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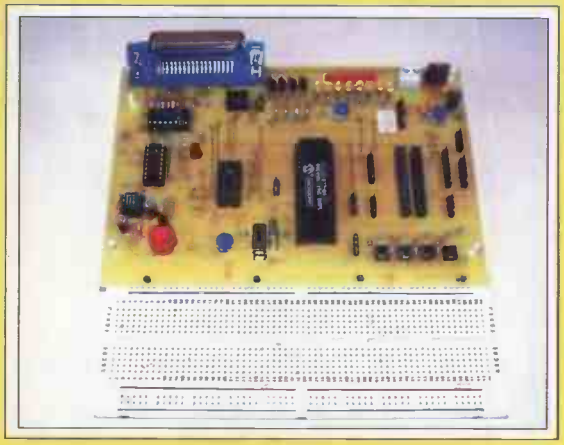

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EMMINENCE LOUDSPEAKERS. 12in. diameter, 50 watts nominal, 100 watts peak, 16 ohm Imp. Pack of 4 just £39.95. Ref SPEAK39.

PIR SECURITY SWITCHES. These brand new swivel mounting PIR units will switch up to 2 kilowatts. Adjustable sensitivity, light level and time delay (9 seconds to 10 minutes), 15m detection range, mains operated, waterproof. £5.95. Ref PIR1PACK or a pack of 5 for £22.95. Ref PIR5PACK or 10 for £39.95 Ref PIR10PACK.

12V 18Ah SEALED LEAD-ACID BATTERIES, new and boxed, unused, pack of 4 £44.95, Ref CYC7 or £15.95 each, Ref CYC6.

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IV400S (400 watt) £89
IV800S (800 watt) £159
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SODIUM LAMP SYSTEMS, £75.70. Complete system with 250W or 400W SON-T Agro bulb, reflector with bulbholder and remote ballast and starter (uncased), all you need is wire. 250W system Ref SLS1, 400W system SLS2.

HYDROPONICS – DO YOU GROW YOUR OWN? Check our web site at **www.bullnet.co.uk.**

PC COMBINED UPS AND PSU. The unit has a total power of 292 watts, standard motherboard connectors and 12 peripheral power leads for drives etc. Inside are three 12V 7·2Ah sealed lead-acid batteries. Backup time is 8 mins at full load or 30 mins at half load. Made in the UK by Magnum, 110V or 240V a.c. input, +5V at 35A, –5V at 0·5A, +12V at 9A, –12V at 0·5A outputs. 170mm x 260mm x 220mm, new and boxed. £29.95. Ref PCUPS2.

AERIAL PHOTOGRAPHY KIT. This rocket comes with a built-in camera, it flies up to 500 feet (150m), turns over, and takes an aerial photograph of the ground below. The rocket then returns, with its film, via its parachute. Takes 110 film. Supplied complete with everything, including a launch pad and three motors (no film). £29.98. Ref ASTRO.

3HP MAINS MOTORS. Single-phase 240V, brand new, 2-pole, 340mm x 180mm, 2,850 rpm, built-in automatic reset overload protector, keyed shaft (40mm x 16mm). Made by Leeson. £99 each. Ref LEE1.

BUILD YOUR OWN WINDFARM FROM SCRAP. New publication gives step-by-step guide to building wind generators and propellors. Armed with this publication and a good local scrapyard could make you self-sufficient in electricity! £12. Ref LOT81.

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SOLAR POWER LAB SPECIAL. 2in. x 6in. x 6in., 6V 130mA cells, 4 l.e.d.s, wire, buzzer, switch plus relay or motor. £7.99. Ref SA27.

SOLAR NiCAD CHARGERS. 4 x AA-size, £9.99. Ref 6P476, 2 x C-size, £9.99. Ref 6P477.

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Hydrogen fuel cells. Our new Hydrogen fuel cells are 1V at up to 1A output, Hydrogen Input, easily driven from a small electrolosis assembly or from a hydrogen source, our demo model uses a solar panel with the output leads in a glass of salt water to produce the hydrogen! Each cell is designed to be completely taken apart, put back together and expanded to whatever capacity you like (up to 10 watts and 12V per assembly). Cells cost £49. Ref HFC11.

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12V SOLAR POWERED WATER PUMP. Perfect for many 12V d.c. uses, from solar fountains to hydroponics! Small and compact, yet powerful, works direct from our 10 watt solar panel in bright sun. Max hd: 17ft., max flow = 8l.p.m., 1·5A. Ref AC8. £18.99

SOLAR MOTORS. Tiny motors which run quite happily on voltages from 3V to 12V d.c. Works on our 6V amorphous 6in. panels, and you can run them from the sun! 32mm dia., 20mm thick. £1.50 each.

WALKIE TALKIES. 1 MILE RANGE, £37/PAIR. REF MAG30.

LIQUID CRYSTAL DISPLAY. Bargain prices, 40-character 1-line 154mm x 16mm, £6.00. Ref SMC4011A.

YOUR HOME COULD BE SELF-SUFFICIENT IN ELECTRICITY. Comprehensive plans with loads of info on designing systems, panels, control electronics, etc. £7. Ref PV1.

SOLAR POWER LAB SPECIAL. 2in. x 6in. x 6in., 6V 130mA cells, 4 l.e.d.s, wire, buzzer, switch plus relay or motor. £7.99. Ref SA27.

SOLAR NiCAD CHARGERS. 4 x AA-size, £9.99. Ref 6P476. 2 x C-size, £9.99. Ref 6P477.

BRAND NEW NATO ISSUE RADIATION DETECTORS, SALE PRICE JUST £39.95. Current NATO issue standard emergency services unit used by most of the world's military personnel. New and boxed. Normal retail price £400, BULL'S bargain price just £99. Ref PDRM.

PC COMBINED UPS AND PSU. The unit has a total power of 292 watts, standard motherboard connectors and 12 peripheral power leads for drives etc. Inside are 3 12V 7·2Ah sealed lead-acid batteries. Back-up time is 8 mins at full load or 30 mins at half load. Made in the UK by Magnum, 110V or 240V a.c. input, +5 at 35A, –5V at 0·5A, +12V at 9A, –12V at 0·5A outputs. 170mm x 260mm x 220mm, new and boxed. £29.95. Ref PCUPS2.

BASIC GUIDE TO BIO DIESEL. HOW TO MAKE DIESEL FUEL FROM USED KITCHEN OIL, £6. REF BIOF.

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33 KILO LIFT MAGNET. Neodynium, 32mm diameter with a fixing bolt on the back for easy mounting. Each magnet will lift 33 kilos, 4 magnets bolted to a plate will lift an incredible 132 kilos! £15. Ref MAG33. Pack of 4 just £39. Ref MAG33AA.

77 KILO LIFT MAGNET. These Samarium magnets measure 57mm x 20mm and have a threaded hole (5/16th UNF) in the centre and a magnetic strength of 2·2 gauss. We have tested these on a steel beam running through the offices and found that they will take more than 77kg (170lb) in weight before being pulled off. Supplied with keeper. £19.95 each. Ref MAG77.

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12V OPERATED SMOKE BOMBS. Type 3 is a 12V trigger and three smoke cannisters, each cannister will fill a room in a very short space of time! £14.99. Ref SB3. Type 2 is 20 smaller cannisters (suitable for mock equipment fires etc.) and one trigger module for £29. Ref SB2. Type 1 is a 12V trigger and 20 large cannisters. £49. Ref SB1.

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Other models available at **www.radargun.co.uk**.

LOPTX. Made by Samsung for colour TV. £3 each. Ref SS52.

WANT TO MAKE SOME MONEY? STUCK FOR AN IDEA? We have collated 140 business manuals that give you information on setting up different businesses, you peruse these at your leisure using the text editor on your PC. Also included is the certificate enabling you to reproduce (and sell) the manuals as much as you like! £14. Ref EP74.

ELECTRONIC SPEED CONTROLLER KIT. For the above motor is £19. Ref MAG17. Save £5 if you buy them both together, one motor plus speed controller rrp is £41. Offer price £36. Ref MOT5A.

INFRA-RED REMOTE CONTROLS. Made for TVs but may have other uses. Pack of 100 £39. Ref IREM.

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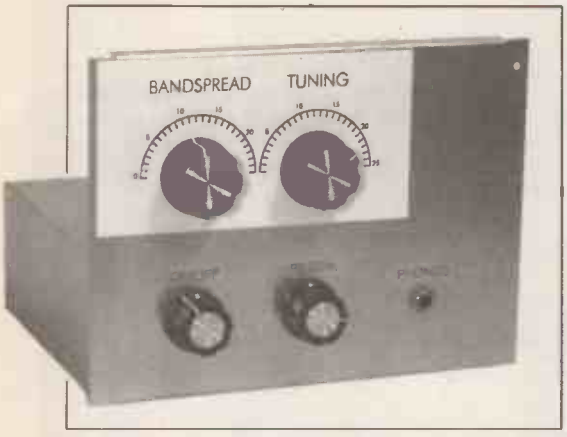

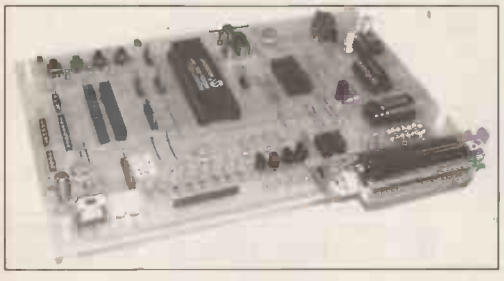

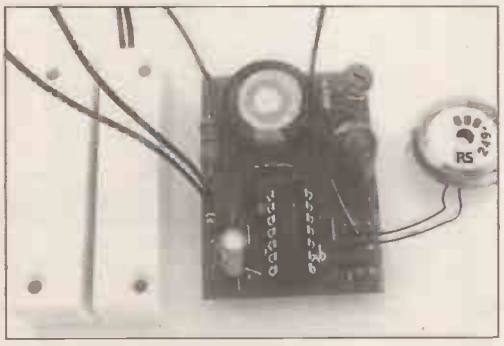

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Our November 2001 issue will be published on Thursday, 11 October 2001. See page 679 for details

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Top quality 19" rack cabinets made in UK by **Optima Enclosures Ltd.** Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and louvered removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting ,plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the *most versatile we have ever sold.* Racks may be stacked side by side and therefore require only two side panels to stand singly or in multiple bays. Overall dimensions are: 77½" H x 32½" D x 22" W. Order as:

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PIC TOOLKIT TK3 FOR WINDOWS

The long-awaited sequel to Toolkit Mk2, crafted for PIC programming enthusiasts by a PIC programming addict. PIC Toolkit TK3 for Windows is the most sophisticated EPE *PIC microcontroller code assembler and programmer ever published.*

Designed explicitly for running in the "desk-top PC" environments of Windows 95 and 98, TK3 is intuitively easy to use, fast in operation, has many extra features that are probably not found elsewhere, and is the ideal programming aid for all who love to play with reprogrammable PICs.

The PIC families catered for are principally the PIC16x84 and PIC16F87x EEPROM-based series, whose members include C84, F84, F873, F874, F876 and F877. It is likely that TK3 can be used with other PICs that also have 14-bit program codes, including F83, F84A and no doubt some other devices.

Written in Visual Basic 6, TK3 is run as a fully stand-alone program, and can be used with the new Toolkit Mk3 programming board published in this current issue, or with the well-established Toolkit Mk2 board of May-June '99.

TEACH-IN 2002

Our new 10-part educational series Teach-In 2002: Making Sense of the Real World, *gives you an insight into the world of sensors. More than ever before, sensors are being deployed to measure environmental parameters, so* Teach-In 2002 *demonstrates what sensors are all about and how to use them effectively.*

Also described are some of the key circuits generally involved in sensing and measuring, including amplifiers, filters, comparators and analogue-to-digital converters (ADCs), as well as specific circuits for various sensor applications.

We aim to give Teach-In 2002 *a broad appeal, so that every reader will gain something from the series in one way or another. We know that the theory will be highly relevant to schools and university students.*

Each part includes practical "Lab Work" based on the sensors, circuits and concepts discussed within it. The experiments can be monitored by a multimeter, or more fully demonstrated via the recommended Picoscope ADC40 PC-based oscilloscope which will be offered to readers at a special price. These labs help reinforce practical principles that you can then incorporate into your own future project designs.

CAPACITANCE METER

Although some modern multimeters have capacitance-measuring capability, this is often limited to a maximum of around 10 microfarads and is often inaccurate at both ends of the scale.

The circuit described next month allows all types of capacitor, including non-polarised, electrolytic and tantalum, to be measured accurately and over a wide range. It measures capacitance from a few picofarads to 10,000 microfarads in three sub-scales (10nF, 10µF, and 10,000µF) and is accurate across the whole range.

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PROJECT KITS

Our electronic kits are supplied complete with all components, high quality PCBs (NOT cheap Tripad strip board!) and detailed assembly/operating instructions

● **2 x 25W CAR BOOSTER AMPLIFIER** Connects to the output of an existing car stereo cassette player, CD player or radio. Heatsinks provided. PCB 76x75mm. **1046KT. £24.95**

● **3-CHANNEL WIRELESS LIGHT MODULATOR** No electrical connection with amplifier. Light modulation achieved via a sensitive electret microphone. Separate sensitivity control per channel. Power handing 400W/channel. PCB 54x112mm. Mains powered. Box provided. **6014KT £24.95**

● **12 RUNNING LIGHT EFFECT** Exciting 12 LED light effect ideal for parties, discos, shop-windows & eye-catching signs. PCB design allows replacement of LEDs with 220V bulbs by inserting 3 TRIACs. Adjustable rotation speed & direction. PCB 54x112mm. **1026KT £15.95; BOX (for mains operation) 2026BX £9.00**

● **DISCO STROBE LIGHT** Probably the most exciting of all light effects. Very bright strobe tube. Adjustable strobe frequency. 1-60Hz. Mains powered. PCB: 60x68mm. Box provided. **6037KT £28.95**

● **ANIMAL SOUNDS** Cat, dog, chicken & cow. Ideal for kids farmyard toys & schools. **SG10M £5.95**

● **3 1/2 DIGIT LED PANEL METER** Use for basic voltage/current displays or customise to measure temperature, light, weight, movement, sound levels, etc. with appropriate sensors (not supplied). Various input circuit designs provided. **3061KT £13.95**

● **IR REMOTE TOGGLE SWITCH** Use any TV/VCR remote control unit to switch onboard 12V/1A relay on/off. **3058KT £10.95**

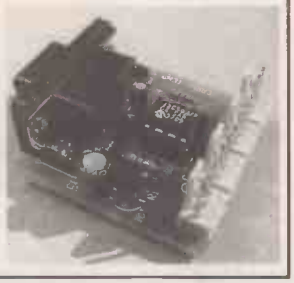
SPEED CONTROLLER for any common DC motor up to 100V/5A. Pulse width modulation gives maximum torque at all speeds 5-15VDC. Box provided. **3067KT £12.95**

● **3 x 8 CHANNEL IR RELAY BOARD** Control eight 12V/1A relays by Infra Red (IR) remote control over a 20m range in sunlight. 6 relays turn on only, the other 2 toggle on/off. 3 operation ranges determined by jumpers. Transmitter case & all components provided. Receiver PCB 76x89mm. **3072KT £52.95**

PRODUCT FEATURE

COMPUTER TEMPERATURE DATA LOGGER

PC serial port controlled 4-channel temperature meter (either deg C or F). Requires no external power. Allows continuous temperature data logging of up to four temperature sensors located 200m+ from motherboard/PC. Ideal use for old 386/486 computers. Users can tailor input data stream to suit their purpose (dump it to a spreadsheet or write your own BASIC programs using the INPUT command to grab the readings). PCB just 38mm x 38mm. Sensors connect via four 3-pin headers. 4 header cables supplied but only one DS18S20 sensor.
Kit software available free from our website.
ORDERING: 3145KT £23.95 (kit form);
AS3145 £29.95 (assembled);
Additional DS18S20 sensors £4.95 each



● **SOUND EFFECTS GENERATOR** Easy to build. Create an almost infinite variety of interesting/unusual sound effects from birds chirping to sirens. 9VDC. PCB 54x85mm. **1045KT £8.95**

● **ROBOT VOICE EFFECT** Make your voice sound similar to a robot or Darlek. Great fun for discos, school plays, theatre productions, radio stations & playing jokes on your friends when answering the phone! PCB 42x71mm. **1131KT £8.95**

● **AUDIO TO LIGHT MODULATOR** Controls intensity of one or more lights in response to an audio input. Safe, modern opto-coupler design. Mains voltage experience required. **3012KT £8.95**

● **MUSIC BOX** Activated by light. Plays 8 Christmas songs and 5 other tunes. **3104KT £7.95**

● **20 SECOND VOICE RECORDER** Uses non-volatile memory - no battery backup needed. Record/replay messages over & over. Playback as required to greet customers etc. Volume control & built-in mic. 6VDC. PCB 50x73mm. **3131KT £12.95**

● **TRAIN SOUNDS** 4 selectable sounds : whistle blowing, level crossing bell, 'clickety-clack' & 4 in sequence. **SG01M £6.95**

● **PC CONTROLLED RELAY BOARD** Convert any 286 upward PC into a dedicated automatic controller to independently turn on/off up to eight lights, motors & other devices around the home, office, laboratory or factory using 8 240VAC/12A onboard relays. DOS utilities, sample test program, full-featured Windows utility & all components (except cable) provided. 12VDC. PCB 70x200mm. **3074KT £31.95**

● **2 CHANNEL UHF RELAY SWITCH** Contains the same transmitter/receiver pair as 30A15 below plus the components and PCB to control two 240VAC/10A relays (also supplied). Ultra bright LEDs used to indicate relay status. **3082KT £27.95**

● **TRANSMITTER RECEIVER PAIR** 2-button keyfob style 300-375MHz Tx with 30m range. Receiver encoder module with matched decoder IC. Components must be built into a circuit like kit 3082 above. **30A15 £14.95**

● **PIC 16C71 FOUR SERVO MOTOR DRIVER** Simultaneously control up to 4 servo motors. Software & all components (except servos/control pots) supplied. 5VDC. PCB 50x70mm. **3102KT £15.95**

● **UNIPOLAR STEPPER MOTOR DRIVER** for any 5/6/8 lead motor. Fast/slow & single step rates. Direction control & on/off switch. Wave, 2-phase & half-wave step modes. 4 LED indicators. PCB 50x65mm. **3109KT £14.95**

● **PC CONTROLLED STEPPER MOTOR DRIVER** Control two unipolar stepper motors (3A max. each) via PC printer port. Wave, 2-phase & half-wave step modes. Software accepts 4 digital inputs from external switches & will single step motors. PCB fits in D-shell case provided. **3113KT £17.95**

● **12-BIT PC DATA ACQUISITION/CONTROL UNIT** Similar to kit 3093 above but uses a 12 bit Analogue-to-Digital Converter (ADC) with internal analogue multiplexor. Reads 8 single ended channels or 4 differential inputs or a mixture of both. Analogue inputs read 0-4V. Four TTL/CMOS compatible digital input/outputs. ADC conversion time <10uS. Software (C, QB & Win), extended D shell case & all components (except sensors & cable) provided. **3118KT £52.95**

● **LIQUID LEVEL SENSOR/RAIN ALARM** Will indicate fluid levels or simply the presence of fluid. Relay output to control a pump to add/remove water when it reaches a certain level. **1080KT £5.95**

● **AM RADIO KIT 1** Tuned Radio Frequency front-end, single chip AM radio IC & 2 stages of audio amplification. All components inc. speaker provided. PCB 32x102mm. **3063KT £10.95**

● **DRILL SPEED CONTROLLER** Adjust the speed of your electric drill according to the job at hand. Suitable for 240V AC mains powered drills up to 700W power. PCB: 48mm x 65mm. Box provided. **6074KT £17.95**

● **3 INPUT MONO MIXER** Independent level control for each input and separate bass/treble controls. Input sensitivity: 240mV. 18V DC. PCB: 60mm x 185mm **1052KT £16.95**

● **NEGATIVE\POSITIVE ION GENERATOR** Standard Cockcroft-Walton multiplier circuit. Mains voltage experience required. **3057KT £10.95**

● **LED DICE** Classic intro to electronics & circuit analysis. 7 LED's simulate dice roll, slow down & land on a number at random. 555 IC circuit. **3003KT £9.95**

● **STAIRWAY TO HEAVEN** Tests hand-eye co-ordination. Press switch when green segment of LED lights to climb the stairway - miss & start again! Good intro to several basic circuits. **3005KT £9.95**

● **ROULETTE LED** 'Ball' spins round the wheel, slows down & drops into a slot. 10 LED's. Good intro to CMOS decade counters & Op-Amps. **3006KT £10.95**

● **9V XENON TUBE FLASHER** Transformer circuit steps up 9V battery to flash a 25mm Xenon tube. Adjustable flash rate (0-25-2 Sec's). **3022KT £11.95**

● **LED FLASHER 1** 5 ultra bright red LED's flash in 7 selectable patterns. **3037MKT £5.95**

● **LED FLASHER 2** Similar to above but flash in sequence or randomly. Ideal for model railways. **3052MKT £5.95**

● **INTRODUCTION TO PIC PROGRAMMING.** Learn programming from scratch. Programming hardware, a P16F84 chip and a two-part, practical, hands-on tutorial series are provided. **3081KT £22.95**

● **SERIAL PIC PROGRAMMER** for all 8/18/28/40 pin DIP serial programmed PICs. Shareware software supplied limited to programming 256 bytes (registration costs £14.95). **3096KT £13.95**

● **ATMEL 89Cx051 PROGRAMMER** Simple-to-use yet powerful programmer for the Atmel 89C1051, 89C2051 & 89C4051 uC's. Programmer does NOT require special software other than a terminal emulator program (built into Windows). Can be used with ANY computer/operating system. **3121KT £24.95**

● **3V/1.5V TO 9V BATTERY CONVERTER** Replace expensive 9V batteries with economic 1.5V batteries. IC based circuit steps up 1 or 2 'AA' batteries to give 9V/18mA. **3035KT £5.95**

● **STABILISED POWER SUPPLY 3-30V/2.5A** Ideal for hobbyist & professional laboratory. Very reliable & versatile design at an extremely reasonable price. Short circuit protection. Variable DC voltages (3-30V). Rated output 2.5 Amps. Large heatsink supplied. You just supply a 24VAC/3A transformer. PCB 55x112mm. Mains operation. **1007KT £16.95.**

● **STABILISED POWER SUPPLY 2-30V/5A** As kit 1007 above but rated at 5Amp. Requires a 24VAC/5A transformer. **1096KT £27.95.**

● **MOTORBIKE ALARM** Uses a reliable vibration sensor (adjustable sensitivity) to detect movement of the bike to trigger the alarm & switch the output relay to which a siren, bikes horn, indicators or other warning device can be attached. Auto-reset. 6-12VDC. PCB 57x64mm. **1011KT £11.95** Box **2011BX £7.00**

● **CAR ALARM SYSTEM** Protect your car from theft. Features vibration sensor, courtesy/boot light voltage drop sensor and bonnet/boot earth switch sensor. Entry/exit delays, auto-reset and adjustable alarm duration. 6-12V DC. PCB: 47mm x 55mm **1019KT £11.95** Box **2019BX £8.00**

● **PIEZO SCREAMER** 110dB of ear piercing noise. Fits in box with 2 x 35mm piezo elements built into their own resonant cavity. Use as an alarm siren or just for fun! 6-9VDC. **3015KT £10.95**

● **COMBINATION LOCK** Versatile electronic lock comprising main circuit & separate keypad for remote opening of lock. Relay supplied. **3029KT £10.95**

● **ULTRASONIC MOVEMENT DETECTOR** Crystal locked detector frequency for stability & reliability. PCB 75x40mm houses all components. 4-7m range. Adjustable sensitivity. Output will drive external relay/circuits. 9VDC. **3049KT £13.95**

● **PIR DETECTOR MODULE** 3-lead assembled unit just 25x35mm as used in commercial burglar alarm systems. **3076KT £8.95**

● **INFRARED SECURITY BEAM** When the invisible IR beam is broken a relay is tripped that can be used to sound a bell or alarm. 25 metre range. Mains rated relays provided. 12VDC operation. **3130KT £12.95**

● **SQUARE WAVE OSCILLATOR** Generates square waves at 6 preset frequencies in factors of 10 from 1Hz-100KHz. Visual output indicator. 5-18VDC. Box provided. **3111KT £8.95**

● **PC DRIVEN POCKET SAMPLER/DATA LOGGER** Analogue voltage sampler records voltages up to 2V or 20V over periods from milli-seconds to months. Can also be used as a simple digital scope to examine audio & other signals up to about 5KHz. Software & D-shell case provided. **3112KT £18.95**

● **20 MHz FUNCTION GENERATOR** Square, triangular and sine waveform up to 20MHz over 3 ranges using 'coarse' and 'fine' frequency adjustment controls. Adjustable output from 0-2V p-p. A TTL output is also provided for connection to a frequency meter. Uses MAX038 IC. Plastic case with printed front/rear panels & all components provided. 7-12VAC. **3101KT £69.95**

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High performance surveillance bugs. Room transmitters supplied with sensitive electret microphone & battery holder/clip. All transmitters can be received on an ordinary VHF/FM radio between 88-108MHz. Available in Kit Form (KT) or Assembled & Tested (AS).

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● ***MTX*** **- MINIATURE 3V TRANSMITTER** Easy to build & guaranteed to transmit 300m @ 3V. Long battery life. 3-5V operation. Only 45x18mm. **B 3007KT £6.95 AS3007 £11.95**

MRTX **- MINIATURE 9V TRANSMITTER** Our best selling bug. Super sensitive, high power - 500m range @ 9V (over 1km with 18V supply and better aerial). 45x19mm. **3018KT £7.95 AS3018 £12.95**

HPTX **- HIGH POWER TRANSMITTER** High performance, 2 stage transmitter gives greater stability & higher quality reception. 1000m range 6-12V DC operation. Size 70x15mm. **3032KT £9.95 AS3032 £18.95**

● ***MMTX*** **- MICRO-MINIATURE 9V TRANSMITTER** The ultimate bug for its size, performance and price. Just 15x25mm. 500m range @ 9V. Good stability 6-18V operation. **3051KT £8.95 AS3051 £14.95**

● ***VTX*** **- VOICE ACTIVATED TRANSMITTER** Operates only when sounds detected. Low standby current. Variable trigger sensitivity. 500m range. Peaking circuit supplied for maximum RF output. On/off switch. 6V operation. Only 63x38mm. **3028KT £12.95 AS3028 £21.95**

HARD-WIRED BUG/TWO STATION INTERCOM Each station has its own amplifier, speaker and mic. Can be set up as either a hard-wired bug or two-station intercom. 10m x 2-core cable supplied. 9V operation. **3021KT £15.95 (kit form only)**

● ***TRVS*** **- TAPE RECORDER VOX SWITCH** Used to automatically operate a tape recorder (not supplied) via its REMOTE socket when sounds are detected. All conversations recorded. Adjustable sensitivity & turn-off delay. 115x19mm. **3013KT £9.95 AS3013 £21.95**

TELEPHONE SURVEILLANCE

● ***MTTX*** **- MINIATURE TELEPHONE TRANSMITTER** Attaches anywhere to phone line. Transmits only when phone is used! Tune-in your radio and hear both parties. 300m range. Uses line as aerial & power source. 20x45mm. **3016KT £8.95 AS3016 £14.95**

● ***TRI*** **- TELEPHONE RECORDING INTERFACE** Automatically record all conversations. Connects between phone line & tape recorder (not supplied). Operates recorders with 1.5-12V battery systems. Powered from line. 50x33mm. **3033KT £9.95 AS3033 £18.95**

● ***TPA*** **- TELEPHONE PICK-UP AMPLIFIER/WIRELESS PHONE BUG** Place pick-up coil on the phone line or near phone earpiece and hear both sides of the conversation. **3055KT £11.95 AS3055 £20.95**

HIGH POWER TRANSMITTERS

● **1 WATT FM TRANSMITTER** Easy to construct. Delivers a crisp, clear signal. Two-stage circuit. Kit includes microphone and requires a simple open dipole aerial. 8-30VDC. PCB 42x45mm. **1009KT £14.95**

● **4 WATT FM TRANSMITTER** Comprises three RF stages and an audio preamplifier stage. Piezoelectric microphone supplied or you can use a separate preamplifier circuit. Antenna can be an open dipole or Ground Plane. Ideal project for those who wish to get started in the fascinating world of FM broadcasting and want a good basic circuit to experiment with. 12-18VDC. PCB 44x146mm. **1028KT. £22.95 AS1028 £34.95**

● **15 WATT FM TRANSMITTER (PRE-ASSEMBLED & TESTED)** Four transistor based stages with Philips BLY 88 in final stage. 15 Watts RF power on the air. 88-108MHz. Accepts open dipole, Ground Plane, 5/8, J, or YAGI antennas. 12-18VDC. PCB 70x220mm. SWS meter needed for alignment. **1021KT £99.95**

● SIMILAR TO ABOVE BUT 25W Output. **1031KT £109.95**

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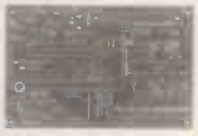
'PICALL' PIC Programmer



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3117KT	'PICALL' PIC Programmer Kit	£59.95
AS3117	Assembled 'PICALL' PIC Programmer	£69.95
AS3117ZIF	Assembled 'PICALL' PIC Programmer c/w ZIF socket	£84.95

ATMEL AVR Programmer

Powerful programmer for Atmel AT90Sxxxx (AVR) micro controller family. All fuse and lock bits are programmable. Connects to serial port. Can be used with ANY computer and operating system. Two LEDs to indicate programming status. Supports 20-pin DIP AT90S1200 & AT90S2313 and 40-pin DIP AT90S4414 & AT90S8515 devices. NO special software required – uses any terminal emulator program (built into Windows). The programmer is supported by BASCOM-AVR Basic Compiler software (see website for details).

NB ZIF sockets not included.

3122KT	ATMEL AVR Programmer	£24.95
AS3122	Assembled 3122	£39.95

Atmel 89Cx051 and 89xxx programmers also available.

PC Data Acquisition & Control Unit

With this kit you can use a PC parallel port as a real world interface. Unit can be connected to a mixture of analogue and digital inputs from pressure, temperature, movement, sound, light intensity, weight sensors, etc. (not supplied) to sensing switch and relay states. It can then process the input data and use the information to control up to 11 physical devices such as motors, sirens, other relays, servo motors & two-stepper motors.

FEATURES:

- 8 Digital Outputs: Open collector, 500mA, 33V max.
- 16 Digital Inputs: 20V max. Protection 1K in series, 5·1V Zener to ground.
- 11 Analogue Inputs: 0-5V, 10 bit (5mV/step.)
- 1 Analogue Output: 0-2·5V or 0-10V. 8 bit (20mV/step.)

All components provided including a plastic case (140mm x 110mm x 35mm) with pre-punched and silk screened front/rear panels to give a professional and attractive finish (see photo) with screen printed front & rear panels supplied. Software utilities & programming examples supplied.

3093KT	PC Data Acquisition & Control Unit	£99.95
AS3093	Assembled 3093	£124.95

See opposite page for ordering Information on these kits

ABC Mini 'Hotchip' Board

Currently learning about microcontrollers? Need to do something more than flash a LED or sound a buzzer? The ABC Mini 'Hotchip' Board is based on Atmel's AVR 8535 RISC technology and will interest both the beginner and expert alike. Beginners will find that they can write and test a simple program, using the BASIC programming language, within an hour or two of connecting it up. Experts will like the power and flexibility of the ATMEL microcontroller, as well as the ease with which the little Hot Chip board can be "designed-in" to a project. The ABC Mini Board 'Starter Pack' includes just about everything you need to get up and experimenting right away. On the hardware side, there's a pre-assembled micro controller PC board with both parallel and serial cables for connection to your PC. Windows software included on CD-ROM features an Assembler, BASIC compiler and in-system programmer The pre-assembled boards only are also available separately.

ABCMINISP	ABC MINI Starter Pack	£64.95
ABCMINIB	ABC MINI Board Only	£39.95

Advanced Schematic Capture and Simulation Software

Serial Port Isolated I/O Controller

Kit provides eight 240VAC/12A (110VAC/15A) rated relay outputs and four optically isolated inputs. Can be used in a variety of control and sensing applications including load switching, external switch input sensing, contact closure and external voltage sensing. Programmed via a computer serial port, it is compatible with ANY computer & operating system. After programming, PC can be disconnected. Serial cable can be up to 35m long, allowing 'remote' control. User can easily write batch file programs to control the kit using simple text commands. NO special software required – uses any terminal emulator program (built into Windows). All components provided including a plastic case with pre-punched and silk screened front/rear panels to give a professional and attractive finish (see photo).

3108KT	Serial Port Isolated I/O Controller Kit	£54.95
AS3108	Assembled Serial Port Isolated I/O Controller	£69.95

Watch Slides on TV.

Make videos of your slides. Digitise your slides (using a video capture card)
"Liesgang diatv" automatic slide viewer with built in high quality colour TV camera. It has a composite video output to a phono plug (SCART & BNC adaptors are available). They are in very good condition with few signs of use. More details see www.diatv.co.uk.
£91.91 + VAT = £108.00

Board cameras all with 512 x 582 pixels 8·5mm 1/3 inch sensor and composite video out. All need to be housed in your own enclosure and have fragile exposed surface mount parts. They all require a power supply of between 10V and 12V DC 150mA.
47MIR size 60 x 36 x 27mm with 6 infra red LEDs (gives the same illumination as a small torch but is not visible to the human eye) £37.00 + VAT = £43.48
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40MC size 39 x 38 x 27mm camera for 'C' mount lens these give a much sharper image than with the smaller lenses £32.00 + VAT = £37.60
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VSL4022F 4mm F1·22 63 x 47 degrees viewing angle £17.65 + VAT £20.74
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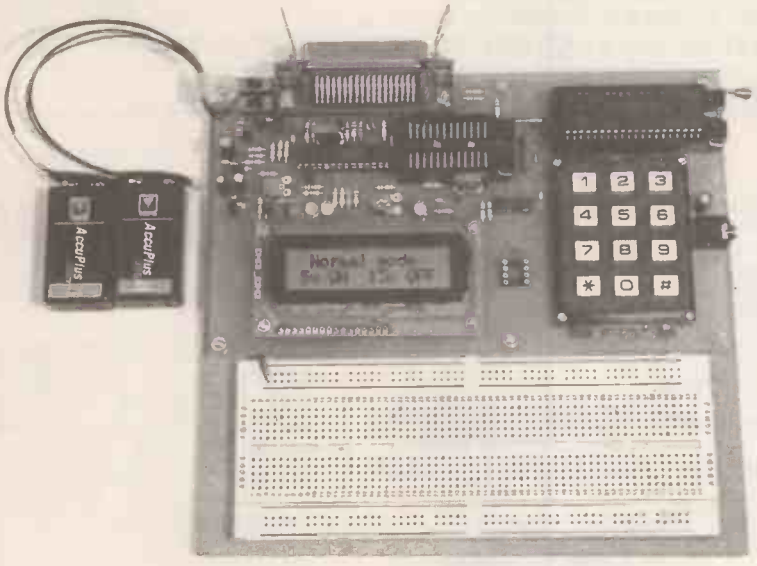

PIC Training & Development System

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

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Our complete PIC training and development system consists of our universal mid range PIC programmer, a 306 page book covering the PIC16F84, a 212 page book introducing the PIC16F877 family, and a suite of programmes to run on a PC. The module is an advanced design using a 28 pin PIC16F872 to handle the timing, programming and voltage switching requirements. The module has two ZIF sockets and an 8 pin socket which between them allow most mid range 8, 18, 28 and 40 pin PICs to be programmed. The plugboard is wired with a 5 volt supply. The software is an integrated system comprising a text editor, assembler disassembler, simulator and programming software. The programming is performed at normal 5 volts and then verified with plus and minus 10% applied to ensure that the device is programmed with a good margin and not poised on the edge of failure. Requires two PP3 batteries which are not supplied.

