## THE No 1 UK MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS



**www.cpcmag.co.uk** 

WWW.CDCMAG.COM

**USB POWER INJECTOR** Automatically Feeds Extra Power Into The USB Line

RGB TO COMPONENT VIDEO CONVERTER For Home Cinema Sciences

# **MIND TRAINER** Exercise Your Grey Cells

**BEADT PIES-Part2 Greating Programs** 

\$6.95 US \$8.99 CAN DEC 2006 PRINTED IN THE UK 25274 07806 6

# Copyright 2006, Wimborne Publishing Ltd (408 Wimborne Road East, Ferndown, Dorset, BH22 9ND, UK)

and TechBites Interactive Inc., (PO Box 857, Madison, Alabama 35758, USA)

All rights reserved.

# WARNING!

The materials and works contained within *EPE Online* which are made available by Wimborne Publishing Ltd and TechBites Interactive Inc are copyrighted. ou are permitted to make a backup copy of the downloaded file and one (1) hard copy of such materials and works for your personal use. International copyright laws, however, prohibit any further copying or reproduction of such materials and works, or any republication of any kind.

TechBites Interactive Inc and Wimborne Publishing Ltd have used their best efforts in preparing these materials and works. However, TechBites Interactive Inc and Wimborne Publishing Ltd make no warranties of any kind, expressed or implied, with regard to the documentation or data contained herein, and specifically disclaim, without limitation, any implied warranties of merchantability and fitness for a particular purpose.

Because of possible variances in the quality and condition of materials and workmanship used by readers, *EPE Onlin*e, its publishers and agents disclaim any responsibility for the safe and proper functioning of reader-constructed projects based on or from information published in these materials and works. In no event shall TechBites Interactive Inc or Wimborne Publishing Ltd be responsible or liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or any other damages in connection with or arising out of furnishing, performance, or use of these materials and works.

#### ISSN 0262 3617

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

VOL. 35. No. 12 DECEMBER 2006









© Wimborne Publishing Ltd 2006. Copyright in all drawings, photographs and articles published in EVERYDAY PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Our January 2007 issue will be published on Thursday, 4 December 2006. See page 72 for details



**INCORPORATING ELECTRONICS TODAY INTERNATIONAL** 

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

# **Projects and Circuits**

RGB TO COMPONENT VIDEO CONVERTER by Jim Rowe18For home cinema set-upsINGENUITY UNLIMITED - Sharing your ideas with others37
<b>INGENUITY UNLIMITED –</b> Sharing your ideas with others 37
1000-Year Flasher
LAPEL MICROPHONE ADAPTOR FOR PA SYSTEMS by John Clarke         38           Allows electret microphones to be used with PA systems         38
MIND TRAINER by Bart Trepak       50         A logic game to exercise your grey cells

# Series and Features

TECHNO TALK by Mark Nelson Banned Substances	14
PIC N' MIX by Mike Hibbett More about using MultiMedia Cards with PICs	16
INTERFACE by Robert Penfold Exploring the graphics capability of Visual Basic 2005 Express	26
C FOR PICs – Part 2 by Mike Hibbett Creating Programs	28
<b>CIRCUIT SURGERY</b> By Ian Bell Final close-up view of 555 timer circuit formulae	56
NET WORK – THE INTERNET PAGE surfed by Alan Winstanley Recycle Risks Confirmed: A Better VNC: IP Cameras	59

# **Regulars and Services**

EDITORIAL	7
<b>NEWS</b> – Barry Fox highlights technology's leading edge Plus everyday news from the world of electronics	8
CD-ROMS FOR ELECTRONICS A wide range of CD-ROMs for hobbyists, students and engineers	34
BACK ISSUES Did you miss these?	46
PIC RESOURCES CD-ROM EPE PIC Tutorial V2, plus PIC Toolkit Mk3 and a selection of PIC related articles	48
SUBSCRIBE TO EPE and save money	54
ELECTRONICS MANUALS The Modern Electronics Manual and Electronics Service Manual on CDROM	60
READOUT John Becker addresses general points arising	61
PIC PROJECTS A plethora of PIC Projects on CD-ROM	64
DIRECT BOOK SERVICE A wide range of technical books available by mail order, plus more CD-ROMs	65
EPE PCB SERVICE PCBs for EPE projects	68
INDEX FOR VOLUME 35	69
ADVERTISERS INDEX	72

7 **Readers Services • Editorial and Advertisement Departments** 

#### NEW ELECTRONIC CONSTRUCTION KITS This 30 in 1 electronic kit

includes an introduction to

electrical and electronic technology. It provides

conponents that can be used to make a variety of

and

This 40 in 1 electronic kit

includes an introduction to

electrical and electronic technology. It provides conponents that can be

used in making basic digi-

tal logic circuits, then pro-

Integrated circuits to make

to

usina

aresses

including

Burglar

experiments

Timers



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



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 conponents that can be used to make and test a wide variety of experi-ments 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

#### 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

#### EVACUATED TUBE SOLAR HOT WATER 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. Phone for delivery charges.



20kW (£13,999) The 200w system is complete apart from 2x12v batteries and concrete for the tower. These low cost systems can provide substantial amounts of power, even in average wind conditions. Phone for delivery charges.

#### STEAM ENGINE KIT



The material in this pack 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, safe-

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. Only £24.99 ref STEAMKIT Silver solder/flux pack £3.50 ref SSK

aged 15 plus. The material pack will enable them to make a fully functional hot air motor. All the critical parts (piston, working cylinder, flywheel and coolers) have been pre-made and are ready for use. The detailed plans show all the

important stages for the required metal working (Measuring with a vernier, sawing, silver soldering, drilling, marking out, thread making, silver soldering, sawing and filing, etc) At the same time the principles of the hot air motor are described in the wide ranging instructions. Technical data : Working cylinder stroke ø 12 x 10 mm Pressure cylinder stroke ø 13 x 11 mm

Unloaded speed approx. 800 rpm Size: Flywheel dia. 55mm Base 130 x130 mm With sinter smooth bearings and ready shaped cooler. £29.70 ref STEAMKIT2 Silversolder pack £3.50 ref SSK

Thermo Peltier element, large Size: 40 x 40 x 4,7 mmTechnical data of the Thermo element:Use as a Peltier element to cool or heat: will pro-



ing, max temp difference between sides of 67°C, maximum output 15V 3,9 Ampere 150°C 3,5 Ohm 250 mW/K 22 g, 49 mV/K £14 ref TEL1

vide 33 Watts of heating or cool-

Die cast illuminated microscope set in plastic carry case Includes a handy carry case with a 1200x magnification microscope. Contents include test tubes, magnifier glass and probe. Requires 2 x AA batteries (not included). ultra-compact, lightweight, easy to use and comfortable to hold. An ideal microscope for the beginner offering a good magnification range. £25.99 ref MAG1200



HENFIELD SUSSEX BN5 9SL TERMS: CARD, CHEQUE, PO, OR CASH ONLINE ORDERING. ALL PRICES PLUS VAT UK DELIVERY £6.50 TEL 0870 7707520 FAX 01273 491813 sales@bullnet.co.uk www.bullnet.co.uk

#### 2kW WIND TURBINE KIT

The 2kW wind turbine is supplied as the following kit: turbine generator 48v three twisted fibreglass blades & hub 8m tower (four x 2m sections) guylines / anchors / tensioners / clamps foundation steel rectifier 2kW inverter heavy-duty pivot Other sizes available from (£299) up to



metal based project for pupils





#### STIRLING ENGINES

HB10 One of our range of Stirling engines The Bohm HB10 Stirling engine is available in both ready built and kit form. The power comes from a small spirit burner, once lit just watch this amazing Stirling engine run. HB10 in kit form is £97.95 or £101.99 built. Many other models in stock. Order online at www.mamodspares.co.uk



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



Rapidos Mobile networking digital surveillance system. Plugs into USB port on computer, takes 4 cameras, NSTC or PAL, 352\*288 res, 1-30 f/s MPEG4 & M.IPEG motion detection, pre and post recording, watermark, date, time and location markings, alarm

notice via FAX, FTP or email, Modes- continuous record, motion detection record, sheduled record, time lapse record, dynamic IP, can send live images to your mobile phone. £109 ref RAPIDOS

HEAT PUMPS

A heat pump is a system that uses a refrigeration-style compressor to transfer heat from outside to inside, in order to heat offices or homes. Heat pumps can take heat from the air, water or ground. Ground source heat pumps are very efficient - in fact you will get 3-4 units of heat for every unit of electricity supplied to the heat-



pump. Basic component parts of a GSHP:

1 A heat pump packaged unit: Water-Water type. (approx. the size of a small fridge) containing two cold water connections and two heated water connections.

2. The heat source which is usually a closed loop of plastic pipe containing water with glycol or common salt to prevent the water from freezing. This pipe is buried in the ground in vertical bore holes or horizontal trenches. The trenches take either straight pipe or coiled (Slinky) pipe, buried about 1.5 to 2m below the surface. A large area is needed for this.

3. The heat distribution system. This is either underfloor heating pipes or conventional radiators of large area connected via normal water pipes.

4. Electrical input and controls. The system will be require an electrical input energy, single phase is perfectly adequate for smaller systems. A specialised controller will be incorporated to provide temperature and timing functions of the system.

This type of installation offers many advantages

a) The water-water heat pump unit is a sealed and reliable self contained unit.

b) There are no corrosion or degradation issues with buried plastic pipes.

c) The system will continue to provide the same output even during extremely cold spells.

d) The installation is fairly invisible. i.e. no tanks or outside unit to see.

e) No regular maintenance reguired.

Some tips

The efficiency of any system will be greatly improved if the heated water is kept as low as possible. For this reason, underfloor heating is preferred to radiators. It is vital to ensure that the underfloor layout is designed to use low water temperatures. i.e. plenty of pipe and high flow-rates. If radiators are to be used, they must be large enough. Double the normal sizing (as used with a boiler) is a good starting point.

5Kw (output) ground to air heat pump £1,099 ref HP5 9kw (output) ground to water heat pump £1,999 ref HP9. Phone for delivery charges



ty vent etc.) are ready finished to ensure success. The

HOT AIR MOTOR (Stirling motor) This is an interesting



Quasar Electronics Limited PO Box 6935, Bishops Stortford CM23 4WP, United Kingdom Tel: 0870 246 1826 Fax: 0870 460 1045 E-mail: sales@quasarelectronics.com Web: www.QuasarElectronics.com



📲 Ho! Ho! Ho! Christmas 2006 is on it's way 🔅

All prices INCLUDE 17.5% VAT. Postage & Packing Options (Up to 2Kg gross weight): UK Standard 3-7 Day Delivery - £3.95; UK Mainland Next Day Delivery - £8.95; Europe (EU) -£6.95; Rest of World - £9.95 (up to 0.5Kg). IOrder online for reduced price UK Postagel Payment: We accept all major credit/debit cards. Make cheques/PO's payable to Quasar Electronics.

payable to Quasar Electronics. Call now for our FREE CATALOGUE with details of over 300 kits, projects, modules and publications. Discounts for bulk quantities.



716



VISA





Secure Online Ordering Facilities • Full Product Listing, Descriptions & Photos • Kit Documentation & Software Downloads



Secure Online Ordering Fa

Secure Online Ordering Facilities • Full Product Listing, Descriptions & Photos • Kit Documentation & Software Downloads











Serial Alphanumeric and Graphic Displays, Mini-Terminals and Bezel kits

# www.milinst.com



Animated Head



3-Axis Machine







#### Robotic models for both the beginner and the advanced hobbyist

Six-Legged Walkers



Development Tools

Milford Instruments Limited Tel 01977 683665, Fax 01977 681465, sales@milinst.com



<b>4000 Ser</b> 4000B 4001B	ies 74HC153 £0.27 74HC154 £0.16 74HC157	£0.30 74LS244 £0.94 74LS245 £0.22 74LS247	£0.41 NE5532N £0.45 NE5534N £0.60 NE5539N	£0.54   38/A £	4.42 <b>Thyrist</b> 2.72 2N5060 0.75 2N5061	£0.19 BC179 £0.19 BC182B £0.19 BC182L	£0.15 BF245B £0.09 BF257 £0.11 BF259	£0.40 ZTX651 £0.33 £0.33 ZTX653 £0.37 £0.33 ZTX689B £0.40
4002B 4008B 4009UB 4010B	£0.19 74HC158 £0.23 74HC160 £0.23 74HC161 £0.23 74HC161 £0.23 74HC162	£0.23 74LS251 £0.64 74LS257 £0.27 74LS258 £0.45 74LS266	£0.24 OP07CN £0.24 OP27CN £0.24 OP90GP £0.14 OP97FP	£0.80 LM317LZ £ £2.33 LM317T £ £2.91 LM317K £ F1.84 LM323K £	0.25 BT151-50 0.30 C106D1 2.28 PO102A4	0R £0.65 BC183L £0.36 BC184 \$ £0.30 BC184L \$ £0.49 BC206B	£0.09 BF337 £0.09 BF422 £0.12 BF423 £0.72 BF459	£0.33         ZTX689B         £0.40           £0.40         ZTX690B         £0.37           £0.15         ZTX705         £0.39           £0.15         ZTX750         £0.25           £0.33         ZTX751         £0.34
4011B 4012B 4013B 4014B	£0.16 74HC163 £0.16 74HC164 £0.18 74HC165 £0.30 74HC173	£0.26 74LS273 £0.23 74LS279 £0.21 74LS283 £0.38 74LS365	£0.32 OP113GP £0.24 OP176GP £0.47 OP177GP £0.21 OP200GP	£3.44 LM334Z £ £2.09 LM337T £ £2.18 LM338K £	0.96 TIC116D 0.64 TIC126D 5.31 <b>Triacs</b>	£0.66 BC208 £0.77 BC209A BC212L	£0.72 BF469 £0.72 BFX29 £0.09 BFX84 £0.12 BFX85	£0.36         ZTX753         £0.40           £0.29         ZTX789A         £0.41           £0.31         ZTX790A         £0.41           £0.33         ZTX7851         £0.50
4015B 4016B 4017B	£0.27 74HC174 £0.20 74HC175 £0.20 74HC193	£0.27 74LS367 £0.35 74LS368 £0.39 74LS373	£0.21 OP213FP £0.21 OP275GP £0.39 OP282GP	£5.20 LM723 £ £2.57 LP2950CZ5.0£ £2.27 REF01CP £	0.40 BT136-60 0.72 BT137-60 2.31 BT137-50	0 £0.50 BC214 0 £0.50 BC214L 0 £0.58 BC214L 0 £1.00 BC225 0 £1.00 BC225	£0.08 BFX88 £0.10 BFY50 £0.15 BFY51 £0.11 BFY52	£0.27 ZTX853 £0.50 £0.30 ZTX951 £0.54 £0.22 ZTX1048A £0.48 £0.24 ZTX1051A £0.46
4018B 4019B 4020B 4021B	£0.29 74HC195 £0.25 74HC240 £0.25 74HC241 £0.31 74HC244	£0.32 74LS374 £0.32 74LS378 £0.37 74LS390 £0.40 74LS393	£0.38 OP283GP £0.62 OP290GP £0.34 OP297GP £0.33 OP400GP	£4.28 TL431CP £ £4.64 Diodes	0.14 BTA08-60	00B £0.84 BC238B 00Bw£0.76 BC250A 00c £0.96 BC261B	£0.11 BS107 £0.15 BS170 £0.30 BU208A	£0.21 ZTX1053A £0.45 £0.15 £1.53 NEW ONLINE
4022B 4023B 4024B 4025B	£0.32 74HC245 £0.23 74HC251 £0.22 74HC253 £0.20 74HC253	£0.34 74LS395 £0.30 <b>74 Series</b> £0.25 7407 £0.25 7407	£0.26 OP495GP RC4136 £0.40 SG3524N SG3543	£8.69 1N916 £1.00 1N4001 £ £0.82 1N4002 £	0.05 BTA08-60 0.05 BTA08-60 0.05 BTA12-60	00sw£0.93 BC262B 00rw£1.10 BC267B 00sw£0.92 BC319C	£0.24 BU326A £0.30 BU500 £0.13 BU508A £0.08 BU508D	£1.40 <b>Transformers</b> £1.54 Large selection £1.40 of mains & £0.98 audio
4026B 4027B 4028B	£0.67 74HC259 £0.21 74HC273 £0.21 74HC299	£0.29 Linear ICs £0.32 AD524AD £0.61 AD548JN	\$\$\$M2141P £23.04 \$\$M2142P £2.48 \$\$M2143P	£3.21 1N4004 £ £6.16 1N4005 £ £3.78 1N4006 £	0.04 BTA16-60 0.04 BTA26-60 0.04 TIC206D	00B £1.28 BC327-25 00B £2.78 BC328 00B £2.78 BC337-16	£0.08 BU806 £0.09 BUT11A £0.10 BUT11AF £0.07 BUX84	£1.06 transformers. £0.57 £1.14
4029B 4030B 4035B 4040B	£0.38 74HC365 £0.17 74HC367 £0.31 74HC368 £0.19 74HC373	£0.29 AD620AN £0.35 AD625JN	£13.92 TBA800 £9.88 TBA810S £16.20 TBA820M	£0.75 1N4148 £ £0.64 1N4149 £	0.03 TIC206M 0.03 TIC226D 0.07 TIC226M 0.08 TIC246D	£0.70 BC337-25 £0.75 BC348B £0.80 BC348B £1.00 BC357 £1.00 BC393 £1.00 BC393	£0.14 BUZ900P £0.25 BUZ905P £0.73 IRF530 £0.41 IRF540	£0.78 £5.60 £0.53 £0.78 20mm, 32mm
4041B 4042B 4043B 4044B	£0.31 74HC374 £0.19 74HC390 £0.35 74HC393 £0.35 74HC393	£0.34 AD633JN £0.52 AD648JN £0.36 AD654JN £0.56 AD711JN	£5.92 TDA1170S £2.57 TDA2004 £5.51 TDA2030AV £1.97 TDA2050V	£4.80 1N5401 £ £2.24 1N5402 £ £1.24 1N5404 £	0.08 TIC246M 0.08 TIC236D 0.09 ZO105D 0.10 Diac	£1.00 BC463 £1.12 BC463 £0.53 BC477 £0.53 BC479	£0.29 IRF630 £0.52 IRF640 £0.32 IRF730	£0.42 Quick Blow & £0.63 Time-lag £0.66 Glass, Ceramic
4046B 4047B 4048B	£0.35 74HC573 £0.24 74HC574 £0.34 74HC595	£0.27 AD712JN £0.30 AD736JN £0.27 AD797AN	£2.51 TDA2611A £5.80 TDA2822A £7.25 TDA2653A	£1.88 1N5407 £ £0.79 1N5408 £ £2.99 6A05 £	0.10 DB3, 32V 0.10 Transis 0.27 Transis 0.30 2N2222A	en 16 BC546B	£0.21 IRF740 £0.12 IRF830 £0.06 IRF840 £0.08 MJ2955	£0.91 £0.68 £0.78 £0.90 www.esr.co.uk
4049B 4049UB 4050B 4051B	£0.29 74HC597 £0.17 74HC688 £0.20 74HC4002 £0.23 74HC4017	£0.22 AD811N £0.46 AD812AN £0.31 AD820AN £0.36 AD822AN	£5.50 TED3718DP £6.32 TEA5115 £3.41 TL061CP £5.20 TL062CP	£3.11 6A2 £ £0.37 6A4 £ £0.60 6A6 £	0.27 2N2369A 0.28 2N2646 0.32 2N2904A	£0.51 BC547A £1.02 BC547B	£0.09 MJ2501 £0.09 MJ3001 £0.10 MJ11015 £0.08 MJ11016	£1.60 £1.84 £2.45 £2.78 Potty about £2.78 Pots!
4052B 4053B 4054B 4055B	£0.32 74HC4020 £0.22 74HC4040 £0.56 74HC4049 £0.34 74HC4051	£0.36 AD829JN £0.29 AD830AN £0.31 AD847JN £0.50 AD9696KN	£6.41 TL064CN £5.44 TL071CN £5.95 TL072CN £7.73 TL074CN	£0.30 6A10 £ £0.40 BA157 £	0.35 2N2907A 0.07 2N3053 0.08 2N3054	£0.28 BC548B £0.38 BC548C £0.85 BC549B	£0.09 MJE340 £0.08 MJE350 £0.09 MPSA05 £0.09 MPSA13	£0.33 We now carry in £0.32 stock a wide £0.14 range of £0.14 positive position
4060B 4063B 4066B	£0.16 74HC4052 £0.41 74HC4053 £0.18 74HC4060	£0.34 ADEL2020A £0.22 ADM222AH £0.23 ADM232AA	£5.06 TL081 £3.55 TL082CN £3.55 TL084CN	£0.28 BA159 £ £0.32 BAT41 £ £0.37 BAT42 £	0.13 2N3055 0.12 2N3439 0.07 2N3440 0.07 2N3702	£0.62 BC550C £0.50 BC556A £0.09 BC556B	£0.11 MPSA42 £0.08 MPSA55 £0.10 MPSA56	£0.14 pots. £0.13 With either with £0.12 a centre click or
4067B 4068B 4069UB 4070B	£2.20 74HC4075 £0.19 74HC4078 £0.17 74HC4511 £0.15 74HC4514	£0.32 ADM666AN £0.64 ADM690AN £0.84 ADM691AN	£2.72 TLC271 £5.13 TS272CN £6.48 TS274CN	£0.63 BAT85 £0.57 BAV21 £0.57 BAW62 £0.50 BAW62	0.09 2N3703 0.07 2N3704 0.07 2N3705 0.07 2N3705 0.05 2N3771	£0.10 BC557A £0.11 BC557B £0.08 BC557C £1.44 BC558A £1.72 BC558B	£0.09 TIP29A £0.09 TIP29C £0.08 TIP30A	£0.32 flons. Log, Lin, £0.33 Single or Dual £0.47 gang.
4071B 4072B 4073B 4075B	£0.20 74HC4538 £0.18 74HC4543 £0.17 74LS Serie £0.17 74LS Serie	CO OD CAUSISUL	4 £6.48 TS555CN 4 £3.58 TMP01FP £0.65 UA741CN £0.87 ULN2003A £0.63 ULN2004A £0.91 ULN2004A	£5.60 BY127 £	0.18 2N3772 0.10 2N3773 0.70 2N3819 0.33 2N3903	£1.72 BC558B £2.30 BC559A £0.27 BC560A £0.11 BC636	£0.09 TIP30C £0.08 TIP31A £0.09 TIP31C £0.10 TIP32A	£0.27 £0.23 £0.35 £0.29
4076B 4077B 4078B 4081B	£0.30 74LS00 £0.28 74LS01 £0.30 74LS02 £0.30 74LS03 £0.16 74LS03	£0.14 CA3240E £0.22 DG211CJ £0.27 DG411D	£1.25 ULN2804A	£0.44 OA91 £ £0.42 OA200 £ £0.41 UF4001 £	0.32 2N3904 0.56 2N3905 0.08 2N3906	£0.05 BC637 £0.10 BC638 £0.05 BC639 £0.08 BC640	£0.19 TIP32C £0.21 TIP33C £0.09 TIP41A £0.13 TIP41C	£0.30 £0.74 £0.32 £0.32
4082B 4085B 4086B 4093B	£0.21 74LS05 £0.28 74LS05 £0.33 74LS08 £0.33 74LS09	£0.30 ICL7106CPL £0.14 ICL7107CPL £0.19 ICL7109CLF £0.15 ICL7611DC	£2.21 24LC08BP £2.06 24LC16BP £5.76 24LC32AP	£0.73 UF4003 £ £0.69 UF4004 £ £1.14 UF4005 £	0.09 2N4403 0.08 2N5245 0.10 2N5296	£0.09 BCY72 £0.80 BD124P £0.57 BD131 £0.12 BD132	£0.20 TIP42A £6.86 TIP42C £0.48 TIP50 £0.46 TIP110	£0.47 £0.43 £0.28 £0.28 £0.28 Components No surplus or £0.28
4094B 4098B 4099B	£0.29 74LS10 £0.22 74LS11 £0.35 74LS12	£0.27 ICL7621 £0.17 ICL7660SCF £0.25 ICM7555 £0.33 ICM7556	£0.84 27256-200 £0.80 27C64A-15F £0.41 27C256B-15	£3.99 UF4007 £ £2.80 Zeners 2.7 to 3 F£3.00 500mW £	0.14 2N5551 33V 2N6491 0.06 2N7000	£0.07 BD135 £1.58 BD136 £0.19 BD137	£0.22 TIP120 £0.21 TIP121 £0.23 TIP122 £0.19 TIP125	£0.30 All from leading £0.32 manufactures.
4502B 4503B 4508B 4510B	£0.32 74LS15 £0.40 74LS20 £1.40 74LS21 £0.45 74LS24	£0.24 L165V £0.27 L272M £0.20 L293E	£1.04 27C512-15F £2.36 27C1001-15 £1.21 27C2001-15 £4.20 27C4001-10	1£2.85 1.3W £ .£3.17 Bridge Rectif .£4.41 IA 50V £	AC127 Iers AC128 0.35 AC187	£0.30 BD138 £0.50 BD139 £0.76 BD140 £0.68 BD150C	£0.23 TIP126 £0.14 TIP127 £0.82 TIP132	£0.31 £0.31 £0.35 £0.50 Co.44 patch on all
4511B 4512B 4515B 4516B	£0.30 74LS27 £0.27 74LS27 £0.99 74LS30 £0.99 74LS32 £0.44 74LS32	£0.25 L297 £0.25 L298N £0.20 L4960 £0.23 L6219 £0.31 L6219	£5.12 93C46N £6.67 £2.81 RAM £4.48 GM76C88.	£0.33 1A 200V £ 1A 600V £ £3.60 1A 800V £	0.32 AC188 0.39 ACY17 0.40 AD149 0.43 AD161	£0.97 BD201 £4.84 BD202 £1.29 BD232 £0.73 BD237	£0.40 TIP137 £0.70 TIP141 £0.50 TIP142 £0.32 TIP147	£0.93 £0.93 Friendly helpful £1.07 staff.
4518B 4520B 4521B 4526B	£0.26 74LS37 £0.34 74LS38 £0.62 74LS40 £0.62 74LS51	£0.18 LF351N £0.14 LF351N £0.24 LF353N £0.24 LF356	£0.46 A/D Conve £0.44 Data Acqu £0.40 tion £0.52 AD420AN	1.5A 100V £ 1.5A 200V £ 1.5A 400V £	0.19 AD162 0.11 BC107 0.19 BC107B 0.20 BC108	£0.95 BD238 £0.15 BD240C £0.14 BD245C £0.13 BD246C	£0.44 TIP2955 £0.37 TIP3055 £1.10 ZVN2106A £1.18 ZVN2110A	£0.46 £0.46 £0.40 £0.45 £0.28 no extra charge.
4527B 4529B 4532B 4536B	£0.40 74LS73 £0.40 74LS75 £0.44 74LS83 £0.24 74LS83 £1.00 74LS85	£0.36 LM311N8 £0.30 LM319N14 £0.38 LM324 £0.48 LM325Z	£0.17 AD7528JN £0.90 AD7545AK £0.20 AD7828KN £1.12 DAC0800	£11.42 1.5A 800V £ £14.04 1.5A 1kV £ £20.33 2A 100V £	0.24 BC108B 0.26 BC108C 0.18 BC109 0.34 BC109C	£0.14 BD283 £0.18 BD284 £0.17 BD400 £0.16 BD437	£0.61 ZVN3306A £0.61 ZVN4206A £0.79 ZVN4210A £0.17 ZVN4306A £0.22 ZVN4310A	£0.52 £0.56 £0.74 Order
4538B 4541B 4543B	£0.40 74L586 £0.33 74L592 £0.47 74L593 £0.47 74L5107	£0.25 LM339N £0.45 LM348N £0.58 LM35DZ £0.30 LM35DZ	£0.19 ICL7109CPL £0.36 £0.76 <b><i>u</i>Controlle</b>	£7.75 2A 200V £7.75 2A 400V £8 2A 800V £64 38 2A 1000V £	0.34 BC114 0.35 BC115 0.36 BC118 0.45 BC132	£0.19 BD438 £0.41 BD442 £0.41 BD534 £0.36 BD535	£0.37 ZVP2106A £0.47 ZVP2110A £0.50 ZVP3306A	£0.88 Order what you £0.42 need, no pack £0.46 quantities or min £0.32 order value.
4555B 4556B 4584B 4585B	£0.32 74LS109 £0.40 74LS112 £0.27 74LS113 £0.47 74LS113	£0.21 LM358N £0.24 LM380N £0.23 LM386 £0.23 LM392N £0.36 LM393N	£0.90 <b>PIC Series</b> £0.45 12C508A041 £0.79 12C509A041	P £0.78 3A 400V £	0.34 BC134 0.40 BC135	£0.36 BD581 £0.36 BD597 £0.75 BD646 £0.50 BD648	£0.62 ZTX302 £0.92 ZTX450 £0.52 ZTX451 £0.52 ZTX453	£0.17 £0.19 £0.19 <b>Quantity</b> £0.19 <b>Discounts</b> £0.26 <b>Available</b>
4724B 40106B 40109B 40174B	£0.94 74LS12 £0.19 74LS123 £0.58 74LS123 £0.46 74LS125 £0.46 74LS126 £0.41 74LS132	£0.36 LM393N £0.31 LM1881 £0.31 LM2901N £0.28 LM2917N8 £0.25 LM3900N £0.47 LM3914	£2.90 16C54BJW £0.15 16C56A-04F	£7.60 4A 200V £	0.33 BC142 0.78 BC142 0.78 BC143 0.80 BC159 0.86 BC160	£0.38 BD650 £0.17 BDX32	£0.52 ZTX453 £0.53 ZTX500 £1.78 ZTX502 £0.45 ZTX550 £0.53 ZTX551 £0.53 ZTX551 £0.50 ZTX600	£0.26 <b>Available</b> £0.16 We offer dis- £0.17 counts for all £0.22 items subject to £0.33 quantity, re-
40175B 74HC Ser 74HC00	£0.41 74LS126 ies 74LS132 £0.16 74LS133 £0.16 74LS136	£0.36 LM3915 £0.23 LM12700	£2.24 16F627-04P £1.35 16F627-20IF	£3.14 4A 600V £3.76 6A 100V £1.53 6A 200V £1.80 6A 400V £1.80 6A 400V £1.80 6A 600V	0.90 BC170B 0.49 BC171B 0.64 BC177 0.53 BC178	£0.28 BDX34C £0.16 BDX53C £0.16 BDX54C £0.15 BF180 £0.18 BF182	£0.50 ZTX600 £0.31 ZTX600B £0.31 ZTX605	£0.33 quired, phone, £0.35 fax or email for £0.36 a quote.
74HC02 74HC03 74HC04 74HC08	145 7415133 £0.16 7415136 £0.17 7415138 £0.21 7415139 £0.14 7415145 £0.16 7415145 £0.21 7415151 £0.21 7415153 £0.18 7415156 £0.28 7415157	£0.33 LMC660CN £0.26 LMC6032IN £0.56 LP311N £0.64 LP324N	£1.55 16F867-04S £0.74 16F877-20P	£5.79 8A 200V £	0.67 0.37 <b>We carr</b> 0.98 Ceramic 1.00 Mylar Fil 1.20 iature Ra	<b>y a large range of</b> Mini Disc, Dipped Cer m, Polystyrene, Plastic dial 105°C Radial Log	capacitors in stor amic Multilayer, Dip Film, MKT Polyester	<b>:k, including:</b> oped & Boxed Polyester, , Tantalum Bead, Sub-min- on Polarised Radial & Ax- ic Trimmers and Tuning
74HC04 74HC08 74HC10 74HC11 74HC14 74HC20	£0.21 74LS151 £0.21 74LS153 £0.18 74LS156 £0.28 74LS157	£0.29 LP339N £0.38 LT1013CN8 £0.36 M34-1 £0.22 M34-2 £0.21 MAX202CP	£0.30 7806		1.33 ial, PCB 1.05 capacitor 1.47 <b>Resisto</b>	Can Electrolytics, Poly rs. Full technical detail rs - Please State Ve	propylene & Ceram s available.	per 100 of one
74HC20 74HC27 74HC30 74HC32 74HC32 74HC42	£0.18 /4LS156 £0.28 74LS157 £0.16 74LS158 £0.22 74LS160 £0.14 74LS161 £0.36 74LS163 £0.15 74LS163 £0.15 74LS164 £0.31 74LS165 £0 23 74LS165	+0.48 ALAYOOOCA	E £2.00 7812	£0.20 25A 400V £	1.02 /4W Meto	rs - Please State Vo bon Film 5% E12 S on Film 5% E12 S al Film 1% E12 S on Film 5% E12 S rewound 5% E12 S	eries 1002-1M	£0.02 Each, £0.80 per 100 £0.02 Each, £0.60 per 100 £0.04 Each, £1.72 per 100 £0.02 Each, £0.95 per 100 £0.02 Each, £0.95 per 100 £0.23 Each
74HC42 74HC73 74HC74 74HC75 74HC75 74HC85	£0.40 74LS163 £0.15 74LS164 £0.31 74LS165 £0.23 74LS165	£0.32 MAX208Ch £0.44 MAX220CP £0.44 MAX222CP £0.32 MAX232CP £0.43 MAX483CP £0.48 MAX485CP £0.24 MAX631AC £0.24 MAX631AC	£5.06 78L06 E £1.30 78L08 £3.13 78L12 £2.04 78L15	£0.32 35A 100V £0.22 35A 200V £0.16 35A 400V £0.26 35A 600V £0.39 35A 1000V £0.39 35A 1000V	1.80 1W, 2W, 5 1.44 <b>Preset</b>	oon Film 5% E12 S rewound 5% E12 S W, 20W, 25W & 50W also <b>Resistors - Please</b> , 10mm Square Horz / .10mm Dia, Horizonta	tate Value Reau	s only, contact sales dept.
74HC85 74HC86 74HC107 74HC123 74HC125	£0.21 74LS174 £0.40 74LS175 £0.33 741S190	£0.30 MAX1232C	P £2.80 78512	£0.53		, 10mm Dia, Horizonta 6mm Dia, Horizontal , 10mm Square, Top A , 19mm Long, End Adi ometers - Please St		0.1W £0.09 Each 0.01W £0.12 Each
74HC123 74HC125 74HC125 74HC126 74HC132 74HC133 74HC133 74HC137 74HC138 74HC139	£0.26 74LS191 £0.46 74LS192 £0.26 74LS193 £0.34 74LS195 £0.30 74LS221	£0.60 MC1458N £0.27 MC1488 £0.60 MC1489 £0.43 MC3302 £0.24 MC4558P	£0.40 7905 £0.35 7912 £0.56 7915 £0.40 7924	L0.33         L0.32           £0.32         £0.23           £0.23 <b>Always</b> £0.24         online!           £0.22         Our catalog           £0.38         is available	ve Single G Single G Dual Ga	ometers - Please Si ang X" Shaft, 25mm D ng X" Shaft, 25mm D ng X" Shaft, 20mm Dia. X" Shaft, 20mm Dia. X" Shaft, 20mm Dia. X" Shaft, 20mm Dia.		
74HC137 74HC138 74HC139 74HC151	£0.30 74LS221 £0.26 74LS240 £0.31 74LS241 £0.33 74LS243	£0.41 MK484 £0.32 NE521N £0.32 NE555N £0.30 NE556N NE565N	£0.40 7924 £0.66 79L05 £6.39 79L12 £0.16 79L15 £0.24 79L24 £2.30 ADM666AN £0.62 L200CV	£0.38is available£0.20view or dow£0.26load.£0.28Up to date w£0.30new products	ith s & PCB Mou	ng¼" Shaft, 20mm Dia. ¼" Shaft, 20mm Dia. ¼" Shaft, 20mm Dia. ¼" Shaft, 20mm Dia.	10k-470k Lo 1k0-2M2 Lin 4k7-2M2 Log m Dia. 4 <u>70</u> Ω-1 <u>M0</u> L	garithmic £1.54 Each ear £1.92 Each garithmic £1.92 Each inear £0.48 Each
	1	NE565N NE592	£2.30 ADM666AN £0.62 L200CV	£3.44 prices	PCB Mou Dual PCE Dual PCE	nt, Splined Shaft, 16m nt, Splined Shaft, 16m 3, Splined Shaft, 16mm 3, Splined Shaft, 16mm	m Dia. 4700,4k7,10 Dia. 10k,50k100k Dia. 10k,50k,100l Dia. 10k,50k,100l	January         L1.72         Luch           Inear         £0.48         Each           0k, 1M0         Log         £0.56         Each           ,500k         Lin         £1.05         Each           ,500k         Log         £1.00         Each
E	52	1000	Contraction of the second s	0191 2514 0191 2522	2206	Station Road	UK Carria	Exclude Vat @17½%. ge £2.50 (less than 1kg) 0 greater than 1kg
	WWW.esr.co	uk 📶	A REAL PROPERTY AND	s@esr.co.uk	2290 1	'vne & Wear 🖁	Cheques / ESR Ele	Postal orders payable to ectronic Components. carriage & vat to all orders



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

## VOL. 35 No. 12 DECEMBER 2006

#### Are We On The Right Track?

A recent discovery made me wonder if we are going in the right direction when it comes to data storage. I personally still keep my 'address book' in the form of printed cards, which I find easier and quicker to use than a database - we also store article details for both EPE and Radio Bygones (our sister vintage radio magazine) on a card system Since the 'live' data is only consulted on a monthly basis and then stored for a number of years once articles have been published this system works well and has 'instant' access for everyone.

