit C). If there is no rollover C = 0, with a rollover C = 1. The flag can then be set into a given pin of one of the Port outputs. Viewed on an oscilloscope, that pin will be seen to be toggling between high and low at a frequency determined by the rate of rollover. Within an adequately high toggling rate range, the frequency can be heard via an audio monitor as a continuous tone.

The frequency of the tone will depend upon the additive value chosen and the clock rate at which each addition is made. With a suitable choice of additive value in relation to the clock rate, the tone can be tuned to correspond to the frequency of a given musical note.

It's a rollover

It is also possible to chain two or more counters in sequence, such that the preceding one's rollover causes the next counter to increment, and that counter's rollover can be used for triggering the frequency output. In theory, any number of counters could be in a chain, providing precision control of the ultimate frequency generated. The basic clock rate needed for the chain to generate musical notes has to be many times faster than with the single counter technique, of course.

It is also possible to take the logic change of another bit in the final counting byte as being the trigger point, rather than the rollover. Depending on the choice of bit, the same note at different octaves can be generated, each subsequent bit of a byte changing at half the rate of the preceding one, the divide-by-two effect of any binary counter. Octaves, by definition, are all sub-multiples of two in relation to a given input counting rate.

In the PIC Polyphonium, two counter bytes are used for each note, the first counting one additive value, the second counting not only the rollover rate of the first, but also adding a second value to itself. In effect, it is like adding a value having several decimal places.

Octaves of any note are generated according to which bit of the second counter is used to trigger an output bit value. Up to eight note generating counter pairs can be controlled using different additive values for each. Each counter's chosen octave setting pin controls its own bit within a master byte, whose value is output to the world, in this case by PORTD of IC2.

Determining frequency

The additive values for any basic note are held by the PIC in a look-up table. Whilst a formula could be evolved to establish the required value for any frequency, that formula would be highly complex, since it depends not only on the PIC's control clock frequency, but also on the number of commands and their type (they take a varying number of clock cycles, typically 1 or 2, depending on the command) within the generating loop. The author has found that the trial and error techique of establishing the correct value is pretty straightforward.

Take a random additive value, and using a frequency counter, find out what frequency that value causes to be generated. If the frequency is too low, double the value, if too high, halve it. Monitor the frequency generated by the new value. If too low double it, if too high reduce the value to midway between its first and second values. Keep on with steps in a similar manner until the correct frequency is obtained.

It is considerably less time consuming than might appear. In reality, the nearest obtainable frequency can be found in less than a dozen steps. When trying values for subsequent notes, knowledge of which values are more appropriate to try than others will increase.

Readers with programming experience will recognise that the process is very similar to the 'binary chop' technique often used in data sorting algorithms.

The additive values actually used in the Polyphonium are shown in the table opposite. The flat of a note has been taken as the sharp of the note preceding it and vice versa, in common with modern musical practice.

The frequency of the notes shown is mathematically based (each frequency being the result of multiplying the frequency of the proceding note by the twelfth root of

Table 1: Additive values

MSB	LSB	TOTAL VALUE	NOTE	FREQUENCY (Hz)
1	9	265	A	440.000 Concert A
1	25	281	A#	466.164
1	41	297	B	493.883
1	60	316	C	523.251 Middle C x 2
1	78	334	C#	554.365
1	98	354	D	587.330
1	119	375	D#	622.254
1	141	397	E	659.255
1	165	421	F	698.456
1	189	445	F#	739.989
1	217	473	G	783.991
1	245	501	G#	830.609

two (equal temperament scale), with Concert A at 440Hz being an internatiaonal standard. It's interesting to note that A has varied enormously in frequency in previous centuries and localities.

For example, the organ at Halberstadt (dated 1361) has a freqency for A of 505.8Hz, whereas Church pitch in Paris in 1648 was 373.7Hz (source, *The Physics of Music*, Alexander Wood, first published 1944).

Practical frequency

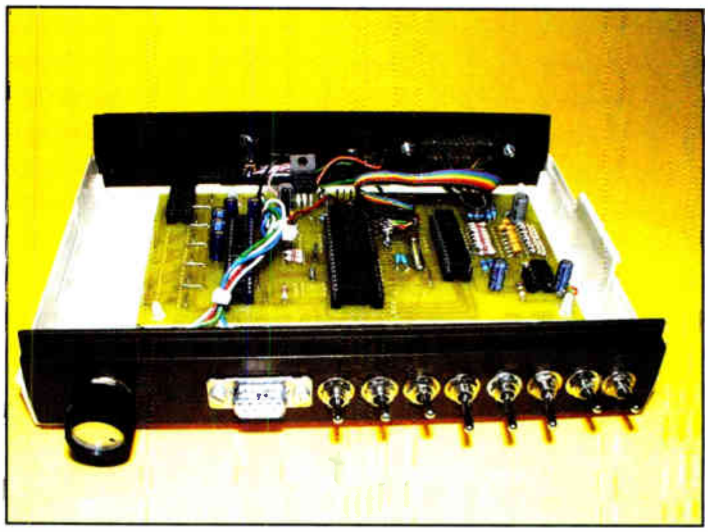
The tuning of the Polyphonium is typically within 0.5% or so. It is a lower accuracy than achieved with the *Stylo-PIC*, but that was only generating one note at a time, whereas this design is generating eight notes simultaneously, even though not all are output at any one time (dummy routines are used when fewer than eight notes are required, to balance the timing).

The nature of this design does not require absolute tuning to the *n*th-degree, and a few Hertz either side of the ideal adds 'character' to it.

It is an astonishingly full sound that can be achieved from the various scores used during development. It had been thought that additional 'voices' would need to be added, things like voltage controlled filters, envelope shapers and reverberation units. It was decided that the unit does not need them, although such could be added by those who have the facilities or constructional skills.

Play Rate control

As said earlier, potentiometer VR1 is the Play Rate control connected across the 5V supply, providing a variable voltage to IC2 pin RA0, which is used in analogue-to-digital mode. Resistor R1 at the 0V side of VR1 reduces the



Prototype front panel rate control, PC serial connector and function switches

Parts List – PIC Polyphonium

Master Controller and Note Generator

1 PC board, code 611, available from the *EPE PCB Service*, size 152.4 x 83.3mm
1 low-profile plastic instrument case, size 202mm x 154mm x 25mm
1 9-pin D-type serial connector, female (SK1)
8 min. s.p.s.t toggle switches (S1 to S8)
1 10MHz crystal (X1)
1 DC power socket, chassis mounting (see text)
1 audio output socket, to suit existing equipment plugs (see text)
1 small plastic control knob
9 8-pin DIL sockets (IC5 to IC13)
1 16-pin DIL socket (IC4)
1 28-pin DIL socket (IC3)
1 40-pin DIL socket (IC2)
4 self-adhesive PCB supports
2 4-way header-pin strips (TB1, TB2)
Connectors to suit future interface circuits (see text); 1mm terminal solder pins (see text); single-core wire; multistand connecting wire; multicoloured ribbon cable

Semiconductors
1 1N4148 signal diode (D1)
1 7805 +5V 1A voltage regulator (IC1)
1 PIC16F877-20 microcontroller, preprogrammed (see text) (IC2)
1 PIC16F876-20 microcontroller, preprogrammed (see text) (IC3)
1 MAX232 serial interface (IC4)
1 TL071 FET op amp (IC5)
8 24LC64 or 24LC256 EEPROM serial memories (IC6 to IC13)

Capacitors
2 10p ceramic disc (C16, C17)
2 100n ceramic disc (C2, C3)
8 220n ceramic disc, 0·1in. pitch (C4 to C11)
5 1μ radial elect. 0·1in. pitch (C18 to C22)
3 22μ radial elect. 16V, 0·1in. pitch (C1, C23, C24)
1 47μ radial elect. 0·1in. pitch (C25)
Note: C12 to C15 not used

Resistors (0.25W 5%)
8 470Ω (R12 to R19)
1 1k (R2)
19 10k (R3, R4 to R11, R28, R29, R33 to R37, R41, R42)
1 33k (R1)
11 100k (R20 to R27, R30 to R32)
Note: R38, R40 and resistors marked with asterisk – see text

Potentiometers
1 10k rotary carbon, panel mounting, log. (optional VR2)
1 100k rotary carbon, panel mounting, lin. (VR1)

overall range of voltage that can be selected. Capacitor C3 slightly smooths the voltage change seen by RA0.

The software simply takes the digital value of the voltage and uses it to set the Play Rate.

Power supply

A power supply of 9V DC is required. The current consumption demands depend on other circuits which this design may be required to drive. As presented here, plus the LED display example unit described in Part Two, current consumption is around 100mA.

It is advisable to use a supply adequately rated to also provide for any additional extension circuits required.

A 7805 1A 5V voltage regulator, IC1, reduces the 9V supply to +5V to suit all the chips used, except for op amp IC5, which is fed direct by the 9V supply. *Only use a 9V supply.*

Provision for programming PICs in situ has been provided via terminal pin groups TB1 and TB2. The connections on the PCBs are in the author's standard order.

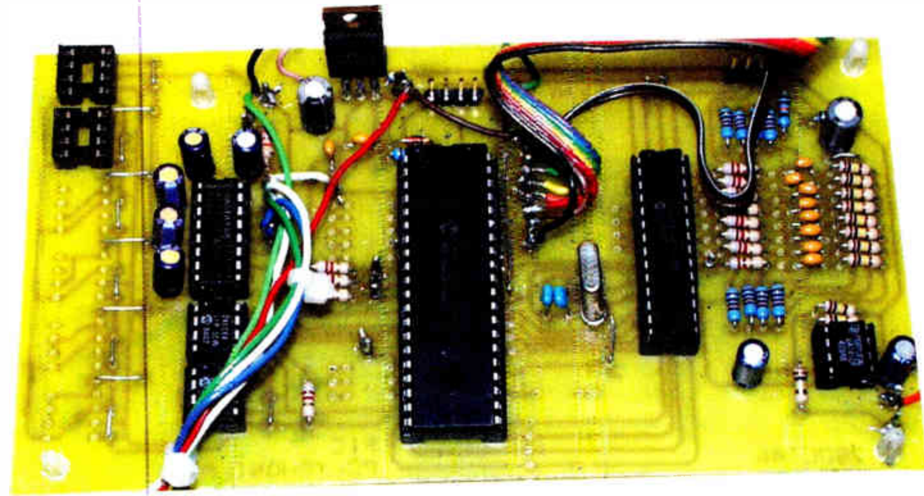
Construction

Construction is on a single PCB, as detailed in Fig.3. This board is available from the *EPE PCB Service*, code 611.

Assemble in the usual order of ascending component size, using sockets for the dual-in-line (DIL) ICs. Double-check everything for good soldering and accuracy of component positioning and orientation. Do not insert the DIL ICs until correctness of the 5V supply from IC1 has been confirmed.

Then insert those ICs, observing normal static electricity precautions (touch something earthed each time before handling them), and make sure they are the right way round. The PICs should be preprogrammed. No sound will be heard until at least one of the serial memories has been programmed by the PC.

The prototype was mounted in a slimline plastic case, measuring 202mm x 154mm x 25mm (8in x 6in x 1in). Arrange the drilling for the switches to place them as three groups, in order of S3-S1; S4, S5 and S8; then S6 and S7; with a visible gap between the groups so that they are instantly recognised in relation to which switch is which when viewed from the front of the case (the author regretted not doing so with the prototype).



General layout of components on the prototype Master printed circuit board. Only two serial memory chips (24LC64) are plugged into this board, below IC4 (MAX232)

Play Rate control potentiometer VR1 also mounts on the front, to the left of the switches. The audio connector and a power connector (if used) are mounted at the rear, possibly along with level control VR2 if used.

Also allow provision for sockets to connect external output data and power lines to other circuits if such are intended to be used.

Software

Software for the PIC and PC aspects of the Polyphonium are available for free download from the *EPE* Downloads site, access via **www.epemag.co.uk**.

Preprogrammed PICs are available from Magenta Electronics. For contact details see their advert in this issue.

The PC program was written in Visual Basic 6 (VB6) and supplied as both source code and standalone .EXE program. Copy all files into a folder named to suit you on Drive C.

Then open that folder and copy the **Musical.ttf** font in the folder and paste it into Windows' own Fonts folder:

My Computer\Control Panel\Fonts

Also, please ensure that the file MSCOMM32.OCX is in the Polyphonium folder, as supplied. This is used with the serial link (PIC Link).

Additionally, note that if you wish to use the VB6 source code rather

Rear view showing the LED Display Interface (next month) connector, the power input connector and audio output socket.

PIC POLYPHONIUM MASTER CONTROLLER CONSTRUCTION

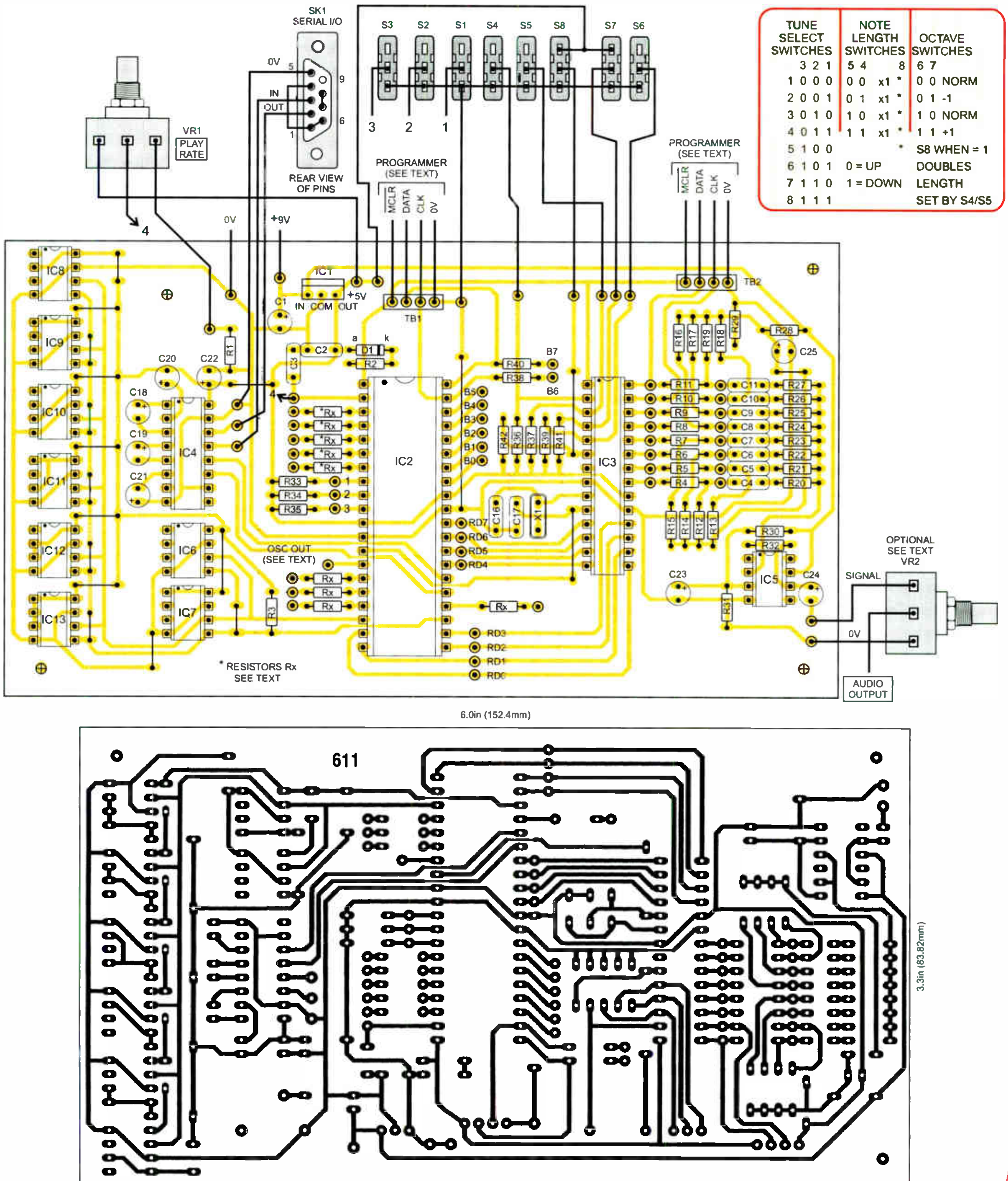


Fig.3. Printed circuit board component layout, off-board wiring details and full-size copper foil master for the PIC Polyphonium

than the EXE file, then Joe Farr's *EPE Serial Interface* files must be installed on your PC. The files are in the Downloads section of the *EPE* website (**www.epemag.co.uk**). VB6 will not run the full Polyphonium program unless these files are installed, crashing when trying to use the serial link.

Using the PC software

To launch the PC software, open the folder in which it is held, and double-click on the **Polyphonium.exe** icon. The program loads automatically going first into a setup routine to check if the program has been used before on this PC. If it hasn't, several additional files are created, which are used to hold various attributes of the program as selected by the user later.

The master screen display is then generated. An example of this showing most of the various controls is shown in Photo 1. The image shown includes one page of one of the author's test scores. At this time, your screen will be blank of such data. A run through of those controls on the main screen now follows.

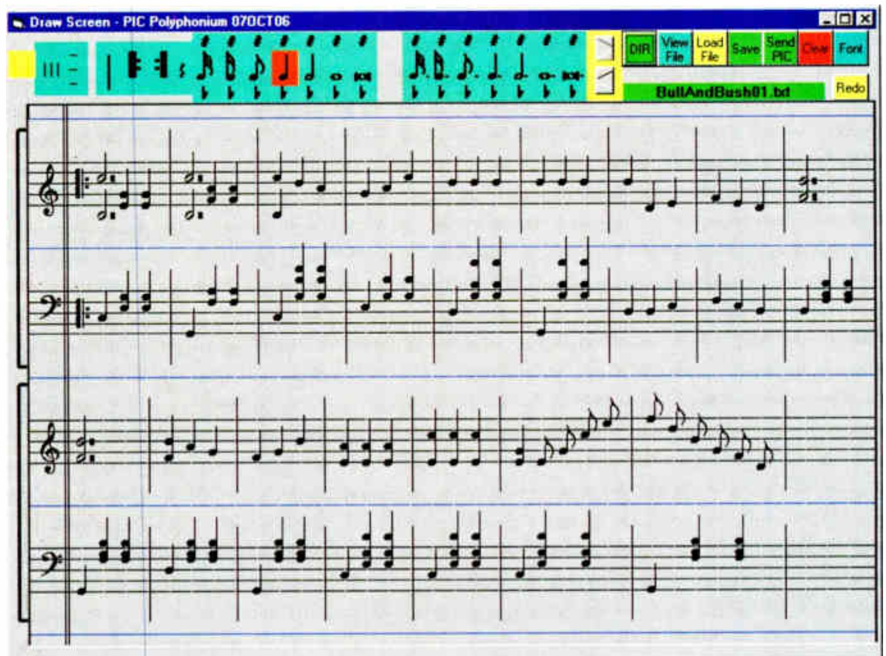


Photo 1: Screen dump showing an example of a section of a music score keyed in, and the majority of the control buttons

Fonts and other matters

At the top of the screen is a line of several buttons containing various musical note symbols. If the buttons do not contain such symbols, make sure you have the **Musical.ttf** font file copied from the Polyphonium folder into Windows' own Fonts folder, as above.

Create a new score title

Left-click on the green DIR button to reveal the Directory screen (Photo 2), then use the 'Make File' option. Full details of the Directory screen are given in its Notes file, selected by clicking its Notes button. Having created a new file, it is automatically shown as a blank area on screen ready for immediate use, with the title given, suffixed '01.txt'.

Grids

Two buttons to the left of the symbol options turn the grid aspects on and off. The three vertical lines button selects the vertical grid, the three horizontal lines button selects the horizontal grid in which the intermediate lines above and below the main stave lines are shown. Notes are automatically placed at the nearest grid intersection when the mouse is clicked.

Even when the grids are not shown, moving the mouse cursor across the screen causes the note and its raw octave data for that theoretical grid point to be shown in the top centre yellow box.

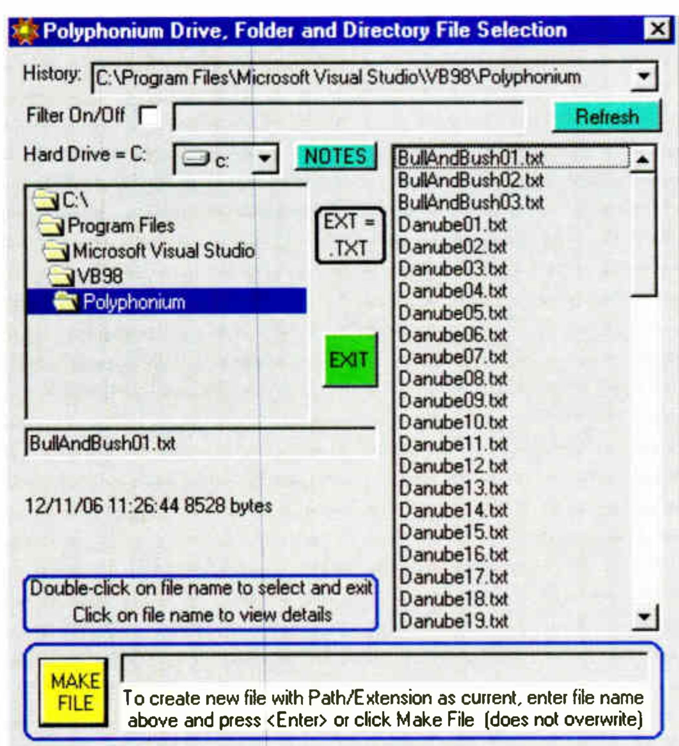


Photo 2: The Directory screen

Select and use a symbol

Left-click on one of the note symbols to select it, then position the mouse cursor over the screen stave position at which you wish to place it, and left-click in that position, 'pasting in' the symbol, which is then shown there. The selected symbol button is shown highlighted in red. The symbol remains selected until a new one is chosen (also see 'Delete a Symbol' below), allowing it to be placed where desired without reselecting it.

Only notes with their vertical 'tails' going upwards are provided. The normal cosmetic music convention of some vertical tails descending, depending on the position within the stave, is ignored. The same applies to the 'tail flags' direction of some notes (eg semiquaver) – they all face to the right.

Delete a symbol

To delete a symbol, position the cursor on or near the symbol to be deleted until that symbol is also repeated in the lower yellow box in the centre of the note symbols, which appears when the correct position has been found, then right-click the mouse whilst still in the same position to delete the symbol. That symbol then becomes the active one when the mouse is again left-clicked on any position.

If you have difficulty finding the 'trigger point' at which a symbol can be deleted, gently move the mouse cursor around and down along the symbol until it is displayed in the yellow box. Such positions are not always what they seem (for a variety of complicated reasons).

It is possible to write a new symbol directly on top of, and replacing, an existing symbol. In some cases, though, that new symbol may only become apparent once the screen has been cleared and subsequently redrawn.

Sharps, flats and naturals

To select the sharp or flat of a note, click the sharp or flat symbol above or below it. This automatically selects both the note and that symbol for immediate use.

Music scores on which a general sharp or flat symbol (note key) is shown at the beginning of, or during a stave, must have those symbols placed in the area enclosing the clef. They are automatically positioned immediately to the right of the clef's vertical position.

Such general sharps or flats when specified are repeated, but not shown, for all octaves of the note referred to in that clef. This is for the benefit of the compilation program. Only the sharps and flats relating to the main octave of a clef are shown, in conventional music fashion.

If a score calls for general sharps or flats somewhere within a stave, the screen display must start at the next available double staves, and the symbols placed at the start of those.

Symbols for 'natural' notes are only required if the score calls for them when a general sharp or flat is specified in the score, it then only refers to that note. All notes are 'naturals' unless selected otherwise.

Bar lines

The long vertical line button selects the bar line marking for placing on the score in the position then clicked. It is cosmetic only and not used by the compilation program.

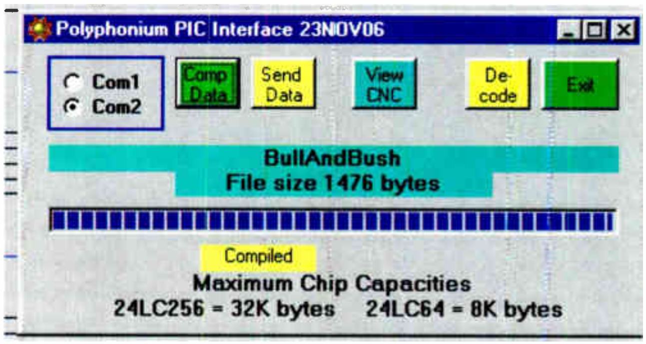


Photo 3: The screen through which PIC data is handled

Repeat symbols buttons

The two symbols to the right of the bar line symbol, respectively, indicate the start and end positions in a score of those sections which are repeated when playing the score after compilation.

Rest symbol

The symbol to the right of the End Repeat symbol indicates where a short rest period occurs. The length of pause depends on the rate at which the Play Rate potentiometer has been set.

Panning between pages

To select the next or previous page in a sequence of files for one theme, click the forward or backward arrow box surrounded by yellow. If the page exists it will be displayed and its name shown in the long green box. If it does not exist, you are offered the choice of creating it as a blank, or of exiting the option. New pages are automatically numbered consecutively.

View file button

The file in which the basic score data is held for any selected page may be examined by clicking the View File button. The file could be amended while open, but the needs are complicated and are not described here.

Save it button

This button only appears once a file has been selected via the DIR button. Left-clicking it causes that file to be resaved to disk under the same name. No facility has been provided for a given file to be renamed. Such must be done through the normal Windows facilities if desired.

Saving changes

Any symbols you key in before a file has been loaded cannot be saved and will be lost when any file is opened or panning between pages occurs, and in other similar circumstances.

Load existing file

Click on the DIR button to reveal the files available (Photo 2, then double-click on a name to select the one required, as described in the Directory's Notes file.

PIC link button

This button only appears once a file has been selected via the DIR button. There are several buttons within the sub-screen, revealed when clicking the PIC Link button (Photo 3).

The Comp Data button causes all files of the theme title selected (regardless of the extension number shown) to be compiled into a form suitable for the PIC, creating a new file of the same basic title with a CNC extension. The Send Data button, causes the named file's CNC file data to be sent to the PIC, which stores it in the memory currently selected by its switches.

The Exit button allows you to exit the screen without either above actions being performed.

Com ports buttons

This screen also allows selection of the COM port through which the serial data is sent to the PIC, COM1 or COM2 (this program is not designed for use with USB links). Click on the port required to reveal a black dot in its 'radio button'. The choice is automatically stored to disk for future recall when the program is loaded. The choice may be changed at any time.

Data transmission is always at 9600 Baud.

View CNC button

The View CNC button allows the contents of the compiled (CNC) data for the PIC to be examined. The file is specific to the base file title selected. The format of the data is complicated and is not described here.

Decode button

The decoding facility was produced for the author's own benefit, but has been left in case you can find a use for it. It takes data from the CNC file for any subject and decodes it back into notes and stores them into files prefixed 'Decode' which can be displayed on the PC screen. No bar lines or general sharp/flat symbols at the beginnings of staves are included. All such notes have the appropriate symbol alongside.

Note also that some notes are common to both treble and bass clefs. Where they are encountered, notes A0 and above are allocated to the treble clef, below A0 they are allocated to the bass clef (and thus the resulting scores may appear to be different from the original in this respect).

All notes are allocated to just the first treble/bass clef pair.

Clear button

The Clear button on the main screen allows the screen data to be totally cleared without changing the contents of the recorded files.

Redo button

The Redo button causes the entire screen data to be redrawn for cosmetic purposes if needed, as for example, after calling either of the View options opened through Notepad.

Font button

Clicking the Font button reveals the full font from which the note symbols have been selected. It is for interest only and cannot be used.

Note spacing

It is not important how far apart notes and other symbols are on the screen grid. Totally blank columns in any stave are ignored. The important thing is that notes which are to be played simultaneously as a chord are immediately in line with each other vertically in the relevant treble and bass clef staves. Each full stave consists of one treble and one base clef stave.

Tooltips

Hovering the mouse cursor over any option button causes a 'Tooltips' text box to appear, describing its basic function.

Scores accuracy and tuning files

All the author's test scores supplied with the software are those which he used during its development, and are supplied 'as is'. No claim is made about their accuracy in relation to the original scores. Indeed, he can hear some notes when played on the Polyphonium which he has obviously keyed in incorrectly. They can be amended if desired by musically knowledgable users.

Amongst the files available are various notes frequency test files. Loading and sending them to the PICs the said note is played continuously. A frequency counter can be used to check the frequency being generated.

The file names include the note and its octave. For example, Tuning1A01.txt generates Concert A, 440Hz.

Satisfaction

To say that the author is pleased with the Polyphonium designs would be an understatement. The five months of development has provided him with a very satisfying challenge. He finds the sounds produced by the test scores to be delightful. It is one of the most pleasing designs he has produced. It's completion leaves him with that feeling craved by all creative designers, a sense of wonder that 'I've done that'!

Next Month

In Part Two is a description of an LED Display Interface which can be used with the main Polyphonium control unit. It uses a block of LEDs arrange in 12 columns seven LEDs high, to show which note and its octave is being played.

As well as being useful, it also illustrates how the Polyphonium can be used to control external facilities, making use of the note, length and octave data provided by IC2 PORTB. The technique used here, and that used to generate the notes in the top octave generator, provide examples of how the data might control the mechanical features used on the fairground organs.

Acknowledgements

The author thanks those readers on our *Chat Zone* who helped with invaluable musical advice during the development of the Polyphonium, *CZ names*:

Alan Jones, ARB, Bob Lawrence, Grab, Joe, Mcclosda, PhilWarn, Scott2734. Thank you all.

Dusk and one of the many steam engines at the Great Dorset Steam Fair, gloriously lit by power from its own generator. Photo John Becker

PRACTICALLY SPEAKING

Robert Penfold looks at the Techniques of Actually Doing It!

THE two previous *Practically Speaking* articles covered building circuit boards and fitting them into the case. Here we move on to the wiring from the circuit board to components such as controls and sockets.

Modern construction techniques have tended to reduced the amount of hard wiring in projects, and in an extreme case there could be little or no additional wiring needed for completion. However, practically every project features at least a few wires and cables. With many projects there is an abundance of them.

While this aspect of electronic projects is not in the hi-tech category, it is perhaps slightly higher-tech than it might at first appear. The sheer number of different wires and cables that are available gives a clue to things being less straightforward than one would probably expect. There are dozens of different types listed in the larger electronic component catalogues.

This need for so many different types of cable is the result of the widely differing types of signal encountered in modern electronics. A cable that is capable of carrying very high currents is physically too thick and cumbersome for applications that involve minute currents. A thinner lead is adequate for low current applications and is a more practical solution. Neither of these is suitable for use in very high frequency applications, such as a television aerial down leads. There is no universal cable that suits all eventualities.

Hard wiring

When dealing with the hard wiring to printed circuit boards it is not usually necessary to resort to any of the more exotic cables. Ordinary connecting wire, which is also called hook-up or equipment wire, is normally all that is needed. This type of cable consists of a thin wire in a sleeve of plastic insulation.