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Experimenting with PIC Microcontrollers

This book introduces the PIC16F84 and PIC16C711, and is the easy way to get started for anyone who is new to PIC programming. We begin with four simple experiments, then having gained some practical experience we study the basic principles of PIC programming, learn about the 8 bit timer, how to drive the liquid crystal display, create a real time clock, experiment with the watchdog timer, sleep mode, beeps and music, including a rendition of Beethoven's *Für Elise*. Finally there are two projects to work through, using the PIC16F84 to create a sinewave generator and investigating the power taken by domestic appliances.

Experimenting with the PIC16F877

We start with the simplest of experiments to get a basic understanding of the PIC16F877 family. Then we look at the 16 bit timer, efficient storage and display of text messages, simple frequency counter, use a keypad for numbers, letters and security codes, and examine the 10 bit A/D converter.

Ordering Information

Telephone with Visa, Mastercard or Switch, or send cheque/PO for immediate despatch. All prices include VAT if applicable. Postage must be added to all orders. UK postage £2.50 per book, £1.00 per kit, maximum £7.50. Europe postage £3.50 per book, £1.50 per kit. Rest of World £6.50 per book, £2.50 per kit.
Web site:- **www.brunningsoftware.co.uk**

NEW 32 bit PC Assembler

Experimenting with PC Computers with its kit is the easiest way ever to learn assembly language programming. If you have enough intelligence to understand the English language and you can operate a PC computer then you have all the necessary background knowledge. Flashing LEDs, digital to analogue converters, simple oscilloscope, charging curves, temperature graphs and audio digitising.
Kit now supplied with our 32 bit assembler with 84 page supplement detailing the new features and including 7 experiments PC to PIC communication. Flashing LEDs, writing to LCD and two way data using 3 wires from PC's parallel port to PIC16F84.

Book Experimenting with PCs £21.50
Kit 1a 'made up' with software £52.00
Kit 1u 'unmade' with software £45.00

C & C++ for the PC

Experimenting with C & C++ Programmes teaches us to programme by using C to drive the simple hardware circuits built using the materials supplied in the kit. The circuits build up to a storage oscilloscope using relatively simple C techniques to construct a programme that is by no means simple. When approached in this way C is only marginally more difficult than BASIC and infinitely more powerful. C programmers are always in demand. Ideal for absolute beginners and experienced programmers.

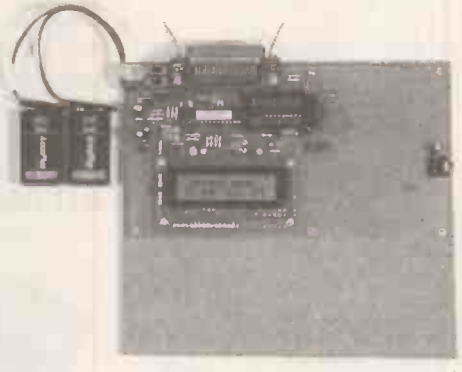
Book Experimenting with C & C++ £24.99
Kit CP2a 'made up' with software £32.51
Kit CP2u 'unmade' with software £26.51
Kit CP2t 'top up' with software £12.99

The Kits

The assembler and C & C++ kits contain the prototyping board, lead assemblies,components and programming software to do all the experiments. The 'made up' kits are supplied ready to start. The 'top up' kit is for readers who have already purchased kit 1a or 1u. The kits do not include the book.

Hardware required

All systems in this advertisement assume you have a PC (386 or better) and a printer lead. The experiments require no soldering.



Part built PIC Training System

This has the same specification as the complete system but is supplied without the keypad, 40 pin ZIF socket and plugboard, with just one book *Experimenting with PIC Microcontrollers*, and with software to programme the PIC16F84 & PIC16C711. Can be upgraded later to the full specification.

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- Full kit with headphones & all hardware

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A powerful 23kHz ultrasound generator in a compact hand-held case. MOSFET output drives a special sealed transducer with intense pulses via a special tuned transformer. Sweeping frequency output is designed to give maximum output without any special setting up.

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Kit includes case, P.C.B., coupling coil and all components.
High coil current ensures maximum effect. L.E.D. monitor.

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- RANDOM PULSES
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★ TENS UNIT ★

DUAL OUTPUT TENS UNIT

As featured in March '97 issue.

Set of 4 spare electrodes £6.50

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Designed for simple assembly and testing and providing high level dual output drive.

KIT 866. . Full kit including four electrodes £32.90

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Kit includes wound coil, cut-out case, meter scale, PCB & ALL components.

KIT 848.....£32.95

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Full set of top quality *NEW* components for this educational series. All parts as specified by *EPE*. Kit includes breadboard, wire, croc clips, pins and all components for experiments, as listed in introduction to Part 1.
**Batteries and tools not included.*

TEACH-IN 2000 -

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NOW WITH PIC16C84 EEPROM CHIP & SOFTWARE DISK

An innovative and exciting project. Wave the wand through the air and your message appears. Programmable to hold any message up to 16 digits long. Comes pre-loaded with "MERRY XMAS". Kit includes PCB, all components & tube plus instructions for message loading.

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A safe low cost eraser for up to 4 EPROMS at a time in less than 20 minutes. Operates from a 12V supply (400mA). Used extensively for mobile work - updating equipment in the field etc. Also in educational situations where mains supplies are not allowed. Safety interlock prevents contact with UV.

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1 WATT O/P, BUILT IN SPEAKER, COMPACT CASE
20kHz-140kHz
NEW DESIGN WITH 40kHz MIC.

A new circuit using a 'full-bridge' audio amplifier i.c., internal speaker, *and* headphone/tape socket. The latest sensitive transducer, and 'double balanced mixer' give a stable, high performance superheterodyne design.

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MOSFET MkII VARIABLE BENCH POWER SUPPLY 0-25V 2·5A

Based on our Mk1 design and preserving all the features, but now with switching pre-regulator for much higher efficiency. Panel meters indicate Volts and Amps. Fully variable down to zero. Toroidal mains transformer. Kit includes punched and printed case and all parts. As featured in April 1994 *EPE*. An essential piece of equipment.

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Programmed PICs for all* EPE Projects
16C84/18F84/16C71
All **£5.90** each
PIC16F877 now in stock
£10 inc. VAT & postage
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ULTRASONIC PEsT SCARER

Keep pets/pests away from newly sown areas, fruit, vegetable and flower beds, children's play areas, patios etc. This project produces intense pulses of ultrasound which deter visiting animals.

- KIT INCLUDES ALL COMPONENTS, PCB & CASE
- EFFICIENT 100V TRANSDUCER OUTPUT
- COMPLETELY INAUDIBLE TO HUMANS
- UP TO 4 METRES RANGE
- LOW CURRENT DRAIN

KIT 812.....£15.00

SIMPLE PIC PROGRAMMER

INCREDIBLE LOW PRICE! **Kit 857 £12.99**

INCLUDES 1-PIC16F84 CHIP SOFTWARE DISK, LEAD CONNECTOR, PROFESSIONAL PC BOARD & INSTRUCTIONS

Power Supply £3.99

EXTRA CHIPS:
PIC 16F84 £4.84

Based on February '96 EPE. Magenta designed PCB and kit. PCB with 'Reset' switch, Program switch, 5V regulator and test L.E.D.s, and connection points for access to all A and B port pins.

PIC 16C84 DISPLAY DRIVER

INCLUDES 1-PIC16F84 WITH DEMO PROGRAM SOFTWARE DISK, PCB, INSTRUCTIONS AND 16-CHARACTER 2-LINE **LCD DISPLAY**

Kit 860 £19.99

Power Supply £3.99

FULL PROGRAM SOURCE CODE SUPPLIED – DEVELOP YOUR OWN APPLICATION!

Another super PIC project from Magenta. Supplied with PCB, industry standard 2-LINE x 16-character display, data, all components, and software to include in your own programs. Ideal development base for meters, terminals, calculators, counters, timers – Just waiting for your application!

PIC 16F84 MAINS POWER 4-CHANNEL CONTROLLER & LIGHT CHASER

- WITH PROGRAMMED 16F84 AND DISK WITH SOURCE CODE IN MPASM
- ZERO VOLT SWITCHING MULTIPLE CHASE PATTERNS
- OPTO ISOLATED 5 AMP OUTPUTS
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LOTS OF OTHER APPLICATIONS

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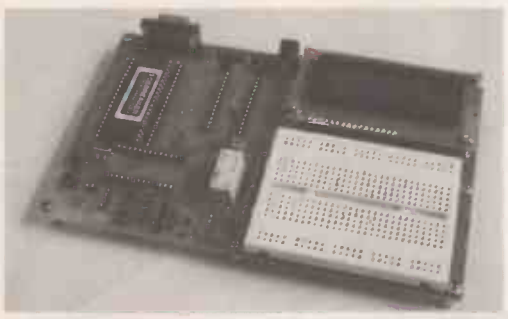

PIC Real Time In-Circuit Emulator

- Icebreaker uses PIC16F877 in circuit debugger
- Links to Standard PC Serial Port (lead supplied)
- Windows™ (95+) Software included
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As featured in March '00 *EPE*. Ideal for beginners AND advanced users.
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EPE PIC Tutorial

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- **Start by lighting l.e.d.s and do 30 tutorials to Sound Generation, Data Display, and a Security System.**
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2002

Two thousand and two is upon us – well our *Teach-In 2002* will be next month. It hardly seems any time at all since we were all worrying about how to celebrate the new millennium and now the numbers have moved on by two. Of course, regular readers will know that every other year we publish a *Teach-In* series with the intention of providing a wide range of educational material on electronics. *TI 2002* will be all about interfacing to the outside world and will look in some depth at sensors, how they work, how to use them and the data they can supply.

This new series is being produced by a team of writers co-ordinated by Alan Winstanley and drawing from the vast range of knowledge of the electronics department at Hull University. Some months have been spent planning the content and working on demonstration projects for readers to build and test. The course will employ a Pico Technology PC-based oscilloscope to provide PC displays of the various parameters to be measured. The scope will be available to readers at a Special Offer price.

SUBJECTS

The course is planned to cover the following areas: Temperature; Light and Colour; Sound and Ultrasonics; Time; Humidity; Gases, Smoke and pH; Electric and Magnetic Fields, Radiation; Movement, Acceleration, Strain and Vibration; Optical/Digital Presence, Distance and Position; Weather. It will look at a range of circuit topics from Basic Principles through Op.Amps, Instrumentation Amplifiers, Filters, Comparators, ADC, Data Logging etc. Each part will have associated labs and projects.

The new series will assume some basic knowledge of electronics, so if you want to start right at the very beginning with a series that requires no previous knowledge, you will need to look at the previous *Teach-In*, which is available on CD-ROM (*Teach-In 2000*) – see page 731 for details.

FREE PIC'INGS

Thanks to John Becker we are now on version three of his highly acclaimed *PIC Toolkit* (see page 700), we know readers will find this totally new design very useful and next month we will publish a free 16-page supplement describing the new Toolkit TK3 for Windows software. We also believe the two free CD-ROMs from Microchip given away with this issue will be invaluable to anyone using PICs.

Don't miss next month's issue, place an order with your newsagent or take out a subscription now!

Mike Kenward

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Constructional Project

CAMCORDER POWER SUPPLY

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Battery replacement with a lot more bottle!

MANY camcorder users manage perfectly well with the battery supplied with their machine. If they need to extend the operating time, they simply buy another battery and carry them both around.

A typical camcorder battery provides an operating time of 45 minutes, including using the zoom lens and rewinding the tape every so often to review the results. Two batteries would still only give 90 minutes of operation.

However, "serious" users often need much more than this between charges, possibly even up to 12 hours. Although high-capacity batteries are available, they are an expensive option.

CIRCUIT OVERVIEW

The circuit described here is a high-capacity supply with integral charger. With the author's camcorder it provides over 11 hours of operation. Charging may be effected either from the mains or a 12V d.c. source, such as plugging it into the car cigar lighter socket, and takes around 15 to 20 hours to recharge.

The author's unit is housed in a camera bag, large enough to accommodate the connecting leads and various pieces of camcorder equipment.

On the front panel there are mains and 12V d.c. input plugs, output socket and mode switch. This latter toggles between charging (CH/OFF) and camera operation (CAM)

While charging, one of a pair of light-emitting diodes (l.e.d.s) indicates whether a mains or 12V supply is connected. In camera mode, a further l.e.d. operates to confirm the output. In addition, three "charge level" l.e.d.s provide an indication of the state of charge of the battery pack, green for high, yellow for medium and red for low.

The unit may be used to power camcorders having an operating voltage between 6V and 9·6V d.c. If you measure it, the voltage will be somewhat higher than the stated nominal value when the battery is fully charged. Note that a 9·6V output may not be available when the battery pack is in a poor state of charge.

CURRENT SITUATION

The maximum current which may be drawn from the unit is 2·5A. However, for the sake of battery life, this should be regarded as a peak figure. A better practical limit is 1·5A. The author's camcorder never requires more than 900mA and it seems unlikely that any amateur equipment would need 1·5A.

If the power (in watts) is stated in the user's manual, divide this by the nominal battery voltage to arrive at the average current. Another method would be to work from the battery's stated amp-hour (Ah) capacity, dividing this by the known operating time in hours. Multiply the average current by 1·5 to give a safety margin and to take account of instantaneous demands.

It is not advisable to measure the current directly unless you are certain of being able to maintain the correct polarity and avoid short-circuiting the battery.

BATTERY CHOICE

Lead-acid batteries have been chosen for this circuit because they provide a high capacity for a relatively small cost. Two 6V batteries are used rather than a single 12V one because these may be charged simultaneously from a 12V car supply. A single 12V battery would *not* be satisfactory because, when the battery was well-charged, there would be no voltage difference to drive the current through.

The specified batteries have a capacity of 7Ah but others could be used with a proportional change in operating and charging time. However, do not use a capacity less than 4Ah. Note that a pair of 7Ah units provides the equivalent of about 10Ah for a 6V camcorder because the circuit delivers around 80 per cent of the total energy to the load.

The disadvantage of lead-acid batteries is that they can be damaged if allowed to discharge below their "low point" (say, 5V for a nominal 6V unit) and especially if left like that for a prolonged period. The "charge level" l.e.d.s should therefore be checked from time to time to make sure the batteries have sufficient charge.

Unlike nickel-cadmium cells, lead-acid batteries may be "topped-up" with charge as the opportunity arises because they do not suffer from the memory effect. In fact, doing this extends their service life. Lead-acid batteries also hold their charge much better than the nickel-cadmium type. If

lead-acid batteries are left charged, they will not self-discharge significantly over a period of several months.

CIRCUIT DESCRIPTION

The complete circuit for the Camcorder Power Supply is shown in Fig.1.

The mains supply is connected via transformer T1. The 12V a.c. secondary voltage is rectified by bridge rectifier REC1. With mode switch S1 set to "CH/OFF", current flows via diode D4 to smoothing capacitor C1.

The capacitor charges to the transformer's peak output voltage less the forward voltage drop of the bridge rectifier diodes and D4. With the specified transformer this gives about 15V d.c. under full load.

When a 12V d.c. supply is connected instead of the mains, current flows into C1 via diode D3, which gives reverse-polarity protection to the 12V input. Diodes D3 and D4 also provide isolation between the two input sources so that current from one cannot possibly drain into the other.

Light-emitting diodes D1 (Mains) and D2 (12V) draw current direct from their respective supply, with current-limiting effected by resistors R1 and R2.

CHARGING VOLTAGE

The rectified voltage at C1 is fed to the input (pin 1) of voltage and current regulator IC1. This is configured to provide the correct output voltage to charge the battery pack.

A voltage higher than that required appears at the output, pin 5. Current then flows through three resistors (all labelled R3) connected in parallel and the excess voltage is developed across them. This forms the current-limiting aspect of the regulator. If the current tends to rise, the voltage across resistors R3 will increase. Pin 2 senses this change and "turns down" IC1 to reduce it.

With a battery in a poor state of charge, the difference between its own voltage and that of the charger output is significant and this drives current through the battery. Without current-limiting, the current would be quite high due to the very small resistances involved, and could be destructive to circuit components or to the batteries themselves.

The "as required" voltage is obtained at the junction of R3/R5 and is determined by the voltage difference between IC1's limit and reference pins (2 and 4). This is set at 7·7V by the potential divider formed by R4, R5 and preset VR1.

Three resistors are used for R3 rather than a single unit because they are easily-obtainable values and also allow for some "trimming" of the limiting current during setting up. With the values specified, the theoretical limit is approximately 1A. However, taking into account "stray" resistance (that of connecting copper tracks, soldered joints and so on), it is likely to be in the region of 900mA.

The 7·7V regulator output is applied to the pair of Schottky diodes, D5 and D6. These route current to the individual 6V batteries, B1 and B2, at a maximum of about 450mA each.

Schottky diodes are used as these have a smaller forward voltage drop than "ordinary" silicon diodes. This varies to some extent with the load but will be typically 0·4V rather than 0·7V. Thus, the voltage appearing across B1 and B2 will be about 7·3V. The diodes also prevent the batteries

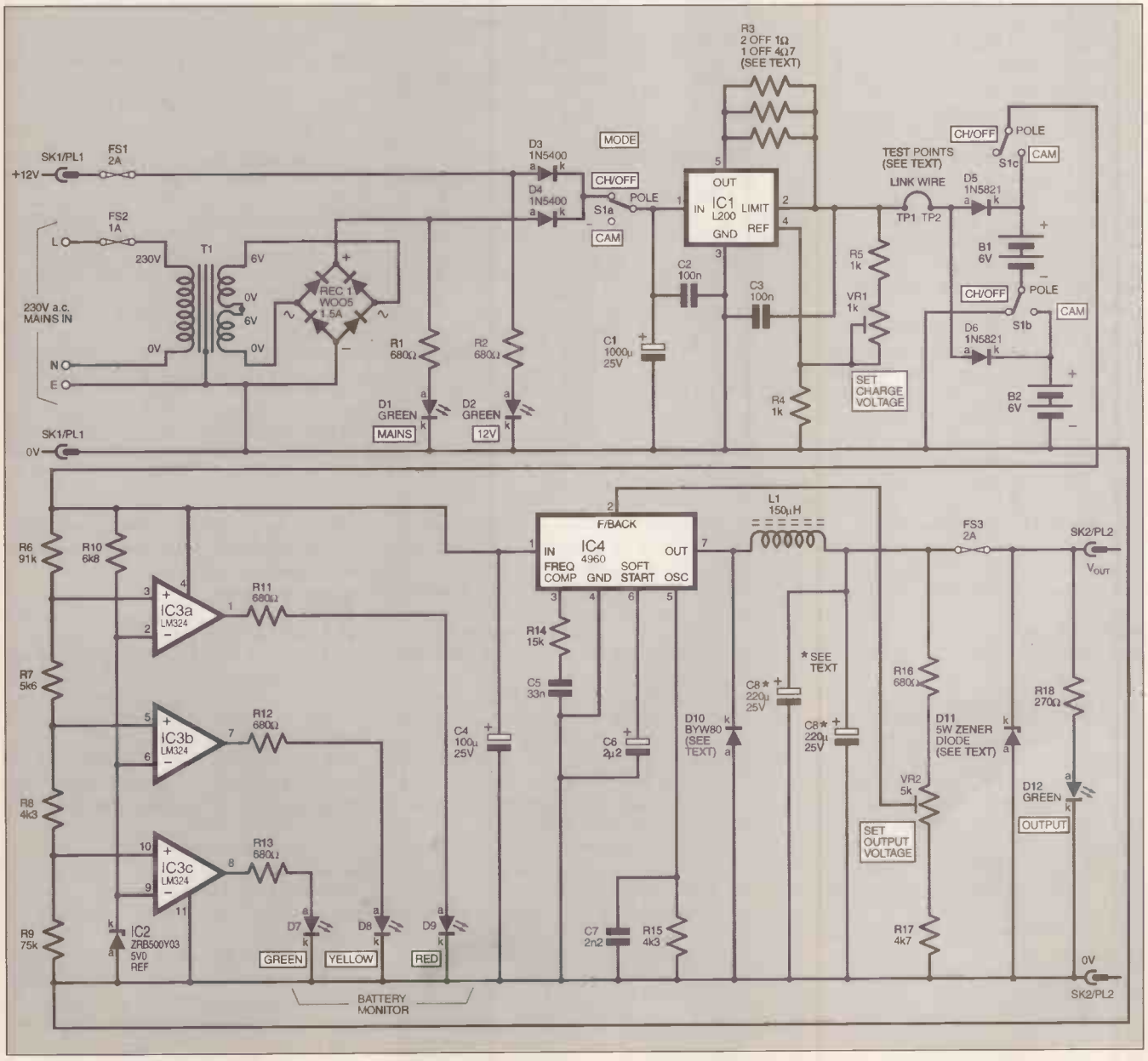


Fig.1. Complete circuit diagram for the Camcorder Power Supply/Charger.

from discharging back into IC1 when the supply is switched off.

As charging progresses, the current flowing into the batteries reduces, to about 50mA when the charging is nearly complete. Some 90 per cent of the required charge is delivered before the current reduces significantly. With the specified batteries, this takes 15 to 20 hours approximately and in most cases the batteries will then be regarded as fully charged.

While charging, switch S1c disconnects the subsequent circuit so current does not drain into this unnecessarily.

ON CAMERA

Camcorder operation is selected by moving switch S1 to "CAM". Switch S1a now disconnects the charging supply if it has been left switched on. Switch S1b connects the two 6V batteries in series so that nominally 12V appears across them, which S1c then connects to the following part of the circuit.

As the batteries discharge, their combined terminal voltage falls slightly. At 10V, they may be regarded as dangerously "flat". The voltage (and hence charge) is monitored by three sections of quad op.amp IC3, configured as comparators.

All three inverting inputs (pins 2, 6 and 9) are connected together and are set at 5V by voltage reference IC2. Resistor R10 limits the current flow though IC2 to ensure its correct operation.

The non-inverting inputs (pins 3, 5 and 10) are connected to points along the potential divider chain which comprises resistors R6 to R9 joined in series across the supply. When the voltage at any of these inputs is higher than the reference voltage, the comparator's output will be high, and its associated l.e.d. (D7 to D9) turned on.

Respectively, the "turn on" voltages for IC3a to IC3c (and their l.e.d.s) are 10·4V, 11·0V and 11·7V. The l.e.d.s represent the charge states: high (D7 – green), medium (D8 – yellow) and low (D9 – red).

As the battery voltage falls, so does the voltage at each comparator's non-inverting input. When the voltage falls below each threshold the relevant output goes low and its associated l.e.d. is turned off.

If all three l.e.d.s are off, the voltage is below 10·4V and the batteries *must* be charged as soon as possible. In use, it will be found that high and medium charge are shown for a relatively long time but low charge is shown for only a short period.

CAMERA VOLTAGE

The correct camcorder operating voltage is obtained from the battery supply using switching regulator IC4. Compared with the linear regulator used for charging the batteries, the switching type is much more efficient, by around 80 per cent or more. This allows as much useful energy as possible to be "squeezed" from the batteries and so maximise the camcorder operating time. At the same time, less waste heat is produced.

The regulator contains an on-chip oscillator which produces a stream of pulses. Their frequency is determined by the value of resistor R15 and capacitor C7 connected in parallel to pin 5 (oscillator). With the values specified it is about 100kHz.

COMPONENTS

Approx. Cost Guidance Only **£35** excluding batts. & case

See SHOP TALK page

Resistors

R1, R2, R11 to R13, R16	680Ω (6 off)
R3	1Ω (2 off) plus 4Ω7 (see text)
R4, R5	1k (2 off)
R6	91k
R7	5k6
R8, R15	4k3 (2 off)
R9	75k
R10	6k8
R14	15k
R17	4k7
R18	270Ω

All 0·6W 1% carbon film.

Potentiometers

VR1	1k min. multiturn preset, top adjust
VR2	5k min. multiturn preset, top adjust

Capacitors

C1	1000μ radial elect. 25V
C2, C3	100n ceramic (2 off)
C4	100μ radial elect. 25V
C5	33n ceramic (see text)
C6	2μ2 radial elect. 16V
C7	2n2 polystyrene
C8	220μ YXF series elect. 50V, 0·12Ω at 100kHz (2 off) (see text)

Semiconductors

REC1	W005 1·5A bridge rectifier
D1, D2, D7, D12	3mm green l.e.d. (4 off)
D3, D4	1N5400 3A rectifier diode (2 off)
D5, D6	1N5821 3A Schottky diode (2 off)
D8	3mm yellow l.e.d.
D9	3mm red l.e.d.
D10	BYW80 fast recovery diode (see text)
D11	5W Zener diode (see text)
IC1	L200CV voltage and current regulator
IC2	ZRB500Y03 +5V voltage reference
IC3	LM324 quad op.amp
IC4	L4960 2.5A switching regulator

Miscellaneous

L1	150μH inductor, 3A rating minimum
FS1, FS3	20mm 2A quick-blow fuse (2 off)
FS2	20mm 1A ceramic fuse, mains rated
B1, B2	6V 7Ah sealed lead acid battery (2 off) (see text)
S1	3-pole 2-way toggle switch, 3A
TB1	5-way p.c.b. screw terminal block, 5mm pitch
TB2	4-way p.c.b. screw terminal block, 5mm pitch
TB3	2-way p.c.b. screw terminal block, 5mm pitch
PL1/SK1	chassis plug and line socket (for 12V Input) (see text)
PL2/SK2	chassis socket and line plug (for output) (see text)
PL3	IEC mains connector, male, chassis mounting
T1	230V mains transformer, twin 6V secondary windings, each 20VA min.

Printed circuit board, available from the *EPE PCB Service*, code 318; aluminium case, 102mm x 76mm x 38mm; 14-pin d.i.l. socket; fuseholder, 20mm, p.c.b. mounting (2 off); fuseholder, 20mm, panel mounting; l.e.d. clip, panel mounting (5 off); sheet aluminium, 15mm x 40mm (see text), transformer primary insulating shield; insulating boots for mains input plug and fuse FS2; mains lead; p.c.b. supports, plastic (4 off); test bulb and holder (see text); solder tags (2 off); battery spade connectors (2 pairs); materials for battery bracket; 3A mains rated wire; connecting wire; 4·7 ohm 3W test resistor (optional – see text); solder, etc.

The output appears at pin 7 and is smoothed by inductor L1 in conjunction with twin capacitors (both labelled C8) connected in parallel. During each pulse, current rises relatively slowly in L1 (as energy is "soaked up" to create the magnetic field) and charge flows into the capacitors and load.

During this time, diode D10 is reverse-biased and has no effect. When the output pulse falls, the resulting negative-going current is conducted through diode D10 rather than from the inductor and the load current is maintained from the stored energy. The process then repeats.

The specification of D10 and capacitor(s) C8 is especially important. Due to the rapid switching involved, the diode must be capable of switching on and off at high speed. It must therefore be of the fast recovery type and have a generous current rating (8A minimum).

Capacitor(s) C8 must have a low impedance at 100kHz and a working voltage of 50V d.c. minimum. Two capacitors in parallel are regarded as better than a single unit of double the value because this also reduces the impedance. These facts must be remembered if different components to those specified are used.

VOLTAGE STABILISATION

The output voltage is connected across the potential divider consisting of fixed resistors R16 and R17 and preset potentiometer VR2. The voltage appearing at the wiper of VR2 is connected to IC4's feedback input, pin 2. This is one input of an on-chip comparator (the error amplifier). Its other input is internally connected to a 5·1V reference source.

The difference between the two voltages is the "error" and this controls the mark/space ratio of the oscillator's output, the regulator varying its operation to reduce the error to zero.

Preset VR2 is adjusted so that the output voltage is at the required value. If it rises, the voltage at the wiper will exceed the reference value and the oscillator "on" times will be reduced in relation to the "off" periods. If the output voltage falls, the "on" times will be increased. The regulator has

in-built short-circuit protection and it will "turn down" when approximately 2·5A is exceeded.

Resistor R14 and capacitor C5 connected in series to pin 3 (frequency compensation) determine the regulation loop gain characteristics. The values specified are those recommended by the manufacturer. Capacitor C6 connected to pin 6 (soft start) prevents a current surge when the regulator is switched on.

FINAL PROTECTION

Optional "last ditch" protection is provided by Zener diode D11, which is connected across the output after fuse FS3. This provides protection in the event of some catastrophic circuit failure resulting in a sudden rise in output voltage.

The Zener breakdown voltage is selected to be about 25 per cent higher than the output voltage so that it does not normally conduct. If the voltage tries to rise for some reason, the Zener diode clamps this at its breakdown voltage and a large current can flow through it. The current would be much greater than could be handled continuously but the fuse should blow quickly enough to prevent destruction of the Zener.

This is not guaranteed to be effective but to provide the best chance of success, a fast-blow fuse should be used for FS3. Also, the value of the fuse should be only a little greater than the maximum load on the output. Great care should be taken over all aspects of construction to prevent faults occurring in the first place.

Because of their rapid on-off action, switching regulators tend to generate radio-frequency interference (r.f.i.) which can flow into power supply lines or be radiated from the connecting wires. This can cause noises from the loudspeakers of radio equipment connected to the same supply or in the vicinity of the circuit.

This is not a problem here because the mains supply is disconnected when the regulator is operating. Also, interference cannot be radiated because the circuit is enclosed in an earthed metal box.

CONSTRUCTION

Construction is based on a single-sided printed circuit board (p.c.b.). The topside component layout and full size underside copper foil track master are shown in Fig.2.

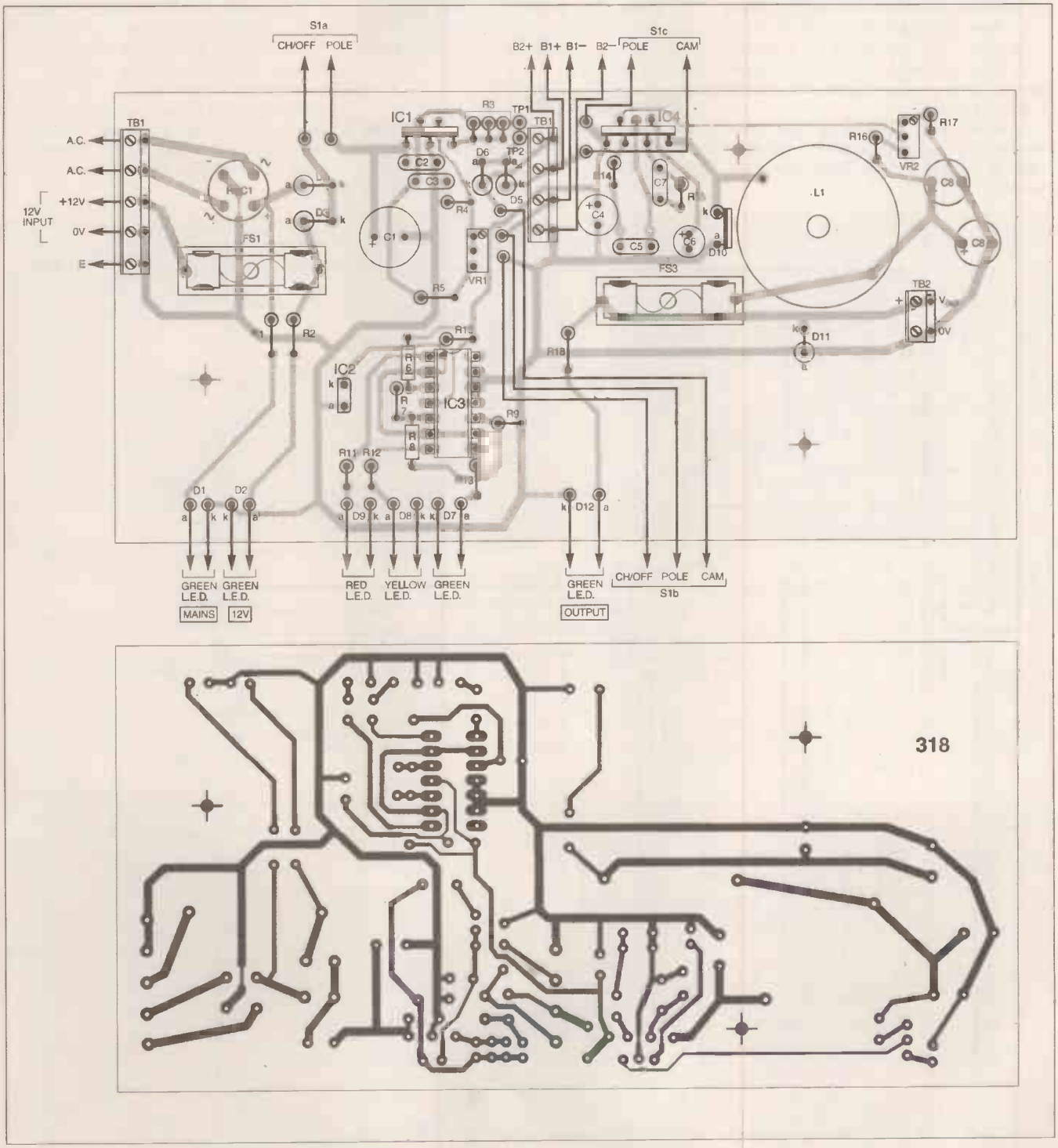


Fig.2. Printed circuit board component layout and full-size copper foil master track pattern for the Camcorder Power Supply.

This board is available from the *EPE PCB Service*, code 318.

Assemble the board in order of component size, observing the correct orientation of polarity-conscious components.

Note that the 4·7 ohm (4Ω7) resistor in the R3 group may need to be changed in value after the unit has been tested (to adjust the limiting current). To enable this to be done more easily, it could be soldered between a pair of solder pins or short wire "stalks". It would then be a simple matter of de-soldering it and replacing it with one of a different value.

The value of capacitor C5 (33n) may not be readily available. Provision has therefore been made to solder two capacitors in parallel, 10n and 22n, to give nearly the same value.

There are different manufactured styles for voltage reference device IC2. Some have three leads instead of two, in which case refer to the pin-out of the particular device (which your component supplier should have available) and cut off the unwanted lead.

Note that IC1, IC2 and IC3 are static-sensitive, so touch something which is earthed (such as a metal water tap) before handling their pins.

Leave the test point, TP1/TP2, link unmade at this time.

The l.e.d.s can be mounted directly to the p.c.b. with their leads bent at right angles to line up with holes in the case front panel. If the leads are too short, extension leads can be added, as was the case with the prototype.

A heatsink is needed for diode D10 (but not shown in the photograph) and this may be a piece of sheet aluminium having minimum dimensions of 15mm by 40mm bent through right angles and attached so as to maintain a clear gap with all internal parts. The diode's integral tab ***must not make metallic contact with anything else*** so, as a precaution, fit a mounting kit so that the tab is electrically isolated from the heatsink.

Solder 15cm pieces of stranded connecting wire of 3A rating minimum to switch S1 pads. Use different colours to avoid errors later.

BOXING UP

This circuit must be mounted in an Earthed metal box. Note that the metalwork is used as a heatsink for the regulators so these must be placed flat against the box. ***It is very important that no part of the circuit makes contact with the case.***

The 12V input and output connectors may be of any polarised type but must be sufficiently rated for the expected load. The 12V and camcorder connectors must be of a different pattern so that the cables cannot be interchanged.

Mount the p.c.b. vertically on plastic stand-off insulators as shown in the photographs.

Using a suitable mounting bracket, attach the batteries securely in position. Make sure there is a clear space between the terminals and everything else. Partially discharged batteries should be used initially to allow correct testing of the charging circuit.

Refer to Fig.3 and complete the wiring, using stranded mains-type wire of 3A rating minimum. Insulate all mains connections so that they cannot be touched.