Recently I realised that our list of published PCBs - kept in an A5 book - dates back to May 1984, over 22 years ago now. The binding on the book had failed (they don't make them like they used to!) and I repaired it. It made me wonder if we had stored the data on computer how far back we would still be able to search it and how many times we would have needed to change the system/software/back-ups over those 22 years. There is a lot to be said for old fashioned pen and paper – although some of the early pencil entries in the book are a little faded they are all readable, so I know what articles requiring PCBs were published in every issue from May 1984 onwards, and it takes me about five seconds to find them. No waiting for a PC to boot up, or a database to open and then a search to be made. For 'static' data like this, that needs long-term storage, there is no better medium. (By the way we have yet to fill in half the pages in the book so it should last for more than 50 years, if the repaired binding holds out!)

Computers certainly have their place and many of our present projects could not be achieved without them. They also save us much time and trouble in the production cycle of the magazine. For instance, all the pages are uploaded to our printer's computer now - nothing goes by post or courier as it once did. Computers also save much time in the printing process where page layouts and printing plate making have all been computerised over the last few years.

The paperless office, much touted when PCs became a reality, certainly has not reached us at EPE. We still have bookcases full to bursting with back issues, data books, contracts, invoices etc. I doubt it will ever change and I doubt it will prove to be better if it does: knowing, as we now do, that computers do crash, do require backing up everyday and sometimes decide not to find the data you know is in there somewhere! But then maybe I'm just old fashioned rather than practical!

the service

#### AVAILABILITY

Copies of EPE are available on subscription anywhere in the world (see opposite), from all UK newsagents (distributed by SEYMOUR) and from the following electronic component retailers: Omni Electronics and Yebo Electronics (S. Africa). 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 Subscriptions for delivery direct to any address in the UK: 6 months £18.75, 12 months £35.50, two years £6; 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 stan-dard air service or £114 express airmail. To subscribe from the USA or Canada see page.54 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 27.95 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 cus-tomers – your credit card will be charged by the card provider in your local currency at the existing exchange rate

Editorial Offices: EVERYDAY PRACTICAL ELECTRONICS EDITORIAL Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 SND

Phone: (01202) 873872. Fax: (01202) 874562. Email: enquiries@epemag.wimborne.co.uk

Web Site: www.epemag.cc.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:

Advertisement Onices: EVERYDAY PRACTICAL ELECTRONICS ADVERTISEMENTS 408 Wimborne Road East, Ferndown, Dorset BH22 9ND Phone: 01202 873872 Fax: 01202 874562 Email: stewart.kearn@wimborne.co.uk

Editor: MIKE KENWARD Consulting Editors: DAVID BARRINGTON

JOHN BECKER

Business Manager: DAVID J. LEAVER Subscriptions: MARILYN GOLDBERG General Manager: FAY KEARN Editorial/Admin: (01202) 873872 Advertising Manager: STEWART KEARN (01202) 873872

**On-Line Editor: ALAN WINSTANLEY** EPE Online (Internet version) Editors: CLIVE (MAX) MAXFIELD and ALVIN BROWN

#### 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 а selfaddressed 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 proiect 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

# **DIGITAL TV'S CONFUSION**

What's the difference between VCRs and PVRs? There are still mysteries to be solved before digital TV can take over, as Barry Fox reports

OT on the heels of Ofcom and Digital UK's confusion over the difference between VCRs and PVRs, two more of the disparate bodies involved in switching the UK over from analogue to digital TV have admitted that VCR conversion is a serious obstacle. After a closed meeting with manufacturers and retailers, from which the press were excluded, the Digital Television Group and Freeview (DTV Services Ltd, owned by the BBC, National Grid Wireless, BSkyB, ITV and Channel 4) issued a telling press release.

#### Announcement

'With digital switchover planned to start in 2008, clear consumer understanding of digital TV recording is needed. Recent Freeview research has shown that there is little consumer awareness of digital TV recorders (PVRs or Personal Video Recorders), a finding supported by limited uptake of the devices already available for the DTT platform.'

The proposed solution is to create a new logo, Freeview Playback, which tells consumers that a device can record digital TV programmes off-air. After the event closed a DTG spokeswoman admitted: 'We don't have any figures for the number of VCRs in use. The public is confused over what they need to buy.'

At the time, the first Freeview Playback brand PVRs were not expected in the market before September 2006. The DTG's spokeswoman acknowledged that there may 'seem to be' a lot of different groups promoting digital TV and switchover, 'but they are trying to tie together.'

#### **Far From Done**

'The broadcasters think that once they have got the signal up to the top of the transmitter mast, it's job done', said a senior manager in a major Japanese manufacturer of TV and video equipment, who has been critical of the way switchover body Digital UK is run by broadcasters. 'The need to replace VCRs has been the big overlooked factor in the whole switchover plan. There is not even any agreement on what a PVR is. Is it a hard disc recorder or a DVD recorder or both?'

The DTG and Freeview have not yet addressed this question.

#### **RAPID'S LATEST INFO**

Rapid Electronics have sent their latest Secondary Focus A4 booklet – over 130 pages of products and info aimed at the Secondary Education sector. We've long known that they are heavily committed to that area and its curriculum requirements.

We won't try and highlight the contents of the booklet, but just say it has subject sections of Exercize Books; Graphics, Art & Design; Maths; Projects & Robotics; Design & Technology; Tools; Power Supplies & Test Equipment; Science; Audio Visual; Seasonal.

Rapid have also sent their New Products Focus publication, naturally highlighting what new product additions they have. Just in time to tell you that Rapid will be at the Design and Techology with ICT Education Show 2006 at NEC Birmingham, 16-18 November.

For more information on the publications or Rapid's products, contact Rapid Electronics Ltd., Dept EPE, Severalls Lane, Colchester, Essex CO4 5JS. Tel: 01206 751188. Email: sales@rapidelec.co.uk. Web: www.rapidonline.com.



## **AC Current Clamp**

As though in timely answer to a question on our *Chatzone* recently, LEM have sent information about their cost-effective high quality compact split-core transducers for AC current measurement. As is common for similar products, this clamp enables currents flowing in cables to be measured without breaking into the cable, just clamping around them.

The LEM AT range allows AC current measurement from 5A to 50A RMS at 50/60Hz and has the current transformer and signal conditioning in a very compact split-core case, producing 0-5V DC, 0-10V DC or 4-20mA standard output. Selfpowered or loop-powered versions are available.

For more information contact: LEM UK Ltd., Dept EPE, West Lancashire Investment Centre, Maple View, White Moss Business Park, Skelmersdale, Lancs WN8 9TG. Tel: +44 1 695 712 560. Web: www.lem.com.

#### **Microchip PSU Design**

Microchip have announced an online Intelligent Power Supply Design Center (their spelling) at www.microchip. com/power. This comprehensive website provides the technical resources needed to design analogue power supplies, augment existing analogue PSU designs with inexpensive microcontrollers, or design switchmode power supplies (SMPS) with full digital control of the power conversion feedback loop.

The site offers direct access to all Microchip's PSU application notes, reference designs and other technical documentation. Links to Microchip simulation tools (including the Mindi battery charger and PSU circuits) are also included.

Microchip has long provided costeffective PIC microcontrollers and analogue products to the power supply market, and has recently announced a new family of dsPIC DSCs for full digital control of SMPSs. For additional information visit Microchip's Web site at www.microchip.com/power.



#### PORTABLE ELECTRONICS

Portable electronics needs a suitcase full of chargers to keep it working. British company Moixa Energy has the answer - a standard size rechargeable battery with a miniaturised charger and standard size USB power connector built-in.

Virtually all computer equipment and even modern hi-fi and videos now have a USB socket for connecting a keyboard, mouse or memory store. The sockets push out 5V to power whatever is plugged in.

Moixa's new AA NiMH (nickel metal hydride) USB cells contain intelligent circuitry that drops the USB supply to around 1.4V to charge the battery. A sensor detects the small heat rise and a voltage drop that signals a full charge, and switches off.

A safety timer shuts the full charge off after five hours anyway, and switches to trickle charge. A fully flat battery (with normal 1.2V reduced to 1V) fully charges in five hours, but 10 minutes is enough to deliver enough charge to keep a mouse running for the rest of the day.

The USB cells went on sale in the UK in mid October, and then will roll out through Europe, with a US launch later. A pair of AA cells will cost £13 but Design Director Chris Wright says he 'hopes to pull down the price through mass production'.

The cells charge from either old USB Version 1 sockets or the newer USB Version 2 standard, because both deliver 5V. The cell charger draws a current of around 250mA, so the cells need to plug direct into the sockets on a PC or powered hub socket which delivers 500mA. Unpowered sockets deliver only around 100mA so are not suitable - but these are increasingly uncommon.

Moixa's tests show that charging from a laptop reduces battery life by less than 10%. 'We have already built a prototype cellphone battery with USB charger', says Wright, 'so if you talk for an hour and need to charge your phone you just find the nearest USB socket and plug it in'.

**Barry Fox** 

### **BlueControl**

RF Solutions has introduced a Bluetooth remote controller that is designed for use with Bluetooth enabled devices such as PCs, PDAs and mobile phones. The BlueControl unit features four relays and is ideal for providing control in applications such as lighting, personal access and power switching.

BlueControl provides a secure and reliable telemetry link over distances up to 100 metres for Class I devices, or 10 metres for Class II. The control has an integral antenna and requires a 12V DC PSU.

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

#### **Churchill Opportunities**

We have received information about the Winston Churchill Travelling Fellowships. These are unique and offer UK citizens from all walks of life and irrespective of background, education or professional qualifications the 'Chance of a Lifetime' to undertake study projects overseas related to their trade, craft or profession. Particpants return richer for the experience, to their benefit and that of the community.

Many people find it difficult to believe that they are elegible and the Trust has asked us to make this opportunity more widely known – we are pleased to do so.

Contact the Winston Churchill Memorial Trust, 15 Queen's Gate Terrace, London SW7 5PR. Tel: 020 7584 9315. Fax: 020 7581 0410. Email: office@wcmt.org.uk. Web: www.wcmt.org.uk.

#### MAPLIN'S LATEST

'Price Crash' is the heading on Maplin's latest info received - a multipage leaflet advising people of the bargain reductions they have on a number of product ranges, including computing and various accessories we all need from time to time - batteries, torches, shredders, fan heaters, etc. There are valuable money-off vouchers in this latest edition.

Maplin invite you to visit one of their 100 stores nationwide or log on to www.maplin.co.uk.

#### EOCS

We have received the latest issue of the Electronic Organ Magazine from the EOCS, the Electronic Organ Constructors Society – worth joining if you're into such interests. A lovely photo in the current issue. No 98, of a harmonium at the Saltire Museum having a notice saying that it has 53 intervals and 84 keys to each octave, to make playing easier! Musicians amongst you will appreciate the humour!

The EOCS can be contacted via Don Bray, 34 Etherton Way, Seaford, Sussex BN25 3QB, also via editor@eocs.org.uk.

#### **New Gadgets Website**

All The Best Gadgets have opened a new website in reponse to an increasing desire for gadgetry. With a wide range of appliances, ranging from plasma TVs to light sabers and iPod accessories, to professional poker chip sets, this website features 'all the best gadgets at all the best prices!'

In a world where the gadget is king, magazine racks are groaning with dedicated widget bibles and inboxes are flooded with online poker deals. The site stands out for a variety of reasons: a wide range of gadgets. gifts and accessories at 'ultra competitive prices', free delivery to anywhere in the mainland UK, fast despatch of goods.

So, contact All The Best Gadets Ltd., 9-10 Jew Street, Brighton, Sussex BN1 1UT. Tel: 01273 726489. Fax: 01273 746920. Email: info@allthebestgadgets.co.uk. Web: www.allthebestgadgets.co.uk.



Do you have a new USB-powered peripheral, like a scanner, that needs more power than can be drawn from the socket on your PC or USB hub? Here's a little gadget that will solve your problem. It allows you to feed extra power into the USB line, controlled automatically by the PC – so your new peripheral will be turned on and off just as if it were being powered directly by the PC. **E**ACH USB SOCKET of a PC or self-powered USB (Universal Serial Bus) hub can supply up to 500mA at 5V DC, which can be used to power many USB peripherals directly. That's one of the advantages of USB and many of the newer peripherals are designed to be powered in this way.

Many low-cost USB hubs are also designed to take their own power from the PC, via their 'upstream' USB cable. That's fine in most cases, as the hub's internal circuitry only needs a few tens of milliamps to operate.

However, things start to get a little more complicated if you try to connect a number of bus-powered USB peripherals to your PC via such a hub, because the hub's 'downstream' output sockets can each only supply a maximum of 100mA. That's because all



Fig.1: the USB Power Injector is essentially a switch and a 5V regulator. The Vbus supply from USB socket CON1 turns on transistor Q1 which then turns on MOSFET Q2. This then feeds unregulated DC to REG1 which in turn supplies 5V to the downstream USB socket CON2.

of their power must ultimately come from the PC itself, of course.

What happens if you have one of these hubs already powering say, three USB-powered peripherals and then you buy a USB-powered scanner or label printer that needs to draw more than 100mA? Ah, that is a problem. Luckily, it's easily solved; all you need is the USB Power Injector described here. It's designed to be connected in series with the USB cable to your new peripheral and also to a 9V AC or DC plugpack.

When it detects 5V DC coming from the PC and/or hub, it switches power from the plugpack through to a builtin 5V regulator, to provide your new peripheral with its own 5V power at up to 500mA.

All of the components used in the USB Power Injector are mounted directly on a very small PC board, which fits snugly inside a small plastic box.

#### How it works

Looking at the circuit diagram of Fig.1, power from the external plugpack comes in via socket CON3 and then passes through diodes D1-D4. These provide rectification for an AC plugpack or automatic polarity correction for a DC plugpack. Either way, a DC voltage of between 8V and 14V (or thereabouts) appears across the 1000µF reservoir capacitor.

CON1 is a USB 'Type B' socket, used as the Injector's 'upstream' or input port. It connects back to one of the USB output/downstream ports of your PC or hub, via a standard USB cable. Both of the data lines of CON1 are connected directly to the corresponding pins of CON2, a USB 'Type A' socket which is the Injector's output/downstream port. This connects to your new USB peripheral via another standard USB connecting cable, so the Injector is fully transparent in terms of USB data communication. USB data can pass straight through the Injector in either direction, between PC and peripheral and vice-versa.

When the PC is powered down though, power from the plugpack is not able to flow through to the peripheral because P-channel power MOSFET Q2 is connected in series and it is normally turned off. When the PC is turned on, +5V appears at pin 1 of CON1 and this switches on transistor Q1 via a  $22k\Omega$  base resistor. Q1 then switches on Q2, which becomes a very low resistance, about  $0.1\Omega$ . This feeds the unregulated DC voltage across the  $1000\mu$ F capacitor through to REG1, a 7805 +5V regulator which now provides +5V to pin 1 of CON2 and your peripheral device.

LED1 is used to provide 'power on' indication. LED1 is fed via the  $820\Omega$  series resistor from the switched DC at the input to REG1, so it's only illuminated when the Injector's power is switched on by Q2.

The  $10\mu$ F and 100nF capacitors are included to ensure stable operation of REG1, while diode D5 is to protect it from reverse-voltage damage when the power is turned off.

Although REG1 has very little heatsinking, it should be able to power virtually any USB-powered peripheral which draws no more than the maximum drain of 500mA.

#### Construction

All the components used in the USB Power Injector (apart from the plugpack) are mounted directly on a small PC board. This measures  $76 \times 46$ mm and is available from the *EPE PCB Service*, code 597.

The artwork (Fig.3) for the PC board has rounded cutouts in each corner, allowing it to fit snugly in the small



Fig.2: follow this component overlay to assemble the PC board. Don't get Q2 and REG1 mixed up – they look the same!



Fig.3: check your PC board carefully against this full-size etching pattern before installing any of the parts.

plastic box  $(83 \times 54 \times 31 \text{mm})$ . It's supported inside the box by four 9mm long M3 tapped spacers, using four countersink 6mm  $\times$  M3 screws through the bottom of the box and another four

### Parts List

- 1 PC board, code 597, available from the *EPE PCB Service*, 76 x 46mm
- 1 plastic utility box, UB-5 size (83 x 54 x 31mm)
- 1 USB socket type B, PC-mount (CON1)
- 1 USB socket type A, PC-mount (CON2)
- 1 2.5mm concentric LV power socket (CON3)
- 4 M3 tapped spacers, 9mm long
- 6 M3 x 6mm machine screws, round head
- 4 M3 x 6mm machine screws, countersink head

#### Semiconductors

- 1 7805 5V regulator (REG1)
- 1 PN100 NPN transistor (Q1)
- 1 IRF9540 P-channel MOSFET (Q2)
- 1 3mm green LED (LED1)
- 5 1N4004 diodes (D1-D5)

#### Capacitors

- 1 1000µF 16V PC electrolytic
- 1 10µF 25V tantalum
- 1 100nF (0.1μF) multilayer monolithic (code 104 or 100n)

#### Resistors (0.25W 1%)

- $1 \ \text{22k}\Omega$
- 2 10kΩ
- 1 820Ω

round-head 6mm × M3 screws through the PC board itself.

Rectangular holes are cut in the narrow ends of the box to provide access to the two USB connectors (CON1 and CON2), while a 3mm round hole is drilled in the end next to CON2, to allow LED1 to protrude through. Similarly, a 9mm hole is drilled in one of the longer sides of the box, to allow access to power input connector CON3. The locations of all box holes are shown in Fig.4.

The component overlay diagram for the PC is shown in Fig.2 and you can cross-check this with the internal photo below.

Fit the low-profile resistors and diodes first, taking care with the diode polarity as usual. Then fit the capacitors, taking care with the polarity of the  $10\mu$ F and  $1000\mu$ F capacitors. Note that the larger capacitor mounts over on its side, to make sure there is clearance between it and the box lid – see photograph below.

Next, fit the three connectors. The two USB connectors are different in terms of their pin layout, so make sure you fit them in their correct positions. You may need to elongate the holes for their attachment lugs slightly with a jeweller's file, before the connectors will fit down against the board.

The last components to fit are the TO-92 transistor Q1, LED1 and the two TO-220 devices Q2 and REG1. Make sure you don't swap the latter



The PC board is mounted inside the case on four M3 x 9mm tapped spacers and secured using machine screws. Note how the 1000 $\mu F$  electrolytic capacitor is mounted.



The power indicator LED protrudes through a hole in the end of the case, adjacent to the USB output socket (CON2).

devices, as this may cause one or both of them to be damaged. Both devices mount flat down against the top of the board, with a 6mm × M3 machine screw and nut used to hold them down and also provide a small amount of heatsinking.

Make sure also that you fit LED1 with its "flat" side towards connector CON2 and its longer anode lead further away. The LED leads are soldered in place with the body about 11mm above the board and they are then bent down at right angles about 4mm above the board, so the body can protrude through the matching hole in the end of the box.

Once you have made the necessary holes in the UB-5 box (including the countersunk holes in the bottom, for the PC board mounting screws), the completed board assembly can be mounted in the box using the 9mm M3 tapped spacers.

#### **Checkout time**

There are no adjustments or setup needed on the completed USB Power Injector and very little in the way of testing. All you need do is connect the output of a 9V DC or AC plugpack to CON3 and confirm that indicator LED1 doesn't light until you also connect CON1 to a downstream USB port on your PC or USB hub.

If the LED then turns on and off when the PC is itself turned on and off, this confirms that it's working



Fig.4: this diagram shows the drilling and cutout details for the plastic case that's used to house the board assembly.



Fig.5: this front panel label can be cut out or photocopied and attached to the lid of the case. It can be protected using wide strips of clear adhesive tape.

correctly. All that remains is to screw on the lid of the box and fit the cover plugs – although you might also want to stick on a dress label as well, to finish the job. The artwork for a suitable label is shown in Fig.5. **EPE** 

# TECHNO-TALK MARK NELSON

## **Banned Substances**

#### Mark Nelson investigates why some commonplace products may soon acquire 'endangered species' status.

NCREASING legislation for consumer protection has got to be a good thing-at least in general. But it can be a real pain when it threatens user choice, particularly for hobbyists who know what they are doing.

In several hobby magazines a previously respected supplier of solder and soldering accessories ran advertisements urging readers to 'Stock up now on (soon to be) Banned Substances'. The words 'soon to be' were in much smaller print and the clear impression was that within a few months tin-lead solder could no longer be sold.

This of course is rubbish, a fact that a rival supplier soon spotted, running advertisements to the effect of 'Don't worry, it's still available from us' and adding that its use was restricted in certain applications. Which is entirely correct. Although since July of this year solder containing lead cannot be used for manufacturing new consumer products, its use is still permissible for repairing equipment already on the market, for making non-consumer items and for non-commercial (hobby) applications.

#### False Allegation

The allegation that tin/lead solder will cease to be available is totally false; it will still be made as there will remain many types of product that are not covered by the new rules. Of course, it may not be so easy to find in the shops and Maplin Electronics, probably Britain's biggest hobby electronics supplier, stopped stocking the stuff quite some time ago. The major online suppliers, such as Farnell, RS Components and Rapid Electronics continue to sell it and long may this last.

Whether the change of regulations will lead to prices plummeting or rising is not so certain. Some optimists imagine there will be a glut of the stuff as vendors dump large stocks, although any well-run business will have run down its stocks in advance of the cut-off date. It's more likely that the declining demand will cause prices to rise, although a shortage of the stuff is very unlikely. We shall see.

#### **Battery Ban**

Some scare stories are true, however, if the thought of not being able to buy rechargeable NiCad batteries fills you with dread. A pan-European effort to exclude poisonous heavy metals from landfill waste will result in a ban – the use of cadmium and mercury in portable batteries, with only a few exemptions. The applications for which NiCads will still be allowed include emergency lighting, power tools, certified medical equipment and the requirements of national security.

A major application that will cease is mobile radios and cordless telephones, in which NiCads have played the mainstay role for many years. These users will have to find compatible new batteries and chargers or else buy new appliances. Another effect of the legislation is the obligation on suppliers to collect and recycle all batteries, at no cost to the user.

There will be tough recycling targets too. Within four years of the directive coming into force, industry will be required to recover 25 per cent by weight of all batteries sold. The EU directive on this subject is expected to be published before the end of this year, with up to two years allowed after that for implementation.

#### 'Worst Law Ever'

If you think these European directives are oppressive, then thank your lucky stars you don't live in Japan, where consumers only just escaped far more draconian legislation. It was in March of this year that the Japanese government did a U-turn and quashed the 'Electrical Appliance and Material Safety Law', which it had already passed in 2001. The legislation aimed to ban the sale of electrical consumer goods manufactured before the year 2001, unless they passed a safety test that would generally cost far more than the item's current value.

The aim of this directive was laudable, to protect users from buying unsafe goods at the same time as revitalising the economy by boosting the sale of new products. However, second-hand dealers were less cheerful; their market was stated to be worth around  $\pounds 500$  million, although this was probably a significant underestimate.

What the do-gooders had failed to think through was the effect the legislation would have on the sale of classic hi-fi equipment, early home computers and gaming consoles, also electronic music apparatus and karaoke machines, all of which have passionate adherents in Japan. It also failed to foresee that the effective ban would lead to a flood of this equipment onto the export market at the same time as driving Japan's electronic heritage out of the country where it arguably belonged.

After stringent public criticism the government moved to a compromise position. For six months it would conduct the safety tests at its own expense (well, public expense really) and exempted 'vintage' musical instruments and certain other categories. Finally, the defining date for what was 'old' and therefore had to be tested was moved back from 2001 to 1989, enabling most second-hand products to escape testing. It was a near thing, though, with little wonder that Japanese citizens dubbed it their country's 'worst law ever'.

#### Grumpy?

Who's grumpy? Well, me for a start. People tell me I was already a Grumpy Old Man decades ago in my twenties, but at last that experience proves that we British are an adaptable race. We grumble for a while and then adjust to new rules and regulations.

Look at workshop solvents for instance. When I was a kid my father had a tin of petrol in the garage, with an old paintbrush in it for degreasing materials. This was considered unsafe, so we changed over to Carbon Tetrachloride (CTC), also sold in every high street as Thawpit dry cleaning fluid (remember the wide-rimmed bottle with a cork applicator that took ages to saturate?).

Then CTC was declared taboo and we had to use 'trike' (Trichloroethylene) instead. Concerns about its toxicity meant it was banned in much of the world during the 1970s. No doubt there's an entirely safe substitute now and a quick Google search indicates Leksol (n-Propyl Bromide) is a direct substitute with no hazards at all (unless you know better). I'm afraid I stopped trying to keep up ages ago and just use Isopropyl Alcohol or Swan Vestas lighter fuel. I do have a Winchester of xylene under the sink as well, but there's so little left of this I'm saving it for later!

#### **Filthy Phone Calls**

While on the subject of cleanliness, I was shocked by another scare story recently, about a new hazard involving mobile phones – nasty bacteria! Under the headline 'Minging Mobiles' a newspaper informed me that keeping handhelds warm and cosy inside pockets makes an ideal breeding ground for nasty bacteria. 'Tens of thousands of microbes live on each square inch of mobile phones and hold more bacteria than a toilet seat,' thundered the article. 'Every time you use your phone to text or put it to your ear, thousands of bacterium [sic] are rubbing off on you to continue breeding', it continued.

Really? Surely these bugs are transferred onto the phone from your body, where they evidently do me no harm, so their advice to use anti-bacterial wipes sounds like a cynical excuse to sell more wipes!



#### x2 360 ▼ Formaty Range x/10 [ Std Dev y = Sin(x / r)y = 0.71 0 1 2 3 4 5 6 7 8 9 a b c d m n x pi r E Abs( Atn( Cos( Exp( Fix( Int( Log( Mod Rnd[ Sgn[ Sin[ Sqr[ Tan( + + \* 1 1 ^ [ ] Constants pi = 3.142: r = 57.30: y = value for x : include all numerical operations + $-6^{\circ}$ . Space Clear Cut Paste

#### With links to Technology, Hobbies and Educational websites. Link your business to thousands of new

Principles V9.2 educational and hobbies visitors every day via our software integrated browsers! Something for all the family! Home Study Pack

Principles V9.2! our top selling package for maths, computing, ICT, physics, CDT, electronics, electrical, mechanics, engineering, PICs, model railways, amateur radio, motor vehicle maintenance. GCSE, A-Level, HNC HND and Degree. Download and fully installed for less than 20p a day, you only pay for as long as you need it!

www.eptsoft.com episoft limited, Glebe House, School Lane, East Keal, Spilsby, Lincolnshire. PE23 4AU Tel: 01790 754037 email info@episoft.com

#### www.BatteryPlanet.co.uk

#### LIK Battery Specialist

Brand new secure online shop

£0.49

£0.49 £0.49 £0.59 £0.59

£0.59 £0.79 £0.79

£0.79 £0.79

£0.79

£0.99

£0.99 £1.29

£1.29

£1.29

£1.49

£1.49 £1.49 £1.49 £1.49 £1.49 £1.49

£0.99

£0.99

£0.99

t0 99 £0.99 £3.99 £5.99 £3.99 £5.99

Zinc Chloric	le Batteries	
Memorex AA	Zinc Chlorid	e (4

Memorex AAA Zinc Chioride (4pk) Memorex AAA Zinc Chioride (4pk) Memorex C Zinc Chloride (2pk) Memorex D Zinc Chloride (2pk) Memorex 9v Zinc Chloride (1pk) Panasonic Special Power AA (4pk) Panasonic Special Power AAA (4pk) Panasonic Special Power C (2pk) Panasonic Special Power D (2pk) Panasonic Special Power 9v (1pk) Alkaline Batteries Memorex AA Alkaline (4pk) Memorex AAA Alkaline (4pk) Memorex C Alkaline (2pk) Memorex D Alkaline (2pk) Memorex 9v Alkaline (1nk)

Memorex 9V Alkaline (1pk) Panasonic Xtreme AA (4pk) Panasonic Xtreme AAA (4pk) Panasonic Xtreme C (2pk) Panasonic Xtreme D (2pk) Panasonic Xtreme 9v (1pk) Lithium/Camera Batteries

Mitsubishi 6v Lithium 2CR5 (1pk) Mitsubishi 3v Lithium CR2 (1pk) Mitsubishi 3v Lithium CR123A (1pk) Mitsubishi 3v Lithium CR123A (1pk) Mitsubishi 6v Lithium CRP2 (1pk) Energizer Ultimate Lithium AA (2pk) Energizer Ultimate Lithium AA (4pk) Energizer Ultimate Lithium AAA (4pk) Energizer Ultimate Lithium AAA (4pk)

#### Zinc Air Hearing Aid Batteries

Rayovac 1.5v 10AE (Yellow) (6pk) Rayovac 1.5v 13AE (Orange) (6pk) Rayovac 1.5v 312AE (Brown) (6pk) Rayovac 1.5v 675AE (Blue) (6pk) £2.99 £2.99 £2.99 £2.99 GP Chargers also available Call£

16 Field Street V/SA ..... Cannock Staffs Stans. WS11 5QP Tel: 0845 166 2314 Fax: 0845 166 2315 PayPal Sales@BatteryPlanet.co.uk



All prices include Vat @ 17.5% UK P&P for batteries £1.00 for 1<sup>st</sup> item, then additional £0.25 per item. Except C/D Cells, £1.50 for 1<sup>st</sup> item, then additional £0.50 per item. Bulk orders please call to arrange carriage. UK P&P for Battery Chargers is £2.95 each Please allow upto 14 days for delivery.