Even with a type of cable as basic as this there are usually several types listed in electronic component catalogues. There are two main categories, and these are the single and multi-core varieties. The single-core type has the advantage of being easily formed into complex shapes, and retaining those shapes. This makes it easy to neatly run a wire from one point to another. Perhaps of greater importance, it also makes it much easier to run several wires side-by-side so that they act as what is effectively a single multi-way cable.

Despite having one or two potential advantages, single-core connecting wire is not used very much for the hard wiring in projects. Unfortunately, the wire is easily damaged when the plastic insulation is stripped away. Using proper wire strippers minimises the risk of the wire being nicked slightly, but does not completely remove the problem. Even a very minor nick tends to seriously weaken the wire at that point, probably causing it to break if there is any flexing of the wire.

Multi-strand

Multi-strand wire has what are typically about six to 12 very fine wires instead of one thicker wire. It is not impervious from the problem of the wires becoming damaged and breaking easily, but it is certainly far less susceptible to it. The multi-strand variety is the only type normally used for the hard wiring in electronic projects.

Equipment wire is produced in various thicknesses. Light-duty connecting wire is usually described as something like '10/0.1', which means that it has 10 strands of 0.1 millimetre diameter wire. Light-duty wire is only suitable for carrying currents of up to about 0.5 amps (500 milliamps), which is actually much higher than the maximum current found in most projects.

However, a medium-duty wire such as the popular 7/0.2 variety is probably a better choice for general project wiring. With a maximum current rating of about 1.5 amps, this type of connecting wire is suitable for a slightly wider range of projects. Also, its slightly larger diameter makes it a little easier to handle and use.

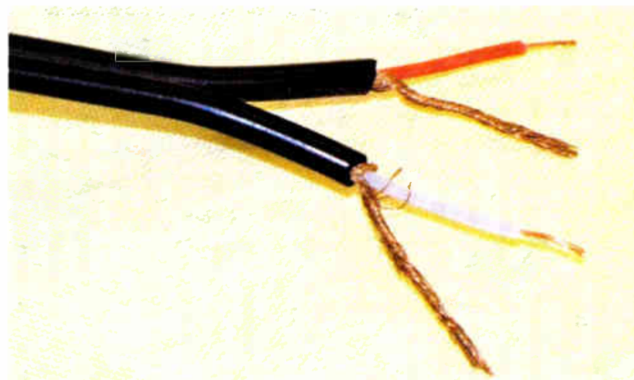


Fig.1: This type of twin screened lead is basically just two individual leads merged into a single cable. The alternative type has two inner conductors in an overall screen

Fig.2: Some coaxial cables have a screen that consists of copper foil and braided wires. The exposed foil must be removed so that the cable can be prepared in the normal way

Heavy-gauge

Heavy-gauge connecting wire is needed for some projects, such as power supply units and audio power amplifiers. These can operate using maximum currents of several amps. Using thinner connecting wires at such high currents could produce unacceptable voltage drops and could also result in overheating. This raises safety concerns, so it is essential to always use heavy-duty wire when large currents are involved. Using 24/0.2 wire can safely accommodate currents of up to 6 amps, which is adequate for most purposes.

From the electrical point of view it is acceptable to use heavy-duty equipment wires when only small currents are involved. However, heavy-duty connecting wire is relatively unwieldy and difficult to use. It is also likely to be more expensive than the thinner types. Therefore, only use heavy-duty connecting wire when high currents are involved.

Most catalogues only list one size of single-strand connecting wire, or none at all. The type you are most likely to encounter is 1/0.6 wire, which is adequate up to medium-duty applications. Any electronics component catalogue should also list a range of enamelled copper wires. The insulation on this type of wire is in the form of a very thin layer of what is basically just some lacquer. This can be scraped away using a penknife.

Enamelled copper wire has its uses, but it is unsuitable for hard wiring because of the ease with which the insulation is damaged. There is also tinned copper wire, which lacks any insulation. It is useful for link-wires on circuit boards, but is not used for hard wiring.

Ribbon cable

Where a multi-way cable is required it is possible to tie or tape together a number of individual insulated wires to make a suitable cable. An alternative is to settle for using a number of separate connecting wires.

A further alternative is to use some form of ready-made multi-way cable. Ribbon cable is a popular choice, and this type of cable has numerous insulated wires laid side by side and joined together. This produces a flat cable that usually has upwards of 10 wires.

There are two types of ribbon cable, one of which is specifically designed for use with solderless computer connectors. This cable is grey in colour apart from a red lead at one edge, and has the wires on a 0.05 inch pitch which matches that of the terminals on the connectors. While this type of ribbon cable is far from unusable in hard wiring applications, it is relatively difficult to use.

The second type of ribbon cable is essentially the same, but it is of heavier construction and the wires have insulation of different colours. This second point is important as it enables each wire to be easily identified. It is normally sold in 10- and 20-way varieties, but peeling off a section having the required number of wires is very easy.

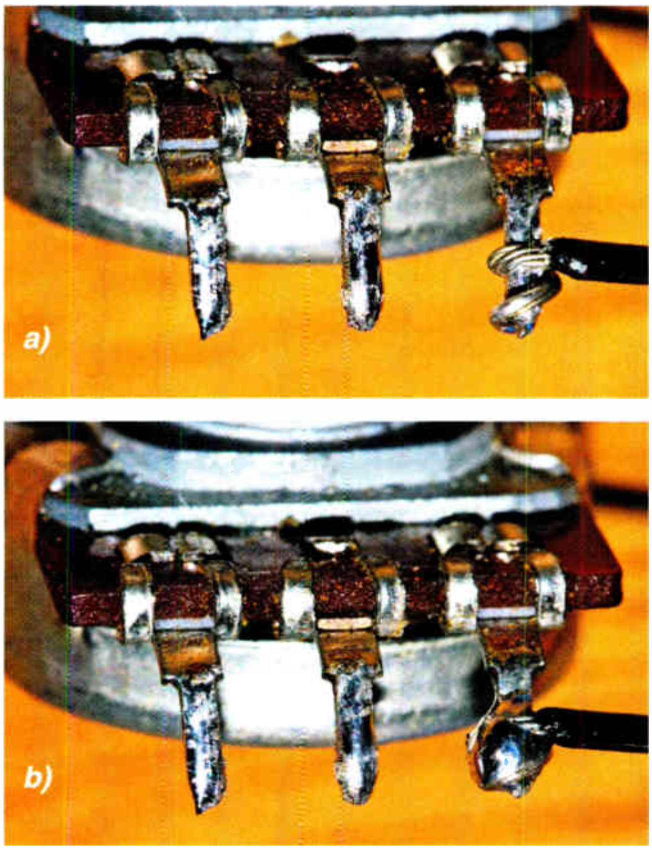


Fig.3: The bare wire is coiled around the pin (a) and then soldered in the usual way (b).

There is a potential problem with ribbon cable, and with multi-way cables made up from individual wires. Capacitance between the wires can sometimes result in signals being coupled from one wire to another. This is known as 'crosstalk', and in an extreme case it can prevent a project from working at all. Consequently, it is advisable not to merge a large number of wires into a single cable unless you are sure you know what you are doing.

Where applicable, wires at the input of a circuit should always be kept well isolated from those at the output. This helps to avoid problems with feedback. Using a separate piece of cable for each component is the safest approach, and will probably be the easiest way to do things anyway.

Screened leads

The internal wiring of some projects requires some 'screened cables'. Screened leads are used a great deal for external wiring, particularly in audio systems. Long audio cables tend to pick up electrical noise in general, and mains 'hum' in particular.

A screened cable has an ordinary insulated wire at its centre, but this is surrounded by some form of metal screen. Most often this is a number of fine wires that are wrapped around the insulation of the inner wire (a 'lapped' screen). The screen is sometimes more complex than this, with the wires woven into a braiding mesh.

Whether the screen is lapped or braided, an overall plastic sheath holds everything together. The basic idea is to have the screen carry the earth (ground) connection so that it acts as a barrier between the inner wire and the outside world. Electrical noise is prevented from reaching the inner conductor. The screen also prevents any signals from being radiated by the inner conductor wire.

There are twin screened leads for use with stereo signals, and there are two basic types. One type is really two separate screened cables having a common overall sheath (Fig.1).

Having separate screens ensures that there is no significant crosstalk. This characteristic is lost with the other type where the two inner conductors share a common screen, but crosstalk is unlikely to be a major problem with short leads.

Audio projects are often screened from the outside world by an earthed metal case, but it can still be necessary to use screened leads within a project. This can be necessary in order to screen sensitive leads from the mains 'hum' produced by an internal power supply, or to prevent problems with feedback.

Screened cables for use at high frequencies look like larger versions of audio cables, but they are designed to operate with a certain source and load impedance. They are generally called coaxial (or just 'coax') cables. However, strictly speaking practically all screened cables are coaxial types. If a project requires a specific type of screened cable, such as a 75-ohm coaxial cable or a special audio type, the article in question should provide full details.

Strip-down

When dealing with screened cables the first task is to remove a piece of the outer sheath from one end of the cable using ordinary wire strippers. Special heavy-duty strippers are needed for the thicker coaxial cables. A low-cost alternative is to use a modelling knife to make cuts on opposite sides of the sheath so that it can be peeled back and trimmed. Whatever method is used, try to avoid seriously damaging any of the fine wires in the screen.

Lapped cables are straightforward to deal with as the wires in the screen can be twisted together to form a short lead. The wires are then tinned with solder to prevent them from splaying. Finally, use wire strippers to remove a short piece of insulation from the inner conductor and tin the end of the wire with solder. The lead is then ready to be connected.

The same method works with some braided cables, but separating the wires in the braiding can sometimes be very difficult. It is then necessary to adopt a different approach. A generous amount of the outer sheath is removed, the braiding is pulled apart to produce a sizeable hole, and then the end of the inner cable is pulled out through the hole. This leaves a free section of braiding that can be twisted to form a lead.

The lack of flexibility in some of the larger coaxial cables makes this method unusable, but it should work well with any reasonably thin screened leads. Some coaxial cables have copper foil in addition to the braiding. With these the exposed foil is cut or torn away (Fig.2), and the cable is then prepared in the usual way.

Making connections

Adding the wiring to sockets, controls, etc., should be fairly straightforward, since an *EPE* project article has detailed diagrams and photographs to guide the constructor. Even so, there is still scope for errors to creep in with this aspect of construction, and due care needs to be taken.

Actually producing the connections is quite easy, but will benefit from some practice. The usual technique is to hook the end of the lead through and around the hole in the tag, apply the bit of the soldering iron, and then feed in some solder. As with any electrical soldering, ensure that the bit is applied to the joint *before* any solder is fed into the joint. This helps the solder to flow properly by ensuring that it is flows over hot metal. The solder tends to solidify too quickly if it is applied to cold surfaces. Where there is a pin rather than a tag, it is just a matter of coiling one or two turns of the wire around the pin (Fig.3a) and then completing the joint (Fig.3b).

Modern components are designed to make it easy to produce good quality connections, but there is no guarantee that the solder will always flow over the joint properly. Always tin tags and pins with solder before making connections. The ends of the leads should be given the same treatment.

With both surfaces properly tinned with solder there is little possibility of producing a 'dry' joint. If a surface is contaminated with dirt or corrosion it will not take a coating of solder. Scraping it with the blade of a penknife should clean away the contamination and permit the surface to be tinned properly.

EPE IS PLEASED TO BE ABLE TO OFFER YOU THESE

ELECTRONICS CD-ROMS

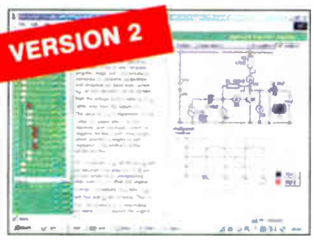
ELECTRONICS PROJECTS

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.

ELECTRONIC CIRCUITS & COMPONENTS V2.0

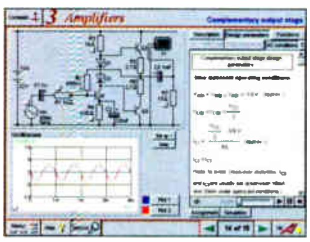
VERSION 2



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

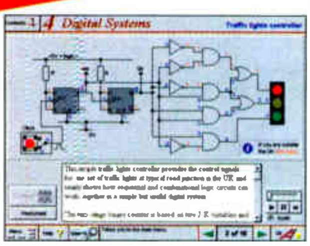


Complimentary output stage

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

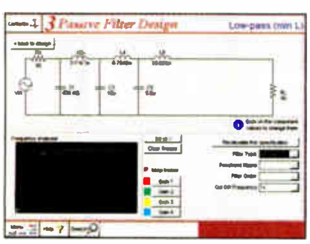
VERSION 2



Virtual laboratory – Traffic Lights

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.

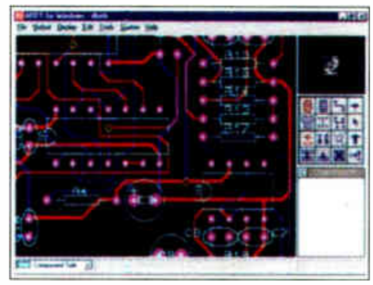
ANALOGUE FILTERS



Filter synthesis

Analogue 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

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.

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

PRICES

Prices for each of the CD-ROMs above are:

(Order form on third page)

Hobbyist/Student .... **£45 inc VAT**
Institutional (Schools/HE/FE/Industry) .... **£99 *plus* VAT**
Institutional 10 user (Network Licence) .... **£249 *plus* VAT**
Site Licence .... **£499 *plus* VAT**

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

PICmicro TUTORIALS AND PROGRAMMING

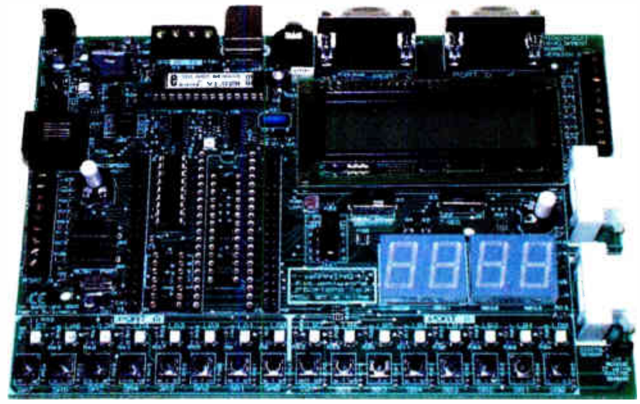
HARDWARE

VERSION 3 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 from the 12, 16 and 18 series PICmicro ranges. 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
- Supports low cost Flash-programmable PICmicro devices
- Fully featured integrated displays – 16 individual l.e.d.s, quad 7-segment display and alphanumeric l.c.d. display
- Supports PICmicro microcontrollers with A/D converters
- Fully protected expansion bus for project work
- USB programmable
- Can be powered by USB (no power supply required)



£158 including VAT and postage

supplied with USB cable and programming software

SOFTWARE

NEW

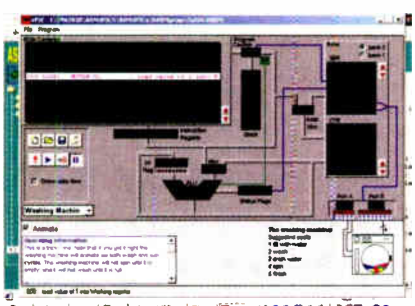
Suitable for use with the Development Board shown above.

ASSEMBLY FOR PICmicro V3

(Formerly PICtutor)

Assembly for PICmicro microcontrollers V3.0 (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 micro-controller. 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 45 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.



'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.

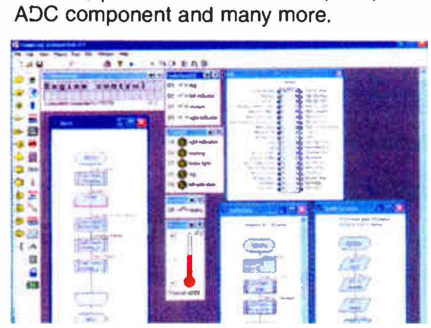
FLOWCODE FOR PICmicro V3

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 l.c.d. displays. The use of macros allows you to control these electronic devices without getting bogged down in understanding the programming.

Flowcode produces MPASM code which is compatible with virtually all PICmicro programmers. When used in conjunction with the Version 3 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 18, 28 and 40-pin devices ● New features in Version 3 include 16-bit arithmetic, strings and string manipulation, improved graphical user interface and printing, support for 18 series devices, pulse width modulation, I2C, new ADC component and many more.



PRICES

Prices for each of the CD-ROMs above are:

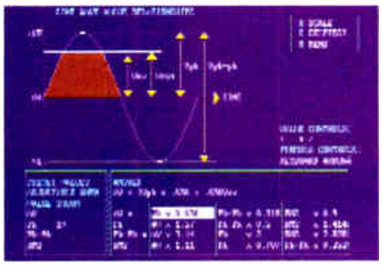
(Order form on next page)

Hobbyist/Student	**£45 inc VAT**
Institutional (Schools/HE/FE/Industry)	**£99 *plus* VAT**
Institutional/Professional 10 user (Network Licence)	**£300 *plus* VAT**
Site Licence	**£599 *plus* VAT**
Flowcode 10 user (Network Licence)	**£350 *plus* VAT**
Flowcode 50 user (Network Licence)	**£699 *plus* VAT**

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

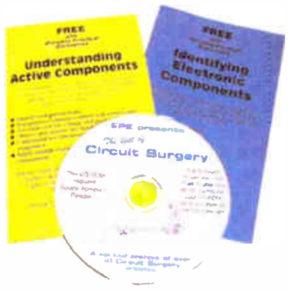
TEACH-IN 2000 – LEARN ELECTRONICS WITH EPE

EPE's own *Teach-In* CD-ROM, contains the full 12-part *Teach-In 2000* series by John Becker in PDF form plus the *Teach-In* interactive software (Win 95, 98, ME and above) 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

FREE TWO BOOKLETS PLUS CD-ROM WITH TEACH-IN 2000



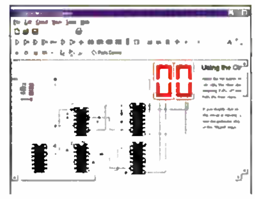
Each part has an associated practical section and the series includes a simple PC interface (Win 95, 98, ME **ONLY**) so you can use your PC as a basic oscilloscope with the various circuits.

A hands-on approach to electronics with numerous breadboard circuits to try out.

£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 – *Understanding Active Components* booklet, *Indentifying Electronic Components* booklet and *The Best Of Circuit Surgery* CDROM.

DIGITAL WORKS 3.0



Counter project

Digital Works Version 3.0 is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability ● Software for simulating digital logic circuits ●Create your own macros – highly scalable ●Create your own circuits, components, and i.c.s ●Easy-to-use digital interface ●Animation brings circuits to life ●Vast library of logic macros and 74 series i.c.s with data sheets ●Powerful tool for designing and learning.

Hobbyist/Student £45 inc. VAT.
Institutional £99 *plus* VAT.
Institutional 10 user £249 *plus* VAT.
Site Licence £599 *plus* VAT.

NEW

PROJECT DESIGN WITH CROCODILE TECHNOLOGY

An Interactive Guide to Circuit Design

An interactive CD-ROM to guide you through the process of circuit design. Choose from an extensive range of input, process and output modules, including CMOS Logic, Op-Amps, PIC/PICAXE, Remote Control Modules (IR and Radio), Transistors, Thyristors, Relays and much more.

Click Data for a complete guide to the pin layouts of i.c.s, transistors etc. Click More Information for detailed background information with many animated diagrams.

Nearly all the circuits can be instantly simulated in Crocodile Technology* (not included on the CD-ROM) and you can customise the designs as required.

Over 150 pages Over 600 images

WHAT'S INCLUDED

Light Modules, Temperature Modules, Sound Modules, Moisture Modules, Switch Modules, Astables including 555, Remote Control (IR & Radio), Transistor Amplifiers, Thyristor, Relay, Op-Amp Modules, Logic Modules, 555 Timer, PIC/PICAXE, Output Devices, Transistor Drivers, Relay Motor Direction & Speed Control, 7 Segment Displays. Data sections with pinouts etc., Example Projects, Full Search Facility, Further Background Information and Animated Diagrams.

Runs in Microsoft Internet Explorer

*All circuits can be viewed, but can only be simulated if your computer has Crocodile Technoloy version 410 or later. A free trial version of Crocodile Technology can be downloaded from: **www.crocodile-clips.com**. Animated diagrams run without Crocodile Technology.

Single User £39.00 inc. VAT.

Multiple Educational Users (under 500 students) £59.00 plus VAT. Over 500 students £79.00 plus VAT.

(UK and EU customers add VAT at 17·5% to "plus VAT" prices)

ELECTRONIC COMPONENTS PHOTOS

A high quality selection of over 200 JPG images of electronic components. This selection of high resolution photos can be used to enhance projects and presentations or to help with training and educational material. They are royalty free for use in commercial or personal printed projects, and can also be used royalty free in books, catalogues, magazine articles as well as worldwide web pages (subject to restrictions – see licence for full details).

Also contains a **FREE** 30-day evaluation of Paint Shop Pro 6 – Paint Shop Pro image editing tips and on-line help included!

Price £19.95 inc. VAT

Minimum system requirements for these CD-ROMs: Pentium PC, CD-ROM drive, 32MB RAM, 10MB hard disk space. Windows 95/98/NT/2000/ME/XP, mouse, sound card, web browser.

Please send me: # CD-ROM ORDER FORM

- ☐ Electronic Projects
- ☐ Electronic Circuits & Components V2.0
- ☐ Analogue Electronics
- ☐ Digital Electronics V2.0
- ☐ Analogue Filters
- ☐ Electronics CAD Pack
- ☐ Robotics & Mechatronics
- ☐ Assembly for PICmicro V3
- ☐ 'C' for PICmicro V2
- ☐ Flowcode V3 for PICmicro
- ☐ Digital Works 3.0

Version required:
- ☐ Hobbyist/Student
- ☐ Institutional
- ☐ Institutional/Professional 10 user
- ☐ Site licence

VISA   Diners Club International   Maestro

- ☐ PICmicro Development Board V3 (hardware)

- ☐ Teach-In 2000 + FREE BOOK
- ☐ Electronic Components Photos
- ☐ Project Design – Single User
- ☐ Project Design – Multiple User (under 500 students)
- ☐ Project Design – Multiple User (over 500 students)

Note: The software on each version is the same, only the licence for use varies.

Full name: . . . .

Address: . . . .

. . . . .Post code: . . . . .Tel. No: . . . .

Signature: . . . .

☐ I enclose cheque/PO in £ sterling payable to WIMBORNE PUBLISHING LTD for £

☐ Please charge my Visa/Mastercard/Amex/Diners Club/Maestro: £

Valid From: . . . . .Card expiry date: . . . .

Card No: . . . . Maestro Issue No. . . . .

Card Security Code . . . . (The last 3 digits on or just under the signature strip)

ORDERING
ALL PRICES INCLUDE UK POSTAGE

Student/Single User/Standard Version price includes postage to most countries in the world
EU residents outside the UK add £5 for airmail postage per order

Institutional, Multiple User and Deluxe Versions – overseas readers add £5 to the basic price of each order for airmail postage (**do not add VAT** unless you live in an EU (European Union) country, then add 17½% VAT or provide your official VAT registration number).

Send your order to:
Direct Book Service
Wimborne Publishing Ltd
408 Wimborne Road East
Ferndown, Dorset BH22 9ND

To order by phone ring
01202 873872. Fax: 01202 874562

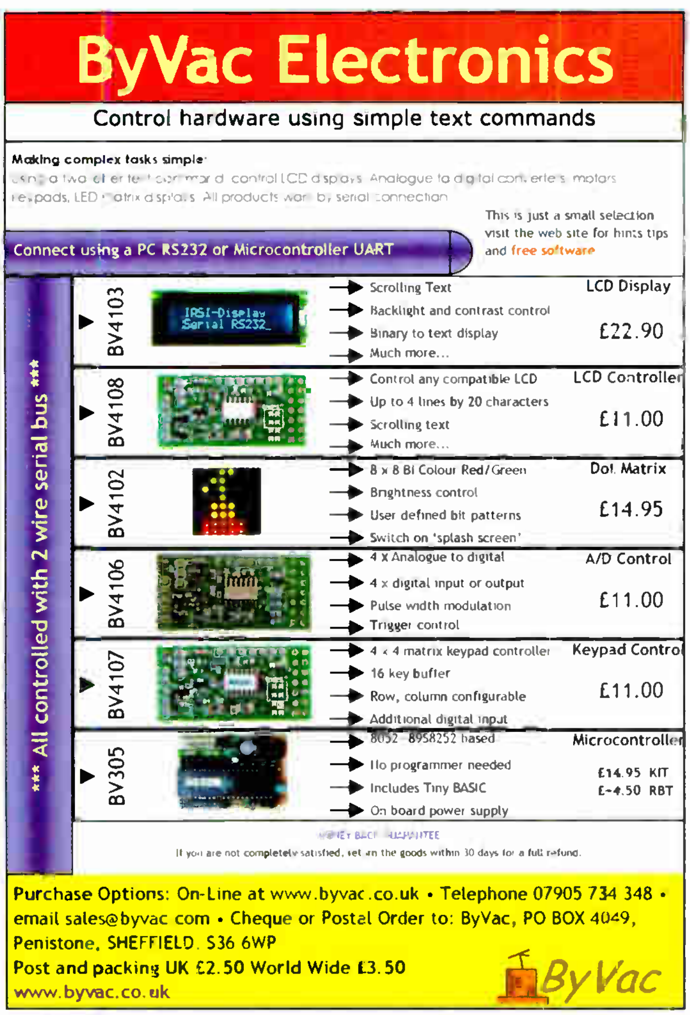
Goods are normally sent within seven days

E-mail: orders@wimborne.co.uk

Online shop:
www.epemag.wimborne.co.uk/shopdoor.htm

PCB-POOL®
SERVICING YOUR COMPLETE PROTOTYPE NEEDS
1 EUROCARD
(160 x 100 mm)
+ Tooling
+ Photoplots
+ VAT
€49
Price example
Any size and contour possible!
Optional:
• Soldermask
• Fast-turnaround
• Silkscreen
• 4-Layer Multilayer
• 6-Layer Multilayer
DOWNLOAD OUR
FREE LAYOUT SOFTWARE!
Over 18,000 Customers
LEAD FREE
Beta LAYOUT
Freephone
0800-3898560
Simply send your files and order ONLINE:
PCB-POOL.COM

PEAK
electronic design ltd
tel. 01298 70012
fax. 01298 70046
www.peakelec.co.uk
sales@peakelec.co.uk
Handheld Test Gear - Cool, Smart.
Atlas DCA
Semiconductor Analyser £55
Atlas LCR
Passive Component Analyser £79
Atlas ESR
Capacitance and ESR Meter £89
Atlas SCR
Triac/Thyristor Analyser £109
Prices include UK delivery and VAT



ByVac Electronics
Control hardware using simple text commands
Making complex tasks simple:
This is just a small selection visit the web site for hints tips and free software
Connect using a PC RS232 or Microcontroller UART
*** All controlled with 2 wire serial bus ***
BV4103 LCD Display £22.90 — Scrolling Text; Backlight and contrast control; Binary to text display; Much more...
BV4108 LCD Controller £11.00 — Control any compatible LCD; Up to 4 lines by 20 characters; Scrolling text; Much more...
BV4102 Dot Matrix £14.95 — 8 x 8 Bi Colour Red/Green; Brightness control; User defined bit patterns; Switch on 'splash screen'
BV4106 A/D Control £11.00 — 4 x Analogue to digital; 4 x digital input or output; Pulse width modulation; Trigger control
BV4107 Keypad Control £11.00 — 4 x 4 matrix keypad controller; 16 key buffer; Row, column configurable; Additional digital input
BV305 Microcontroller £14.95 KIT £-4.50 RBT — 8052 - 89S8252 based; No programmer needed; Includes Tiny BASIC; On board power supply
If you are not completely satisfied, return the goods within 30 days for a full refund.
Purchase Options: On-Line at www.byvac.co.uk • Telephone 07905 734 348 • email sales@byvac com • Cheque or Postal Order to: ByVac, PO BOX 4049, Penistone, SHEFFIELD. S36 6WP
Post and packing UK £2.50 World Wide £3.50
www.byvac.co.uk
ByVac

www.epemag.co.uk

ANDRE LAMOTHE'S
XGAMESTATION
LEARN STEP-BY-STEP HOW TO DESIGN AND BUILD YOUR OWN VIDEO GAME CONSOLE!
Design inspired by the Atari 800/2600, Sinclair ZX Spectrum, Apple II & Commodore 64!
Complete Package
eBook
Integrated IDE
SX52 CPU 80 MIPS!
OPEN SOURCE
FEATURES:
• Great for Hobbyists AND Students!
• Complete Software Development Kit!
• eBook on Designing the XGS Console!
• Parallax SX-Key Compatible!
• Fully Assembled XGS Micro Edition Unit!
• The Fun Way to Learn Embedded Systems!
PAL & NTSC COMPATIBLE!
WWW.XGAMESTATION.COM
SUPPORT@NURVE.NET | PH 925.736.2098 (USA)

By JIM ROWE

IR Remote Checker

Do your remote controls often fail? Is it due to dead batteries, poor contacts under the switch buttons or a more serious fault? How would you know if it was working anyway? Here is the answer – a Remote Control Checker. It lets you very easily check whether an infrared (IR) remote control is sending out a code when each of its buttons is pressed, so you can avoid opening the thing up for cleaning or repair if it 'ain't really broke'.

NOWADAYS, JUST ABOUT every item of home entertainment gear has its own remote control, so you can control its operation without ever having to get up from your easy chair – if you don't want to, that is. Most homes have plenty of remotes but in most cases their reliability isn't wonderful. Probably that's because they have to take quite a lot of physical pounding: easily dropped, squashed, kicked, trodden on, splashed with drink and otherwise abused.