Make up a lead (or use a ready-made one) to connect the car cigar lighter socket to the 12V input observing the correct polarity. ***It is essential for an in-line fuseholder and 3A fuse to be included in this lead.***

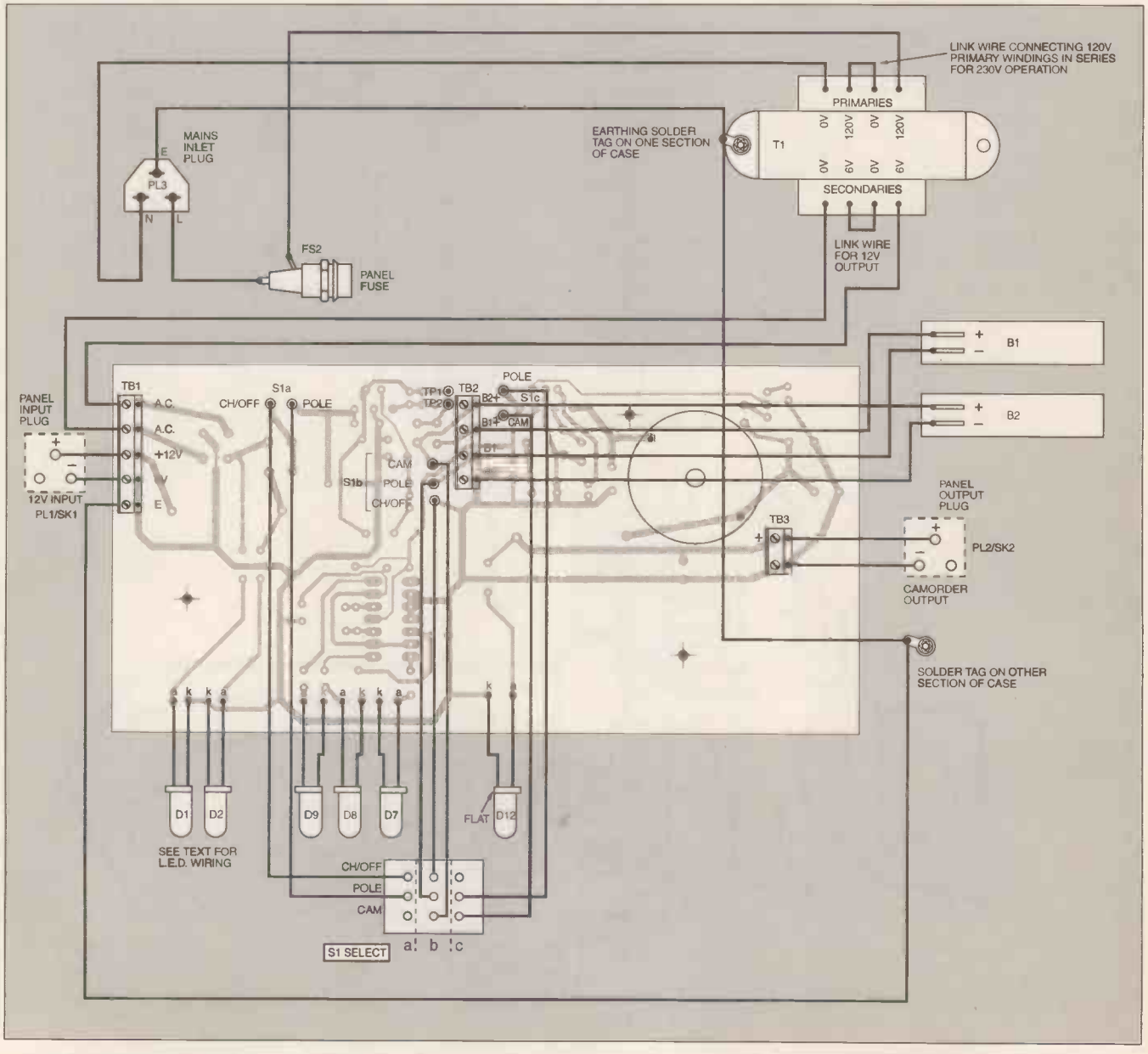


Fig.3. Interwiring between circuit board and off-board components. Use stranded mains-type wire of 3A rating minimum.

ADJUSTMENTS

Initial testing should be made using a 12V car battery or bench power supply.

Whenever a mains supply is plugged in, the case must be fully enclosed so that there is no access to internal parts.

Switch S1 to "CH/OFF" and connect the supply. The "12V" l.e.d. should operate. Adjust VR1 to give a voltage at test point TP1 of 7·7V.

Connect an ammeter between test points TP1 and TP2 and switch to "CH/OFF". If the ammeter reads less than 950mA, no action is needed. If it is too high, experiment by increasing the value of the 4Ω7 resistor in the R3 group until a satisfactory reading is achieved.

With the current limit set, permanently link TP1 to TP2.

Once the batteries have reached a reasonable charge level, set switch S1 to "CAM". Adjust preset VR2 until the correct voltage is obtained across the output terminals (SK2). If fuse FS3 blows, or regulator IC4 becomes hot, switch off immediately. Investigate and correct the fault before proceeding.

Note that the presence of Zener diode D11 will limit the maximum output voltage. It will also increase the current flow if IC4 tries to raise the voltage above the Zener threshold.

Make checks on the circuit using a filament bulb (6V rating for up to 7·2V and 12V for more than this) and run the battery pack down to "low". Check all aspects of operation and make certain the unit and camcorder operate correctly.

Disconnect the 12V test supply and plug into the mains. Check that the output voltage at SK2 is still the same.

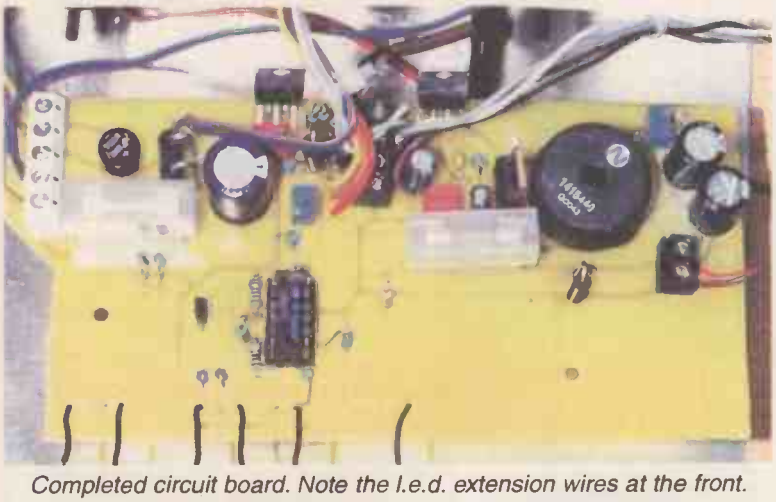
Now fully charge the batteries using the mains supply. After 30 minutes, then at hourly intervals, unplug the supply, remove the lid and check that nothing is excessively hot. If necessary, drill ventilation holes in the case but make sure they are small enough so that nothing conductive could be pushed through and touch a mains connection.

Internal view showing the p.c.b. bolted to the front panel and battery bracket.

FINALLY

When the unit is not in use, remember to return the mode switch to "CH/OFF". When in use, the batteries need recharging when only the red l.e.d. remains on (or when all l.e.d.s. are off!).

The unit should be removed from the camera bag while charging. This is because the bag would insulate the case and could cause the unit to overheat. □



Completed circuit board. Note the l.e.d. extension wires at the front.

Front panel component positioning.

£1 BARGAIN PACKS
Selected Items

PIEZO ELECTRIC SOUNDER, also operates efficiently as a microphone. Approximately 30mm diameter, easily mountable, 2 for £1. Order Ref: 1084.

LIQUID CRYSTAL DISPLAY on p.c.b. with i.c.s etc. to drive it to give 2 rows of 8 figures or letters with data. Order Ref: 1085.

30A PANEL MOUNTING TOGGLE SWITCH. Double-pole. Order Ref: 166.

SUB MIN TOGGLE SWITCHES. Pack of 3. Order Ref: 214.

HIGH POWER 3in. SPEAKER (11W 8ohm). Order Ref: 246.

MEDIUM WAVE PERMEABILITY TUNER. It's almost a complete radio with circuit. Order Ref: 247.

HEATING ELEMENT, mains voltage 100W, brass encased. Order Ref: 8.

MAINS MOTOR with gearbox giving 1 rev per 24 hours. Order Ref: 89.

ROUND POINTER KNOBS for flatted ¼in. spindles. Pack of 10. Order Ref: 295.

CERAMIC WAVE-CHANGE SWITCH. 12-pole, 3-way with ¼in. spindle. Order Ref: 303.

REVERSING SWITCH. 20A double-pole or 40A single pole. Order Ref: 343.

LUMINOUS PUSH-ON PUSH-OFF SWITCHES. Pack of 3. Order Ref: 373.

SLIDE SWITCHES. Single pole changeover. Pack of 10. Order Ref: 1053.

PAXOLIN PANEL. Approximately 12in. x 12in. Order Ref: 1033.

CLOCKWORK MOTOR. Suitable for up to 6 hours. Order Ref: 1038.

TRANSISTOR DRIVER TRANSFORMER. Maker's ref. no. LT44, impedance ratio 20k ohm to 1k ohm; centre tapped, 50p. Order Ref: 1/23R4.

HIGH CURRENT RELAY, 12V d.c. or 24V a.c., operates changeover cocntacts. Order Ref: 1026.

3-CONTACT MICROSWITCHES, operated with slightest touch, pack of 2. Order Ref: 861.

HIVAC NUMICATOR TUBE, Hivac ref XN3. Order Ref: 865 or XN11 Order Ref: 866.

2IN. ROUND LOUDSPEAKERS. 50Ω coil. Pack of 2. Order Ref: 908.

5K POT, standard size with DP switch, good length ¼in. spindle, pack of 2. Order Ref: 11R24.

13A PLUG, fully legal with insulated legs, pack of 3. Order Ref: GR19.

OPTO-SWITCH on p.c.b., size 2in. x 1in., pack of 2. Order Ref: GR21.

COMPONENT MOUNTING PANEL, heavy paxolin 10in. x 2in., 32 pairs of brass pillars for soldering binding components. Order Ref: 7RC26.

HIGH AMP THYRISTOR, normal 2 contacts from top, heavy threaded fixing underneath, think amperage to be at least 25A, pack of 2. Order Ref: 7FC43.

BRIDGE RECTIFIER, ideal for 12V to 24V charger at 5A, pack of 2. Order Ref: 1070.

TEST PRODS FOR MULTIMETER with 4mm sockets. Good length flexible lead. Order Ref: D86.

LUMINOUS ROCKER SWITCH, approximately 30mm square, pack of 2. Order Ref: D64.

MES LAMPHOLDERS slide on to ¼in. tag, pack of 10. Order Ref: 1054.

HALL EFFECT DEVICES, mounted on small heatsink, pack of 2. Order Ref: 1022.

12V POLARISED RELAY, 2 changeover contacts. Order Ref: 1032.

PROJECT CASE, 95mm x 66mm x 23mm with removable lid held by 4 screws, pack of 2. Order Ref: 876.

LARGE MICROSWITCHES, 20mm x 6mm x 10mm, changeover contacts, pack of 2. Order Ref: 826.

MAINS RELAY with 15A changeover contacts. Order Ref: 965.

COPPER CLAD PANELS, size 7in. x 4in., pack of 2. Order Ref: 973.

100M COIL OF CONNECTING WIRE. Order Ref: 685.

WHITE PROJECT BOX, 78mm x 115mm x 35mm. Order Ref: 106.

LEVER-OPERATED MICROSWITCHES, ex-equipment, batch tested, any faulty would be replaced, pack of 10. Order Ref: 755.

MAINS TRANSFORMER, 12V-0V-12V, 6W. Order Ref: 811.

THIS MONTH'S SPECIAL

IT IS A DIGITAL MULTITESTER, complete with backrest to stand it and hands-free test prod holder. This tester measures d.c. volts up to 1,000 and a.c. volts up to 750; d.c. current up to 10A and resistance up to 2 megs. Also tests transistors and diodes and has an internal buzzer for continuity tests. Comes complete with test prods, battery and instructions. Price £6.99. Order Ref: 7P29.

1mA PANEL METER. Approximately 80mm x 55mm, front engraved 0-100. Price £1.50 each. Order Ref: 1/16R2.

VERY THIN DRILLS. 12 assorted sizes vary between 0·6mm and 1·6mm. Price £1. Order Ref: 128.

EVEN THINNER DRILLS. 12 that vary between 0·1mm and 0·5mm. Price £1. Order Ref:129.

BT PLUG WITH TWIN SOCKET. Enables you to plug 2 telephones into the one socket for all normal BT plugs. Price £1.50. Order Ref: 1.5P50.

D.C. MOTOR WITH GEARBOX. Size 60mm long, 30mm diameter. Very powerful, operates off any voltage between 6V and 24V D.C. Speed at 6V is 200 rpm, speed controller available. Special price £3 each. Order Ref: 3P108.

FLASHING BEACON. Ideal for putting on a van, a tractor or any vehicle that should always be seen. Uses a Xenon tube and has an amber coloured dome. Separate fixing base is included so unit can be put away if desirable. Price £5. Order Ref: 5P267.

MOST USEFUL POWER SUPPLY. Rated at 9V 1A, this plugs into a 13A socket, is really nicely boxed. £2. Order Ref: 2P733.

MOTOR SPEED CONTROLLER. These are suitable for D.C. motors for voltages up to 12V and any power up to 1/6h.p. They reduce the speed by intermittent full voltage pulses so there should be no loss of power. In kit form these are £12. Order Ref: 12P34. Or made up and tested, £20. Order Ref: 20P39.

BT TELEPHONE EXTENSION WIRE. This is proper heavy duty cable for running around the skirting board when you want to make a permanent extension. 4 cores properly colour coded, 25m length. Only £1. Order Ref:1067.

LARGE TYPE MICROSWITCH with 2in. lever, changeover contacts rated at 15A at 250V, 2 for £1. Order Ref: 1/2R7.

BALANCE ASSEMBLY KITS. Japanese made, when assembled ideal for chemical experiments, complete with tweezers and 6 weights 0·5 to 5 grams. Price £2. Order Ref: 2P44.

CYCLE LAMP BARGAIN. You can have 100 6V 0·5A MES bulbs for just £2.50 or 1,000 for £20. They are beautifully made, slightly larger than the standard 6·3V pilot bulb so they would be ideal for making displays for night lights and similar applications.

DOORBELL PSU. This has AC voltage output so is ideal for operating most doorbells. The unit is totally enclosed so perfectly safe and it plugs into a 13A socket. Price only £1. Order Ref: 1/30R1.

INSULATION TESTER WITH MULTIMETER. Internally generates voltages which enable you to read insulation directly in megohms. The multi-meter has four ranges, AC/DC volts, 3 ranges DC milliamps, 3 ranges resistance and 5 amp range. These instruments are ex-British Telecom but in very good condition, tested and guaranteed OK, probably cost at least £50 each, yours for only £7.50 with leads, carrying case £2 extra. Order Ref: 7.5P4.

REPAIRABLE METERS. We have some of the above testers but slightly faulty, not working on all ranges, should be repairable, we supply diagram, £3. Order Ref: 3P176.

TWO MORE POST OFFICE INSTRUMENTS

Both instruments contain lots of useful parts, including sub-min toggle switch sold by many at £1 each. They are both in extremely nice cases, with battery compartment and flexible carrying handles, so if you don't need the intruments themselves, the case may be just right for a project you have in mind.

The first is **Oscillator 87F.** This has an output, continuous or interrupted, of 1kHz. It is in a plastic box size 115mm wide, 145mm high and 50mm deep. Price only £1. Order Ref: 7R1.

The other is **Amplifier Ref. No. 109G.** This is in a case size 80mm wide, 130mm high and 35mm deep. Price £1. Order Ref: 7R2.

HEAVY DUTY POT

Rated at 25W, this is 20 ohm resistance so it could be just right for speed controlling a d.c. motor or device or to control the output of a high current amplifier. Price £1. Order Ref: 1/33L1.

STEPPER MOTOR

Made by Philips as specified for the wind-up torch in the Oct '00 Practical Electronics is still available, price £2. Order Ref: 2P457.

SOLDERING IRON, super mains powered with long-life ceramic element, heavy duty 40W for the extra special job, complete with plated wire stand and 245mm lead, £3. Order Ref: 3P221.

RELAYS

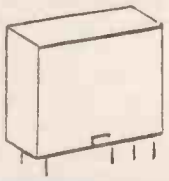
We have thousands of relays of various sorts in stock, so if you need anything special give us a ring. A few new ones that have just arrived are special in that they are plug-in and come complete with a special base which enables you to check voltages of connections of it without having to go underneath. We have 6 different types with varying coil voltages and contact arrangements. All contacts are rated at 10A 250V AC.

Coil Voltage	Contacts	Price	Order Ref:
12V DC	4-pole changeover	£2.00	FR10
24V DC	2-pole changeover	£1.50	FR12
24V DC	4-pole changeover	£2.00	FR13
240V AC	1-pole changeover	£1.50	FR14
240V AC	4-pole changeover	£2.00	FR15

Prices include base

MINI POWER RELAYS

For p.c.b. mounting, size 28mm x 25mm x 12mm, all have 16A changeover contacts for up to 250V. Four versions available, they all look the same but have different coils:



6V Order Ref: FR17
12V Order Ref: FR18
24V Order Ref: FR19
48V Order Ref: FR20

Price £1 each less 10% if ordered in quantities of 10, same or mixed values.

NOT MUCH BIGGER THAN AN OXO CUBE. Another relay just arrived is extra small with a 12V coil and 6A changeover contacts. It is sealed so it can be mounted in any position or on a p.c.b. Price 75p each, 10 for £6 or 100 for £50. Order Ref: FR16.

RECHARGEABLE NICAD BATTERIES. AA size, 25p each, which is a real bargain considering many firms charge as much as £2 each. These are in packs of 10, coupled together with an output lead so are a 12V unit but easily divideable into 2 x 6V or 10 x 1·2V. £2.50 per pack, 10 packs for £25 including carriage. Order Ref: 2.5P34.

FOR QUICK HOOK-UPS. You can't beat leads with a croc clip each end. You can have a set of 10 leads, 2 each of 5 assorted colours with insulated crocodile clips on each end. Lead length 36cm, £2 per set. Order Ref: 2P459.

BIG 12V TRANSFORMER. It is 55VA so that is over 4A which is normal working, intermittently it would be a much higher amperage. Beautiful transformer, well made and very well insulated, terminals are in a plastic frame so can't be accidentally touched. Price £3.50. Order Ref: 3.5P20.

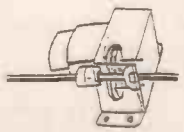
BUY ONE GET ONE FREE

ULTRASONIC MOVEMENT DETECTOR. Nicely cased, free standing, has internal alarm which can be silenced. Also has connections for external speaker or light. Price £10. Order Ref: 10P154.

CASED POWER SUPPLIES which, with a few small extra components and a bit of modifying, would give 12V at 10A. Originally £9.50 each, now 2 for £9.50. Order Ref: 9.5P4.

3-OCTAVE KEYBOARDS with piano size keys, brand new, previous price £9.50, now 2 for the price of one. Order Ref: 9.5P5.

1·5V-6V MOTOR WITH GEARBOX. Motor is mounted on the gearbox which has interchangeable gears giving a range of speeds and motor torques. Comes with full instructions for changing gears and calculating speeds, £7. Order Ref: 7P26.



MINI BLOWER HEATER. 1kW, ideal for under desk or airing cupboard, etc., needs only a simple mounting frame, price £5. Order Ref: 5P23.

TERMS

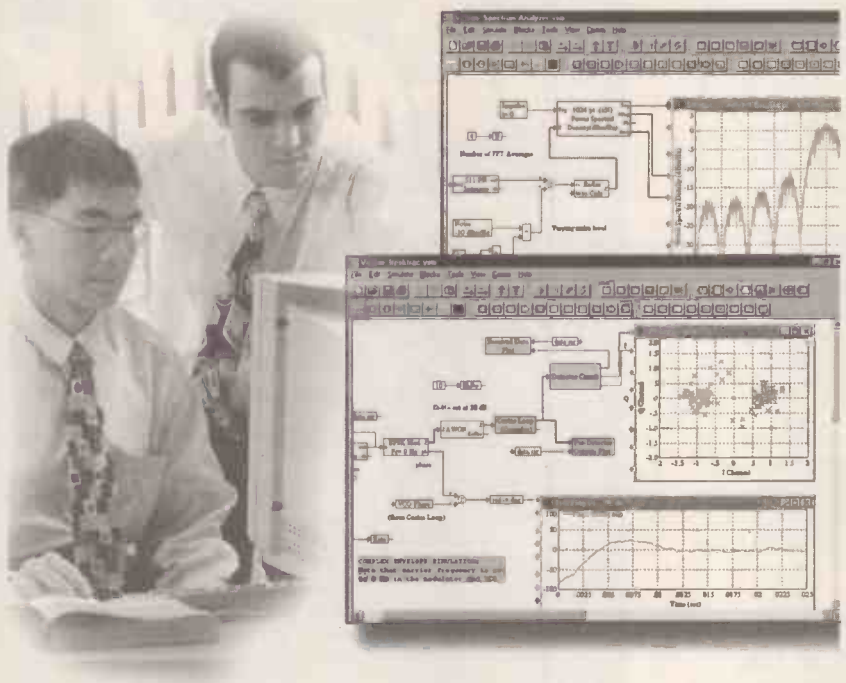
Send cash, PO, cheque or quote credit card number – orders under £25 add £4.50 service charge.

J & N FACTORS
Pilgrim Works (Dept.E.E.)
Stairbridge Lane, Bolney
Sussex RH17 5PA
Telephone: 01444 881965
E-mail: jnfactors@aol.com

News . . .

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

COMMSIM FOR EWB



ADEPT Scientific has announced the introduction of Commsim, a new product from Electronics Workbench. Commsim is a powerful and easy to use Windows-based simulation environment for modelling analogue, digital or mixed-signal networks.

Commsim offers hundreds of communication and maths blocks for powerful yet intuitive design, so modelling and simulation can be performed, say Adept, without having to write a single line of code. The product reflects the new system level approach currently being taught in colleges and universities throughout the world to introduce electronics and its real world applications to engineering students.

Consistent with the approach taken by other renowned Electronics Workbench products, Commsim offers both hierarchical modelling and embedded compound blocks, facilitating rapid prototyping. Once designed the system can be simulated to determine its performance under a variety of operating conditions.

For more information contact Anna Moorhouse, Dept. EPE, Adept Scientific plc, Amor Way, Letchworth, Herts SG6 1ZA. Tel: 01462 480055. Fax: 01462 480213.

E-mail ewb@adeptscience.co.uk. Web: www.adeptscience.co.uk.

LEICESTER SHOW

The *30th Leicester Amateur Radio Show* (LARS) will be held at Donington Park, on 21 and 22 September 2001.

LARS is cllaimed to be the UK's largest amateur radio, computing and electronics event. For further information contact LARS committee member G. W. Dover G4AFJ, 31 Newbold Road, Kirkby Mallory, Leics LE9 7QG.

Tel: 01455 823344. Fax: 01455 828273.

E-mail: g4afj@argonet.co.uk.

Web: www.lars.org.uk.

Please mention *EPE* when contacting.

ENERGY FACTS

The Department of Trade and Industry has recently sent information on Energy Statistics for period February to April 2001.

It is interesting to note that the production of primary fuels such as coal and other solid fuels, petrol, gas and electricity, is actually down by 6·9 per cent compared to the same period last year. As to quite how this squares with the 3·9 per cent *rise* in consumption of the same fuels in that period is unclear, presumably it means we are importing more.

For more information, browse **www.dti.gov/energy/energystats/energystats.htm.**

V92 MODEMS

By Barry Fox

IF you are buying a new modem, be sure it carries the telltale mark "V92 Ready". Otherwise you will miss out on the chance to access the Internet more quickly, and do so with a single conventional phone line without blocking speech calls.

A V92 modem with Quick Connect can halve tiresome logon times. Modem on Hold pauses the PC while it is Internet surfing, to let the user take an incoming speech call on the same phone line. When the talking stops, the PC clicks back to the Internet without the need to redial.

The International Telecommunications Union sets the V standards which ensure that modems round the world talk to each other. V90, as now widely used, pushes the data capacity of phone lines to their practical limit, by receiving at up to 56Kbps and sending at up to 33.6Kbps.

Because reliable working speed varies with line quality, existing V90 modems waste up to a minute each time a connection is made by "handshaking" with line test signals. If the phone line has a call-waiting service, which sends bleep tones down the line to warn that someone is trying to make a voice call while the line is engaged, existing modems often mistake call-waiting for a disconnect tone and hang up on the Internet, without giving the surfer any choices.

A V92 modem solves both these problems with non-volatile memory which builds a library of previous settings. When the modem dials an Internet service with matching software they quickly recognise a known situation and skip the rest of the handshake.

The V92 modem also recognises a call-waiting tone for what it is, puts the Internet connection on hold and then uses the stored settings to reconnect quickly when the speech caller hangs up.

Connexant, the spin-off from modem chip maker Rockwell which has driven V92, expects ISPs to offer the services by the end of this year. Some modems already promise V92 in the small print. Clearer publicity might spoil V90 sales.

ELECTROMAIL CEASES MAIL ORDER

Electromail (a division of RS Components) have confirmed that they have ceased to provide a mail order service. However, it is still possible to purchase RS goods on credit card (only), either via the web site **http://rswww.com** or via telephone to 01536 444079.

MUSICAL DRIVE-BY

Barry Fox

If you are driving along and your car suddenly starts singing, you can probably thank Gert van der Merwe of South Africa. His international patent filing WO 01/32989 tells how it's done.

A series of small metal ridges is built into the road, like miniature sleeping policeman speed humps. The ridges are around 15mm apart and in a pattern that matches the peaks of a musical waveform. So the car vibrates to play a tune. If slightly different sets of ridges are formed, to the left and right of the road, the car vibrates in stereo sympathy. The ridges can be temporary, on a mat laid on the road alongside an advertising sign, to play a matching jingle.

NRPB VIDEO

"Mobile Telephony and Health" is the title of a 30-minute VHS video produced by NPRP (National Radiological Protection Board). It provides a timely, digestible review of the current state of knowledge about possible health effects of mobile phone handsets and the associated mobile transmission masts.

There are documentary style interviews with leading scientists in the field, and members of the Independent Expert Group on Mobile Phones whose report was published last year.

The video has been produced professionally and contains graphics and other material to illustrate points made. For example, there are useful graphic sequences showing how mobile phones work, what the possible heating effects could be in the head and how people are exposed to transmissions from masts.

NRPB felt there was a need for a video giving straightforward, factual information about mobile phones and health issues. There is a charge of £6.00 and copies can be obtained from Information Services, NRPB, Chilton, Didcot, Oxon OX11 0RQ, or by telephoning Jane True/Jill Cook on 01235 822742 to order by major credit cards.

The NRPB's web site is at **www.nrpb.org.uk**.

SONY'S TECHNOLOOK

Sony has announced the development of a comprehensive range of TechnoLook products, following the successful introduction of its first video microscope last year. The expanded TechnoLook range includes higher magnification and semi-digital models, taking the first step towards a fully digital microscope.

Rudy Cosjins, Sony General Manager for Visual Solutions Marketing Europe, comments, "Sony tackled a number of major issues faced by users of traditional microscopes with the introduction of the TechnoLook. Our aim was to create an easy to use product that could be connected to a PC, eliminate eyestrain and reduce neck and back problems."

For more information contact Sony United Kingdom, Pippa Copeman-Hill, Corporate Communications. Tel: 01932 816488. Fax: 01932 817029. E-mail: pippa.copeman-hill@eu.sony.com. Web: www.sony.com.

TETRA AND HEALTH

In the National news recently, concerns have been raised about possible health effects of exposure to radio frequency (r.f.) radiation via TETRA (Terrestrial Trunked Radio) cables. TETRA is the new digital radio system for use by commercial organisations and the emergency services. Its operation results in pulse modulation of the r.f. signal at a low frequency (17·6Hz).

The National Radiological Protection Board (NRPB) has sent us the following statement on behalf of AGNIR, the NRPB Advisory Group on Non-ionising Radiation:

"Agnir has reviewed the features of operation of the TETRA system, the likely levels of exposure of people, and studies relevant to the assessment of any biological effects. It has noted that the signals from base stations are not pulsed whereas those from hand portables and from terminals built into vehicles are.

"Agnir has concluded that although areas of uncertainty remain about the biological effects of low-level r.f. radiation in general, including modulated signals, current evidence suggests that it is unlikely that the special features of signals from TETRA hand portables and terminals mounted in vehicles pose a hazard to health."

For more information contact NRPB, Chilton, Didcot, Oxon, OX11 0RQ. Tel: 01235 822744. Fax: 01235 822746. Web: www.nrpb.org.uk.

SPECIAL READER OFFER - SEE WEBSITE FOR DETAILS

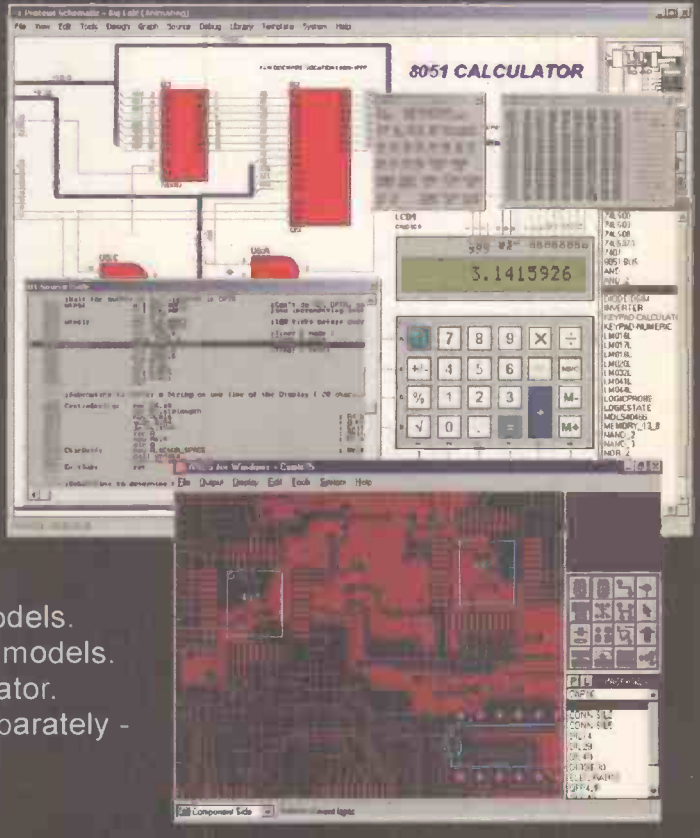
PROTEUS VSM

Virtual System Modelling

Build It In Cyberspace

www.labcenter.co.uk

Develop and test complete micro-controller designs without building a physical prototype. PROTEUS VSM simulates the CPU and any additional electronics used in your designs. And it does so in real time. *



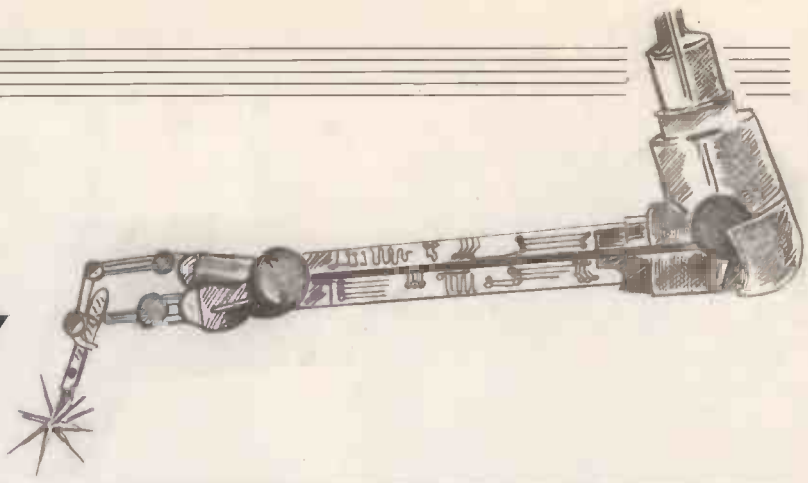
- CPU models for PIC and 8051 and series micro-controllers available now. 68HC11 comming soon. More CPU models under development. See website for latest info.
- Interactive device models include LCD displays, RS232 terminal, universal keypad plus a range of switches, buttons, pots, LEDs, 7 segment displays and much more.
- Extensive debugging facilities including register and memory contents, breakpoints and single step modes.
- Source level debugging supported for selected development tools.
- Integrated 'make' utility - compile and simulate with one keystroke.
- Over 4000 standard SPICE models included. Fully compatible with manufacturers' SPICE models.
- DLL interfaces provided for application specific models.
- Based on SPICE3F5 mixed mode circuit simulator.
- CPU and interactive device models are sold separately - build up your VSM system in affordable stages.
- ARES Lite PCB Layout also available.

Labcenter Electronics

*E.g. PROTEUS VSM can simulate an 8051 clocked at 12MHz on a 300MHz Pentium II

Write, phone or fax for your free demo CD - or email info@labcenter.co.uk.
Tel: 01756 753440. Fax: 01756 752857. 53-55 Main St, Grassington. BD23 5AA.

CIRCUIT SURGERY



ALAN WINSTANLEY and IAN BELL

Out consultant troubleshooters take a look at basic heatsink calculations this month

LAST month we outlined some of the basic considerations related to the power and heat dissipated by components. Without doubt some parts (e.g. mains transformers) can become very hot indeed even in normal operation, especially if they are mounted on plastic cases which don't dissipate heat very well at all. Hopefully, adequate ventilation will be available to help with the throughflow of air. Obviously, bolting such parts to a steel or aluminium chassis will help dissipate heat.

The point was made last month that heatsinks are often necessary on certain devices – regulator chips or power transistors for example – but if the heatsinks become very hot it's usually just a sign that the heatsink is doing its job of conveying heat from the regulator. If the heatsink system has been correctly designed, it will prevent the semiconductor junction from exceeding the manufacturer's maximum temperature rating.

Although a wide variety of parts (e.g. 3-pin regulators) have built-in thermal overload protection, relying on this feature is not a good way of compensating for the use of inadequate heatsinking; thermal cycling between extremes of temperature may ultimately "stress" the device leading to premature failure over time.

Thermal Resistance

In this month's *Circuit Surgery* we describe the basic procedure for selecting the correct heatsink for a device. The idea is to carry heat away from the part that matters most – the semiconductor junction or i.c. die. Just as electric current flows through a conductor, heat flows from a semiconductor chip to the outside ambient air also through a path of "conductors" – air, metals and alloys which carry the heat away through a *thermal conduction* action. Hence, anything getting in the way of this path adds to the system's overall *thermal resistance*, preventing the heat from being conveyed so efficiently.

Thermal resistance is measured in °C/Watt – it indicates how much the temperature will increase across a "thermal resistor" for a given power dissipation. A large, expensive heatsink rated at 1°C/W increases temperature by only one degree per watt of power dissipated, and is far more efficient (because it has a much lower thermal resistance) than a small heatsink of, say, 25°C/W.

A typical heatsink system contains the elements described in the photo. This could represent any power transistor containing a junction, or say a voltage regulator chip such as a the TO-3 type opened up for the photograph. The requirement is to ensure that the semiconductor junction temperature (symbol T_J) does not exceed a figure of 125°C usually, a typical value specified by data sheets.