#### More about using MultiMedia Cards with PICs

N last month's *Pic n' Mix* we detailed the low level hardware and software interfacing to MultiMedia Cards (MMC), showing how simple they are to use. Reading and writing to them is surprisingly straightforward once you get over the hurdle of the various specification documents.

#### **Accessing Data**

Accessing the data outside of your project, however, is rather more difficult, especially if you intend to store the data in your own, non-standard way. If you are going to write or read large amounts of data – after all, that would be the reason for designing the media into your project in the first place – then you are likely to want to be able to access the data on a PC.

MMC readers for the PC are readily available and very cheap, as low as £5. These readers expect the media cards to have data organised on them in a structured way, typically either FAT12, FAT16 or FAT32 format.

Most Media cards are supplied pre-formatted to the FAT16 standard. What this means is that some of the memory locations on your card contain data that defines a FAT file system, just like a hard disk. And this can involve quite a lot of your precious memory; for example, on our MMC over 256KB of the total memory available is reserved for the FAT data. As this represents only 0.1% of total space, the loss is a small price to pay for the convenience.

#### **FAT Tables**

FAT16 stands for 'File Allocation Table, 16-bit'. It is an old disk file system designed by Microsoft that is capable of handling storage devices with capacities up to 2GB. It has been in common use on DOS and Windows based PCs for many years, but has now found its way onto removable media such as MMCs. The use of the FAT16 file system on removable media is a significant reason why transferring data from digital cameras, MP3 players etc to a PC is so simple.

A FAT is a collection of data structures that are placed onto the device that define how big the storage device is, how the memory is organised, and where the files are. Hard disks are quite complex devices with multiple platters, heads etc, but Media cards are, of course, just an array of bytes and so there is more information inside these data structures than we need. When we get on to describe the data structures we will skip over the unused parts, and concentrate on the fields of interest to us. The specification of FAT16 is not trivial, but once we have gone through it you will find the software easy to use. Storing data in FAT format on a media card offers a world of opportunities not possible before – easily sharing data between your PICbased project and a PC. Not only can you save text, images, sound files, binary files etc but you could (with a little thought and some further code) create PIC programs that you could 'run' by transferring from the Media card to the PIC's flash. You could create your own 'DOS' for the PIC!

#### WinHex

Before we start working through the FAT specification, you might want to download the program *WinHex* from the Internet (see the links under Reference at the end of this article). WinHex is one of a number of tools produced by X-Ways Software Technology AG designed for 'forensic analysis' of storage media.

In our case, it can be used to view the raw data on the card when attached to the PC via a cardreader. It's a small 1MB download that can be used free of charge in evaluation mode. Once downloaded, extract the files to a temporary directory, run the **setup.exe** and install to the default directory. Once installed, you can remove the temporary directory. When you run it for the first time a dialog, Fig.1, is shown.



Fig.1. Initial dialog screen

Set the tick boxes as shown, then click on 'OK'. To view the contents of the MMC card click on 'Tools' followed by 'Open Disk'. In the dialog box that appears, select the entry 'Removable Medium' from under 'Physical Media'. The contents of your card will be displayed.

#### FAT16 Specification

Now, to the FAT16 specification. First, some terminology. As FAT was originally designed for hard drives which contained several disks and read heads, the means of identifying a particular byte within the unit is complicated. The original scheme was called CHS addressing – Cylinder, Head and Sector. This has been superseded by LBA, Logical Block Addressing, which uses a simple incrementing counter to identify the position of a byte; the drive takes care of where the byte is actually located.

For Media cards, implementing a simple linear array of bytes, CHS has no meaning and we consider data locations in terms of sectors. A *sector* is the smallest unit of data (i.e., size) managed by the file system, and typically consists of 512 bytes. A *cluster* is another unit of data, which can vary depending on the size of the card. The number of bytes per sector and number of sectors per cluster are defined within the FAT tables, which we read when we first power up the card.

So, why do we use sectors and clusters rather than bytes? It allows us to reduce the number of bits required when addressing, or indexing, into the card's data. If files are set to start at the beginning of a cluster, then you only need a 20-bit pointer rather than a 32-bit pointer (on a 2GB disk) to address the file. This saves space on the storage of file pointers. As we will see later, there can be a lot of them in the FAT, so reducing their size is a good idea.

#### **Data Structures**

There are several data structures that make up a FAT16 organised card, shown in Fig.2.



#### Fig.2. FAT16 Data structures

The size and locations of these vary, so we have to read each one in sequence and decode the information to find where the others are. The first one is the Master Boot Record, or MBR, conveniently located at sector 0, the first byte on the card. This record normally holds the initial software run by a computer (only 446 bytes) and the details of the locations of up to four partitions. A *partition* is an area of memory that

Master Boot Record - MBR				
Index, Size, in Description in hex decimal				
0x000	446	Initial boot code		
0x1BE	16	Partition 1 details		
0x1CE	16	Partition 2 details		
0x1DE	16	Partition 3 details		
0x1EE	16	Partition 4 details		
0x1FE	2	End marker (0xAA55)		

#### Fig.3. MBR information

can be assigned to a logical disk; thus, you could have up to four logical drives. Each partition will hold a FAT16 boot record, FAT tables, a directory table and a large block of space for the actual file data itself. Fig.3 shows the information held in the MBR.

Note that in all the descriptions that follow, word and long word numbers (2-byte and 4-byte) are stored lowest value first, highest value last. So the number 0x1234 would appear in memory as 34 followed by 12. This is referred to as 'little endian' and is the format used by Intel processors when storing multi-byte values.

#### Partitions

Media cards are typically created with a single partition, so we look through the MBR's partition table details to find where this partition actually starts, as shown in Fig.4. We look for a value of 4, 6 or 14 in the partition type (which signifies a FAT16 file system) and then look to the offset field to find where the partition proper starts.

Partition – Directory Table				
Index, in hex	Size, in decimal	Description		
0x00	8	File name, ASCII		
0x08	3	File extension, ASCII		
0x0B	1	File attributes		
0x16	2	File creation time		
0x18	2	File creation date		
0x1A	2	File start cluster		
0x1C	4	Size of file		

#### Fig.4. MBR partitions

As you can see, there are a number of hoops that need to be jumped through, but this only needs to be done once when you power up the card. We are getting close to finding the data!

Another quick note: Most Media cards are supplied pre-formatted with these data structures, but in some cases when the card is reformatted by Windows the MBR is discarded, and location 0 holds the start of the partition. On a Media card the only use for the MBR is to locate the active partition so this does not cause us a problem, we just need to check to find out if the MBR is present or not.

#### FAT records

The FAT16 boot record, which you can see in Fig.5, appears at the beginning of the partition. Lots of key information in here helps us locate the remaining data on the card. It also tells us how many sectors are used for each cluster; a detail that will be important later on.

The first FAT table follows after the 'Number of reserved sectors'. The FAT table contains the list of clusters that make up your files. It's a type of linked list,

enabling the file to be stored in chunks, filling up unused holes left by previously deleted files. It is obviously extremely important that the FAT table does not become corrupted, so there are typically two or more copies of the FAT table. When we write to a file, we must update all copies of the FAT.

The FAT table consists of a simple list of words (16 bits), one for each data cluster in the partition. The first two words are reserved and the next word holds the 'next in chain' pointer for cluster number two. By convention, cluster number two is the first data cluster, and it follows immediately after the directory table.

As an example of how the FAT table is organised, let's say you create a big file that needs three clusters to hold it. If this is the first file on the partition, it will occupy clusters 2, 3 and 4. The third entry in the FAT table, which is the marker for cluster number 2, will hold the value 3. The next word entry in the FAT table, for cluster number 3, will hold the value 4. The starting cluster for the file (2 in this case) is found by looking in the directory entry for that file.

#### Cluster Attributes

There are special values to indicate when the file ends, unused clusters etc. These are:

0x0000 : Cluster is unused

0x0003 : 0xFFEF : Next cluster in the file

0xFFF7 : Cluster contains a bad sector (do not use)

0xFFF8 - 0xFFFF : Last cluster in the file

As you can see, media that has a large cluster size will not be efficient at storing large numbers of files. If your cluster size is 4KB and you store a 4.1KB file, the file will occupy 8KB. This is the nature of FAT file systems; it is a trade off between storage efficiency and speed of access to files. The size of the cluster is not under your control, so you have to live with it.

The names, creation date and attributes of each file are not held with the file data but instead in the directory table that follows immediately after the FAT tables. The content of this data structure can been seen in Fig.6. The specification for the bit fields is detailed in the source code that accompanies this article, in the file **FAT16.inc**.

Partition – FAT16 Boot Record				
Index, Size, in Description				
in hex	decimal			
0x000	3	Reserved		
0x003	8	OEM Name, ASCII		
0x00B	2	Number of bytes / sector		
0x00D	1	Number of sectors / cluster		
0x00E	2	Number of reserved sectors		
0x010	1	Number of FAT copies		
0x011	2	Maximum root entries		
0x16	2	Number of sectors / FAT		
0x20	4	Number of sectors in the		
		partition		
0x26	1	Magic number (0x29)		
0x2B	11	Volume name, ASCII		
0x36	8	FAT type, ASCII (FAT16)		
0x1FE	2	End marker, 0xAA55		

Fig.5. FAT16 Boot Record partitions

Partition - Directory Table				
Index, in hex	Size, in decimal	Description		
0x00	8	File name, ASCII		
0x08	3	File extension, ASCII		
0x0B	1	File attributes		
0x16	2	File creation time		
0x18	2	File creation date		
0x1A	2	File start cluster		
0x1C	4	Size of file		

#### Fig.6. Partitions Directory Table

The filename and extension should be padded with spaces if not eight and three characters respectively. The first byte of the filename has a special meaning; a value of 0xE5 means 'This entry is free', and is the value you write in when the file is deleted. A value of 0x00 means 'No more files in the directory' and is used to signal to software that it does not need to continue looking for filenames.

The creation time and date fields are not mandatory, so you can leave them empty if you wish, or set them to a default value.

# Sub-directories and File Names

In order to simplify matters we have left off an explanation of sub-directory and long filename handling; they are not necessary for basic file handling.

In the implementation we have also made a simplification to the way files are written; when we open the file we find the last cluster used on the disk, then we write data to consecutive clusters without trying to 'fill in' unused clusters elsewhere in memory. This enables the software to support high speed writing to the media, which is likely to be important for many embedded projects.

#### Example Software

The example software for this article (available from the Downloads section of the *EPE* website – **www.epemag.co.uk**) builds on last month's low level code. We have also added some new commands to the RS232 debug user interface to display a directory listing, the contents of a file etc. All the high level access functions are listed in **FAT16.inc**.

The nice thing about implementing a FAT interface is that the underlying software need implement only two functions; *readBlock* and *writeBlock*. We did just that last month, so this month's code focuses on the higher level FAT interfacing and ignores almost completely the underlying complexities of the card interface. This is a typical design practice; implement the software in 'layers', with each subsequent layer providing a greater level of abstraction from the preceding layers. No need to worry about SPI commands and bit twiddling this month!

#### Finally

This has been quite a length and complex discussion, but we hope that you can see the potential benefits are enormous, and quite good fun to experiment with.

#### Reference

WinHex: http://www.x-ways.net/

This unit is easy to build, with all parts installed on a double-sided PC board to eliminate internal wiring. It simply connects between the video source (eg, a set-top box) and your TV set or video projector.

GB TO COMPONENT

## **By JIM ROWE**

# RGB to Component Video Converter

OK, YOU'VE JUST arrived home with your new widescreen TV set and tried to hook it up. But there's a problem – your new set has Y/Cb/Cr component video inputs while your digital set-top box only provides high-quality signals in RGB format. You've got three choices – throw a wobbly, use the composite video output (but at the expense of picture quality) or build this low-cost RGB to Component Video Converter. **T**F YOU LIVE in an area where digital FTA (free-to-air) TV signals are available, it's well worth investing in the service because of their better picture and sound quality. However, to achieve the best possible picture quality, you have to use the component video signals from the DTV set-top box and feed these into the matching inputs of your TV set or video projector.

The big catch here is that some settop boxes only provide RGB video signals, with separated red, blue and green outputs. In most cases, these signals are made available via one of the large 20-pin SCART sockets or Euroconnectors.

> This doesn't suit some of the latest large-screen (and widescreen) TVs and video

projectors. These are usually designed to accept Y/Cb/Cr (or Y/B-Y/R-Y) component video, the same format as provided by the latest DVD players.

Unfortunately, you can't feed RGB signals

directly into these sets or projectors. But you can convert the RGB signals into Y/B-Y/R-Y form, using the simple converter unit described here. It simply connects between your settop box and your TV set or projector.

As shown in the photographs, the complete converter fits in a small instrument box. It runs from a 9V AC plugpack supply, drawing less than 50mA – ie, less than half a watt of power.

#### How it works

ONVERTER

The operation of the converter is quite straightforward, because it simply duplicates the kind of matrixing used to produce the luminance (Y) and colour difference (R-Y and B-Y) signals from the original colour camera signals. To do this, it first creates the Y signal by combining the R, G and B signals in the correct proportions; ie:

Y = 0.3R + 0.59G + 0.11B

That done, it subtracts this Y signal from the R and B signals, to create the colour difference signals.

Fig.1 shows how this is done. The Y signal is produced by the mixer/ adder stage based on IC1a which (like all of the other op amps used)



Fig.1: the RGB signals are added in the correct proportions in op amp IC1a to produce a -Y (inverted luminance) signal. This is then fed to IC1b & IC2b to produce the R-Y and B-Y colour difference signals, while inverter IC2a produces the Y luminance signal.

is one half of a MAX4451ESA dual wideband amplifier. This stage is used to combine the three input signals in the right proportions, as determined by the three input resistor values.

Because IC1a is connected as an inverting amplifier, the signal at its output is an inverted version of the Y signal (ie, -Y). This -Y signal is then added to the R signal in IC1b to derive the R-Y colour difference signal.

In fact, IC1b operates with a gain of two (as set by the R1 resistor values), so its output signal corresponds to 2(R-Y). This is done to compensate for the voltage division that occurs when the converter's R-Y output is connected to the R-Y input of a TV set or video projector – ie, due to the effect of the converter's  $75\Omega$  'back termination' output resistor and the set's  $75\Omega$  input impedance.





Fig.2: the complete circuit for the RGB To Component Video Converter. Op amps IC1a, IC2a & IC2b all operate with a gain of two, to compensate for the signal losses that occur due to the  $75\Omega$  "back termination" output resistors and the set's  $75\Omega$  input impedance.

Exactly the same arrangement is used to produce a 2(B-Y) colour difference signal, using adder stage IC2b. In this case, we simply add the -Y signal to the B signal and again amplify their sum by two.

The centre output buffer stage using IC2a operates as an inverting amplifier with a gain of two and converts the -Y (luminance) signal from IC1a into an output signal of 2Y. As before, this stage operates with a gain of two to compensate for the inevitable voltage

division due to the  $75\Omega$  back termination and input resistors.

Now take a look at Fig.2 which shows the full circuit details. As shown, all the resistors shown as R1 in Fig.1 actually have a value of  $510\Omega$ . These resistors are in the feedback networks and at the inputs to IC1b, IC2a & IC2b. By contrast, the various parallel resistor combinations between the three video inputs and IC1a's inverting input (pin 2) are chosen to give the correct mixing proportions. For example, the  $2.2k\Omega$  and  $7.5k\Omega$ resistors from CON1 give a value of 1701 $\Omega$ , which is very close to the correct figure for the R component (ie, 510/0.3 = 1700 $\Omega$ ) Similarly, the 1k $\Omega$  and 6.2k $\Omega$  resistors give a value of 861.1 $\Omega$ , which is very close to the correct figure for the G component (510/0.59 = 864.4 $\Omega$ ). And finally, the 5.1k $\Omega$  and 51k $\Omega$  resistors give 4636 $\Omega$ , exactly the right figure for the B component (510/0.11 = 4636 $\Omega$ ). The 91 $\Omega$  and 82 $\Omega$  resistors across the three video inputs ensure that each has the correct 75 $\Omega$  input resistance. Note that these resistors are all somewhat higher than 75 $\Omega$ , to compensate for the effects of the various mixing resistors connected to them. This impedance matching is necessary to ensure that the input cables from your set-top box or other RGB video source are correctly terminated, to prevent ringing.

#### **Power supply**

The converter's power supply is simple, as the MAX4451 devices operate from  $\pm 5V$  supply rails and draw quite low current.

Power is derived from a 9VAC plugpack and this feeds half-wave rectifiers D1 and D2. These produce +13V and -13V rails which are filtered using two 2200 $\mu$ F electrolytic capacitors and fed to 3-terminal voltage regulators, REG1 and REG2. The +5V and -5V regulator outputs are then filtered using 100 $\mu$ F capacitors and fed to the op amps supply pins (4 & 8).

LED1 provides power-on indication. It is simply connected across the +5V rail in series with a  $470\Omega$  current-limiting resistor.

#### Construction

All of the converter circuitry is built on a double-sided PC board, coded 596, measuring  $117 \times 102$ mm. This in turn is housed in a standard instrument case measuring  $140 \times 110$  $\times 35$ mm, to produce a very compact and neat unit.

There's no off-board wiring at all – all the RCA input and output connectors are mounted directly on the PC



Fig.3: install the parts on the top of the PC board as shown here. The red dots indicate where component leads (and the single 'via' above left from CON1) are soldered to both sides. The two MAX4451 dual op amps are mounted on the underside – see Fig.5.

board along the front and rear edges. These are all accessed through holes in the front and rear panels when the case is assembled.

It is necessary to solder some component leads on both sides of the board. You'll also need to solder a short length of tinned copper wire (such as a resistor lead offcut) through one 'via' hole, to make the connection between top and bottom tracks. To make it easy, these points are all indicated on the PC board overlay diagram (Fig.3) with red dots. The full-size top and bottom copper-foil masters are given in Fig.6.

Most of the components fit on the top of the board in the usual way. The only exceptions are the two MAX4451ESA

Table 1: Resistor Colour Codes							
	No.	Value	4-Band Code (1%)	5-Band Code (1%)			
	1	51kΩ	green brown orange brown	green brown black red brown			
	1	7.5kΩ	violet green red brown	violet green black brown brown			
	1	6.2kΩ	blue red red brown	blue red black brown brown			
	1	5.1kΩ	green brown red brown	green brown black brown brown			
	1	2.2kΩ	red red red brown	red red black brown brown			
	1	1.5kΩ	brown green red brown	brown green black brown brown			
	2	1kΩ	brown black red brown	brown black black brown brown			
	10	510Ω	green brown brown brown	green brown black black brown			
	1	470Ω	yellow violet brown brown	yellow violet black black brown			
	2	91Ω	white brown black brown	white brown black gold brown			
	1	82Ω	grey red black brown	grey red black gold brown			
	3	75Ω	violet green black brown	violet green black gold brown			



The assembly is straightforward but be sure to install all polarised parts with the correct orientation. These include the diodes, 3-terminal voltage regulators, the LED and the two 'surface-mount' op amps.

surface-mount SOIC packages, which are mounted on the bottom of the PC board (more on this later).

Begin the board assembly by fitting the short wire link which forms a 'via' between the top and bottom copper tracks of the -5V supply rail. It's located near the front of the board, about 17mm to the right of the  $470\Omega$  resistor just behind LED1. Fitting this link first will make sure you don't forget it.

Next fit the resistors, making sure you solder their 'earthy' leads to both sides of the board where indicated.



Fig.4: these full-size artworks can be used as drilling templates for the front and rear panels.

Table 1 shows the resistor colour codes but we advise checking each value on a multimeter before it is fitted, just to make sure. That done, install the RCA sockets and the 9V AC power socket, using a small drill to enlarge their mounting holes if necessary.

The three small 100nF monolithic capacitors can be fitted next, again taking care to solder their leads to both sides of the board where indicated. That done, fit the two 10µF tantalum capacitors and the larger electrolytics, making sure each of these polarised components is orientated correctly. The earthy lead of both tantalum capacitors is soldered to the top copper as well, as shown in Fig.3.

Next fit the two diodes (D1 & D2) in the power supply,



Fig.5: the two MAX4451ESA dual op amps are mounted on the underside of the PC board, as shown here. Be sure to install them the right way around.

again watching their polarity. Follow with the two regulators, making sure that you fit each one in the correct position. REG2 (the 7905) goes on the lefthand side, while REG1 (the 7805) mounts to the right of REG2. Don't get them mixed up!

Each regulator is mounted horizontally, with its three leads bent downwards 5mm from the device body so that they pass through the holes in the PC board. They are both secured using  $6 \text{mm} \times \text{M3}$  machine screws and nuts and this should be done before soldering their leads. Note that REG1's centre lead is soldered on both sides of the board, as are two leads for REG2.



You will need a fine-tipped soldering iron to install IC1 & IC2. Make sure that you don't overheat them or leave solder bridges between their pins.

#### Surface mount ICs

Once the regulators are in, you are ready to fit the two surface-mount ICs (IC1 & IC2). These are 8-lead SOIC packages and mount on the underside of the board – see Fig.5. They have a 1.25mm lead spacing, so they're not too small for manual handling and soldering, providing you're careful and use a soldering iron with a fine-tipped bit.

To fit these ICs, invert the board and locate their mounting positions – you'll find the two sets of four small rectangular pads in each position. That done, remove the devices from their packaging and examine each one with a magnifying glass to identify the small chamfer along one side (ie, adjacent to pins 1-4 of the device).

Both devices are mounted on the board with this chamfered side towards the front – ie, downwards in Fig.5. Be sure to use a fine-tipped soldering iron for this job and be careful not to overheat them or leave solder bridges between their pins.

The best way to install them is to hold each device in place with a toothpick while you press down gently on one of its leads with the tip of the soldering iron. This will usually make a weak solder joint between the lead and the tinning on the board copper

### **Parts List**

- 1 PC board, code 596, available from the *EPE PCB Service*, 117 x 102mm (double-sided)
- 1 plastic instrument case, 140 x 110 x 35mm
- 6 RCA phono sockets, PC-mount (2 x red, 2 x blue, 1 x green, 1 x yellow)
- 1 2.5mm concentric LV power connector (CON7)
- 2 M3 x 6mm machine screws with M3 nuts
- 6 4G x 6mm self-tapping screws, pan head

#### Semiconductors

- 2 MAX4451ESA dual wideband op amps (IC1,IC2)
- 1 7805 +5V regulator (REG1)
- 1 7905 -5V regulator (REG2)
- 1 3mm green LED (LED1)
- 2 1N4004 1A diode (D1,D2)

#### Capacitors

- 2 2200µF 16V RB electrolytic
- 2 100µF 16V RB electrolytic
- 2 10µF 25V tantalum
- 4 100nF multilayer monolithic (code 100n or 104)

#### Resistors (0.25W 1%)

1 51kΩ	2 1kΩ
1 7.5kΩ	10 510Ω
1 6.2kΩ	1 470Ω
1 5.1kΩ	2 91Ω
1 2.2kΩ	1 82Ω
3 75Ω	

– enough to hold the device in place while you solder the remaining leads to their pads. That done, you can then go back and solder the first lead properly, to complete the job.

The final component to fit is LED1 (the power LED). This in installed on the top of the board, with its longer anode lead towards the right (ie, towards CON1). It should be mounted with its body about 17mm above the top of the board (a strip of cardboard between the leads makes a handy spacer).

After mounting, bend its leads down together at right angles at a point 9mm above the board. This ensures that it will later protrude through its matching hole in the front panel when the board is installed in its case.

#### Drilling the panels

The next step in the construction is to prepare the front and rear panels



Fig.6a: Full-size top etching pattern for the PC board.

of the case. This involves drilling and reaming a small number of holes for the various connectors and the power indicator LED, using photocopies of the panel artworks as templates see Fig.4. Once that's done, additional photocopies of the artworks can attached to the outside of each panel for a professional finish. The way to do this is to first make a copy of each artwork on



Unfortunately, some set-top boxes do not output a 'sync-ongreen', which in the converter circuit would propagate through to the Y (luminance) output for use in the TV. However, they do have composite video outputs. This little add-on circuit extracts the sync pulses from the composite signal and adds them to the Y output to correct this deficiency. (If the syncon-green is not present the set will probably display a blank screen).

A fourth RCA input socket can be added to the front panel of the converter to accept the composite signal from the set-top box (or other appliance). The appliance may have a composite output in the form of a separate RCA phono socket or as adhesive-backed A4 label sheet paper. The labels are then trimmed, peeled off the backing and attached to the panels. That done, a length of clear packaging tape (ie, wide adhesive tape) is applied over each panel to protect it from dirt and finger grease.

Finally, any excess tape is trimmed off and the holes cut out using a sharp hobby knife.

#### **Final assembly**

Now for the final assembly. This is done by first fitting the panels over the connectors on each side of the board (and also over the LED in the case of the front panel). That done, lower the assembly into the bottom half of the case, sliding each panel into its mating slot. It's then simply a matter of fitting eight 6mm-long self-tapping screws (four along the front and four along the rear) to hold the PC board in place.

Finally, the top half of the case can be fitted and secured from the bottom using the two long countersink-head self-tappers provided.

Your RGB to Component Video Converter is now complete and ready for use. There are no adjustments to make – all that's needed is to connect a suitable 9V AC plugpack and it should spring to life.

part of the SCART connector. Alternatively, the 'Y' channel of a Y/C output can be used as the source.

The composite video signal is first terminated with a  $75\Omega$  resistor (see diagram) and excessive chroma or noise is attenuated with a simple low-pass RC filter, formed by the 560 $\Omega$  resistor and the 470pF capacitor. The signal is then ACcoupled to the input of an LM1881 sync separator IC.

The separated sync pulses appear on pin 1 of the LM1881, after which they're inverted by transistor Q1. The result is injected into the Y signal path by feeding it into the input (pin 2) of op amp IC2a on the converter PC board. An  $8.2k\Omega$  series resistor effectively sets the sync level at about 0.3V.

The circuit can be built on a small piece of stripboard (approx. 20 × 40mm) and attached to a vacant area of the PC board with doublesided tape. **Graham Bowman** 



Fig.6b: Full-size bottom etching pattern for the PC board.

#### Troubleshooting

In the unlikely event that it doesn't work, the first step is to go back over your work and carefully check that all components are correctly positioned and orientated. Check also for missed solder joints, especially where leads have to be soldered on both sides of the PC board.

Next, check the power supply rails with your multimeter. There should be +5V at the output of REG1 and -5V at the output of REG2. If you don't get these voltages, check the two regulators and diodes D1 and D2, plus the polarity of all electrolytic capacitors.

You should also be able to measure +5V (with respect to board earth) on pin 8 of each of the two surface-mount ICs. Similarly, pin 4 of each device should be at -5V, but be careful not to short out adjacent pins with the meter probe when making these measurements.

Finally, if LED1 fails to light even though the +5V rail is correct, check that the LED has been installed correctly. Check also that its  $470\Omega$  resistor is correct. **EPE** 

Dico

icoscope

# PicoScope 3000 Series PC Oscilloscopes

The PicoScope 3000 series oscilloscopes are the latest offerings from the market leader in PC oscilloscopes combining high bandwidths with large buffer memories. Using the latest advances in electronics, the oscilloscopes connect to the USB port of any modern PC, making full use of the PCs' processing capabilities, large screens and familiar graphical user interfaces.

- High performance: 10GS/s sampling rate
   & 200MHz bandwidth
- 1MB buffer memory
- High speed USB 2.0 interface
- Advanced display & trigger modes
- Compact & portable
- Supplied with PicoScope & PicoLog software

## Tel: 01480 396395 www.picotech.com/scope364





# Robert Penfold \_\_\_\_\_



## EXPLORING THE GRAPHICS CAPABILITY OF VISUAL BASIC 2005 EXPRESS

icrosoft's Visual BASIC Express 2005 Mhas been mentioned in previous Interface articles, and it created a significant amount of interest from EPE readers. This is not surprising, as it is a reasonably competent version of Visual BASIC that is available as a free download from the Microsoft web site.

Although the original intention was for this program to be available as normal commercial software after November 7 2006, it will now remain as a free download for its lifetime. Thus, it should still be available as a free download when this magazine appears in the newsagents, and for some time thereafter.

There is no way of knowing how long Microsoft will continue to support this program, so it is probably advisable to download it sooner rather than later if it is something that might be of use to you.

The Microsoft web site has a great deal of useful information about Visual BASIC 2005 Express, and the other programs in the Visual Studio 2005 Express range. These are all available as free downloads incidentally. This is the best place to start for information on Visual BASIC 2005 Express, and there is also a link to the download on this page:

http://msdn.microsoft.com/vstudio/ express/vb/

**Graphics Capability?** Although Visual BASIC 2005 Express is in many ways a very capable piece of software, it would be naïve to expect it to be the equal of the full-price versions of Visual BASIC. It is inevitable that some aspects of the program are limited or absent. Some readers have queried the lack of any graphics capability, but it is a case of the graphics tools being limited rather than completely absent.

The most obvious omissions are the Shape and Line components, which enable such things as rectangles, circles, ellipses, and lines of various widths to be drawn on the screen. These are not supplied as part of Visual BASIC 2005 Express, and there are no cut-down versions of them either. However, it is possible to produce some simple graphics using conventional programming and the Graphics.Drawline instruction.

Unfortunately, the graphics capabilities seem to be a substantially cut down version of those found in Visual BASIC.Net. Consequently, trying to produce simple animated graphics for such things as virtual controls and panel meters is probably not a worthwhile proposition.

This is not to say that the graphics of Visual BASIC 2005 Express are of no use when writing software for electronic projects. It does mean that any graphics will mainly be used to give a smarter and more functional appearance, rather than providing things such as virtual controls.

WindowsA	pplication 1 - Microsoft V	isual Basic 2005 Express Edit	ion	_ d 🗙
		t Tools Window Estimutity Help		
DirectorySearch	• # X Formi.vb [Design]*			• X Soldion Explorat • 9 X
the second capacity -	Options			WindowsApplication1 SMy Project Form1.vb
FileSystemWe     FileSystemWe     FileSystemWe     FordAreDowser     FordAreDow	Enricement     Terminal     Forth and Colors     Forth and Soliditars     Projects and Soliditars     Fort Editor Revis     Windows Forms Designer	Code Generation Settings (ptinuos Code Generation Exposit Settings CokSize Layout Hude Samotai	True B, B SvoToGrad True True True True	Solution. Taolitie - 3 X ormi System Windless (+ Bildenands 0, 0 Qeading 100%) Pacifica 0, 0, 0, 0
Panel PerformanceG PictureBoe PrintDialog PrintDialog PrintDialog	Show all settings		OK (	Cancel RightToLe No RightToLe Felos Shortfrom True Shortfrom True
Bror List				- U × <sup>III</sup> Sibi 799, 633 Sabrinipist Auto
Description	Warnings 1 O Nessagan	Pie	Line Column (	Project Shap Ford True Tray Tool Form! Text Text Text associated vit
Error List Ready	III Bernand Water Billion			10 15, 15 Ø 799 x 633

Fig.1. The Options window enables the screen and snap grid facilities to be switched on and off. The horizontal and vertical grid sizes are individually adjustable

Fortunately, Visual BASIC 2005 Express does include the usual range of controls such as scrollbars and buttons, and it can produce big digital readouts via Label components and suitably large text sizes. Something like the numeric keypad featured in the previous Interface article should be equally easy to produce using Visual BASIC 2005 Express.