When a remote fails completely, it's usually just a matter of replacing the battery and away it goes again for another year or two. But what about when replacing the battery doesn't fix it or one or two of the buttons seem to have stopped working? Then it can get a bit tricky and you want to be sure the

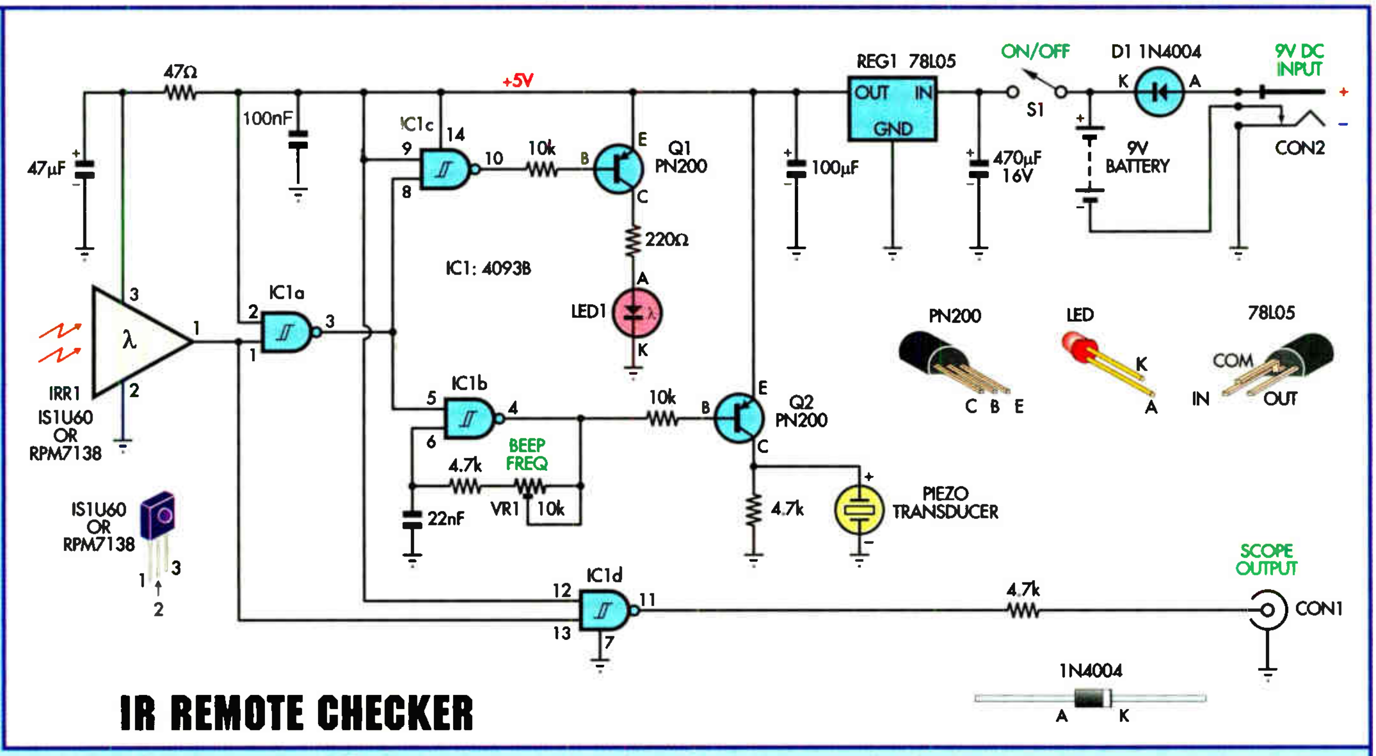


Fig.1: the complete circuit for the IR Remote Checker. Infrared pulses from the remote are picked up by sensor receiver IRR1 and fed to gate IC1a. IC1a then drives gates IC1b & IC1c which in turn activate the piezo transducer and LED1.

fault is in the remote rather than in the equipment it's supposed to control.

Unfortunately, most of the remotes made in the last few years don't seem to be made for easy access to the insides, without damaging the case. They're clipped together using a series of tiny lugs, moulded into the inside edges of the case top and bottom. The lugs can be hard to find from the outside and even harder to unclip without breaking one or more of them. So you don't want to open up a remote unless it's absolutely necessary.

The little IR Remote Checker described here is designed to help in such cases, letting you quickly find out whether or not any suspect buttons are sending out codes from the remote's IR LED. This will let you decide whether the fault is in the remote or in the equipment itself.

You simply point the remote's invisible output beam at the Checker's sensor window and then press the various buttons. If the sensor picks up any codes, it gives you immediate confirmation by flashing a visible LED and sounding a small piezo beeper.

The Checker can be operated from an internal 9V battery or an external DC plugpack power supply. As a bonus, it also provides an electrical copy of the control code pulses received from the remote, so you can feed them to a scope or logic analyser for further analysis. This would also make the Checker a handy tool for anyone developing custom remote controls.

The Checker uses only a handful of low-cost parts, all mounted on a small PC board which fits into a small plastic box. You should be able to assemble it in a couple of hours.

How it works

Fig.1 shows the circuit diagram of the IR Remote Checker. The infrared pulse trains from the remote are picked up by sensor/receiver IRR1, which strips them from their supersonic carrier signal (usually about 38kHz) and provides them as negative-going electrical pulses from its output pin 1. We feed these pulses to pin 1 of gate IC1a, used here as an inverting buffer. The output of IC1a then drives one input each of two further gates, IC1c and IC1b.

IC1c is also used as an inverter, to drive transistor Q1. Q1 is then used to switch current to LED1, so it flashes for the duration of each code pulse.

IC1b is used as an oscillator which is gated on by the pulses from IC1a. The oscillator's frequency is dependent on the 22nF capacitor and the total feedback resistance, so trimpot VR1 allows it to be adjusted over a reasonable range.

The output from the oscillator is used to drive transistor Q2, which in turn drives the piezo transducer with a 5V peak-to-peak waveform. The 4.7kΩ resistor across the transducer is used to provide a DC load for the transistor, and also to discharge the piezo transducer's capacitance between pulses. The idea of including trimpot VR1 is so that you can adjust the oscillator's frequency to match the transducer's resonant frequency, for maximum 'beep' output.

IC1's fourth gate (IC1d) is used as another inverting buffer, driven directly from the output of IRR1. The output of this inverter is then fed to output socket CON1, via a series 4.7kΩ resistor, to provide the IR Remote Checker's output pulses so they can be measured by an oscilloscope.

All of the IR Remote Checker's circuitry operates from +5V DC and draws very little current, even when

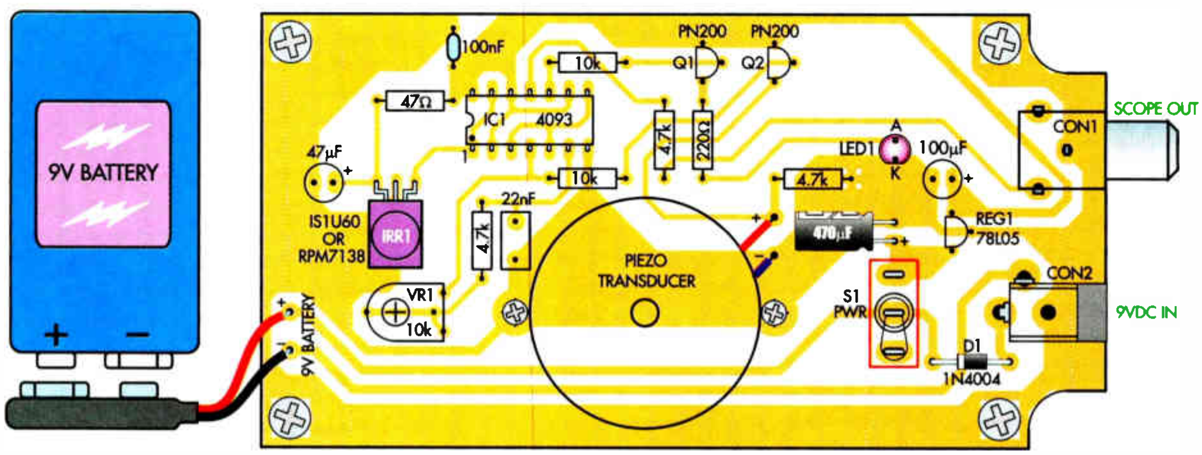


Fig.2: install the parts on the PC board as shown here, taking care to ensure that all polarised components go in the right way around. Note the mounting details for IRR1 and the 470µF electrolytic capacitor.

responding to IR pulses. The 5V supply is provided by regulator REG1, a low-power 78L05 device.

The raw input for REG1 is controlled by power switch S1 and comes from the internal 9V battery or from an external 9V DC plugpack. Diode D1 ensures that the circuit cannot be damaged if the plugpack's polarity is reversed.

Construction

Apart from the 9V battery, all of the components used in the Checker are mounted on a small PC board measuring 112 × 57mm and coded 608. The component overlay diagram is shown in Fig.2.

The board is designed to fit inside a standard size plastic box (130 × 67 x 34mm) and mounts on the rear of the box lid using four 15mm × M3 tapped spacers with eight M3 × 6mm long screws (4 × countersink head). The 9V battery is held in the bottom of the box using a length of gaffer tape. Both external connectors are accessed by holes in the end of the box, when it's assembled.

You should be able to see the location and orientation of all the components on the PC board from the internal photos and the overlay diagram of Fig.2. Note that the piezo transducer is attached to the top of the board near the centre, using M2 machine screws and nuts.

Begin the board assembly by fitting the two connectors to one end, see Fig.2. Then fit the four PC terminal pins, two of which go on the far end of the board for the battery lead connections. The other two go near the centre, for the piezo transducer leads.

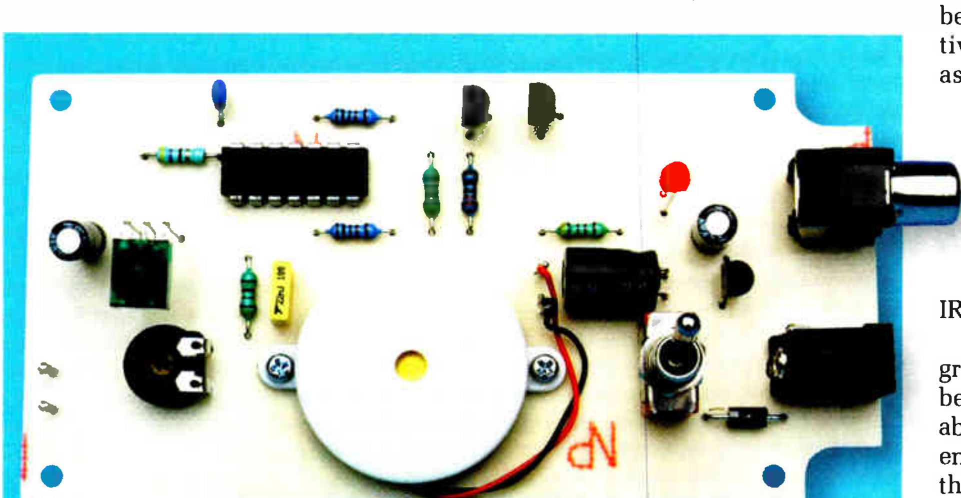
Next, fit toggle switch S1, which mounts with its connection lugs passing down through the matching slots in the board as far as they'll go, before soldering underneath. After this, fit trimpot VR1, near the battery terminal pins.

The resistors come next; all fit horizontally. Diode D1 fits in the same way just behind CON2, with its banded cathode end towards switch S1.

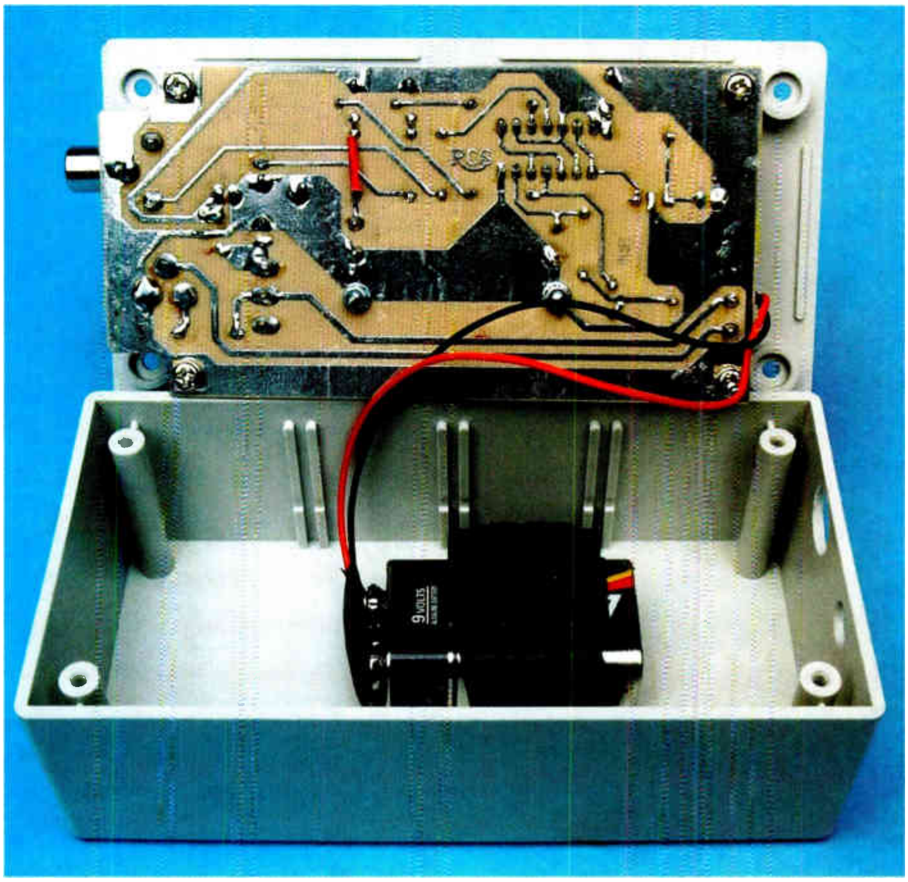
Now fit the capacitors. These all mount in the usual vertical fashion, except for the largest 470µF electrolytic, which is fitted lying on its side, with its leads bent down at 90° about 2mm from its body. Make sure you bend them the right way, so the positive lead ends up closer to switch S1 as shown. Watch the polarity of the other electrolytics too, as they are all polarised.

Regulator REG1 and the two transistors are fitted next, with all three having their leads cranked outwards to mate with the board holes. That done, fit the IR sensor device.

As shown in the photos and diagrams, this mounts with all three leads bent carefully downwards by 90°, about 2.5mm from its body. The very ends of the leads are then passed down through the matching board holes and soldered, so the sensor ends up facing directly upwards and with the top of its hemispherical lens 15.5mm above the board.



This view of the fully-assembled PC board shows just how easy the unit is to build. The sockets mount directly on the board, so the only external wiring is to the 9V battery.



The PC board is secured to the lid of the case using 15mm tapped spacers and M3 screws. Note that a prototype board is shown here (the wire link is not necessary on the final version).

Next fit the IC, making sure that it is mounted the correct way around as shown in Fig.2. Because it is a CMOS device, make sure you use an earthed soldering iron and earth yourself when you solder its pins to their pads, to avoid damage due to static discharge.

Mounting the piezo device

Now cut the two leads of the piezo transducer to about 50mm long, assuming you've already mounted the transducer itself to the board in the right position using the M2 screws and nuts. Then bare about 4mm of wire on the end of both leads, and carefully solder them to the two PC terminal pins just to the left of the 470μF electrolytic capacitor. The red positive lead should connect to the pin nearest to the 4.7kΩ resistor.

The LED can also be fitted at this stage, but not with both leads soldered. Solder only one lead to its pad with a bare minimum of solder, so it will be held in place temporarily until final positioning when the board is attached to the box lid.

The last step at this stage is to solder the battery-snap leads to the terminal pins on the end of the board, making sure that the red positive lead solders to the upper pin near IRR1.

Now prepare the box lid by cutting the various holes in it, as shown in the

Parts List

- 1 PC board, code 608, available from the *EPE PCB Service*, size 112 x 57mm
- 1 plastic utility box, 130 x 67 x 34mm
- 1 mini toggle switch, SPDT (S1)
- 1 PC-mount RCA socket (CON1)
- 1 PC-mount 2.5mm DC socket (CON2)
- 1 9V battery, 216 type
- 1 9V battery-snap lead
- 1 piezo transducer, 30mm dia. x 5mm high
- 4 PC board terminal pins, 1mm diameter
- 4 M3 x 15mm tapped spacers
- 4 M3 x 6mm machine screws, countersink head
- 4 M3 x 6mm machine screws, round head
- 2 M2 x 10mm machine screws, round head
- 2 M2 nuts with star-lock washers
- 1 10kΩ mini horizontal trimpot (VR1)

Semiconductors
- 1 IR receiver, RPM7138 or IS1U60 (IRR1)
- 1 4093B quad Schmitt NAND gate (IC1)
- 1 78L05 low power +5V voltage regulator (REG1)
- 2 PN200 PNP transistors (Q1, Q2)
- 1 3mm red LED (LED1)
- 1 1N4004 power diode (D1)

Capacitors
- 1 470μF 16V PC electrolytic
- 1 100μF 10V PC electrolytic
- 1 47μF 10V PC electrolytic
- 1 100nF (0.1μF) multilayer monolithic (code 100n or 104)
- 1 22nF (.022μF) MKT polyester (code 22n or 223)

Resistors (0.25W 1%)
- 2 10kΩ
- 1 220Ω
- 3 4.7kΩ
- 1 47Ω

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	220Ω	red red brown brown	red red black black brown
❑	1	47Ω	yellow violet black brown	yellow violet black gold brown

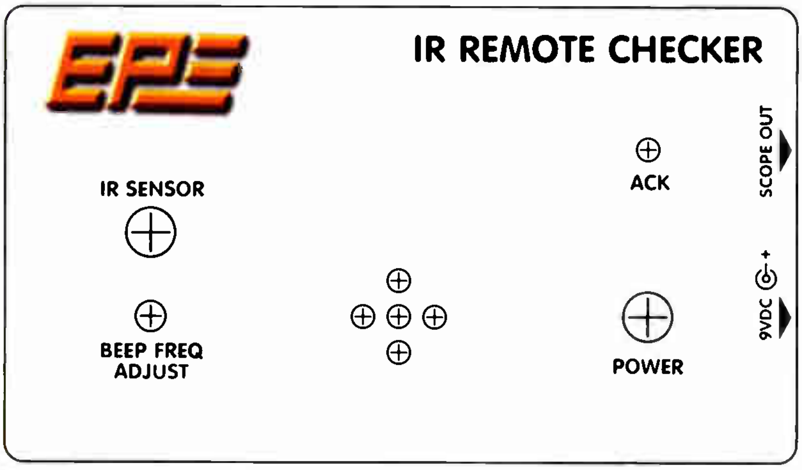


Fig.3: this full-size artwork can be photocopied onto an adhesive label and covered with clear 'Contact' film for a professional finish.

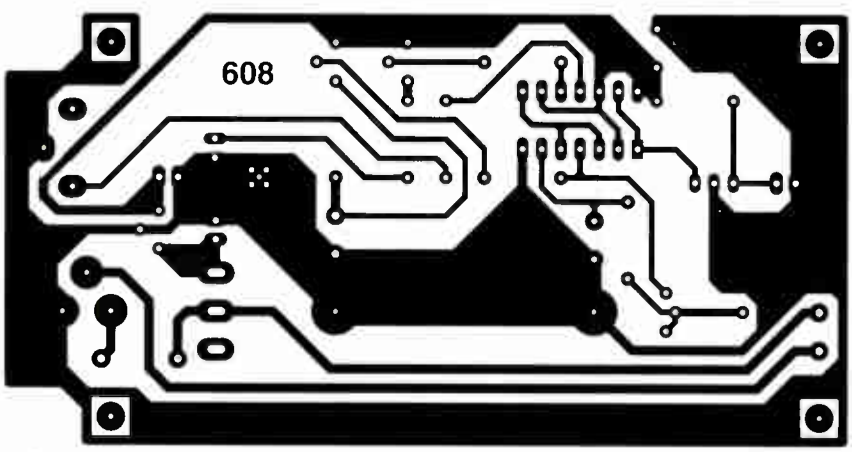


Fig.4: check your PC board against this full-size etching pattern before installing any of the parts.

drilling diagram of Fig.5. Note that the four outermost 3mm holes should be countersunk to allow for the heads of the board-mounting spacer screws.

While you're preparing the box lid you can also cut the two holes in the end of the box as well, for the access holes for CON1 and CON2. Remove any burrs which are left on the inside and outside of all holes in the box and lid to make a tidy job.

Once the lid has been prepared, attach the four board mounting spacers to the rear of it using the four countersunk-head M3 screws. Tighten these up quite firmly, so the top of each screw head is flush with the top surface of the lid itself. This will then allow you to stick on a front panel, made by photocopying the artwork (Fig.3) we've provided, onto an adhesive-backed label.

With the front panel attached, you can cover it with a piece of clear 'Contact' or similar adhesive film for protection. It is then just a matter of neatly cutting out holes in this double-layer panel escutcheon using a sharp hobby knife, to match the holes already cut in the lid underneath.

Mounting the PC board

The PC board assembly is mounted on four 15mm-long tapped M3 spacers behind the front panel, with the threaded ferrule of switch S1 passing through a matching 6.5mm hole. Check that IRR1's lens just touches the rear of the front panel and that it is in line with its 6.5mm 'viewing' hole. Once everything is in position, fasten the board to the spacers using four round-head M3 screws.

Now you can unsolder the temporary joint holding the LED in place on the board. This will allow you to slide it forward until its body just passes through the 3.5mm hole in the box lid/front panel immediately above. That done, you can solder both leads to their board pads permanently. Trim off any excess leads.

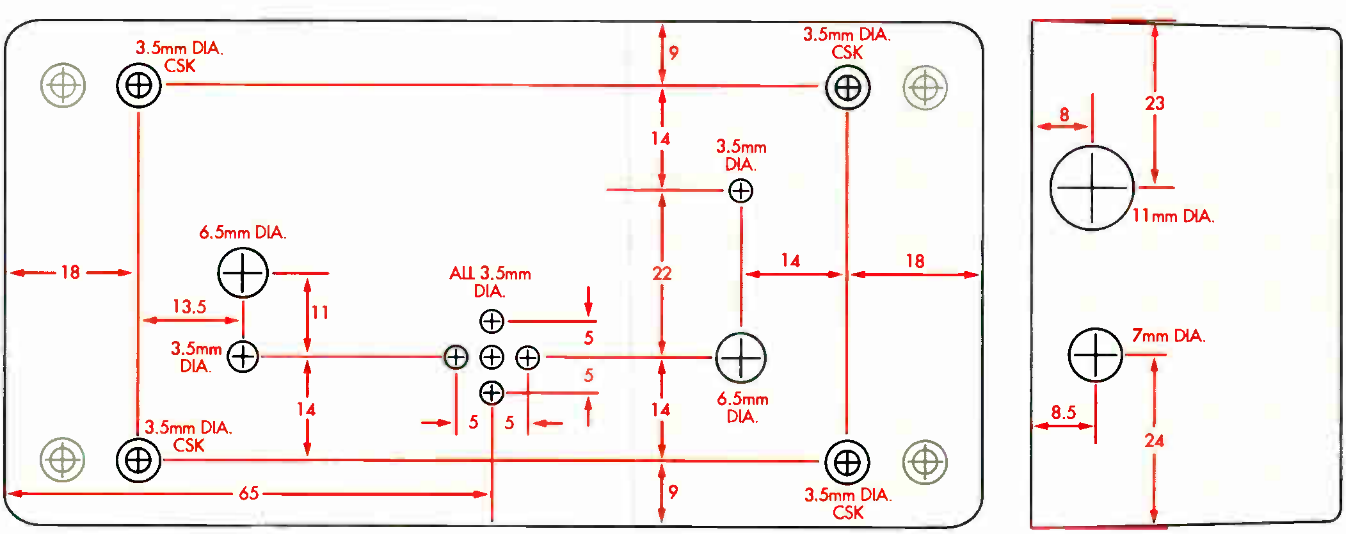


Fig.5: this diagram shows the drilling details for the case lid and for the end panel of the base.

Checkout time

Your IR Remote Checker should now be complete, apart from fitting it into the box and screwing it all together using the lid attachment screws. Before you do this, connect a 9V battery to the snap lead (or plug the output of a 9V DC plugpack into CON2, if you prefer).

That done, turn on switch S1, and you should notice a very brief flash of light from LED1.

Now bring an IR remote control (one that you know is working!) within a couple of metres of the IR Remote Checker, pointing it roughly at the IR sensor 'window'. Then try pressing any of the buttons on the remote and you should be rewarded with a series of flashes from LED1 and simultaneous beeps from the piezo transducer.

The pattern of flashes and beeps may change with the various buttons or they may all seem very similar – it depends on the coding used by the remote control concerned. But you should get a series of flashes and beeps when each button is pressed, if the remote is working correctly.

So if this is what you get, all that's left to do is the final assembly of the IR Remote Checker. Fit the 9V battery into the bottom of the box using a length of gaffer tape to hold it down, then manoeuvre the lid/PC board assembly into position by sliding the RCA phono connector (CON1) into its matching 11mm hole before swinging the assembly down into position.

Fit the four small self-tapping screws supplied with the box to hold it all together. Your IR Remote Checker will then be complete and ready for use.

Finally, you might want to adjust trimpot VR1 using a small screwdriver, with its shank passing down through the 'Beep Freq Adjust' hole in the front panel. As explained previously, this sets the Checker's oscillator frequency to match the resonant frequency of the piezo transducer, to give the loudest and clearest beeps. This adjustment can be done at any time and is basically a matter of taste.

Troubleshooting

Of course, if you are NOT rewarded with any flashes and beeps when you send IR codes to the Checker from a known good remote, you must have a fault in the Checker itself. In this case, you'll have to unscrew the PC board assembly from the box lid and start searching for the fault.

You may have fitted one of the polarised components (diode D1, electrolytic caps, transistors Q1 or Q2, LED1, REG1, IRR1 or IC1) the wrong way around, or accidentally left a component lead unsoldered. Or perhaps you've left a solder bridge shorting between two pads or tracks on the board, when you were soldering one of the component leads. It's really just a matter of searching for whatever your fault happens to be and then fixing it. ***EPE***

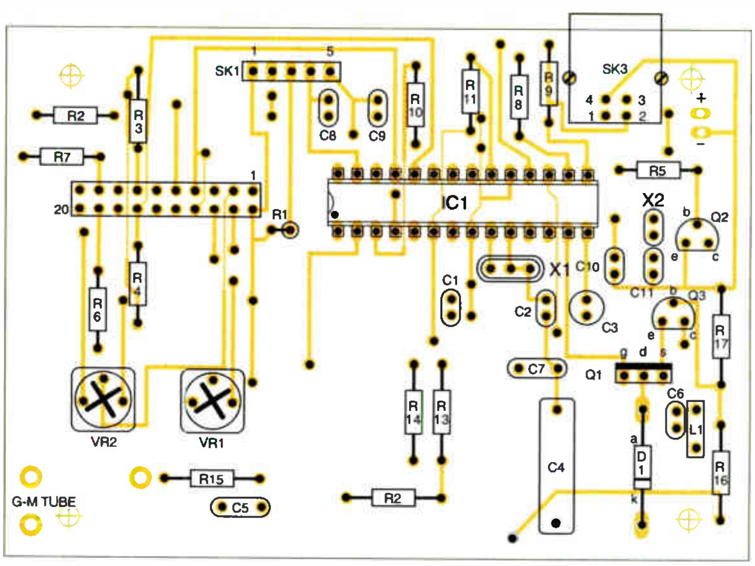
Reproduced by arrangement with
SILICON CHIP magazine 2007.
www.siliconchip.com.au

PLEASE TAKE NOTE

PIC Digital Geiger Counter PCB

Unfortunately the PCB overlay for the *PIC Digital Geiger Counter* in the February 2007 issue, page 14 Fig.2., is incorrect (it was an early version, not the final corrected artwork). The overlay shown opposite is correct as far as we are aware. The *EPE* PCB is not a plated through hole type so all the 'vias' need connecting through the board with short offcuts of wire, soldered both sides; some components also need soldering both sides. Provision has been made on the PCB for different size crystals and GM tube connections.

We apologise for any confusion caused by the artwork error.



EVERYDAY PRACTICAL ELECTRONICS

THE No1 UK MAGAZINE FOR ELECTRONICS TECHNOLOGY AND COMPUTER PROJECTS

BACK ISSUES

We can supply back issues of *EPE* by post, most issues from the past five years are available. An *EPE* index for the last five years is also available at **www.epemag.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 Jan. 99 are available on CD-ROM – see next page – and back issues from recent years are also available to download from **www.epemag.com**.

Please make sure all components are still available before commencing any project from a back-dated issue.

DID YOU MISS THESE?

NOV '05 Photocopies only

PROJECTS • Speed Camera Watch Mk2 • PIC Chromatone • Multi-Function R/C Switch • Noughts and Crosses Enigma • Weather Vane Repeater
FEATURES • Teach-In 2006 – Part 1 • Circuit Surgery • Back To Basics – 8 • Techno Talk • Practically Speaking • Ingenuity Unlimed • PIC 'N' Mix • NetWork – The Internet Page

DEC '05 Photocopies only

PROJECTS • Vehicle Frost Box Mk2 • Propeller Monitor • Solid-State Hammond • Solid State Valve Power Supply
FEATURES • Teach-In 2006 – Part 2 • Techno Talk • Viewing The Future • Circuit Surgery • Interface • PIC 'N' Mix • NetWork – The Internet Page

JAN '06 Photocopies only

PROJECTS • A "Tiptronic-Style" Gear Indicator • Sunset Switch • PIC Ambilux • Current Clamp Adapter For Multimeters
FEATURES • Teach-In 2006 – Part 3 • Circuit Surgery • Techno Talk • Practically Speaking • PIC 'N' Mix • NetWork – The Internet Page

FEB '06 Photocopies only

PROJECTS • Highly Flexible Keypad Alarm • Active 3-way Crossover • Status Monitor • Jazzy Heart.
FEATURES • Teach-In 2006 – Part 4 • Techno Talk • Circuit Surgery • Interface • PIC 'N' Mix • Network – The Internet Page

MAR '06 Photocopies only

PROJECTS • PortaPAL Public Address Amplifier – Part 1 • Telescope Interface • Power Up • Video – Audio Booster
FEATURES • Teach-In 2006 – Part 5 • Practically Speaking • Circuit Surgery • Techno Talk • PIC 'N' Mix • Net Work – The Internet Page

APR '06 Photocopies only

PROJECTS • A Programmable Continuity Tester • Omni Pendulum • PortaPAL Public Address Amplifier – Part 2 • 'Smart' Slave Flash Trigger
FEATURES • Teach-In 2006 – Part 6 • Consumer Electronics Show • E-Chip Review • Techno Talk • PIC-'N'-Mix • Net Work – The Internet Page

MAY '06

PROJECTS • LED Lighting For Your Car • Smart Card Reader and Programmer • Nail Sniffer and Volts Hound • Digital Reaction Timer.
FEATURES • Teach-In 2006 – Part 7 • Practically Speaking •Ingenuity Unlimited • Circuit Surgery • Techo Talk • PIC 'N' Mix • Net Work – The Internet Page

JUN '06

PROJECTS • Poor Man's Metal Locator • Widgy Box Distortion Effects For Your Guitar • Phone Ring & Test • Digital Instrument Display For Cars – Part 1.
FEATURES • Interface • Circuit Surgery • Ingenuity Unlimited • Techno Talk • PIC 'N' Mix • Teach-In 2006 – Part 8 • Net Work – The Internet Page

JUL '06 Photocopies only

PROJECTS • PIC Sudoku Unit • A Dirt Cheap High Current Bench Supply • PC Power Monitor • Digital Instrument Display For Cars – Part 2.
FEATURES • Teach-In 2006 – Part 9 • Ingenuity Unlimited • Practically Speaking • Circuit Surgery • Techno Talk • PIC 'N' MIX • Net Work – The Internet Page

AUG '06

PROJECTS • Loudspeaker Level Meter • Telephone Dialler for Burglar Alarms • Adjustable DC-DC Converter for Cars • High Intensity Torch
FEATURES • Circuit Surgery • Techno Talk • Teach-In 2006 – Part 10 • PIC 'N' Mix • Interface • Ingenuity Unlimited • Net Work – The Internet Page

SEPT '06

PROJECTS • Low Cost 50 MHz Frequency Meter • Smart Mixture Display for Your Car • Human Powered LED Torches • Water Level Gauge
FEATURES • Teach-In 2006 – Part 11 • Ingenuity Unlimited • Circuit Surgery • Techno Talk • PIC 'N' Mix • Practically Speaking • Net Work – The Internet Page

OCT '06

PROJECTS • Studio 350 Power Amplifier - Part 1 • Fridge Door-Open Alarm • Through-Glass Alarm • Linear Supply for 1W Star LEDs
FEATURES • Ingenuity Unlimited • Circuit Surgery • Techno Talk • PIC 'N' Mix • Interface • Net Work – The Internet Page

NOV '06

PROJECTS • Giant LED Message Display • Micropower Battery Protector • Quick Brake • Studio 350 Power Amplifier – Part 2
FEATURES • C For PICs – Part 1 • Ingenuity Unlimited • Circuit Surgery • Techno Talk • PIC 'N' Mix • Practically Speaking • Net Work – The Internet Page

DEC '06

PROJECTS • USB Power Injector • RGB To Component Video Converter • Lapel Microphone Adaptor For PA Systems • Mind Trainer
FEATURES • C For PICs – Part 2 • Circuit Surgery • Interface • Ingenuity Unlimited • Techno Talk • PIC 'N' Mix • Net Work – The Internet Page

JAN '07

PROJECTS • Balanced Microphone Preamp • Jumping Spider • High Efficiency Power Supply For 1W Luxeon Star LEDs • Charger For Deep-Cycle 12V Batteries – Part 1
FEATURES • C For PICs – Part 3 • Circuit Surgery • Practically Speaking • Techno Talk • PIC 'N' Mix • Net Work – The Internet Page

FEB '07

PROJECTS • PIC Digital Geiger Counter • Courtesy Light Delay • Programmable Robot • Charger for Deep Cycle 12V Batteries – Part 2
FEATURES • C For PICs – Part 4 • Techno Talk • PIC 'N' Mix • Interface • ISngenuity Unlimited • Circuit Surgery • Net Work – The Internet Page

BACK ISSUES ONLY £4.00 each inc. UK p&p.
Overseas prices £4.75 each surface mail, £5.75 each airmail.