The junction is at the heart of the package, but unfortunately for us, various elements of the system hinder the passage of heat and have to be accounted for. Everything possesses a thermal resistance, symbol θ (theta), which can be sub-defined as follows:

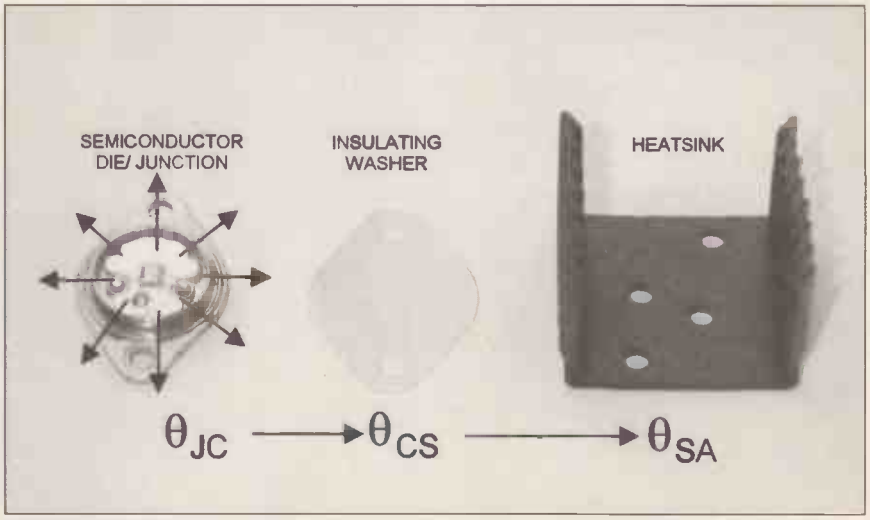
θ_{JC} – thermal resistance between junction and the case;

θ_{CS} – thermal resistance between the case and heatsink;

θ_{SA} – thermal resistance between heatsink and ambient.

The electronics designer will hopefully see a number of "thermal resistors" in series: each resistor prevents heat from flowing to ambient, so heatsink design implies calculating to ensure that the overall thermal resistance of the system is not so large as to prevent heat flowing away efficiently, or this will result in the semiconductor junction producing more heat than can be carried away effectively.

A TO-3 can style regulator sawn off to reveal the i.c. chip inside.



A typical assembly showing how the thermal resistance is divided between the device and heatsink.

On the Case

The first item θ_{JC} corresponds to the material between the junction and the case wall. The junction of a TO-3 device will be fixed to a steel base, but the case might also be packed with thermal conductive grease to help improve (reduce) the thermal resistance; it is usually just full of fresh air though.

A junction mounted in a TO-202 or TO-220 device will be embedded in a plastic resin, not known for its heat conducting properties but the metal tab is there to help with heatsinking.

Manufacturers' data sheets give the values for the thermal resistances of different case types. For comparison National Semiconductor quotes θ_{JC} of 3°C/W for a TO-3 LM320 regulator, 4°C/W for the TO-220 and 12°C/W for the TO-202 version. The differences in thermal efficiencies are obvious.

The next parameter θ_{CS} relates to the thermal resistance between the case and sink (heatsink). This means an insulating washer as shown in the photo, perhaps with a smear of thermal conductive grease. You might want to allow say 0·5°C/W for this.

Lastly θ_{SA} – the thermal resistance between the heatsink and ambient temperature which is actually the thermal resistance of the heatsink itself. In some catalogues, it is shown as R_{th}. Some typical heatsinks are shown in the photo, including types intended for integrated circuits.

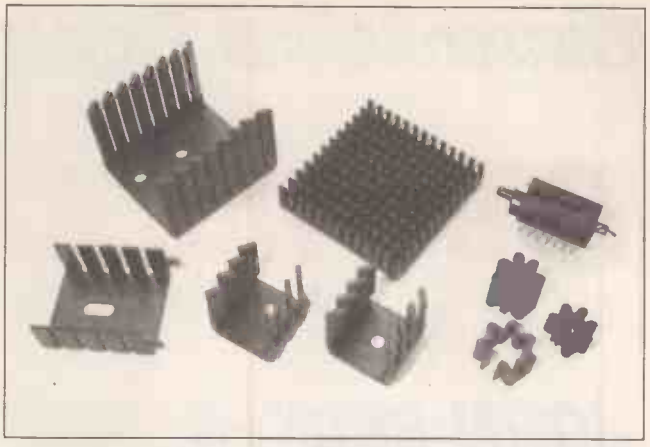
Choose a Heatsink

Let's now look at a typical design example. A semiconductor is calculated to be dissipating 10 watts (some quick V × I calculations told us that). The first question is, what is the device's ambient temperature (T_A) likely to be? This directly affects our calculation and it depends on ventilation and the proximity of any other hot devices.

For now let us say that it is 40°C. Therefore, if the maximum junction temperature permitted is 125°C, the total permissible thermal resistance from end to end is (125 – 40)/10 Watts = 8·5°C/W. Suddenly, those heatsink ratings need scrutinising carefully!

Breaking it down further, we would firstly pick a semiconductor package with an appropriate thermal resistance θ_{JC}. If we were using an LM320 regulator we could rule out the TO-202 package, a 12°C/W device. Choosing a TO-3 package, that accounts for 3°C/W already of our total permitted thermal resistance.

You might also add in say 0·5°C/W for silicon grease and a washer (θ_{CS}) leaving us with a value of 5°C/W remaining for the heatsink. If this value is exceeded then heat may not be dissipated efficiently enough to prevent the junction overheating.



A selection of heatsinks including types to fit integrated circuits.

Stay Cool

Clearly the likely ambient temperature surrounding the assembly directly affects the heatsink specification. This factor relates to ventilation and cabinet or circuit board layout. A cooler ambient figure of 25°C makes life easier for the semiconductor, it means the overall thermal resistance allowed can be raised to 10°C/W. A higher ambient – 65°C say – and you are left with a total value of 6°C/W, implying a heftier heatsink rating of 2·5°C/W. What effect would using the smaller TO-220 package have instead? The higher thermal resistance means that a better heatsink would be required.

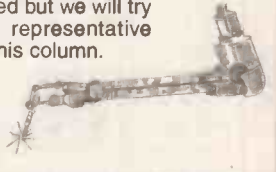
There is often the need to compromise somewhere along the line. Larger heatsinks are costlier and take up more space, implying a larger and more expensive cabinet. Looking at it another way, if a TO-3 device is used on a 2·5°C/W heatsink with silicon grease, then the maximum permissible ambient temperature allowed is 65°. Heatsinks might be mounted on the outside of a box with a lower ambient temperature, rather than being fixed within, at a much higher temperature. All these aspects should be borne in mind by the budding designer.

Some really purposeful-looking heatsinks are available which include 10in. diameter fan-assisted cooling to lower their thermal resistance to a staggering 0·03°C/Watt: unfortunately they cost nearly £250 ($350) without the fan! Computer enthusiasts will be well aware of the need to fan-cool processor and video chips and a wide variety of very impressive-looking processor fans with heatsinks are now available.

AW

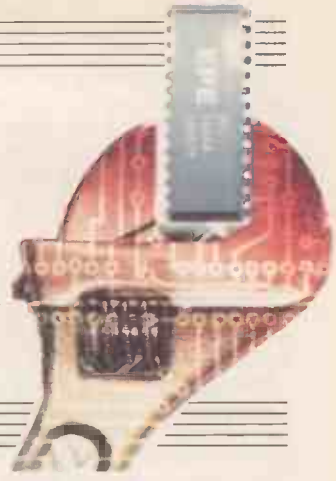
CIRCUIT THERAPY

Circuit Surgery is your column. If you have any queries or comments, please write to: Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset, BH22 9ND. E-mail (no attachments) **alan@epemag.co.uk**. Please indicate if your query is not for publication. A personal reply cannot be guaranteed but we will try to publish representative answers in this column.



Constructional Project

PIC TOOLKIT Mk3



JOHN BECKER

By popular demand – an enhanced PIC microcontroller programming development board.

THIS PIC-programming printed circuit board has been designed for use with the software for the new Windows-based *Toolkit TK3*, to be described next month, and the DOS-based *Toolkit V2.4*, originally released in May/June '99.

The board has been introduced following readership suggestions about how the original Mk2 board could be beneficially extended to allow its greater use as a PIC design development facility.

The Mk2 board was principally designed as a platform on which various PIC types could be programmed via the accompanying software. Whilst it provided limited access to the pins of an on-board PIC16x84 microcontroller, allowing it to be used *in situ* as the rudimentary heart of a developing hardware circuit, it did not offer direct access to all pins of the larger PIC16F87x family that could be programmed on it.

This new board design is intended to rectify this situation, allowing the four PIC sizes that it can accept to be hard-wired not only to additional on-board hardware, but also external components in conjunction with an optional plug-in breadboard. In this context, it is not only a programmer, but its options are also closely allied to the facilities available on the highly successful *EPE PIC Tutorial* board of Mar-May '98.

Direct connection of the programming lines can be made to external PIC-controlled circuits under development or final completion (such as published *EPE* PIC-based designs).

The notable difference between the *PIC Tutorial* board and that of Toolkit Mk3 is that the latter, like its Mk2 predecessor, is under complete programming control by the connected PC-compatible computer. The *Tutorial* board, you may recall, had to be manually switched at different stages of the programming procedure.

TOOLKIT Mk3 CIRCUIT

The main circuit diagram for the PIC Toolkit Mk3 board is shown in Fig.1.

Electronically, the circuit is essentially the same as that for the Mk2 board. Connections between the PC-compatible computer and the board are made via the parallel printer port and a standard connector cable. The connections are buffered by IC2a to IC2e, ensuring that the input and output signals are maintained at optimum logic levels.

The input signals also have ballast and pull-down resistors, R1 to R8. The ballast resistors protect the connected computer output lines when the board is unpowered. The pull-down resistors provide a 0V bias to the buffer inputs when the computer is unpowered, or the port connector is unplugged.

Data and clock signals are brought in via printer port lines DA0 and DA1. Reset control of the PIC is via port line DA3, and programming mode control via DA4.

A fifth port line connection, ACK, sends signals back to the computer during PIC data reading, such as is required in code verification and disassembly modes.

A new sixth connection has been added, between IC2 pin 2 and the $\overline{\text{BUSY}}$ line at connector pin 11. This allows the software to check that the printer port cable is connected and the p.c.b. power is switched on.

MULTIPLEXER

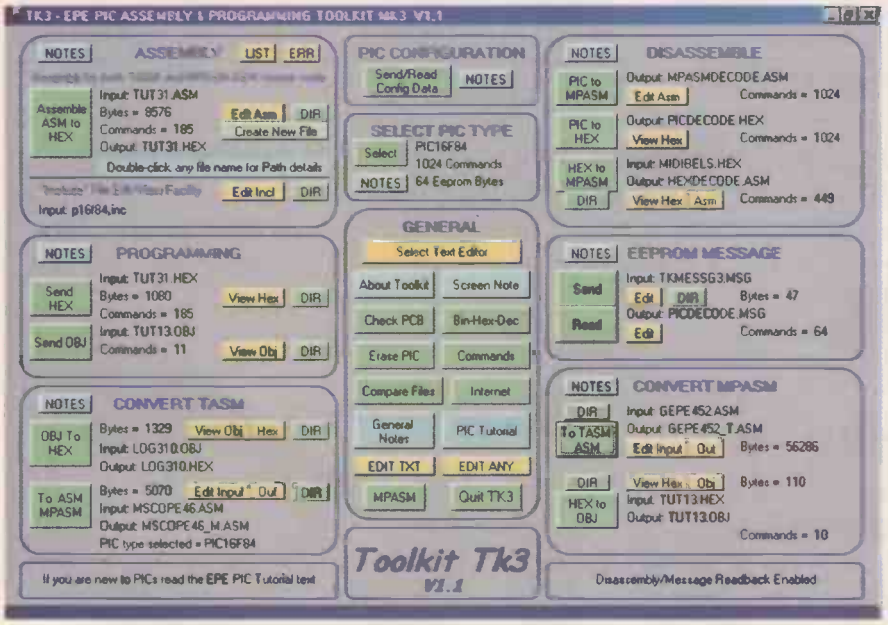
Multiplexer IC3 is a 3-channel 2-way "changeover switch" and routes the PIC's data and clock connections according to the programming or non-programming mode, which is controlled by port line DA4. The logic is illustrated in the block diagram in Fig.2.

During programming, the PIC's data and clock lines are connected to the Port's DA0 and DA1 lines. At other times they are disconnected from the port and routed as PIC data lines to any development circuit connected to them. This prevents the two PIC lines, and the computer, from being adversely affected by external circuit loads during programming.

The third 2-way path in IC3 controls the on-board voltage converter IC1, via its SHDN (shutdown) pin. When this pin is held low, during non-programming mode, IC1 outputs +5V via its V_{out} pin to the $\overline{\text{MCLR}}$ pins of the PIC(s), allowing the PIC to run its loaded program.

During programming mode, the SHDN pin is held at +5V and IC1 generates a V_{out} voltage of +12V, as required by the PIC at this time. Visual advice that the PIC is in programming mode is provided by l.e.d. D8, being turned on during programming and data read back.

When the PIC needs to be reset, port line DA3 is set high and turns on *npn* transistor TR1. This pulls the PIC $\overline{\text{MCLR}}$ pin



Typical main screen display of the controlling software described in the 16-page Free supplement to be published next month.

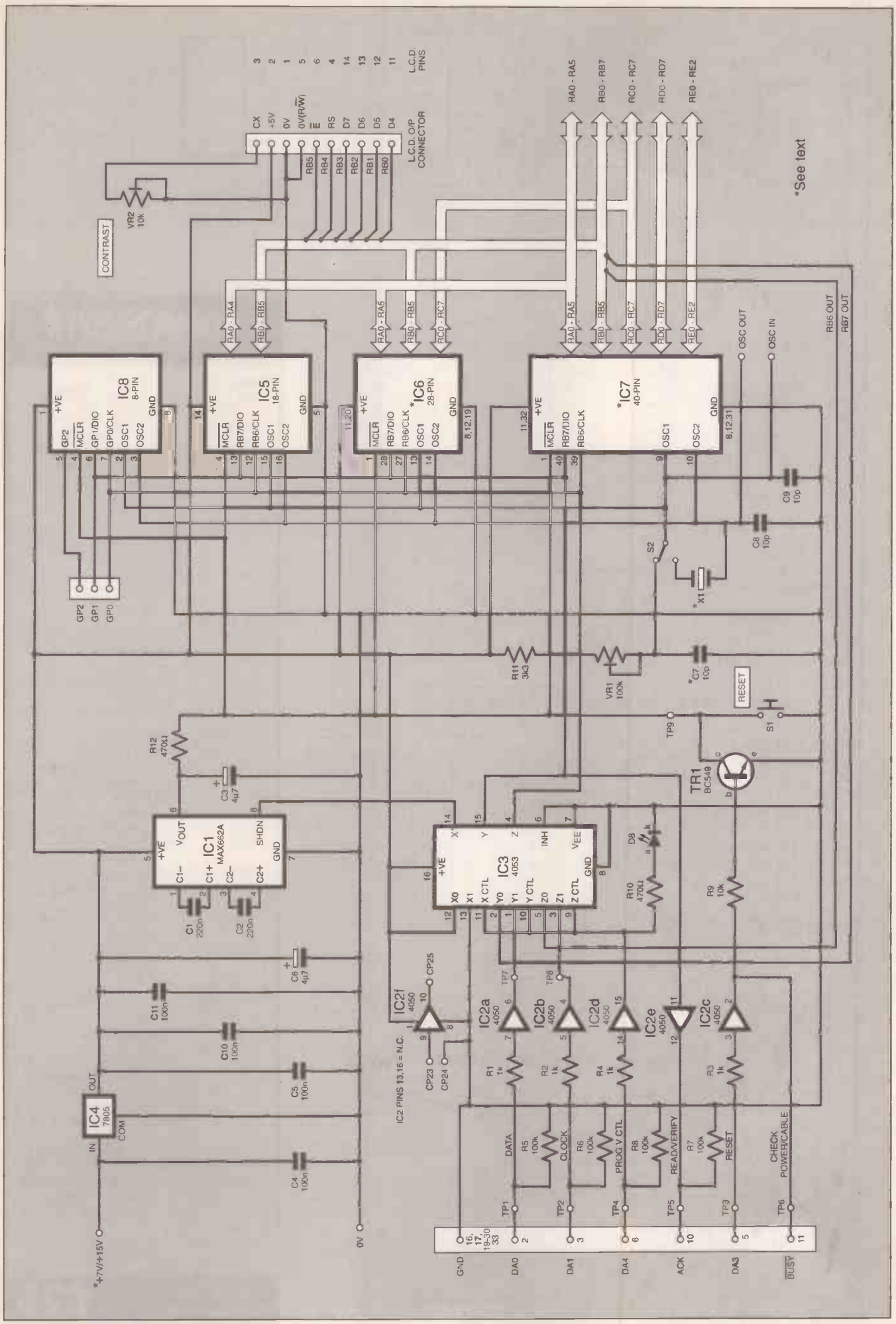


Fig.1. Main circuit diagram for the PIC Toolkit Mk3 printed circuit board.

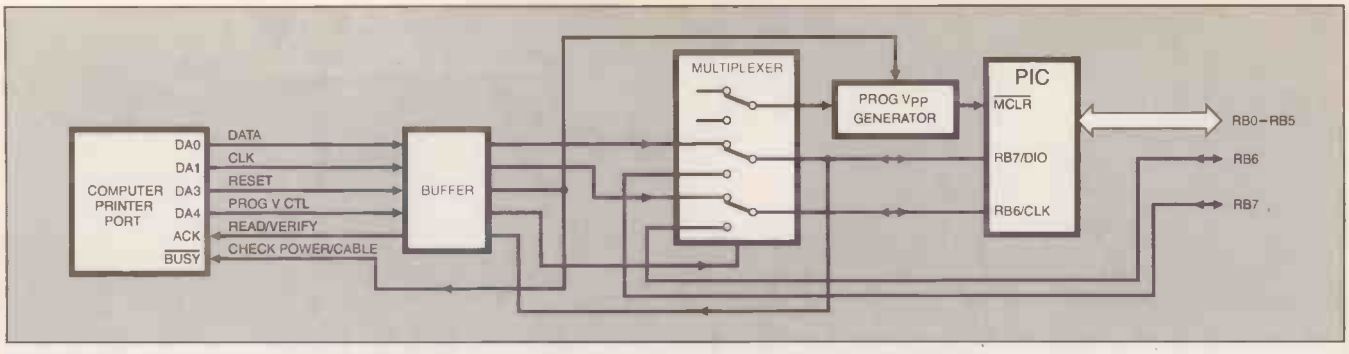


Fig.2. Block diagram illustrating the signal connection logic.

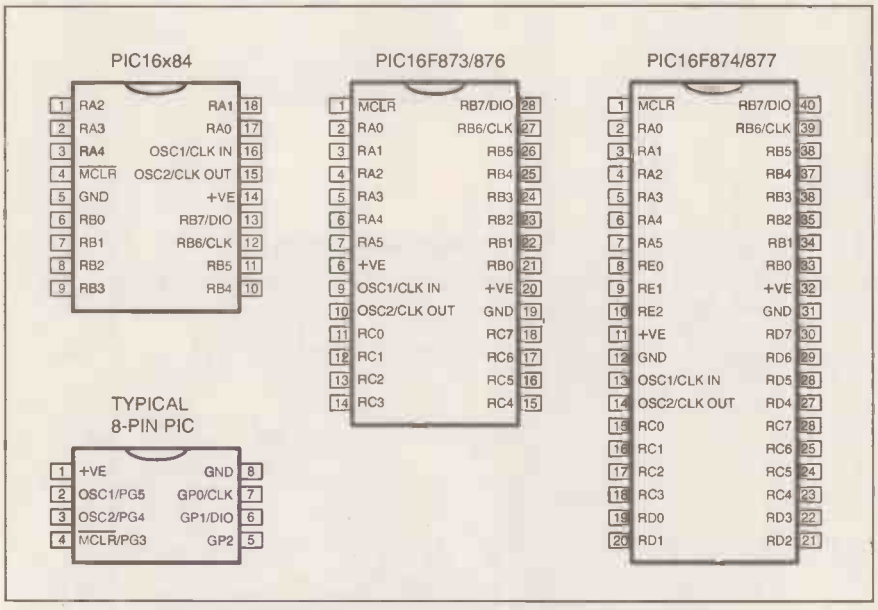


Fig.3. Pin-out identities for the PIC sockets on the p.c.b.

low, which is held in reset mode until DA3 goes low again. Ballast resistor R12 prevents IC1 V_{out} from being shorted to 0V during reset.

The PIC may also be reset manually by pushbutton switch S1. This facility is useful during code development, allowing the PIC to be repeatedly reset in order that some programmed actions can be observed from the beginning.

CONNECTION POINTS

The board has four PIC-insertion sockets, catering for 8-pin, 18-pin, 28-pin and 40-pin PICs (see Fig.3). The PICs are notated as IC5 to IC8 and their data input/output pins are variously combined onto five bus lines, as shown in Fig.1. The bus lines are terminated at pin header strips or terminal pins to which external circuit components can be connected.

The three larger sockets are intended for use with PIC16x84 and 'F87x devices, although it is likely that some other PIC types can also be programmed via them. The 8-pin socket has been included at reader suggestion. There are several small PICs that are likely to be suitable for programming via this socket, although none have been tested. Consult data sheets for PIC types not specifically mentioned here by name.

It is recommended that ZIF sockets are installed in any PIC position which is likely to be regularly used (but they are not made in 8-pin size so far as is known).

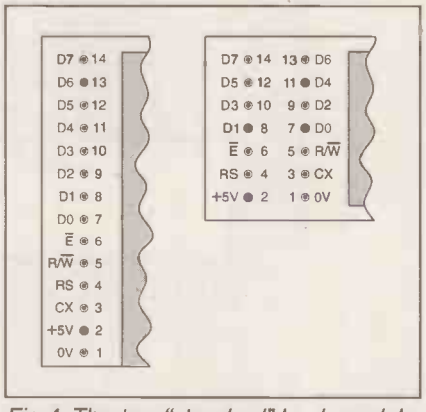


Fig.4. The two "standard" l.c.d. module pinout arrangements.

L.C.D. CONNECTION

An additional pin-header strip is connected to PIC port pins RB0 to RB5, which is intended for the plugged connection of an optional alphanumeric liquid crystal display (l.c.d.), whose typical pinouts are shown in Fig.4.

Also connected to this pin header are VR2, the l.c.d. contrast setting preset, and the +5V and 0V connections as required. All connections at this header are the same as specified in all the author's recent (since 1998) alphanumeric l.c.d. based PIC designs.

Magenta Electronics supply 2-line × 16-character (per line) l.c.d.s which have pre-connected sockets intended for plugging

COMPONENTS

See SHOP TALK page

Resistors

R1 to R4, R10, R11	1k (6 off)
R5 to R8	100k (4 off)
R9, R13 to R20	10k (9 off)
R12	470Ω
RM1	470Ω commoned 8-resistor module

Potentiometers

VR1	500k cermet preset, round
VR2, VR3	10k cermet preset, round (2 off)

Capacitors

C1, C2	220n ceramic disc (2 off)
C3, C6	4μ7 radial elect. 16V (2 off)
C4, C5	100n ceramic disc (2 off)
C7	see text
C8, C9	10p ceramic disc (2 off)

Semiconductors

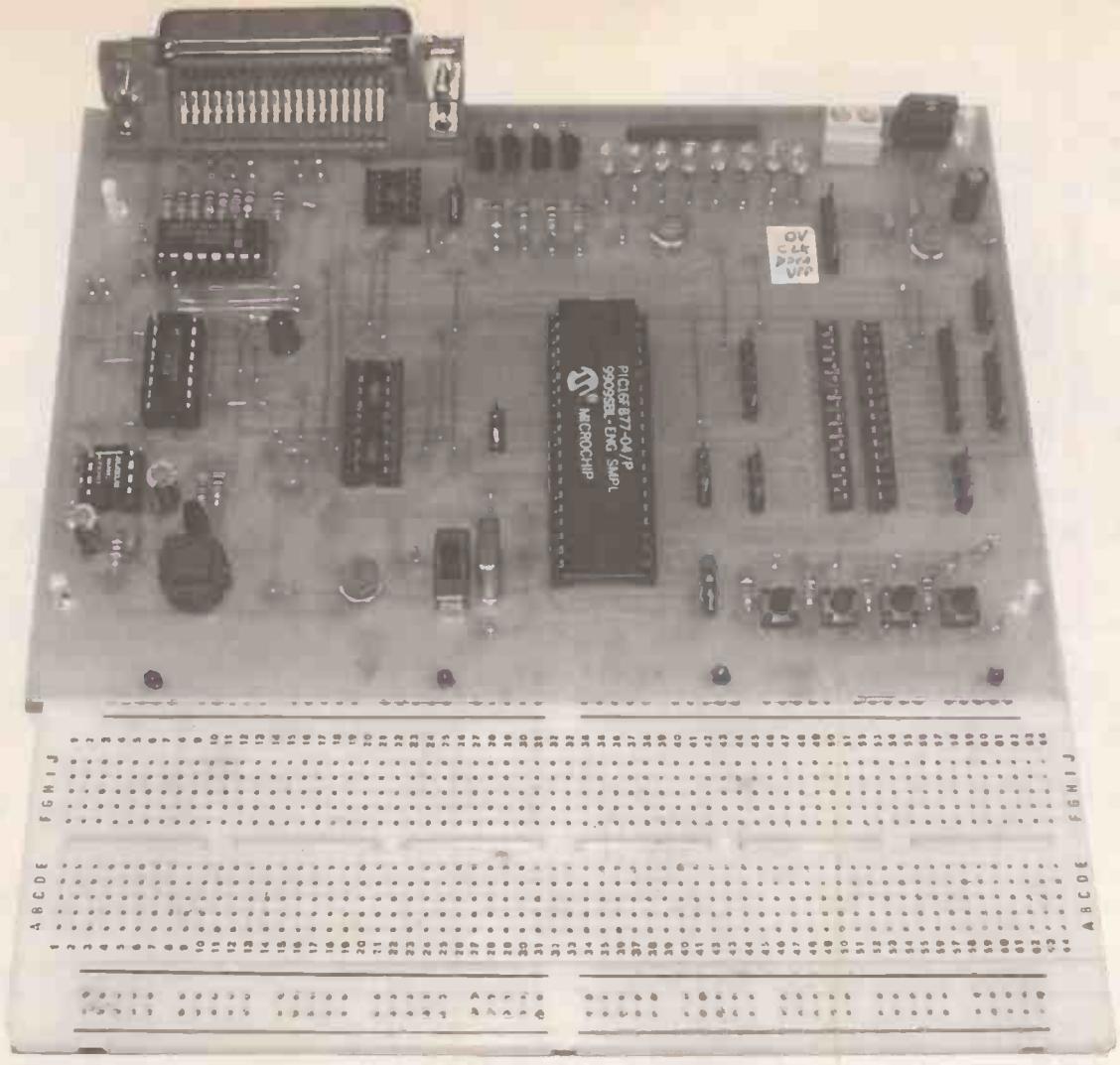
D0 to D8	red l.e.d. (9 off)
TR1 to TR5	BC549 or similar *npn* transistor
IC1	MAX662A 12V 30mA Flash memory programming supply
IC2	4050 non-inverting hex buffer
IC3	4053 triple 2-channel analogue multiplexer
IC4	7805 +5V 1A voltage regulator
IC5 to IC8	PIC microcontroller (see text)

Miscellaneous

S1, S3 to S6	min. s.p. push-to-make switch
S2	s.p.d.t. slide switch, p.c.b. mounting
SK1	36-way Centronics female parallel printer connector, p.c.b. mounting
X1	crystal (see text)

Printed circuit board, available from the *EPE PCB Service*, code 319; alphanumeric l.c.d. (see text); 8-pin d.i.l. socket (2 off); 16-pin d.i.l. socket (2 off); 18-pin d.i.l. or ZIF socket; 28-pin d.i.l. or ZIF socket; 40-pin d.i.l. or ZIF socket; 1mm pin header strips; 2-pin socket (2 off) (for crystal and C1, see text); solder, etc.

Approx. Cost Guidance Only **£25** *excluding PICs*



onto this header. It is the same l.c.d. as supplied with the p.c.b. for *PICtutor*, the CD-ROM based *PIC Tutorial* and development kit.

If ordering this l.c.d. from Magenta, you MUST specify that it is this l.c.d. version required (you will otherwise be supplied with a connector-less l.c.d.).

OSCILLATOR COMPONENTS

The Mk3 board includes facilities for crystal and *RC* (resistor-capacitor) oscillator components. Crystal X1 is used in conjunction with capacitors C8 and C9. It is recommended that a crystal socket is used on the p.c.b. so that a crystal of any required frequency may be inserted.

The RC oscillator generation is controlled by capacitor C7 and the total resistance across R11 and preset VR1. It is also recommended that a p.c.b. socket is used for C7 so that its value can be readily changed as needed.

Switch S2 allows crystal or RC oscillation mode to be selected. It should be noted that the PIC requires its Configuration bits set to different logic values in relation to the oscillator type used.

UNCOMMITTED OPTIONS

Several "uncommitted" components can be included on the p.c.b. The components are shown in Fig.5. They comprise four *npn* transistors (TR2 to TR5) with 10kΩ ballast resistors (R13 to R16) on their bases (Fig.5a).

Their emitters are grounded and you may connect their open-collectors to other circuits that require currents greater than the PIC can provide (about 100mA maximum per transistor, compared to about 25mA per PIC pin – see PIC data sheets for more information on the currents permitted).

The bases can be connected to any PIC pin as required, via the ballast resistors provided.

Eight uncommitted l.e.d.s (Fig.5b) can be included, D7 to D0 (numbered in this way to simplify PIC connection numbering when all are connected to the same port). They all have 470Ω ballast resistors (module RM1) in series, providing enough current for adequate brilliance without overloading the PIC.

Referring to Fig.5c, four uncommitted parallel switches (S3 to S6) can also be added. They are normally-open pushbuttons, with 10kΩ resistors (R17 to R20) in series. Their commoned outer

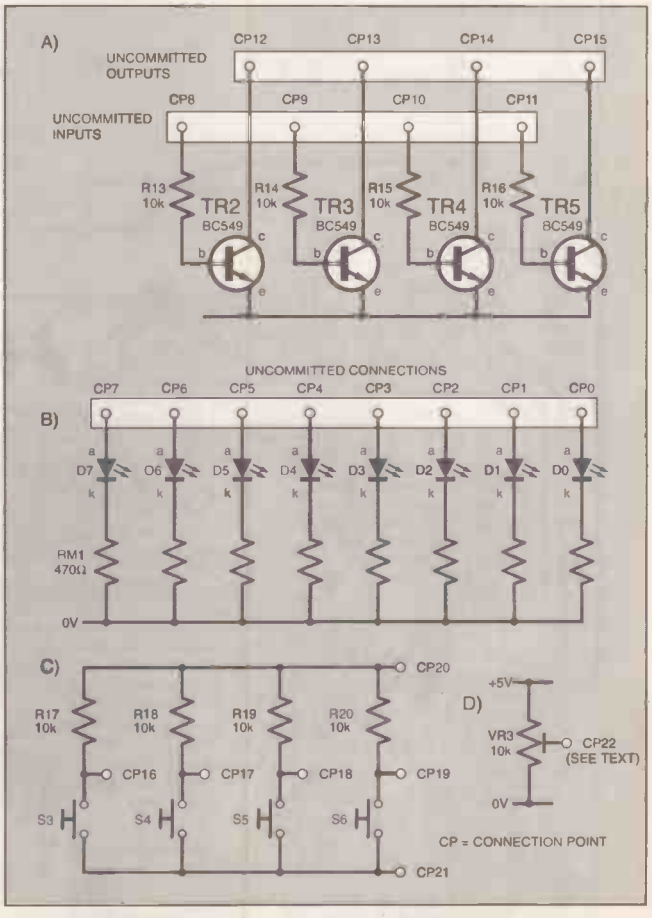


Fig.5. The "uncommitted" component options.

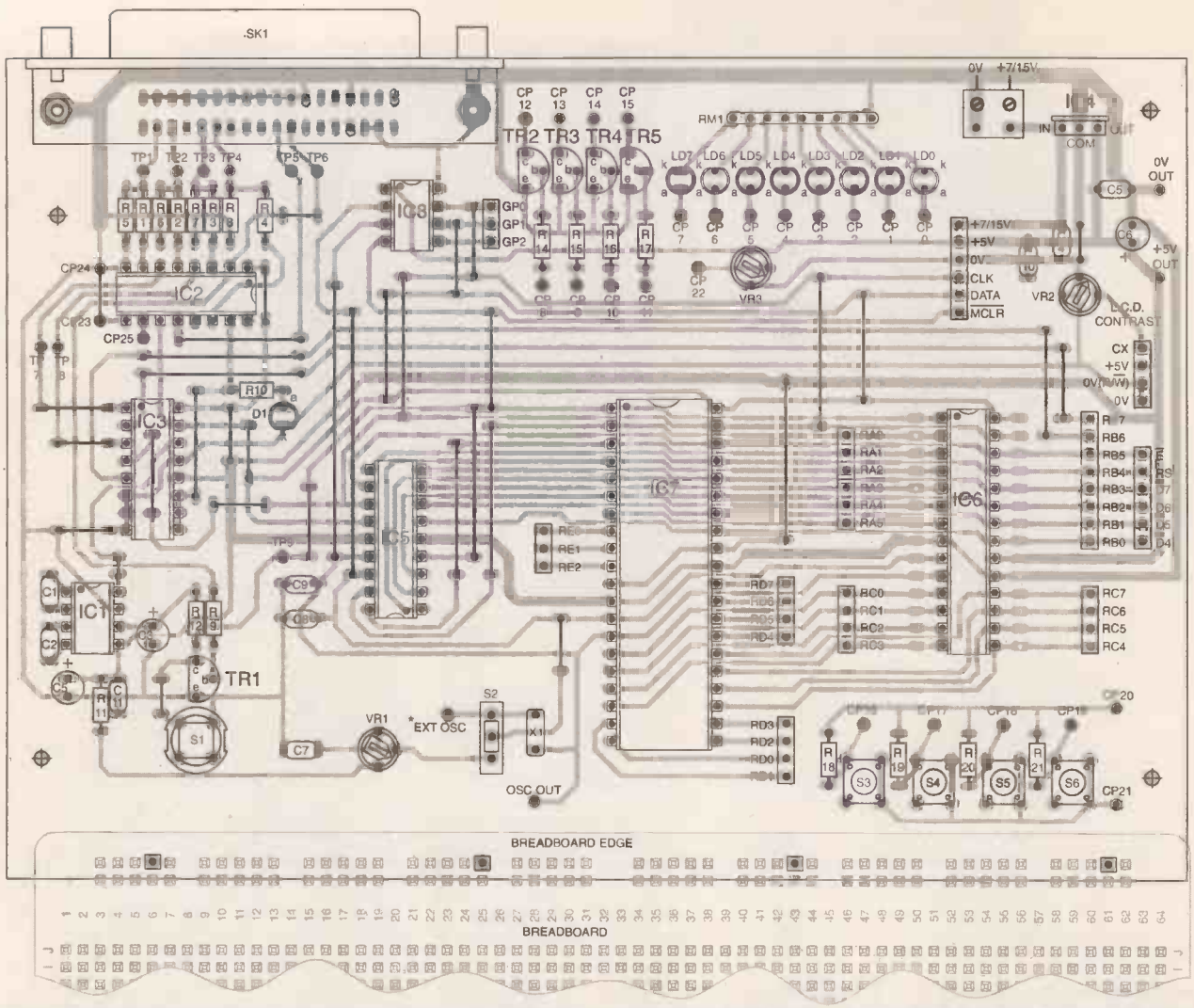
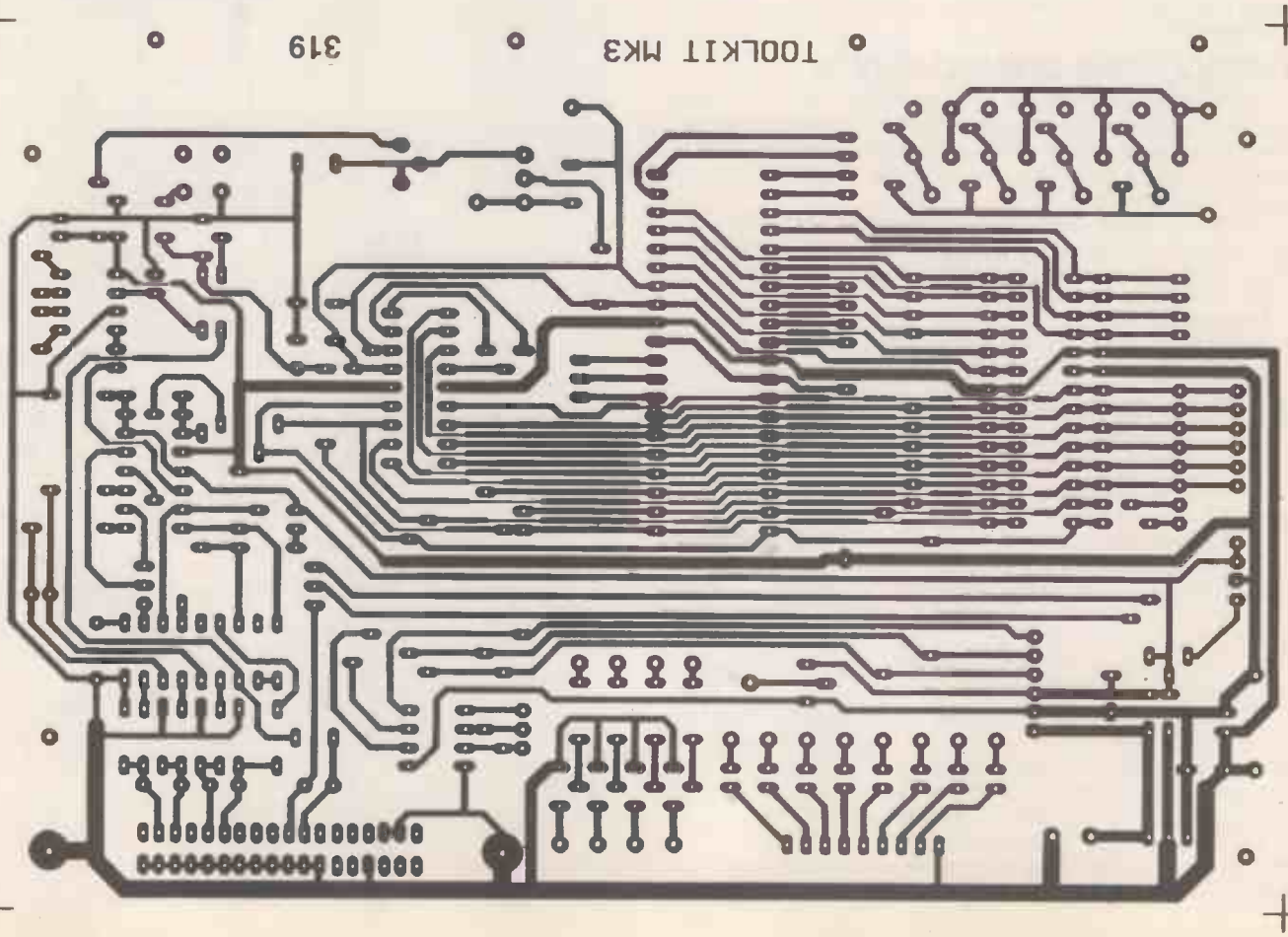


Fig.6. Printed circuit board component layout and full size master track pattern for PIC Toolkit Mk3, showing positioning of optional breadboard.



terminations can be connected to the 0V/5V power lines, with the polarity order as required. The "active" switch pins can be connected to any PIC data pin.