One slight problem when you first start using the program is that the form lacks both visual and snap grids. This makes it very difficult to get buttons, labels, etc., accurately aligned on the form. Both visual and snap grids are available, and will almost certainly be required when producing any software for PC add-ons.

The window that controls the grids is obtained by going to the Tools menu and selecting Options. Then select General in the left-hand panel of the Options window. This has controls that enable the grids to be switched on or off, and the grid size to be set (Fig.1). The grid size is set in pixels, with the horizontal and vertical sizes being independently adjustable.

#### Drawing

Drawing lines is done in a rather roundabout fashion. The first step is to doubleclick a blank area of the form so that the code window appears. Next, select Paint from drop-down menu in the top right-hand corner of the code window. This produces a basic subroutine in the code window, into which the graphics program is added. For this example I used six lines of code to add some lines to the dummy control panel shown in Fig.2. Apart from decoration, the purpose of the lines is to group five buttons that will effectively operate as a bank of radio buttons.

Private Sub Form1\_Paint(ByVal sender As Object, ByVal e As System. Windows.Forms.PaintEventArgs) Handles Me Paint

- e.Graphics.DrawLine(Pens.Black, 40, 350, 700, 350)
- e.Graphics.DrawLine(Pens.Black, 40, 450, 700, 450)
- e.Graphics.DrawLine(Pens.Black, 40, 350, 40, 450)

e.Graphics.DrawLine(Pens.Black, 700, 350, 700, 450)

e.Graphics.DrawLine(Pens.Black, 515, 350, 515, 450)

e.Graphics.DrawLine(Pens.Black, 578, 350, 578, 450)

#### End Sub

Each instruction has five parameters within the brackets, and the first of these is the colour of the line. When typing the instruction, the built-in tint system presents a list of the available colours at this point,

so it is just a matter of selecting the required colour from the list. The other four parameters are pairs of co-ordinates. The Visual BASIC 2005 Express co-ordinate system is like the one used in other versions of Visual BASIC in that it has 0,0 in the top left-hand corner of the window.

It is different in that it operates using pixels rather than the more arbitrary system of other versions. The first line is therefore drawn from a point 40 pixels in from the left and 350 pixels from the top, to one 700 pixels from the left and 350 pixels from the top of the window.

<sup>1</sup>There is a big drawback in using conventional programming rather than the visual approach. The lines never appear on the form, so it is necessary to press F5 and run the program in order to check whether the graphics code is having the desired effect. Working out designs on graph paper should provide initial results that are reasonably accurate. Even so, it will usually be necessary to do a little 'fine tuning' in order to get things just right.

#### Filled In

The lack of a width parameter is a major limitation of the DrawLine instruction, but there is a way of drawing thick lines. There is a DrawRectangle instruction, which draws the outline of a rectangle using a one-pixel wide line. This can be used to draw 'hollow' lines.

Perhaps of more use, there is a FillRectangle command that produces 'solid' rectangles. By drawing long and thin rectangles it is possible to produce thick lines. This subroutine uses filled rectangles to produce a 'thicker' version of the panel design (Fig.3):

Private Sub Form1\_Paint(ByVal sender As Object, ByVal e As System. Windows.Forms.PaintEventArgs) Handles Me.Paint

e.Graphics.FillRectangle(Brushes.Black, 40, 350, 660, 5)

e.Graphics.FillRectangle(Brushes.Black, 40, 450, 660, 5)

- e.Graphics.FillRectangle(Brushes.Black, 40, 350, 5, 100)
- e.Graphics.FillRectangle(Brushes.Black, 700, 350, 5, 105)
- e.Graphics.FillRectangle(Brushes.Black, 515, 350, 5, 105)
- e.Graphics.FillRectangle(Brushes.Black, 578, 350, 5, 105)

End Sub



Fig.2. Lines are easily programmed, but with this method there is no way of adjusting the line width Note that for filled shapes the colour is set using Brushes parameter rather than the Pens type. The four co-ordinates again work in pairs, but only the first two are true co-ordinates. These set the position of the top left-hand corner of the rectangle. The next two values respectively set the width and height of the rectangle. In the current context, they effectively set the length and the width of horizontal lines, or the width and length of vertical lines.

There are other shapes available, including ellipses. The co-ordinate parameter for ellipses operates in essentially the same way as for rectangles, and they specify the position and size of an imaginary rectangle that is just large enough to contain the ellipse.

By default, objects drawn on the form will go behind visible components such as buttons and labels. This can often be used to good effect, as in the alternative version of the virtual voltmeter front panel design of Fig.4. Only three graphics instructions are needed to produce this design:

Private Sub Form1\_Paint(ByVal sender As Object, ByVal e As System. Windows.Forms.PaintEventArgs) Handles Me.Paint

- e.Graphics.FillRectangle(Brushes.Red, 40, 350, 480, 100)
- e.Graphics.FillRectangle(Brushes.Red, 580, 350, 120, 100)
- e.Graphics.FillEllipse(Brushes.Red, 98, 65, 550, 250)

End Sub



Fig.3. Thick lines can be produced by programming filled rectangles. Using this method it is possible to have line widths of any desired number of pixels

It is permissible to use numeric variables for the co-ordinates in the graphics instructions, so it is possible to produce simple animated graphics. In theory, it should therefore be possible to produce virtual panel meters, bargraphs, and so on. However, the Visual BASIC 2005 Express graphics seem to be designed primarily as a means of producing backgrounds rather than animated graphics. Getting the graphics to move requires relatively clumsy techniques, and it has to be regarded as doing things the hard way. This type of thing is much easier using Visual BASIC.Net or, better still, Visual BASIC 6.0.

#### Background

Some commercial software that includes a virtual control panel has a fancy background, such as one that looks remarkably like real brushed aluminium. The reason that most of these panels look so realistic is that they are produced using a photograph



Fig.4. Filled rectangles and ellipses are easily programmed. They can be positioned behind buttons, labels, and other visible components



Fig.5. In this example the background is provided by a photograph of an aluminium panel. Any bitmap in JPG, GIF or BMP format can be added to the form

of the genuine article. It is possible to add a background image using any modern version of Visual BASIC, including Visual BASIC 2005 Express.

One way of doing it is to add a PictureBox component to the form. This can then be dragged to the required size, and if necessary it can cover the entire form. To add an image to the PictureBox go to its properties window and operate the button in the Image section. This produces a pop-up window where the image can be selected if it has already been added to the project as a resource.

Preloading the image is not really necessary though, and an image file on the computer's hard drive can be loaded by operating the Import button. A file browser then appears, and this is used to locate and load the image file in the normal way.

Note that the image must be in JPG, GIF, or BMP format. In the example of Fig.5 I have photographed a small area of sheet aluminium and the used the JPG image in a PictureBox.

In order to ensure that the image is in the background with everything else visible on top of it, make sure that the background image is added before any visible components are added to the form. Alternatively, select the PictureBox, go to the Format menu, and then select Order and Send to Back.

#### Finally

When using Visual BASIC 2005 Express or Visual BASIC.Net it is important to bear in mind that the underlying programming language is not the same as the one used in earlier versions of Visual BASIC. There are also differences when using the visual approach to programming. It is no good trying to do things in exactly the same way as you would when using Visual BASIC 5.0 or 6.0.

Those familiar with earlier versions of Visual BASIC will have to learn new ways of doing things in order to use the modern versions to full effect.



## A four part beginners guide to using the C programming language for PIC microcontrollers Part 2 – Creating Programs

### By Mike Hibbett

**F**OLLOWING on from last month's whistle-stop tour of the Microchip C compiler, we now take a closer look at how programs are created, and what files are involved in the build. We will start by looking at the contents of a typical C program.

#### **Program Groups**

Once compiled, a C program typically consists of four groups of code: C-Startup, Standard Library Code, Application Code and Library Code. We will go through these in reverse order.

Library Code consists of source files that you have compiled previously, or perhaps obtained from a third party, that you are making use of in your application. Library code is pre-compiled to a binary code file and does not require its original source code to be present (although source code will help when debugging). The code is often supplied packaged together in a 'library' file (with a .lib extension), or as a single object file (with a .o or .obj extension).

You add these files to your project by creating links to them in the .mcw window within the IDE. You simply right-click over 'Library Files', then select 'Add Files...'. Library files generally hold useful functions that you can call from your application. To get access to the functions within a library vou must also include its associated header file, which normally has the same name but an extension of .h. You add the header files to your project in a similar way to adding the library files - right-click over the 'Header Files' option in the .mcw window on your IDE. We will come back to header files in a minute.

Application Code is, well, your stuff; the result of compiling all your source code. Where exactly that gets placed in the code address space is normally unknown to you, and most of the time of little interest. An exception would be the code that goes into the interrupt vector locations, which we will cover in more detail next month.

**Standard Library Code** is a set of useful functions that are supplied as standard by all C compilers; **printf**, for example, is a standard library function. Because these are standard libraries you do not have to add them to your project – they are automatically referenced by the linker program. You must include the appropriate header file in your source code, of course.

Library code – be it standard or user supplied – is only added once, since it is a set of functions. The linker program will find out which library functions are used by your application code and copies them in from the appropriate library file into your program. It only includes the functions that you call (directly, or in-directly), which helps to minimise the amount of code memory used. The compilation process is quite smart and does its best to be as efficient as possible with your limited code and data resources.

So, if we do not know where our code ends up in memory, how do we tell the compiler where to place our startup routine, our **main()** function? Well, this is the role of the final group of code, **C-Startup**. This is a small piece of software that handles the operation of the microcontroller as it leaves the reset state, initialises various variables and jumps to the user's application code.

That was an over-simplification of what **C-Startup** does, so lets go into a little more detail.

#### **C-Startup Detail**

When the processor comes out of reset, it starts executing software at code location 0. In assembly language programs, we use an **ORG 0** statement and follow that with our initialisation code. **C-Startup** contains the code that runs from location 0. It sets up the software stack – a reserved area of RAM used by the C language to pass parameters to functions – then initialises all of our global variables.

Remember, global variables (outside of any function), or statically declared variables inside of functions, will be initialised after reset to either zero or whatever value you specify when you declared the variable. Having done that, **C-Startup** finishes by passing control (i.e., jumping to) our **main**() function. Your application code takes over from there.

General purpose embedded C compilers would normally supply a skeleton **C-Startup** file which you have to modify to suit your hardware. You would be expected to define the code and data memory layout, what address the processor jumps to after reset, etc. As the PIC has all its code and data storage internally, all these 'options' are effectively fixed by Microchip and a single **C-Startup** routine will suit all processors and projects. Thus, you should never need to edit the file.

#### **C-Startup Versions**

There are, however, three versions of the **C-Startup** code for you to choose from: **c018i.o**, **c018iz.o** and **c018.o**. Version **c018i.o** is the default startup routine. The other two provide extra or fewer features, which affect the size of your program file. The reason for the choice is related to what C does with variable initialisation. If you declare a global or static variable and initialise it to a value at the same time, for example:

#### int baudRate = 9600;

C-Startup is responsible for performing the initialisation of the variable's value before your **main()** function is called. The default startup file, c018i.o, does this for you. The C language standard also dictates that global or static variables that are not initialised to a value must be set to 0. To save code space, c018i. **o** does not do this; if you want fully standard compliant variable initialisation. use the file **c018iz.o**. The third file, c018.o, performs no variable initialisation at all, which means you must perform your initialisation manually. i.e.:

#### int baudRate;

#### baudRate = 9600;

In some cases this restriction is acceptable, and will save you a few hundred bytes of code space.

#### Linker File

You specify the **C-Startup** file to use in the linker file that you include in your project. If you edit the linker file that we used in last week's example, **18f2420.lkr**, you will see lines like the following:

#### FILES c018i.o FILES clib.lib FILES p18f2420.lib

If you want to change the choice of startup file just change the reference in the linker file, save it, and re-build your program. You can experiment with this, and then look at the map file to see how the code size changes. Building the code with c018.o, c018i.o and then c018iz.o resulted in code sizes of 145, 307 and 327 bytes. As you can see, for small projects the startup code has quite an effect on the code size. As project size increases, however, the overhead of the startup code reduces. Our recommendation is to stick with the default startup file and consider changing only if you are running out of code space.

#### **Table Block**

To assist **C-Startup** perform the initialisation of global variables there is another block of information, a table, that gets stored in your code and placed in flash memory. As you might imagine, when the **C-Startup** code is filling in all your global variable initialisations, it needs an efficient way to store a list of those variables, their type and the value to write into them. This information is held in a table.

Global variable initialisation has an interesting implication on the size of your code. If you want to define a variable that will never change – for example, the number of seconds in a minute – you might be inclined to write the following:

#### int secondsPerMinute = 60;

This is not very efficient. The reason for this is that the C compiler will allocate some RAM space for your variable, and it will store the value '60' into the code table, and then at startup copy the value 60 into the variable. What would be better would be to do this:

# const rom int secondsPerMinute = 60;

The 'const rom' qualifier (called a storage qualifier, as it affects the way a variable is stored) tells the compiler that this variable will never change, and that it should place it directly in flash memory. No precious RAM space is used. Doing this has the added benefit that the compiler will be able to detect coding errors like this:

#### if (secondsPerMinute = count)

The compiler 'knows' that **seconds PerMinute** is a constant and will raise an error on the accidental attempt to assign a new value to it (a very common mistake!).

It's a good idea to experiment with these kinds of issue, making small changes, building the program and comparing the results in the **.map** file with previous builds. You will quickly discover how different features affect the code size.

#### **Other Linker Information**

We mentioned earlier that the linker file holds the definition of which type of **C-Startup** code will be called. The linker file holds other vital information too; it is the key to how the various variables and functions get arranged into the final binary code.

To a certain extent, the choice of where objects get placed in memory is removed from you, and this is a blessing – you want to concentrate on writing software, not deciding where things are placed. Sometimes, however, you will want to specify where objects are placed. Interrupt routines are a typical example, where you must explicitly tell the compiler things like 'This function must start at code location 0x18'.

The compiler also wants to be able to specify where objects should go; variables into RAM, functions into code space. The linker file is the link (sic) between the memory layout of your particular device and the C compiler. The compiler is a general purpose program and is not expected to know individual processor configurations, and so it will examine the project's linker file to find out. That is why you will find a linker file for each processor in the microchip PIC18 range, and they all follow a similar layout.

#### Some Linker Detail

Let's take a look at the linker file we used last month, **18f2420.lkr**. After specifying the standard library files and the startup code, it lists a number of memory sections. For example:

#### CODEPAGE NAME=vectors START=0x0 END=0x29 PROTECT-ED

This is an area of memory reserved for interrupt vectors. The compiler will avoid placing user code in this section. Next up:

#### CODEPAGE NAME = page START=0x2A END=0x3FFF

This identifies the remaining space available in code for user functions. If the code you write exceeds 0x3FFF bytes, the compiler will indicate an error that you have used too much memory.

You will not normally need to change this file unless you are writing some complex code, or you want to reserve some memory that should not be used by the compiler – perhaps because you have a bootloader on the chip.

Build Options For Project "test.mcp"	? 🔼
General MPASM/C17/C18 Suite	e
	AB C18
Categories: Memory Model	
Generate Command Line	
Code Model Small code model (<= 64K bytes) Large code model (> 64K bytes) Data Model Large data model (all RAM banks) Small data model (access RAM only)	
Stack Model Single-bank model Multi-bank model	
Inherit global settings	Defaults
-k -mL -OuOtObOpOrOdOpa-	
- Use Alternate Settings - k - Our - Ot Ob Op Or Od Opa-	
OK Cancel	<u>A</u> pply

Fig.1. Typical Build Options window

#### .MCP and .MCW Files

There are a couple of files that are created when you make a new project; a .mcp and a .mcw file. The .mcw file is a binary file that contains information about your current IDE setup; what windows are open, for example, which .mcp file you are using. It is the file that you double-click on if you want to open up your project in the IDE.

The .mcp file contains a list of your project files and the build options you have chosen. Several other files are created, and it is best not to delete them. The main output files from your source code will be the .hex file (the actual program code), a .lst listing file and a .map file which lists the actual locations of all the variables and functions, plus a summary of how much code space has been used up.

#### **Build Process**

Let's move back to the build process. If you think back to last month, we built the project by selecting 'Project' then 'Build All' from the main menu. You may not realise it yet, but there is a large number of options available to us to change the way the compiler works when it is translating our source files into the program code.

There are two types of build options available; *project build* options and *file build* options. Project build options allow us to define the default compiler options for the whole project, such as where to find system files and default build options for source files. File build options enable you to 'over-ride' the project build settings on individual files. Most of these options can (and should) be left at defaults until you have become experienced with the compiler.

There is one important option that should be changed, however, which we should cover. If you right click over the **.mcp** reference at the top of the **.mcw** window within the IDE and then select 'Build Options...', an options dialog window will appear. Click on the **MPLAB C18** tab, to display the compiler options page. There are too



#### Fig.2. Add Files window

many options to fit on one page, so they are grouped into categories. Select 'Memory Model' from the Categories drop down list, and you should see the options as shown in Fig.1.

These options are very important because they affect the assumptions the compiler makes about how it should be addressing memory. The 'Code Model' option allows you to specify whether the compiler should expect code to potentially grow to a size greater than 64K byte, therefore requiring it to use large (24-bit) pointers for jump instructions. The 'Data Model' allows the compiler to ignore the Bank Select bits when accessing RAM variables, and assume that all variables are within the Access RAM area.

Choosing small code and data models will result in the smallest code utilisation, but is only suitable if your application will fit in 64KB and never use more than 128 bytes of RAM. When the C compiler is deciding on RAM utilisation it's rather difficult to know these things in advance. That's not a problem though, because you can change any of these options at any time and simply rebuild the code; you do not need to change your source code or start a fresh project. It's quite normal to tinker with these parameters and then look at the **.map** file to see how the changes affect the code size and data utilisation.

There is one big caveat to the memory model options: The standard C libraries (those supplied by Microchip that implement all the standard functions such as **printf**, etc) have been built with the large code memory model. Functions in these libraries therefore expect to be passed large pointers rather than small ones. You must therefore select the Large Code model as shown in Fig.1 for all your application source files when you use library functions. You only need to do this once; changes you make to your project settings are stored in the .mcp and .mcw project files.

#### **Adding Files**

Adding a file to the project can be a little confusing because there are several options, and it is not particularly intuitive as to how you should do it. If you have an existing file that you want to add (a source file or header file, for example) then first copy that file into your project directory. Simply copying a file into the directory does not add it to your project – the C compiler will ignore it unless you add a reference to it in the .mcw window. To do that right click over the appropriate heading ('Source Files' or 'Header Files') and click on 'Add Files...'. A dialog like that in Fig. 2 will appear.

Navigate to the file you want to add to the project and click once on it. You should now specify the way in which the file is added: Auto, User or System. Any files that are in your project directory are 'User', while files outside your project directory – such as a linker file, for example – are 'System'. All that happens when you do this is that references to user files are stored with a path name relative to your directory (e.g. **utils\file. c**) whereas system files would be stored with the full path name (e.g. **C:\myproject\utils\file.c**).

This will seem a strange requirement until you start moving your project directory around your hard disk. System files will always be in the directory in which they were installed, but you want to be free to move your project directory to another directory without having to re-specify all your file paths. It's not uncommon to have many tens of source files in a project, so this is a useful feature.

The reason why there is a section for source files and another for header files is to do with the way in which the C compiler builds your program. First, the C compiler only compiles files in the source files list. If, however, a source file has not changed since the last time the project was built, that file will not need to be re-built. When you have many source files in a project, this can save a lot of time.

Header files are not compiled by the C compiler, but it will look though the list of files in the Header Files section to see if any of them have changed. If they have, the compiler will re-compile any source file that uses those header files.

If a header file is not included in the Header Files section, it is not uncommon for very nasty, difficult to locate bugs to appear in your project as a result of a change to a header file not being detected. Consider two source files that share the same header file - one file implementing a function, the other file using it - the header file defines the parameters that are passed to and returned from the function. If the two source files have a different view of how the function works, the resulting code will crash or behave unpredictably. Always include your header files in the project! There is no need to include the standard header files, such as **stdio.h** in your project - these files are system files that do not change.

#### **Structuring Programs**

The final point we will cover this time is how you should structure your programs. Structuring programs in any language is always a difficult task. It's never easy when faced with a blank piece of paper or an empty editing window, and the temptation is to just start writing, keeping going until the code is finished. Subroutines may appear on occasions, or there may be long sequences of repeated code.

There is nothing wrong with this for small applications. Indeed the author has seen more than one commercial program written like this. There are, however, problems with this 'monolithic' style of programming. Your code will very quickly become difficult to maintain. A pain in fact. It will be almost impossible to re-use code that you have previously designed, because it will have become tightly coupled with the rest of your code.

Do we really want this pain, or do we want to enjoy the craft of creating new software? Nobody enjoys re-inventing the wheel. Here are some useful tips:

Think about what your program is going to do, and try to break it down into some high level functions like 'Read from EEPROM' or 'Get ADC value'. Write functions to do these before writing your main application. When you come to start writing your main application you will be able to write code and think at a higher 'level' of abstraction, which means thinking of questions like 'Is the signal above two volts' rather than 'Should I skip on Carry or Not Carry'?

#### **Function Source Files**

The functions you have created can go in their own source files, with a header file that describes the interface into them. So, for example, an EEPROM module will have a source file called **eeprom.c** and a header file **eeprom.h** that contains a list of the functions such as **init\_eeprom**, **read\_eeprom**, **write-eeprom**, etc that are the 'interface' into this module. Those functions can then be re-used in later projects by simply including the header file and the compiled **.o** file of the module.

We don't have space in this series of articles to go into code structuring in any detail, but fortunately there is an excellent book on the subject. *Code Complete* by Steve McConnell offers some excellent tips on how to write good software, tips that are not just for professional writers. It's also a fun read, and your local library can probably get hold of a copy.

For those of you who are learning the C language from scratch, there are plenty of tutorials and even books published free of charge on the Internet. Two good examples are listed at the end of this article.

#### Next Month

We have covered important ground in this part and hopefully de-mystified some of the issues. Next month we will look at some practical issues with embedded C programming and hopefully guide you through some of the pitfalls that have welcomed many a programmer in the past.

#### References

Online C book: http://publications. gbdirect.co.uk/c\_book/

C guidelines: http://syque.com/ cstyle/

elebrate our 25th Birthday and this ive season with the best in c kits. For a FREE copy of ou 0+ page catalogue, log onto our website vw.jaycarelectronics.co.uk/catalogue

All prices in £ Stg.

## 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

#### High Performance Electronic **Projects for Cars Book** BS-5080 £7.00 + post & packing

Australia's leading electronics magazine Silicon Chip, has developed a range of projects for performance cars. There are 16 projects in total, ranging from devices for remapping fuel curves, to nitrous controllers. The book includes all instructions, components lists, colour pictures, and circuit layouts. There are also chapters on engine management, advanced systems and DIY modifications. Over 150 pages! All the projects are available in kit form, exclusively to Jaycar. Check out our website for all the details.

Improved

**Model!** 

#### Hand Controller for Digital Adjusters KC-5386 £25.95 + post & packing

This hand controller is used for

mapping/programming the independant electronic boost controller Kit (shown below). It features a two line LCD, and easy to use push buttons. It can be used to program the adjusters then removed, or left permanently connected to display the adjuster's operation. It is designed as an interface and display, and is not required for general adjuster functions after they have been programmed. Kit supplied with silkscreened and

machined case, PCB, LCD, and all electronic components.



#### Independent Electronic **Boost Controller**

KC-5387 £25.95 + post & packing It can be used in cars fitted with factory electronic boost control using the factory control solenoid, or cars without electronic boost control using a solenoid from a wrecker etc. It has two different completely programmable boost curves. This is ideal for switching between say, a race/street mode, or a performance/wet weather mode. Boost curve . selection is via a dashboard switch, and is all programmed using the handheld digital controller KC-5386 (shown above). Kit supplied with PCB, machined case, and all

electronic components. Suitable for EFI and engine management systems only



POST AND PACKING CHARGES: Cost Order Value £5 £200 - £499. Order Value Cost £20 - £49.99 £50 - £99.99 £200 - £499.99 £30 £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

#### **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



#### Smart Fuel Mixture Display Kit KC-5374 £8.95 + post & packing

This kit features auto dimming for night driving, emergency lean-out alarm, better circuit protection, and a 'dancing' display which functions when the ECU is operating in closed loop. Kit supplied with PCB and all electronic components. Car must be fitted with air flow and EGO sensors (standard on all EFI systems) for full

Recommended box UB3 (HB-6013)

functionality.

£1.40 each

#### Intelligent Turbo Timer Kit KC-5383 £14.75 + post & packing

This great module uses input from an airflow, oxygen, or MAP sensor to determine how hard the car has been driven. It then uses this information to calculate how long the car needs to idle, reducing unnecessary idle time. The sensitivity and maximum idle time are both adjustable, so you can be sure your turbo will cool properly. Kit supplied with PCB, and all electronic components.

Recommended box UB3 (HB-6013) £1.40 each

#### Magnetic Cartridge Pre-amp £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 vour 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

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 #JC91Y £14.99)

used in the

Beach Boys

Vibration

classic hit

4

Improved Model!

**IR Romote Control** Extender MKII 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 £9.99)





# Jaycar Electronícs Celebrates its

#### PRESS **OP**

EPE had 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, guality fibreglass tinned PCBs and have clear English instructions.

#### Delta Throttle Timer 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

#### 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



#JC91Y £14.99)

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.

#### AC/DC Current Clamp **Meter Kit for DMMs** KC-5368 £8.75 + post & packing

A great low cost alternative. It uses a simple hall effect sensor, an iron ring core and connects to your digital multimeter. It will measure AC and DC current and has a calibration dial to allow for any magnetising of the core. Kit supplied with PCB, clamp, case with silkscreened front

panel and all electronic components.

 As published in **Everyday Practical** Electronics January 2006

#### Studio 350 High Power Amplifier Kit KC-5372 £55.95 + post & pa

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

#### 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



#### Audio Video Booster Kit KC-5350 £31.95 + post & packing

This kit will boost your video and audio signals preserving them for the highest quality transmission to your projector or large screen TV. It boosts composite, S-Video, and stereo audio signals. Kit includes case with silkscreened and punched panels, PCB and all electronic components. As published in Everyday Practical Electronics March 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 £9.99).

#### **Programmable Continuity Tester Kit**

## KC-5362 £8.70 + post & packing This unit will test for continuity from

1-100ohms, making it ideal for measuring low resistance devices. It is accurate, reliable, and works extremely well. Kit supplied with PCB, case with silkscreened panel and all electronic components.

 As published in Everyday Practical Electronics April 2006



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 **All prices** Silverwater NSW 2128 Sydney AUSTRALIA

Requires 9VAC wall adaptor (Maplin #GU09K £9.99).

410+ page Catalogue

in f

Jaycar 106


# 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.

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

# **ELECTRONIC CIRCUITS & COMPONENTS V2.0**



**Circuit simulation screen** 



# ANALOGUE ELECTRONICS

Complimentary output stage



Virtual laboratory - Traffic Lights



Filter synthesis

Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.

Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections), Transistors (4 sections), Waveshaping Circuits (6 sections). **Op.Amps** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. Systems – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

# **DIGITAL ELECTRONICS V2.0**

Digital Electronics builds on the knowledge of logic gates covered in Electronic *Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.

Covers binary and hexadecimal numbering systems, ASCII, basic logic gates 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

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

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)

an autorouter operating on user generated Net Lists



**ELECTRONICS** 

CAD PACK

### PCB Layout Electronics CADPACK allows users to design complex circuit schematics, to view

circuit animations using a unique SPICEbased 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





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 Interactive Virtual Laboratories

- Little previous knowledge required
- Mathematics is kept to a minimum and all calculations are explained
- Clear circuit simulations

# **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 I.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)



supplied with USB cable and programming software

### SOFTWARE -

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 microcontroller. This is a simulation tool that allows users to write and execute MPASM assembler code for the PIC16F84 microcontroller on-screen. Using this you can actually see what happens inside the PICmicro MCU as each instruction is executed which enhances understanding.

● Comprehensive instruction through 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 V2

Flowcode is a very high level language programming system for PICmicro microcontrollers based on flowcharts. Flowcode allows you to design and simulate complex robotics and control systems in a matter of minutes.

Flowcode is a powerful language that uses macros to facilitate the control of complex devices like 7-segment displays, motor controllers and I.c.d. displays. The use of macros allows you to control these electronic devices without getting bogged down in understanding the programming involved.

Flowcode produces MPASM code which is compatible with virtually all PICmicro programmers. When used in conjunction with the Version 2 development board this provides a seamless solution that allows you to program chips in minutes.

Requires no programming experience

 Allows complex PICmicro applications to be designed quickly 
 Uses international standard flow chart symbols (ISO5807) Full on-screen simulation allows debugging and speeds up the development process

 Facilitates learning via a full suite of demonstration tutorials
 Produces ASM code for a range of 18, 28 and 40-pin devices • Professional versions include virtual systems (burglar alarm, buggy and maze, plus RS232, IrDa etc.).



**PRICES** Prices for each of the CD-ROMs above are: (Order form on next page)

Hobbyist/Student Flowcode V2 Hobbyist/Student Institutional (Schools/HE/FE/Industry) Flowcode Professional Institutional/Professional 10 user (Network Licence) Site Licence (UK and EU customers add VAT at 17.5% to "plus VAT" prices)

£45 inc VAT £57 inc VAT £99 plus VAT £99 plus VAT £300 plus VAT £599 *plus* VAT

# 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 In interactive solware (win 95, 95, 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 *Torach leavies neurous Chaw Cride* and 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



Sine wave relationship values and Sensor Amplifiers, Transistors, Transformers and Rectifiers, Voltage Regulation, Integration, Differentiation, 7-segment Displays, L.C.D.s, Digital-to-Analogue. 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.

**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.

### WHAT'S INCLUDED

NEW

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 Technolog 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)

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.

Over 150 pages Over 600 images

Please send me:       CD-ROM ORDER FORM         Electronic Projects       Electronic Circuits & Components V2.0         Analogue Electronics       Version required:         Digital Electronics V2.0       Hobbyist/Student         Analogue Filters       Institutional         Electronics CAD Pack       Institutional         Robotics & Mechatronics       Site licence         C' for PICmicro V2       Site licence         Flowcode V2 for PICmicro       Digital Works 3.0	S
<ul> <li>□ PICmicro Development Board V3 (hardware)</li> <li>□ Teach-In 2000 + FREE BOOK</li> <li>□ Electronic Components Photos</li> <li>□ Project Design - Single User</li> </ul>	Ins Ver bas (do
<ul> <li>Project Design – Multiple User (under 500 students)</li> <li>Project Design – Multiple User (over 500 students)</li> <li>Full name:</li> </ul>	VAT
Address:	
	i 🗌
Signature:	
☐ I enclose cheque/PO in £ sterling payable to WIMBORNE PUBLISHING LTD for £ ☐ Please charge my Visa/Mastercard/Amex/Diners Club/Switch: £	01
Valid From:Card expiry date:	G
Card No: Switch Issue No	1
Card Security Code (The last 3 digits on or just under the signature strip)	ww
l L	i 🦳

# **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 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.

**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

### ORDERING ALL PRICES INCLUDE UK POSTAGE

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

titutional, Multiple User and Deluxe sions - overseas readers add £5 to the ic price of each order for airmail postage not add VAT unless you live in an EU ropean Union) country, then add 17½% or provide your official VAT registration ber)

> Send your order to: **Direct Book Service** Wimborne Publishing Ltd 408 Wimborne Road East Ferndown, Dorset BH22 9ND To order by phone ring

### 202 873872. Fax: 01202 874562 oods are normally sent within seven days E-mail: orders@wimborne.co.uk **Online shop:** w.epemag.wimborne.co.uk/shopdoor.htm

# **Readers' Circuits**

# **Ingenuity Unlimited**



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!** 

# 1000-Year Flasher – *Heralding the Next Millennium*

HE author is not certain how one would define a micropower circuit. He would put it at less than about  $20\mu$ A. Very few integrated circuits work with such low power – but those that do include the quad NAND Schmitt trigger IC1 shown in the simple flasher circuit of Fig.1. In fact IC1 ordinarily draws more than  $500\mu$ A at 9V.

## Flash Time

However, IC1 can be persuaded to use much less power than this, simply by restricting the current flow through resistor R2. With the component values shown in Fig.1, this circuit will brightly flash an ultrabright LED at 0.5Hz for more than twenty years – drawing 12 $\mu$ A off six high capacity AA batteries. If the component values in Table 1 are used, it will flash, although more dimly, for close to one thousand years – drawing just 0.3 $\mu$ A.

The circuit is unorthodox, in that IC1 requires a minimum of 3V, yet when LED D1 flashes, the voltage across IC1a drops to 2V. At this point, the circuit is theoretically non-functional – yet it does permit capacitor C1 to recharge through R1 and R2. As the voltage across IC1a again approaches 3V, IC1a kicks into life, and the discharge of C1 is again permitted, through LED D1. Unused gates are tied high to conserve power as well as prevent them from 'floating'.