We can also supply issues from earlier years: 2001 (except Feb., May, Aug. to Nov.), 2002 (except Feb., June, Aug. to Nov.), 2003 (except June), 2004 (except June, July, Oct. and Dec.), 2005 (except Feb., Nov., Dec.), 2006 (except Jan., Feb., Mar., Apr. and July). Where we do not have an issue a photocopy of any ***one article*** or ***one part*** of a series can be provided at the same price.

ORDER FORM – BACK ISSUES – PHOTOCOPIES– INDEXES

☐ Send back issues dated ....

☐ Send photocopies of (article title and issue date) ....

☐ Send copies of last five years indexes (£4.00 for five inc. p&p – Overseas £4.75 surface, £5.75 airmail)

Name ....

Address ....

.... Tel: ....

☐ I enclose cheque/P.O./bank draft to the value of £ ....

☐ Please charge my Visa/Mastercard/Amex/Diners Club/Maestro £ ....

Card No. .... Maestro Issue No ....

Valid From .... Card Expiry Date .... Card Security Code ....
(The last 3 digits on or just under the signature strip)

SEND TO: **Everyday Practical Electronics, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND.**
Tel: 01202 873872. Fax: 01202 874562.

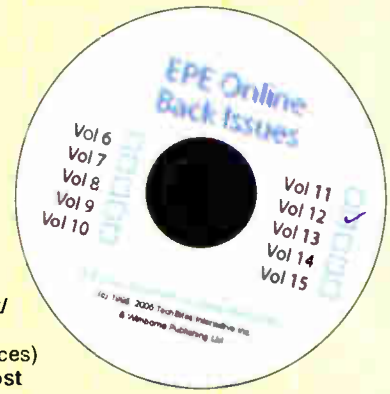
E-mail: orders@epemag.wimborne.co.uk **On-line Shop:** www.epemag.wimborne.co.uk/shopdoor.htm
Payments must be in £ sterling – cheque or bank draft drawn on a UK bank. Normally supplied within seven days of receipt of order.
Send a copy of this form, or order by letter if you do not wish to cut your issue.

M03/07

STORE YOUR BACK ISSUES ON CD-ROMS

VOL 15 NOW AVAILABLE

ONLY £14.45 each including VAT and p&p



A great way to buy *EPE* Back Issues – our CD-ROMs contain back issues from our *EPE Online* website plus bonus articles, all the relevant PIC software and web links. Note: no free gifts are included. All this for just £14.45 each including postage and packing.

VOL 1: BACK ISSUES – January 1999 to June 1999
Plus some bonus material from Nov and Dec 1998
VOL 2: BACK ISSUES – July 1999 to December 1999
VOL 3: BACK ISSUES – January 2000 to June 2000
VOL 4: BACK ISSUES – July 2000 to December 2000
VOL 5: BACK ISSUES – January 2001 to June 2001
VOL 6: BACK ISSUES – July 2001 to December 2001
VOL 7: BACK ISSUES – January 2002 to June 2002
VOL 8: BACK ISSUES – July 2002 to December 2002
VOL 9: BACK ISSUES – January 2003 to June 2003
VOL 10: BACK ISSUES – July 2003 to December 2003
VOL 11: BACK ISSUES – January 2004 to June 2004
VOL 12: BACK ISSUES – July 2004 to December 2004
VOL 13: BACK ISSUES – January 2005 to June 2005
VOL 14: BACK ISSUES – July 2005 to December 2005
VOL 15: BACK ISSUES – January 2006 to June 2006

NOTE: These CD-ROMs are suitable for use on any PC with a CD-ROM drive. They require Adobe Acrobat Reader (available free from the Internet – **www.adobe.com/acrobat**)

WHAT IS INCLUDED

All volumes include the *EPE Online* editorial content of every listed issue, plus all the available **PIC Project Codes** for the PIC projects published in those issues. Please note that we are unable to answer technical queries or provide data on articles that are more than five years old. Please also ensure that all components are still available before commencing construction of a project from a back issue.
Note: Some supplements etc. can be downloaded free from the Library on the *EPE Online* website at **www.epemag.com**.
No advertisements are included in Volumes 1 and 2; from Volume 5 onwards the available relevant software for *Interface* articles is also included.

EXTRA ARTICLES – ON ALL VOLUMES

BASIC SOLDERING GUIDE – Alan Winstanley's internationally acclaimed fully illustrated guide. **UNDERSTANDING PASSIVE COMPONENTS** – Introduction to the basic principles of passive components. **HOW TO USE INTELLIGENT L.C.Ds**, by Julyan Ilett – An utterly practical guide to interfacing and programming intelligent liquid crystal display modules. **PhyzzyB COMPUTERS BONUS ARTICLE 1** – Signed and Unsigned Binary Numbers. By Clive "Max" Maxfield and Alvin Brown. **PhyzzyB COMPUTERS BONUS ARTICLE 2** – Creating an Event Counter. By Clive "Max" Maxfield and Alvin Brown. **INTERGRAPH COMPUTER SYSTEMS 3D GRAPHICS** – A chapter from Intergraph's book that explains computer graphics technology. **FROM RUSSIA WITH LOVE,** by Barry Fox – Russian rockets launching American Satellites. **PC ENGINES,** by Ernest Flint – The evolution of Intel's microprocessors. **THE END TO ALL DISEASE,** by Aubrey Scoon – The original work of Rife. **COLLECTING AND RESTORING VINTAGE RADIOS,** by Paul Stenning. **THE LIFE & WORKS OF KONRAD ZUSE** – a brilliant pioneer in the evolution of computers.
Note: Some of the **EXTRA ARTICLES** require WinZip to unzip them.

Order on-line from
www.epemag.wimborne.co.uk/shopdoor.htm
or www.epemag.com (USA $ prices)
or by phone, Fax, E-mail or Post

BACK ISSUES CD-ROM ORDER FORM

Please send me the following Back Issue CD-ROMs. Volume Numbers:. . . . .

. . . .

. . . .

Price £14.45 each – includes postage to anywhere in the world.

Name . . . .

Address . . . .

. . . .

. . . . Post Code . . . .

☐ I enclose cheque/P.O./bank draft to the value of £ . . . .

☐ Please charge my Visa/Mastercard/Amex/Diners Club/Maestro

£ . . . .

Card No. . . . .

Card Security Code . . . . (The last 3 digits on or just under the signature strip)

Valid From . . . . .Expiry Date . . . .

Maestro Issue No. . . . .

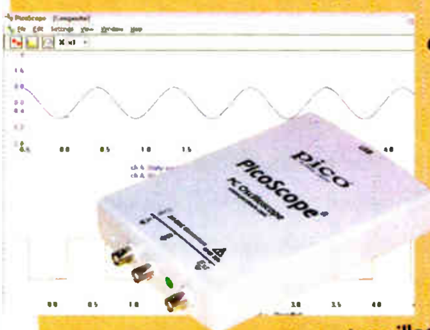
SEND TO: **Everyday Practical Electronics, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND.**

Tel: 01202 873872. Fax: 01202 874562.
E-mail: orders@epemag.wimborne.co.uk

Payments must be by card or in £ Sterling – cheque or bank draft drawn on a UK bank.
Normally supplied within seven days of receipt of order.

Ingenuity Unlimited

WIN A PICO PC-BASED OSCILLOSCOPE WORTH £586



- 5GS/s Dual Channel Storage Oscilloscope
- 50MHz Spectrum Analyser
- Multimeter
- Frequency Meter
- USB Interface.

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 a PicoScope 3205 digital storage oscilloscope for the best IU submission. In addition a DrDAQ Data Logger/Scope worth £59 will be presented to the runner up.

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 published or 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 include a full circuit diagram showing all 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 email.) Your ideas could earn you some cash **and a prize!**

2-Wire LEDs Driver – *Colourfully Simple*

IN this circuit, multiple pairs of LEDs are independently controlled and driven with just two wires. The author had a number of LEDs in different locations in a building, driven by the same pair of wires from his system. The time came when he needed to indicate two different states by means of two LEDs in each location, when either, neither, or both would be on. But he only had one pair of wires.

Circuit details

In Fig.1, an oscillator, formed from two NOR gates, IC1b and IC1c, provides anti-phase square waves at around 130Hz. These are used to gate the non-inverting inputs to two op amps, IC2a and IC2b, chosen for their high output current handling capabilities.

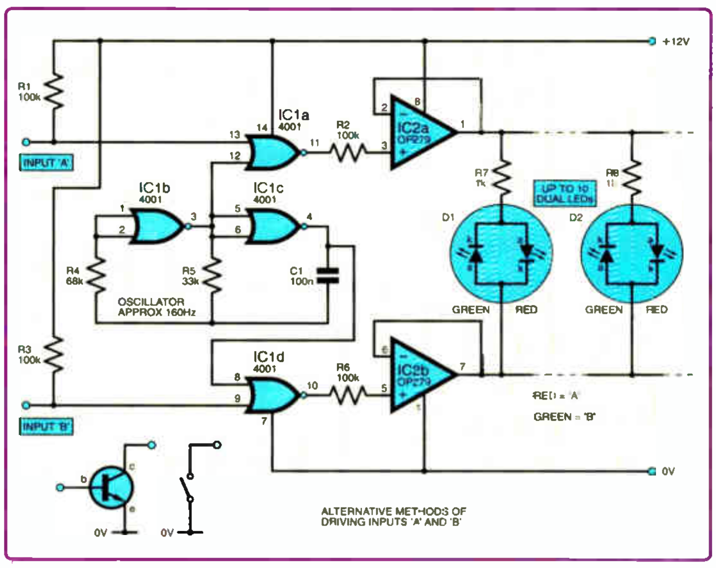
When input A is low, the output of IC1a at pin 11 will be high when input pin 12 is also low, the op amp output at IC2a pin 1 will then be high. However, when IC1a pin 12 is low, so IC1d input pin 8 will be high, and IC1d output pin 10 will be low. This will make op amp IC2b pin 7 low. Therefore, the red LED of the bi-colour LED pairs, D1 etc, will be on.

Conversely, if input B is taken low, the green LEDs will illuminate. Because the oscillator frequency is around 130Hz, no flicker will be seen.

Two possible schemes for driving the inputs are shown in the circuit diagram. The transistor also could be replaced by a digital output (for example, from a PIC), while the switch might be either a toggle switch, or a relay. It was chosen not to use transistors instead of the op amps because the op amps provide protection against short-circuits on their outputs.

If such a high current is not required, a more common dual op amp may be substituted in place of the OP279.

Steve Roberts, Bude, Cornwall



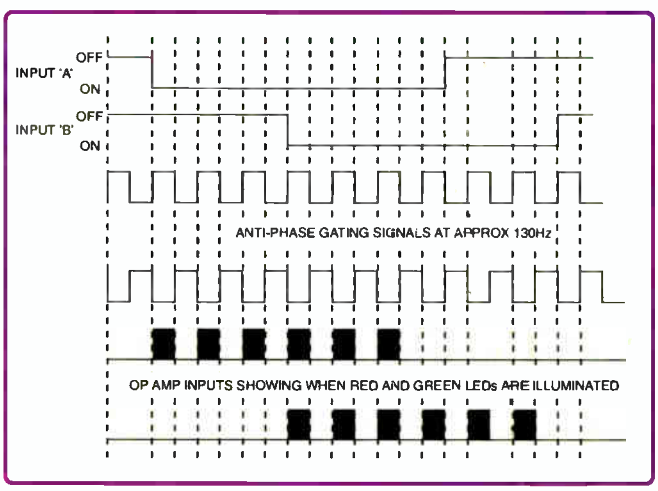


Fig.1. Circuit diagram and waveforms for the 2-wire LEDs Driver

Switched-Capacitor Sinewave Generator – *Sine of the times*

THIS circuit converts a square wave into a sinewave, which is at 1/100th of the original frequency. The output frequency ranges from 0.1Hz to 30kHz using the popular MF10 switched-capacitor filter device, or 0.1Hz to 50kHz using the LMF100 chip.

A square wave can be converted into a sinewave by a low pass filter tuned to the same frequency. Unfortunately, if the square wave frequency is changed then the filter must be retuned as well. Using a traditional active filter this is prohibitively complicated because the values of a large number of resistors and capacitors need to be tuned simultaneously.

A neat solution is a switchedcapacitor filter device such as National Semiconductor's MF10 integrated circuit (IC). In this chip, traditional op amp integrators are replaced by on-chip capacitors and clocked switches as shown in Fig.2.

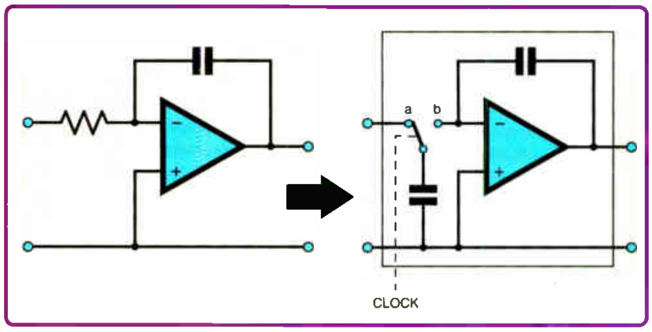


Fig.2. Traditional op amp integrator (left) and its capacitor/clocked switched filter (right)

When the analogue switch is in position 'a' the input capacitor charges to the input voltage. When the switch changes to position 'b' the charge is transferred to the op amp capacitor. The result is an integrator whose speed is determined by the clock frequency. This allows several integrators to be tuned by the same variable clock rather than by changing many resistors and capacitors.

The MF10 contains two separate second-order filters. In Fig.3 the two filters are connected in series in the datasheet's Mode 1 to provide a 4th order filter with a centre frequency 1/50th of the clock frequency on pins 10 and 11. IC1, a 74HC390 dual decade counter, divides the MF10 clock by 50 to give a square wave at the centre frequency. This is fed into the MF10 via resistor R1, which has a higher value than the other resistors in order to avoid over-driving the filter, leading to clipping.

A spare section of IC1 divides the input clock by two to give a 50% mark-space ratio clock for the MF10, giving a divide-by-100 overall. The sine wave is available at pins 19 and 20 of IC2. Here pin 19, the Bandpass Output, is used because this filters out the DC offset from the input clock.

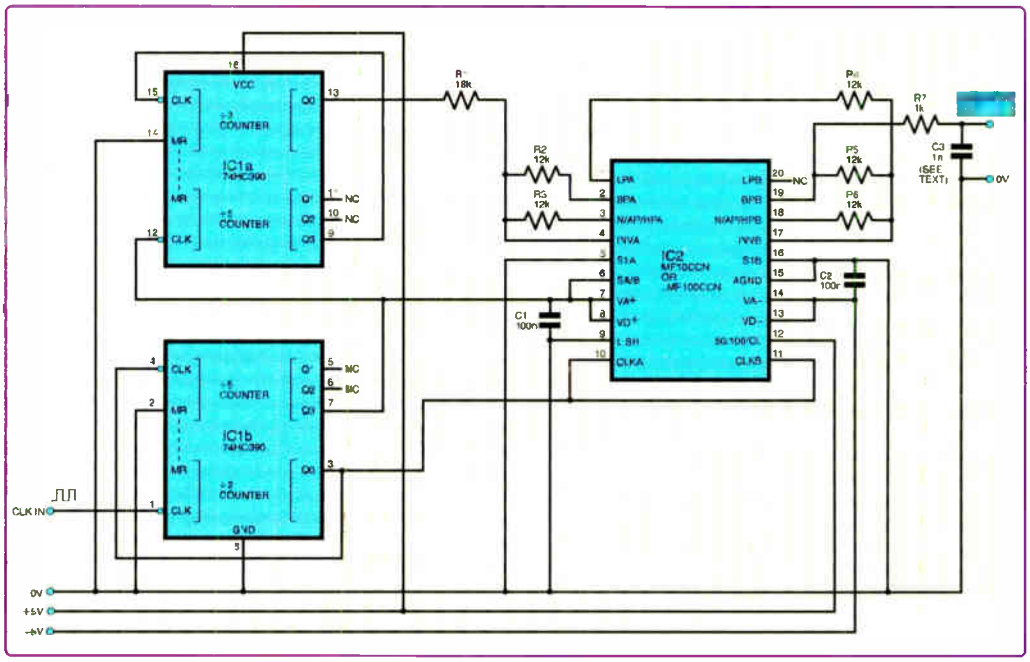


Fig.3. Complete circuit diagram for the Switched Capacitor Sinewave Generator

An oscilloscope will show the sinewave to have discrete switching steps caused by the clock. Resistor R7 and capacitor C3 filter out the clock frequency to give a smooth waveform. However, the switching noise will be more apparent at lower frequencies, so it may be desirable to increase the value of C3 in low frequency applications.

Several variations on the theme are possible. Tying IC2 pin 12 to 0V changes the centre frequency to 1/100th of the clock. Adjusting the IC1 divider likewise would give a finer quality sinewave, but a lower maximum frequency. Also, the MF10 can operate from a single 10V supply instead of split 5V supplies. Readers are referred to the chip's datasheet for details, obtainable via National Semiconductor's site at **www.national.com**.

The CCN suffix in the type number for IC2 refers to the dual-in-line package normally preferred by hobbyists.

Rob S, Kenilworth

Circuit Surgery

Ian Bell

A Brief Guide To Counters

IN the past, *Circuit Surgery* received a large number of letters from readers, but this is no longer the case as it is now more common for readers to post queries on the *EPE Chat Zone* (**www.chatzones.co.uk**). As you may have noticed, most recent *Circuit Surgery* articles have been based on *Chat Zone* questions. However, we do still occasionally get letters and have recently received a query from ***Edward Bibby*** of Warrington on the subject of the CD4029 CMOS counter IC. This had been recommended to him for a project he was working on. He described how he was not able to get it to operate correctly in all its modes.

Edward did not provide many details, so we cannot provide a definite reason for this, but we will discuss some general reasons why digital ICs may fail, or seem to fail, to work as expected when tried out on a breadboard. We will then have a look at counter circuits in general, with particular reference to the 4029 (but much of the discussion in this section applies to numerous counters IC and not just to the 4029).

Datasheet websites

One reason why a device may appear to fail is that you simply do not know enough about it to use it correctly. With basic logic devices such as 4000 series counters, it is often possible to guess the operation and suitable circuit configuration just by looking at the pinout details, but this may not work, particularly if your source of the pinout did not accurately define if the inputs and outputs are active high or active low.

When experimenting with a new device you should always try to get a copy of the datasheet first. These are available from various manufacturer's websites. For 'generic' and commonly second-source ICs, such as basic logic and some op amps, it is worth trying the following sites (try the first three in particular for 4000 series digital and similar devices). For single-source components you obviously need to go to the specific manufacturer's website.

Texas Instruments **www.ti.com**

NXP (previously Philips Semiconductor) **ww.nxp.com**

National Semiconductor **www.national.com**

Maxim **www.maxim-ic.com**

Analog Devices **www.analog.com**

Linear Technology **www.linear.com**

ST Microelectronics **www.st.com**

For 4000 series devices try searching for just the number (e.g. 4029 or with common prefixes such as CD4029 or HEF4029). If this does not work, manufacturers' websites often have 'product trees' where you can click on links to narrow down your choice, or enter required specification via a form.

You can also try searching using Google or other search engines using the IC's number and the word 'datasheet' in the search box. It is often possible to get more than one different datasheet for the same device from different manufactures. This is often worth checking as some datasheets are better than others in terms of detail, and even accuracy – as discussed recently on the *Chat Zone* forum.

Device status

Another thing that is worth checking on manufacturers' websites is the status of the device, that is, whether it is regarded as obsolete or not. Of course, this is far less important for the hobbyist than a commercial designer (particularly if you have plenty of the devices in your 'junk box'!). However, it is worth bearing in mind that obsolete devices may be (or become) difficult to get hold of, which may affect you if you want to build another copy of your project, pass the idea on to others, or even publish it. The 4029 has an active status from Texas Instruments but it has been discontinued or made obsolete by National Semiconductor and NXP (Philips). So it looks like the 4029 may be on the way out and alternatives should be considered for new projects.

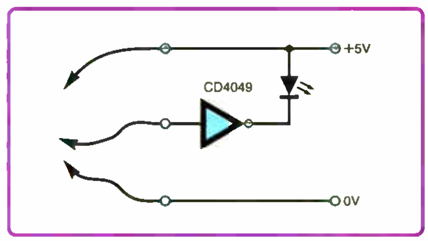


Fig.2. Circuit for experiment. (see text)

The product selection systems on manufacturers' web sites can be used to find alternatives to obsolete devices, or simply to identify the best device for a project idea. Fig.1 illustrates this process. This is a screen shot from the excellent (easy to use) product selector for NXP's web site. Here we have used the parametric filter to identify BCD CMOS counters. Two devices meet these criteria, the 74HC160 and the HEF4518B.

To get to this page select 'Logic' from the 'Products' menu on the NXP home page and then click on the 'counters' link under the list of product functions. This will take you to the selection filter and you start to narrow in on the appropriate device.

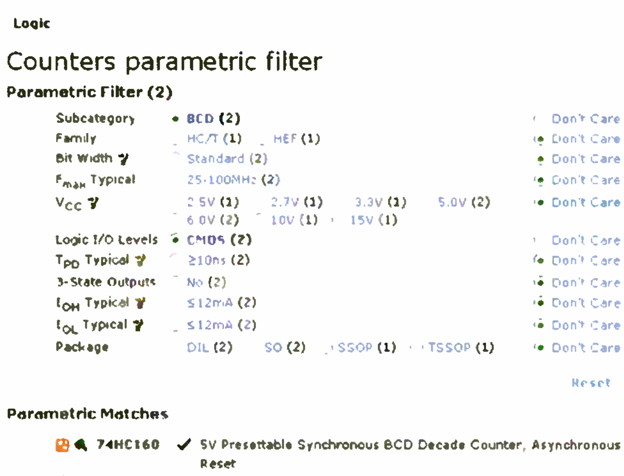


Fig.1. Using on-line product selection to find the right IC. This is a screenshot of part of a page from NXP's site.

Breadboarding

Once you have the datasheet and understand how to use the device you may want to try out some circuit ideas, probably using a solderless breadboard. There are some potential pitfalls here even with very simple logic chips. The following experiment can demonstrate the apparently erratic behaviour of CMOS digital ICs which can occur if unused inputs are not connected, or if 'flying leads' are used to investigate a device using a breadboarded circuit.

Use a CD4049 inverter chip with an LED connected directly to one of its output pins as shown in Fig.2. Wire this up on a solderless breadboard. Note that for the LED to be on (the inverter output low), the appropriate inverter's input must be high. If you operate this circuit at much more than +5V (4000-series CMOS will run at up to +15V) then you would need an LED series resistor. We can exploit the output V-I characteristics of the 4049 to obviate the use of a series resistor with the LED at +5V.

Connect a flying lead to the inverter's input so that the other end stands out in 'mid-air'. Two more flying leads connect to the breadboard, at +5V and 0V, so that there are three wires sticking out from the breadboard. Grasp the insulation of the +5V flying lead and briefly touch it to the inverter input wire. Release it, then do the same with the 0V lead, touching this briefly to the inverter input lead. For best results, keep your own hand well away from the inverter input wire, and obviously avoid connecting the +5V and 0V wires together.

You should hopefully find that when you connect the 0V flying lead to the inverter

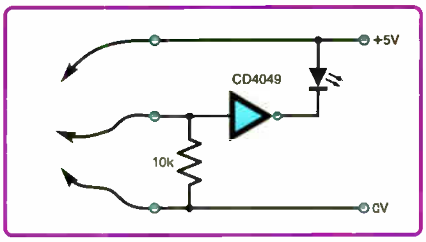


Fig.3. Circuit for experiment – adding a pull-down resistor (see text)

input wire, the LED will extinguish (indicating logic 0), and when you touch the +5V lead to it, the LED will glow (indicating logic 1). However, when neither lead is connected, the LED will remain in the state it was prior to disconnecting the flying leads. It may not be as bright, or it may flicker 'on its own'.

Now set the LED off (0V wire) and disconnect both 0V and +5V flying leads. Touch the inverter lead with your hand, and the LED may illuminate. We're not being definite about what happens here because the behaviour of CMOS with 'floating' (unconnected) inputs can be unpredictable! Experiment a bit to see what effect touching the input lead has. (But discharge static electricity from your body first, by touching the bare-metal (unpainted) surface of a grounded item of equipment.)

Now connect a 10kΩ resistor as shown in Fig.3. You will find that the circuit will now behave completely predictably.

Pitfalls

Not all digital ICs suffer from this problem, as some have internal pull-up or pull-down resistors. Datasheets will often inform you if unused inputs have to be tied to a particular logic level. If in doubt, it is best to tie unused logic inputs to ground or supply (depending on the logic

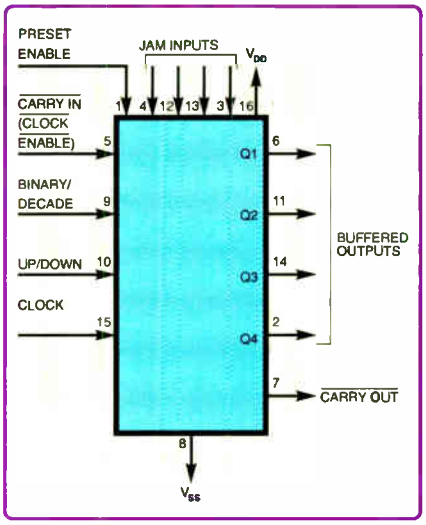


Fig.4. Pinout connections for the CD4029 counter IC (from Texas datasheet, 2003)

requirements). Usually, you can wire the pins directly, but if they are bidirectional (that is they can be outputs too, as is common on microcontrollers such as PICs), or if you may change your mind later and want to use the signal, use a pull-up or pull-down resistor.

Another possible cause of strange behaviour in CMOS ICs is powering through the logic inputs. This can happen if the supply pin is not connected, but at least one input is at logic 1. Obviously, this is far from ideal and if all the inputs happen to go to logic 0 the device will switch off and reset, losing its current memory (e.g. current count value).

While on the subject of power it is also worth mentioning supply decoupling capacitors (typically 100nF across the supplies physically close to the chip). Failure to include these may cause problems, particularly if you are clocking your circuit at high speed or you have long wires from your bench power supply to the breadboard.

4049 Up-Down counter

The CMOS 4029 (e.g. CD4029, see Fig.4) is a presettable up/down counter which counts in either binary or decade mode depending on the logic value at its binary/decade input. When this input is at logic 1, counting is in binary, otherwise counting is in decades. Of course, the output is in binary numbers for both modes, but decade counting refers to binary coded decimal, or BCD. This is illustrated in Fig.5 which shows the count sequences for up counting in the two modes. Note that in both cases when the counter reaches its maximum value the next count operation returns the output to zero.

The binary/decade mode selection is an unusual feature (possibly unique to the 4029), however, there are probably not many applications which would require dynamic switching between these modes – the mode selection would probably be hardwired. If this is the case an alternative binary BCD up/down counter should not be too difficult to find, if necessary.

If the up/down input is at logic 1 the counter counts up (as shown in Fig.5a). If this input is low the counter counts down (in the reverse order to Fig.5a).

No.	Counter Output
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111
0	0000
1	0001

Fig.5a. Counter output sequence for binary up counting.

No.	Counter Output
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
0	0000
1	0001

Fig.5b. Counter output sequence for decade up counting.

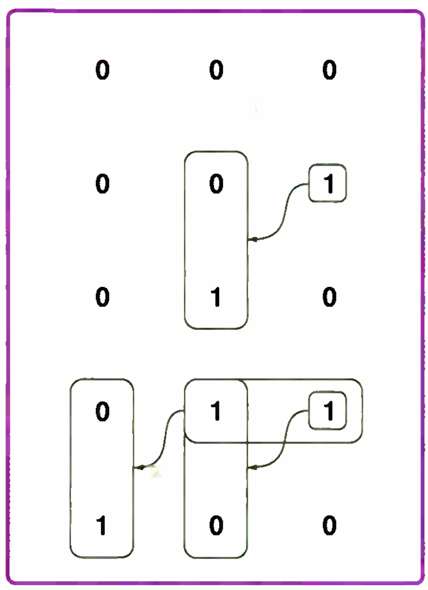


Fig.6. When all lesser significant bits are 1, the next significant bit will toggle at the next clock input.