Lastly (Fig.5d), a 10kΩ preset (VR3) is provided, with its outer connections across the 0V/5V power lines. Its wiper can be used to provide a reference voltage to an A-to-D (analogue-to-digital) pin of any PIC that provides A-to-D conversion (the PIC16F87x family, for instance).

EXTERNAL BREADBOARD

There are terminal pin connections (not electrically connected to anything) which allow the p.c.b. to be mounted firmly onto a prototyping breadboard (of the same type, for example, as used in the *EPE Teach-In 2000* series of Nov '99 to Oct '00). This allows additional components to be breadboarded alongside the Toolkit Mk3 board for extended circuit development use.

Connections between the two boards can be made via solid-core connecting wires, soldered or "pinned" as required.

POWER SUPPLY

The Toolkit Mk3 board can be powered by any d.c. supply of between about +7V and +12V. IC4 in Fig.1 regulates this supply down to +5V. A 7805 1A device (IC4) is recommended to provide enough current to power the board and other development circuits connected to it.

The external power supply should be chosen so that it can satisfactorily handle the power required of it. Also note that regulator IC4 may require a heatsink at higher input voltages and output currents.

CONSTRUCTION

Printed circuit connection and tracking details are shown in Fig.6. This board is available from the *EPE PCB Service*, code 319.

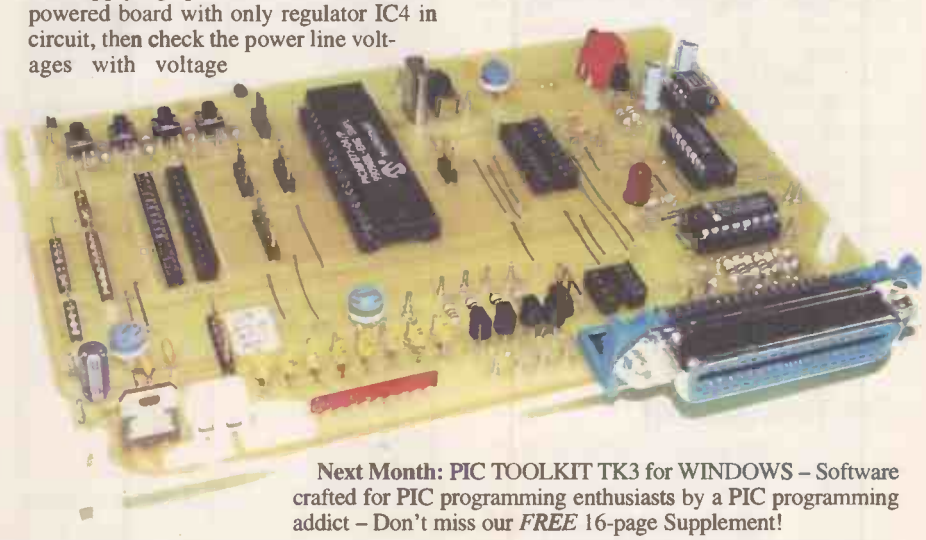
It is suggested that you assemble the board in order of wire links (don't forget the one underneath IC3), i.c. sockets, and the other components in order of size or convenience.

Thoroughly check the board for assembly errors before inserting the d.i.l. devices and applying power. Next check the powered board with only regulator IC4 in circuit, then check the power line voltages with voltage converter IC1 inserted as well. From then, fully populate with the other i.c.s, and a chosen PIC type (a PIC16F84 is suggested at this time). ***Only one PIC should be inserted at any one time.***

The rest is up to you and your computer, either using your existing DOS-based *Toolkit V2.4* software, or migrating to the exciting new *Toolkit TK3 for Windows* software described next month's Supplement. May your programming dreams be fulfilled!

ACKNOWLEDGEMENT

The author thanks Andy Flind for suggestions regarding some of the p.c.b. facilities included with Toolkit Mk3.



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New Technology Update

The latest accelerometer technology promises to speed up their introduction into many areas, reports Ian Poole.

ACCELEROMETERS are used in many areas of testing. Usually their operation depends on a solid mass that is allowed to move under the differing conditions of acceleration and its position monitored to give an indication of the acceleration.

These devices have a number of disadvantages including the difficulty of manufacturing them and using integrated circuit technology. Although in recent years new micro-machining techniques have been introduced that allow for accelerometers to be manufactured as integrated items.

However, these processes involve many masks and etching steps in the manufacturing process. Not only is this complicated but it is also very expensive.

New Development

In a new development organised by the American National Institute of Standards and Technology in Gaithersburg in Maryland, USA, researchers have overcome the problems of incorporating an accelerometer into an integrated circuit. The idea is based around a concept that has recently been proposed using the effect of acceleration on natural heat convection. The device uses heat generated from conductors that is transferred into the gas surrounding the device. It is hermetically sealed to ensure that it is not influenced by external pressure or airflow.

The new implementation of this idea uses standard CMOS circuitry and micro-machined thermopile or thermistor sensors for temperature sensing. In view of this it is possible to have a completely integrated sensor on a single chip including all the sensing and drive circuitry.

This can give significant cost advantages over existing sensors. Not only this but the sensors show significant performance advantages over other types.

These manifest themselves in terms of much lower power consumption and a higher frequency response, extending up to figures of a few hundreds of Hertz rather than a few tens of Hertz when compared to other convective sensors.

Construction

The basic device consists of a suspended polysilicon micro-heater, see Fig.1. When a current is passed through this heated element the thermal difference between the element and the surrounding gas generates a convective flow of gas.

When the device experiences some acceleration the change in the convection flow of the gas causes a temperature difference between the sides of the heated element. Temperature sensors placed on either side of the heater element then detect a temperature difference. The acceleration is proportional to that applied to the device.

The temperature sensors can be either thermocouples or thermistors. Both types are equally compatible with CMOS fabrication technology and the interfacing requirements for both types can be accommodated equally as well. However, there are a few differences in the actual construction of the devices.

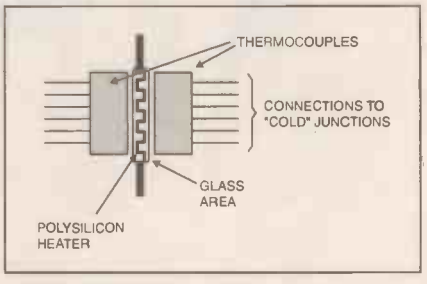

Fig.1. Thermocouple-based accelerometer.

In the device using thermocouples a polysilicon heater encapsulated in a glass passivation is suspended in air. The thermocouple junctions are then located either side and close to the heater. A thermocouple requires a second junction at a different temperature and this "cold" junction is located above the base silicon material.

Whilst it would be possible to use a single pair of junctions either side of the heater, greater sensitivity can be achieved by using several thermouples in series. In the development examples twelve thermocouples were used in series on either side of the heater, giving far greater level of output and hence sensitivity.

A different configuration was used for the thermistor-based devices, see Fig.2. Here two parallel polysilicon resistors were suspended but with an air gap between them. These were connected in a Wheatstone bridge circuit with two reference or "cold" resistors that were not suspended.

Two heaters then heated the suspended resistors. These heaters were micromachined to give exactly the required conditions. When the circuit experienced acceleration the convection pattern was disrupted such that the bridge conditions were altered.

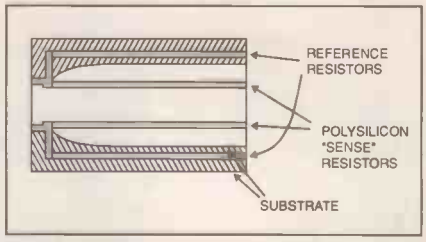

Fig.2. Concept of thermistor-based accelerometer.

Test Conditions

The accelerometers were tested under a variety of conditions. One crucial test was that of investigating how the devices operated when they were inclined to the horizontal. Their operation was tested between plus and minus 90 degrees and for accelerations between zero and 7g.

They were also tested over a range of vibration frequencies from 30Hz to 3kHz.

Results

The accelerometers showed very good levels of linearity. Errors of less than 0·5% were achieved under tilt conditions of up to ±90 degrees, and less than two per cent for accelerations of less than 7g. The sensitivity was also good and was found to be almost a linear function of the heater power.

Using a heater running at 100mW, sensitivity levels of just over 100μV per g were achieved for the thermocouple devices. Values of 25μV per g were obtained for thermistor devices.

Sensitivity is of considerable importance. If values fall too low then the output voltage can become lost in the noise. A typical thermocouple device with a resistance of 64 kilohms produced a noise voltage of 32nV/Hz$^{1/2}$ (32 nanovolts per square root Hertz) and for a thermistor device with a resistance of 4 kilohms the value was about a quarter of this.

It was also found that the thermistor device had a higher frequency response than the thermocouple. This is thought to result from the significantly smaller spacing between the sensing devices.

Summary

In manufacture these devices only use one additional mask post-processing step. This makes them ideal for easy introduction into production. This will also result in their cost not being significantly above many other specialist devices, and considerably cheaper than other accelerometers.

A further advantage is their robustness as they have no mechanically moving parts.

Further development work is still required. The devices can be further optimised and their performance needs to be characterised using different gases, pressures and temperatures. Other geometries internal to the device also need to be investigated.

This new technology shows a significant amount of promise and should enable accelerometers to become cheaper, smaller and more flexible in their use.

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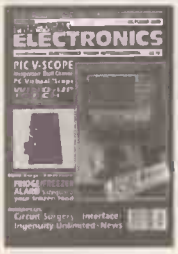

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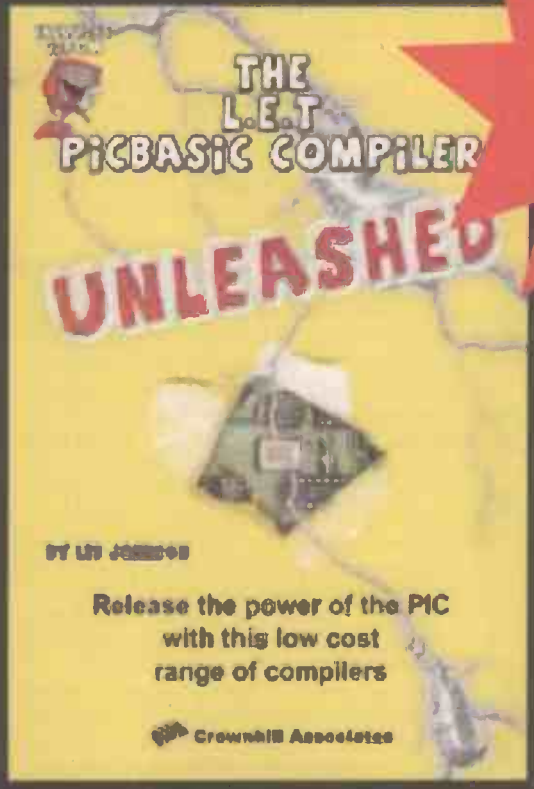

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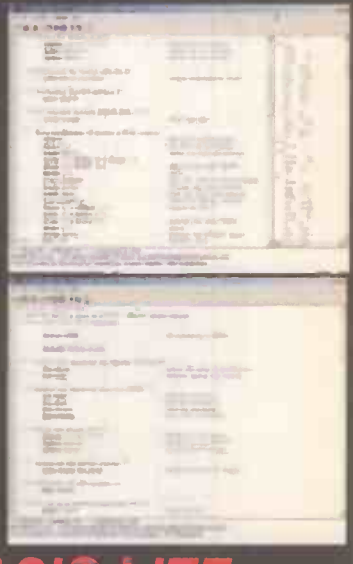

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We hear much about air traffic controllers, but more important to our daily lives are those relatively inconspicuous systems and people who control the flow of traffic in our busy cities. This article describes how electronics and computers are used to make their work possible.

INCONSPICUOUS CONTROL

Anyone standing on the pavement outside the Norfolk County Council Urban Traffic Control Centre in Norwich would probably not notice the inconspicuous semi-basement entrance. Yet behind this door lies the UTCC, under the control of a DEC ALPHAstation 255 computer, running at 300MHz.

This computer keeps the traffic flowing (or at least minimises the delays) not only for Norwich city but also for the whole of the county of Norfolk. It keeps the pedestrians flowing too for, out of the 256 signals linked to the system, about 50 per cent are pedestrian crossings.

The control centre is manned during the day but the computer is able to function unassisted during the evenings and night. Fortunately for the motorists, the computer can call on an engineer to handle emergencies out of hours. Fortunately for the engineer, this can be done through a remote link to a PC in the engineer's own home.

INDEPENDENT LIGHTS

It makes sense for the signal lights situated in the more remote parts of Norfolk (happily, there are still a few such parts!) to be independently controlled. A single road junction might have the layout shown in Fig.1.

Vehicles approaching the junction are detected by inductive loops. Essentially, an inductive loop is a loop of cable embedded just beneath the road surface. The loop is connected into an a.c. bridge circuit set up to measure the self-inductance of the loop. This changes when a massive ferromagnetic object such as a vehicle is situated above the loop.

Changes in inductance change the input to the control computer that is located beside the road junction. Information from the inductive loops can tell the computer the length of the traffic queue at the lights and also the speed and approximate size of vehicles approaching the lights. The computer is programmed to read this data and to use it to decide which lights are to be switched to GO and which to STOP and for how long.

In the centre of a small town there may be two sets of lights with a link road joining them. Each junction has its own independent set of inductive loops, traffic lights and computer. However, their programs are designed so that the action of the two computers is coordinated. They are linked by a data cable and they both run according to clocks driven by the mains frequency. Thus their action is synchronised and takes into account the time delay of traffic leaving one junction and proceeding along the link road to the other junction.

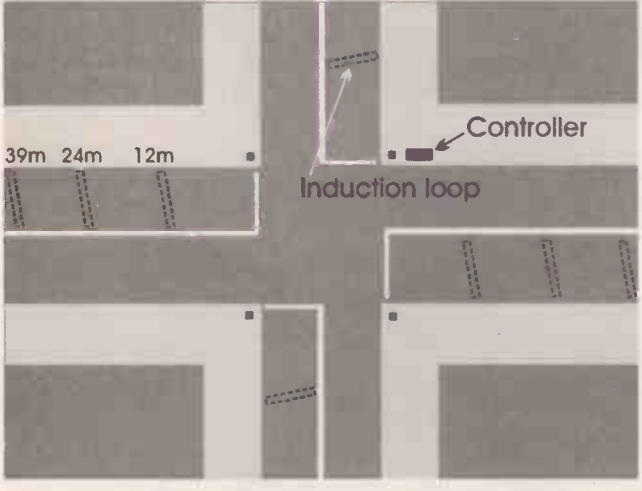

Fig.1. At an independently controlled road junction, each approach lane has three inductive loops.

Although their local computers independently control these single and double junctions, their action is monitored remotely by dedicated BT telephone line to the UTCC. Here the operator can call up the data for any particular junction.

The monitor screen displays a plan of the junction or junctions and pedestrian crossing too. The plan shows the state of the inductive loops, the state of the lights and the state of the pedestrians' pushbutton on the crossing. Sitting in the UTCC in Norwich, an operator can check that all of the signals systems in Norfolk are operating correctly.

SCOOT

In a larger town, where there are more than two junctions close together, the junction computers are connected to and controlled by the central computer at the UTCC. Connection is through an Outstation Transmission Unit (OTU) which comprises a modem wired to BT telephone lines. The kerbside computer controls the lights at the junction but is under the supervision of the control computer in the UTCC.

The main computer runs traffic control software known as SCOOT. This program is written in C and its name is short for Split Cycle and Offset Optimisation Technique. The difference between SCOOT and an ordinary pre-planned light sequencing controller is that the SCOOT computer responds instantly to current traffic demands.

SCOOT also depends on sensing traffic by means of inductive loops. These are additional loops on the exits from junctions, where traffic leaves the junction to pass along a stretch of roadway to the next junction. In some places there may be two loops close together to allow the speed of the vehicles to be measured.

Other kinds of sensor are used where appropriate. On the faster roads there may be Doppler-effect microwave sensors to detect the presence and speed of vehicles. These register vehicles at a distance of about 50 metres.

Doppler-effect sensors are also used on pedestrian crossings to detect the presence of people waiting to cross or actually crossing. Active infrared detectors are also used on pedestrian crossings, as well as sensor mats on the waiting area on the pavement.

ENGINEERING DATA

Data collected by the control computer is available to the engineers in several ways. As mentioned earlier, the controller can call up a display to check the operation

```
Fr 09:32:01   DO1217   DEREHAM/LKMAN 0   [OPE]   Congestion formed
Fr 09:33:16   X41160   LITLPORT/HIGHGT   [0511]  TX fault
Fr 09:34:17   X41160   LITLPORT/HIGHGT   [0511]  TX replies restored
Fr 09:35:00   D01217   DEREHAM/LKMAN O   [OPE]   Congestion cleared
Fr 09:35:00   DO4317   BSHPBG/BSHPGT S   [OPE]   Congestion cleared
Fr 09:38:00   DO4317   BSHPBG/BSHPGT S   [OPE]   Congestion formed
Fr 09:40:36   ZO5329   SVD Chartwell     Bus arrival
Fr 09:40:40   Z05329   SVD Chartwell     Bus departed
Fr 09:41:01   DO4317   BSHPBG/BSHPGT S   [OPE]   Congestion cleared
```

Fig.2. The traffic log records all events on the system immediately they occur.

of lights at all road junctions. This information is also presented for all the junctions in an area in tabular form. The computer also displays a running log of events on the system. Fig.2 shows a typical abstract from this and illustrates the kinds of event reported just after 9.32, one Friday morning in September.

A few minutes after the last entry in the figure, the log reported the failure of a Wait lamp at the junction of High Street and Baker Street in Gorleston. The maintenance contractor was automatically alerted to the failure. The log went on to show that the lamp was replaced nine minutes and 33 seconds later. The data is used only for monitoring and is not stored.

In addition to monitoring the system, the controller can call up visuals from a number of remotely controlled video cameras mounted at strategic points in the Norfolk road system. These cameras have full aiming and zooming features. This allows the operator to sort out any serious problems such as might arise from a traffic accident or football crowd.

For an overall view of the situation, the controller watches the map that covers one entire wall of the control room (Fig.3). Lamps on this map indicate the status of the lights at each junction. On the same wall are subsidiary maps for the two large towns, Great Yarmouth and King's Lynn.

AUTOMATIC CONTROL

Each junction in the system has a basic plan for the sequencing and timing of the lights. Because that sequencing is done by software, rather than by mechanical means or logic circuits, it opens up all kinds of possibilities.

SCOOT allows for a large number of different plans to be available for each junction and to switch from one plan to the other as the situation demands. The selected plan at each junction may change automatically at different times of day to cope with daily variations in traffic flow. However, under SCOOT, the plan may be changed or modified automatically second by second.

For instance, if signals from the inductive loops show that a vehicle (perhaps an HGV) is moving slowly toward a junction, SCOOT can extend the green period to allow the vehicle to clear the junction. On the other hand, if further data input shows that the vehicle is speeding up, the extension of green time can be automatically cancelled.

In the longer term, SCOOT also accumulates traffic data at a given junction over a period of time and then amends the green times on different branches so as to minimise waiting times. Changes of the current sequencing plan at each junction are noted on the log as they come into effect.

Fig.3. The control room of the Norfolk UTCC has a large-scale map showing the current state of all the traffic lights in Norwich, including pedestrian crossings.

DIRECTION SENSING

In the narrower streets of this ancient city, cars may find their way blocked by vehicles parked on the left at the kerbside. They are then obliged to cross into the other traffic lane in order to pass the obstruction. While doing this, they might well pass over an inductive sensor, which would then indicate a vehicle apparently travelling in the opposite direction. SCOOT software is able to recognise such a situation and ignores the misleading data.

The flexibility of the system is such that it can receive input from the emergency services. A signal from the Fire Station for example can bring about a "green wave". Along a number of selected routes, the "green wave" puts the lights at green in an expanding zone centred on the Fire Station. The emergency vehicles are thus given priority on their way to the fire.

Pedestrians too benefit from the flexibility and intelligence of SCOOT. If the crossing detector shows that a person is a slow walker, the green time on the crossing is automatically extended.

Motorists at crossings benefit too. One is only too familiar with the exasperating situation of being stopped at a pedestrian crossing when there is no one wanting to cross. The pedestrian had pressed the crossing button and subsequently decided not to cross, or managed to cross during a lucky break in the traffic. With SCOOT, the sensors detect that the person is no longer waiting and the call is cancelled.

BY THE ROADSIDE

The photograph shows the inside of one of those boxes that stand on the pavement at traffic junctions. The box has been opened (which fact will have been noted in the log) so that we can see (1) the SCOOT detector. This one reads data from four inductive loops placed in the road at the four exits from the junction.

At (2) there are the circuits for the inductive loops on the approaches to the junction. Data from (1) and (2) are relayed to the control room through the OTU, which is item (3) in the photograph. Below, at (4) is the rack holding the processor cards of the local junction computer. Its power supply is to the right of this.

Below the computer and out of sight in the photograph is the power supply for the signal lamps. These are 24V lamps and receive their supply from a transformer working on the 230V a.c. mains.

The system incorporates a photosensor that detects low ambient light levels, such as occur at night and during overcast weather. Under such conditions the supply to the transformer is automatically reduced to 160V. The lamps receive only 16V but they are still bright enough for signalling under low light conditions and the low voltage prolongs their life.

OPTIMISING

The software has three optimisation procedures. The first is the Split Optimiser, which analyses the current red and green timings. It determines whether the change times should be advanced, retarded or remain the same. It increments or decrements the timings by one to four seconds at each analysis.

The Offset Optimiser delays or advances the whole red-green timing in units of four seconds during each cycle, so as to optimise traffic flow.

Finally, the Cycle Time Organiser operates once every five minutes (or every two and a half minutes when necessary). It identifies the most critical road junction in a region and attempts to adjust the cycle time of the lights to reduce congestion. Cycle time can be increased or decreased by amounts of four, eight or 16 seconds.

By this combination of relatively small changes in the timings, SCOOT is able to respond rapidly to the current demands of traffic.

BENEFITS

The benefits of using a computer-controlled system based on electronic sensors have been demonstrated by surveys in several urban areas, including Worcester, Southampton, Glasgow and Coventry. SCOOT systems have always improved journey times when compared with fixed-time systems. On average it has been estimated that using SCOOT reduces traffic delays by 20 per cent.

It takes months of work to collect the data and produce the plan for a fixed-time system. The SCOOT system continuously updates itself to take account of present and future changes in traffic conditions.

ACKNOWLEDGEMENT

Thanks are due to Peter Lock of the NCCUTCC for demonstrating and explaining the system to the author. □

The contents of this kerbside traffic control box are described in the text.

READ MORE ABOUT IT

Owen Bishop continues the theme of electronic control in his book *Understand Electronic Control Systems*, ISBN 0-7506-4601-2, which is available through our *Direct Book Service*. Order code NE35 price £17.99 including UK p&p. See page 744 for ordering details.

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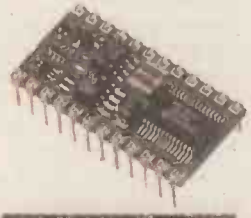

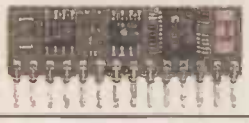

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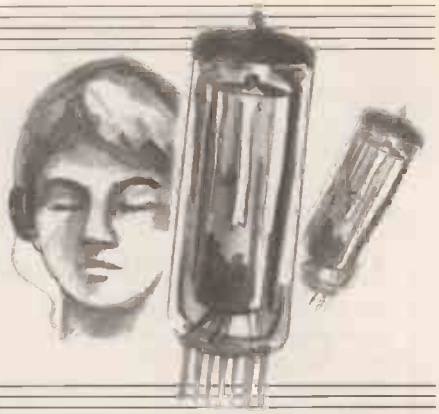
Constructional Project

2-VALVE SW RECEIVER



ROBERT PENFOLD

Designed for valve radio enthusiasts, or anyone who would like to try the nostalgic approach to shortwave listening.

DESPITE continuing advances in semiconductor technology the humble valve refuses to totally stand aside in favour of modern technology. Audio equipment having the true "valve sound" has a strong following, as do *olde worlde* electronic music equipment and radios.

I wish I could say that I do not remember the days when this type of receiver was the normal introduction to the shortwave bands, but it is very much the type of set that I built as a lad in the 1960s. I still remember the HAC two-valve set with its pre-war valves the size of 100W light bulbs, and the RCS "Telstar" with its miniature "acorn" valves that really were more or less acorn shaped.

BATTERY POWER

The design featured here follows along the same general lines as these sets, with its simple chassis and front panel method of construction and regenerative detector. It covers an approximate tuning range of 5MHz to 13MHz using a simple home constructed tuning coil. This provides coverage of several popular shortwave broadcast bands.

Sets of this type were almost invariably powered from batteries, and required about 90 volts for the main supply and around 1·5 to 6 volts for the heaters. These were respectively the HT (high tension) and LT (low-tension) supplies.

Suitable HT batteries are no longer produced, but the design featured here will work well using three or four "bog standard" PP3 size 9V batteries wired in series. A single 1·5V cell is needed to power the heaters. By the standards of battery powered valve sets the unit is quite economic to run. When HT batteries were available they were far from cheap.

In the "old days" the normal aerial for a set of this type was the longest piece of wire that your garden could accommodate. Band conditions have changed somewhat over the years, and there are now many more stations on air. Also, they are using higher output powers and more efficient aerials than in the past.

Going for the strongest possible aerial signal these days tends to overload a simple receiver and give poor results. A short indoor antenna consisting of about one to five metres of wire is perfectly adequate for use with this receiver. The output will drive practically any type of headphones at good volume.

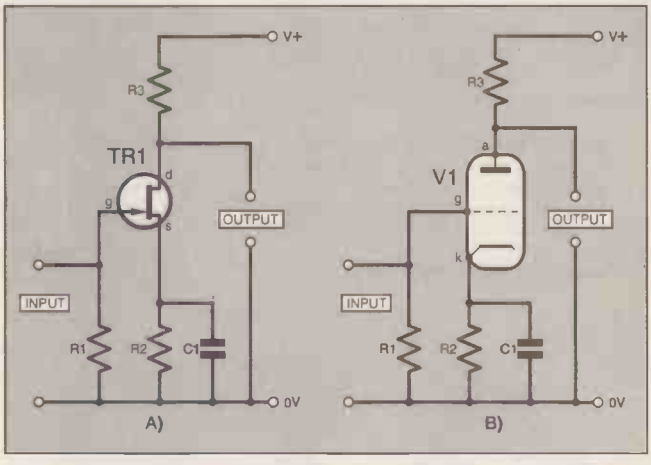


Fig.1. Biasing for a f.e.t. (a) is essentially the same as that for a valve (b).

BIASED VIEW

Valve circuits are substantially different to those using bipolar transistors, but have strong similarities to field effect transistor (f.e.t.) circuits. A typical f.e.t. amplifier has the configuration shown in Fig.1a.

Unlike a bipolar transistor, which requires a forward bias for linear amplification, a f.e.t. normally conducts strongly between its drain (d) and source (s) terminals. A small reverse bias must be applied to its gate (g) in order to make it conduct less heavily so that it can provide linear amplification.

This bias is provided by resistor R1, which ties the gate to the 0V rail, in conjunction with the positive bias provided to the source (s) by resistor R2. The gate is therefore negative of the source, and the required reverse bias is obtained. Capacitor C1 removes the negative feedback that would otherwise be introduced by R2.

The valve equivalent, shown in Fig.1b, operates in the same manner. Resistor R1 biases the control grid (g) to the 0V rail. With f.e.t.s and valves there is very little current flow at the input. Consequently, in both cases resistor R1 can have a high value and the circuit as a whole can have a high input impedance. Also as before, resistor R2 provides

a positive bias, but this time to the cathode (k). The output signal is developed across anode (a) load resistor R3.

CIRCUIT OPERATION

The full circuit diagram for the 2-Valve SW Receiver is shown in Fig.2. Valve V1 is used in the regenerative detector and V2 operates as an audio amplifier. A valve type DF91 is used for both stages, and these are pentodes that are specifically designed for battery operation.

Inductor coil L2, tuning capacitor VC1, and bandspread capacitor VC2 form the tuned circuit. Bandspread capacitor VC2 has a low value so that it covers only a limited range of frequencies, facilitating easier fine-tuning. Because the input impedance at the control grid of V1 (pin 6) is very high it is acceptable to couple the tuned circuit directly to the grid.

Coil L2 effectively provides the grid bias resistance for V1. The aerial is normally coupled to a low impedance tap on L2, but SK2 provides a more direct coupling for use with very short aerials.

not be possible. For reasons that will be explained shortly, optimum results are produced with the amount of feedback just below the point at which oscillation occurs.

The audio load for valve V1 is resistor R1 or inductor L4. Both components are shown in the circuit diagram of Fig.2, but only one or the other is actually needed. Using a resistor saves money and significantly reduces the cost of the receiver, but it also reduces the efficiency of the circuit very noticeably. It is certainly worthwhile using an inductor if available funds permit.

SOUND REGENERATION

On the face of it there will be no audio output from the detector. Capacitor C3 provides smoothing of the r.f. signal so that the audio output signal is equal to the average voltage in the r.f. signal. With no rectification the positive and negative half cycles should cancel out one another to produce zero output.

centre of the receiver's passband where the gain is already higher, and less towards the edges where the gain is lower. As the regeneration is increased, the selectivity of the set is therefore greatly improved. Instead of receiving two stations on adjacent channels simultaneously, with the enhanced selectivity the tuning controls can be used to pick out one station or the other.

This factor is very important with the plethora of stations that are often to be found on the shortwave broadcast bands. High sensitivity alone is not sufficient to guarantee good results.

It is clearly essential to have some means of accurately adjusting the level of feedback so that it can be set just below the point of oscillation, where optimum results are obtained. Trimmer capacitor VC3 is used to provide a preset amount of feedback, but potentiometer VR1 is the Regeneration control. This component provides a variable bias voltage to the screen grid of V1 (pin 3).

The gain obtained at the control grid depends on the bias voltage at the screen

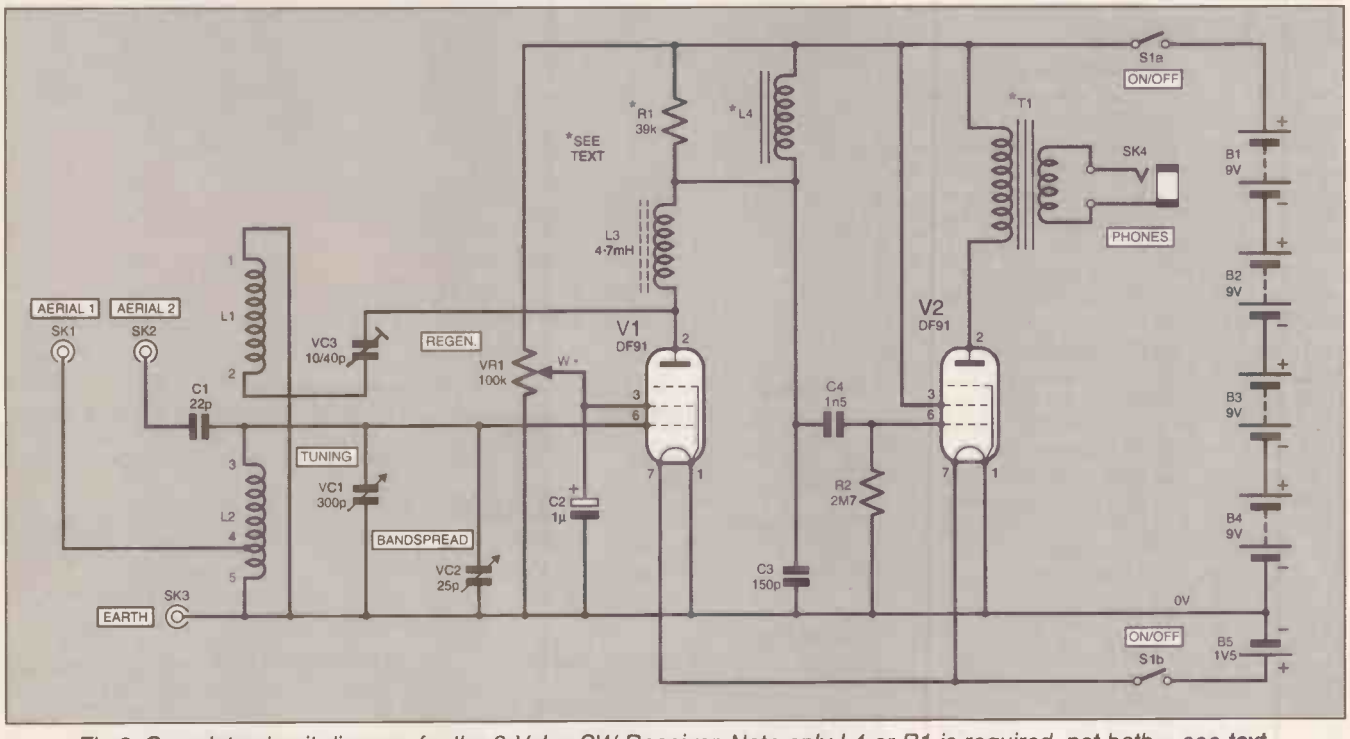


Fig.2. Complete circuit diagram for the 2-Valve SW Receiver. Note only L4 or R1 is required, not both – see text.