Fig.1. Circuit diagram for the 1000-Year Flasher

### Components

The author used the Motorola version of IC1 (the MC14093BCP). While other CMOS 4093 ICs should work in this position, this has not been tested. D1 should be an ultrabright red LED. Capacitor C1 should be a new good quality, low-leakage component.

He would be obliged if readers who build this circuit confirm in due course that it has conformed to its descriptive title!

Thomas Scarborough, Cape Town, South Africa

# INGENUITY UNLIMITED

## **BE INTERACTIVE**

IU is your forum where you can offer other readers the benefit of your Ingenuity. Share those ideas, earn some cash and possibly a prize.



This simple adaptor allows commonly available electret lapel and headset microphones to be used with public address systems. It features a balanced output and is built into a compact case that can be clipped to a belt or slipped into a pocket.

**By JOHN CLARKE** 

# Lapel microphone adaptor for PA systems

Microphone

Adaptor

WHILE STANDARD HAND-HELD microphones are generally used for most public address (PA) applications, there are times when a lapel microphone is much more convenient. A lapel microphone not only frees up a user's hands but also allows the wearer to roam about easily. They are ideal when giving talks and lectures, and for certain types of theatre work.

Another advantage of lapel microphones is that they provide a reasonably consistent output, even when the person speaking turns their head. That's because a lapel microphone is usually clipped to the user's clothing around the chest area and so remains at a similar distance from the mouth regardless of head movement. By contrast, handheld microphones must always be held close to the mouth, otherwise the signal level will vary drastically.

Lapel microphones are generally available in two forms. By far the most common form for PA use at the present time is the radio microphone. This consists of the lapel microphone itself plus a small radio transmitter which is worn by the user – eg, inside a shirt pocket or by attaching it to a belt. The signals from the transmitter are picked up by a corresponding receiver which then feeds the signal to the PA system.

The big advantage of the radio microphone is that it allows the user





Fig.1: the circuit uses op amps IC1a & IC1b to provide a balanced output signal, while relays RLY1 & RLY2 shunt the signal to ground when activated, to provide muting.

to roam freely over several tens of metres without being tethered to a lead. However, this freedom comes at a high cost.

Despite its advantages, this high cost cannot always be justified, especially when full use of the radio transmitting feature is not exploited. This particularly applies to applications where the user doesn't need to roam too far. In those situations, a much cheaper solution is to dispense with the radio system and instead use a tethered lapel microphone – ie, one that's tethered to the PA amplifier via a lead.

However, obtaining such a wired lapel system is quite another matter.

Music shops are keen to sell the wireless microphones but are usually at a loss when asked to supply a wired type. The older-style dynamic lapel microphones simply no longer appear to be available, while the smaller electret microphones require a power source.

So why can't you simply use an electret microphone and power it from the phantom supply that's sometimes available in PA mixers? Unfortunately, it's not as simple as that, for a couple of reasons.

First, many mixers do not have phantom power and if they do, the current available is well in excess of that required for an electret micro-

## Main Features

- Uses standard electret lapel microphone
- Adaptor attached to belt or in pocket
- Battery powered (9V)
- Balanced output
- Muting facility
- Battery indicator

phone. Electrets require only 0.5mA or less for correct operation, whereas the phantom power from a PA mixer is usually between 14mA and 60mA

# Parts List – Lapel Microphone Adaptor

- 1 PC board, code 593 available from the EPE PCB Service
- 1 case measuring 135 x 70 x 24mm, with separate battery compartment
- 2 panel labels, 59 x 16mm and 114 x 50mm
- 1 belt/pocket clip
- 1 lapel electret microphone
- 2 5V reed relays (RLY1, RLY2)
- 1 double-pole 3-position slide switch (S1), with 2 x M2.6 mounting screws
- 1 3.5mm PC board jack socket (Jaycar PS 0133) or 3-pin chassis male miniature XLR connector – see text
- 1 right-angle stereo 6.35mm jack plug to 3-pin XLR line plug lead – see text
- 5 metres of dual-screened microphone cable
- 1 stereo 6.35mm metal line socket
- 1 9V battery clip lead
- 1 9V battery
- 3 M3 x 6mm screws
- 1 M3 x 10mm countersunk screw

– enough to destroy an electret unless precautions are taken.

Second, an electret microphone provides only a single 'unbalanced' output. This means that there are just two output connections – ie, the shield or screening and the signal wire. However, any leads that are several metres long or more in a PA system can readily pick up 50Hz mains frequency hum which is then amplified and fed through to the loudspeakers as an annoying buzz.

### **Balanced output**

The way around this problem is to use what's known as a 'balanced' output. This type of output has two signal outputs plus a shield lead, with one output inverted with respect to the other.

In this case, both signal leads still pick up mains frequency hum but because the lines are balanced, the hum signal can be rejected to just leave the wanted microphone signal. This is done in the PA mixer – it receives the balanced signal and subtracts the non-inverted microphone signal from

- 1 M3 x 20mm countersunk screw
- 1 M3 x 10mm tapped spacer
- 1 50mm cable tie
- 13 PC stakes

### Semiconductors

- 1 TL072 dual op amp (IC1)
- 1 BC328 PNP transistor (Q1)
- 1 4.7V 1W Zener diode (ZD1)
- 1 1N5819 Schottky diode (D1)
- 2 1N4148 or 1N914 diodes (D2,D3)
- 1 3mm green LED (LED1)

### Capacitors

1 470µF 16V PC electrolytic 4 100µF 16V PC electrolytic 1 22µF 16V PC electrolytic 2 10µF 16V PC electrolytic 1 100nF MKT polvester 1 1nF MKT polyester **Resistors** (1% 0.25W) 1 100kΩ 1 680Ω 1 22kΩ 2 560Ω  $6 \ 10 k\Omega$ 1 220Ω  $2.6.8k\Omega$ 2 100Ω 1 1kΩ 1 22Ω

the inverted microphone signal. This removes the mains hum signal, since the same signal will be present in both leads. By contrast, the microphone signal is doubled, since subtracting an inverted signal from the non-inverted signal gives twice the signal level.

### Lapel Microphone Adaptor

That's where the Lapel Microphone Adaptor comes in – it not only provides power to a standard electret microphone but also includes all the necessary circuitry to provide balanced output signals. In addition, it also includes a muting facility which shorts the signal output to ground, so that sound is no longer heard through

# **Specifications**

**Frequency response:** 16Hz to 16kHz (actual response depends on the microphone used)

Output level: typically 100mV

Current consumption: 4mA when on, 11mA on mute,  $0.1\mu A$  when off

the PA system. This muting function is completely silent in operation – ie, there are no clicks and pops in the sound when the muting is switched in or out.

As shown in the photos, the unit is housed in a small case which contains a separate battery compartment. The lapel microphone plugs into a socket at the top of the case, while the output lead plugs into a 6.35mm stereo socket on one side.

A single 3-position slide switch is used to switch the power on/off and to select the muting. An adjacent green indicator LED flashes when the power is switched on and this can also be used to indicate the battery condition. A bright flash indicates a good battery, with the LED becoming increasingly dim as the battery goes flat.

In addition, the LED serves as an indicator by glowing faintly when the switch is in the Mute position. It also flashes brightly and decays when the unit is switched off, to acknowledge the switch selection.

### **Circuit details**

Fig.1 shows the full circuit details of the Lapel Microphone Adaptor. It includes a dual op amp package (IC1) to do the audio signal processing, plus two relays to shunt the signal on each balanced line to ground during muting. Power for the circuit is derived from a 9V battery and is applied via reverse polarity protection diode D1 and power switch S1.

The electret microphone is plugged into a mini XLR male socket or a 3.5mm jack socket, depending on the type of electret used. It is powered from the 9V battery via  $1k\Omega \& 22k\Omega$ resistors and a 100µF filter capacitor. This decoupling is necessary to keep supply noise and ripple from degrading the microphone signal.

The output signal from the microphone is fed to the pin 5 (non-inverting) input of op amp IC1a via a 100nF capacitor. This capacitor and its associated  $100k\Omega$  resistor roll off the lowfrequency response below 16Hz

Note that IC1a's pin 5 input is biased at half-supply (ie, Vcc/2) via the  $100k\Omega$ resistor which is connected to a voltage divider consisting of two  $10k\Omega$  resistors across the 9V rail. This allows the op amp's output to swing symmetrically above and below Vcc/2.

IC1a is wired as a non-inverting buffer stage and provides an output



This is the view inside the completed prototype. The 6.35mm jack socket has its outer cover removed and is secured to the PC board using a cable tie. The socket is then further secured by its threaded boss when the lid is fastened down.

which is in phase with the microphone signal. By contrast, IC1b is connected as an inverting amplifier. It operates with a gain of -1, as set by the two  $10k\Omega$  input and feedback resistors.

IC1b is fed from IC1a's output (pin 7) and provides a complementary out of phase signal at its pin 1 output. The 1nF capacitor across the feedback resistor rolls the signal off above about 16kHz to ensure stability.

As a result, IC1a's output provides the in-phase signal while IC1b's output provides the out-of-phase (or inverted) signal. The op amp outputs are then AC-coupled to the output socket via series 10µF capacitors and 560Ω resistors. The 560Ω resistors provide a nominal 600Ω output impedance and prevent the op amps from oscillating (due to the extra capacitance) when the balanced microphone cable is connected.

The  $10\mu$ F capacitors are necessary to remove the DC levels that are present at the outputs of IC1a and IC1b.

### Muting

As previously mentioned, the outputs can be muted and this is achieved using relays RLY1 and RLY2 which short the outputs to ground when powered.

In addition, the outputs are muted at switch-on. This is necessary because

when power is initially applied to op amps IC1a & IC1b (via switch S1b), their outputs quickly rise to half supply (Vcc/2). Without muting, this voltage would be coupled into the PA system and cause large switch-on thumps. To circumvent this, relays RLY1 & RLY2 are switched on at power up to short the signal outputs to ground until the voltages settle.

The relays are switched via switch S1a and its associated circuitry based on transistor Q1. This works as follows.

Switch S1 is a double-pole 3-position switch and when S1 is in position 1, no power is applied to the circuit. In position 2, S1b's contacts feed power to op amp IC1, while the corresponding contacts in S1a connect transistor Q1's  $10k\Omega$  base resistor to ground via a  $100\Omega$  resistor. As a result, Q1 turns on and applies power to the relay coils.

As shown on Fig.1, the relay coils are connected in series, with one side going to ground via a 470 $\mu$ F capacitor and a 680 $\Omega$  resistor connected in parallel. Initially, the 470 $\mu$ F capacitor is discharged and so the full 9V is applied across the series-connected relay coils – ie, 4.5V for each relay. This is quite sufficient to activate the 5V relay coils and close the contacts, RLY1&2. As the  $470\mu$ F capacitor charges, the voltage across the relay coils decreases. However, the relays remain closed because their dropout voltage is much lower than the voltage required to activate them. The  $680\Omega$  resistor sets the minimum voltage across the relay coils to around 2.7V per relay. This resistor is included to reduce the current drawn from the battery while the relays are closed.

The resistor and capacitor also cause LED1 to momentarily flash when the power is switched on. Initially, when power is applied and the 470µF capacitor is discharged, LED1 is fed via a 4.7V Zener diode (ZD1) and the series 220 $\Omega$  resistor. The LED will glow brightly with a fresh battery but as the battery voltage falls to around 7.2V, there will be insufficient current to light it at full brightness.

It works like this: since there is 4.7V across ZD1 and a nominal 2V across the LED, this leaves only 0.5V across the 220 $\Omega$  resistor when the battery is at 7.2V. As a result, the LED current is only about 2.3mA and so the LED will only glow dimly.

By contrast, if the battery is at 9V, the resistor will have 2.3V across it and so the LED current will be around 10mA. As a result, LED1 will glow brightly. However, the LED does not light for long, as the  $470\mu$ F capacitor quickly



charges via the relay coils and turns LED1 off again.

When S1 is placed in position 3, IC1 is still powered but Q1's  $10k\Omega$  base resistor is disconnected from ground. As a result, the  $22\mu$ F capacitor is now left to supply Q1's base current for a short time as it charges towards the 9V supply rail via the two series  $10k\Omega$ resistors. After about 1s, Q1 switches off and the relays also turn off, thereby releasing the shorts across the output lines from IC1a and IC1b.

Diode D3 quenches the back-EMF voltage that's generated when the relay coils are switched off. This back-EMF voltage is further damped by the 100µF capacitor at D2's cathode.

Note that the muting can be reactivated at any time by switching S1 back to position 2, so that the relays are switched on again. In addition, when the power is fully switched off (S1 switched to position 1), the relays remain on for one second while the  $22\mu$ F capacitor charges. This ensures that IC1 is fully powered down before the relays are switched off, to prevent loud switching thumps in the PA system.

As a further precaution, the  $100\mu$ F capacitor that's used to decouple IC1's supply rail is quickly discharged via a  $100\Omega$  resistor and position 1 of S1a. Diode D2 is included to ensure that the  $470\mu$ F capacitor also discharges, so that the relays turn on if power is quickly applied again.

The  $22\Omega$  resistor in series with pin 8 of IC1 limits the surge current through the switch when power is applied. Similarly, the  $100\Omega$  resistor at position 2 of S1a limits the discharge current from the associated  $22\mu$ F capacitor when S1a switches this contact to ground.

### Construction

The assembly is straightforward since all the parts are mounted on a single PC board. This board is available from the *EPE PCB Service*, code 593.

Begin by checking the PC board for any possible shorts between tracks or

breaks in the copper pattern. Check also that the hole sizes are correct. Note that a cutout will need to be made in the board to provide space for a mini XLR panel-mount socket if you are using a lapel microphone fitted with a mini XLR (female) plug.

The XLR cutout is shown as an outline on the PC board. You also need to file the edge of the PC board slightly where shown, to allow room for the XLR securing nut to encroach into the PC board space.

Alternatively, if you are using a microphone with a 3.5mm jack plug, you can use a PC-mount 3.5mm socket instead. In that case, you won't need to make the cutout.

Fig.2 shows the assembly details. Start by installing all the PC stakes at the wiring and switch terminal points, then install the resistors, diodes D1 to D3, Zener diode ZD1 and the IC. Make sure you place each component in its correct position and with the correct orientation.

Table 1 shows the resistor colour codes but it's also a good idea to check the values using a digital multimeter as some of the colours can be difficult to distinguish.

The relays and transistor Q1 can go in next, followed by the capacitors. Be sure to install the electrolytic capacitors with the polarity shown. The 3.5mm socket can also now be installed if it is being fitted.

The 3-position slide switch (S1) is mounted on its side, with its top face aligned with the edge of the PC board. Five of its bottom terminals are soldered directly to the previously



installed PC stakes as shown on Fig.2, while three of the top terminals connect to their PC stakes via short lengths of tinned copper wire.

### Drilling the front panel

The front panel can now be drilled to accept the switch, LED and microphone input socket, see Fig.5. Note that you will need to drill out a slot for the slide switch operating toggle. That done, attach the front panel label, then attach the front panel to the PC board assembly by installing the supplied switch screws and by fitting the securing nut to the 3.5mm jack socket.

That done, the LED's leads can be bent at right angles about 4mm from its body and the LED slipped into position so that it protrudes through the front panel. Adjust its leads as necessary and make sure that it is oriented correctly before finally soldering it into position.

In particular, note that anode lead (A) is the longer of the two. This lead goes towards the bottom edge of the PC board as shown on Fig.2.



Fig.4: this diagram shows how the M3 × 10mm tapped spacer is secured to the PC board. This helps secure the 6.35mm socket when the lid is screwed down.

A separate battery compartment accommodates the 9V battery that's used to power the circuit. The screw in the back of the jack socket) is used to secure the 10mm tapped spacer to the PC board (see Fig.4).

### 6.35mm jack socket

A hole is needed in the side of the box for the 6.35mm jack socket which is used without its outer cover. Mark the hole location with the case clipped together, noting that the socket sits directly on the PC board and against the battery compartment.

# **Table 2: Capacitor Codes**

Value	μ <b>F code</b>	IEC Code	EIA Code
100nF	0.1µF	100n	104
1nF	$0.001 \mu F$	1n0	102

Table 1: Resistor Colour Codes				
	No.	Value	4-Band Code (1%)	5-Band Code (1%)
	1	100kΩ	brown black yellow brown	brown black black orange brown
	1	$22k\Omega$	red red orange brown	red red black red brown
	6	$10 k\Omega$	brown black orange brown	brown black black red brown
	2	6.8kΩ	blue grey red brown	blue grey black brown brown
	1	1kΩ	brown black red brown	brown black black brown brown
	1	680Ω	blue grey brown brown	blue grey black black brown
	2	560Ω	green blue brown brown	green blue black black brown
	1	220Ω	red red brown brown	red red black black brown
	2	100Ω	brown black brown brown	brown black black black brown
	1	22Ω	red red black brown	red red black gold brown

(+)	+	÷ (	)⊕	
mic	batt	on mute	off	

# Fig.5: this artwork can be used as a drilling template for the front panel.

The mounting hole must be drilled and reamed out to 10mm diameter, which will not be large enough for the threaded section of the socket. That done, place the PC board in the case and secure it in position using three M3 screws (two at the top and one at bottom right).

Next, position the socket in its mounting hole and tighten down the case lid with the four self-tapping screws supplied. Now heat the socket using your soldering iron until the plastic case begins to melt, at the same time pressing the case together so that it forms a tight fit around the socket and closes correctly.

Finally, remove the iron and wait for the heated case to cool.

The case will now have formed a moulding around the threaded section of the 6.35mm jack socket. It should then be prised open again and the socket secured in position using a cable tie which passes through a hole in the PC board and then around the edge of the board.

To further secure the socket, a 10mm M3 spacer is installed on the PC board adjacent to it so that the lid can be firmly screwed down at this point. To do this, the mounting post in the base of the case adjacent to the socket is

drilled out to 3mm and this hole goes right through the case. In addition, you have to drill out the post in the case lid directly above this point.

That done, countersink the holes and cut off the post in the lid using a sharp utility knife. The 10mm M3 spacer can then be fitted in position and secured using an M3 x 20mm screw installed from the bottom of the case as shown in Fig.4.

All that remains now is to complete the wiring to the stereo socket and connect the battery clip lead. Note that the leads from the battery clip will have to be fed through from the battery compartment before soldering them to the supply terminals on the PC board.

### Testing

To test the unit, apply power and check that the relay contacts close and that the LED flashes. If not, check that transistor Q1 has been installed correctly and check its associated components. If the relays do close but the LED doesn't flash, check that the LED has been installed with the correct polarity and check the orientation of ZD1.

Finally, check that pins 1 and 7 of IC1 are at about 4.5V (ie, Vcc/2). This voltage should also be present on pins 3 & 5 (ie, the non-inverting inputs). If everything checks out, then it is likely that the unit is working correctly and it can be tested by connecting it to a PA system and plugging in an electret microphone. **EPE** 



Reproduced by arrangement with SILICON CHIP magazine 2006. www.siliconchip.com.au



tel. 01298 70012 fax. 01298 70046 www.peakelec.co.uk sales@peakelec.co.uk

atlas DCA

hcement

MOSFE

mode

PEAK

# electronic design Itd

# 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



THE No1 UK MAGAZINE FOR ELECTRONICS TECHNOLOGY AND COMPUTER PROJECTS

# 

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 issues from the last six months 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?

### AUG '05

PROJECTS 

Motor Amplifier

Pain Monitor

Audio System-Communications

Kitchen Timer

Room Thermometer

FEATURES 
 Back To Basics – 5 
 Circuit Surgery
 Interface 
 Ingenuity Unlimited 
 Techno Talk 
 PIC 'N' Mix 
 NetWork – The Internet Page

### SEPT '05

PROJECTS 

All Band Radio

Storeboard

Multicore

Cable

Tester

Controlling

Model

Railway

Signals

Daily

Reminder

Whistle

Switch

FEATURES

Back

To

Logic

Basics

6

Circuit

Surgery

Practically

Speaking

Ingenuity

Unlimited

Techno

Talk

PIC

'N'

Mix

Net

Work

The

Idex pred

Page

Control

The Internet Page

### **OCT '05**

PROJECTS • Haloween Howler • PIC Based USB Interface 

Photic Phone 

Telephone Switch

Parking Radar

FEATURES • Introducing the Virtual DIY Calculator Ingenuity Unlimited 
 Back To Basics – 7
 Circuit
 Surgery 
 Techno Talk
 PIC 'N' Mix
 Interface
 NetWork - The Internet Page

### **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 '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



### 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 • Heart.

FEATURES • Teach-In 2006 - Part 4 • Techno Talk • Circuit Surgery • Interface • PIC 'N' Mix • Network - The Internet Page

### **MAR** '06

**JAN '06** 

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 • PIĆ 'N' Mix 

 Net Work – The Internet Page

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**

JUL '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





### 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 

### AUG '06

PROJECTS • Loudspeaker Level Meter • Telephone Dialler for Burglar Alarms 

Adjustable DC-DC Converter for Cars 

High Intensity Torch
FEATURES

Circuit Surgery

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

Internet Page

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 Pare

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. and April) 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
I enclose cheque/P.O./bank draft to the value of £
Please charge my Visa/Mastercard/Amex/Diners Club/Switch £
Card No
Valid FromCard Expiry DateCard Security Code
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 £ stering – 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 M12/06

# **STORE YOUR BACK ISSUES ON CD-ROMS**



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

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.

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 COMPO-NENTS - Introduction to the basic principles of passive components. HOW TO USE INTELLIGENT L.C.Ds, by Julyan Ilett – An utterly practi-cal 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. A bonus article on his life and work written by his eldest son, including many previously unpublished photographs.

Note: Some of the EXTRA ARTICLES require WinZip to unzip them.



EPE Online ack Issues Vol 6 Vol7 Vol 8 Vol 11 Vol 9 Vol 12 2 Vol 10 Vol 13 Vo/ 14 Vol 15 www.epemag.wimborne.co.uk/ or www.epemag.com (USA \$ prices) or by phone, Fax, E-mail or Post

# **BACK ISSUES CD-ROM ORDER FORM**

Order on-line from

shopdoor.htm

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 .....  $\Box$  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@epemaq.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.

. . . . . . . . . . . . . . . . . .

# EPE PIC RESOURCES CD-ROM V2

# Version 2 includes the EPE PIC Tutorial V2 series of Supplements (EPE April, May, June 2003)

### The CD-ROM contains the following Tutorial-related software and texts:

- EPE PIC Tutorial V2 complete series of articles plus demonstration software, John Becker, April, May, June '03
- PIC Toolkit Mk3 (TK3 hardware construction details), John Becker, Oct '01
- PIC Toolkit TK3 for Windows (software details), John Becker, Nov '01

Plus these useful texts to help you get the most out of your PIC programming:

• How to Use Intelligent L.C.D.s, Julyan llett, Feb/Mar '97

- PIC16F87x Microcontrollers (Review), John Becker, April '99
- PIC16F87x Mini Tutorial, John Becker, Oct '99
- Using PICs and Keypads, John Becker, Jan '01
- How to Use Graphics L.C.D.s with PICs, John Becker, Feb '01
- PIC16F87x Extended Memory (how to use it), John Becker, June '01
- PIC to Printer Interfacing (dot-matrix), John Becker, July '01
- PIC Magick Musick (use of 40kHz transducers), John Becker, Jan '02
- Programming PIC Interrupts, Malcolm Wiles, Mar/Apr '02
- Using the PIC's PCLATH Command, John Waller, July '02
- EPE StyloPIC (precision tuning musical notes), John Becker, July '02
- Using Square Roots with PICs, Peter Hemsley, Aug '02
- Using TK3 with Windows XP and 2000, Mark Jones, Oct '02
- PIC Macros and Computed GOTOs, Malcolm Wiles, Jan '03
- Asynchronous Serial Communications (RS-232), John Waller, unpublished
- Using I<sup>2</sup>C Facilities in the PIC16F877, John Waller, unpublished
- Using Serial EEPROMs, Gary Moulton, unpublished
- Additional text for EPE PIC Tutorial V2, John Becker, unpublished

NOTE: The PDF files on this CD-ROM are suitable to use on any PC with a CD-ROM drive. They require Adobe Acrobat Reader – included on the CD-ROM AVAILABLE ELECTRONICS

This CD-ROM requires Adobe Acrobat\* Reader\*\* Acrobat Reader v5.05 is included on the CD-ROM

INCLUDING

VAT and P&P

The software should auto-run. If not, double-click on: My Computer, your CD drive and then on the file index.pdf

## **PIC RESOURCES V2**

Wimborne Publishing Ltd 2003 www.epemag.wimborne.co.uk

# Order on-line from

www.epemag.wimborne.co.uk/shopdoor.htm or www.epemag.com (USA \$ prices) or by Phone, Fax, Email or Post.

# EPE PIC RESOURCES V2 CD-ROM ORDER FORM

Please send me (quantity) EPE PIC RESOURCES V2 CD-ROM
Price $\pounds14.45$ each – includes postage to anywhere in the world.
Name
Address
· · · · · · Post Code · · · · · · · ·
$\Box$ I enclose cheque/P.O./bank draft to the value of £ $\ldots$
□ Please charge my Visa/Mastercard/Amex/Diners Club/ Maestro
٤
Card No
Card Security Code (The last 3 digits on or just under the signature strip)
Valid FromExpiry 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. Email: 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. Send a copy of this form, or order by letter if you do not wish to cut your issue.

# **BECOME A PIC WIZARD WITH THE HELP OF EPE!**

# 

It may surprise you but buying an Antex soldering iron costs less than you think in the long run. British made to exacting standards, they last significantly longer than imported brands. And with a wide range of thermally balanced soldering irons, you can pick up a "fixed temperature" or "in-handle" temperature model that will suit your needs perfectly.

None of which will burn a hole in your pocket.

If your hobby demands the best iron for the job but you don't want to get your fingers burnt by the cost, visit our website or your electronics retailer for the coolest models around.

Pick up an



# **Build Your Own** Weather Station



Weather Starter Kit £59 **RS232** Interface £25 **USB** Interface £29 **Humidity Module** £39 **Pressure Module** £49 **Rainfall Gauge** £59

Prices exclude VAT and delivery

Measure Wind Speed

- Measure Wind Direction
- Measure Temperature
- Easy Build Kit
- **FREE Software**
- USB or RS232
- Optional **Humidity Module**
- Optional **Pressure Module**
- Optional Rainfall Gauge
- Simple 1-wire® connection
- Build and add your own devices

For more information, manuals and downloads on this and other interesting products see WWW.audon.co.uk

Electronics www.audon.co.uk | +44 (0)115 925 8412 | Fax +44 (0)115 925 9757

# Vac Electronics

Control hardware using simple text commands

Makina complex tasks simple:

Using a two letter text command, control LCD displays, Analogue to digital converters, motors, keypads, LED matrix displays. All products work by serial connection This is just a small selection

Connec	t using a	PC RS232 or Microcontroll	visit the web	small selection site for hints tips tware
	33		Scrolling Text	LCD Display
	► BV4103	1051-Disclas Secial PS232	Backlight and contrast control	£22.90
*	BX.		<ul> <li>Binary to text display</li> <li>Much more</li> </ul>	
*** All controlled with 2 wire serial bus ***	8		Control any compatible LCD	LCD Controller
sn	▼ BV4108		Up to 4 lines by 20 characters	£11.00
q	ĺ Ž		Scrolling text Much more	L11.00
ria			8 x 8 Bi Colour Red/Green	Dot Matrix
se	6		Brightness control	DOL MALTIX
<u>e</u>	▼ BV4102		User defined bit patterns	£14.95
Ŵ	6		Switch on 'splash screen'	
2	9	THE R. LEWIS CO., LANSING MICH.	4 x Analogue to digital	A/D Control
ith	▼ BV4106	Commission -	4 x digital input or output	
8	1		Pulse width modulation	£11.00
ed		On Property of the Party of the	Trigger control	
ollo	6		4 x 4 matrix keypad controller	Keypad Control
ltr.	► BV4107	and a second second	16 key buffer	£11.00
lo lo			<ul> <li>Row, column configurable</li> <li>Additional digital input</li> </ul>	211.00
=			► 8052-8958252 based	Microcontroller
<b>A</b>	▼ BV305	Stational Contract	No programmer needed	
4	► ♡	And	Includes Tiny BASIC	£14.95 KIT £+4.50 RBT
		Sector Se	On board power supply	
MOIIEY BACK GUARAITEE				
		If you are not completely satisfie	d, return the goods within 30 days for a full rel	und.
Purchase Options: On-Line at www.byvac.co.uk • Telephone 07905 734 348 •				

email sales@byyac.com • Cheque or Postal Order to: ByVac Penistone, SHEFFIELD, S36 6WP Post and packing UK £2.50 World Wide £3.50 BvVac www.byvac.co.uk

Everyday Practical Electronics, December 2006

# Mind Trainer

Exercise your mind in an enjoyable way!

# **By BART TREPAK**

THE idea behind the Mind Trainer is quite simple but it requires a good deal of thought. It is based on an old brain-testing game normally played with coloured pegs. Although it is really a game for only one player, two are required to play – one of them being a 'dummy'!

In this version, a PIC microcontroller is cast in the role of the dummy (an excellent position for it as it will never get bored if the player takes too long considering a next move, or comment on incorrect choices).

In the original game, the dummy arranges four coloured pegs in a board out of view of the player and the player has to guess the colour and position of the pegs in the smallest number of attempts by placing further coloured pegs in holes on the board. The dummy helps in this by indicating the number of correct colours and/or correct positions in each attempt, but not which ones are correct.

### **Electronic equivalent**

This game is the electronic equivalent of this but instead of coloured pegs a 4-digit LED display is used. The PIC selects four digits randomly and as these are not displayed, they are therefore unknown to the player. This is done at the start of each game by pressing the hash (#) button on the keypad.

The player then tries to guess the 4-digit number by entering it via a

keypad and this is shown on the display. Pressing the star (\*) button on the keypad enters this guess, changing the display to two digits; the right hand one showing how many correct numbers have been entered in their correct position, while the left hand one displays the number of correct digits that are in the wrong positions.

### **Hidden numbers**

For example, suppose that the hidden number is 1234 and the user has entered 3514. On pressing the \* button, 2--1 will be displayed (where '-' indicates a blank digit) because although three correct numbers have been chosen (1, 3 and 4), two are in the wrong position and only one (the 4) is in its correct position. Note that no indication is given as to which the incorrect number is or which one is in its correct position. Pressing the \* button also automatically increases the score counter.

Pressing the # key will reveal the last entry again and enable a new 4-digit number to be entered. The entered digits scroll across the display from right to left as they would if they had been entered on a calculator. Note that a guess is only accepted by the unit when the \* button is pressed, so that keys pressed incorrectly may be overwritten and the entry made only when the player is satisfied with the new 4-digit number chosen. Eventually, after a number of unsuccessful guesses, the correct number will be entered and this time when the \* button is pressed a display in the form --XX will be shown, again the '-' signifying a blank digit and the XX the number of entries made. Since the idea of the game is to make this score as low as possible, a 2-digit score display (i.e. 99 attempts) should be more than enough for even the most illogical thinker!

### **Circuit description**

The circuit, shown in Fig.1, consists of the PIC (IC1) plus the 4-digit LED display (X1) and a 12-way keypad (S2), together with the usual LED current limiting and pull-up resistors, R1 to R8 and R14 to R16 respectively. The PIC's clock frequency is not critical and so a simple resistor-capacitor option has been chosen (R13/C1).

The limited number of PIC I/O (input/output) lines means that both the display and the keypad have been multiplexed. Multiplexing is a widely used technique and operates (as far as the display is concerned) by outputting the seven-segment code for each digit on Port B while switching on each corresponding digit sequentially via four lines of Port A. This is done so fast that the eye perceives it as a continuous display so that all four digits appear to be on simultaneously.

After displaying the digits, four lines of port B (RB4 to RB7) are switched to function as outputs and driven low in turn while RB0 to RB2 are designated as inputs. If a key is being pressed, one of the inputs will now read low and depending on which input is low, the program determines which key is pressed.

Because the same port is used to output the 7-segment data and both drive and read the keypad, isolating resistors R9 to R12 are used to prevent key presses affecting the display.

### Construction

The printed circuit board component and track layouts are shown in Fig.2. This board is available from the *EPE PCB Service*, code 598.