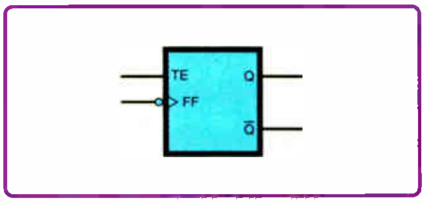


Fig.7. Toggle/Hold (toggle enable) flip-flop symbol

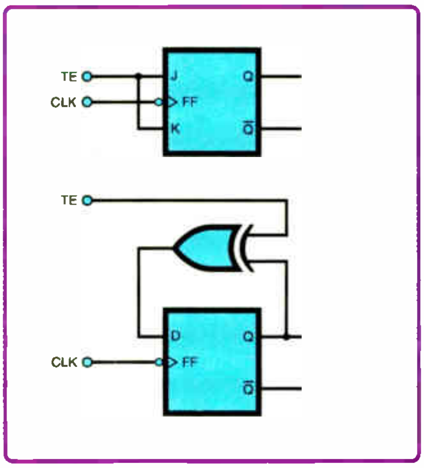


Fig.8. Forming a toggle/hold flip-flop from a JK or D-type flip-flop

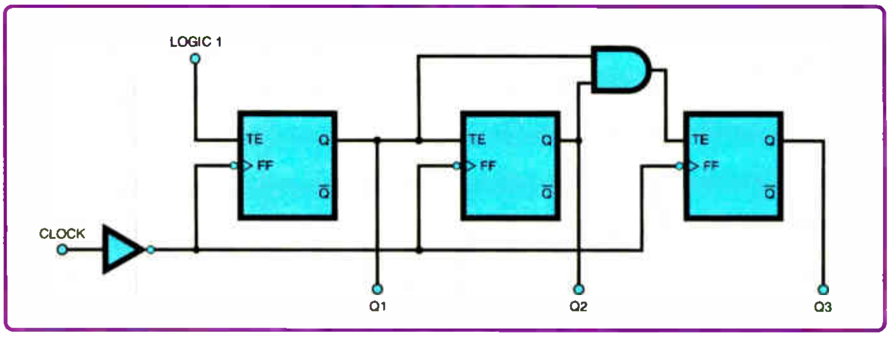


Fig.9. A 3-bit synchronous up counter using toggle/hold flip-flops

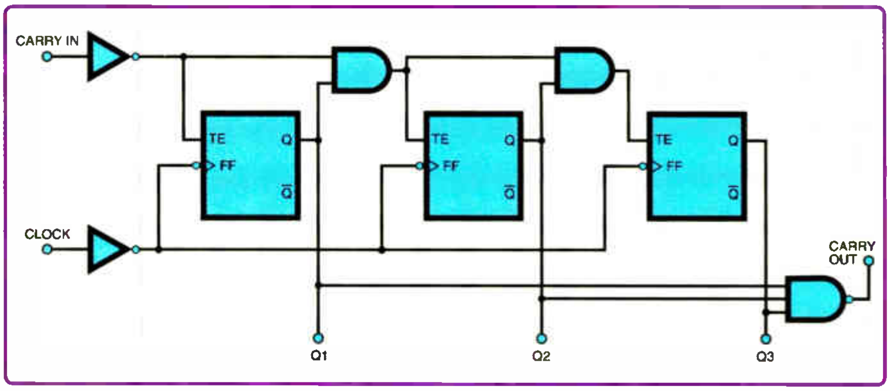


Fig.10. Carry-in and carry-out added to the circuit in Fig.9.

If you look at Fig.5a you should be able to see a pattern in the binary sequence. Notice that a bit toggles whenever all lesser significant bits are 1 (see Fig.6). The least significant bit always toggles.

Toggle/Hold Flip-flops

From this observation we can derive the logic for a synchronous binary up counter. We can build the counter from toggle/hold flip-flops which either toggle their output or stay the same depending on the value of a Toggle Enable (TE) input. The symbol for a (negative-edge triggered) toggle/hold flip-flop is shown in Fig.7. The 4029 uses toggle/hold flip-flops.

We can use JK flip-flops with J and K connected together, or a D-type with an OR gate to obtain a toggle/hold function, as shown in Fig.8. Other toggle flip-flop circuits are possible too.

With a series of such flip-flops, the first stage always toggles so the first flip-flop has its toggle/hold wired to logic 1. The second bit (Q2) toggles if the first bit (Q1) is 1, so we connect Q1 to toggle/hold the second flip-flop. The third bit (Q3) toggles when both Q1 *and* Q2 are 1 so we use an AND gate to obtain this function, connecting its output to the toggle/hold of the third flip-flop. We arrive at the circuit shown in Fig.9. This circuit is a synchronous counter because all the flip-flops are clocked together. The inverting clock buffer means that the counter is positive-edge triggered (opposite to the flip-flops). This is similar to the 4029.

We can derive similar toggle control circuits for down counting. Up/down counters such as the 4029 use their up/down inputs to determine whether the up-count or down-count toggle control signals reach the flipflops' TE inputs.

Carry-In and Carry-Out

In common with many other counter ICs, the 4029 has carry-in and carry-out signals which allow several devices to be connected together to form a larger counter. The 4029 will count if its carry in input is at logic 0, but not if it is at logic 1. The carry out signal is normally at logic 1 but goes to logic 0 when the counter reaches its maximum count in the up mode, or the minimum count in the down mode, provided the carry input is at logic 0.

Fig.10 shows how similar carry signals could be added to the basic counter from Fig.9. When carry-in is at logic 1 it forces all the flip-flop TE inputs to logic 0 to prevent counting. Larger counters can be made by connecting the carry-out of one circuit to the carry-in input of another.

A further relatively unusual feature of the 4029 is an asynchronous preset function. A logic 1 on the preset enable input allows information at the JAM inputs to preset the counter to any state asynchronously with the clock (and inhibits counting). For counting to take place, Preset Enable must be at logic 0.

It is more common for presettable counters to have synchronous load facilities, that is, if the Load control is active the preset value is loaded into the counter by the next active clock edge. The 4029 does not have a reset pin. To implement a reset connect all the JAM inputs to logic 0. The Preset Enable then behaves as an active high asynchronous reset.

Paltronix Limited

www.paltronix.com

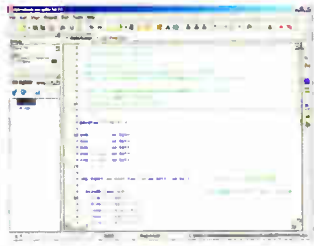
Microcontroller Development Tools

PICmicro Starter Pack now with ICD—still £99

- High-quality development board with on-board USB programmer and built-in I/O devices.
- Supports 8, 14, 18, 20, 28 and 40-pin PICs in 10F, 12F, 16F and 18F families.
- Now features mikroICD in-circuit debugger.
- Supplied with PIC16F877A.

The new EasyPIC4 development board now supports even more PICs including 8, 14, 18, 20, 28 and 40-pin devices from the 10F, 12F, 16F and 18F families. With its on-board USB programmer, mikroICD in-circuit debugger and useful I/O devices, the EasyPIC4 must be the best-value development board on the market. Our Starter Pack includes the EasyPIC4 board, USB cable, 16x2 LCD, 128x64 GLCD, DS1820 temperature sensor and a starter's guide with example programs in assembly language, BASIC, C and Pascal.

PICmicro BASIC, C and Pascal Compilers—from £59.50



- Easy to use with user-friendly IDE.
- Features simulator and mikroICD in-circuit debugger.
- Plentiful ready-written routines and example programs.
- 30% discount for customers purchasing EasyPIC4/BIGPIC4 development boards.

MikroElektronika's popular mikroBASIC, mikroC and mikroPascal compilers now include the mikroICD in-circuit debugger for use with the EasyPIC4 and BIGPIC4 development boards—programs can now be executed on a target PIC with variable values, special function registers, memory and EEPROM viewed on the PC screen. Great value at £85 each for mikroBASIC/mikroPascal and £145 for mikroC, or when bought with an EasyPIC4/BIGPIC4 only £59.50 each for mikroBASIC/mikroPascal, and £101.50 for mikroC.

We also stock development tools for 8051, ARM, AVR, dsPIC, PICmicro, PSoC and other devices—please see our website for details

Educational Products

PICmicro Microcontroller Training System—£99

- Teaches both assembly language programming and interfacing.
- Based on the popular PIC16F877A.
- Includes USB programmer.
- Features built-in I/O devices and solderless breadboard.
- Supplied with tutorial and program examples.

The PICmicro Microcontroller Training System is an ideal platform for students and hobbyists alike to learn about PIC microcontrollers. The experiment board features a range of built-in I/O devices and a solderless breadboard on which experiments may be conducted. Circuits are connected using the provided jumper wires. A USB programmer is also supplied and connects to the experiment board to program the PIC. Also included are a mains power adapter, 16x2 character LCD, connecting leads and a tutorial with example programs.

Digital Logic Training System—£99

- Ideal for learning about and experimenting with digital logic devices.
- Built-in logic and pulse switches, LEDs, 7-segment displays, piezo speaker, pulse generator, logic probe and solderless breadboard.
- Supplied with useful range of ICs, jumper wire and mains adapter.

The Digital Logic Training System makes learning about digital logic and experimenting with discrete logic ICs easy. The experiment board features a range of built-in I/O devices and a solderless breadboard on which experiments may be conducted. Circuits are connected using the provided jumper wires and the system includes features such as a power supply, pulse generator and logic probe. Also included is a mains power adapter, selection of ICs and a tutorial with example circuits.

We also stock other trainers, circuit labs and solderless breadboards—please see our website for details

Robots and Accessories

Robo-BOX 3.0 Robot Kit—£99

- Complete robot kit including controller, programming software and all mechanical parts.
- Build different robot configurations from one kit, including wheel-based and track-based.
- Program intelligence to follow light, detect collisions and trace lines.

Learn about, experiment and have fun with robotics with Robo-BOX 3.0—an incredibly easy-to-build yet adaptable and expandable robot. Various wheel-based and track-based robots can be built from the standard kit including light-following, collision-detecting and line-tracing models. Programming is carried out in graphical Logo. A range of low-cost options allow for easy expansion and the development of more sophisticated robots. We also stock similar robot kits based on PICmicro, 8051 and 68HC11 microcontrollers.

Test Equipment

PoScope USB Oscilloscope/Logic Analyser—only £99

- Low-cost PC-based instrument featuring oscilloscope, spectrum analyser, logic analyser, pattern generator, and chart recorder.
- Decodes serial buses including UART, SPI, I2C and 1-wire.
- Supplied with logic analyser test lead set, two oscilloscope probes, USB cable and software.

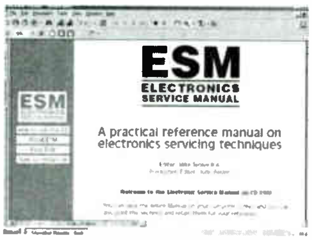
PoScope has to be one of the best-value pieces of test equipment available and features a dual channel oscilloscope (100Hz to 200kHz sample rate), 16 channel logic analyser (1kHz to 8MHz sample rate), and 8-channel pattern generator (1kHz to 1MHz). What makes the PoScope really useful to those working with microcontrollers is its ability to decode serial communications including RS-232, I2C, SPI and 1-wire. Priced at only £99, the PoScope comes with a USB cable, logic analyser test lead set, two oscilloscope probes and software.

Tel: 0845 226 9451 Fax: 0845 226 9452 Email: sales@paltronix.com

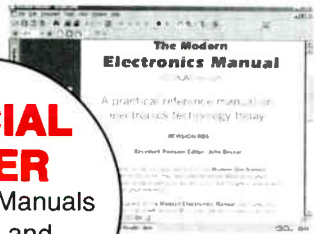
All prices exclude UK delivery (£5 standard/£10 next-day) and VAT. Major credit and debit cards accepted. Secure online ordering.

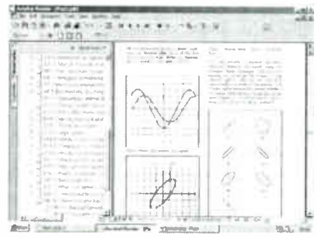
ELECTRONICS MANUALS ON CD-ROM £29.95 EACH

ELECTRONICS SERVICE MANUAL



THE MODERN ELECTRONICS MANUAL





SPECIAL OFFER
Order both Manuals together and
SAVE £10

Everything you need to know to get started in repairing electronic equipment

• Around 900 pages • Fundamental principles • Troubleshooting techniques • Servicing techniques • Choosing and using test equipment • Reference data • Manufacturers' web links • Easy-to-use Adobe Acrobat format • Clear and simple layout • Vital safety precautions • Professionally written • Supplements

SAFETY: Safety Regulations, Electrical Safety and First Aid. **UNDERPINNING KNOWLEDGE:** Electrical and Electronic Principles, Active and Passive Components, Circuit Diagrams, Circuit Measurements, Radio, Computers, Valves and Manufacturers' Data, etc. **PRACTICAL SKILLS:** Learn how to identify Electronic Components, Avoid Static Hazards, Carry Out Soldering and Wiring, Remove and Replace Components. **TEST EQUIPMENT:** How to Choose and Use Test Equipment, Assemble a Toolkit, Set Up a Workshop, and Get the Most from Your Multimeter and Oscilloscope, etc. **SERVICING TECHNIQUES:** The Manual includes vital guidelines on how to Service Audio Amplifiers. The Supplements include similar guidelines for Radio Receivers, TV Receivers, Cassette Recorders, Video Recorders, Personal Computers, etc. **TECHNICAL NOTES:** Commencing with the IBM PC, this section and the Supplements deal with a very wide range of specific types of equipment – radios, TVs, cassette recorders, amplifiers, video recorders etc. **REFERENCE DATA:** Diodes, Small-Signal Transistors, Power Transistors, Thyristors, Triacs and Field Effect Transistors. Supplements include Operational Amplifiers, Logic Circuits, Optoelectronic Devices, etc.

The essential reference work for everyone studying electronics

• Over 800 pages • In-depth theory • Projects to build • Detailed assembly instructions • Full components checklists • Extensive data tables • Manufacturers' web links • Easy-to-use Adobe Acrobat format • Clear and simple layout • Comprehensive subject range • Professionally written • Supplements

BASIC PRINCIPLES: Electronic Components and their Characteristics; Circuits Using Passive Components; Power Supplies; The Amateur Electronics Workshop; The Uses of Semiconductors; Digital Electronics; Operational Amplifiers; Introduction to Physics, including practical experiments; Semiconductors and Digital Instruments.
CIRCUITS TO BUILD: The Base Manual describes 12 projects including a Theremin and a Simple TENS Unit.
ESSENTIAL DATA: Extensive tables on diodes, transistors, thyristors and triacs, digital and linear i.c.s.
EXTENSIVE GLOSSARY: Should you come across a technical word, phrase or abbreviation you're not familiar with, simply look up the glossary and you'll find a comprehensive definition in plain English.
The Manual also covers **Safety** and provides web links to component and equipment **Manufacturers and Suppliers.**

Full contents list available online at: www.epemag.wimborne.co.uk

SUPPLEMENTS: Additional CD-ROMs each containing approximately 500 pages of additional information on specific areas of electronics are available for £19.95 each. Information on the availability and content of each Supplement CD-ROM will be sent to you.

Presentation: CD-ROM suitable for any modern PC. Requires Adobe Acrobat Reader which is included on the CD-ROM.

Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872. Fax: 01202 874562.

PLEASE send me

☐ **THE MODERN ELECTRONICS MANUAL CD-ROM**

☐ **ELECTRONICS SERVICE MANUAL CD-ROM**

I enclose payment of £29.95 (for one Manual) or £49.90 for both Manuals (saving £10 by ordering both together).

FULL NAME ....
(PLEASE PRINT)
ADDRESS ....

....

.... **POSTCODE** ....

SIGNATURE ....

☐ **I enclose cheque/PO in UK pounds payable to Wimborne Publishing Ltd.**
☐ **Please charge my Visa/Mastercard/Amex/Diners Club/Switch/Maestro**

Card No .... **Switch/Maestro Issue No** ......

Valid From .... **Expiry Date** ....

Card Security Code .... **(The last 3 digits on or just under the signature strip)**

ORDER FORM

Simply complete and return the order form with your payment to the following address:

Wimborne Publishing Ltd,
408 Wimborne Road East, Ferndown,
Dorset BH22 9ND
Price includes postage to anywhere in the World

We will happily exchange any *faulty* CD-ROMs but since the content can be printed out we do not offer a refund on these items.

Your CD-ROM(s) will be posted to you by first class mail or airmail, normally within four working days of receipt of your order

EPE EVERYDAY PRACTICAL ELECTRONICS

UK readers you can

SAVE 54p

on every issue of *EPE*

How would you like to pay £2.96 instead of £3.50 for your copy of *EPE*?
Well you can – just take out a one year subscription and save 54p an issue, or £6.50 over the year

You can even **save 75p an issue** if you subscribe for two years – a total saving of **£18.00**

Overseas rates also represent exceptional value

You also:

- Avoid any cover price increase for the duration of your subscription
- Get your magazine delivered to your door each month
- Ensure your copy, even if the newsagents sell out

Order by phone or fax with a credit card or by post with a cheque or postal order, or buy on-line from **www.epemag.co.uk** (click on "Subscribe Now")

EPE SUBSCRIPTION PRICES

Subscriptions for delivery direct to any address in the UK: 6 months £18.75, 12 months £35.50, two years £66; Overseas: 6 months £21.75 standard air service or £30.75 express airmail, 12 months £41.50 standard air service or £59.50 express airmail, 24 months £78 standard air service or £114 express airmail.
Cheques or bank drafts (in **£ sterling only**) payable to *Everyday Practical Electronics* and sent to *EPE* Subs. Dept., Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872. Fax: 01202 874562. **Email**: subs@epemag.wimborne.co.uk. Also via the **Web** at **http://www.epemag.co.uk**. Subscriptions start with the next available issue. We accept MasterCard, Amex, Diners Club, Maestro or Visa. (For past issues see the *Back Issues* page.)

ONLINE SUBSCRIPTIONS

Online subscriptions, for downloading the magazine via the Internet, $15.99US (approx. £9.00) for one year available from **www.epemag.com**.

USA/CANADA SUBSCRIPTIONS

To subscribe to *EPE* from the USA or Canada please telephone Express Mag toll free on 1877 363-1310 and have your credit card details ready. Or fax (514) 355 3332 or write to Express Mag, PO Box 2769, Plattsburgh, NY 12901-0239 or Express Mag, 8155 Larrey Street, Anjou, Quebec, H1J 2L5.
Email address: expsmag@expressmag.com.
Web site: **www.expressmag.com**.
USA price $60(US) per annum, Canada price $97(Can) per annum – 12 issues per year.
Everyday Practical Electronics, periodicals pending, ISSN 0262 3617 is published twelve times a year by Wimborne Publishing Ltd., USA agent USACAN at 1320 Route 9, Champlain, NY 12919. Subscription price in US $60(US) per annum. Periodicals postage paid at Champlain NY and at additional mailing offices. POSTMASTER: Send USA and Canada address changes to Everyday Practical Electronics, c/o Express Mag., PO Box 2769, Plattsburgh, NY, USA 12901-0239.

SUBSCRIPTION ORDER FORM

☐ 6 Months: UK £18.75, Overseas £21.75 (standard air service), £30.75 (express airmail)
☐ 1 Year: UK £35.50, Overseas £41.50 (standard air service) £59.50 (express airmail)
☐ 2 Years: UK £66.00, Overseas £78.00 (standard air service) £114 (express airmail)

To: Everyday Practical Electronics, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND
Tel: 01202 873872 Fax: 01202 874562
E-mail: subs@epemag.wimborne.co.uk

I enclose payment of £ .... (cheque/PO in £ sterling only), payable to *Everyday Practical Electronics*

My card number is: ....
Please print clearly, and check that you have the number correct

Signature ....

Card Security Code .... (The last 3 digits on or just under the signature strip)

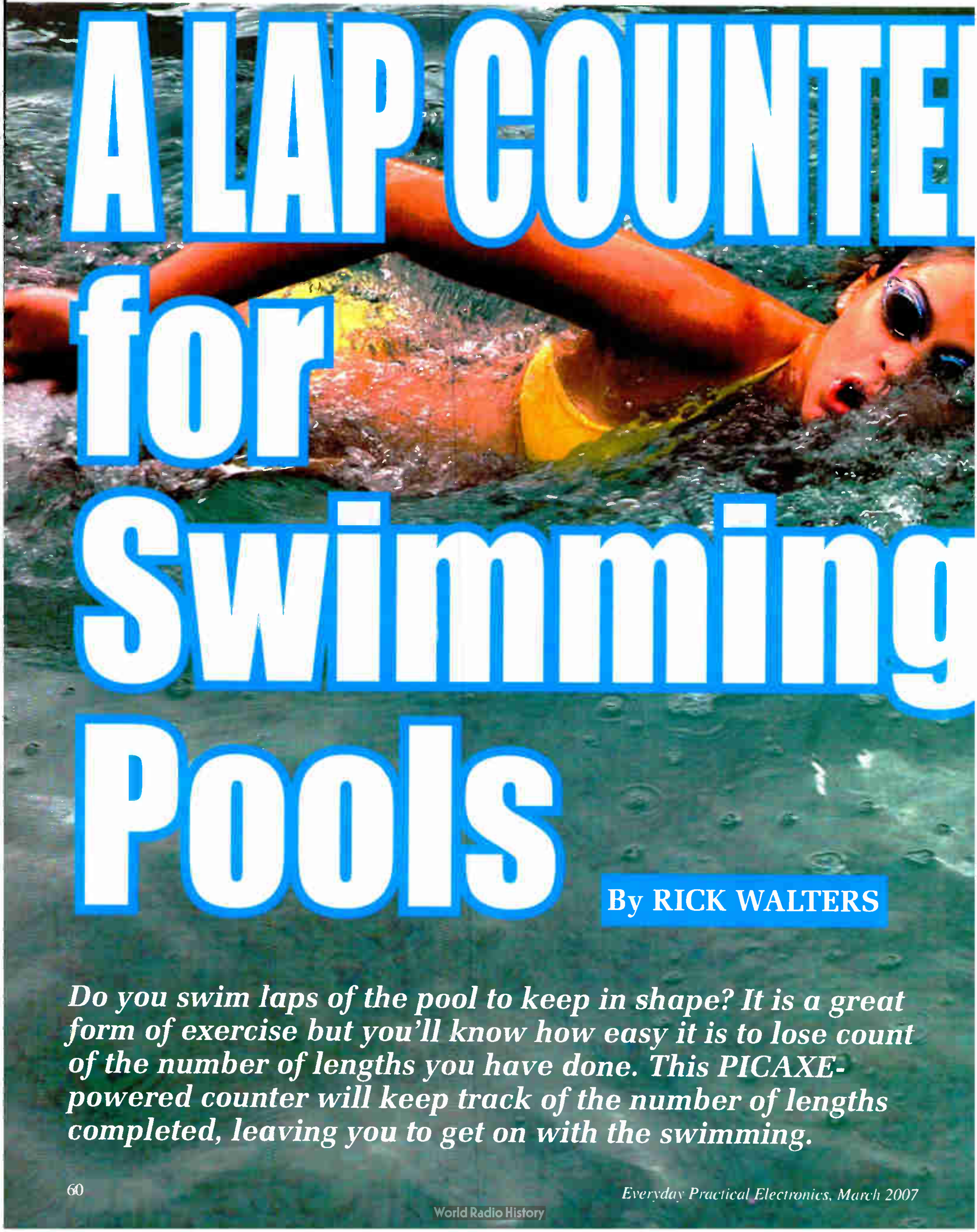
Card Ex. Date .... Maestro Issue No. ....

Name ....

Address ....

Post code .... Tel. ....

Subscriptions can only start with the next available issue.



A LAP COUNTER for Swimming Pools

By RICK WALTERS

Do you swim laps of the pool to keep in shape? It is a great form of exercise but you'll know how easy it is to lose count of the number of lengths you have done. This PICAXE-powered counter will keep track of the number of lengths completed, leaving you to get on with the swimming.

THOSE FORTUNATE ENOUGH to swim in a 50-metre pool don't have to count very many lengths in order to cover a reasonable distance.

For example, just 20 lengths means that you have swum a kilometre. But even then, as you plough up and down the pool, it is pretty easy to get distracted and lose count. Some people cope with the problem by swimming five lengths freestyle, five breast-stroke, five back-stroke and so on.

The problem is worse if you're swimming in a 25-metre pool (as many top-level swimmers regularly train in) and much worse if you're swimming in a small pool, which may be only 10 or 15 metres long. For a 10-metre pool, you need to do 100 lengths to cover a kilometre.

Believe us, trying to keep track of that many lengths in a small pool while you swim back and forth is practically impossible.

This is where our Pool Lap Counter comes to the rescue. It will display the number of lengths you have completed on a 2-digit or 3-digit readout, so you can let your mind wander, do mental arithmetic or compose your new symphony while you swim up and down.

The Pool Lap Counter consists of two small plastic boxes. One, the 'main' box, contains the Picaxe counter circuit and 2-digit readout, while the other contains a large air-switch pushbutton which connects to the main box via a thin air hose and actuates a microswitch when pressed. This is to avoid an electrical connection (even in a battery-powered, low voltage device) around the very damp(!) chemical-laden pool environment.

If you swim more than 99 lengths, you will have to add 100 to the count or add the third 7-segment LED display.

Two ways of counting

The way it works is as follows. You place the air-switch at the far end of the pool (from where you normally start). You then dive in (or gingerly wade in), swim to the other end and push the button, whereupon the display indicates '01'. Congratulations, you have completed one length. When you swim up and back and press the button again, the display will indicate '03'.

In other words, the display increments by two each time the button is pressed.

As an alternative, because this Pool Lap Counter uses the intelligence of a Picaxe, you can start and finish your lengths at the same end of the pool. In this case, you push the button to start and it displays '00'. You then swim up and back, press the button and it displays '02' and so on, until you are exhausted!

Eight AA cells (12V) power the counter. To obtain a reasonable battery life, the 7-segment displays are lit for just five seconds each time the button is pressed.

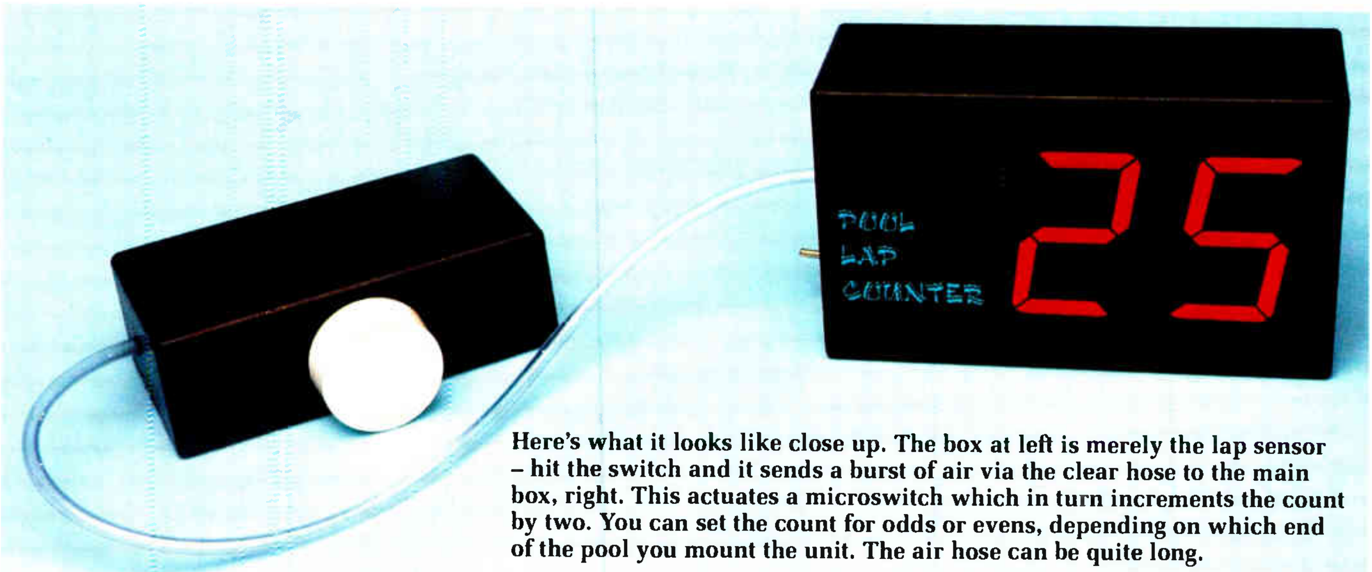
Of course, the counter ICs are powered whenever the unit is switched on but this amounts to only a couple of milliamps.

How the circuit works

Looking at the circuit of Fig.1, IC2 is a 4553 3-digit counter (normally, we only utilise two digits) with a multiplexed output. IC2 internally selects digit one, two or three and places the BCD data for this digit on outputs Q0-Q3. These feed IC3, a 4511 7-segment decoder, which energises the segments of the two digits, corresponding to the BCD code. At the same time, output DS1 or DS2 (pin 2 or pin 1) of IC2 turns on transistor Q4 or Q5 to power the corresponding LED display.

The 10µF capacitor and the 100kΩ resistor on pin 13 of IC2 reset the count to zero when power is applied. The 1nF capacitor between pins 3 & 4 sets the display multiplexing frequency.

All this is fairly straightforward. The tricky bits are carried out by IC1, a Picaxe-08 microcontroller. Among



Here's what it looks like close up. The box at left is merely the lap sensor – hit the switch and it sends a burst of air via the clear hose to the main box, right. This actuates a microswitch which in turn increments the count by two. You can set the count for odds or evens, depending on which end of the pool you mount the unit. The air hose can be quite long.

other things, the Picaxe needs to cater for people who place the Lap Counter at their start end or at the far end. As noted earlier, if you place it at the far end, the Lap Counter should count to one the first time you touch the button and then increment by two for each subsequent touch.

We cover both contingencies by fitting jumper J2 for odd increments and omitting it for even. CON1 is arranged to allow programming of the chip 'in circuit'. Jumper J1 has to be removed to do this although with the 47kΩ base resistor for Q1, it is probably unnecessary.

This method means you must remove jumper J1 (thus removing any load from pin 7) before you can reprogram the chip.

We also use IC1 to debounce the pushbutton microswitch S1. This achieves two things. First, it stops multiple counts from being recorded because of contact bounce within the microswitch itself.

Second, it prevents a miscount if you accidentally push the button twice within five seconds. You could easily do this if you come to the end of a lap, touch the button (or plate or whatever) and then press it again as you push off for another length.Each time the Picaxe registers the closing of the microswitch, it generates two clock pulses to increment counter IC2.

If you look at the Picaxe listing (LAPCOUNT.BAS), you will probably be able to glean what it does but let's just briefly outline the procedure. Each time you push the button, several things happen. First, IC2 is incremented by two counts (or one count if it is the first time) and then it is disabled, preventing it from registering multiple counts. At the same time, the display is unblanked for five seconds so that you can see the count.

Three outputs from IC1 are used to achieve this procedure. Pin 6 disables the counter by going high (for five seconds) to turn on transistor Q2 which then pulls pin 11 (DIS) of IC2 low. Pin 5 of IC1 provides the clock pulses which are inverted by transistor Q3 before being fed to pin 12 (CLK) of IC2. Finally, pin 7 of IC1 unblanks the display by turning on transistor Q1 to pull pin 4 ($\overline{BL}$) of IC3 low for five seconds.

The three transistors (Q1-Q3) also provide level translation between the 5V signals from IC1 and IC2 & IC3 which run from the full 12V provided by the eight AA cells. Regulator REG1 is fitted to provide the 5V rail for the Picaxe.

As noted last month, there is a great deal of confusion over the way the Picaxe ports are numbered, for what they call pin 3 is actually pin 4 on the IC and so on. We have taken the liberty of renaming them in the more conventional manner as P0, P1, P2, etc. We have used the decimal point (pin 8) of the units display as a power indicator to remind you to turn the Lap Counter off. This stays illuminated even when the lap count is blanked.

Air-switch

S1 is an all-plastic 'air-switch' which is normally used in areas where water and electricity don't mix.

We use it here mainly because any electrical switch put near a pool with salt and chlorine would not last very long.

When the air-switch button is pressed it compresses small bellows which

(Left) the air-powered switch we used to actuate the counter. It's normally used in spas and should be available from pool shops, similar switches are available from electronic component supplies like RS Components, Farnell etc.