Because the DF91 valve is intended for battery operation it does not use a separate cathode and heater. The heating filament is also the cathode. On the face of it there is no reverse bias to the control grid since one side of the heater/cathode connects direct to the 0V rail. However, the other connection to the heater/cathode is taken about 1·5 volts positive by the LT battery, B5, so there is actually a small reverse bias on the control grid.

Valve V1 provides radio frequency (r.f.) amplification with r.f. choke L3 acting as the anode load. Some of the output signal at the anode is fed back to the aerial coil, via trimmer capacitor VC3 and coupling winding L1. There is an inversion of the signal through V1, but the phasing of L1 is such that positive feedback (regeneration) is applied.

If too much feedback is applied the circuit will oscillate and proper reception will

In practice there is less than perfect linearity through a valve or any other amplifying device, and one set of half cycles receives more amplification than the other set. This gives a very inefficient form of rectification, but does provide some audio output from an a.m. (amplitude modulation) broadcast signal.

Negative feedback is often used to reduce distortion, and the positive feedback utilized here has the opposite effect. As the amount of regeneration is increased, the gain of the circuit is boosted, but the increase is much larger on the set of half cycles that originally received only slightly higher gain. Advancing the Regeneration control VR1 therefore produces a much higher output level, with both the gain and detection efficiency being boosted.

Another advantage of the regeneration is that it provides a greater boost in gain at the

grid, with higher voltage giving increased gain. Control VR1 therefore controls the regeneration by altering the gain of V1 rather than adjusting the amount of feedback. This method gives very precise control and avoids problems with tuning shifts that can occur with other systems.

AUDIO STAGE

Valve V2 is used in a straightforward audio amplifier set up. Resistor R2 is the grid bias resistor and capacitor C4 couples the output of the detector to the input of the amplifier.

The original sets of this type where mainly used with high impedance (about 2kΩ to 4kΩ) headphones, but these have not been produced for many years. A genuine valve output transformer might still be available from a specialist supplier of valve components, but the simpler and cheaper alternative is to use a small mains

transformer for T1. Either way, the receiver can then be used with ordinary 8 ohm impedance headphones.

Although the valves are designed to operate from 90 volts, they will actually work very well on much lower supply potentials. Four 9V batteries, B1 to B4, connected in series to give a nominal 36V supply are shown in the circuit diagram Fig.2. This is obviously well short of the designed operating voltage of the valves, but it actually gives very good results.

In fact, adding a fifth battery to take the supply to 45V did not bring any obvious increase in performance. It was found that the circuit will actually work reasonably well from three batteries giving a nominal 27V supply.

The HT supply current is only about 2·5mA to 3mA, so there is no need to use any form of "high power" battery. Ordinary zinc chloride PP3 batteries can be obtained for less than a pound each and are perfectly adequate. A single 1·5V cell powers the heaters, and it is advisable to use a high capacity type such as a D-size cell as the current consumption is around 100mA.

COMPONENTS

In a retro design such as this it is inevitable that some of the components require further explanation. The DF91 valves are available from any specialist valve supplier, as are B7G chassis mounting valveholders. An equivalent valve for the DF91 is the 1T4 and is also suitable for this circuit. Inductor L3 is a Maplin r.f. choke (see *Shoptalk*), but any inductor of about this value and for high frequency use should work just as well.

An audio frequency inductor having a value of a few Henries is required for L4. If a suitable component can be found it is likely to be very expensive. The cheaper alternative is to use the primary winding of a small mains transformer. Several types were tried and there was no obvious difference in performance between them. The secondary voltage is irrelevant since it is unused, so simply use the cheapest mains transformer you can find.

A small mains transformer is also used for T1, but in this case the secondary voltage is very important. A very high step-down ratio is needed in order to give good performance, and a 3V-0V-3V type was found to give the best results. The full secondary winding is used to drive the headphones with the centre-tap being left unused.

VARIABLE CAPACITORS

Ideally the tuning and bandspread capacitors would be high quality air-spaced types, but these are now very expensive. If you can, salvage suitable components from the spares box or obtain surplus components. Any value from about 200pF to 400pF should be all right for VC1, and a value of around 10pF to 30pF will suffice for VC2.

The alternative is to use modern miniature components having a solid dielectric. For VC1 the two a.m. gangs are wired in parallel and should provide a maximum value of 250pF or more. The component used for VC2 must be a type that includes low value sections (about 20pF) intended for use in a f.m. receiver. Either of these sections can be used for VC2 and the other three sections of the component are left unused.

Trimmer capacitor VC3 can be any type having a maximum value of around 40pF to 65pF. A 10/40pF ceramic component is used on the prototype but a 5·5/65pF foil type was found to work just as well.

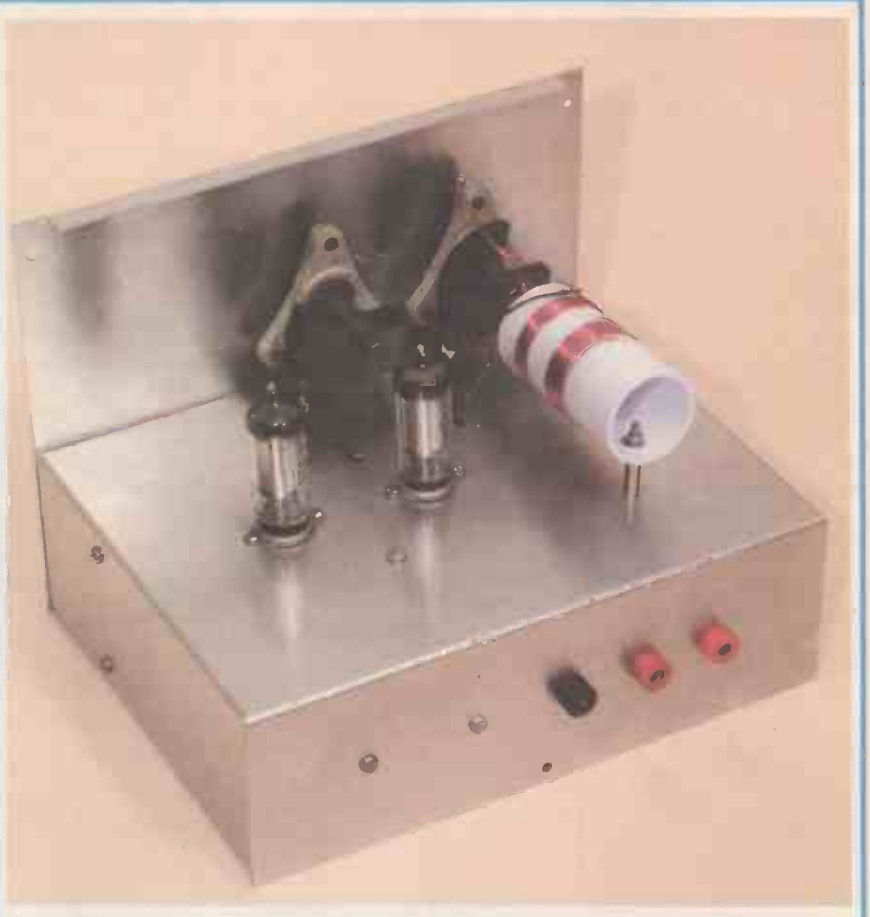
COIL DETAILS

Plug-in coils are no longer made, and those coils that are still available are not well suited for use with valves. Coil formers and ferrite cores would seem to be unobtainable these days. The most practical solution is to use a simple home-made coil of the air-cored variety. These were often used with valve receivers and give surprisingly good results.

The coil used in this set is wound on a 32mm diameter plastic former about 65mm long. The former is actually cut from a "32mm Trap-Inlet Height Adjuster", which should be available from

COMPONENTS

Approx. Cost Guidance Only excluding batts. & headphones **£39**



Resistors

R1	39k (see text)
R2	2M7

All 0·25W 5% carbon film (see text)

Potentiometer

VR1	100k rotary carbon, linear

Capacitors

C1	22p ceramic plate or polystyrene
C2	1μ radial elect. 100V
C3	150p ceramic plate or polystyrene
C4	1n5 polystyrene
VC1	300p air-spaced variable (see text)
VC2	25p air-spaced variable (see text)
VC3	10p to 40p ceramic or 5·5p to 65p foil trimmer

Valves

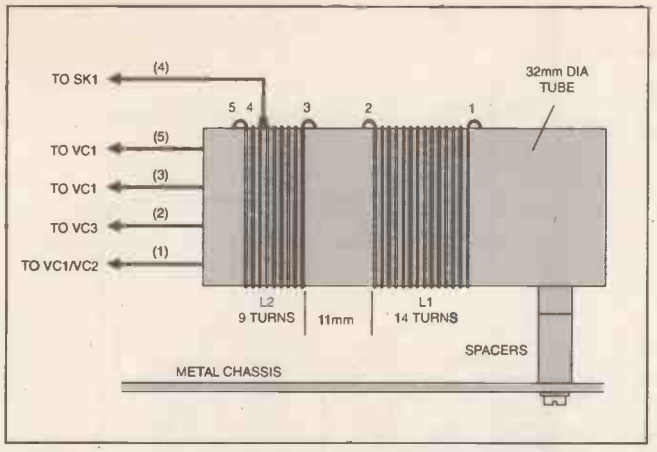
V1, V2	DF91 or 1T4 pentode (2 off)

See SHOP TALK page

Miscellaneous

B1 to B4	9V battery, PP3 size (4 off)
B5	1·5V, D-size battery
L1, L2	see text
L3	4·7mH r.f. choke
L4	small mains transformer (see text)
T1	230V mains primary, 3V-0V-3V secondary
S1	d.p.s.t. rotary or toggle switch
SK1, SK2	4mm socket, red (2 off)
SK3	4mm socket, black
SK4	6·35mm standard mono jack socket

Aluminium chassis, with base/front panel, size 203mm x 63mm x 152mm approx.; B7G valveholder (2 off); battery holder for B5; PP3 battery clip (4 off); 32mm tube and 0·56mm enamelled copper wire for L1/L2 (see text); control knob (4 off); five-way tagstrip; 8 ohm headphones; aerial wire; M3 spacers; multi-strand connecting wire; solder tags (3 off); solder; fixings, etc.



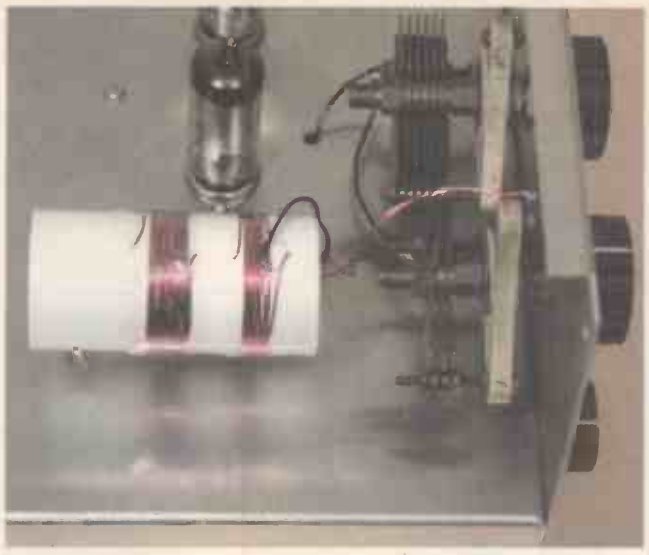


Fig.3. Details of the home-made tuning coil. The plastic coil former measures 32mm diameter by about 65mm length. Strips of tape can be used to stop the windings unravelling – see photograph right.

the plumbing department of your local DIY superstore. However, any rigid plastic tube of about the right size will suffice.

Details of the coil are provided in Fig.3. Both windings are made using 24s.w.g. (0·56mm) enamelled copper wire. The windings will tend to unwind and spring apart, and the simplest method of resisting this is to drill holes of about 1mm in diameter to take the leads from the coil. This provides a simple but effective means of holding the ends of each winding in place.

Tuned winding L2 starts about 10mm or so from one end of the former. Start by threading the free end of the wire through the appropriate hole (5) in the former to leave a lead about 250mm in length. Then wind two turns around the former and produce a small loop (4) in the wire. This will act as a connection point for the tapping on coil L2.

To complete the winding add a further seven turns of wire, cut the wire to leave a lead about 250mm long, and then thread the lead through the appropriate hole (3) in the former.

Try to keep the wire taut with the turns of wire closely bunched together. Even with the ends of the winding held in place it is likely that the turns will tend to spring apart slightly, but some pieces of tape can be used to hold them in place. Use the blade of a penknife or a miniature file to scrape the insulation from the small loop of wire and then tin (coat) it with solder.

FEEDBACK WINDING

The feedback winding L1 is made in the same way, but it has 14 turns and no tapping. The feedback winding will look rather large if you are used to semiconductor radio circuits, but valves generally have much higher output impedances than semiconductor equivalents. Hence the feedback winding is much larger than it would be for a regenerative set based on transistors.

The completed coil can be mounted on the chassis vertically or horizontally, and the simplest method is to bolt it in place in a horizontal position, see photographs. However, a small gap is needed between the metal chassis and the coil, so some spacers must be used between the chassis and the coil former. A gap of around 15mm to 20mm is more than adequate.

CONSTRUCTION – CHASSIS DETAILS

Sets of this type traditionally use an open aluminium chassis construction, but an outer casing is easily added if preferred. A chassis measuring approximately 203mm × 63mm × 152mm will comfortably accommodate everything. What is intended to be the base plate is used here as the front panel.

The general layout of the receiver can be seen from the photographs, and the exact positioning of the main components is not critical. Switch S1, potentiometer VR1, and 'phone jack socket SK4 are effectively used to bolt the front panel to the chassis.

Tuning capacitor VC1 and bandspread capacitor VC2 are mounted on the front panel above the chassis. Some variable capacitors have ordinary 10mm mounting bushes, but most types use two or three mounting bolts. If mounting bolts are used it is essential that they do not penetrate more than about three or four millimetres into the capacitor. With greater penetration there is a real risk that the bolts will foul the plates and ruin the component.

The valveholders require main mounting holes about 16mm in diameter. The holders themselves can be used as templates when marking the positions of the smaller mounting holes. These take either metric M3 or 6BA mounting bolts. Solder-tags are mounted on three of these bolts on the underside of the chassis to provide chassis connection points.

Hard wired construction is used throughout, and this requires some additional anchor points for the components. These points are provided by a five-way tagstrip mounted on the underside of the chassis just to the rear of the two valveholders. Note that the centre tag connects to the chassis via the tagstrip's mounting bracket, and that it can *only* be used as a chassis (Earth/0V) connection point.

Sockets SK1 to SK3 are mounted on the rear panel of the chassis, as is L4 if it is used. Transformer T1 is mounted on the right-hand side panel, and the plastic holder for B5 is glued or bolted to the left-hand side panel. A couple of holes about 3mm or 4mm in diameter are drilled in the top panel of the chassis, just in front of the valveholder for V2. These enable the components above the chassis to be wired to the main assembly on the underside.

Front panel is held in position by the mounting bolts of the switch, potentiometer and headphones socket.

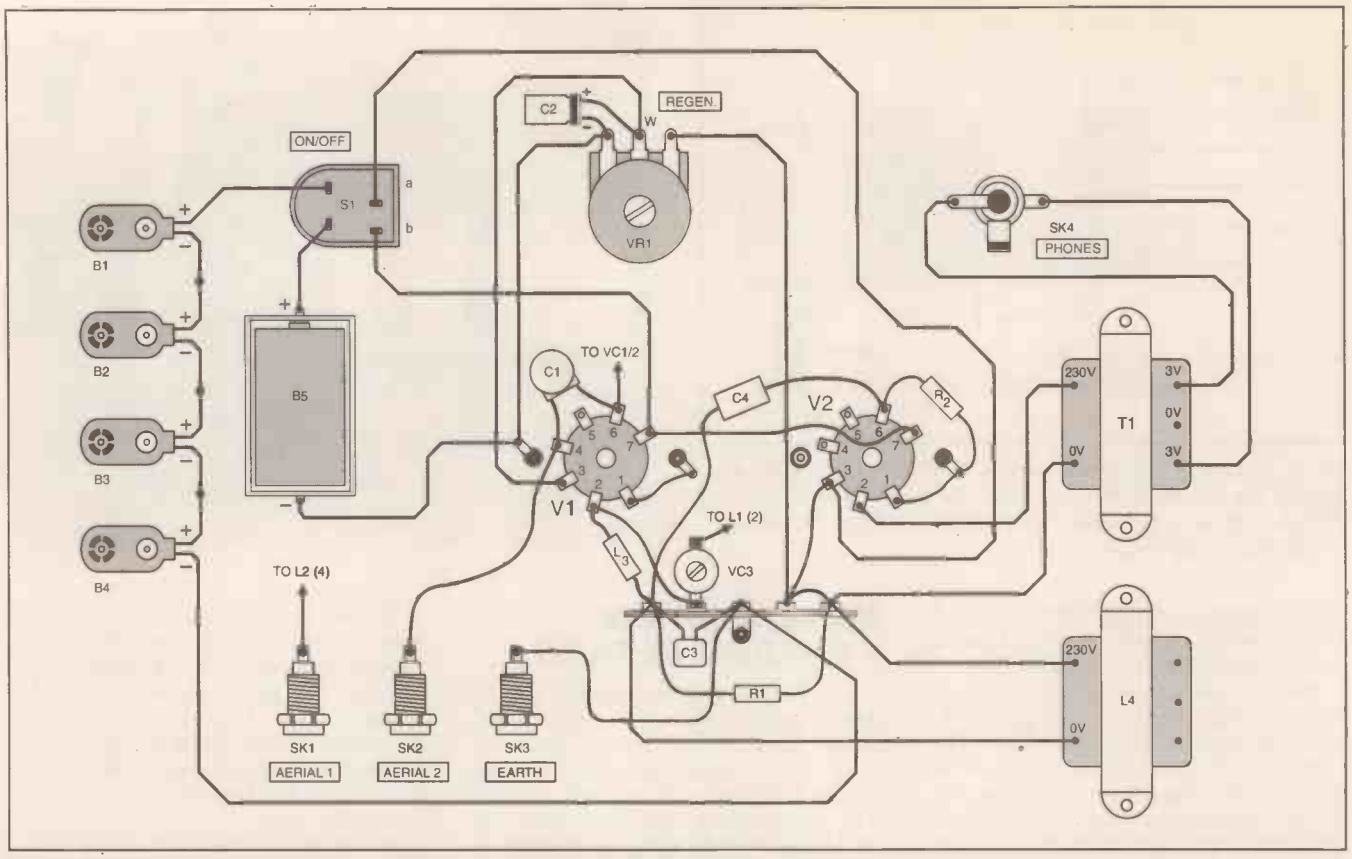


Fig.4. Interwiring details between the valve bases and underside components. The metal chassis forms the common "earth/0V" connection via the solder tags and centre mounting tag of the 5-way tagstrip. Pin 4 of valveholder V1 is used as an anchor point for C1 and socket SK2.

WIRING-UP

All the interwiring on the underside of the chassis is shown in Fig.4, which should be used in conjunction with Fig.3 and Fig.5. The latter shows the connections to VC1 and VC2, and is correct for most miniature solid dielectric components. With other types, or different styles of solid dielectric capacitor it may be necessary to experiment a little to find the correct method of connection. One side of a variable capacitor connects internally to the chassis, so getting the connections around the wrong way will place a short circuit across coil L2 and prevent the circuit from working.

Getting all the wiring installed is not too difficult. As with any "hard wiring", strong joints are more or less guaranteed if the tags and ends of the leadout wires are solder-tinned prior to making a connection.

Pin 4 of valve V1 is used as a convenient anchor point for one lead of capacitor C1. Do not use pin 5 as this does have an internal connection to the valve.

There are three connections between the 9V batteries, and these must all be insulated with tape or sleeving to make sure that they cannot accidentally come into electrical contact with each other or other parts of the circuit. The batteries can be fixed to the right-hand side panel of the chassis using adhesive pads. The unused leads of T1 and L4 should be cut short, and any exposed wire must be insulated to ensure that no unwanted connections occur.

HEADPHONES

Low impedance mono headphones can be used with a standard jack socket used for SK4. Stereo headphones will also work, but only one phone will be driven. For operation with stereo headphones it is preferable to use a stereo jack socket, and it does not seem to make much difference whether the phones are driven in series or parallel.

The circuit will also work quite well with medium impedance headphones of the type sold as replacements for personal stereo units. Socket SK4 should then be a 3·5mm jack type and results are best with the phones driven in parallel.

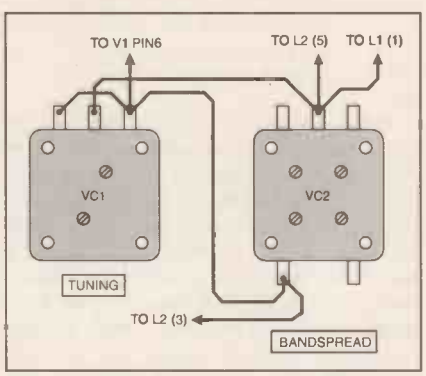
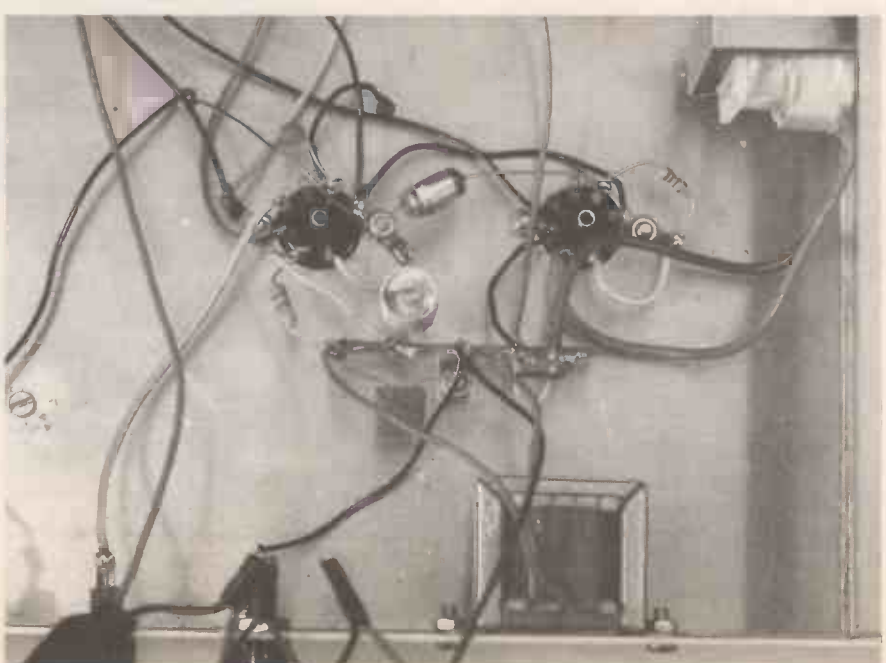


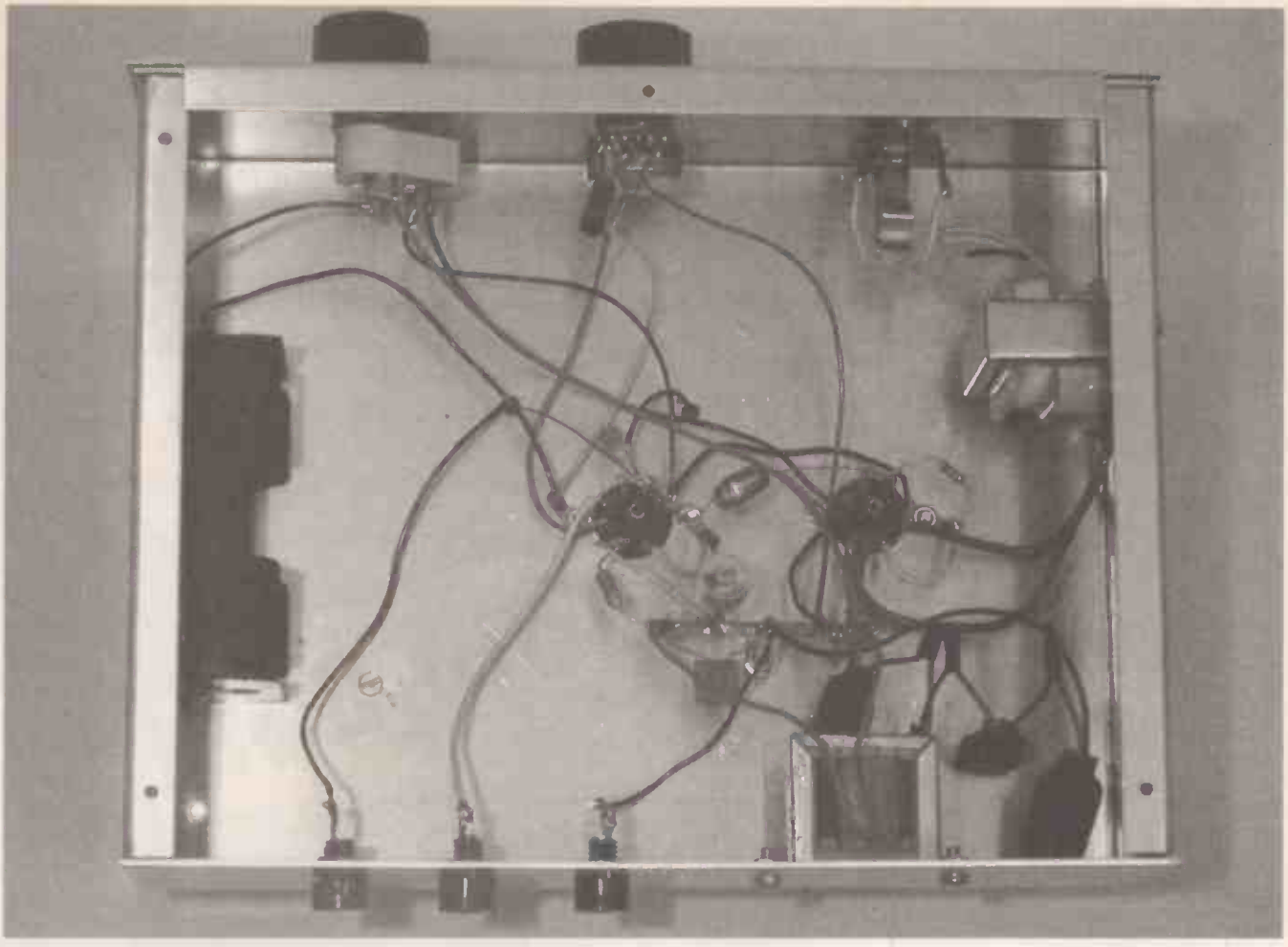
Fig.5. Wiring to variable capacitors VC1 and VC2 (solid dielectric type).

TESTING AND USE

Give the wiring a thorough check before testing the finished receiver. In particular, make sure that the HT and LT supplies have not been accidentally swapped over at the On/Off switch S1.

Components soldered directly to the valveholder pins and wiring to the 5-way tagstrip. Note the "earthing" solder tags secured to the chassis by the mounting bolts of the valve bases.





Main assembly underside general component layout and interwiring details. Note the two "transformers" and battery holder mounted on the chassis internal side panels.

The valves should plug into the holders quite easily. Do not try forcing them into place if fitting them proves to be difficult. Examine the pins and carefully straighten any that are significantly bent out of position.

Long aerials do not generally work well with a set of this type. They tend to load the tuned circuit making it difficult to obtain sufficient regeneration, and very strong signals overload the detector. About 0·5 to 1 metre of wire connected to socket SK2 or about 2 to 5 metres connected to SK1 is sufficient to give good results.

If you were looking forward to a nostalgic wait for the valves to warm up followed by a glow from the filaments you will be disappointed. The combined heaters and cathodes give an almost instant warm up and there is no obvious light output from the valves.

REGENERATION

With Regeneration control VR1 well backed off in a counter clockwise direction it may be possible to receive a few of the stronger broadcast stations by adjusting Tuning control VC1. If not, advance VR1 in a clockwise direction and try again. If there is a lack of reception switch off at once and recheck the wiring.

Band conditions vary according to various factors such as the time of day, the time of year, and "sunspot" activity. Normally at least one broadcast band within the tuning range of the receiver will be "open", and the strength of the signals will be such that the broadcast bands will not be difficult to find.

It is important to realise that VR1 is not a volume control. It can be backed off slightly if the volume becomes excessive, but it must otherwise be adjusted close to the point at which oscillation occurs. It is readily apparent when the detector is oscillating, because there is a change in the background noise level and notes of varying pitch will be heard as the set is tuned across stations.

OSCILLATION

With some regenerative receivers there is a tendency for the detector to slide into oscillation, and the regeneration control then has to be well backed off in order to take the set out of oscillation. This makes accurate control of the regeneration level almost impossible. There is no such problem with this design, and the feedback can be carefully adjusted to the optimum setting.

Unfortunately, with sets of this type it is not possible to find a universal setting that is suitable for all reception frequencies. Significant changes in the settings of the tuning controls may necessitate readjustment of VR1. This clearly makes regenerative receivers more difficult to use, but it is all part of their charm!

Try experimenting with trimmer capacitor VC3 at various settings. Best results will be obtained with a setting that enables oscillation to be achieved at any settings of the tuning controls, but with VR1 well advanced.

With too little feedback through VC3 it may be impossible to obtain sufficient regeneration on some bands. With too much feedback through VC3, valve V1 will be operating at relatively low gains and this might adversely affect performance.

If VC1 and VC2 have built-in trimmers, coverage will probably be best if they are set for minimum value. However, there is no harm in trying various settings to find the ones that provide the most useful coverage.

PERFORMANCE

The simple valve receivers used in the 1960s all seemed to suffer from a lack of audio output. The high volume levels available from this receiver, with its greatly reduced HT voltage, surprised the author. With most headphones it was found to be necessary to back off VR1 on strong signals in order to keep the volume down to a reasonable level. A two-transistor receiver would be unlikely to provide a similar problem.

The precision with which the regeneration level can be set aids the level of performance, which is certainly very creditable for such a simple receiver. The shortwave broadcast bands have plenty of English language transmissions from countries all over the world.

Some dabbling with the 2-Valve SW Receiver over a weekend produced stations from across Europe and into Asia and North America. With skill, patience, and the right propagation conditions it would probably be possible to receive broadcasts from anywhere in the world. □

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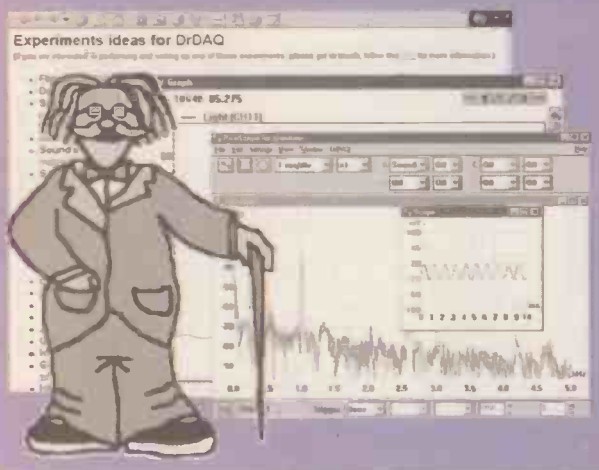

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READOUT

E-mail: editorial@epemag.wimborne.co.uk

John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

WIN A DIGITAL MULTIMETER

A 3½ digit pocket-sized l.c.d. multimeter which measures a.c. and d.c. voltage, d.c. current and resistance. It can also test diodes and bipolar transistors.

Every month we will give a Digital Multimeter to the author of the best *Readout* letter.

★ LETTER OF THE MONTH ★

MORE ON ELECTRONICS SHORTAGE

Dear EPE,

I fully concur with your *Readout* Aug '01 correspondent Brian Whittle. When I was made redundant in the early seventies I found it impossible to gain employment in my field. I was a qualified Electrical Engineer with an HND and a Post Advanced Diploma. Redundancy carried a stigma and perhaps it still does today.

I was fortunate to meet up with an American who offered me a trial in Algeria. He asked me what I knew of SCRs, large d.c. motors and drilling rigs. I said I had no experience of these but Electricity was Electricity. I grossly over simplified the subject by stating that there were only three faults: open circuits, short circuits, and intermittent faults and only the intermittent were really difficult to troubleshoot.

On this basis I got a start in the Petroleum industry, and after three weeks I was offered a full time position. I have since spoken to many people in the industry and have heard the same story over and over. At that time the oil industry in the UK was in its infancy, what experienced people we had were already making their name, fame and fortune working overseas. Americans in the UK recruited on the basis that if you think you can do the job, try and I will fire you if you cannot. No one can ask for anything more.

This is where I believe the UK management goes wrong, they are far too cautious in offering employment. Give your applicants a chance, would be my advice. Do not offer low pay until you prove yourself, which I must confess I have accepted many years ago. Do not employ via agencies, which many do and the agency takes a good proportion of what should go to the employee. Simply give one a chance to prove oneself.

My son faced the same problem as many UK University graduates. He has a first class Honours degree in Computer Science from a prestigious University. He had many interviews, sometimes even up to three and some months later the positions were still being advertised. The usual response was he had no experience or that he was overqualified for the position. He took the opportunity to work on a very short contract in Switzerland and shortly afterwards he was offered a staff position. He is still there after some eleven years.

My original qualifications were in power engineering and I have always wanted to be able to troubleshoot down to component level and only at the age of 63 when I had to leave the North Sea because of ill health did I get a suitable opportunity. I signed up for a City and Guilds diploma in Digital Electronics and Computer maintenance. The course was excellent but I found that I was the only one there of my own volition, everyone else had been sent by the DSS. And much as I applaud the Government for giving others and me the opportunity, forcing people to sign up for courses is not the way to train specialists.

As a final point, one chap who was indeed very good actually found work. Making, installing, and fault finding computer systems. He was offered a derisory wage of £150 and he was told that the DSS could give him extra to bring him in to the level at which he was then receiving from the DSS. He would have had to travel, buy meals etc., look after his disabled wife, and incur the entire extra costs involved in accepting the position. Needless to say, he is still unemployed. I would suggest that it is not that the DSS payments are too high but the rewards for working are too low. We do ourselves no good by being a low wage economy.

Jim from Derby, via the Net

Jim, for once I am lost for words, other than to say that it is hard not to feel very despondent about the way in which technology and its employment opportunities seem to be suffering so greatly in this country.

Has anyone any positive *comments to make on the subject?*

PIC TO DISK?

Dear EPE,

I found the *PIC to Printer Interface* in the July issue very interesting – a good use for redundant printers.

On a similar vein – is it possible to interface a PIC to a 3·5 inch floppy disk drive? With all those old PCs that get outdated rapidly, there must be a lot of drives about and the additional (long term) storage would be very useful for any number of PIC projects.

Obviously it would be best if the data recorded was readable on a PC and in that event a PC could be used for formatting.

Roger Warrington, via the Net

Thank you Roger, it probably would be feasible but I can't offer to do it as I do not have a spare drive, nor indeed do I know the command protocol for accessing drives. Does anyone know how easy it might be?