Assembly should begin with the resistors, followed by the capacitors

# Parts List – Mind Trainer

- 1 PC board, code 598, available from the *EPE PCB Service*, size 51mm × 76mm
- 1 Plastic case (optional), size and type to invidual choice
- 1 12-key, 3 × 4 matrix, keypad (S2)
- 1 SPST miniature toggle switch (S1)
- 1 4-digit, common cathode, red LED display (CC56-12EWA) (X1)
- 1 battery holder for two AA or AAA cells, with battery clips
- 1 18-pin DIL socket

### Semiconductors

1 PIC16F54 microcontroller, preprogrammed – see text (IC1)

### Capacitors

- 1 22p ceramic disc (C1)
- 1 100n ceramic disc (C2)
- 1  $47\mu$  radial elect. 10V (C3)

### Resistors (0.25W 5% carbon film)

- 8 100Ω (R1 to R8)
- 5 4k7 (R9 to R13)
- 3 100k (R14 to R16)

Multistrand connecting wire; ribbon cable, optional – see text; solder, etc.



Fig.1. Complete circuit diagram for the Mind Trainer. Power is supplied by two AA or AAA type cells

and higher profile components, with the PIC's socket mounted last.

The pinouts for the display and keypad are shown in Fig.3 and Fig.4. These items should be mounted on the track side of the PCB, using short lengths of discarded resistor leads or ribbon cable as preferred.

When assembly is finished check all of the connections to ensure that there are no solder splashes between adjacent copper tracks or pins, and that the joints are all sound. If this is so, the preprogrammed PIC should be plugged in, ensuring that it is the correct way around.

The circuit can now be powered up, using a 3V battery or two 1.5V cells in series (AA or AAA are suitable). These are best mounted in a battery holder which should be connected to the PCB, either directly or via a suitable connector. On/off switch S1 is inserted in the +3V battery lead.



Fig.3. LED display pinout details



Fig.4. Keyboard connection details. End pads 1 and 9 are not connected on the PCB



Fig.2. Mind Trainer printed circuit board component layout, full size copper foil master and wiring to the On/Off battery supply switch. Note that keypad pins/ pads 1 and 9 are not connected to the board. Use an IC socket for the PIC

There are no adjustments to be made and provided the circuit has been correctly assembled, it should work as described.

The circuit draws about 15mA when operating which, although not too high for battery operation, would soon drain an AA battery if left on for extended periods.

### Playing the game

As a further example of how the game is played, the sequence of a real game is reproduced in Table 1. The unknown number happened to be 2489 and the first digits entered were 1234 as shown, which resulted in the display 2--0 indicating that two of these digits were correct but neither was in its correct position.

## Table 1. Example game play

Guess	Result No.	Position
1234	2	0
1256	1	0
1356	0	0
2478	1	2
2489	Final score 05	



Topside PCB component layout. Note the radial electroytic is mounted on it's side

It was assumed that the digits 1 and 2 were correct and that 3 and 4 were not part of the hidden number, so that the next entry made was 1256 which gave the result 1--0. From this it was guessed that 5 and 6 were probably not part of the hidden number and that only one of the remaining numbers 1 or 2 was correct.

The hidden number thus included 1 or 2 and 3 or 4. To find out which, a further guess was made by assuming that the correct numbers were 1 and 3 so that 1356 was entered which gave the result 0--0. This was lucky as it immediately showed that 2 and 4 were two of the numbers required and 5 and 6 were definitely not part of the hidden number.

At this point it was still not known what the other two numbers were, except that they could be 7, 8, 9, 0 or indeed 2 and 4 again, as each correct digit is only counted once even if it appears again in the hidden number. The next entry made was therefore 2478 and this gave the result 1--2 showing that either 7 or 8 also figured in the final number and, as a bonus, two of the digits were also in their correct positions.

The last entry was the result of two lucky guesses where it was assumed that it was 2 and 4 that were in their correct positions, and that 8 was the correct number but in the wrong position. Changing its position and trying the next number by entering 2489 displayed the final score as --05.



Underside view of the board showing the display and keypad

This shows that to achieve a low score, a certain amount of luck is also required, but this does not mean that a logical thinking process is not involved. No doubt the final number could have been found by randomly entering numbers into the unit, but this would almost certainly result in a higher final score than by extracting the maximum amount of information from the results obtained from each entry.

### Demo mode

As a further aid to understanding the game, the software is designed so that when the unit is first switched on, a 'random number' is entered into its memory. The user can then press the # key and enter any digits preferred to see how the unit processes the guess. This will give the player an insight into what display is to be expected when, for example, the random number contains repeated digits.

In general, any number which is in its correct position is displayed in the 'correct position' score and is not counted again even if it also appears in another position in the random number. Thus the right-hand display shows the number of correct digits in the correct position and the left-hand display the number of remaining correct digits in the wrong position.

After this, to start a game, simply enter the correct number and press \* (which will display your score) and then press the # key again. This will

### Resources

Software for the PIC can be downloaded free from the EPE Downloads site, accessible via the home page at www.epemag.co.uk. It is held in the PICs folder. Download all the files within that folder.

Preprogrammed PICs are available from Magenta Electronics Ltd, contact details as in their advert in this issue.

blank the display and generate a new (this time hidden) random number when the # key is pressed again. The score will be reset to zero and the display will change to 0000, ready to accept the first guess.

If the practice session is not required, press the \* button after switching the unit on, followed by the # button which will blank the display, and then the # key again before entering your first guess. The practice feature is available only after the unit has first been switched on, so that after subsequent games the # key should be pressed twice to start each new game.

The unit also features a recall of the previous entry so that the last number entered and the result obtained can be re-examined. This is done by pressing the # button when the number has been entered and the result will be displayed alternately. Pressing the \* key is always treated as a new entry so this key should be pressed only when you are ready to make a new guess.

The circuit does not keep a record of previous numbers entered or the results obtained, so that if this function is required, an older technology (pencil and paper) will need to be used)! Alternatively, it could be argued that a person who could not remember previous entries was not thinking very logically anyway and should be penalised if the same 4-digit number was entered two or more times!

Finally, the efficacy of this unit in maintaining mental faculties obviously requires further independent research. The author considers himself much too young to have lost any of those he possessed and therefore is not a suitable subject. Modesty prevents him revealing his best score but suffice it to say that a third digit to display this has not been required (yet)! **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 £11.50 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.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.

<ul> <li>SUBSCRIPTION ORDER FORM</li> <li>6 Months: UK £18.75, Overseas £21.75 (standard air service), £30.75 (express airmail)</li> <li>1 Year: UK £35.50, Overseas £41.50 (standard air service) £59.50 (express airmail)</li> <li>2 Years: UK £66.00, Overseas £78.00 (standard air service) £114 (express airmail)</li> <li>To: Everyday Practical Electronics, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND</li> <li>Tel: 01202 873872 Fax: 01202 874562</li> <li>E-mail: subs@epemag.wimborne.co.uk</li> </ul>
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.

# Learn About Microcontrollers



# PIC Training & Development System

The best place to start learning about microcontrollers is the PIC16F84 with its simple easy to understand internal structure. Then continue on using the more sophisticated PIC16F877 family.

At the heart of our system are two real books which lie open on your desk while you use your computer to type in the programme and control the hardware. Start with four simple programmes. Run the simulator to see how they work. Test them with real hardware. Follow on with a little theory ...

Our PIC training course consists of our PIC programmer module, a 298 page book teaching the fundamentals of PIC programming in assembly language, a pook teaching the fundamentals of PIC programming in assembly language, a 274 page book introducing the C programming language for PICs, and a suite of programmes to run on a PC. The module is an advanced design using a PIC16F870 to handle the timing, programming and switching requirements. Two ZIF sockets allow most 18, 28 and 40 pin PICs to be programmed. The plugboard is wired with a 5 volt supply. The programming is performed at 5 volts, verified with 2 volts or 3 volts applied and verified again with 5.5 volts applied to ensure the PIC is programmed correctly over its full operating voltage. UK orders include a plugtop power supply.

P901 PIC Training System comprising.....

- Universal 16C, 16F and 18F PIC programmer module
- + Book Experimenting with PIC Microcontrollers
- + Book Experimenting with PIC C
- + PIC assembler and C compiler software suite

+ PIC16F84, PIC16F870, PIC16F88 test PICs. . . £159.00

(Postage & insurance UK £10, Europe £18, Rest of world £25) Optional book Exp with 18F PICs + PIC18F2525.....£ 30.00

(Additional postage UK £0, Europe £3, Rest of world £5)

# Experimenting with PIC Microcontrollers

This book introduces PIC assembly language programming using the PIC16F84, and is the best way to get started for anyone who is new to PIC programming. We begin with four easy experiments. The first is explained over ten and a half pages assuming no starting knowledge of PICs. Then having gained some practical experience we study the basic principles of PIC programming, learn about the 8 bit timer, how to drive the LCD, create a real time clock, experiment with the watchdog timer, sleep mode, beeps and music, including a rendition of Beethoven's *Fur Elise*. Finally there are two projects, using the PIC16F84 as a sinewave generator and investigating using the PIC16F88 (from the PIC16F877 family) to monitor the power taken by domestic appliances. In 24 exper-iments, 2 projects and 56 exercises we go from absolute beginner to experienced engineer level.

# Experimenting with PIC C

The second book starts with an easy to understand explanation of how to write PIC programmes in C. The first few programmes are written for a PIC16F84 then we see how to use the PIC16F627 and PIC16F877 families. We study how to create programme loops, we experiment with the IF statement, use the 8 bit and 16 bit timers, write text, integer, and floating point variables to the LCD, use the keypad to enter numbers, create a siren sound, experiment with the PICs USART......

### Web site:- www.brunningsoftware.co.uk

Mail order address:

# Experimenting with 18F PICs

This book introduces the latest 18F series of PIC Microcontrollers. We start with simple programmes to drive the LEDs, write text to the LCD and create a real time clock. We experiment with the various oscillator modes, the watchdog and the sleep mode. We use the analogue to digital converter as a voltmeter and experiment with the serial port. Finally we study the operation and control of stepper motors.

Book Experimenting with 18F PICs . . . . . £ 25.00 AUX145-SM Stepper motor controller. . . . £ 49.00 5 volt 7.5 degree stepper motor. . . . . . . £ 4.50

(Postage, UK ≈ £8, Europe ≈ £12, Rest ≈ £20)

You need to own or update to our P901 PIC Training System before purchasing the above.

# Experimenting with Visual C

Our new training system for complete beginners teaching Windows programming and simple PC interfacing. The book starts with details of how to build a latching serial port using a PIC18F2525. We use this port as our interface to our PC. As we work through the book we wire simple circuits into the plugboard of the latching serial port and write Windows programmes in Visual C to operate our circuits. We start by flashing LEDs, build a dice machine and an IC tester. We use the PC to write messages to a liquid crystal display. We learn to draw graphs on our PC screen. Then we build a digital to analogue converter, an analogue to digital converter, an audio oscilloscope, and a waveform analyser. Windows programming has never been so easy or so exciting. Release date late November. Price around £100. See

our web site for the latest information.

# **Ordering Information**

Our PIC programmer module connects to the serial port of your PC (COM1 or COM2). Our PIC programming software will operate within Windows 98, XP, NT, 2000 etc. The new Visual C training system will require Windows XP, NT, 2000 etc.

Telephone with Visa. Mastercard or Switch, or send cheque/PO. All prices include VAT if applicable.



### White LED and Motors

Our PIC training system uses a very practical approach. Towards the end of the PIC C book circuits need to be built on the plugboard. The 5 volt supply which is already wired to the plugboard has a current limit setting which ensures that even the most severe wiring errors will not be a fire hazard and are very unlikely to damage PICs or other ICs.

We use a PIC16F627 as a freezer thaw monitor, as a step up switching regulator to drive 3 ultra bright white LEDs, and to control the speed of a DC motor with maximum torque still available. A kit of parts can be purchased (£30) to build the circuits using the white LEDs and the two motors. See our web site for details.

138 The Street, Little Clacton, Clacton-on-sea, Essex, CO16 9LS. Tel 01255 862308

**Brunning Software** 





# Ian Bell

# The final part of our close-up view of 555 timer circuit formulae

**T**HIS is the third and final part of our extended answer to **CherryTree's** question from the *EPE Chat Zone* about where the formulae used in 555 (and similar) RC-based timer circuits come from. Over the past couple of months we have looked at the mathematics behind a resistor charging through a capacitor – which is more advanced than you might expect for such an apparently simple circuit. In fact you need calculus and differential equations to describe what is happening.

The results of performing the calculus are equations for the voltage at given times after the capacitor starts charging, and for the time taken to reach a particular voltage. These formulae can be applied in many circuit situations without the need to go back to calculus. The formulae involve the exponential function or natural logarithms, which we looked at in depth last month. For reference, see the basic RC Equations panel.



Fig.1. Simple comparator-based timer triggered at power up



Fig.2. A discharge transistor added to the circuit in Fig.1 allows it to perform its timing operation more than once after power-on

Last month we started looking at more practical aspects of RC timing. We arrived at the circuit shown in Fig.1.

This circuit uses a comparator to detect when a charging capacitor reaches a particular voltage, determined by the potential divider R2 and R3. This circuit represents a portion of the 555 and we will develop it from this point to the full 555 block diagram by adding extra functionality. First, though, a quick word on timing formulae.

### **Timing Formulae**

Rather than thinking of the comparator switching point for Fig.1 as being at a particular voltage, it is better to consider it as a fraction of the supply voltage. If we do this, then as we saw last month, the applied voltage (supply voltage) can be cancelled from the charging equation. We get

$$t = -RC \cdot \ln(1 - k_1)$$

where in the specific case of the circuit in Fig.1

$$k_1 = \frac{R3}{R2 + R3}$$

For which we can find the value of the natural log (call this  $k_2$ ) to get

 $t = k_2 RC$ 

Table 1 shows some RC timing formulae for a few simple fractions ( $k_1$  values) and special case of  $k_1 = 0.632$  for which  $k_2 = 1$ 

The circuit in Fig.1 is not particularly useful because it only times once power is when applied. This is easily solved by adding a transistor to discharge the capacitor, which is what is done in the 555. Applying a signal to the control input to turn on TR1 will discharge the capacitor. If the control input is then held at 0V, C1 will start charging and the comparator will switch at the time determined by the

 Table 1. Example RC charging equations for different fractions of applied voltage

Fraction of applied voltage	Timing Equation (comp switches at)
1/3	t = 0.405RC
1/2	t = 0.693RC
0.632	t = RC
2/3	t = 1.10RC
3/4	t = 1.39RC

supply voltage fraction set by resistors R2 and R3. The timing formulae in Table 1 can be applied (R = R1 times C = C1) in this situation.

### Triggering

In general, if we want to start a timing operation in a circuit it is better to trigger it using the edge of the control waveform, that is a 1 to 0 or 0 to 1 transition, rather than requiring that the control signal is held in place for at least the duration of the timed period, as is the case with the circuit in Fig.2. To achieve this we can use a flip-flop to hold the control signal in the appropriate state – see Fig.3.

In the circuit in Fig.3, when the circuit is idle the output is low and the control signal is high, so the transistor is on and the capacitor is discharged. When the trigger input goes low, the flip-flop sets, so Q (and hence the output) goes high, and Q goes low, causing the transistor to



Fig.3. Timer with edge-triggered start

turn off, allowing the capacitor to charge. Thus the timing cycle starts and  $V_C$  charges towards the supply voltage.

When  $V_C$  reaches the comparator (IC1) threshold set by R2 and R3, the comparator switches (output goes low) and the flip-flop (IC2) is reset. The circuit output (flip-flop Q) goes low again and the transistor switches on, discharging the capacitor. This removes the reset signal from the flip-flop so it is ready for the next trigger input. The circuit waveforms (for two timing operations) are shown in Fig.4.

The timing period for the circuit in Fig.3 is the same as that in Fig.2. The circuit in Fig.3 performs in almost the same way as the 555 in monostable mode. For the 555, the comparator switching threshold is set at two-thirds of the supply voltage by internal resistors (equivalent to R2 and R3), thus from Table 1 (or formulae given above) the timed period, T, is

### T= 1.1RC

OUT

V<sub>c</sub>

CONTROL

COMPARATOR OUT

TRIGGER (FLIP-FLOP RESET)

The circuit in Fig.3 requires a short trigger pulse, just as the 555 does, which only has to be long enough to set the flip-flop

> $T = k_2 RC$ (SEE TEXT

### **Continuous Pulses**

So far all the circuits we have discussed have provided monostable or 'one-shot' timing. It is also common to need a continuous sequence of timed pulses, referred to as astable or 'free running' operation. To achieve this we need to continuously switch between charging and discharging the timing capacitor.

The waveform in Fig.4 shows the capacitor voltage falling very quickly once the transistor turns on to discharge it. The capacitor will follow a discharge curve whose timing is governed by the effective collector to emitter resistance of the transistor. This resistance is small and so the discharge is rapid, however, if we insert a resistor in series with the transistor we can slow down the discharge to be similar to the charging time.

In Fig.5 is shown part of the circuit from Fig.3 with the addition of a possible way of including a discharge resistor. This is perhaps the most obvious way to do it, but it is not ideal because R1 and R4 create a potential divider which would prevent the capacitor fully discharging. Hopefully this can be seen clearly in the simplified equivalent circuit.



Fig.4. Waveforms for the circuit in Fig.3 for two timing operations and which must be shorter than the monostable timing period. In standard 555 monostable circuits, R1 and C1 are the external timing components (R2 and R3

are internal, as already mentioned).

in which resistors R1 and R4 are the external timing resistors.

Our current circuit (Fig.3) has a single comparator which detects when the capacitor voltage reaches the limit to



Fig.5. Showing where a resistor could be inserted in the circuit in Fig.3 to set the discharge time. Fig.6 shows a better approach



Fig.6. Better approach to adding a resistor to control discharge timing.

# **RC EQUATIONS**

### **Capacitor Charging**

C charges from 0V towards  $V_{in}$  through R when S closes at time t = 0



Voltage at time t after S closes

$$V_C = V_{in} \left[ I - exp\left(\frac{-t}{RC}\right) \right]$$

Time after S closes taken to reach voltage  $V_{\rm C}$ 

$$t = -RC \cdot \ln\left(1 - \frac{V_C}{V_{in}}\right)$$

### **Capacitor Discharging**

C discharges from  $V_i$  towards 0V through R when S closes at time t = 0



Voltage at time t after S closes

$$V_C = V_i \exp\left(\frac{-i}{RC}\right)$$

Time after S closes taken to reach voltage  $V_{\rm c}$ 

$$\mathbf{t} = -RC \cdot \ln\left(\frac{V_c}{V_i}\right)$$

which we want it to charge (at the end of the charging period). For astable operation we also need to define the end of the discharge period and detect when the capacitor reaches this voltage. We need another comparator to accomplish this. Obviously the discharge limit voltage must always be less than the charging limit voltage. A good circuit arrangement for this is shown in Fig.7.

In Fig.7, comparator 1 (IC1) is used to detect the charging limit. This is equivalent to the comparator we have already used. Comparator 2 (IC2) is a new addition to our circuit and detects the discharge limit.

Both comparator thresholds can be expressed as fractions of the supply voltage as follows:

$$k_{comp1} = \frac{R3 + R5}{R2 + R3 + R5} \quad k_{comp2} = \frac{R5}{R2 + R3 + R5}$$

If all three resistors have the same value (R2 = R3 = R5) we get  $k_{comp1} = 2/3$  and  $k_{comp2} = 1/3$ . This is what is done in the 555 (these resistors are internal components).

### **Astable Operation**

Fig.8 shows the full circuit for astable operation – Fig.3 with the additional circuitry that we have just discussed. The circuit operates as follows. At power-up C1 is fully discharged. The voltage is below the lower threshold, so comparator 2 will set the flip-flop and the transistor will be off, allowing the capacitor to charge towards  $V_{\rm DD}$  through R1 and R4.

As  $V_C$  passes  $k_{comp2}V_{DD}$  (one-third supply for the 555) comparator 2 switches and removes the set signal from the flip-flop, but it remains in the set state. The capacitor continues to charge. When  $V_C$  reaches  $k_{comp1}V_{DD}$  (two-thirds supply for the 555) comparator 1 switches and resets the flip-flop. This switches the transistor on and C1 starts discharging via R4 and TR1.

 $V_C$  will very quickly drop below  $k_{compl}V_{DD}$  (two-thirds supply) switching



Fig.7. Resistor and comparator arrangement to detect charge and discharge limits for astable operation (timing resistors and discharge transistor not shown)

comparator 1 and removing the reset signal from the flip-flop, which however will remain in the reset state. The capacitor continues to discharge through R4 and the transistor. When V<sub>C</sub> passes  $k_{comp2}V_{DD}$  (one-third supply) comparator 2 will switch and apply a set to the flip-flop. This will switch off the transistor allowing C1 to charge again through R1 and R4. V<sub>C</sub> will very quickly rise above  $k_{comp2}V_{DD}$  (one-third supply) again switching comparator 2 and removing the set signal from the flip-flop, which however will remain in the set state.

This process will repeat indefinitely so that  $V_C$  will charge up to  $k_{comp1}V_{DD}$  and then discharge to  $k_{comp2}V_{DD}$ . For the 555, the capacitor voltage oscillates between one and two-thirds of the supply voltage.

### Calculating Astable Timing

To calculate the timing period of the astable, we have to work out the charge time

and the discharge time and add these together. For this we will assume that the charge and discharge limits are set to two-thirds and one-third of the supply voltage respectively, as they are in the 555.

In these articles we have not developed a formula to directly give us the time taken to charge from one-third to twothirds of the supply (or similar situations), but this is straightforward to work out. All we have to do is take the time taken to reach two-thirds of the supply charging from 0, and subtract the time taken to reach onethird of the supply voltage charging from 0.

$$\begin{split} t_{charge} &= -RC \cdot \ln(1-2/3) - -RC \cdot \ln(1-1/3) \\ t_{charge} &= -RC \cdot \ln(1/3) + RC \cdot \ln(2/3) \\ t_{charge} &= 1.09861RC - 0.40546RC \\ t_{charge} &= 0.693RC \end{split}$$

For charging we have R = R1+R4 and C = C1 so for the circuit in Fig 8 we get

$$t_{charge} = 0.963(R1 + R4)C1$$

For the discharge phase the situation is simpler – we can use the discharge formula we have discussed before directly (see RC panel). Written in terms of initial voltage fraction  $k_I$ , the formula becomes:

$$t = \operatorname{RC} \cdot \ln\left(\frac{1}{k_I}\right)$$

If the initial voltage is two-thirds of the supply and the voltage we are interested in is one-third of the supply, so we have a situation where the capacitor voltage falls to half its initial value, that is  $k_I = 1/2$ . So the discharge time is:

$$t_{discharge} = RC \cdot \ln(2)$$
  
 $t_{discharge} = 0.693RC$ 

For discharge we have R = R4 and C = C1, so for the circuit in Fig.8 we get:

 $t_{discharge} = 0.693R4C1$ 

The total time of one cycle, *T*, is the sum of the charge and discharge times:

 $\begin{array}{l} T = t_{charge} + t_{discharge} = 0.693(R1 + R4) \\ C1 + 0.693\ R4C1 \end{array}$ 

T = 0.693(R1 + 2R4)C1

The frequency of oscillation of the astable is f = 1/T so:

$$f = \frac{1.44}{(R1 + 2R4)C1}$$

These formulae (T and f) give the timing for the standard 555 astable.

The modified circuit in Fig.8 can also be used to form the basis of the monostable shown in Fig.3 (note that R4 is not present in the monostable). One difference is that the trigger signal passes through comparator 2 rather than being connected directly to the flip-flop. This means that the monostable trigger activates as the trigger voltage falls below one-third of the supply. Note that the trigger signal is connected to the external trigger, not to the capacitor for monostable operation.



Everyday Practical Electronics, December 2006



Fig.8. Astable timer circuit. This is very similar to the 555 in astable mode. Signals corresponding with pins on the 555 are indicated on the schematic

# Surfing The Internet

# Net Work

# Alan Winstanley

### **Recycle Risk Confirmed**

This month's *Net Work* is over to you, readers, with your feedback following up on recent articles.

In October's issue I described how old computers and personal data dumped by consumers onto British rubbish tips were finding their way into the hands of Nigerian dealers. I suggested various software products that could shred personal data thoroughly, to protect against data theft once a disk is discarded. A reader supplied more background:

"Your October 2006 column queried how personal computer hardware and data could end up on sale in Nigeria. I run an electronics repair company, and I buy faulty discarded electronic equipment that I refurbish and sell on: for years my source of this faulty equipment has been the local authority rubbish tip or 'recycling centre'.

"Most people associate the word 'recycling' with items that have been smashed up, melted down and made into something else, but in reality this is far from the truth. Go to your local recycling centre with a pocket full of cash and you can buy anything on display, of course items such as TVs and videos will probably be faulty and require some sort of repair – no problem to someone like myself, but computers are usually thrown away working because people have upgraded to the latest model.

"Two computers I have bought in the past come to mind, one was from a solicitor's office and contained confidential files and letters, and another came from a florist and had company accounts, names and addresses of bad payers etc. One guy I met was removing hard drives and buying them for a couple of pounds a time, when I questioned what use he had for them he said: "none at all, J just put them on eBay and sell them at a profit". It's not really difficult to see how your old hard drive can end up in Nigeria." *Name and address supplied.* 

Thank you for confirming what I half-suspected. It is also why I remove disk drive platters and destroy them completely, rather than allow them to be 'recycled'. In my local county, however, it seems the policy is to 'rotate' the staff on duty at recycling centres to prevent people becoming too friendly with them.

### A Better VNC?

**Thomas Stratford** writes: "In last month's *Net Work* article you mention Real VNC as a way of remotely operating a PC. We use it all the time at work as it works really well but the screen refresh is a little slow. I have recently found out that there were security flaws in Real VNC, see the Techtarget web site at **http://tinyurl.com/y95h6q** 

"One of our customers was hacked, they had Real VNC loaded. The hacker opened Microsoft Word and defaced a document, closed Word again then disconnected. If we find Real VNC installed now we are removing it and installing Tight VNC instead, from **www.tightvnc.com**."

Tight VNC is claimed to be an enhanced version of Real VNC. An upgrade claiming to fix all known security issues was posted by Real VNC in May 2006, and a limited version of the latest version 4.1.2 is available as a free download from **www.realvnc.com**. Incidentally readers, Thomas does a sterling job of running the Official *EPE* PIC Mirror Site at http://homepages.nildram. co.uk/%7Estarbug/epepic.htm or link via the *EPE* Downloads



page. This is a very useful web-style front end to almost every *EPE* PIC source code ever published.

### **IP** Cameras

My thanks to regular reader *Allan Sancto EA/G0LFM (via email)* who writes from Spain:

"I read with great interest your *Net Work* article about webcams in September 2006 *EPE*. We have lived in rural Spain for a few months and were just beginning to feel at home and reasonably secure, when my nearest neighbour some 200 metres away was burgled in spite of a very expensive alarm system connected (via mobile phone technology I believe) to the nearest Police Station! I have the same system!

"Consequently your piece on Webcam security looks very interesting for our purposes. If I wish to connect more than one camera, would it not be necessary to provide some amplification on cable runs longer than the average webcam connection to the PC?"

For reliable operation, there is a theoretical limit on a USB lead length of 5 metres or so. The simplest solution is an Active 5 Metre USB repeater cable, which amplifies the signal over longer cable runs. One supplier claims that you can daisy-chain up to five of them together, so you could make up to a 25 metre USB link. Examples are on eBay (search for 'USB repeater') for roughly £6 to £10 each. This becomes a bit pricey for a multiple camera setup, though.

Note that webcams tend to use a fair amount of power (judging by how warm mine becomes) so if you use multiple cameras it might be worth trying a powered USB hub, running from a mains adaptor (see our *USB Power Injector* in this issue).

A smarter but far more expensive solution to the cable problem is to use an 802.11g wireless IP camera – the IP (Internet Protocol) bit means that it acts as its own server with its own IP address (so no host PC is needed), so it can be hooked directly to a TCP/ IP network wirelessly. The clever Panasonic BLC30 (see photo) is a tripod-mountable indoor wireless camera offering PIR motion detection, remote control of pan and tilt via a PC or Internet-connected mobile phone, a Privacy button and E-mail snapshots.

The wireless signal is encrypted to prevent unauthorised interception. Panasonic claims that setup is very simple but a bit of experience of handling an IP network might be handy. Wireless network users will know that brick walls, copper pipes, wiring etc. tend to interfere with the signal range. More

details and a data sheet from www.panasonic.co.uk/ip-cam eras/blc30.html. Online vendors of the BLC30 include www.ipcctvcameras.co.uk

A wide range of wireless CCTV cameras and other dedicated devices are available by mail order from Cricklewood Electronics (www.cricklewoodelec tronics.co.uk) and Henrys Electronics (www.henrys. co.uk).

If you have any comments or possible suggestions for future topics, you can email the author at **alan epemag.demon.co.uk** 



# **ELECTRONICS MANUALS ON CD-ROM £29.95 EACH**

## **ELECTRONICS SERVICE MANUAL**



# 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

THE MODERN ELECTRONICS MANUAL

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	Simply complete and return the order form with your payment to the
l enclose payment of £29.95 (for one Manual) or £49.90 for both Manuals (saving £10 by ordering both together).	following address:
ordening bour together).	Wimborne Publishing Ltd,
FULL NAME	408 Wimborne Road East, Ferndown,
(PLEASE PRINT) ADDRESS	Dorset BH22 9ND
	Price includes postage to anywhere in
	the World
POSTCODE	
	We will happily exchange any <i>faulty</i>
SIGNATURE	CD-ROMs but since the content can be printed out we do not offer a refund on these items.
I enclose cheque/PO in UK pounds payable to Wimborne Publishing Ltd.	out we do not oner a refund on these items.
Please charge my Visa/Mastercard/Amex/Diners Club/Switch/Maestro	Your CD-ROM(s) will be
Card No Switch/Maestro Issue No	posted to you by first class mail or airmail, normally
Valid From Expiry Date	within four working days of
Card Security Code	receipt of your order



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.

### Li-ion Batteries

Dear EPE,

Batteries for lions (*Readout* Sept '06)? What will they think of next?

Seriously though, I have at least three of them in various units and I have not experienced the problems highlighted by Godfrey Manning. With all these new batteries, like NiCads, they all loose a small percentage of the stored charge weekly and I can only assume that Godfrey's friend had an older digital camera which was battery hungry.

I still have a four-year old Ricoh camera, complete with power zoom, which needed four sets of four spare AA rechargeables if you went out for the day and just took about 40 shots, and that was not using flash either. I later got hold of a set of big 1.2V rechargeables from JPG Electronics (see their ad) which I wired up into two sets of four and carried them around in a holdall connected to the camera by a three-foot cable, and even then I used to exhaust one set after about 60 shots.

Luckily the camera could only support a 32 meg memory card. If it had supported a one gig card, like the present camera, it would have needed a shopping trolley to carry enough batteries.

My latest camera is a two-year old Fuji that has twice the resolution, a 256 meg card and a spare battery I carry around, and I have never had cause to use it yet.

### George Chatley, via email

Thanks George, I passed your comments on to Godfrey.

On the subject of unusual uses for batteries, I once jokingly commented to a woman that the discarded batteries in the pond we were both looking at were food for the electric eels in there. And she believed me!

### **Screwdrivers Update**

Dear EPE,

I've an update for my letter, *Screwdrivers* in *Readout* Oct '06. I've just received the latest Maplin catalogue and see that they now include a triangular screwdriver bit in a 62-piece set, order code N53AW. Unfortunately, it costs £19.99 (plus carriage if a small order). Anyway, as nothing else was forthcoming, I stumped up the cash, the set arrived and indeed there is a  $2 \times 2 \times 2$ mm equilateral-triangle bit.

It's a slightly sloppy fit to the No.4 self-tapper that's shown with my letter,

## 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  $1\mu$ H to 10H, capacitance from 1pF to 10,000 $\mu$ F and resistance from 1\Omega to 2MΩ with a basic accuracy of 1%. www.peakelec.co.uk



# ★ LETTER OF THE MONTH ★

### **Un-flash PICs!**

Dear EPE,

I know John is always interested in PICs, so this is what happened to me recently.

There was a terrific storm here with tremendous thunder and lightning. There was one almighty flash and an instant roll of thunder and I thought it had hit the house. In fact, it had hit a tree about 100 yards away and several houses nearby had their windows blown in. In my case it blew the modem, completely dead, and it had to be replaced.

My HAL project, which controls the house, had its LCD display completely destroyed. There was nothing – it was

also it's on a 6mm hex shank and so can't go far down a counterbore. But it's better than nothing. The set also contains ranges of the more established security bits, but includes some of the unusual sizes, plus a rather nice ratcheting handle for holding the bits. So, worth buying for these various features put together.

Godfrey Manning, via email

That's good news Godfrey. A happy ending to a very detailed search.

### **Readout Error and Food Allergy**

Dear EPE,

I've spotted an error in *Readout* Oct '06 regarding Robert Powell's good idea for fluorescent light capacitor testing. Fig.1 text says 'all in series' = 13.8 ohm, but the resistors are shown drawn in parallel = 3.33 ohm, oops!