(Right): the switch fitted in an open case. The switch *just* fits in this case. The length of 5mm plastic air hose can be as long as required.

The main box end-on, showing the connection for the air hose to the pushbutton lap counter switch.

transmit the pressure along the plastic tube to the microswitch mounted in the Lap Counter case.

If you don't wish to go to the added expense of the air-switch, you could use a standard pushbutton in the actuator box and run a piece of light duty figure-8 flex to the Lap Counter case.

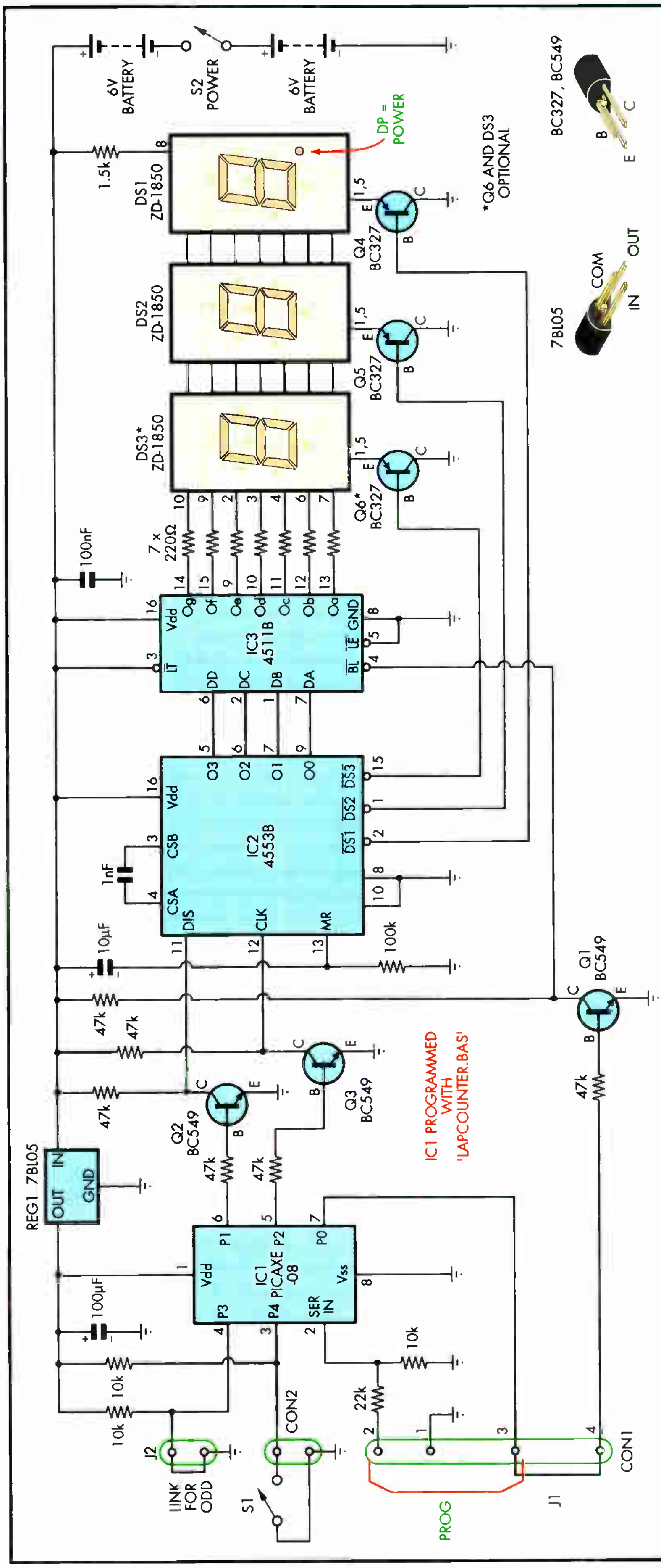
Construction

All the circuitry for the Pool Lap Counter is mounted on a PC board measuring 141 × 83mm and coded 610. It has a notch at one end to accommodate the microswitch and chamfers on the four corners.

Even though most people will only use two 7-segment displays, we have made provision for a third display (DS3), together with its driving transistor (Q6). If you fit the third display, you will have to install another 10 machined pins for DS3 as well as fitting Q6. We have shown the jumper, which connects IC2 to the base of Q6 on the overlay so this link will already be in place.

The board assembly is reasonably straightforward, but as usual, first

Here are the giant LED displays we used – they are visible for a long way! We've turned one upside down so you can see the pin arrangement. Take care: you can get them upside down.



POOL LAP COUNTER

Fig.1: the circuit consists of two basic parts – the Picaxe-08 which senses the input from S1 and a display circuit, consisting of IC2, IC3 and giant LED displays. Display DS3 is optional and is only required if you want to count more than 99 lengths.

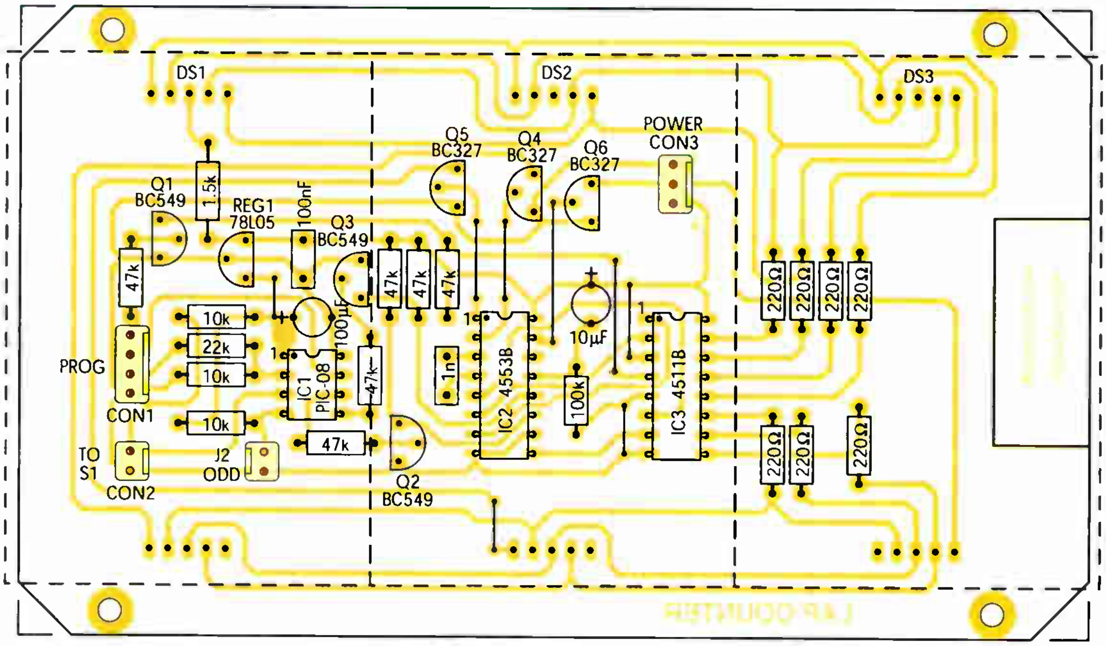
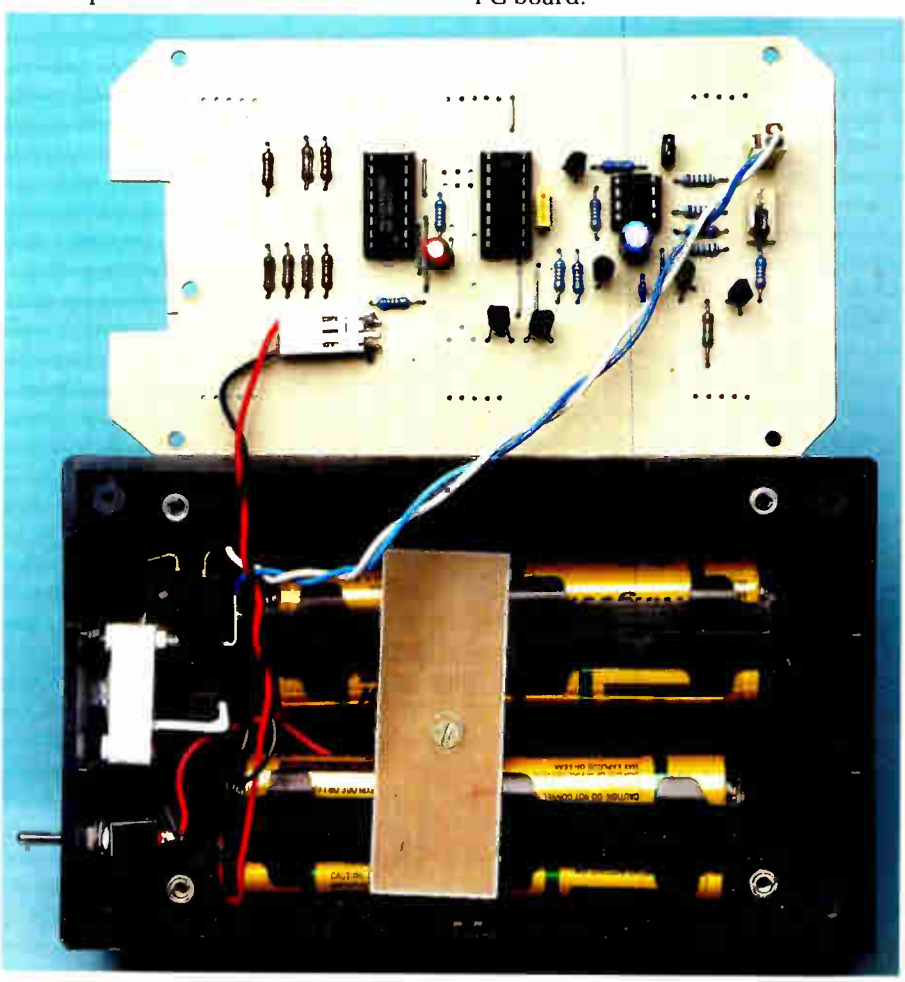


Fig.2: the component overlay shows the position of all components. Note that the sockets for the LED displays are mounted on the track side of the PC board.

check the board for open circuit tracks and etching faults, particularly where the tracks go between IC socket pins.

The first components to mount are the LED display sockets which mount on the copper (ie, solder) side of the PC board.



This is the completed 'main box' immediately before the PC board is folded over and mounted upside down on the four tapped pillars. The battery holders are held in place with our highly technical (and patented) battery holder holder.

To get the spacing exact, we use the displays themselves to hold the pins while we 'tack' the pins in. Cut the pin strip into four pieces of five pins and carefully align the LED pins with the strips and push them on.

Now place the LED sockets on the ***track*** side of the PC board – not the component side – in the DS1 and DS2 (units & tens) positions. That done, place the PC board on a flat surface and solder the outside pins on each pin strip on both the top and bottom of the display. There is no need to worry about the display orientation at this stage.

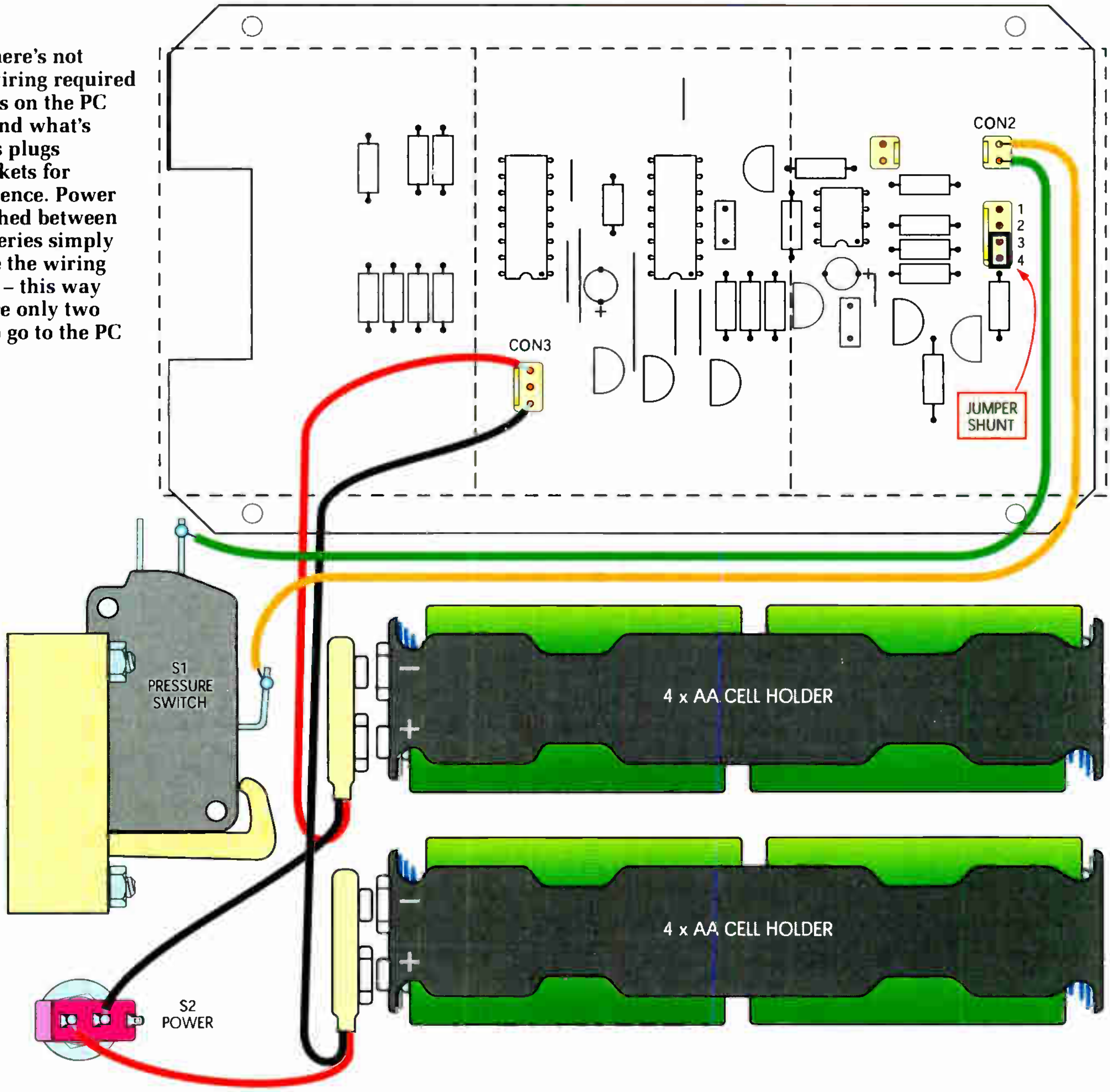
Now carefully remove the displays and solder the remaining pins. A pointed tip on your soldering iron will make the job easier but we managed with the usual spade tip and a lot of care.

Cut about 2mm off each pin on each display so that it fits flush against the pin strip.

Now turn the board over to the component side and fit the eight links, then the resistors, followed by the IC sockets, jumper, transistors, electrolytics and the three polarised connectors. Make sure you insert the electrolytics with the correct polarity – and note that the 10µF electrolytic must lie flat on the PC board to prevent it fouling the batteries.

The 3-pin header must also lie flat on the PC board. As right-angle connectors are rare, put a dob of glue on the flange and use cut-off resistor leads to connect it to the board. Only the

Fig.3: there's not much wiring required – most is on the PC board and what's left uses plugs and sockets for convenience. Power is switched between the batteries simply to make the wiring simpler – this way there are only two wires to go to the PC board.



outside pins need to be connected. The mating header has pin 1 marked on it when you come to connect wires.

Next, fit the mini-shunts to J2, but not pins 3 & 4 of CON1.

Power switch S2 is wired between the two AA battery holders to simplify the wiring. Solder one lead from each battery holder to the switch (one red, one black) and then the other battery wires go to connector PL3: black to pin 3 and red to pin 1. Plug PL3 in.

Now fit the batteries, turn the switch on and measure the voltage between pins 16 & 8 on both IC2 & IC3 (the meter's red test lead goes to pin 16 in each case). It should be slightly more than +12V. Similarly the voltage between pins 1 & 8 of IC1 should be within 10% of 5V.

Once these voltages are correct, turn off the power, insert the three ICs and then program the PIC. Then fit J1 between pins 3 & 4 of CON1.

Turn the power on and after a second, the decimal point on the righthand display should light. So far

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	6	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	3	10kΩ	brown black orange brown	brown black black red brown
❑	1	1.5kΩ	brown green red brown	brown green black brown brown
❑	7	220Ω	red red brown brown	red red black black brown

Parts List – Swimming Pool Lap Counter

1 PC board, code 610 available from the *EPE PCB Service*, size 141 x 83mm
1 plastic case, 158 x 95 x 53mm
1 plastic case, 130 x 67 x 43mm
2 16-pin IC sockets
1 8-pin IC socket
1 air-switch, including microswitch (S1)
1 SPST miniature toggle switch (S2)
2 flat battery holders to suit 4 AA cells
8 AA cells
20/32 of IC socket strip
1 2-pin strip 0.1inch spacing (J2)
2 mini-shunts
1 2-pin polarised male connector
1 2-pin header (with pins)
1 3-pin polarised male connector
1 3-pin header (with pins)
1 4-pin polarised male connector (for PIC programmer cable)
4 25mm threaded hex spacers
1 10mm threaded hex spacer
2 3mm x 20mm countersunk head bolts (air-switch)
5 3 x 6mm countersunk head bolts
1 3 x 10mm countersunk head bolt
4 3 x 6 mm cheese head bolts
7 3mm nuts
6 3mm star washers
1 65 x 20mm aluminium or fibreglass (battery clamp)
Suitable length hookup wire for air switch

Semiconductors
1 Picaxe PIC-08 (IC1)programmed with LAPCOUNT. BAS available from the 'Downloads' section of the *EPE* website. For Picaxe chips, free programming software etc see www.rev-ed.co.uk
1 4553 3-digit counter (IC2)
1 4511 BCD to 7-segment decoder (IC3)
3 BC549 NPN transistors (Q1-Q3)
2 BC327 PNP transistors (Q4-Q5)
1 BC327 PNP transistor (Q6 optional)
1 78L05 5V regulator (REG1)
2 70mm 7-segment displays (DS1-2)
1 70mm 7-segment display (DS3 optional)

Capacitors
1 100µF 16V PC-mount electrolytic
1 10µF 50V RB low leakage electrolytic
1 100nF (0.1µF) 50V monolithic ceramic (code 104 or 100n)
1 1nF (0.001µF) MKT polyester (code 102 or 1n0)

Resistors (0.25W, 1%)

1 100kΩ	6 47kΩ	1 22kΩ
3 10kΩ	1 1.5kΩ	7 220Ω

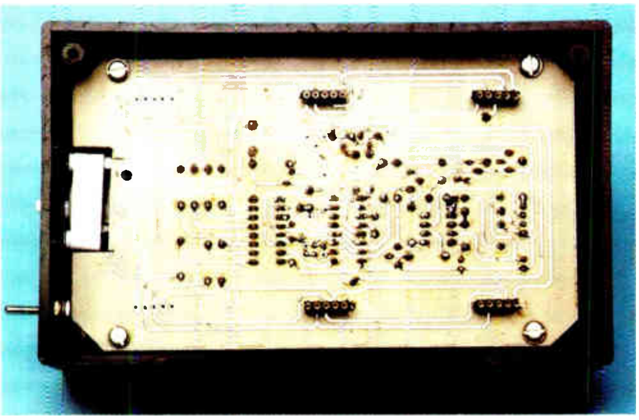
```
;   PICAXE-08 CODE for LAP COUNTER
;   using 4553 and 4511 to drive 2 ZD1850 displays
;
;Define inputs and outputs
;
        symbol  msin = pin4
        symbol  evenodd = pin3
        symbol  blankdisp = 0
        symbol  addcount = 2
        symbol  odd = 1
;
;Set output states
;
        high    blankdisp
        high    odd
        low     addcount
;
;
        wait    3               ;allow IC2 to reset
;
init:   if evenodd > 0 then initeven  ;if jumper missing start at 0 & inc
                                        by 2
        if msin = 0 then initodd
        goto    init            ;
;
initodd:low     odd             ;else jumper fitted, IC2 pin 11 high
        pause   10              ;hold high for 10 mS
        high    odd             ;then take low, 1 clocked into counter
        goto    unblank         ;(Q2 inverts logic)
;
initeven:if msin = 0 then inccount  ;wait for microswitch to close
        goto    initeven        ;
;
inccount:high addcount          ;2 counts must be added to the display
        pause   10              ;take IC2 pin 12 low for 10mS (Q3 inverts)
        low     addcount        ;then high for 2 mS
        pause   2               ;
        high    addcount        ;then low for another 10 mS
        pause   10              ;
        low     addcount        ;then high again
        goto    unblank         ;now show the new count
;
unblank:low     blankdisp       ;take IC3 pin 4 high for 5 seconds
        wait    5               ;(Q1 inverts logic)
        high    blankdisp       ;turn display off
        goto    initeven        ;wait for next closure of microswitch
```

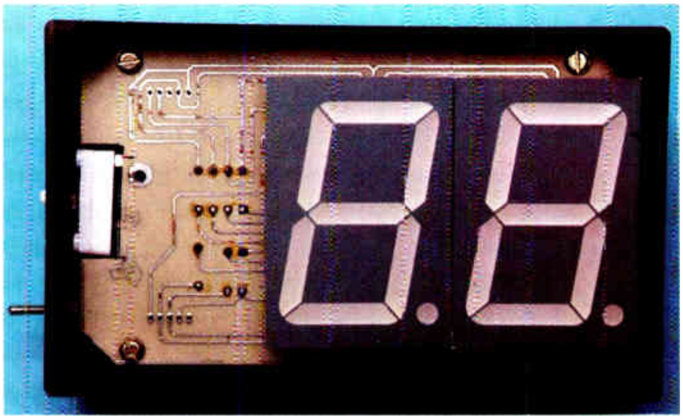
so good. Run two twisted wires from the microswitch NO and C(ommon) contacts to the 2-pin header (PL2). The polarity is immaterial.

Plug it in and, after connecting the tubing from the air-switch pushbutton to the microswitch connector, each push of the button should advance the counter by two counts. After five seconds, the count should blank. Note: the count will only advance after the 5-second delay when the display is blank.

If everything is operating correctly, you can drill the holes in the plastic case and fit the four 25mm spacers, first fitting a 3mm nut on each of the countersunk screws. The nut brings the front of the displays flush with the rear of the Perspex, thus holding them firmly in place.

Mount the microswitch and power switch, fit the batteries into the battery holders and drop them into





Left: this view shows the PC board mounted inside the case before the 7-segment LED displays are fitted. Note that the display sockets are fitted to the *track* side of the PC board. At right is the same shot but with the displays inserted. The decimal point goes to the bottom, as shown here

the case, then sit the PC board on the spacers. Adjust the spacers until the four of them align with the board holes. Place the clamp strip on top of the batteries to prevent them moving, then secure the PC board using four cheese-head machine screws and star washers.

The front panel cutout may prove a challenge. We obtained a small piece of 3mm neutral tint Perspex from a plastics supplier and cut it to size with a chamfer on all four sides. We carefully cut the hole in the case lid with the reverse chamfer, thus allowing the Perspex to almost sit flush with the lid. A few drops of superglue held it firmly in place.

The lap 'sensor'

The pushbutton switch we used is great for keeping water and chemicals away from the 'works' but is not particularly convenient as far as the swimmer is concerned. Our swimmer found it a real drag (no pun intended) to have to stop at the end of each lap and press the button. With a little thought, we're sure you can come up with a much better arrangement.

One possibility is to use a reasonably-sized hinged flap which the swimmer merely has to make slight contact with at the end of each lap. Given the mechanical advantage such an arrangement could produce, a small movement of the flap could translate into a very positive movement against the air-switch via a suitable actuator.

Such an arrangement could also be used for swimmers making 'tumble-turns'. As long as the flap was anchored securely at the end of the pool, the swimmer's feet could do all the switching as he/she pushed off at the end of each second lap. Whatever you do, just make sure that it is suitably anchored so that there is no danger of injury to the swimmer.

You could run a much longer air hose than the length our photos show (merely for a convenient photo!). The pressure system is quite sensitive, so we assume several metres would not be a problem.

That's it: a lap counter that will keep track for you whether you are swimming for fitness... or in training for the London Olympics. ***EPE***

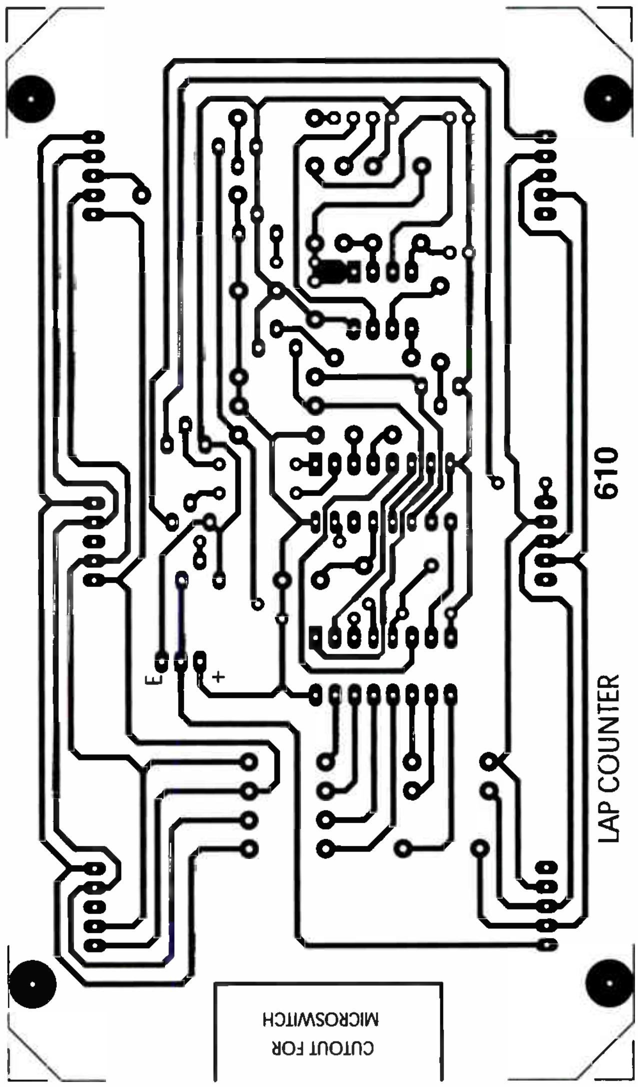


Fig.4: full-size PC board artwork.

Reproduced by arrangement with
SILICON CHIP magazine 2007.
www.siliconchip.com.au

Net Work

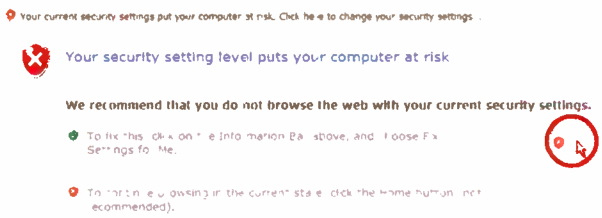
Alan Winstanley

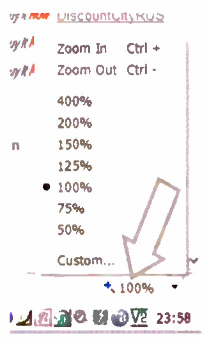
The casual browser

Several months have elapsed since Microsoft's latest version of their web browser – Internet Explorer 7 – escaped into the mainstream marketplace. The upgrade is available to owners of validated Windows software, as part of Windows Automatic Update. Many non-skilled users will doubtless have sleep-walked into having the upgrade foisted onto their system.

As if the Windows XP SP2 update wasn't challenging enough, IE7 introduces some worthwhile and long overdue improvements as well as some serious annoyances that now just interrupt the flow of work. In particular, its security settings – as deemed appropriate by Microsoft – are downright obstructive and bordering on the paranoid, and as time goes by the author is finding them ever more infuriating. Turning off some security settings results in permanent 'Are you sure?' reminder bars popping up, with the browser nagging that your security settings are at risk; IE7 won't shut up unless you allow it to 'fix the problem'. Even expert users struggle to silence this pestilence using the arcane options available in Security Settings.

Another major usability niggle noted by the author is that IE7 is somewhat slow to load, even on a fast machine. Or rather, some third party toolbars such as Google and Roboform no longer load for several seconds after the main browser has opened. So just as the user starts to type a URL into the address bar, the browser resizes itself and loses focus. What appears in the address bar is just the tail-end of the URL, such as '......borne.co.uk'. Countless times the URL has to be retyped in full. A fully-loaded Internet Explorer 7 is not for fast workers.





(Above) Internet Explorer 7 is almost paranoid about security

(Left) The browser has a zoom control that enlarges both text and images for easier viewing

Last month I mentioned how to turn off the built-in Phishing Filter, and regular *Net Work* reader ***Glynne Hewlett*** says: "the Phishing Filter in IE7 can be nuisance if downloading, say, a book from the Internet. The filter thinks that I'm downloading an altered Web page, which should not have been altered or which may be a security risk. I've found that the only way to download page after page of an online book is to turn the Phishing Filter off then back on when I've completed my work."

Problems, Problems

Other problems have started to emerge after upgrading to IE7. For example, apart from damaging the writer's WSFTP program installation, a bug is introduced with Sonic Solution's Roxio Digital Media burning program. After installing IE7, Roxio generates a string of error messages when it closes, which suddenly became evident on the author's brand new laptop. Reader ***G. S. Chatley*** says: "I switched to IE7 and have mixed feelings because an excellent freebie program I had called Winclean, which used to clear out all the rubbish that Windows XP collects, no longer works, and the makers of the program don't seem to be interested in fixing it. By and large, with all these wonderful new all singing and dancing programs all you seem to end up with is a much larger slice of your hard disk taken up."

It is deeply frustrating when working programs are damaged by system upgrades. And who should we blame? We may cuss Microsoft, but rightly or wrongly, pressure is then heaped on the software vendors such as Sonic Solutions and Ipswitch to fix a program that worked perfectly previously. They may be tempted to refuse to patch an old product, forcing a new version onto their users instead, as some Sonic users fear may happen with their favourite CD burning program.

The IE7 upgrade is not a waste of time though, as the web browser does finally implement tabbed browsing, although it eats into valuable pixel real estate, especially on a smaller laptop screen. The useful Zoom feature lets you expand the web page (text and images), which is brilliant for those with lesser vision capabilities. I mentioned before how I welcome the improved web printing feature (consider using Primo PDF and print to a PDF instead of using paper, and help save the planet). If nothing else, those dratted IE7 security settings protect neophyte users by default, and there is support for RSS (Really Simple [News] Syndication) feeds. You can subscribe to RSS news feeds wherever you see the distinctive orange symbol on web sites such as BBC News (Google for 'BBC RSS newsfeed' for details). Your RSS newsfeed subscriptions will be found on the IE7 Favorites toolbar.

Hasta La Vista?

As if an IE7 upgrade isn't hard enough, what about an entire operating system upgrade? The big news in personal computer circles is, of course, the arrival of Windows Vista, Microsoft's most ambitious OS yet, and one that is destined to appear on almost every new Windows PC being sold from the end of January 2007. More details at **http://www.microsoft.com/windowsvista/** . Vista is claimed to offer enhanced security and a radically improved graphical interface. One embittered computer expert looked at a Vista machine, sniffed 'so what?' and declared that XP is perfectly good enough for the time being.