SURROUND SOUND

Dear EPE,

Some additional comments and information that some readers might find interesting, on your *Stereo/Surround Sound Amplifier* (July '01):

The technique of extracting a disparity or ambience signal from a stereo pair has been around for some time, it having appeared (under the trade name Dynaquad, I seem to remember?) in the 1960s.

It's actually exactly the same process used by the non-Prologic Dolby Surround system, which goes a bit further in adding a delay of typically 20ms to the surround signal (because in most home environments the listener is closer to the rear speakers than to the front speakers) and adding a bit of noise reduction, based on a modified Dolby B-type processor, to the L-R signal. Even Pro-Logic uses this technique to extract the surround information, but goes even further by generating steering vectors to dynamically control the levels of the surround and centre levels derived.

The article refers to a "pseudo surround" signal, but the L-R signal in fact contains the true surround component. Dolby Stereo encoding essentially takes the surround signal, and phase shifts it by +90° and –90° before adding it to the original left and right signals respectively, to maintain a two-channel recording. By taking the difference of the two signals on playback, you get the true surround signal, *plus*, unfortunately, any component not common to the original left and right signals. There is no simple analogue signal processing that can eliminate this.

Returning to the project: for most home installations, if the reader already has a stereo setup, the use of an additional amplifier is entirely unnecessary! Exactly the same effect can be achieved by wiring an additional loudspeaker system to the "hot" outputs of the power amplifier, ignoring the ground connection.

With respect to the rear speakers, the amplifier is then operating in bridged mode, but the phase inversion usually required for bridged mode is inherent in the recording itself. This wiring method works because almost all stereo amplifiers use a common speaker ground connection for both channels.

If the stereo system normally uses 8Ω loudspeakers, then a pair of rear speakers also rated 8Ω, and wired in series (to present 16Ω to the "bridge" amplifier) provides a more-or-less correct sound volume in relation to the front speakers. The rear speakers should not be wired in parallel, but in series, and in the same phase. If the surround volume is too high and the ambience effect intrusive, a large (10W or so) resistor or rheostat of around 8Ω to 16Ω can be inserted to correct this.

The added load on the amplifier shouldn't be a problem to any self-respecting commercial hi-fi amplifier. Most of these are rated for 8Ω, but can happily drive a 4Ω load without stress except at close to their clipping threshold when they might overheat.

Because very little bass information comes through the surround channel (bass is usually mono'd at the recording stage – that used to be done to make LPs more trackable, but they seem to still do it on CDs) the surround speakers can be of a considerably lower power handling capacity than the front speakers. Since directional hearing doesn't work at bass frequencies, this bass-mono characteristic is never a problem. The exception is THX videodiscs, some of which carry a very large bass disparity component – watch out for distortion or overloading.

I have been using this technique on a ReVox B250 and a Teac A70 amplifier for over 10 years in a home environment and have never had any overheating. In fact the overall sound quality provided by this setup *far* exceeds that of a big-brand name amp I unfortunately bought, with its in-board Dolby Pro Logic and multitude of "digitally sampled" surround modes.

David Tilch M.Sc., via the Net

Thank you for the interesting information. We are pleased to share it with readers.

RADIO POWER

Dear EPE,

I found both the *Mechanical Radio* (April '99) and *L.E.D. Torch* (Oct '00) very interesting but wondered if some readers would be put off by having to build the generator. My local electronics shop sells old-fashioned DynoTorches (squeeze a lever) for £10. They have an a.c. generator that drives a 2·5V 0·15A bulb, but my digital multimeter showed it would output approximately 5V to 6V a.c. into a 68Ω resistor.

There is not enough room in the front of the torch for much circuitry so either a suitable box would need to be attached to the front of the torch or the DynoTorch could be fitted with a power-out socket and the radio/l.e.d. torch fitted with a power-in plug (this would allow them to share a generator).

Note that the radio would require a protective 5V1 5W Zener diode across the C4 supercap and I think D1 to D4 should be upgraded to fast recovery higher rated diodes such as 1N5818. Also the torch's D1 should be similarly upgraded (and only one bridge would be required).

The DynoTorch is manufactured for Fascinations, Seattle, WA 98148 NB.

Alan Bradley, via the Net

Thanks for the info Alan. Readers can search for Fascinations via the excellent web search engine www.google.com.

MORE LANGUAGE DEBATE

Dear EPE,

So far the arguments have been on the merits and functionality of various languages C, Delphi etc. However, this is not in my opinion the major issue in choosing a language for use in an educational magazine. The language used for further projects I suggest should be C/C++ for the following reasons:

I have just finished an HNC in electronics of which C was a core module, so articles which relate to C would help those studying electronics.

The C books I have read show very little on how to use C to interface with the rest of the world or use it to program microcontrollers. There are C compilers cheaply available for all computer platforms and for all types of microprocessor.

C is also very often the chosen language for many electronics companies in industry.

C has been around for a long time and is well understood by a great many, therefore requests for problem solving and improving published designs should be forth coming.

Stuart McGhee, Norwich, via E-mail

Thank you Stuart. It's interesting how various "camps" are now becoming apparent. We continue to keep an open mind about whether or not we should embrace any particular "new route".

Anyone wishing to know how C can be used when writing PIC code is recommended to consider buying the "C" For PICmicro Microcontrollers *CD-ROM as advertised on our CD-ROM pages.*

SOLDERING TIP

Dear EPE,

Referring to the letter from Arthur Green in July '01 and Alan's reply:

The device that I have used for twenty or more years requires only a mains voltage rated diode having a suitable current passing capability. The diode is connected in series with the soldering iron and in parallel with the diode is a microswitch.

Mechanically the hardware is arranged so that the iron when not in use is hung on a rest. Mine was made from a wire coat hanger, the end of which actuates the microswitch to become "open", the diode is now in circuit putting the soldering iron to half power. Lift the iron off its rest and the switch closes to short the diode and give full power to the iron, which will heat up to correct temperature within seconds.

I cannot claim to be the originator of the above idea. The original article was printed in the long time defunct *Radio Constructor* magazine many years ago.

Mike Trueblood, via the Net

Thank you Mike. We too published something similar many years ago, we also published, in Sept '97, Bart Trepak's Soldering Iron Controller.

TIME MACHINE

Dear EPE,

I have always been interested in time and have built your *PIC Time Machine* (Nov '97). Having taken early retirement some years ago I took on the task of "looking after" the clock in the parish church. It had gone through many stages of modification up to 1998 when I built a church clock control system around your *Time Machine* design.

The clock has been developed a bit since it was installed and now adds/subtracts the BST, rings the angelus one, two or three times each day and can ring the bell three times on command from the pulpit about 30 metres below. The control system drives an a.c. motor to ring the bell and a photoswitch counts the rings, one per rev. The fingers (about four metres diameter) are driven from a small a.c. motor through a worm box, a photoswitch gives one count per rev, which is 30 seconds on the fingers. Every 30 seconds the control system starts the motor until one count has occurred.

The clock has only malfunctioned twice in the last two years. Both times when the MSF signal from Rugby was down for maintenance and an update took place with no Rugby signal, just on noise, and a purely random time resulted.

It would seem that the checksum cannot always validate the data and, given enough reads, the occasional good data bit will be given on just the noise signal.

Jim Fell, via the Net

As I recall, the software validates incoming data according to information supplied by the National Physical Laboratory. Your problem has not been reported by other readers and I have not experienced it myself.

The only simple suggestion I can make is that the MSF receiver is switched off during Rugby maintenance periods, allowing the clock to run purely under its own crystal control.

PIC DIVISION

Dear EPE,

Many amateur programmers who do not fully understand binary numbers often find binary arithmetic a daunting prospect and may resort to cheating, i.e. using multiple additions and subtractions to perform multiplication and division.

The following routine divides two 16-bit numbers, the dividend by the divisor, which have been pre-loaded into **dividl,h** and **divisl,h** respectively, and returns the result (quotient) in **dividl,h** with the remainder in **remdrl,h**. The original dividend is lost, being overwritten by the quotient.

Readers who are familiar with arithmetic routines will not find anything unusual in the listing, in fact it is based on a standard algorithm, optimised for the PIC instruction set. Note the lines that show how to compare two 16-bit numbers using the limited instructions of the PIC.

However, it is worth noting that a bug exists in Microchip's standard division routine. It's the carry (or borrow) out from double precision addition or subtraction that I found is not guaranteed to be correct for all possible input values. The double precision addition and subtraction codes are standard ones published in various Microchip documents and must have been used an unimaginable number of times by PIC programmers around the world. The good news is that my division routine is OK because a borrow out from the double precision subtraction is guaranteed not to occur.

```
; Divide 16-bit dividend (dividL,H) by 16-bit divisor (divisL,H)
; Result (quotient) in dividL,H and remdrL,H

  processor 16f84
  include p16f84.inc
  radix dec

; Ram equates
dividL  equ 0xC         ; Dividend and quotient
quotL   equ dividL
dividH  equ 0xD
quotH   equ dividH
remdrL  equ 0xE         ; Remainder
remdrH  equ 0xF
divisL  equ 0x10        ; Divisor
divisH  equ 0x11
bitcnt  equ 0x12        ; Bit count
divd    equ 5432        ; Test code for MPLAB simulator
divs    equ 22

        org 0
test    movlw low divd
        movwf dividL
        movlw high divd
        movwf dividH
        movlw low divs
        movwf divisL
        movlw high divs
        movwf divisH
        call divide
        return
divide  movfw divisL
        iorwf divisH,w
        skpnz
        goto div0       ; Division by zero !
        movlw 16        ; 16-bit division
        movwf bitcnt
        clrf remdrH     ; Clear remainder
        clrf remdrL
        dvloop clrc     ; Set quotient bit to 0
        rlf dividL      ; Shift left dividend and quotient
        rlf dividH      ; Msb into carry
        rlf remdrL      ; and then into partial remainder
        rlf remdrH
        movfw divisH    ; Compare partial remainder and divisor
        subwf remdrH,w
        skpz
        goto testgt     ; Not equal so test if remdrH is greater
        movfw divisL    ; High bytes are equal,compare low bytes
        subwf remdrL,w
        testgt skpc     ; Carry set if remdr >= divis
        goto remrlt
        movfw divisL    ; Subtract divisor from partial remainder
        subwf remdrL
        skpc            ; Test for borrow
        decf remdrH     ; Subtract borrow
        movfw divisH
        subwf remdrH
        bsf dividL,0    ; Set quotient bit to 1
                        ; Quotient replaces dividend which is lost
remrlt  decfsz bitcnt
        goto dvloop
        clr             ; Clear error flag (z)
div0    return          ; Return with z set if error
        end
```

Peter Hemsley, via the Net

Thank you Peter, that's great. This code has been added to our PIC Tricks *folder, which is available on* EPE Disk 4 *and from our FTP site (see* EPE PCB Service *page for details).*

Readers, we now have several hints and code routines of use to PIC programmers in our PIC Tricks *folder. If you have any short hints or bits of code you think might be useful to add as well, send it to me for possible inclusion.*

PLCs AND SCHOOLS

Regarding your July '01 Editorial, I rather got the impression that Editor Mike was apologising for the inclusion of the PLC article in that edition. Well, he need not be so concerned – I for one found it useful.

PLC control is making its way into the AS level syllabus, as is PIC programming and the usual electronics. As a Systems and Control teacher, I found the PLC article very useful as it gives details of practical solutions. I have a PLC to demonstrate with, although Ladder Logic represented on its small l.c.d. display is a little difficult to cope with.

Be encouraged with the PIC articles, too. We recently bought PIC Logicator (as reviewed by Robert Penfold in Nov '00) and I was pleased to help one of my A-Level students to (hopefully) success with his major project. He programmed his work in MPASM, including serial in/out at 9600 baud with a PIC16F84. Without the encouragement of *EPE*, I am sure we'd still be using huge circuit boards and major logic networks.

Much of our school's work is on the technology department's website at **www.roulson.net/techweb** and I feel that many would find the site worth a visit.

Ivan Roulson, The King's School, Ottery St Mary, Devon, via the Net

Mike says that he was simply pointing out that we do not feel we can go more deeply into how PLCs work. It is interesting to learn that they are part of the AS level syllabus. Thank you for your observations.

LOW VOLTAGE PCs

Dear EPE,

I have recently invested in a pre-assembled *PIC Tutorial* (Mar-May '98) board and have a problem – I can't re-program the PIC on it. The installation has been followed correctly, yet the PIC continues to run the TUTTEST program as pre-loaded by Magenta. I have checked the software installation, power supply and PC printer port register correctness, and I have tested that the pins can correctly change their logic levels, although the voltage for Logic 1 is around 3·35V for both the pins 12 and 13, dropping back correctly to 0V. The 12V programming voltage has been checked, and is found to be 11·8V d.c.

The computer I am using is a Gateway Pentium III running Windows 98, but the PIC software still refuses to work when the computer is booted straight into DOS mode.

Alan Whailin, via the Net

In his lengthy letter, Alan gave a lot of detail about the tests he had run, the above is merely a summary.

The programming voltage being at 11·8V should be no problem – I've programmed PICs with a Vpp as low as 9V. Alan's reference to 3·3V gave me the answer, though – it certainly was too low. A number of computers being released now output this lower voltage and for this reason Microchip have introduced a variant of the PIC16F84 that will handle these lower voltages, namely the PIC16F84A. I said as much to Alan, who replied:

Thanks for your help! The problem was as you said, the voltage was too little to program the PIC. As I don't live near a supplier I decided to try out a circuit to take the printer pin voltages from my computer (3·3V) and change them to 5·0V. I placed the circuit on stripboard and fitted it to one side of a 25-way D-type connector and then connected the other end to the Centronics printer cable.

An interesting solution but, Readers, if your PC does only deliver a 3V (or so) Logic 1 output, using the PIC16F84A would seem to be the better option.

BASIC IS EASIER

Dear EPE,

I agree wholeheartedly with Roger Warrington (*Readout* July '01). I too have around 25 years of programming, mostly in various dialects of Basic and a little assembler. I have also used Visual Basic but prefer Delphi for Windows style programs. I too find Basic easier to pick up again, especially for one-off projects.

My coding skills are not great but I usually pull through. Recently I tried to learn C as a means of programming PICs because I needed to time the reactions of various components in a fast moving machine and thought Basic might be a bit slow. Unfortunately I hardly got off of the starting blocks, partly because of problems with the environment I was using but mainly because at the age of 50 my powers of learning are somewhat diminished, or as I tell my colleagues "after 45 years of cramming my brain with information it is full and cannot take anymore".

Trevor Wilson, Aberdeen, via the Net

Well, Trevor, one of my colleagues suggests that from time to time we should all have a "half-price clearance sale" of any no longer required mental information, thus making room for more – a sort-of "defrag" in computing terms! The trouble is you never really know what might become useful and personally I'd hate to discard anything. Perhaps evolution might one day give us the equivalent of "disk data compression" without having to increase our brain size.

But there are many examples of people in excess of 50 years taking up adult education and acquiring new skills and knowledge. And look at all those PIC projects I've designed – they're from a brain considerably more ancient than yours and which still loves the challenge of software!

Whatever your age, don't ever think that you are past learning!

VIDEOS ON ELECTRONICS

A range of videos selected by *EPE* and designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They have proved particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc

BASICS

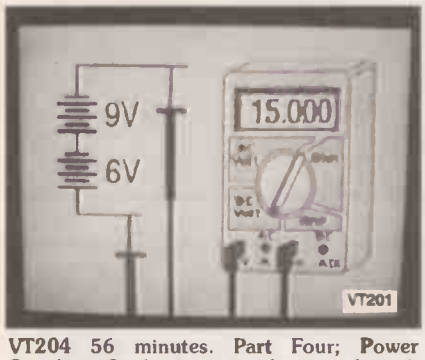
VT201 to **VT206** is a basic electronics course and is designed to be used as a complete series, if required.

VT201 54 minutes. Part One; D.C. Circuits. This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more. Order Code **VT201**

VT202 62 minutes. Part Two; A.C. Circuits. This is your next step in understanding the basics of electronics. You will learn about how coils, transformers, capacitors, etc are used in common circuits. Order Code **VT202**

VT203 57 minutes. Part Three; Semiconductors. Gives you an exciting look into the world of semiconductors. With basic semiconductor theory. Plus 15 different semiconductor devices explained.

Order Code **VT203**



VT204 56 minutes. Part Four; Power Supplies. Guides you step-by-step through different sections of a power supply.

Order Code **VT204**

VT205 57 minutes. Part Five; Amplifiers. Shows you how amplifiers work as you have never seen them before. Class A, class B, class C, op.amps. etc. Order Code **VT205**

VT206 54 minutes. Part Six; Oscillators. Oscillators are found in both linear and digital circuits. Gives a good basic background in oscillator circuits. Order Code **VT206**

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VCR MAINTENANCE

VT102 84 minutes: Introduction to VCR Repair. Warning, not for the beginner. Through the use of block diagrams this video will take you through the various circuits found in the NTSC VHS system. You will follow the signal from the input to the audio/video heads then from the heads back to the output.

Order Code **VT102**

VT103 35 minutes: A step-by-step easy to follow procedure for professionally cleaning the tape path and replacing many of the belts in most VHS VCR's. The viewer will also become familiar with the various parts found in the tape path.

Order Code **VT103**

DIGITAL

Now for the digital series of six videos. This series is designed to provide a good grounding in digital and computer technology.

VT301 54 minutes. Digital One; Gates begins with the basics as you learn about seven of the most common gates which are used in almost every digital circuit, plus Binary notation. Order Code **VT301**

VT302 55 minutes. Digital Two; Flip Flops will further enhance your knowledge of digital basics. You will learn about Octal and Hexadecimal notation groups, flip-flops, counters, etc. Order Code **VT302**

VT303 54 minutes. Digital Three; Registers and Displays is your next step in obtaining a solid understanding of the basic circuits found in today's digital designs. Gets into multiplexers, registers, display devices, etc.

Order Code **VT303**

VT304 59 minutes. Digital Four; DAC and ADC shows you how the computer is able to communicate with the real world. You will learn about digital-to-analogue and analogue-to-digital converter circuits.

Order Code **VT304**

VT305 56 minutes. Digital Five; Memory Devices introduces you to the technology used in many of today's memory devices. You will learn all about ROM devices and then proceed into PROM, EPROM, EEPROM, SRAM, DRAM, and MBM devices.

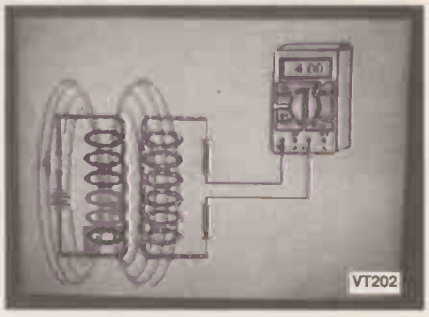
Order Code **VT305**

VT306 56 minutes. Digital Six; The CPU gives you a thorough understanding in the basics of the central processing unit and the input/output circuits used to make the system work. Order Code **VT306**

RADIO

VT401 61 minutes. A.M. Radio Theory. The most complete video ever produced on a.m. radio. Begins with the basics of a.m. transmission and proceeds to the five major stages of a.m. reception. Learn how the signal is detected, converted and reproduced. Also covers the Motorola C-QUAM a.m. stereo system. Order Code **VT401**

VT402 58 minutes. F.M. Radio Part 1. F.M. basics including the functional blocks of a receiver. Plus r.f. amplifier, mixer oscillator, i.f. amplifier, limiter and f.m. decoder stages of a typical f.m. receiver. Order Code **VT402**



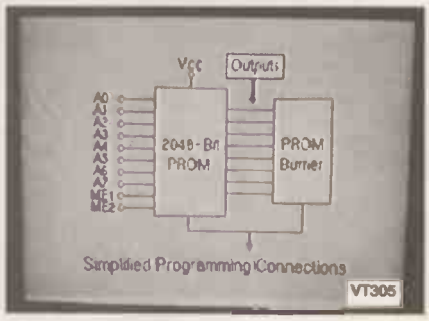
VT403 58 minutes. F.M. Radio Part 2. A continuation of f.m. technology from Part 1. Begins with the detector stage output, proceeds to the 19kHz amplifier, frequency doubler, stereo demultiplexer and audio amplifier stages. Also covers RDS digital data encoding and decoding. Order Code **VT403**

MISCELLANEOUS

VT501 58 minutes. Fibre Optics. From the fundamentals of fibre optic technology through cable manufacture to connectors, transmitters and receivers.

Order Code **VT501**

VT502 57 minutes. Laser Technology A basic introduction covering some of the common uses of laser devices, plus the operation of the Ruby Rod laser, HeNe laser, CO_2 gas laser and semiconductor laser devices. Also covers the basics of CD and bar code scanning.
Order Code **VT502**



Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier. We are the worldwide distributors of the PAL and SECAM versions of these tapes. (All videos are to the UK PAL standard on VHS tapes unless you specifically request SECAM versions.)

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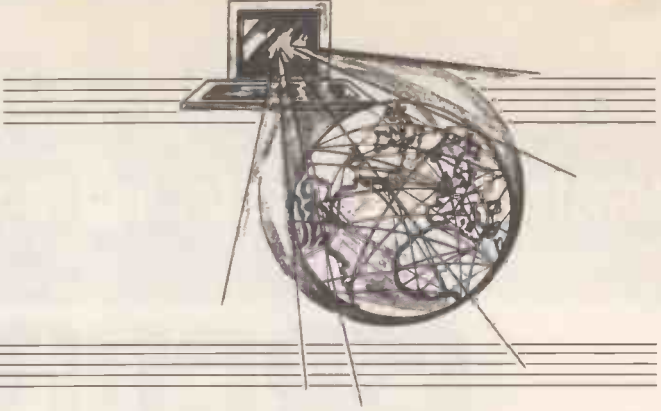
SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY

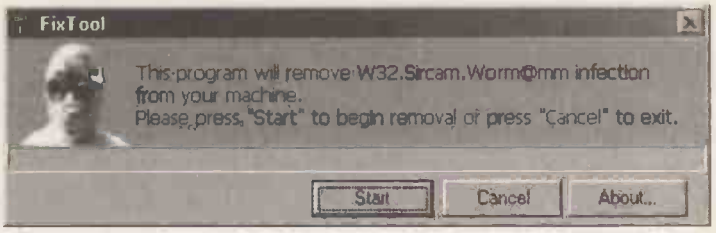


Arise, Sircam

WHAT an eventful month this has been for Internet users. Much of the popular media prophesied an imminent meltdown of the Internet due to the "CodeRed Worm" alert. Defeating *CodeRed* and *CodeRed2* is a technical issue which network managers must confront.

However, the same press and TV could have done everyday Internet users a service by covering a much more troublesome nuisance, a plague in the shape of the *Sircam* worm. This nasty little creature burrows its way towards your Windows Address Book in search of tasty E-mail addresses. The Sircam worm also has an appetite for computer files stored on your hard disk: it likes to share them with your friends, so the worm attaches itself to any one of your files – private ones stored in the My Documents folder will do nicely.

Then using its built-in SMTP engine, Sircam will E-mail the file to all and sundry, often without the hapless owner ever knowing. Being a gregarious sort of worm, Sircam propagates itself using the recipient's address book, but as a supplementary diet Sircam is also said to find E-mail addresses lurking in your web browser cache. It could also do more severe damage to host computers – filling a hard disk with junk and trashing essential files, delivering its nasty payload sometime in October. In practice, Sircam has caused an awful lot of damage, easily trouncing "ILOVEYOU" according to McAfee.



Symantec's Sircam Removal Tool – a familiar sight for all too many.

The Worm has Turned

One of the benefits of using a fairly obscure E-mail package (Turnpike) is that it uses a proprietary address book that is immune to Windows address book attacks. No worm-holes to be found there. So what about all those incoming files? My first bout of Sircam-mania happened in July when strange E-mails started arriving from Argentina, then from Brazil a few days later, then Mexico, and then the USA. Mails then arrived from Korea, Japan, South Africa and eventually mainland Europe.

Each mail contained the same message and Turnpike made it easy to spot that an unsolicited file was attached. Some files were very large – several megabytes long which reduced my mailfeed to a crawl at times. A quick scan with anti-virus software soon revealed the sinister truth, and from then on it was a case of circling the wagons: I sensed something big was about to break out.

The trickle of files turned into a minor deluge, files of every description arriving from people I'd never heard of. Spreadsheets, images and .doc files all tried to wriggle their way onto my hard disk. In the early stages, I would E-mail the senders, thanking them very much but alerting them to the presence of their unwanted guest; if users were on a fast network, they would probably never ever know that the Sircam worm had infested their system. In several cases my E-mail bounced back – their mailbox quota had been exceeded, presumably because Sircam had created such a logjam that their network couldn't mail the worm out quickly enough.

Infra Dig

Things took a turn for the worse when I fired up my new infra-red phone (see last month) and a new laptop, in order to fetch some E-mail. You guessed it, Sircam was soon trying to wriggle its way through the airwaves via my mobile phone. In fact, it attached itself to a quarter-megabyte file which took an eternity to fetch via the mobile, which wasn't quite the flying start to mobile communications I had hoped for. Sad to say, Sircam finally found its way onto my new laptop, costing me quite a few pounds in phone charges in the process.

Somehow or other an infected file was opened accidentally. Call it lack of familiarity with Outlook Express. Symantec Anti Virus did a good job of isolating the worm, but what it could *not* do was repair any infected files. In the case of my new laptop, Sircam attached itself to two files stored in the _restore folder of Windows ME, and only by disabling the System Restore function could the infected files be quarantined, losing them in the process.

Back to the desktop PC system then: by now Sircam worms were being picked off every few hours but, due to an oversight lasting several "ohno-seconds", I accidentally double clicked an offending filename (a single push of the mouse roller, actually) instead of scanning it, and with one bound Sircam was free to roam around my network. Naturally I was kicking myself at this point, but I supposed that if NASA could crash a satellite into the surface of Mars due to an unfortunate mix-up over units of measurement, then mere mortals like myself would double-click an infected filename occasionally. At least, that was my excuse.

The day's work came to an abrupt halt – offending files such as *Sircam32.exe* were deleted but when the PC was rebooted, Sircam complained about that missing file and crippled the machine. When the Sircam files were restored as a workaround, the worm jumped in and prevented all other programs (Applications) from launching – so the system was totally paralysed.

The Whys? after the Event

Hot-footing it to another PC, mercifully the Symantec web site (**www.symantec.com**) offered a Sircam removal tool for download. This was loaded onto a floppy disk and after running it I was eventually back in business, a whole lot wiser! A month later, I am amazed to see that the Sircam Worm is still being E-mailed to me, presumably by neophyte Internet users.

What are the lessons to be learned? It should go without saying that up to date anti-virus software is crucial: Symantec and McAfee (**www.mcafee.com**) are two of the respected brands available. Subscribe! Do us all a service and pay for the regular downloads to keep your virus definitions up to date.

Obviously, if you don't scan all files "on-the-hoof" then all suspicious file attachments should be quarantined for scanning before they are opened. As a corporate service, MessageLabs (**www.messagelabs.com**) offers a 30 day free trial of their service which intercepts any infected mail en-route before it can be delivered.

Worms and viruses are a fact of Internet life and they will only ever get worse, especially with the gradual uptake of always-on Internet access (cable, satellite and DSL). This will make it much easier for worms to propagate quickly without the knowledge of the user.

Another *essential* tool is an anti-intrusion program such as the freeware Zone Alarm (**www.zonelabs.com**) to guard against "Internet background noise" (to quote Steve Gibson of **grc.com**). Note that in the writer's system, as an added bonus Zone Alarm also "padlocked" Sircam-infected files ready for scanning/quarantining.

Intrusion attempts are commonplace – expect a few dozen every day. Check your system today, and get your anti-virus and anti-intrusion software up to date this minute! You can contact the writer at **alan@epemag.co.uk**.

SHOP TALK
with David Barrington

WE commence this month with the news that **Electromail**, the mail order arm of RS Components, no longer exists. However, the good news is that RS components can still be purchased on a "one-off" order basis via their "RS New Business Reception" by telephone on ***01536 444079*** or through their web site at **rswww.com**. *All goods must be ordered by Credit Card only.* They did indicate that a post and packing charge will be incurred and is as follows: orders up to £30 – £4.60 p&p; over £30 to £79.99 –£2.95; over £80 – £1.75.

Camcorder Power Supply

It is important that readers keep to the specified types for some of the components needed to build the *Camcorder Power Supply* project. The specification of diode D10 and capacitor C8 is especially important.

The diode BYW80 used in the prototype is a high-speed, fast recovery type capable of handling 8A and was purchased from **Farnell** (☎ ***0113 263 6311*** or ***www.farnell.com***) code 366-705. It is also listed by **Maplin** (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code AH57M. You will also need a semiconductor insulating kit to electrically isolate the device from the small fabricated aluminium (15mm x 40mm) heatsink.

Capacitor C8 must have a low impedance at 100kHz and a minimum working voltage of 50V d.c. A Rubycon **YXF** series capacitor (2 off) ordered from Farnell (see above), code 580-612, was used in the prototype. They can only be ordered in multiples of five minimum. The same company also supplied the ZRB500Y03 +5V voltage reference (code 302-4210) and the Newport high current 150μH 4A inductor, code 432-040.

The printed circuit board is available from the *EPE PCB Service*, code **318** (see page 745).

PIC TOOLKIT Mk3

Most items for the *PIC Toolkit Mk3* are RS components and can be ordered through any *bona-fide* stockist, including some of our advertisers. If you have a credit card, you can place an order with **RS** on ***01536 444079*** or through their web site: ***rswww.com***.

The MAX662CPA charge-pump d.c.-to-d.c. converter chip, designed to provide +12V at 30mA from 4·5V to 5·5V inputs, is currently listed by RS as code 299-575. The rest of the semiconductor devices should be readily available.

There should not be any problems finding the optional 2-line 16-character per line alphanumeric l.c.d. module as connection details are included for two possible formats. The one used in the author's model came from **Magenta Electronics** (☎ ***01283 565435*** or ***www.magenta2000.co.uk***). If ordering from Magenta you should specify that you wish to purchase one with a pin connector attached.

The printed circuit board is available from the *EPE PCB Service*, code **319** (see page 745). Incidentally, if you browse through our component advertisers' pages you will soon find that PICs are now widely stocked and should not cause any sourcing problems.

2-Valve SW Receiver

Being a little out of touch with valve circuit requirements, we asked Gerald Myers of **Chevet Supplies** (☎ ***01253 751858*** or E-mail ***chevet@globalnet.co.uk***) regarding the availability of the DF91 valve used in the *2-Valve SW Receiver* project. We were informed that it is becoming in short supply, they only have two in stock at present, but gave us some equivalents, i.e. IT4, W17, CV785 and CV197. We have not been able to check these out. You could also try contacting **Bull Electrical** (***0871 871 1300***), **Cricklewood** (☎ ***020 8452 0161***), **J&N Factors** (☎ ***01444 881965***) or **Greenweld** (☎ ***01277 811042***), who may be able to help.

For the tuning capacitors we suggest you also contact the above companies plus **Mainline Surplus Sales** (☎ ***0870 241 0810***), who sometimes have these components "on special offer", including the cheaper solid-dielectric "transistor radio" types mentioned in the article.

A small mains transformer was used for the audio output transformer and one with a high step-down ratio is needed to give good results. One with 3V-0V-3V secondary windings was found to give the best results and was purchased from **Maplin** (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code YN12N. Note the full secondary winding is used, the centre-tap not being required.

The above company also supplied the aluminium case (code XB68Y), open style 6·35mm mono jack socket (code HF91Y) and the 4·7mH r.f. choke for inductor L3, code UK80B.

Perpetual Projects 4 – Gate Sentinel, Solar-Powered Bird Scarer and Register

As pointed out in previous parts of the *Perpetual Projects* and this final instalment, readers are advised to use the Motorola MC4093BCP version of the 4093 quad 2-input NAND Schmitt trigger i.c. This device is listed (code 640-765) by RS Components and can be ordered through any *bona fide* stockists or directly, using your credit card, from **RS** (☎ ***01536 444079*** or ***rswww.com***).

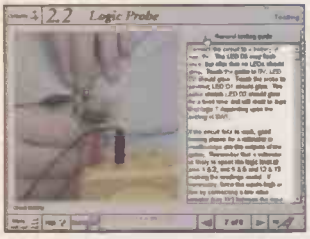
The *Gate Sentinel* magnet-operated reed type switch has *normally-closed* contacts which may be difficult to find. The prototype uses an RS Form B type (code 361-4961) and can be ordered as outlined above. The same applies to the Honeywell SDP8405 phototransistor used in the *Bird Scarer*, code 195-827. Note the code given last month was for the data sheet. The phototransistor is also listed by **Farnell**, (☎ ***0113 263 6311*** or ***www.farnell.com***), code 327-505.

The 5mm extreme brightness (6cd) green l.e.d., with a 15 degrees viewing angle, for the *Register* project, came from **Maplin** (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code NR87U.

The Uniboard printed circuit board is obtainable from the *EPE PCB Service*, code 305 (see page 745).

ELECTRONICS CD-ROMS

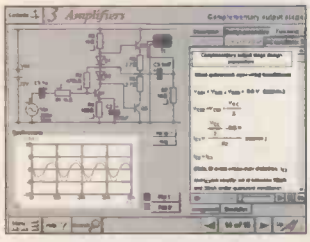
ELECTRONICS PROJECTS



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.

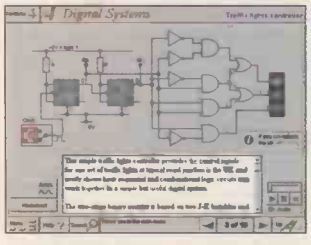
ANALOGUE ELECTRONICS



Complimentary output stage

Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.
Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections), Transistors (4 sections), Waveshaping Circuits (6 sections). **Op.Amps** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. **Systems** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

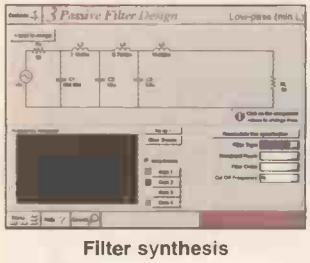
DIGITAL ELECTRONICS



Virtual laboratory – **Traffic Lights**

Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.
Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units.

FILTERS



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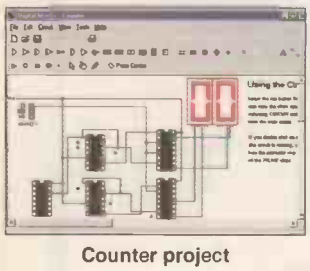

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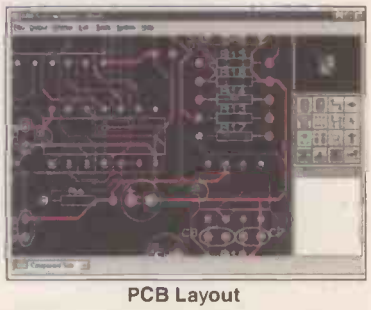

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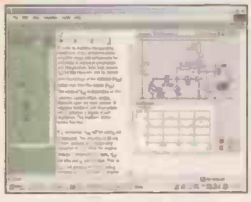

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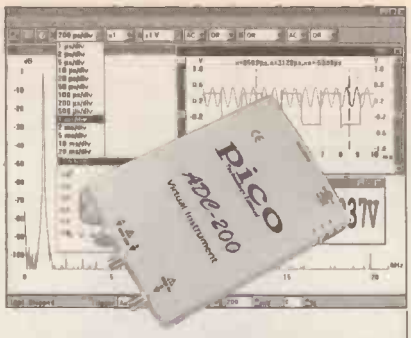

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Three-way Lighting – Logically

TRADITIONAL three-way lighting circuits (in which a lamp can be operated using any one of three switches) are complicated and they are physically difficult to wire together. The electronic alternative detailed in the circuit diagram of Fig.1 gives much simpler wiring, and as it operates at a switched low voltage it gives an easier and more economical installation.