A quickie about food allergy testing with a Vega? electronic machine – a lady friend of ours has just had a food allergy test and described how different glass phials with various food substances were used to diagnose her reaction by measuring skin resistance. As she described the test I could not see how her body could react to anything in an insulated glass tube.

I then did a bit of research on the net and found that the BBC had run a program de-bunking the machine. Now my total medical knowledge is confined to an aspirin tablet, but... are there any of your readers who can explain how such a machine could work? What if an AC carrier/current of ×-frequency was completely dead. I replaced it and then found that the PIC16F877 controlling the system was completely unharmed. It was ticking away quite merrily. The 877 must have been extremely robust.

Peter (Chat Zone user Merlin), via email

That's an amazing tale Peter. You were lucky in many ways. The nearest I've been to a lightning strike was in Malaya many years ago, it felled a tree near where we were in a jungle hut sheltering from the monsoon rain while filming (when the rain stops!), and long before PICs were invented. Only just missed the hut.

passed through the substance in the glass tube as a capacitive dielectric and then through the person under test? Food for thought?

Great mag, eagerly awaited every month!

### Bryon Epps, via email

Whoops, that oversight is down to me! I no longer have Robert Powell's email address, and cannot check with him, what he really meant to say/show. Robert – are you tuned in here? If so, drop me an email via HQ please.

Regarding the question, readers can you help Bryon?

### Chip off the Old Block?

Dear EPE,

It's nice to know that there are still people who make good use of salvaged components – not to mention pieces of kitchen chopping boards – in order to create something new and useful (*Human Powered Torches*, Sep '06).

Thank you for the interesting article. Now I know what to do with my old stepper motors.

### Francis K. Hall, Meinerzhagen, Germany

So many things, Francis, have uses well beyond that which they were designed for. That's a general philosophy I follow when I'm designing something and am looking for unusual non-electronic parts. Amazing what you can find that has multiple uses if you put your mind to it.

Radio The leadin	g magazine for	Now Also
	e radio enthusiast	S Available to BUY ONLINE
Bygones		www.radiobygones.com Log on, pay by credit card and download the magazine to
ARTICLES on restoration and repair, history, circuit techniques, perso	malities reminiscences and just pla	your PC
nostalgia – you'll find them all. Plus features on museums at colour photo-feature in every issue. IT'S MOSTLY about valves.	nd private collections and a full	FOR 6 ISSUES
of the coherer and spark-gap variety or early transistors – al Maxwell, Hertz, Lodge and Marconi to what was the state-of	so has a place. FROM THE DAYS	of available
THERE IS ALSO a selection of free readers' For Sale and Wante	ed advertisements in every issu	e.
<b>Radio Bygones</b> covers it all! THE MAGAZINE is published six times a year, and is only availa	ble by postal subscription It is	not available at newsagents.
TO TAKE OUT a subscription, or to request a sample copy, RADIO BYGONES, Wimborne Publishing Ltd, 408 Wir	please complete the form bel	ow and return it to:
Tel: 01202 873872. Fax: 01202 874562. Web sites: ww		
<b>TIME RADIO BYGONI</b>	ES ORDER FORM	
A SAMPLE COPY of Radio Bygones£3.75	My card number is:	Down Chile barmaireal
(Add 75p for overseas Airmail postage)		
SUBSCRIPTIONS (post paid):1 YEAR 2 YEARUNITED KINGDOM£21.00£40.00		neck that you have the number correct
Rest of Europe (Airmail) £23.50 £45.00		To: (Exp. date)
REST OF THE WORLD (AIRMAIL) £29.00 £56.00		(the last 3 digits on the signature strip)
Yes, I would like a sample copy for £3.75 (A free issue is available for download from www.radiobygones.com)		
Yes, I would like to take out a subscription for: One year (6 issues) Two years (12 issues)		
I enclose a cheque/Eurocheque/PO for £		
payable to Wimborne Publishing Ltd	*	Tel
Please debit my Visa/Mastercard/Switch/Maestro ca	rd Signed	
		ANDRE LAMOTHE'S
agar super		GAMESTATION
Circuits 🎢		Learn Step-By-Step How to Design d Build Your Own Video Game Console
PCB DESIGN & MANUFACTURE		Design inspired by the Atart 800/ 2600, Iclair ZX Spectrum, Apple II & Commodore 64
for both the Hobbyist and Professional		
PCBs designed and produced from : • Notes • Schematics • Specifications		
Descriptions      Print - outs      Gerbers		
Available With or without component assembly		nplete Package eBook Integrated IDE
* FREE * PCB PROTOTYPE With Quantity Orders		52 CPU
Email: adinfo@agarciruits.com		
Tel: 028 (90) 738 897		1000 2000
		20.20 151
Laser 🧖 💼		Q 44
Laser Business Systems Ltd C-Bus Shop		EATURES:
http://www.cbus-shop.com #CLIPSAL C-Bus Tel: +44 (0) 20 8441 9788		eat for Hobbyists AND Students! mplete Software Development Kit!
Fax: +44 (0) 20 8449 0430 New C-BUS WIFeless Email: Info@laser.com coming soon	•eB • Pa	ook on Designing the XGS Console: PAL & NTS comparing the XGS Console: Comparing the rallax SX:Key Compatible: Iy Assembled XGS Micro Edition Unit!
<u>xao</u> two		ly Assembled XGS Micro Edition Unit! Fun Way to Learn Embedded Systems!
We are an authorized distribute of C flow intelligent lightless and		
We are an authorised distributor of C-Bus intelligent lighting and control system from Clipsal Integrated Systems with an extensive range of home automation related products. We also stock Barix		
Ethernet based MP3, communications and control products and CAT5e based KAT5 AV transmission and IR control system.		
Why tolerate when you can automate?	W	WW.XGAMESTATION.COM
<b>= = 28</b>	SL	PPORT@NURVE.NET PH 925.736.2098(US

Everyday Practical Electronics, December 2006

# ichfield Electronics.

for soldering equipment and electronics kits



### Sunkko 850D+

High power SMD Rework Station for BGA removal, QFP and larger soldering Digital readout of set and actual temp Large nozzle for large chips (BGA, etc) 0.3-24 L/Min air output. 1,200W max output (650W norm) Auto on/off by handle position. CE marked, complete with nozzle & IC lifting fork.



### Sunkko 936D

50W Temperature Controlled Digital Soldering Iron Suitable for fine soldering of delicate chips Digital LED readout of actual iron temperature Iron tip sits over the ceramic heater element. 24V low voltage design. 200-480° C ±1°C Comes with solid metal iron stand which does not cool the tip. CE Marked.

£50 Inc Vat & Postage

### Sunkko 152A

0.15-15V 2A Power Supply with large LED display. Fine and coarse current and voltage controls 20W Temperature Controlled Soldering Iron. 210-490°C Suitable for fine soldering of delicate chips. Iron tip sits over the ceramic heater element. £40 Inc Vat & Postage 15V Max low voltage design.

Postage to UK mainland only, contact us for postage elsewhere. Price inc postage is valid for phone and mail orders. Internet price calculated by weight.

Christmas Electronic Kit packs now available online or in our shop, We have 125 kits & 24 project boxes for sale! www.LichfieldElectronics.co.uk Lichfield Electronics, Conduit Street, Lichfield, Staffs. WS13 6JU City Centre Shop open Mon-Tue Thur-Sat 9:15-5:00.

# SHERWOOD ELECTRONICS

### FREE COMPONENTS

Buy 10 x £1 Special Packs and choose another one EREE

buy TO X £T Special Packs and	u choos	
P1 15 x 5mm Red LEDs	SP135	5 x Miniature slide switches
P2 12 x 5mm Green LEDs	SP136	3 x BFY50 transistors
P3 12 x 5mm Yellow LEDs	SP137	4 x W005 1.5A bridge rectifiers
	SP138	20 x 2·2/63V radial elect. caps.
	SP140	
		3 x W04 1.5A bridge rectifiers
	SP142	2 x CMOS 4017
P8 10 x 3mm Yellow LEDs	SP143	5 Pairs min. crocodile clips
SP9 25 x 3mm 1 part LED clips		(Red & Black)
P10 100 x 1N4148 diodes	SP144	5 Pairs min.crocodile clips
SP11 30 x 1N4001 diodes		(assorted colours)
P12 30 x 1N4002 diodes	SP146	10 x 2N3704 transistors
P18 20 x BC182 transistors	SP147	5 x Stripboard 9 strips x
P20 20 x BC184 transistors		25 holes
	SP151	4 x 8mm Red LEDs
P24 4 x CMOS 4001	SP152	4 x 8mm Green LEDs
P25 4 x 555 timers	SP153	4 x 8mm Yellow LEDs
P26 4 x 741 Op.Amps	SP154	15 x BC548 transistors
P28 4 x CMOS 4011	SP156	3 x Stripboard, 14 strips x
SP29 3 x CMOS 4013	01 100	27 holes
P33 4 x CMOS 4081	SP160	10 x 2N3904 transistors
P34 20 x 1N914 diodes	SP161	10 x 2N3906 transistors
P36 25 x 10/25V radial elect. caps.	SP164	2 x C106D thyristors
$12 \times 10/35 \text{V}$ radial elect. caps.		
	SP165	2 x LF351 Op.Amps
	SP166	20 x 1N4003 diodes
P39 10 x 470/16V radial elect. caps.	SP167	5 x BC107 transistors
P40 15 x BC237 transistors	SP168	5 x BC108 transistors
P41 20 x Mixed transistors	SP171	8 Metres 18SWG solder
P42 200 x Mixed 0.25W C.F. resistors	SP172	4 x Standard slide switches
P47 5 x Min. PB switches	SP173	10 x 220/25V radial elect. caps
P49 4 x 5 metres stranded core wire	SP174	20 x 22/25V radial elect. caps
P101 8 Metres 22SWG solder	SP175	20 x 1/63V radial elect. caps.
P102 20 x 8-pin DIL sockets	SP177	10 x 1A 20mm quick blow fuses
P103 15 x 14-pin DIL sockets	SP178	10 x 2A 20mm quick blow fuses
P104 15 x 16-pin DIL sockets	SP181	5 x Phono plugs – asstd colours
SP105 4 x 74LS00	SP182	20 x 4.7/63V radial elect. caps.
P109 15 x BC557 transistors	SP183	20 x BC547 transistors
P112 4 x CMOS 4093	SP187	15 x BC239 transistors
P115 3 x 10mm Red LEDs	SP189	4 x 5 metres solid core wire
P116 3 x 10mm Green LEDs	SP192	3 x CMOS 4066
P118 2 x CMOS 4047	SP195	3 x 10mm Yellow LEDs
P124 20 x Assorted ceramic disc caps	SP197	6 x 20 pin DIL sockets
P126 6 x Battery clips – 3 ea.	SP198	5 x 24 pin DIL sockets
PP3 + PP9	SP199	5 x 2.5mm mono jack plugs
P130 100 x Mixed 0.5W C.F. resistors	SP200	5 x 2.5mm mono jack sockets
P131 2 x TL071 Op.Amps	01 200	
P133 20 x 1N4004 diodes		
P134 15 x 1N4007 diodes	2007	Catalogue available £1 inc.
10 T		
RESISTOR PACKS – C.Film		or <b>FREE</b> with first order.
	D 2. D	£1.75 per order NO VAT

### 5 each value – total 365 0.25W 10 each value – total 730 0.25W 1000 popular values 0.25W RP3 £3.40 £4.65 £6.60 RP7 RP10 RP4 5 each value-total 345 0.5W £4.30 RP8 10 each value-total 690 0.5W £6.95 RP11 1000 popular values 0.5W £8.95

C. P&P £1.75 per order, NO VA Cheques and Postal Orders to: **Sherwood Electronics**, 7 Williamson St., Mansfield, Notts. NG19 6TD.

# PLEASE ENSURE YOU TELEPHONE TO CHECK AVAILABILITY OF EQUIPMENT BEFORE ORDERING OR CALLING.

SSSS

3300

### OSCILLOSCOPES

TEKTRONIX 2247A 4 Channel 100MHz
Counter/Timer/ Voltmeter£275
Counter/Timer/ Voltmeter
TEKTRONIX 485 Dual Trace 350MHz Delay Sweep£300
IWATSU SS5711 4 Channel 100MHz Delay Sweep£150
PHILIPS 3065 2+1 Channel 100MHz Dual TB/Delay - Autoset £200
PHILIPS 3055 2+1 Channel 60MHz Dual TB/Delay - Autoset £150
PHILIPS PM3217 Dual Trace 50MHz Delay Sweep£125
KIKUSUI COS6100 5 Trace 100MHz Delay£150
TEKTRONIX 475A Dual Trace 250MHz Delay Sweep£175
TEKTRONIX 475 Dual Trace 200MHz Delay Sweep£150
TEKTRONIX 465B Dual Trace 100MHz Delay Sweep£125
TEKTRONIX 465 Dual Trace 100MHz Delay Sweep£95
PHILIPS PM3209 Dual Trace 40MHz Delay£125
PHILIPS PM3215 Dual Trace 50MHz£75
KENWOOD CS4035 Dual Trace 40MHz£50
PANASONIC VP5564A Dual Trace 40MHz£50
HITACHI V525 Dual Trace 50MHz Cusors£95
HITACHI V523 Dual Trace 50MHz Delay
HITACHI V425 Dual Trace 40MHz Cursors£75
HITACHI V422 Dual Trace 40MHz£60
HITACHI V223 Dual Trace 20MHz Delay£60
HITACHI V222 Dual Trace 20MHz£50
HITACHI V212 Dual Trace 20MHz£50
FARNELL DTV12-14 Dual Trace 12MHz£40
STORAGE
PHILIPS PM3320 Dual Trace 200MHz 250Ms/S£300
LECROY 9400 Dual Trace 125MHz£325
LECROY 9400 Dual Trace 125MHz£325 TEKTRONIX 468 Dual Trace 100MHz Delay Sweep Digital
Storage
VELLEMAN HPS5 1MHz 5MHz Sampling. Handheld Unused £60
ANALYSERS
ANALISENS
ADVANTEST R3265A 100Hz-8GHz£4500

TEKTRONIX 492P 50kHz-21GHz HP8560A 50Hz-29GHz Buill In Tracking Gen HP 8560A 10Hz-22GHz HP 8565A 10MHz-22GHz HP 8565A 10MHz-22GHz HP 8565A 10MHz-22GHz HP 8565A 10MHz-21GHz HP 182T with 8555B 100kHz-1500MHz

TEKTRONIX 492P 50kHz-21GHz

### HP 182T with 8557A 10kHz-350MHz . HP 140T with 8555A 10MHz-18GHz ... ADVANTEST TR4131 10kHz-3.5GHz ... £300-£400 .£500 .£950 WAYNE KERR SSA1000A 150kHz-1GHz £950 MARCONI 2382 200Hz-400MHz High Resolution £1250 ....£500

£275 eep£125 ep£130 ep£150 – Autoset £200 Autoset £150 ep£125	MARCON 2382 200H2-400MH2 High Resolution . £1250 MARCON 2370 3012-1100MH2
£150 eep£175	SIGNAL GENERATORS
ep£150 eep£155 eep£95 £50 £50 £50 £50 £60 £60 £50	HP 8350B Sweeper with 83592B 10MHz-20GHz         £1500           HP 8350A Sweeper with 83592h 10MHz-20GHz         £1250           HP 8350A Sweeper with 83592h 10MHz-20GHz         £1250           HP 8350B Min Frame Only         £125           HP 8352B RF Plug-in for 8350 0.01-8.4GHz         £500           HP 83520B RF Plug-in for 8350 2-20GHz         £800           HP 8650C Sig Gen 2.6GHz         £450           HP 8660C Sig Gen 2.6GHz         £750           HP 86602B 200MHz         £750           HP 8662C 300 C 1.2600MHz         £           HP8662T 8.0MH Section for 8660C         £           HP8662B Modulation Section for 8660C         £           HP8662T 8.0MH Section for 8660C         £           HP8662T 8.0MH Section for 8660C         £           LIKE 660B AMF MS no Sig Gen 1.04Hz-1050MHz         £320           LEADER LS6221B Sig Gen 25-950MHz         £300           HP 85658 Synthesised 0.1-960MHz         £500           HP 85658 Synthesised 0.1-960MHz         £500           HP 85658 Synthesised 0.1-960MHz         £500           HP 85658 Synthesised 0.1-960MHz         £400           HP 85658 Synthesised 0.1-360MHz         £400
£300 £325 Sweep Digital	HP 8640A         AM/FM 500kHz-512MHz         £150           HP 8620C         Sweep Osc with 86290B 2-18.6GHz         £500           HP8620C Sweep Osc with 86222B 0.01-2.4GHz         £400           HP8620CAMA with any of the following plucins         £150-£200
£200 Id Unused £60	HP 86220A Plug in 10-1300MHz HP 86230B Plug in 1.5-4GHz HP 86230B Plug in 1.7-4.3GHz HP 86240A Plug in 2-8.3GHz HP 86240A Plug in 2-8.45.4GHz HP 86245A Plug in 5.9-12.4GHz
£4500 £2250 £3250	HP86250B Plug in 8-12.4GHz HP 86250D Plug in 8-12.4GHz HP 86260A Plug in 12.4-18GHz
£2950 £950 £750 £1100 £750 £750 £600	MARCONITE2015 AM/FM 10-520MHz         £95           MARCONITE2016 AM/FM 10-6Hz         £95           PHILPS PMS28 1004Hz-100MHz with         200MHz Freq Counter IEEE         £225           PANASONIC VENTDA AM/FM 100Hz-110MHz         FM 0-100Hz         £225           FM 0-100Hz         Ligital Display etc. Unused         £225
lortimer, 933 1111	READING Near Reading RG7 3RS I. Fax: (0118) 933 2375

SPECIAL OFFERS HP 8165A Programmable Signal Source 1MHz-50MHz (Pulse/ Function) HP 3325A Synthesised Function Gen 21MHz HP 3312A Function Gen 0.1Hz-13MHz AM/FM £325 £350 rst etc. .£200 WAVETEK 21 Stabilised Function Gen 11MHz 
 WAVETEK 21 Stabilised Function Gen 11MHz
 2225

 WAVETEK 23 Synthesised Function Gen 12MHz
 1275

 EXACT 529 AM/FM Function Gen 20MHz
 1150

 ANALOGUE 2030 Synthesised Multi Function Waveform 2230
 1215

 THANDER TGS02 ShuesFunction Gen SMHz
 1195

 THANDER TGS02 ShuesFunction Gen SMHz
 1195

 HP 310B Into as 3310A + etc.
 119

 P3 310A Funct Gen 0.0005H2-SMHz SInteSMHz SINteSMHz 1.510
 119

 PHILIPS PMIS132 Function Gen 0.11+2/MHz
 129
 £225 
 PMLIDP BMISS Function Gene ULA Strategy intentity Protection
 201

 PMLIDP BMISS Function Gen ULA-SMAtz
 205

 PMLIDP BMISS Function Gen ULA-SMAtz
 205

 PMLIDP BMISS Function Gen ULA-SMAtz
 205

 PMLIDP BMISS Function Gen ULA-SMAtz
 2750

 PM STATIS AND SMART SUBMISSION FUNCTION FUNCTIO MARCONI SANDERS 6070 Signal Source 12-18GHz MARCONI SANDERS 6070A Signal Source 12-18GHz FLUKE 6011A Synthesised 11MHz £125 .£125 .£125 Colour Bar Generator Video PHILIPS 5514V .£195 BLACK STAR ORION Colour Bar Gen ...... BLACK STAR ORION Later Version Metal Case .£50 .£75

### FREQUENCY COUNTERS/TIMERS EIP 371 Source Locking Microwave Counter 10Hz-18GHz ... EIP 331 Autohet Microwave Counter 825MHz-18GHz ..... £325 HP 5386A Counter 10Hz-3GHz .... FEEDBACK SC230 Counter 1.3GHz .£350 £75 RECUBAR SC200 Conner 13:0+72 RACAL 9916 Cunter 1014-52:00Htz RACAL 9906 Universal Counter 200MHz RACAL 9904 Cunter/Timer 1014Hz RACAL 1991 Counter/Timer 1014Hz MARCON 2437 Frequency Meter 200MHz MARCON 2437 Cunter/Timer 100HHz HP 5340A Automet Microwave Counter 10Hz-18/GHz £75 .£95 £195 .£50

HP 5316A Universal Counter 0-100MHz HPIB	£95
THANDAR TF810 Frequency Counter 5Hz-200MHz Battery	£60
THANDAR TF200 Frequency Meter 10Hz-200MHz 8 digit	
BLACK STAR Meteor 100 Counter 5Hz-100MHz	
BLACK STAR 1325 Counter Timer 1300MHz	£150
BECKMAN UC10A Universal Counter 120MHz	£60
EADER LDC9043 Digital Counter 100MHz	£125

### DIGITAL MULTIMETERS ETC

SOLARTRON 7150 61/2 digit True RMS IEEE£75
SOLARTRON 7150Plus As Above + Temp Measurement £100
DATRON 1065 51/2 digit Autocal AC/DC Resistance IEEE £95
FLUKE 77 31/2 digit Handheld £35
FLUKE 77 Series 2 31/2 digit Handheld £45
FLUKE 8060A 41/2 digit True RMS Handheld£75
BECKMAN HD110 31/2 digit Handheld in Carry Case £30
TTI 1905A 51/2 digit Bench£60
SOLARTRON 7045 41/2 digit Bench
AVO DA116 31/2 digit with Batteries & Leads£20
AVO 8 Mk6 in Ever Ready Case with Leads etc £75
AVO 8 Mk5 with Leads etc£50
RACAL 9301A True RMS RF Millivoltmeter£125
RACAL 9300 True RMS Millivoltmeter 5Hz-20MHz
usable to 60MHz£30
RACAL 9300B as 9300£45
GOODWILL GVT427 Dual Chan AC Millivoltmeter 10mV in
12 ranges 10Hz-1MHz Unused£75
KENWOOD VT176 Dual Chan Millivoltmeter

### POWER SUPPLIES

ARNELL XA35.2T 0-35V 0-2A Twice Digital
FARNELL LT30-2 0-30V 0-2A Twice £110
ARNELL B30/20 30V 20A Variable No Meters
ARNELL B30/10 30V 10A Variable No Meters
EARNELL LT30-1 0-30V 0-1A Twice
FARNELL L30.2 0-30V 0-2A
FARNELL L30.1 0-30V 0-1A
ARNELL E350 0-350V 0-200mA £125
FARNELL D30-2T 0-30V 0-2A Twice Digital£95
HURLBY PL330 0-32V 0-3A Digital (Kenwood badged) £75
THURLBY TS3021S 0-30V 0-2A LCD
THURLBY PL320 0-30V 0-2A Digital£55
TAKASAGO GMO35-3 0-35V 0-3A 2 Meters £45
TAKASAGO TMO35-2 0-35V 0-2A 2 Meters£35
SOLATING TRANSFORMER - Yellow - 500VA with
I3Amp Socket£35

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

£250

Everyday Practical Electronics, December 2006

**STEWART** of

17A King Street, Mortimer, Telephone: (0118) 933 111

www.ste

Open 9am-5.00pm Monday to Friday (other times by arrangement)

# EPE PIC PROJECTS VOLUME 1 MINI CD-ROM

# A plethora of 20 "hand-PICked" PIC Projects from selected past issues of *EPE*

### Together with the PIC programming

software for each project plus bonus articles

### The projects are:

### PIC-Based Ultrasonic Tape Measure

You've got it taped if you  $\dot{\text{PIC}}$  this ultrasonic distance measuring calculator

EPE Mind PICkler

### Want seven ways to relax? Try our PIC-controlled mind machine! PIC MIDI Sustain Pedal

Add sustain and glissando to your MIDI line-up with this inexpensive PIC-controlled effects unit

### **PIC-based MIDI Handbells**

Ring out thy bells with merry tolling – plus a MIDI PIC-up, of course!

### EPE Mood PICker

Oh for a good night's sleep! Insomniacs rejoice – your wakeful nights could soon be over with this mini-micro under the pillow!

PIC Micro-Probe A hardware tool to help debug your PIC software

**PIC Video Cleaner** 

Improving video viewing on poorly maintained TVs and VCRs PIC Graphics LCD Scope

A PIC and graphics LCD signal monitor for your workshop

### PIC to Printer Interface

How to use dot-matrix printers as data loggers with  $\ensuremath{\mathsf{PIC}}$  microcontrollers

### PIC Polywhatsit

A novel compendium of musical effects to delight the creative musician

### PIC Magick Musick

Conjure music from thin air at the mere untouching gesture of a fingertip

PIC Mini-Enigma Share encrypted messages with your friends — true spymaster entertainment

### PIC Virus Zapper

Can disease be cured electronically? Investigate this controversial subject for yourself

### PIC Controlled Intruder Alarm

A sophisticated multi-zone intruder detection system that offers a variety of monitoring facilities

**PIC Big-Digit Display** Control the giant ex-British Rail platform clock 7-segment digits that are now available on the surplus market

### **PIC Freezer Alarm**

How to prevent your food from defrosting unexpectedly **PIC World Clock** 

Graphically displays world map, calendar, clock and global time-zone data

### **PICAXE** Projects

A 3-part series using PICAXE devices – PIC microcontrollers that do not need specialist knowledge or programming equipment

### PIC-based Tuning Fork and Metronome

Thrill everyone by at long last getting your instrument properly tuned!

### Versatile PIC Flasher

An attractive display to enhance your Christmas decorations or your child's ceiling

Use your browser to open 0 (c) 1988 - 2003 TexhBise Interactive & Wintome Publishing Ltd

INCLUDING

ONLY

VAT and P&P

Vol 1

Vol 2 Vol 3

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

NOTE: The PDF files on this CD-ROM are suitable to use on any PC with a CD-ROM drive. They require Adobe Acrobat Reader.

# EPE PIC PROJECTS CD-ROM ORDER FORM

Please send me (quantity) EPE PIC PROJECTS VOL 1 CD-ROM
Price £14.45 each - includes postage to anywhere in the world.
Name
Address
····· Post Code ·····
$\Box$ I enclose cheque/P.O./bank draft to the value of £ $\hdots \ldots \ldots$
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)
Start Date 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. Email: 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.
Send a copy of this form, or order by letter if you do not wish to cut your issue.

# **BECOME A PIC PROJECT BUILDER WITH THE HELP OF EPE!**

FREE Two booklets (Identifying Electronic Components and Understanding Active Components) and a Circuit Surgery CD-ROM with 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 oscilloscop

ONLY £12.45 including VAT and p&p

THE AMATEUR SCIENTIST 3-0 CD-ROM The complete collection of The Amateur Scientist arti-cles from *Scientific American* magazine. Over 1,000

cles from Scientific American magazine. Over 1,000 classic science projects from a renowned source of winning projects. All projects are rated for cost, difficul-ty 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.

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

Order code ASICD-ROM CD-ROM £19.95

# 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 profession-al engineers or designers, students or hobbyists.

167 pages	Order code BP44	£5.49

### POWER SUPPLY PROJECTS

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, volt-age step-up circuit and a simple inverter. 49

91 pages	Order code BP76	£5.4
		-

### HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT R. A. Penfold

This book explains the basic function of an oscilloscope 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, includ-ing signal generators, logic probes, logic pulsers and crystal calibrators

104 pages

Order code BP267

# DIRECT BOO SERVIC

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

### ELECTRONIC PROJECT BUILDING FOR REGINNERS

R. A. Penfold

Ch

This book is for complete beginners to electronic project building. It provides a complete introduction to the practi cal 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

104 pages



### TEST FOUIPMENT 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 wing 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.



### COMPUTING FOR THE OLDER GENERATION

IOMPUTI

Jin Gatenby Especially written for the over 50s, using plain English and avoiding technical jargon. Large clear type for easy

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 holi-days 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.

### Order code BP601 308 pages

### 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

to join the local computer class. This book explains how to use your PC on the Internet

Inis book explains now 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 our which On ling choosing and home banking. Setting 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 effi-cient 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.

### Order code BP300

### 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.

Order code BP278	£4.00

£4.45

### 25 SIMPLE INDOOR AND WINDOW AERIALS E. M. Noll

E. M. NoIl 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 errected. 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 experiresults. However, with some additional effort and experi-mentation 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.

> Order code BP136 £2.25

### TICKLING THE CRYSTAL Domestic British Crystal Sets of the 1920's Ian L. Sanders

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 peri-od 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 guality photographs and a wealth of previously unpublished al, it cannot fail to be an invaluable reference for any one interested in the history of early wireless receivers.

256 pages hardback

Order code TC1 £34.00

£5.49



72 pages

50 pages

# THEORY AND REFERENC

### 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 knowl-edge 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, resis-tance, capacitance and inductance; Semiconductors; primitive logic functions; Binary arithmetic; Boolean alge-bra; Karnaugh maps; State diagrams, tables and machines; Analog-to-digital and digital-to-analog; Integrated dircuits (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

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 begin-nings 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, infor-mative 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 experi-ence is assumed. Using these simple component and circuit testing techniques the reader should be able to con-fidently tackle servicing of most electronic projects.



### DIGITAL GATES AND FLIP-FLOPS lan R. SInclair

96 pages

200 pages

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 expla-nation of microprocessor techniques as applied to digital logic.



### 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 elec-tronics, Hardware components and practical work, Micro-controllers and PLCs, Digital broadcasting, Electronic security.

Order code NE21 440 pages £19.99

### IUSIC.

### QUICK GUIDE TO ANALOGUE SYNTHESIS lan Waugh

Even though music production has moved into the digi-Even though music production has moved into the digi-tal domain, modern synthesisers invariably use ana-logue synthesis techniques. The reason is simple – analogue synthesis is flexible and versatile, and it's rel-atively easy for us to understand. The basics are the same for all analogue synths, and you'll quickly be able to adapt the principles to any instrument, to edit existing sounds and create exciting new ones. This book describes: How analogue synthesis works; The essen-tial modules every synthesiser has; The three steps to synthesis; How to create phat bass sounds; How to generate filter sweeps; Advanced synth modules; How to create simple and complex synth patches; Where to

to create simple and complex synth patches; Where to find soft synths on the Web. If you want to take your synthesiser – of the hardware or software variety – past the presets, and program your own sounds and effects, this practical and well-illustrated book tells you what you need to know.

Order code PC118 60 pages £7.45

## QUICK GUIDE TO MP3 AND DIGITAL MUSIC

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-

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.

i0 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 dia-grams. Where appropriate, simple setting up procedures are described in detail; no test equipment is needed.

are described in detait; no test equipment is needed. The projects covered in this book include: Four chan-nel audio mixer, Four channel stereo mixer, Dynamic noise limiter (DNL), Automatic audio fader, Video faders, Video wipers, Video crispener, Mains power supply unit. Order code BP356

109 pages





### 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 regardso revolutionary that most of his contemporaries regard-ed 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 princi-pal 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

During the Second World War, Alah Burnlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H25' – blind-bornbing radar. Tragically, during an experi-mental H2S flight in June 1942, the Halifax bomber in which Blurnlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirty-pith birtded. ninth birthday.

420 pages

### 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 originally to your video recordings, an audio mixer and noise reducer to enhance your sound-tracks 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, shop-ing lists of companyon achies an experturition, and wild

ping lists of components, advice on construction, and guid-ance 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, pushbut-ton fader, computer control interface, 12 volt mains power supply.

		210.00
124 pages	Order code PC115	£5.45

6

Order code NE32 £17.99

# FAULT FINDING. CIRCUITS AND DESIG

### DISCOVERING PICS W.D.Phillips A good introduction to PIC pro-

**BOOK + CDROM** + HARDWARE

gramming, 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 I.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 fre-quency 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	
----------------------------	--

### PIC IN PRACTICE David W. Smith

A graded course based around the practical use of the PIC microcontroller through project work. Principles are intro-Incoordinate in the project work. Principles are into-duced 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; Using inputs; Keypad scanning; Program examples; The 16C54 micro-extended Ubbacureatic displayer. Analogue to disited controller; Alphanumeric displays; Analogue to digital conversion; Radio transmitters and receivers; EEPROM

data memory; Interrupts; The 12C5XX 8-pin microcon-troller; The 16F87X microcontroller; The 16F62X micro-controller; Projects; Instruction set, files and registers; Appendices; Index 272 pages £17.49

### Order code NE39

### COIL DESIGN AND CONSTRUCTIONAL MANUAL B. B. Babani

B. B. Babani A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and trans-formers. 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 profession of the solid explanation for the function of the book of the solid explanation. changed in coil design since it was written.

### Order code BP160 96 pages

### 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 infor-mation and guidance, a college student, a hobbyist building a project from a magazine, or simply a keen self-taught ama-teur 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

I ne fundamentai 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.