Beware the Vista hype, as far as there is any: if Windows XP works for you today then there is no reason to splash out on an upgrade, unless you are the sort of computer user who enjoys throwing money at computers for the sake of it and wrestling with problems afterwards. Windows Vista is not guaranteed to be compatible with your current hardware or software. Instead, watch out for XP Service Pack 3 (SP3) some time this year. The hidden running costs of PCs can be extraordinary, and we will now enter another round of pressure to update our systems, because that's what hungry manufacturers need us to do. There are many years of life left in Windows XP though.

In the coming months I'll be looking at various interesting hardware and software applications to help make your Internet life easier. You can e-mail me at **alan@epemag.demon.co.uk**

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.

WIN AN ATLAS LCR ANALYSER WORTH £79

An Atlas LCR Passive Component Analyser, kindly donated by Peak Electronic Design Ltd., will be awarded to the author of the *Letter Of The Month* each month.

The Atlas LCR automatically measures inductance from 1μH to 10H, capacitance from 1pF to 10,000μF and resistance from 1Ω to 2MΩ with a basic accuracy of 1%.

www.peakelec.co.uk

★ LETTER OF THE MONTH ★

PIC Articles

Dear EPE,

Many thanks for a great mag, I've been an avid reader since the mid 70's. I'm especially grateful to you for your PIC introduction course published in 1998. I'd just recently started programming the Z80 by writing the program by hand, looking up the opcode and then entering this into EPROM byte-by-byte which took hours. The concept of the PIC seemed too good to be true. I ordered the *PIC Toolkit* kit with software from Magenta and I was away, the Z80 became history instantly.

Initially, PIC programming was a hobby used for gadgets around the house, but lately the company I work for have seen the immense capabilities of the PIC and my job now involves designing electronics revolving around PICs.

I notice that the 18F series of PICs seem to be appearing in more and more projects and articles, How about doing another introduction course but this time specifically for the 18F series. I feel that the USB capabilities of certain 18F series devices would also be useful to explore, how about an article on these?

I now use a Microchip ICD2 programmer to program PICs so the *PIC Toolkit* has become redundant, but what does frustrate me is the use of bootloaders in some of your application examples alleviating the need for a programmer. Perhaps an article on bootloader implementation would help me and others understand them.

Many thanks again, that initial course started off a new hobby for me which has now resulted in a new career avenue.

Dave Gillery, via email

Thanks for that Dave. I also sent it on to Mike Hibbett for his info. The 18F series, Malc Wiles and I covered as much as we intend to, maybe 18 months ago. Mike Hibbett will be looking at bootloaders again soon (I'm in discussion with him). Mike also replied to Dave:

I picked up on the USB interface of the 18F devices in Part 4 of my C for PICs *programming tutorial, which was in the Feb '07 issue. The USB peripheral is extremely complex and I feel it is well worth simply picking up the example firmware driver supplied free by Microchip – that way you can save yourself a large headache!*

In relation to the bootloader, its use doesn't make programming hardware redundant yet – you still need to program the bootloader into the PIC in the first place! I do find, however, that a bootloader is invaluable during code development, because it speeds up the process. If you are doing a lot of small code changes, it is really nice to be able to download the code to your hardware quickly and without having to plug in additional hardware or pop chips out. I don't know about you, but I have destroyed several PICs as a result of wrongly inserting them into a board when I have been in a hurry.

The bootloader that I use in many of my articles was described in a PIC N' Mix *article in the December 2005 issue; if you get a chance to read it, we would be interested to hear your thoughts on whether this covered it in enough detail.*

Mike Hibbett via email

November '06 Issue

Dear EPE,

I have some comments about the November '06 issue. I know I'm late but I bought the November issue at a USA bookstore in early December. (I don't have the December issue at the time of writing, but hope to purchase it shortly. I probably will get an online subscription soon.)

I like several of the articles. *Micropower Battery Controller* looks quite useful. The constructional articles *Studio 350 Power Amplifier Module* (Oct and Nov) look good.

However, I have one comment regarding the latter. The power supply capacitors (Fig.6, Nov) are shown as 8000μF 75V. I think the voltage rating should be a little higher. If the mains voltage is 10% high, the voltage on the capacitors will be about 77V. I see in the Jaycar advertisement that they are selling a kit (without power supply) for this amplifier. Their RU-6710 capacitor is 8000μF 80V, which allows a little voltage safety factor. I like a little more safety factor, and I might use their RU-6712 (10000μF 100V). The RU-6712 has a much higher ripple current rating (8.1A compared to 3.47A for the RU-6710). A higher ripple current rating indicates a lower ESR, which would indicate lower internal heat and longer life for the capacitor, with slightly lower ripple voltage. The only problem with the RU-6712 is that the price is twice that of the RU-6710.

Bill Stiles, Hillsboro, USA, via email

Thanks for the comments Bill. We've no problem with you increasing the safety margin if you feel happier.

Battery Genie

Dear EPE,

Could you ask on your page if anybody else has experience of using these things called *battery genie* and the like for recharging zinc/magnesium torch batteries, etc.

My criteria for testing after they have been recharged is to use an AVO set to the 10A range and anything showing over 1A is a good one. However, it's been my experience that if you buy any of these Panasonic batteries from the street markets, I think they have a very marginal spare capacity of chemicals inside to allow for much of a recharge. Usually I just get about one tiny short lived boost and the next time round you boil the battery for about eight hours and never actually achieve anything. Keep it up for a couple of days and you will be told that the battery is spent.

By the way, in the street markets we have had the Panasonic four Pack AA batteries on sale for 60p for about two years, and now suddenly, magically, as Christmas approached the price shot up to a pound. I never did understand the pricing policy where a pack of the smaller AAA batteries was more expensive than a pack of AA ones.

Ages ago I read that we paid over £1000 per kilowatt for batteries and I guess now that is a serious underestimate. Then we get the story that purchasing printing ink in those tiny containers is more expensive than the best quality champagne per litre. Well, as far as I'm concerned both of them are undrinkable!

George Chetley, via email

Thanks George – consider your question asked!

TK3 vs The Rest

Dear EPE,

I believe you like suggestions, and as a longstanding reader and sometimes contributor I have one to make. Teaching us all about PICS has been excellent, and no doubt kept up the circulation. But I do not think that in-house programmers like *TK3* can possibly compete with the ongoing output of Microchip. Indeed, you yourself added a note to this effect to Mike Hibbett's article in the September issue.

Microchip now produce about 500 different PICs, as can be seen on their website. The sensible thing to do is clear– if you can't beat them, join them.

Your website has on it a very old MPASM programmer that goes no further than C devices, not reaching the F = Flash gadgets like 16F84 even. So those of us that did not follow TASM but picked up elsewhere early MPASM programmers need some help. (Yes I know *TK3* will do MPASM, but it's too late for those of us who went the MPASM way, and anyway it cannot keep up with Microchip's output.)

Microchip MPLAB offers everything, including simulators, programmers, etc, for the said 500 chips, and on their website there is some help in using it. But it is quite complex compared with some of their earlier programmers. On the other hand they do keep it up to date, and will continue to do so. I can use MPLAB in a basic manner, but I know I am missing a lot.

So my request is for a short series from one of your professionally trained occasional contributors who now appear in *EPE*, leading us simpletons step by step through MPLAB. A good method would be to use as an example a simple 16F84 program. Then anyone could advance to a more complex program (it's not programming that's the difficulty) or to another processor, once they have seen how to steer MPLAB towards it.

The current *C for PICs* leaves me standing, although I do write programs that fill two 16F84s. I think my need is for basic MPLAB before tackling C – and if I feel that, so perhaps do others.

Michael McLoughlin, via email

Hi again Michael, thanks for the useful comments.

I share your views that TK3 has run its effective course, and I shall not attempt to upgrade it further for additional PICs, unless I also feel the need to use one of those PICs.

TK3 has successfully fullfilled an earlier need – a simple assembler/programmer with a lot of facilities that helps the dedicated programmming reader (including myself) to develop code more readily. It also filled an earlier need for translating between TASM (through which EPE *was first introduced to PICs a decade ago) and MPASM, the nearly universal standard now.*

For those readers for whom TK3 does not offer the facilities for the newer PICs so frequently being introduced, I have no hesitation in recommending that they use a commercial design of assembler/programmer, such as Microchip's own for example. Their facilities will enable any of the PIC range to be handled.

The idea of covering MPLAB certainly has merits, but it too is not universal, and various suppliers of PIC programmers and assemblers also provide their own programming software extras. It seems appropriate for us to wait and see what readers might say about the idea after they have read your letter, along with this reply.

Using a 16F84 for any such tutorial would be inappropriate, though, as it is effectively an obsolete device, but there are other PICs that could be chosen.

Thoughts please readers ...

Finding FTP Files

Dear EPE,

I find it a tedious task to find the code mentioned in an *EPE* article. For example, Nov '06 issue, page 20, author references to *Joe Farr's Serial Interface* software, but I cannot find it.

Also, the RESOURCES box says 'software, including source code, is available', yet, I am unable to locate it. My point is that the directory structure of the FTP site needs to be overhauled.

Charles Newberry, USA, via email

Webmaster Alan replied to Charles:

I understand and can agree how the file area must be a bit frustrating to use at times. Unfortunately, it's due to the way it evolved over a decade or more. The FTP file area dates from the mid 1990s when we started to give away our PIC source codes. The site predates the web site by many years, and we have to ensure that the file area information is retro-compatible with all the EPE *back issues that are still in circulation. So even if we redesigned it, we have the problem of tallying with the information that is still out there in print.*

*Unfortunately, it wasn't possible to see how it would develop at a time when the web didn't even exist, so in a way we are handicapped by the need to handle an expanding number of FTP files, along with the need to keep it all backwards-compatible. We try to be consistent, and the Downloads page of the web site **www.epemag.wimborne.co.uk/downloads.html** was developed as a friendlier web interface to the FTP site. You may have more success there.*

We support the file downloads fully and in case of difficulty all that is needed is a quick email to us or check what other users are doing via the EPE Chat Zone *forum. Also, Joe Farr generously supports users in our CZ forum, so there is a good chance of receiving further help that way.*

The Serial *software is available via the Downloads page, under the heading 'All PIC Microcontroller Source Codes' -> 'PICS', -> Serial Interface for PICS and VB6 which points to **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/SerialOCX/**.*

The EPE Chat Zone *forum is hosted at **www.chatzones.co.uk**.*

Alan Winstanley, On-line Editor

C for PICs

Dear EPE,

I received my November issue and read with interest Mike Hibbett's articles as well as John B's amazing moving message implementation. Mike certainly has a broad range of PIC-related interests.

I programmed mainframes and PCs in various implementations of C for quite a few years, but never PICs, so I decided to give it a try. Mike's use of Microsoft C18 seems very appropriate, but his suggestion of HiTech PICC Lite as a compiler does not appear reasonable. This compiler only compiles for eight PICs (actually five different PICs) under very strong limitations on RAM use, among other things. However, the 'MikroC' compiler from Mikroelectronika (**www.mikroelectro nika.co.uk**) compiles for almost all PIC 12C, 12F, 16C, 16F and 18F MCUs (except Baseline – 12-bit instruction – PICs). The registered (free) version is limited only by restriction to 2K commands in the **.hex** file. PICC Lite never allows more than 2K instructions, and usually less.

I find MikroC has a very attractive interface, and the fact that it it does not integrate with MPLAB is no real disadvantage, particularly if you use PICkit 2 as a programmer, as I do (MPLAB only integrates with PICkit 2 for one PIC). Just send the hex files to your PICs with whatever programmer that you use.

Ed Grens, via email

Ed's email was sent on to Mike Hibbett, who replied:

Thanks for your comments Ed. On the subject of compilers I hadn't intended to endorse any one particular compiler, just indicate that there is more than one available. Although by selecting the Microchip offering for the tutorial I guess I am demonstrating some bias!

I hope people will note your comments and give the MikroC compiler a try. While I would find the 2K limit too limiting, others may not.

*I'm hoping to produce an objective evaluation of a number of compilers (both free and commercial) sometime in the near future in **EPE** when I can arrange the loan of the software from the vendors. It will be interesting to compare how efficient the products are, since converting C to PIC assembly is no simple task.*

Mike Hibbett, via email

Get your mouth

Visit us at www.jaycarelectronics.co.uk/catalogue and get your beak around our catalogue from Australia, you'll be flipping mad to miss out! All prices in £ Stg.

POST AND PACKING CHARGES:

Order Value	Cost	Order Value	Cost
£20 - £49.99	£5	£200 - £499.99	£30
£50 - £99.99	£10	£500+	£40
£100 - £199.99	£20		

Max weight 12lb (5kg). Heavier parcels POA. Minimum order £20.

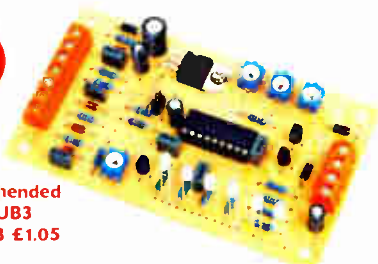
Note: Products are dispatched from Australia, so local customs duty and taxes may apply.

Car Air Conditioner Controller Kit

KC-5437 £11.75 + post & packing

This kits stops the air conditioner in your car from taking engine power under acceleration. It will allow the compressor to run with low throttle even when the cabin temperature setting has been reached and will automatically switch the compressor off at idle. It also features an override switch, an LED function indicator. Kit supplied with PCB with overlay and all electronic components with clear English instructions.

NEW



Recommended box UB3 HB-6013 £1.05

Speedo Corrector MkII

Improved Model!

KC-5435 £14.50 + post & packing

When you modify your gearbox, diff ratio or change to a large circumference tyre, it may result in an inaccurate speedometer. This kit alters the speedometer signal up or down from 0% to 99% of the original signal. With this improved model, the input set-up selection can be automatically selected and it also features an LED indicator to show when the input signal is being received. Kit supplied with PCB with overlay and all electronic components with clear English instructions.

NEW

Galactic Voice Kit

KC-5431 £13.25 + post & packing

Be the envy of everyone at the next Interplanetary Conference for Evil Beings with this galactic voice simulator kit. Effect and depth controls allow you to vary the effect to simulate everything from the metallically-challenged C-3PO, to the hysterical ranting of Daleks hell-bent on exterminating anything not nailed down. The kit includes PCB with overlay, enclosure, speaker and all components. For those who really need to get out of the house a lot more. Take me to your leader.

- Requires 9V battery

DC Relay Switch

KC-5434 £4.50 + post & packing

An extremely useful and versatile kit that enables you to use a tiny trigger current - as low as 400µA at 12V to switch up to 30A at 50VDC. It has an isolated input, and is suitable for a variety of triggering options. The kit includes PCB with overlay and all electronic components with clear English instructions.

NEW

Battery Zapper MKII

KC-5427 £29.00 + post & packing

This kit attacks a common cause of failure in wet lead acid cell batteries: sulphation. The circuit produces short bursts of high level energy to reverse the damaging sulphation effect. This new improved unit features a battery health checker with LED indicator, new circuit protection against badly sulphated batteries, test points for a DMM and connection for a battery charger. Kit includes case with screen printed lid, PCB with overlay, all electronic components and clear English instructions. Suitable for 6, 12 and 24V batteries

- Powered by the battery itself

Improved Model!

IR Remote Control Extender MKII

Improved Model!

KC-5432 £7.25 + post & packing

Operate your DVD player or digital decoder using its remote control from another room. It picks up the signal from the remote control and sends it via a 2-wire cable to an infrared LED located close to the device. This improved model features fast data transfer, capable of transmitting Foxtel digital remote control signals using the Pace 400 series decoder. Kit supplied with case, screen printed front panel, PCB with overlay and all electronic components.

Requires 9VDC wall adaptor (Maplin #GS74R £10.99)

Radar Speed Gun

NEW

KC-5429 £29.00 + post & packing

This Doppler radar gun reads speed in km/h or mph up to 250 km/h or 155 mph. It has a resolution of 1 km/h or 1 mph with an accuracy of 1%, and also has a hold switch so you can freeze the reading. There's a jiffy box to mount the electronics in, and the enclosure for the radar gun assembly is made from 2 x coffee tins or similar. Details included. Kit includes PCB and all specified components with clear English instructions.

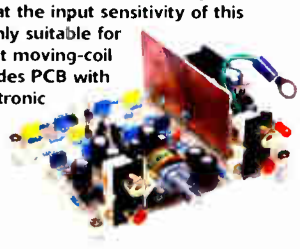
- Requires 12VDC power.

Magnetic Cartridge Pre-amp

KC-5433 £11.75 + post & packing

This kit is used to amplify the 3-4mV signals from a phono cartridge to line level, so you can use your turntable with the CD or tuner inputs on your Hi-Fi amplifier - most modern amps don't include a phono input any more. Dust off the old LP collection or use it to record your LPs on to CD. The design is suitable for 12" LPs, and also allows for RIAA equalisation of all the really old 78s. Please note that the input sensitivity of this design means it's only suitable for moving-magnet, not moving-coil cartridges. Kit includes PCB with overlay and all electronic components.

- Requires 12VAC power



Theremin Synthesiser MKII

Improved Model!

KC-5426 £43.50 + post & packing

By moving your hand between the metal antennae, create unusual sound effects! The Theremin MkII improves on its predecessor by allowing adjustments to the tonal quality by providing a better waveform. With a multitude of controls, this instrument's musical potential is only limited by the skill and imagination of its player. Kit includes stand, PCB with overlay, machined case with silkscreen printed lid, loudspeaker, pitch antennae, all specified electronic components and clear English instructions.

Requires 9-12VDC wall adaptor (Maplin #UG01B £13.99)

As used in the Beach Boys classic hit 'Good Vibrations'

around our Catalogue!

Everyday Practical Electronics Feature Kits

Over the last 12 months and continuing into the New Year, Everyday Practical Electronics Magazine has been publishing a series of popular kits by the acclaimed Silicon Chip Magazine Australia. These projects are brilliantly designed 'bullet proof' and already tested down under. All Jaycar kits are supplied with specified board components, quality fibreglass tinned PCBs and have clear English instructions. Watch this space for future featured kits.

SMS Controller Module Kit

KC-5400 £15.95 + post & packing

Control appliances or receive alert notification from anywhere. By sending plain text messages this kit will allow you to control up to eight devices. It can also monitor four digital inputs. It works with old Nokia handsets such as the 5110, 6110, 3210, and 3310, which can be bought inexpensively if you do not already own one. Kit supplied with PCB, pre-programmed microcontroller and all electronics components with clear English instructions.

* Requires a Nokia data cable which can be readily found in mobile phone accessory stores.

As published in this month's Everyday Practical Electronics Magazine!

Speaker Bass Extender Kit

KC-5411 £6.00 + post & packing

Most audiophiles know that loudspeaker enclosures have a natural frequency rolloff which is inherent in their design. The bass extender kit boosts the level of the bass to counteract the natural rolloff of the enclosure, producing rich, natural bass. It gives an extra octave of response, and is sure to please even the most avid audiophiles. Kit supplied with PCB, and all electronic components with clear English instructions.

Automotive Courtesy Light Delay

KC-5392 £5.95 + post & packing

This kit provides a time delay in your vehicle's interior light, for you to buckle-up your seat belt and get organsied before the light dims and fades out. It has a 'soft' fade-out after a set time has elapsed, and has universal wiring. Kit supplied with PCB with overlay, all electronics components and clear English instructions.

• As published in Everyday Practical Electronics February 2007

Recommended box UB5 HB-6015 £0.83

Delta Throttle Timer Kit

KC-5373 £7.95 + post & packing

It will trigger a relay when the throttle is depressed or lifted quickly. There is a long list of uses for this kit, such as automatic transmission switching of economy to power modes, triggering electronic blow-off valves on quick throttle lifts and much more. It is completely adjustable, and uses the output of a standard throttle position sensor. Kit supplied with PCB and all electronic components.

• As published in Everyday Practical Electronics November 2006

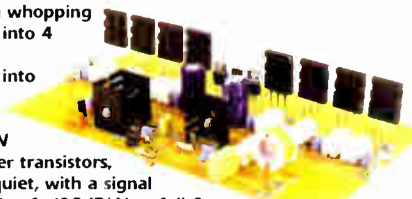
Recommended box UB3 HB-6013 £1.05

Studio 350 High Power Amplifier Kit

KC-5372 £55.95 + post & packing

It delivers a whopping 350WRMS into 4 ohms, or 200WRMS into 8 ohms. Using eight 250V 200W plastic power transistors. It is super quiet, with a signal to noise ratio of -125dB(A) at full 8 ohm power. Harmonic distortion is just 0.002%, and frequency response is almost flat (less than -1dB) between 15Hz and 60kHz. Kit supplied in short form with PCB and electronic components. Kit requires heatsink and +/- 70V power supply (a suitable supply is described in the instructions).

• As published in Everyday Practical Electronics October & November 2006



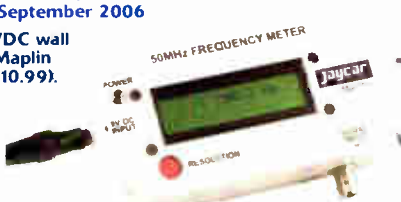
50MHz Frequency Meter Kit

KC-5369 £22.50 + post & packing

This meter is autoranging and displays the frequency in either hertz, kilohertz or megahertz. Features compact size (130 x 67 x 44mm), 8 digit LCD, high and low resolution modes, 0.1Hz resolution up to 150Hz, 1Hz resolution maximum up to 150Hz and 10Hz resolution above 16MHz. Kit includes PCB, case with machined and silkscreened lid, pre-programmed PIC and all electronic components with clear English instructions.

• As published in Everyday Practical Electronics September 2006

Requires 9VDC wall adaptor (Maplin #GS74R £10.99).



2 Amp DC-DC Converter Kit

KC-5358 £13.75 + post & packing

This kit will step-up 12V to between 13.8 and 24VDC. Use it to charge 12V sealed lead acid batteries (6.5Ah or larger), run your laptop and many other devices from a 12V supply. It uses an efficient switchmode design, features fuse and reverse polarity protection, and an LED power indicator. Kit includes PCB, all electronic components, and silkscreened front panel.

• As published in Everyday Practical Electronics August 2006

Smart Card Reader and Programmer Kit

KC-5361 £15.95 + post & packing

Program both the microcontroller and EEPROM in the popular gold, silver and emerald wafer cards. Card used needs to conform to ISO-7816 standards, which includes ones sold by Jaycar. Powered by 9-12 VDC wall adaptor or a 9V battery. Instructions outline software requirements that are freely available on the internet. Kit supplied with PCB, wafer card socket and all electronic components. PCB measures: 141 x 101mm.

• As published in Everyday Practical Electronics May 2006

Requires 9-12VDC wall adaptor (Maplin #UG01B £13.99)

Jaycar cannot accept responsibility for the operation of this device, its related software, or its potential to be used in relation to illegal copying of smart cards in cable TV set top boxes.

Log on to
www.jaycarelectronics.co.uk/catalogue
for your FREE catalogue!

0800 032 7241

(Monday - Friday 09.00 to 17.30 GMT + 10 hours only).
For those who want to write: 100 Silverwater Rd
Silverwater NSW 2128 Sydney AUSTRALIA

410+ page Catalogue

All prices in £

Jaycar Electronics

FREE *Two booklets* (Identifying Electronic Components *and* Understanding Active Components) *and a* Circuit Surgery CD-ROM with Teach-In 2000 CD-ROM

EPE TEACH-IN 2000 CD-ROM

The whole of the 12-part *Teach-In 2000* series by John Becker (published in *EPE* Nov '99 to Oct 2000) is now available on CD-ROM in PDF form. Plus the *Teach-In 2000* interactive software (Win 95, 98, ME and above) covering all aspects of the series and Alan Winstanley's *Basic Soldering Guide* (including illustrations and Desoldering).

Teach-In 2000 covers all the basic principles of electronics from Ohm's Law to Displays, including Op.Amps, Logic Gates etc. Each part has its own section on the interactive software where you can also change component values in the various on-screen demonstration circuits.

The series gives a hands-on approach to electronics with numerous breadboard circuits to try out, plus a simple computer interface (Win 95, 98, ME **ONLY**) which allows a PC to be used as a basic oscilloscope.

ONLY **£12.45** including VAT and p&p

Order code Teach-In CDROM

THE AMATEUR SCIENTIST 3·0 CD-ROM

CD-ROM

The complete collection of The Amateur Scientist articles from *Scientific American* magazine. Over 1,000 classic science projects from a renowned source of winning projects. All projects are rated for cost, difficulty and possible hazards.
Plus over 1,000 pages of helpful science techniques that never appeared in *Scientific American.*
Exciting science projects in: Astronomy; Earth Science; Biology; Physics; Chemistry; Weather . . . and much more! The most complete resource ever assembled for hobbyists, and professionals looking for novel solutions to research problems.
Includes extensive Science Software Library with even more science tools.
Suitable for Mac, Windows, Linux or UNIX. 32MB RAM minimum, Netscape 4.0 or higher or Internet Explorer 4.0 or higher.

Over 1,000 projects

CD-ROM — **Order code ASICD-ROM** — £19.95

DIRECT BOOK SERVICE

The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.

FOR A FURTHER SELECTION OF BOOKS SEE THE NEXT TWO ISSUES OF EPE.

All prices include UK postage

PROJECT CONSTRUCTION

IC 555 PROJECTS
E. A. Parr

Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are over 70 circuit diagrams and descriptions covering basic and general circuits, motor car and model railway circuits, alarms and noise makers as well as a section on 556, 558 and 559 timers. (Note. No construction details are given.) A reference book of invaluable use to all those who have any interest in electronics, be they professional engineers or designers, students or hobbyists.

167 pages — **Order code BP44** — £5.49

POWER SUPPLY PROJECTS
R. A. Penfold

This book offers a number of power supply designs, including simple unstabilised types, and variable voltage stabilised 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.

91 pages — **Order code BP76** — £5.49

HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT
R. A. Penfold

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 pulsers and crystal calibrators.

104 pages — **Order code BP267** — £5.49

ELECTRONIC PROJECT BUILDING FOR BEGINNERS
R. A. Penfold

This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics:

Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.

In fact everything you need to know in order to get started in this absorbing and creative hobby.

135 pages — **Order code BP392** — £5.49

TEST EQUIPMENT CONSTRUCTION
R. A. Penfold

This book describes in detail how to construct some simple and inexpensive but extremely useful, pieces of test equipment. Stripboard layouts are provided for all designs, together with wiring diagrams where appropriate, plus notes on construction and use.

The following designs are included:-

AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Mullivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe. The designs are suitable for both newcomers and more experienced hobbyists.

104 pages — **Order code BP248** — £4.49

COMPUTING

COMPUTING FOR THE OLDER GENERATION
Jim Gatenby

Especially written for the over 50s, using plain English and avoiding technical jargon. Large clear type for easy reading.

Among the many practical and useful ideas for using your PC that are covered in this book are: Choosing, setting up and understanding your computer and its main components. Writing letters, leaflets, invitations, etc., and other word processing jobs. Keeping track of your finances using a spreadsheet. Recording details of holidays and other ideas using a database. Using the Internet to find useful information, and email to keep in touch with family and friends. Making 'back-up' copies of your work and checking for viruses. How to use Windows XP to help people with impaired vision, hearing or mobility.

Provides the basic knowledge so you can gain enough confidence to join the local computer class.

308 pages — **Order code BP601** — £8.99

THE INTERNET FOR THE OLDER GENERATION
Jim Gatenby

Especially written for the over 50s. Uses only clear and easy-to-understand language. Larger type size for easy reading. Provides basic knowledge to give you confidence to join the local computer class.

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., so that you can keep in touch with family and friends all over the world. Searching for and saving information on any subject. On-line shopping and home banking. Setting up your own simple web site.

228 pages — **Order code BP600** — £8.99

RADIO

SETTING UP AN AMATEUR RADIO STATION
I. D. Poole

The aim of this book is to give guidance on the decisions which have to be made when setting up any amateur radio or short wave listening station. Often the experience which is needed is learned by one's mistakes, however, this can be expensive. To help overcome this, guidance is given on many aspects of setting up and running an efficient station. It then proceeds to the steps that need to be taken in gaining a full transmitting licence.

Topics covered include: The equipment that is needed; Setting up the shack; Which aerials to use; Methods of construction; Preparing for the licence.

86 pages — **Order code BP300** — £4.45

EXPERIMENTAL ANTENNA TOPICS
H. C. Wright

Although nearly a century has passed since Marconi's first demonstration or radio communication, there is still research and experiment to be carried out in the field of antenna design and behaviour.

The aim of the experimenter will be to make a measurement or confirm a principle, and this can be done with relatively fragile, short-life apparatus. Because of this, devices described in this book make liberal use of cardboard, cooking foil, plastic bottles, cat food tins, etc.

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.

72 pages — **Order code BP278** — £4.00

25 SIMPLE INDOOR AND WINDOW AERIALS
E. M. Noll

Many people live in flats and apartments or other types of accommodation where outdoor aerials are prohibited, or a lack of garden space etc. prevents aerials from being erected. This does not mean you have to forgo shortwave-listening, for even a 20-foot length of wire stretched out along the skirting board of a room can produce acceptable results. However, with some additional effort and experimentation one may well be able to improve performance further.

This concise book tells the story, and shows the reader how to construct and use 25 indoor and window aerials that the author has proven to be sure performers.

50 pages — **Order code BP136** — £2.25

TICKLING THE CRYSTAL Domestic British Crystal Sets of the 1920's
Ian L. Sanders

The first book dedicated to the topic of British crystal sets to be published in the last 25 years. For a very brief period during the early 1920's, these simple receivers played a crucial role in the expansion of domestic wireless throughout the United Kingdom. For many families, rich and poor, the crystal set provided an introduction to the new pastime of listening-in to broadcast programmes. Rapidly made obsolete from homes as suddenly as it had arrived, but not without leaving its mark on the history of wireless.

Written by a long-time authority and enthusiast, *Tickling the Crystal* is the most comprehensive work on the subject ever assembled. Containing almost two hundred excellent quality photographs and a wealth of previously unpublished material, it cannot fail to be an invaluable reference for anyone interested in the history of early wireless receivers.

256 pages hardback — **Order code TC1** — £34.00

THEORY AND REFERENCE

BEBOP TO THE BOOLEAN BOOGIE
Second Edition
Clive (call me Max) Maxfield

This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more. The author's tongue-in-cheek humour makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate.

Contents: Fundamental concepts; Analog versus digital; Conductors and insulators; Voltage, current, resistance, capacitance and inductance; Semiconductors; Primitive logic functions; Binary arithmetic; Boolean algebra; Karnaugh maps; State diagrams, tables and machines; Analog-to-digital and digital-to-analog; Integrated circuits (ICs); Memory ICs; Programmable ICs; Application-specific integrated circuits (ASICs); Circuit boards (PWBs and DWBs); Hybrids; Multichip modules (MCMs); Alternative and future technologies.

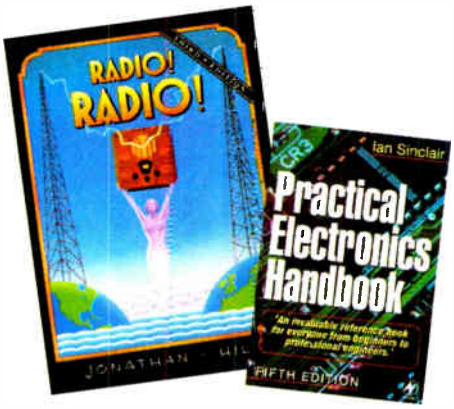
470 pages – large format **Order code BEB1** £26.95

BEBOP BYTES BACK (and the Beboputer Computer Simulator) CD-ROM
Clive (Max) Maxfield and Alvin Brown

This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the CD-ROM contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia and hundreds of carefully drawn illustrations, the CD-ROM contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers. If you're the slightest bit interested in the inner workings of computers, then don't dare to miss this!

Over 800 pages in Adobe Acrobat format

CD-ROM **Order code BEB2 CD-ROM** £21.95



RADIO! RADIO! (Third Edition)
Jonathan Hill

A celebration in words and pictures of the development of the British wireless set from it's experimental beginnings in Victorian England, to the foundation of a domestic wireless manufacturing industry and the inception of broadcasting in the early 1920's. The story continues on throught the design-conscious 1930's (where the radio really came into it's own as a piece of furniture), to the war-torn and austere days of the 1940's.

The first transistor radios began to appear in the second half of the 1950s and in this new edition, this rather neglected area has been fully covered by a section all of it's own which includes a directory listing of nearly 3,000 different transistor models. The book finishes after the 1960s, by which time our long established and once great radio industry had all but been destroyed by foreign imports.

Now with 320 pages and over 1,000 illustrations, informative captions and carefully researched text *Radio! Radio!* is the first and still the only truly comprehensive book of its kind ever to be published.

320 pages (A4 Hardback) **Order code RR1** £40.95

GETTING THE MOST FROM YOUR MULTIMETER
R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages **Order code BP239** £5.49

DIGITAL GATES AND FLIP-FLOPS
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.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages **Order code PC106** £9.95

OPERATIONAL AMPLIFIER USER'S HANDBOOK
R. A. Penfold

The first part of this book covers standard operational amplifer based "building blocks" (integrator, precision rectifier, function generator, amplifiers, etc), and considers the ways in which modern devices can be used to give superior performance in each one. The second part describes a number of practical circuits that exploit modern operational amplifiers, such as high slew-rate, ultra low noise, and low input offset devices. The projects include: Low noise tape preamplifier, low noise RIAA preamplifier, audio power amplifiers, d.c. power controllers, opto-isolator audio link, audio millivolt meter, temperature monitor, low distortion audio signalgenerator, simple video fader, and many more.

120 pages **Order code BP335** £5.45

PRACTICAL ELECTRONICS HANDBOOK –
Fifth Edition. Ian Sinclair

Provides a practical and comprehensive collection of circuits, rules of thumb and design data for professional engineers, students and enthusaists, and therefore enough background to allow the understanding and development of a range of basic circuits.

Contents: Passive components, Active discrete components, Circuits, Linear I.C.s, Energy conversion components, Digital I.C.s, Microprocessors and microprocessor systems, Transferring digital data, Digital-analogue conversions, Computer aids in electronics, Hardware components and practical work, Micro-controllers and PLCs, Digital broadcasting, Electronic security.

440 pages **Order code NE21** £24.50

MUSIC, AUDIO AND VIDEO

QUICK GUIDE TO MP3 AND DIGITAL MUSIC
Ian Waugh

MP3 files, the latest digital music format, have taken the music industry by storm. What are they? Where do you get them? How do you use them? Why have they thrown record companies into a panic? Will they make music easier to buy? And cheaper? Is this the future of music?

All these questions and more are answered in this concise and practical book which explains everything you need to know about MP3s in a simple and easy-to-understand manner. It explains:

How to play MP3s on your computer; How to use MP3s with handheld MP3 players; Where to find MP3s on the Web; How MP3s work; How to tune into Internet radio stations; How to create your own MP3s; How to record your own CDs from MP3 files; Other digital audio music formats.

60 pages **Order code PC119** £7.45

ELECTRONIC PROJECTS FOR VIDEO ENTHUSIASTS
R. A. Penfold

This book provides a number of practical designs for video accessories that will help you get the best results from your camcorder and VCR. All the projects use inexpensive components that are readily available, and they are easy to construct. Full construction details are provided, including stripboard layouts and wiring diagrams. Where appropriate, simple setting up procedures are described in detail; no test equipment is needed.

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

THE INVENTOR OF STEREO – THE LIFE AND WORKS OF ALAN DOWER BLUMLEIN
Robert Charles Alexander

This book is the definitive study of the life and works of one of Britain's most important inventors who, due to a cruel set of circumstances, has all but been overlooked by history.

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 elecronic 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 thirty-ninth birthday.

420 pages **Order code NE32** £23.00

VIDEO PROJECTS FOR THE ELECTRONICS CONSTRUCTOR
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.

Complete with explanations of how the circuit works, shopping lists of components, advice on construction, and guidance on setting up and using the projects, this invaluable book will save you a small fortune.

Circuits include: video enhancer, improved video enhancer, video fader, horizontal wiper, improved video wiper, negative video unit, fade to grey unit, black and white keyer, vertical wiper, audio mixer, stereo headphone amplifier, dynamic noise reducer, automatic fader, pushbutton fader, computer control interface, 12 volt mains power supply.

~~£10.95~~

124 pages **Order code PC115** £5.45

FAULT FINDING, CIRCUITS AND DESIGN

PIC BASIC PROJECTS – 30 PROJECTS USING PICBASIC AND PICBASIC PRO
BOOK + CDROM
Dogan Ibrahim
Covering the PICBASIC and PICBASIC PRO compliers, this thoroughly revised edition, previously entitled PICBASIC Programming and Projects, provides an easy-to-use toolkit for developing applications with PICBASIC. Numerous simple projects give clear and concrete examples of how PICBASIC can be used to develop electronics applications, while larger and more advanced projects describe program operation in detail and give useful insights into developing more involved microcontroller applications.

Packed with simple and advanced projects which show how to programme a variety of interesting electronic applications using PICBASIC. Covers the new and powerful PIC16F627 and PIC16F73, and the popular PIC16F84 and PIC16F877 models. The CDROM includes program source files, HEX code, data sheets of devices, sensors and schematics of the circuits used in the book.

358 pages **Order code NE44** **£21.50**

DISCOVERING PICS
BOOK + CDROM + HARDWARE
W.D.Phillips
A good introduction to PIC programming, covering everything you need to know to get you started. No previous knowledge of microcontrollers is required, but some previous experience with electronic circuits is assumed. Covers the basic concept of a microcontroller, fundamentals of a PIC-based circuit and using the MPLAB program. Further chapters introduce binary, PIC architecture, the instruction set, the PIC memory map and special registers plus real world programming. Four simple projects are also fully described; a Wavy Wand, an Electronic Dice, a Games Timer and a Pulse Monitor.

The associated CDROM contains the book in PDF format, MPLAB (plus instruction manuals in PDF format) and all the programs covered in the book as assembler (ASM) files. Those that wish to programme their own PICs will require a PIC programmer.

In addition a p.c.b. based hardware kit is also available that makes up into the Wavy Wand which will spell out a short message via a line of l.e.d.s when waved through the air.

190 pages, A4 spiral bound

Book + CDROM Order code DOC1 **£22.00**

Book + CDROM + Hardware Order code DOC2 **£28.50**

PRACTICAL OSCILLATOR CIRCUITS
A. Flind
Extensive coverage is given to circuits using capacitors and resistors to control frequency. Designs using CMOS, timer i.c.s and op.amps are all described in detail, with a special chapter on "waveform generator" i.c.s. Reliable "white" and "pink" noise generator circuits are also included. 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.

Crystal oscillators have their own chapter. Many of the circuits shown are readily available special i.c.s for simplicity and reliability, and offer several output frequencies. Finally, complete constructional details are given for an audio sinewave generator.

133 pages **Order code BP393** **£5.49**

PIC IN PRACTICE (2nd Edition)
David W. Smith
A graded course based around the practical use of the PIC microcontroller through project work. Principles are introduced gradually, through hands-on experience, enabling hobbyists and students to develop their understanding at their own pace. The book can be used at a variety of levels.
Contents: Introduction to the PIC microcontroller; Programming the 16F84 microcontroller; Introductory projects; Headers, porting code – which micro?; Using inputs; Keypad scanning; Program examples; The 16C54 microcontroller; Alphanumeric displays; Analogue to digital conversion; Radio transmitters and receivers; EEPROM data memory; Interrupts; The 12 series 8-pin microcontroller; The 16F87X microcontroller; The 16F62X microcontroller; Projects; Instruction set, files and registers; Appendices; Index.

308 pages **Order code NE39** **£19.50**

COIL DESIGN AND CONSTRUCTIONAL MANUAL
B. B. Babani
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now twenty years old, with the exception of toroids and pulse transformers little has changed in coil design since it was written.

96 pages **Order code BP160** **£4.49**

PRACTICAL ELECTRONIC FAULT FINDING AND TROUBLESHOOTING
Robin Pain
To be a real fault finder, you must be able to get a feel for what is going on in the circuit you are examining. In this book Robin Pain explains the basic techniques needed to be a fault finder.

Simple circuit examples are used to illustrate principles and concepts fundamental to the process of fault finding. This is not a book of theory, it is a book of practical tips, hints and rules of thumb, all of which will equip the reader to tackle any job. You may be an engineer or technician in search of information and guidance, a college student, a hobbyist building a project from a magazine, or simply a keen self-taught amateur who is interested in electronic fault finding but finds books on the subject too mathematical or specialised.

The fundamental principles of analogue and digital fault finding are described (although, of course, there is no such thing as a "digital fault" – all faults are by nature analogue). This book is written entirely for a fault finder using only the basic fault-finding equipment: a digital multimeter and an oscilloscope. The treatment is non-mathematical (apart from Ohm's law) and all jargon is strictly avoided.

274 pages **Order code NE22** **£28.99**

A BEGINNERS GUIDE TO CMOS DIGITAL ICs
R. A. Penfold
Getting started with logic circuits can be difficult, since many of the fundamental concepts of digital design tend to seem rather abstract, and remote from obviously useful applications. This book covers the basic theory of digital electronics and the use of CMOS integrated circuits, but does not lose sight of the fact that digital electronics has numerous "real world" applications.

The topics covered in this book include: the basic concepts of logic circuits; the functions of gates, inverters and other logic "building blocks"; CMOS logic i.c. characteristics, and their advantages in practical circuit design; oscillators and monostables (timers); flip/flops, binary dividers and binary counters; decade counters and display drivers.

119 pages **Order code BP333** **£5.45**

AUDIO AMPS

BUILDING VALVE AMPLIFIERS
Morgan Jones
The practical guide to building, modifying, fault-finding and repairing valve amplifiers. A hands-on approach to valve electronics – classic and modern – with a minimum of theory. Planning, fault-finding, and testing are each illustrated by step-by-step examples.
A unique hands-on guide for anyone working with valve (*tube* in USA) audio equipment – as an electronics experimenter, audiophile or audio engineer.
Particular attention has been paid to answering questions commonly asked by newcomers to the world of the vacuum tube, whether audio enthusiasts tackling their first build, or more experienced amplifier designers seeking to learn the ropes of working with valves. The practical side of this book is reinforced by numerous clear illustrations throughout.

368 pages **Order code NE40** **£22.50**

AUDIO AMPLIFIER PROJECTS
R. A. Penfold
A wide range of useful audio amplifier projects, each project features a circuit diagram, an explanation of the circuit operation and a stripboard layout diagram. All constructional details are provided along with a shopping list of components, and none of the designs requires the use of any test equipment in order to set up properly. All the projects are designed for straightforward assembly on simple circuit boards.

Circuits include: High impedance mic preamp, Low impedance mic preamp, Crystal mic preamp, Guitar and GP preamplifier, Scratch and rumble filter, RIAA preamplifier, Tape preamplifier, Audio limiter, Bass and treble tone controls, Loudness filter, Loudness control, Simple graphic equaliser, Basic audio mixer, Small (300mW) audio power amp, 6 watt audio power amp, 20/32 watt power amp and power supply, Dynamic noise limiter.

A must for audio enthusiasts with more sense than money!

116 pages **Order code PC113** ~~£10.95~~ **£5.45**

VALVE AMPLIFIERS
Second Edition. Morgan Jones
This book allows those with a limited knowledge of the field to understand both the theory and practice of valve audio amplifier design, such that they can analyse and modify circuits, and build or restore an amplifier. Design principles and construction techniques are provided so readers can devise and build from scratch, designs that actually work.

The second edition of this popular book builds on its main strength – exploring and illustrating theory with practical applications. Numerous new sections include: output transformer problems; heater regulators; phase splitter analysis; and component technology. In addition to the numerous amplifier and preamplifier circuits, three major new designs are included: a low-noise single-ended LP stage, and a pair of high voltage amplifiers for driving electrostatic transducers directly – one for headphones, one for loudspeakers.

288 pages **Order code NE33** **£34.00**

BOOK ORDERING DETAILS

All prices include UK postage. For postage to Europe (air) and the rest of the world (surface) please add £2 per book. For the rest of the world airmail add £3 per book. CD-ROM prices include VAT and/or postage to anywhere in the world. Send a PO, cheque, international money order (£ sterling only) made payable to **Direct Book Service** or card details, Visa, Mastercard, Amex, Diners Club or Switch/Maestro to: **DIRECT BOOK SERVICE, WIMBORNE PUBLISHING LIMITED, 408 WIMBORNE ROAD EAST, FERNDOWN, DORSET BH22 9ND.**

Books are normally sent within seven days of receipt of order, but please allow 28 days for delivery – more for overseas orders. *Please check price and availability (see latest issue of* Everyday Practical Electronics*) before ordering from old lists.*

For a further selection of books see the next two issues of *EPE*.

Tel 01202 873872 Fax 01202 874562. E-mail: dbs@wimborne.co.uk

Order from our online shop at: www.epemag.co.uk

BOOK ORDER FORM

Full name: ....

Address: ....

....

....

.... Post code: .... Telephone No: ....

Signature: ....

☐ I enclose cheque/PO payable to DIRECT BOOK SERVICE for £ ....

☐ Please charge my card £ .... Card expiry date...

Card Number .... Switch/Maestro Issue No....................

Card Security Code .... (the last three digits on or just below the signature strip)

Please send book order codes: ....

....

Please continue on separate sheet of paper if necessary

PCB SERVICE

Printed circuit boards for most recent *EPE* constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. Double-sided boards are NOT plated through hole and will require 'vias' and some components soldering both sides. All prices include VAT and postage and packing. Add £1 per board for *airmail* outside of Europe. Remittances should be sent to **The PCB Service, *Everyday Practical Electronics*, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872; Fax 01202 874562;Email: orders@epemag.wimborne.co.uk. On-line Shop: www.epemag.wimborne.co.uk/shopdoor.htm.** Cheques should be crossed and made payable to *Everyday Practical Electronics* **(Payment in £ sterling only). NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.**
Back numbers or photocopies of articles are available if required – see the *Back Issues* page for details. We do not supply kits or components for our projects.

Please check price and availability in the latest issue. A large number of older boards are listed on, and can be ordered from, our website.
Boards can only be supplied on a payment with order basis.

PROJECT TITLE		Order Code	Cost
All-Band Radio – Full Version	SEPT '05	523	£5.71
– Mini Version		524	£5.23
★Multicore Cable Tester – Main		525	£6.19
– Active		526	£5.55
Back-To-Basics 6 – Daily Reminder		527	£6.19
– Whistle Switch		528	£5.87
★Model Railway Signal Control		529	£6.19
★Snooker/Darts Scoreboard		530	£8.72
Photic Phone – Transmitter	OCT '05	531 } pair	£6.98
– Receiver		532	
Back-To-Basics 7 – Parking Radar		533	£5.71
– Telephone Switch		534	£5.55
★Haloween Howler		535	£6.02
★PIC-Based USB Interface		536	£6.19
★PIC Chromatone	NOV '05	537	£6.82
Back-To-Basics 8 – Noughts and Crosses Enigma		538	£6.66
– Weather Vane Repeater		539	£6.18
★Multi-Function R/C Switch		540	£5.87
★Speed Camera Watch Mk2		541	£6.35
Solid-State Valve Power Supply	DEC '05	542	£6.35
★Vehicle Frost Box Mk2		543	£5.71
★Propeller Monitor		544	£6.02
Solid-State Hammond		545	£6.18
★PIC Ambilux	JAN '06	546	£5.71
Sunset Switch		547	£6.98
Current Clamp Adaptor for Multimeters		548	£5.39
★Tiptronic-Style Gear Indicator			
– Micro Board		549 } per set	£7.61
– Display Board		550	
– Hall Speed Board		551	
★Keypad Alarm	FEB '06	552	£6.02
3-Way Active Crossover		553	£9.20
Jazzy Heart		554	£6.02
Status Monitor– Transmitter		555 } pair	£7.61
– Reciever		556	
Power Up	MAR '06	557	£6.82
Video/Audio Booster (double-sided)		558	£12.00
★Telescope Interface		559	£6.50
'Smart' Slave Flash	APR '06	560	£6.18
Programmable Continuity Tester		561	£5.87
PortaPAL			
– Microphone Board		562	£6.18
– Auxilary Board		563	£5.87
– Main Board		564	£8.56
– Charger Board		565	£6.66
Omni Pendulum		566	£6.34
Smart Card Reader/Programmer	MAY '06	567	£7.61
LED Lighting For Your Car (set of 15 boards)		568	£14.75
Digital Reaction Timer		569	£7.13
Poor Man's Metal Locator	JUN '06	570	£5.71
★Digital Instrument Display for Cars			
– Micro Board		571 } pair	£7.77
– Display Board		572	
Widgy Box		573	£7.29
Phone Ring & Test		574	£6.82
★Sudoku Unit	JUL '06	575	£6.66
PC Power Monitor		576	£6.50
Home Theatre Sound Level Checker	AUG '06	577	£6.66
Adjustable DC-DC Converter For Cars		578	£6.50
★Telephone Dialler For Buglar Alarms		579	£6.97
★High Intensity Torch		580	£5.39

PROJECT TITLE		Order Code	Cost
★ Low Cost 50MHz Frequency Meter	SEP '06		
Version 1		581	£6.66
Version 2		582	£6.66
Version 3		583	£6.66
Smart Mixture Display for your Car		584	£6.50
Water Level Gauge – Sensor		585 } pair	£6.98
– Display		586	
Fridge Door-Open Alarm	OCT '06	587	£5.71
Linear Supply For 1W Star LEDs (Pair)		588a & b	£6.50
Through-Glass Alarm		589	£7.61
Quick Brake	NOV '06	590	£6.50
Studio 350 Power Amplifier		591	£9.51
Micropower Battery Protector		592	£5.71
★Giant LED Message Display – Master		594	£5.55
– Slave		595	£6.50
Lapel Microphone Adaptor	DEC '06	593	£6.18
RGB To Component Video Converter (double sided)		596	£12.69
USB Power Injector		597	£5.87
★Mind Trainer		598	£6.50
Balanced Microphone Preamp	JAN '07	599	£6.82
High-Efficiency Power Supply for 1W Star LEDs		600	£6.19
Jumping Spider		601	£5.71
★Programmable Robot	FEB '07	602	£6.50
Courtesy Light Delay		603	£5.87
★Deep Cycle Battery Charger			
Power Board		604 } set	£11.10
Control Board		605	
Display Board		606	
★PIC Digital Geiger Counter (double sided)		607	£12.53
IR Remote Checker	MAR '07	608	£6.35
★SMS Controller		609	£7.93
★Lap Counter For Swimming Pools		610	£7.14
★PIC Polyphonium – Main Board		611	£8.25

EPE SOFTWARE

★ All software programs for *EPE* Projects marked with an asterisk, and others previously published, can be downloaded *free* from our Downloads site, accessible via our home page at: **www.epemag.co.uk.**

PCB MASTERS

PCB masters for boards published from the March '06 issue onwards can also be downloaded from our UK website (**www.epemag.co.uk**); go to the "Downloads" section.

EPE PRINTED CIRCUIT BOARD SERVICE

Order Code Project Quantity Price

....

Name ....

Address ....

....

Tel. No. ....

I enclose payment of £................ (cheque/PO in £ **sterling only**) to:

Everyday Practical Electronics

MasterCard, Amex, Diners Club, Visa or Switch/Maestro

Card No ....

Valid From .... Expiry Date ....

Card Security Code .... Maestro Issue No ....
(The last 3 digits on or just under the signature strip)

Signature ....

NOTE: You can also order p.c.b.s by phone, Fax, Email or via the shop on our website on a secure server:
http://www.epemag.co.uk

CLASSIFIED ADVERTISEMENTS

EPE EVERYDAY PRACTICAL ELECTRONICS

Everyday Practical Electronics reaches more UK readers than any other UK monthly hobby electronics magazine, our sales figures prove it. We have been the leading monthly magazine in this market for the last twenty-two years.

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £10 (+VAT) per single column centimetre (minimum 2·5cm). The prepaid rate for classified adverts is 40p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Phone: 01202 873872. Fax: 01202 874562. Email: epeads@wimborne.co.uk. For rates and information on display and classified advertising please contact our Advertisement Manager, Stewart Kearn as above.

---

www.CONTROLBITZ.com

BTEC ELECTRONICS TECHNICIAN TRAINING

NATIONAL ELECTRONICS
VCE ADVANCED ICT
HNC AND HND ELECTRONICS
FOUNDATION DEGREES
NVQ ENGINEERING AND IT
DESIGN AND TECHNOLOGY

LONDON ELECTRONICS COLLEGE
20 PENYWERN ROAD
EARLS COURT, LONDON SW5 9SU
TEL: (020) 7373 8721
www.lec.org.uk

BOWOOD ELECTRONICS LTD

Suppliers of Electronic Components

Place a secure order on our website or call our sales line
All major credit cards accepted
Web: www.bowood-electronics.co.uk
Unit 1, McGregor's Way, Turnoaks Business Park, Chesterfield, S40 2WB. Sales: 01246 200222
Send 60p stamp for catalogue

SAFFRON ELECTRONICS LTD

Suppliers of High Quality Electronic Components since 1991

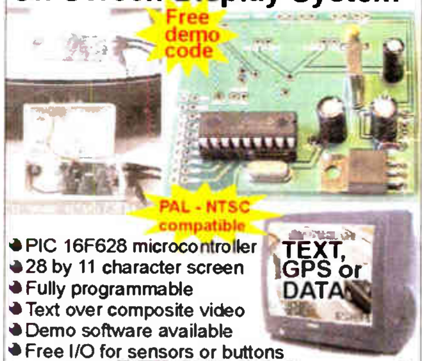
Resistors, Caps, Batteries, Chargers, Semiconductors, LED's, IC's, PCB's, Switches, Solder, Cable, Wire, Etc.
Online Catalogue and Shop available at
www.SaffronElectronics.co.uk
Saffron House, 16 Field Street, Cannock, Staffs. WS11 5QPTelephone: **0845 166 2314** (local rate)

EPE EVERYDAY PRACTICAL ELECTRONICS

VISIT OUR ONLINE SHOP TO ORDER BACK ISSUES, CDROMS, BOOKS, PCBS, AND MANUALS

www.epemag.co.uk

Versatile Programmable PIC On Screen Display System



- PIC 16F628 microcontroller
- 28 by 11 character screen
- Fully programmable
- Text over composite video
- Demo software available
- Free I/O for sensors or buttons

www.STV5730A.co.uk

N.R. BARDWELL Ltd – est 1948
Electronic Component Supplies

LED's, Semis, IC's Resistors, Caps, etc send 44p for lists. 1000's bargains at our secure site: **www.bardwells.co.uk**
288, Abbeydale Rd. Sheffield. S7 1FL
0845 166 2329 (local rate)

HEROS TECHNOLOGY LTD

http://www.herostechnology.co.uk

- Electronic Components and Services.
- RF Components.
- PIC microcontollers practical applications never been so simple with our Modules Boards and Software.
- Peripheral modules for all microcontrollers
- Solution for Developers, Pre-production, Educational and Hobby applications.

CPS Solar

Solar panels, solar cells, and many more alternative energy products for battery charging etc. please visit our website for further info or call
Tel: 0870 765 2334.
www.solarpanelsonline.co.uk

Your own complete eCommerce 24/7 site for only £10 per week!
Domain, secure hosting, emails, shopping basket, etc, **included.**
details: **www.eConcept.co.uk**

Miscellaneous

VALVES AND ALLIED COMPONENTS IN STOCK. Phone for free list. Valves, books and magazines wanted. Geoff Davies (Radio), tel. 01788 574774.

WANTED OLD HALF INCH FERRITE RODS. Must be half inch (12.7mm) in diameter and be six inches long or more, will pay very good money for the rods. Contact Peter Tankard on 0114 2316321 between 9am and 10pm.

FOR ½ PRICE VALVE CLEARANCE catalogue send £1.00 in 1st or 2nd class stamps FOR COMBINED VALVE & COMPONENT CLEARANCE list send £1.50 in 1st or 2nd class stamps. W. Burcher, 676 Foxhall Road, Ipswich, Suffolk. IP3 8NQ. Tel: 01473 272218.

KITS, TOOLS, COMPONENTS. S.A.E catalogue. SIR-KIT ELECTRONICS, 52 Severn Road, Clacton, CO15 3RB. www.geocities.com/sirkituk

EPE Online
www.epemag.com

Get your magazine 'instantly' anywhere in the world – buy and download from the web.

TAKE A LOOK, A FREE ISSUE IS AVAILABLE

A one year subscription (12 issues) costs just $15.99 (US)

Back issues are also available

EPE Online
www.epemag.com

EVERYDAY PRACTICAL ELECTRONICS

NEXT MONTH

STUDENTS' AMP

A 20W RMS audio amplifier module that sounds great, is cheap and dead-easy to build. The article also describes a simple matching power supply.

★ Signal-to-noise ratio 105dB
★ Total harmonic distortion <0.04%
★ Frequency response 14Hz to 100kHz

STAR POWER

A high-efficiency supply for 1W and 5W ultrabright Luxeon Star LEDs. It's easy to build, runs off 12V DC and is ideal for use in boats, caravans and cars.

PIC POLYPHONIUM – 2

An LED interface for the PIC Polyphonium. It uses a block of LEDs arranged in 12 columns, seven LEDs high, to show which note and its octave is being played.

As well as being useful, it also illustrates how the Polyphonium can be used to control external facilities, making use of the note, length and octave data.

APRIL '07 ISSUE ON SALE MARCH 8

ADVERTISERS INDEX

ADVERTISEMENT OFFICES:
408 WIMBORNE ROAD EAST, FERNDOWN, DORSET BH22 9ND
PHONE: 01202 873872 FAX: 01202 874562
EMAIL: epeads@wimborne.co.uk

For Editorial address and phone numbers see page 7

Everyday Practical Electronics, ISSN 0262 3617 is published monthly (12 times per year) by Wimborne Publishing Ltd., USA agent USACAN Media Dist. Srv. Corp. at 26 Power Dam Way Suite S1-S3, Plattsburgh, NY 12901. Periodicals postage paid at Plattsburgh, NY and at additional mailing Offices. POSTMASTER: Send address changes to Everyday Practical Electronics, c/o Express Mag., PO Box 2769, Plattsburgh, NY, USA 12901-0239.

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 Seymour, 86 Newman St., London W1T 3EX. **Subscriptions** INLAND: £18.75 (6 months): £35.50 (12 months): £66 (2 years). OVERSEAS: Standard air service, £21.75 (6 months): £41.50 (12 months): £78 (2 years). Express airmail, £30.75 (6 months): £59.50 (12 months): £114 (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.

SERIAL COMMUNICATIONS SPECIALISTS
Test and Measurement Solutions

EasySYNC™

featured products

CAN-USB
USB - CAN Bus adapter
£81.50

CAN-232
RS232 CAN Bus Adapter
£61.00

Affordable CAN Bus Solutions from £61 (CAN-232)

CANUSB and CAN-232 are small adapters that plug into any PC USB / RS232 Port respectively to give instant CAN connectivity. These can be treated by software as a standard Windows COM Port. Sending and receiving can be done in standard ASCII format. These are high performance products for much less than competitive solutions.

--- Bronze Prize Winner ---
NASA Tech Briefs 2004
Products of the Year
£125.00

DS1M12 2 channel 1MS/s PC scope, signal generator & data logger

ANT16
16 channel logic analyzer
- probe set extra
£195.00

USB Instruments - PC Oscilloscopes & Logic Analyzers

Our PC Instruments may be budget priced but have a wealth of features normally only found in more expensive instrumentation. Our oscilloscopes have sophisticated digital triggering including delayed timebase and come with application software and DLL interface to 3rd Party apps. Our ANT8 and ANT16 Logic Analyzers feature 8/16 capture channels of data at a blazing 500MS/S sample rate in a compact enclosure.

Low Profile Version also available

uPCI-400HS
4 Port UPCI RS232 Serial Card
Spider Cable or COMBOX IO
(extra)
£65.00

£10.00

UPCI Serial Cards from £15 (uPCI-100L)

Discover our great value for money range of multi-port uPCI serial cards. Supporting from one to eight ports, the range includes RS232, RS422, RS485 and opto-isolated versions. Our 4 port and 8 port models can connect through external cables or the innovative wall mounting COMBOX.

USB-2COM-M £36.00
2 Port Industrial USB RS232 Serial with wall mount bracket and 5V DC auxiliary output

** NEW LOW PRICE **

USB-COM-PL
£12.50
Quality USB to RS232 converter cable with detachable 10cm extender cable. FTDI Chipset and Drivers for superior compatibility and O.S. support.

1 to 16 port USB to Serial Adapters from £12.50

With over 20 different models available, we probably stock the widest range of USB Serial Adapters available anywhere. We offer converter cables, multi-port enclosure style models in metal and plastic, also rack mount units with integral PSU such as the USB-16COM-RM. Serial interfaces supported include RS232, RS422 and RS485. We also supply opto-isolated RS422 and RS485 versions for reliable long distance communications. All our USB Serial products are based on the premium chipsets and drivers from FTDI Chip for superior compatibility, performance and technical support across Windows, MAC-OS, CE and Linux platforms.

NETCOM-813
£350.00

8 Port Industrial Ethernet RS232 / RS422 / RS485 Serial Server with wall mount bracket and PSU.

ES-W-3001-M
£125.00

Single Port high performance Industrial Wireless Ethernet RS232 / RS422 / RS485 Serial Server with PSU and wall mount bracket. Connects wired also.

Ethernet & Wi-Fi 802-11b/g RS232/422/485 Serial Servers

One to eight port industrial strength Ethernet and Wireless ethernet serial RS232/RS422/RS485 Servers. Connect to your serial device remotely over your Wireless network, Ethernet or via the Internet. Based on the 32-bit ARM CPU these systems offer powerful serial connectivity and a wealth of features. WLAN models comply with IEEE 802.11b/g, max. 54 Mb/s and also offer a 10/100Mbps secondary ethernet connection. All models come complete with PSU.
Prices start at only £85.00 (NetCOM 111).

EasySync Ltd

373 Scotland Street
Glasgow G5 8QB U.K.
Tel: +44 (141) 418-0181 Fax: +44 (141) 418-0110
Web : http://www.easysync.co.uk
E-Mail: sales@easysync.co.uk

* Prices shown exclude carriage and VAT where applicable