Order code NE22

£25 99

£4.49

### **OPERATIONAL AMPLIFIER USER'S HANDBOOK** R. A. Penfold

274 pages

120 pages

H. A. Periodo The first part of this book covers standard operational amplifer based "building blocks" (integrator, precision rectifier, function generator, amplifiers, etc), and consid-ers 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 mod-ern 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 pre-amplifier, 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.

Order code BP335

£5.45

# BOOK ORDERING DETAILS

£5.49

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 elivery - more for overseas orders. Please check price and availability (see latest issue of deliverv 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:
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

A REGINNERS 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, invert-ers 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.



### BUILDING VALVE AMPLIFIERS Morgan Jones

368 pages

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.

Order code NE40

£21.99

### AUDIO AMPLIFIER PROJECTS R. A. Penfold

A wide range of useful audio amplifier projects, each A white failing of useful adult adult aniphier project features a circuit diagram, an explanation of the circuit operation and a stripboard layout diagram. All constructional details are provided along with a shop-ping 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 straight-

The property and the projects are designed for straight-forward 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 pre-amplifier, 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

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 head-phones, one for loudspeakers.

288 pages

Order code NE33

£32.99

# b servic

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. 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/shopdor.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.

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 our website.

Boards can only be supplied on a payment with order basis.

PROJECT TITLE	Order Code	Cost
★PIC Ultrasonic Scanner       JUN '05         ★Radio Control Model Switcher       Back-To-Basics 3 – Scarecrow         - Digital Lock       CompactFlash Interface Board	503 504 505 506 507	£6.66 £5.87 £5.55 £6.66 £6.66
LF/VLF Converter JUL '05 − Fixed Capacitor Board − Mixer/Oscillator Board − Buffer Amplifier − Q-Multiplier − Tuning Capacitor Board Back-To-Basics 4 – Doorchime − Electronic Dice ★ Cybervox Multi-Clap Switch	508 509 511 406 512 513 514 515	£5.71 £5.86 £5.23 £5.23 £4.28 £6.34 £6.02 £6.82 £6.66
Audio System AUG '05 – Preamplifier – Mic. Supply Board – Power Amp ★ Pain Monitor MotorAmp Back-To-Basics 5 – Kitchen Timer – Room Thermometer	516 517 518 519 520 521 522	£6.02 £5.23 £6.02 £7.14 £7.45 £5.87 £6.02
All-Band Radio – Full Version     SEPT '05       - Mini Version     ★ Multicore Cable Tester – Main       - Active     Back-To-Basics 6 – Daily Reminder       - Whistle Switch     ★ Model Railway Signal Control       ★ Snooker/Darts Scoreboard     ★ Snooker/Darts	523 524 525 526 527 528 529 530	£5.71 £5.23 £6.19 £5.55 £6.19 £5.87 £6.19 £8.72
Photic Phone – Transmitter – Receiver Back-To-Basics 7 – Parking Radar – Telephone Switch ★ Haloween Howler ★ PIC-Based USB Interface	531 532 533 534 535 536	£6.98 £5.71 £5.55 £6.02 £6.19
<ul> <li>★ PIC Chromatone</li> <li>NOV '05</li> <li>Back-To-Basics 8 – Noughts and Crosses Enigma</li> <li>– Weather Vane Repeater</li> <li>★ Multi-Function R/C Switch</li> <li>★ Speed Camera Watch Mk2</li> </ul>	537 538 539 540 541	£6.82 £6.66 £6.18 £5.87 £6.35
Solid-State Valve Power Supply     DEC '05       ★ Vehicle Frost Box Mk2     ★ Propeller Monitor       Solid-State Hammond     Solid-State Hammond	542 543 544 545	£6.35 £5.71 £6.02 £6.18
<ul> <li>★ PIC Ambilux</li> <li>Sunset Switch</li> <li>Current Clamp Adaptor for Multimeters</li> <li>★ Tiptronic-Style Gear Indicator         <ul> <li>Micro Board</li> <li>JAN '06</li> </ul> </li> </ul>	546 547 548 549 per	£5.71 £6.98 £5.39
<ul> <li>Display Board</li> <li>Hall Speed Board</li> </ul>	550 551	£7.61
★ Keypad Alarm 3-Way Active Crossover Jazzy Heart Status Monitor- Transmitter - Reciever	552 553 554 555 556	£6.02 £9.20 £6.02 £7.61
Power Up Video/Audio Booster (double-sided) ★Telescope Interface	557 558 559	£6.82 £12.00 £6.50
'Smart' Slave Flash APR '06 Programmable Continuity Tester	560 561	£6.18 £5.87
PortaPAL APR '06 - Microphone Board - Auxilary Board - Main Board - Charger Board Omni Pendulum	562 563 564 565 566	£6.18 £5.87 £8.56 £6.66 £6.34

PROJECT TITLE	Order Code	Cost
Smart Card Reader/Programmer         MAY '06           LED Lighting For Your Car (set of 15 boards)         Digital Reaction Timer	567 568 569	£7.61 £14.75 £7.13
Poor Man's Metal Locator JUN '06 ★ Digital Instrument Display for Cars - Micro Board - Display Board Widgy Box Phone Ring & Test	570 571 572 573 573 574	£5.71 £7.77 £7.29 £6.82
★Sudoku Unit JUL '06 PC Power Monitor	575 576	£6.66 £6.50
Home Theatre Sound Level Checker Adjustable DC-DC Converter For Cars ★ Telephone Dialler For Buglar Alarms ★ High Intensity Torch	577 578 579 580	£6.66 £6.50 £6.97 £5.39
★ Low Cost 50MHz Frequency Meter Version 1 Version 2 Version 3 Smart Mixture Display for your Car Water Level Gauge – Sensor – Display	581 582 583 584 585 586	£6.66 £6.66 £6.66 £6.50 £6.98
Fridge Door-Open Alarm OCT '06 Linear Supply For 1W Star LEDs (Pair) Through-Glass Alarm	587 588a & b 589	£5.71 £6.50 £7.61
Quick Brake     NOV '06       Studio 350 Power Amplifier     Micropower Battery Protector       ★ Giant LED Message Display – Master     Slave	590 591 592 594 595	£6.50 £9.51 £5.71 £5.55 £6.50
Lapel Microphone Adaptor DEC '06 RGB To Component Video Converter (double sided) USB Power Injector ★Mind Trainer	593 596 597 598	£6.18 £12.69 £5.87 £6.50

# 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 PRINTE	D CIRCUI	T BOARD S	ERVICE
Order Code	Project	Quantity	Price
Name			
Address			
Tel. No			
I enclose payment o			
VISA Prac	Every tical Ele		Deers Cut Deersativest
Concerning and the second s	erCard, Ame Visa or Swite		
Card No			
Valid From	Exp	iry Date	
Card Security Coo (The last 3 digits of	de on or just unde	Maestro Issue er the signature	e No strip)
Signature			
	so order p.c.b.s b Web site on a se	y phone, Fax, Ema cure server:	ail or via our
http://www.ep	emag.wimbor	ne.co.uk/shop	door.htm

**VOLUME 35 INDEX** 

JANUARY 2006 TO DECEMBER 2006

The No 1 UK Magazine for Electronics Technology& Computer Projects

CONSTRUCTIONAL PROJECTS

EVERYDAY PRACTICAL

T

1W STAR LEDs, LINEAR SUPPLY FOR 3-WAY CROSSOVER FOR LOUDSPEAKER SYSTEMS, ACTI 13-5V, 17A HIGH CURRENT BENCH SUPPLY 50MHz FREQUENCY METER, LOW-COST ACTIVE 3-WAY CROSSOVER FOR LOUDSPEAKER	Oct 46 Feb 22 Jul 31 Sept 10
ADAPTOR FOR MULTIMETERS, CURRENT CLAMP ADAPTOR FOR MULTIMETERS, CURRENT CLAMP ADAPTOR FOR PA SYSTEMS, LAPEL MICROPHONE ADDRESS AMPLIFIER, PORTAPAL PUBLIC ADJUSTABLE DC-DC CONVERTER FOR CARS	Feb 22 Jan 60 Dec 38 Mar 10, Apr 30
by John Clarke	Aug 34
ALARM, FRIDGE, DOOR-OPEN	Oct 22
ALARM, HIGHLY FLEXIBLE KEYPAD	Feb 10
ALARMS, THROUGH-GLASS	Oct 31
ALARMS, TELEPHONE DIALLER FOR BURGLAR	Aug 22
AMBILUX, PIC	Jan 40
AMPLIFIER MODULE, STUDIO 350 POWER	Oct 10, Nov 54
AMPLIFIER, PORTAPAL PUBLIC ADDRESS	Mar 10, Apr 30
BATTERY PROTECTOR, MICROPOWER	Nov 44
CONTINUITY TESTER, PROGRAMMABLE CONVERTER FOR CARS, ADJUSTABLE DC-DC CONVERTER, RGB TO COMPONENT VIDEO CROSSOVER FOR LOUDSPEAKER SYSTEMS, ACTIVE 3-W CURRENT BENCH SUPPLY, DIRT CHEAP HIGH	Jul 31 Mar 62 Nov 24 Aug 22 May 54 May 28 Nov 24 Sept 26 Jan 10 Aug 34 Jun 18, Jul 34 Jul 31 Jan 60 Ayr 10 Aug 34 Dec 18 AY Feb 22 Jul 31
CURRENT CLAMP ADAPTOR FOR MULTIMETERS by John ( DC-DC CONVERTER FOR CARS, ADJUSTABLE DIALLER FOR BURGLAR ALARMS, TELEPHONE DIGITAL INSTRUMENT DISPLAY FOR CARS by John Clarke DIGITAL REACTION TIMER by Jim Rowe DIRT CHEAP HIGH CURRENT BENCH SUPPLY by Col Hodgson, VK2ZCO DISPLAY FOR CARS, DIGITAL INSTRUMENT DISPLAY FOR YOUR CAR, SMART MIXTURE	Clarke Jan 60 Aug 34 Aug 22
DISPLAY, GIANT LED MESSAGE	Nov 10
DISTORTION EFFECTS FOR YOUR GUITAR, WIDGY BOX	Jun 30
DOOR-OPEN ALARM, FRIDGE	Oct 22
EFFECTS FOR YOUR GUITAR, WIDGY BOX DISTORTION	Jun 30
FLASH TRIGGER, SMART SLAVE	Apr 60
FLEXIBLE KEYPAD ALARM, HIGHLY	Feb 10
FREQUENCY METER, LOW-COST 50MHz	Sept 10
FRIDGE DOOR-OPEN ALARM by John Clarke	Oct 22
GAME, MIND TRAINER	Dec 50
GAUGE, WATER LEVEL	Sept 62
GEAR INDICATOR, TIPTRONIC-STYLE	Jan 10
GIANT LED MESSAGE DISPLAY by John Becker	Nov 10
GUITAR, WIDGY BOX DISTORTION EFFECTS FOR YOUR	Jun 30
HEART, JAZZY	Feb 66
HIGH CURRENT BENCH SUPPLY, DIRT CHEAP	Jul 31
HIGH INTENSITY TORCH by Gerard Samblancat	Aug 60
HIGHLY FLEXIBLE KEYPAD ALARM by John Clarke	Feb 10
HOME THEATRE SYSTEMS, LOUDSPEAKER LEVEL METEF	FOR Aug 10
HOME THEATRE, VIDEO-AUDIO BOOSTER FOR THE	Mar 62
HOUND, NAIL SNIFFER AND VOLTS	May 20
HUMAN-POWERED LED TORCHES by Julian Edgar	Sept 36
INDICATOR, TIPTRONIC-STYLE GEAR	Jan 10
INJECTOR, USB POWER	Dec 10
INSTRUMENT DISPLAY FOR CARS, DIGITAL	Jun 18, Jul 54
INTENSITY TORCH, HIGH	Aug 60
INTERFACE, TELESCOPE	Mar 22
JAZZY HEART by Thomas Scarborough	Feb 66
KEYPAD ALARM, HIGHLY FLEXIBLE	Feb 10
LAPEL MICROPHONE ADAPTOR FOR PA SYSTEMS by John	n Clarke Dec 38
LED FLASHER, JAZZY HEART	Feb 66
LED LIGHTING FOR YOUR CAR by Peter Smith	May 28
LED MESSAGE DISPLAY, GIANT	Nov 10
LED TORCHES, HUMAN-POWERED	Sept 36
LED TORCH, HIGH INTENSITY	Aug 60
LEDs, LINEAR SUPPLY FOR 1W STAR	Oct 46
LEVEL GAUGE, WATER	Sept 62
LEVEL METER, LOUDSPEAKER	Aug 10
LIGHT-SENSING LED DISPLAY, PIC AMBILUX	Jan 40
LIGHTING FOR YOUR CAR, LED	May 28

LINEAR SUPPLY FOR 1W STAR LEDs by Peter Smith		Oct 46
LOCATOR, POOR MAN'S METAL LOUDSPEAKER LEVEL METER by John Clarke	Ä	Jun 10 Aug 10
LOUDSPEAKER SYSTEMS, ACTIVE 3-WAY CROSSOVER F		Aug 10 Feb 22
LOW-COST 50MHz FREQUENCY METER by John Clarke		ept 10
MESSAGE DISPLAY, GIANT LED METAL LOCATOR, POOR MAN'S		Nov 10 Jun 10
METER, LOUDSPEAKER LEVEL		Aug 10 ept 10
METER, LOW-COST 50MHz FREQUENCY MICROPHONE ADAPTOR FOR PA SYSTEMS, LAPEL		ept 10 Dec 38
MICROPOWER BATTERY PROTECTOR by Peter Smith	Ν	lov 44
MIND TRAINER by Bart Trepak MIXTURE DISPLAY FOR YOUR CAR, SMART	S	Dec 50 ept 26
MODULE, STUDIO 350 POWER AMPLIFIER	Oct 10, N	lov 54
MONITOR, PC POWER MONITOR, STATUS		Jul 22 Feb 40
MULTIMETERS, CURRENT CLAMP ADAPTOR FOR		Jan 60
NAIL SNIFFER AND VOLTS HOUND		lav 20
by Edwin Chicken MBE MSc OMNI PENDULUM by Thomas Scarborough		/lay 20 Apr 19
PA SYSTEMS, LAPEL MICROPHONE ADAPTOR FOR		Dec 38
PC POWER MONITOR by Jim Rowe		Jul 22
PENDULUM, OMNI PHONE RING AND TEST by Terry de Vaux-Balbirnie		Apr 19 Jun 56
PIC AMBILUX by John Becker		Jan 40
PIC CONTROLLED LED TORCH, HIGH INTENSITY PIC SUDOKU UNIT by John Becker		Aug 60 Jul 10
POOR MAN'S METAL LOCATOR by Thomas Scarborough		Jun 10
PORTAPAL PUBLIC ADDRESS AMPLIFIER by John Clarke and Leo Simpson	Mar 10, /	Apr 30
POWER AMPLIFIER MODULE. STUDIO 350	Oct 10, N	Vov 54
POWER INJECTOR, USB POWER MONITOR, PC		Dec 10 Jul 22
POWER UP by John Clarke	N	Mar 38
PROGRAMMABLE CONTINUITY TESTER by Trent Jackson PROGRAMMER, SMART CARD READER AND	Ń	Apr 10 ⁄Iay 54
PROTECTOR, MICROPOWER BATTERY	Ν	Vov 44
	Mar 10, 1	
QUICK BRAKE by Julian Edgar and John Clarke		Nov 24
RADIO RECEIVER, TRF REACTION TIMER, DIGITAL		ept 44 /lay 10
READER AND PROGRAMMER, SMART CARD RGB TO COMPONENT VIDEO CONVERTER by Jim Rowe		/lay 54 Dec 18
RING AND TEST, PHONE		Jun 56
SLAVE FLASH TRIGGER, SMART		Apr 60
SMART CARD READER AND PROGRAMMER by Peter Smith SMART MIXTURE DISPLAY FOR YOUR CAR	n N	<i>l</i> lay 54
by Julian Edgar & John Clarke		ept 26
SMÅRT SLAVE FLASH TRIGGER by Jim Rowe SNIFFER AND VOLTS HOUND, NAIL		Apr 60 ⁄lay 20
STAR LEDs, LINEAR SUPPLY FOR 1W	(	Oct 46
STATUS MONITOR by Terry de Vaux-Balbirnie STUDIO 350 POWER AMPLIFIER MODULE	r	Feb 40
by Leo Simpson and Peter Smith SUDOKU UNIT, PIC	Oct 10, N	Vov 54 Jul 10
SUNSET SWITCH by John Clarke		Jan 26
SUPPLY FOR 1W STAR LEDs, LINEAR SUPPLY, DIRT CHEAP HIGH CURRENT BENCH		Oct 46 Jul 31
SWITCH, POWER UP	N	Mar 38
SWITCH, SUNSET SYSTEMS, ACTIVE 3-WAY CROSSOVER FOR LOUDSPEAK		Jan 26 Feb 22
TELEPHONE DIALLER FOR BURGLAR ALARMS		60 22
by Leon Williams	4	Aug 22
TELÈSCOPE INTERFACE by John Becker TEST, PHONE RING AND		Mar 22 Jun 56
TESTER, PROGRAMMABLE CONTINUITY		Apr 10
THEATRE, VIDEO-AUDIO BOOSTER FOR THE HOME THROUGH-GLASS ALARM	P.	Mar 62
by Godfrey Manning BSc MB BS G4GLM		Oct 31
TIMER, DIGITAL REACTION TIPTRONIC-STYLE GEAR INDICATOR by John Clarke	N.	/lay 10 Jan 10
TORCH, HIGH INTENSITY	A	Aug 60
TORCHES, HUMAN-POWERED LED TRAINER, MIND		ept 36 Dec50
TRF RADIO RECEIVER (Teach-In '06) TRIGGER, SMART SLAVE FLASH		ept 44 Apr 60
UP. POWER		Mar 38
USB POWER INJECTOR by Jim Rowe		Dec 10
VIDEO-AUDIO BOOSTER FOR THE HOME THEATRE by Jim		Mar 62
VIDEO CONVERTER, RGB TO COMPONENT VOLTS HOUND, NAIL SNIFFER AND		Dec 18 /lay 20
WATER LEVEL GAUGE by Terry de Vaux Balbirnie		ept 62
WIDGY BOX DISTORTION EFFECTS FOR YOUR GUITAR by Peter Smith		Jun 30
_,		

### SPECIAL SERIES

C FOR PICs by Mike Hibbett PART 1: Introduction, overview and getting started PART 2: Creating Programs	Nov 32 Dec 28
CIRCUIT SURGERY by lan Bell Common Mode Rejection Ratio Connected transistor pairs Driving multiple LEDs Logic Level Conversion More On Extending PIC Output Capabilities More on gain and impedance calculations More on timing formulae for 555 timers Op amp Output Capabilities Schmitt Trigger Circuits Shift registers can extend PIC output capabilities Timing Formulae for 555 Timers Oct 56	Sept 54 Feb 38 May 25 Aug 52 Apr 27 Jan 36 Nov 64 Jun 65 Jul 61 Mar 68 6, Dec 56
INGENUITY UNLIMITED 1000 Year Flasher Adjustable Touch Switch Aug 40 Automatic Doorbell May 67 Clipping Indicator for the STA7360 Feb 20 Disco Light Nov 41 Dog Alert Magic Bulb Jul 40 Pico Prize Winners Random Colour Generator Simple FM Radio Simple FM Radio Solar Radio Solar Radio Solar Radio Sound Effects Generator Super Vibration Switch Switch Mode LED Unit	Dec 37 Mar 70 0, Aug 40 Mar 70 Oct 40 Jan 24 Jun 52 Sept 34 Apr 28 Jun 51 Oct 41
INTERFACE by Robert Penfold Boosting output currents Exploring the graphics capability of Visual Basic 2005 Express Improving the input voltage span from an A/D converter PC interfacing software Visual approach to producing virtual controls More on a visual approach to producing virtual controls	Apr 54 Dec 26 Feb 58 Jun 28 Aug 18 Oct 28

32 28	PIC N' MIX by Mike Hibbett (unless marked) Experimenting with overclocking PICs More about using MultiMedia cards with PICs	Apr 25 Dec 26
54	MultiMedia cards have serious storage capacity for PIC projects Multiplexing – a trick or two PIC and software reliability	Nov 22 Jul 20 May 68
38 25 52 27		Jun 16 Aug 32 Sept 58
36 64	Understanding PIC datasheets Using SPI bus devices Jan 33, Using the RS485 protocol for series comms	Oct 20 Feb 33 Mar 33
65 61 68	PLEASE TAKE NOTE Halloween Howler (OCt '05) Magic Bulb (//U Jul '06)	Sept 9 Aug 40
56	PRACTICALLY SPEAKING by Robert Penfold Basic project building and soldering problems	Jul 28
37	Capacitor types and selection More on front panel overlays using a PC Mounting electronic components	May 49 Mar 56 Nov 30
	Producing front panel overlays using a computer	Sept 22 Jan 57
70 40	TEACH-IN 2006 by Mike Tooley BA	
70	Part 3: Charge and Capacitance, Introducing Capacitors	Jan 50
40 24 52	Part 4: Semiconductors, Introducing Diodes Part 5: Introducting Magnetism and Inductance, Introducing Inductors, Transformers, Rectifiers and Voltage Regulation	Feb 50 Mar 48
34 28 51	Part 6: Transistors: types, operation, and characteristics. Basic concepts of amplifiers: gain, frequency response and bandwidth.	
41	Some practical amplifier circuits Part 7: Test and Measurement: Meters, Ohmmeters, Oscilloscopes,	Apr 44
54 26	Waveforms, Distortion and Frequency Response Testing. Part 8: Digital Electronics: Introducing logic circuits; logic families;	May 40
58	logic gates	Jun 42
28 18	Part 9: Bistable Investigation: Microprocessors and Microcontrollers Part 10: PIC Microcontrollers and Operational Amplifiers	Jul 42 Aug 42
28		Sept 44

## **REGULAR FEATURES**

EDITORIAL	Monthly
NET WORK - THE INTERNET PAGE surfed by Alan Winstanley A slipped disk Anti-virus and anti-spam plus Google conversions Gone phishing; CallingID toolbar It's good to talk; Voice on the Net; Simply Skype Let's start with Skype! MSN Messenger Recycle risk confirmed; A better VNC;IP cameras Route to your network; As easy as VNC The phone age? Tried the <i>EPE Chatzone</i> ? VoIP phones; Video stars Webcam security system	Oct 60 Jan 36 Apr 73 May 64 Aug 70 Dec 59 Nov 70 Jul 68 Feb 36 Jun 68 Sept 72
NEWS plus reports by Barry Fox	Monthly
READOUT addressed by John Becker	Monthly

# TECHNO TALK by Mark Nelson An XMAX tale Banned substances Jan 22 Dec 14 Mar 20 Nov 21 May 18 Apr 16 Oct 18 Feb 18 Sept 20 Aug 16 Jul 18 Body cells Day of the RFIDs Extreme electronics Externe electronics Funny facts about the mains Mushroom magic and the quest for green volts Pronounced guilty without trial Simply confused, or not so soure? Strange but true Terahertz: the anti-terrorism solution? The memory lingers on Jun 26

### GENERAL FEATURES

CONSUMER ELECTRONICS SHOW REVIEWED by Barry Fox E-CHIP REVIEW by Robert Penfold Apr 24 Apr 68

*Monthly* Jan 74 Feb 64, Apr 52, Jun 76, Jul 76, Aug 76, Oct 54, Nov 50, Dec 46 ADVERTISERS INDEX BACK ISSUE CD-ROMS BACK ISSUES PRINTED CIRCUIT BOARD SERVICE PIC PROJECTS CD ROM PIC RESOURCES CD-ROM CD-ROMS FOR ELECTRONICS DIRECT BOOK SERVICE Monthly monthly, except Sept **PICSTART Plus Competition** ELECTRO ELECTRONICS ELECTRONICS ELECTRONIC GEAR INDICATOR YPAB ALS BRIE O iiiiii ELECTRONICS ELECTRONICS ELECTRONICS ELECTRONIC: ELECTRONICS

THRE HISPLAT

1111:



ELECTRONICS MANUALS

Feb 70, Apr 67, Jul 67, Aug 65, Oct 45, Dec 60 Nov 77, Dec 64 Feb 77, Apr 51, Sept 60, Oct 59, Nov 52, Dec 48 Oct 53, Nov 68



ELECTRONICS



Everyday Practical Electronics reaches twice as many UK readers as 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 one 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.



### 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

# RSHELECTRONICS

ELECTRONIC COMPONENTS & KITS Component Packs from £1.00 Stripboard Project Kits from £1.45 P&P £2.50 (orders over £25 Free P&P) A wide range of popular components. No Minimum Order. No Sign-up. No VAT.

Visit our easy to use website www.rshelectronics.co.uk

### SAFFRON ELECTRONICS LTD

Suppliers of High Quality Electronic Components 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 16 Field Street, Cannock, Staffs. WS11 5QP Telephone: 0845 166 2314 (local rate)

### **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 600 stamp for catalogue

### Interesting electronics Www.astik.net

Electronic plans that work, Keyloggers, and other stuff



### 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

www.herostechnology.co.uk

Introducing Modular Concept for microcontrollers. Suitable for Developers, Pre-production, Educational and Hobby applications.

- WinPIC2006 USB full speed programmer.
- CPU microcontroller modules.
- Peripheral modules for all microcontrollers.

# 

Transformers and Chokes for all types of circuits including specialist valve units Custom design or standard range High and low voltage

Variable Voltage Technology Ltd Unit 3, Sheat Manor Farm, Chillerton, Newport, Isle of Wight, PO30 3HP Tel: 0870 243 0414 Fax: 01983 721572 email: sales@vvt-cowes.freeserve.co.uk

www.vvttransformers.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 COMPO-NENTS 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 in diameter and be six inches long or more, will pay good money for the rods. Contact Peter Tankard on 0114 2316321 between 9am and 10pm.

<sup>1</sup>/<sub>2</sub> **PRICE VALVES** Over 1480 different valve numbers. Catalogue available for £1, refundable on 1st order. W. Burcher, 676 Foxhall Road, Ipswich, Suffolk, IP3 8NQ. Tel: 01473 272218

CHAFFINCH ENGINEERING. Services to the electronics enthusiast and experimenter in science and technology. Custom made: spindles, pulley-wheels, small gear trains, probe bodies, mounting plates, mounting brackets, knobs, screws, nuts, washers etc.. Enclosures modified and assembled, to your requirements. One-off and short or long runs no problem. Cheap rates. Free quotations. Telephone: 020 8898 0933, any time, and leave a message.



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)

# Europe's Largest Surplus Store

## 20,000,000 Items on line NOW ! New items added daily

Established for over 25 years, UK company Display Electronics prides itself on offering a massive range of electronic and associated electro-mechanical equipment and parts to the Hobbyist, Educational and Industrial user. Many current and obsolete hard to get parts are available from our vast stocks, which include:

- 6,000,000 Semiconductors
- ◆ 5,000 Power Supplies
- ◆ 25,000 Electric Motors
- 10,000 Connectors
- 100,000 Relays & Contactors
- 2000 Rack Cabinets & Accessories
- ◆ 4000 Items of Test Equipment
- ♦ 5000 Hard Disk Drives

# www.distel.co.uk

Display Electronics 29 / 35 Osborne Road Thornton Heath Surrey UK CR7 8PD Telephone [44] 020 8653 3333 Fax [44] 020 8653 8888

### **Rechargeable Batteries With Solder Tags**

### NIMH

NICAD

AA 2000mAh C 4Ah	£2.82 £4.70	AA 650mAh C 2.5Ah	£1.41 £3.60
D 9Ah	£7.60	D 4Ah	£4.95
	£4.95		

Instrument case with edge connector and screw terminals

Size 112mm x 52mm x 105mm tall

This box consists of a cream base with a PCB slot, a cover plate to protect your circuit, a black lid with a 12 way edge connector and 12 screw terminals built in (8mm pitch) and 2 screws to hold the lid on. The cream bases have minor marks from dust and handling price  $\pounds 2.00 + VAT(=\pounds 2.35)$  for a sample or  $\pounds 44.00+VAT(=\pounds 51.70)$  for a box of 44.





866 battery pack originally intended to be used with an orbitel mobile telephone it contains 10 1.6Ah sub C batteries (42 x 22 dia. the size usually used in cordless screwdrivers etc.) the pack is new and unused and can be broken open quite easily  $27.46 + VAT = \mathbf{$28.77}$ 



Please add  $\pounds$ 1.66 + VAT =  $\pounds$ 1.95 postage & packing per order

JPG Electronics Shaws Row, Old Road, Chesterfield, S40 2RB. Tel 01246 211202 Fax 01246 550959 www.JPGElectronics.com Mastercard/Visa/Switch Callers welcome 9.30 a.m. to 5.30 p.m. Monday to Saturday



### **DEEP CYCLE BATTERY CHARGER**

If deep cycle batteries are not properly charged, they will never be able to deliver their full capacity and their life will be greatly reduced. You can't use a general purpose 12V car battery charger. This 3-step charger is specially designed for deep cycle batteries and will charge at up to 16.6A.

### **BALANCED MICROPHONE PREAMP**

This Balanced Microphone Preamp comes with a 3-band equaliser and is suitable for Karaoke, public address or many other applications. It can run from a plugpack, its own internal 9V battery or phantom power.

### HIGH-EFFICIENCY POWER SUPPLY FOR 1W LUXEON STAR LEDs

Looking for a highly-efficient switchmode power supply to run a 1W Luxeon Star LED from batteries? This easy-tobuild design lets you use a pair of 1.5V 'D' cells and includes brightness control to further extend battery life.

# JANUARY '07 ISSUE ON SALE DEC 14

# ADVERTISERS INDEX

	~~
AGAR	
ANTEX	
AUDON ELECTRONICS	49
BETA-LAYOUT	15
BRUNNING SOFTWARE	55
BULL GROUP	Cover (ii)
BYVAC	49
DISPLAY ELECTRONICS	
EASYSYNC	
EPT SOFTWARE	· · ·
ESR ELECTRONIC COMPONENTS	
JPG ELECTRONICS	
LABCENTER	Cover (iv)
LASER	
LICHFIELD ELECTRONICS	63
MAGENTA ELECTRONICS	5
MILFORD INSTRUMENTS	4
NURVE NETWORKS LLC	
PEAK ELECTRONIC DESIGN	
PICO TECHNOLOGY	25
QUASAR ELECTRONICS	2/3
QUASAR ELECTRONICS	

### **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); £18 (2 years). Expression and a service, £21.75 (6 months); £18.75 (6 months); £66 (2 years). OVERSEAS: Standard air service, £21.75 (6 months); £18.75 (6 months); £18.75 (months); £18.75 (6 months); £18.75 (months); £19.50 (12 months); £19.70 (12 months); £19.70

## SERIAL COMMUNICATIONS SPECIALISTS Test and Measurement Solutions



# featured products



### 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

ANT16 16 channel logic analyzer - probe set extra £195.00

2 channel 1MS/s PC scope, DS1M12 signal generator & data logger

### 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.



### 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

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.

\* NEW LOW PRICE \*\*

### 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.

8 Port Industrial Ethernet RS232 / RS422 / RS485 Serial Server with wall mount bracket and

NETCOM-813 £350.00

PSU.

Single Port high performance Industrial Wireless Ethernet RS232 / RS422 / RS485 Serial Server with PSU and wall mount bracket. Connects wired also.

ES-W-3001-M £125.00

### 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

# PROTEUS ELECTRONIC DESIGN

# FROM CONCEPT

### **ISIS SCHEMATIC CAPTURE**

SCHEMATIC CAPTURE

A powerful capture package tailored for todays engineer and designed to allow rapid entry of complex schematics for simulation and PCB Layout.

EMBEDDED SIMULATION

### PROSPICE MIXED MODE SIMULATOR

PROSPICE

A customised implementation of the industry standard Berkeley SPICE 3F5 engine with extensive optimisations and enhancements for true mixed mode simulation and circuit animation.

### VSM VIRTUAL SYSTEM MODELLING

The worlds first and best schematic based microcontroller co-simulation software. Proteus VSM allows you to simulate the interaction between software running on a microcontroller and any analog or digital electronics connected to it. This streamlines the project lifecycle and obviates the need for expensive hardware analysis tools.

### ARES PCB DESIGN

A modern and professional layout package which seamlessly integrates with the ISIS capture software. Features such as autoplacement and autorouting, interactive DRC and an intuitive interface all serve to maximise productivity and reduce time to market.

### LABCENTER ELECTRONICS LTD.

A technology pioneer in the EDA industry since 1988. Technical support direct from the program authors. Flexible packages and pricing tailored to customer requirements.



CONTACT US NOW to discuss requirements or request a FREE evaluation copy.

PCB DESIGN

Tel: 01756 753440 Fax: 01756 752857 Email: info@labcenter.co.uk

Labcenter Electronics Ltd., 53-55 Main Street, Grassington, North Yorks, BD23 5AA. Registered in England 4692454