The wiring to the switches can be in low current alarm cable for example, and it can be used to operate a wide variety of loads, not necessarily mains-powered.

How It Works

The circuit works in the following way. Logic gate IC1a applies an exclusive-OR function to switches S1 and S2 (two-way switching), then IC1b applies the same function with the output from IC1a and the state of switch S3. This gives the effect of an optional inverted signal depending on the condition of S3. All eight possible combinations are detailed in the truth table shown, an analysis of which shows that in effect, changing any state of any switch toggles the lamp on or off accordingly.

The *RC* networks R4 to R6 and C1 to C3 are for improved noise immunity. Resistors R1 to R3 provide a load for the switches which promotes reliable operation at low voltage and also assists with noise immunity by lowering the input impedance of the circuit.

The output buffer transistor TR1 can be any low power *n*-channel MOSFET which switches the relay. The remainder of the circuit is a low power regulated power supply.

Note that although signal switching is done at a low voltage, if the wiring is run alongside other insulated mains wiring, the same standards must be followed to ensure safety. *(Take extra precautions to ensure that there is no possibility of others mistaking low-voltage "signal" wires for live mains wiring, or vice versa – ARW.)*

Kate Turner
St. Leonards-on-Sea

Table 1: Truth Table

S1	S2	S3	Lamp
off	off	off	off
off	off	on	on
off	on	off	on
off	on	on	off
on	off	off	on
on	off	on	off
on	on	off	off
on	on	on	on

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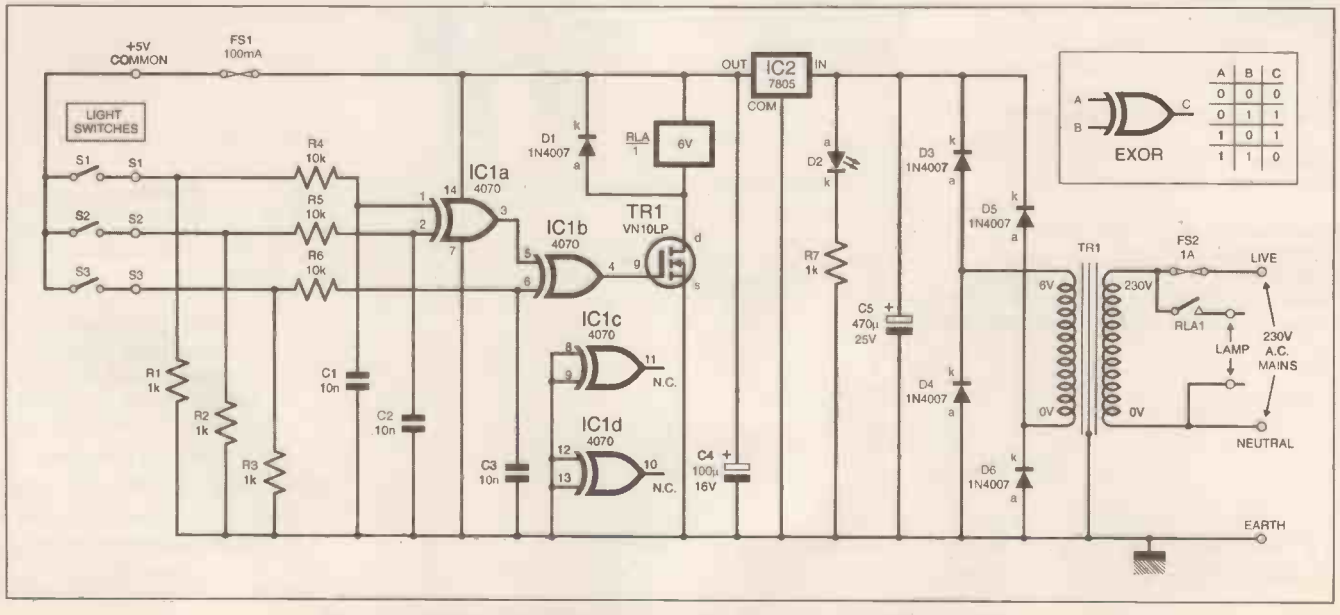


Fig.1. Complete circuit diagram for the Three-way Lighting system.

Perpetual Projects – 4

GATE SENTINEL

THOMAS SCARBOROUGH

Be on your guard against unwanted visitors.

WE CONCLUDE this month with the final part of our four-part series of "perpetual" projects. All are based on one small p.c.b. called a Uniboard. Each is powered around the clock – perpetually – by a single, high quality, memory back-up capacitor and a small solar cell (no battery). Each is designed to run unattended for months at a time – in fact for years !

The solar-powered power supply and regulator constructed in the first part (July '01) of this series form the basis for each of the projects and it only remains for you to choose which one most appeals to you! This month we cover the following three Perpetual Projects:

☆ ***Gate Sentinel*** ☆
☆ ***Solar-Powered Bird Scarer*** ☆
☆ ***Register*** ☆

Besides these three projects, suggestions are made for one variation – a Break Contact Alarm.

All the projects are built on a low-cost Uniboard (printed circuit board – one required for each project, unless you are expert at desoldering!). This should also include the *Solar-Powered Power Supply and Voltage Regulator* circuit described in Part 1 (July '01).

Note that all the projects may also be run off batteries – see Part 1.

The solar-powered supply section is only required once, unless you wish to build and keep all the projects as separate modules. It is now over to you to choose which specific project you would like to add to your Uniboard.

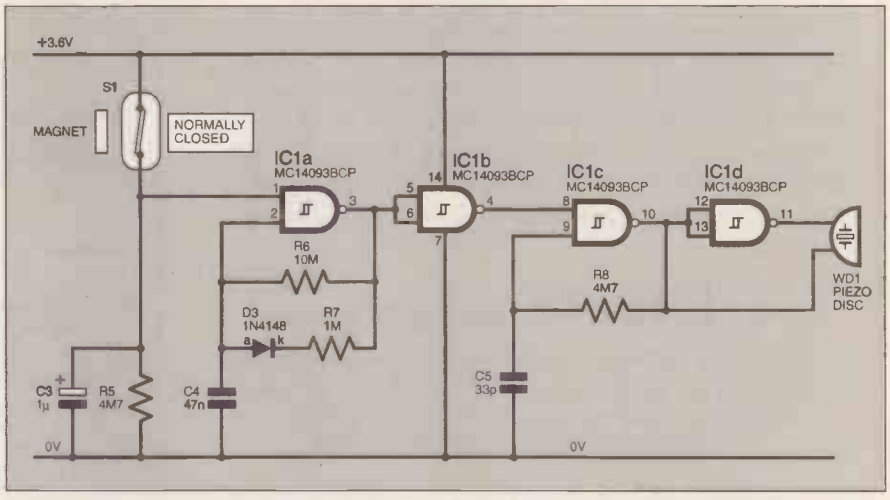


Fig.1. Circuit diagram for the Gate Sentinel. Component references follow on from the Solar-Powered Power Supply and Voltage Regulator *(July '01).*

GATE SENTINEL

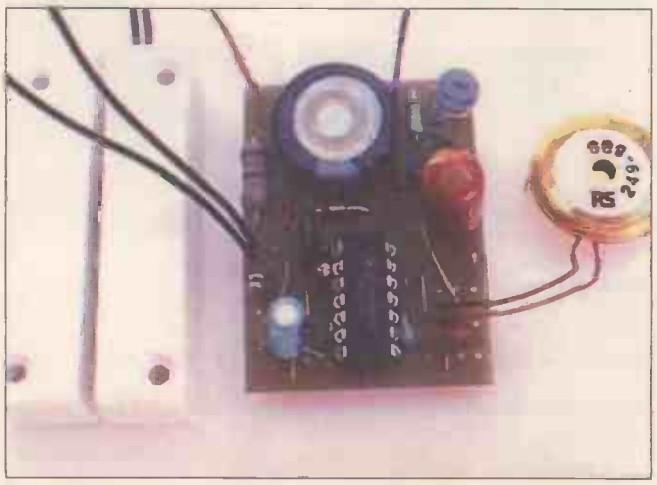
The full circuit diagram for the Gate Sentinel (minus, of course, the solar-powered supply/regulator) is shown in Fig.1. Note that the component references follow on from the regulator circuit published in the July '01 issue.

The Sentinel is intended to sound when a person enters your front gate. It is not intended so much as an alarm, but rather to give the impression: "You have been noticed." It therefore emits a pip-pip-pip tone.

Two oscillators are employed in this project, the first of which (a slow oscillator, IC1a) modulates the second (a fast oscillator, IC1c), to produce the pip-pip-pip tone. Diode D3 and resistor R7 provide an unequal mark-space ratio for the slow oscillator IC1a so that the pip-pip-pip tone is produced rather than a beep-beep-beep.

In order not to give the impression that this is merely a "dumb" device, the Gate Sentinel does more than merely switch on when your gate is opened, and off when it is closed – in that case, an intruder would know that it was directly linked to the gate. It emits some ten pips *after* the gate has been closed, so as to give the impression: "I'm more clever than a simple on-off device."

This is achieved with the help of capacitor C3. When the gate is closed, switch S1



SUGGESTION 1 – BREAK CONTACT ALARM

This simple Break Contact Alarm has one distinct advantage over last month's Loop Burglar Alarm. When a door or a window is opened, it will not be silenced simply by closing the door or window again. Instead, it will continue to sound for about ten minutes before falling silent. It also gives a pulsed tone, which is more easily noticed.

Using the circuit of the Gate Sentinel as a guide, make the following modifications:

- Remove diode D3 and resistor R7.
- Substitute a 22 megohms (22M) resistor for R5
- Substitute a 22µF electrolytic capacitor for C3

Any number of normally-closed magnetic switches or microswitches may be wired *in parallel* with S1 so as to cover as many doors or windows as desired.

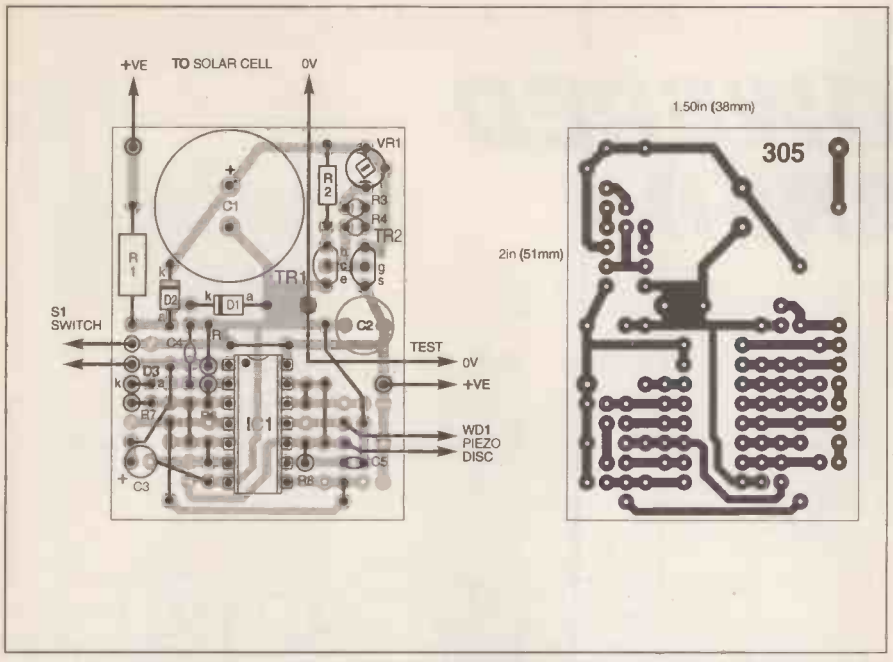


Fig.2. Uniboard p.c.b. component layout and full-size copper foil master for the Gate Sentinel. Includes components for the power supply regulator – see photograph.

is held open by the "proximity magnet" mounted on the gate When the gate is opened, S1 reverts to its normal closed state, and capacitor C3 charges up through the switch, taking IC1a pin 1 high (logic 1), thus triggering the Sentinel.

When the gate is closed again, and switch S1 is held open by the "proximity magnet" mounted on the gate, capacitor C3 requires a short period to discharge through resistor R5. This introduces a delay before the Gate Sentinel again falls silent. To increase the period for which the Sentinel sounds after closing your gate, increase the value of C3.

SWITCHED-OFF

A normally-closed, magnet-operated, reed type switch would be ideal for S1. These switches are harder to come by than normally-open switches of the same type, so it would be worth noting that a magnet may be glued strategically to the side of a normally-open switch of this type, to convert it to a normally-closed switch. A continuity tester will quickly show where the magnet should be glued.

Any number of normally-closed switches (microswitches included, which are cheaper) may be wired in series with switch S1. These open when the gate is closed. Normally-open vibration switches would also be well suited in this position, closing briefly when the gate is opened.

A special challenge of this project was to switch off both oscillators simultaneously when switch S1 opened, so that no oscillator would be left running "in the background" (see Part 1 of the series). This was achieved by using a *normally closed* magnetic switch to trigger gate IC1a, as well as inverter IC1b.

LIGHT WORK

Piezo disc sounder WD1 may be replaced with an l.e.d. if desired, or a l.e.d. may be used together with WD1. The l.e.d. is wired between IC1 pin 10 and the positive supply line, with its anode ((a) the longest lead) being taken to positive.

Use a ballast resistor in series with the l.e.d. – use the current limiting formula $R=(V-V_F)/I$ (see Part 2 – Aug '01). A white l.e.d. requires no ballast resistor, since the effective current flow is limited by the regulator. Only an extreme brightness l.e.d., preferably with a narrow viewing angle, should be used.

CONSTRUCTION

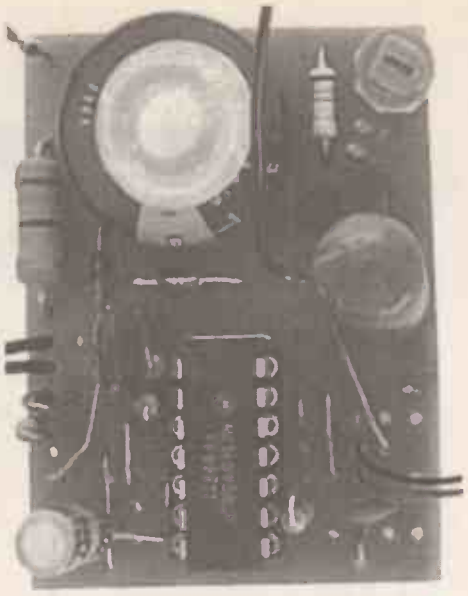
The Gate Sentinel is built up on the Uniboard p.c.b., as shown in the topside component layout details of Fig.2, together with the copper foil master. This board (*minus components*) is available from the *EPE PCB Service*, code 305. The *Solar-Powered Power Supply and Voltage Regulator* (July '01) components are included in this diagram.

Commence construction by soldering the link wires and the resistors in position, continuing with the diode and the capacitors. The cathode (k) of diode D3 is banded and should be inserted as indicated in Fig.2. Finally, insert IC1 in its d.i.l. socket, being careful to observe the correct orientation, as well as anti-static precautions.

SETTING-UP

Assuming the circuit is being solar powered, once the power supply capacitor C1 has been fully charged in the sun, via the solar cell (see Part 1), adjust the regulator's preset trimmer VR1 until 3·6V is measured across electrolytic capacitor C2 (solder pins are provided on both sides of C2) – while the Gate Sentinel is *sounding*. This it will do as long as your gate is open. Remember that capacitor C2 causes a delay to any adjustments that are made to the voltage.

Current consumption is virtually nil on standby, and about 60μA when the buzzer is sounding.



COMPONENTS

GATE SENTINEL

Resistors

R5, R8	4M7 (2 off)	
R6	10M	
R7	1M	

All 0·25W 5% carbon film

See SHOP TALK page

Capacitor

C3	1µ min. radial elect 10V
C4	47n polyester film
C5	33p ceramic plate

Semiconductors

D3	1N4148 signal diode
IC1	MC14093BCP quad 2-input NAND Schmitt trigger

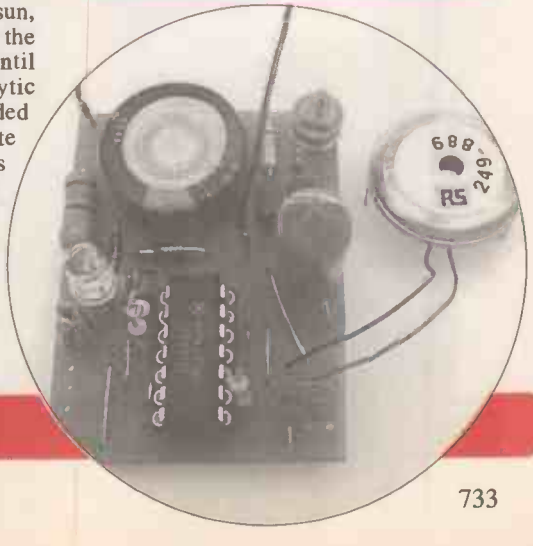
Miscellaneous

WD1	low profile wire-ended piezo sounder
S1	normally-closed reed proximity switch, with bar magnet (see text)

Printed circuit board (Uniboard) available from the *EPE PCB Service*, code 305; multistrand connecting wire; link wires; solder pins; solder etc.

Note: Component designations run on from the Solar-Powered Power Supply and Voltage Regulator *described in the July '01 issue.*

Approx. Cost Guidance Only **£6**



SOLAR-POWERED BIRD SCARER

Ruffle a few feathers with this harmless "electronic scarecrow"!

IT HAS been shown that birds particularly dislike a rasping sound around 200Hz, and will for a while avoid it. The present project (could also be called an Electronic Scarecrow) was given to a farmer to test on his grapes, and proved very effective over a radius of three to four metres. In fact the farmer was quite excited about the results.

Having said this, however, after about three weeks the birds grew accustomed to the sound, and it was a sorry looking farmer who asked the author whether he could "get the Bird Scarer working again". This did not mean that it had malfunctioned, as the author imagined – the birds merely paid no more attention to it!

Thus the Bird Scarer would be particularly useful for the *temporary* protection of seedlings or fruit.

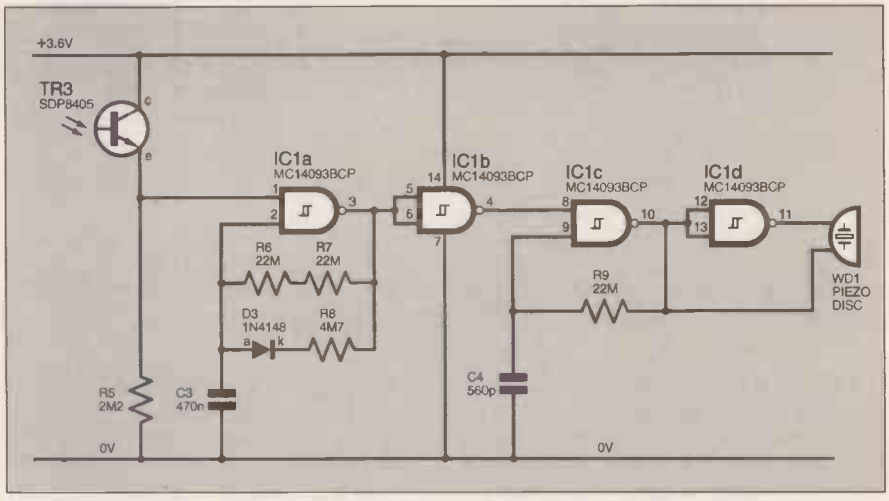


Fig.3. Circuit diagram for the Solar-Powered Bird Scarer. Component numbering continues on from the power supply/regulator published in the July '01 issue.

CIRCUIT DETAILS

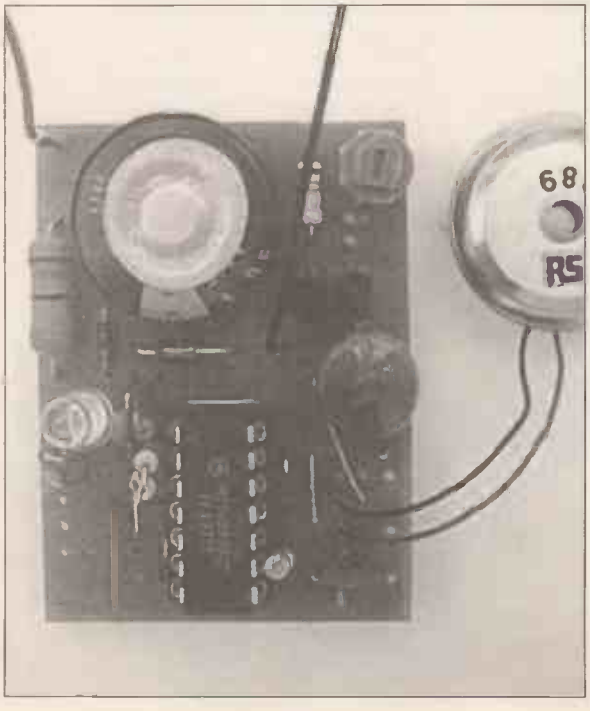
Since this project will only be needed during the daylight hours (most birds go to roost in the darkness), we can allow a higher current consumption during the day, and put the circuit to sleep at night. This circuit is more power-hungry than the rest, mainly because its two oscillators (IC1a and IC1b) run continuously during the day. Again, *both* of the oscillators need to be switched off simultaneously – in this case at night.

The full circuit diagram for the Solar-Powered Bird Scarer is shown in Fig.3. The component references follow on from the supply/voltage regulator circuit (July '01).

As with the Gate Sentinel, the low frequency oscillator IC1a modulates the high frequency oscillator IC1c, and the piezo disc WD1 is operated in push-pull fashion for maximum volume by IC1c and IC1d.

An *npn* phototransistor TR3 is used to switch off the two oscillators in the darkness, and this should be mounted away from any night-time light sources. A phototransistor is used because of its high dark resistance, so that it consumes less power in this position than many other devices would do.

The Bird Scarer is located at the centre of the area which you would like to protect from birds, preferably tucked away among some leaves. The solar panel should, of course, be positioned to receive full sunlight.



(Left). Completed Bird Scarer Uniboard p.c.b. It also includes the components (except the solar cell) for the Solar-Powered Power Supply and Regulator from the July '01 issue.

CONSTRUCTION

The Solar-Powered Bird Scarer is built up on the Uniboard p.c.b., as shown in the topside component layout details of Fig.4, together with copper foil master. This board (*minus*

COMPONENTS

BIRD SCARER

Resistors

R5	2M2 carbon film	
R6, R7, R9	22M metal film (3 off)	
R8	4M7 carbon film	

All 0·25W 5% or better

See SHOP TALK page

Capacitor

C3	470n min. polyester film
C4	560p min. ceramic plate

Semiconductors

D3	1N4148 signal diode
TR3	SDP8405 *npn* phototransistor
IC1	MC14093BCP quad 2-input NAND Schmitt trigger

Miscellaneous

WD1	low profile wire-ended piezo sounder

Printed circuit board (Uniboard) available from the *EPE PCB Service*, code 305; multistrand connecting wire; link wires; solder pins; solder etc.

Note: Component designations run on from the Solar-Powered Power Supply and Voltage Regulator *described in the July '01 issue.*

Approx. Cost Guidance Only **£6**

components) is available from the *EPE PCB Service*, code 305. Once again, the *Solar-Powered Power Supply and Voltage Regulator* components are included in this diagram.

Follow the same procedures as previously described, soldering the components to the board in sequence, and finally inserting IC1 in its holder, observing anti-static precautions.

Note that R6 and R7 are wired in series, and together make up the required value of 44 megohms. One end of each of the two resistors should have their leads twisted and soldered together. The opposite (free) ends of the resistors should be inserted in the board, across pins 2 and 3 of IC1, as shown in Fig.4.

SETTING-UP

Assuming the solar power supply is active, adjust the regulator's voltage to 3·6V – while the Bird Scarer is *sounding*. Remember that capacitor C2 in the regulator circuit causes a short delay to any adjustments that are made to the voltage.

Current consumption is less than 1µA at night, and fluctuates between about 10µA and 30µA when it is in operation.

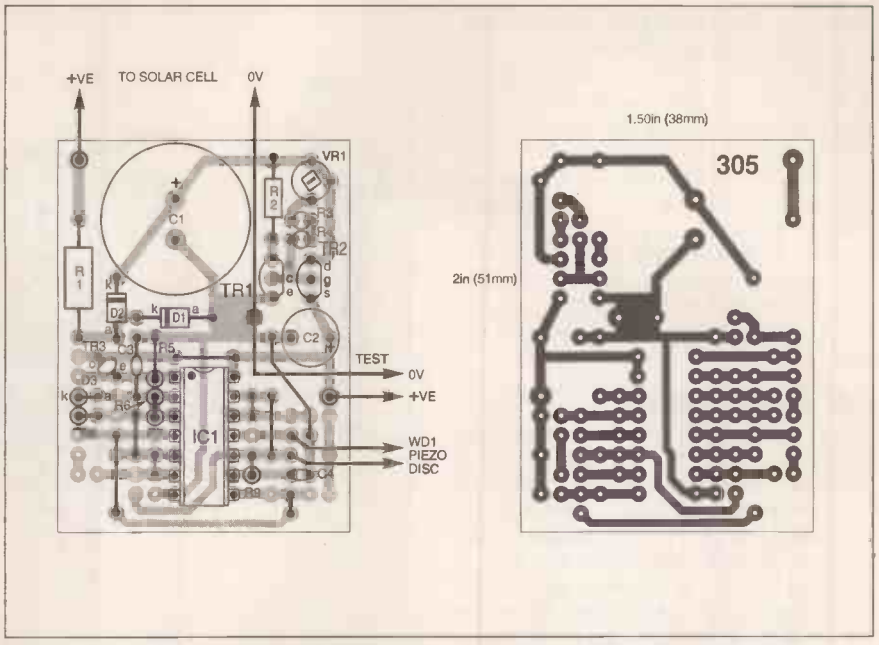
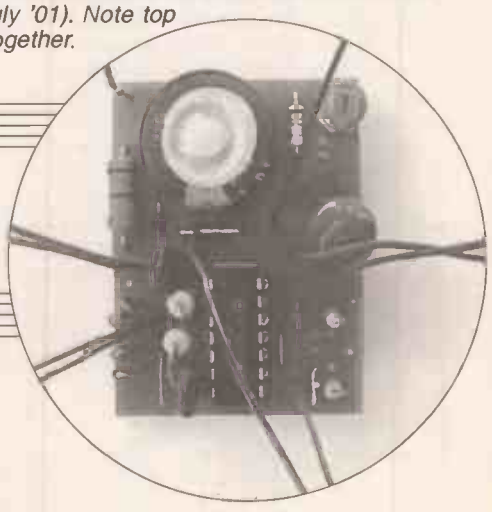


Fig.4. Uniboard component layout and full-size foil master for the Bird Scarer. Includes power supply components (July '01). Note top end leads of R6 and R7 are soldered together.

SOLAR-POWERED REGISTER



Is there anyone at home?

OUR FINAL Perpetual Project is a Register. This device is useful especially to indicate whether a person is in or out. It will flash Green if a person is In, and Red if a person is Out. A series of these devices together in a hallway could inform residents of a small "digs" as to who is in and who is out – residents would simply touch a touchswitch as they passed to indicate that they were coming or going.

Alternatively, it could send secret messages to the street from your bedroom window. A green flashing l.e.d. might indicate: "See you at the bowling alley tonight," while a red flashing l.e.d. might indicate: "I'm grounded."

CIRCUIT DETAILS

The complete circuit diagram for the *Solar-Powered Register* is shown in Fig.5. Like all the previous circuits, the component numbering follows on from the voltage regulator published in the July '01 issue.

Both l.e.d.s are pulsed in order to conserve power. Do not even think of using other types of l.e.d. besides extreme brightness types – *other types will be virtually useless.* A narrow viewing angle is recommended – a wider viewing angle could seriously compromise brightness.

In this final design, we dispense with buffer gates, to gain more gates to utilise in the circuit.

Note that the specified values for ballast resistors R7 and R10 were chosen experimentally in relation to the forward voltage (V_F) drop of l.e.d.s D4 and D6, which varies with the colour (typically red V_F = 1·85V, green V_F = 2·2V). If either oscillator fails to work, experiment with different values for the respective ballast resistor.

BISTABLE LATCH

Each of the two l.e.d. flashers, IC1a and IC1b, is turned on or off respectively by a simple bistable latch circuit made up of IC1c and IC1d. When touchswitch S1 is touched, the input at IC1c pin 8 goes low. According to NAND logic, the output terminal, pin 10, therefore must go high. Both inputs of IC1d (pins 12 and 13) are thus

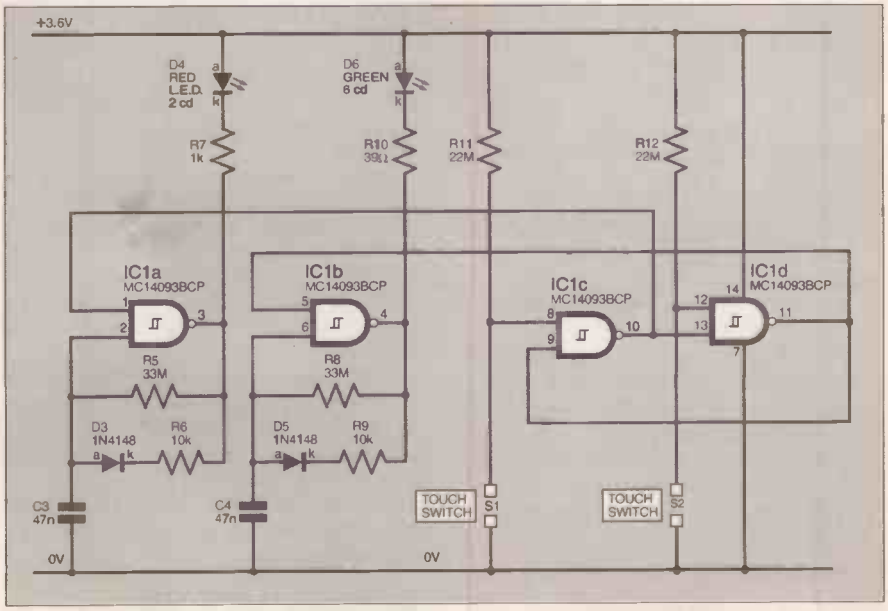


Fig.5. Circuit diagram for the Solar-Powered Register. Note component numbering follows on from the power supply (July '01).

high – its output terminal is therefore low, as well as input pin 9 of IC1c.

When touchswitch S1 opens again, IC1c's output terminal remains high, since one of its inputs is now low. Now, imagine then that the other touchswitch S2 (IC1d) is touched. Follow the same logic sequence, and you will see that the bistable latch changes state.

Since IC1c and IC1d essentially invert one another, when one output is high the other is low, and vice versa. This switches one l.e.d. flasher on while it switches the other off.

IN SEQUENCE

It is interesting to note that we have here (arguably) a one-bit computer. It has a "keyboard" (two touchswitches), a memory – to memorise your last key-press (logic i.c.s may serve as a form of memory), and a display (the different coloured l.e.d.s).

At any rate, this is the only project in this "Uniboard" series which uses *sequential* logic instead of *combinational* logic. Combinational logic merely reacts to the present state of the inputs (or the *combination* of highs and lows which are present at the inputs). Sequential logic, on the other hand, is influenced by a *previous state* of the inputs.

Also, it is interesting to note just what it is that constitutes "memory". In digital electronics, it is *feedback* which is used to store events. In this case, the outputs of IC1c and IC1d are fed back to one of the other inputs at pin 13 and pin 9 respectively, to serve as the most basic form of memory – the bistable latch.

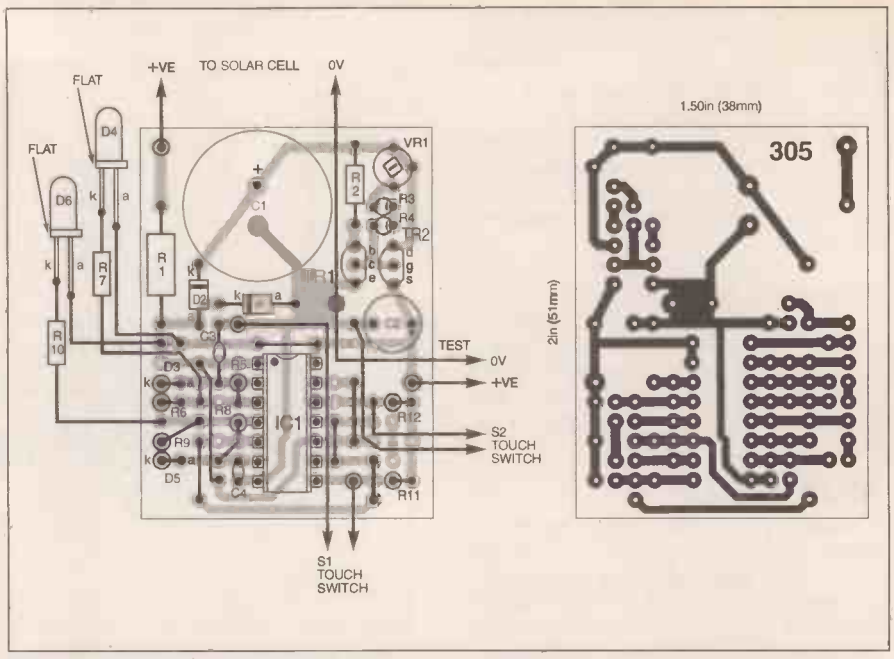


Fig.6. Uniboard component layout and full-size copper foil master for the Solar-Powered Register. Includes power supply from Part 1 (July '01). Note cathode (k) lead of D4 and D6 is shorter than the anode (a) lead.

The subjective brightness of the two l.e.d.s (D4 and D6) may be increased considerably by changing the values of resistors R6 and R9 to 47 kilohms (47k) to change the flashing mark space ratio. However, the power supply charge lifespan would be reduced to about fifteen hours.

The *rate* of flashing may be increased by decreasing the value of resistors R5 and R8, but this will also reduce the power supply effective life.

One "Goldcap" memory backup capacitor, C1 in the power supply/voltage regulator (Part 1 – July '01) could support two registers in sunnier climes. A few such registers placed in a passageway could keep track of the movements of a few people at the same time.

TOUCH SWITCH

It was decided to use touchswitches throughout this series, since the symbolism of the "perpetual" might be compromised if any mechanical switches were included.

A touch-switch was constructed by the author from the pieces of a broken ultrasonic transducer, the cavity between the "switch" contacts being filled with quick-set putty. Any "home produced" switch should be constructed in such a way that a finger is sure to close the gap across the two contacts.

It would be worth noting that touchswitches can pick up static. A recommended simple means of protecting all the circuits in this series against static would be to wire a one megohm resistor in series with each touchswitch. This would be desirable especially if there is an expanse of carpeting near the touchswitch.

CONSTRUCTION

The Solar-Powered Register is built up on the Uniboard p.c.b., which may or may not already hold the regulator and d.i.l. socket (see July issue, Fig.2) – as shown in the topside component layout details of Fig.6. This board (*minus all components*) is available from the *EPE PCB Service*, code 305.

Follow the same procedures as previously described, soldering the components to the board in sequence, and finally inserting IC1, observing anti-static precautions. In order to conserve space, ballast resistors are wired directly to the l.e.d.s as shown.

Note again that some extreme brightness l.e.d.s also require anti-static precautions.

SETTING-UP

Once the memory retention capacitor (supply/regulator circuit) C1 has been fully charged in the sun (see July '01), adjust the regulator's preset trimmer VR1 until 3·6V is measured across electrolytic capacitor C2 (solder pins are provided for this purpose on both sides of C2). Remember that C2 causes a short delay to any adjustments that are made to the voltage.

Current consumption (excluding the regulator) is below 15μA. If you measure more than 20μA make IC1 your prime suspect. A CMOS i.c. can be partially damaged by static, while seeming to function correctly. If the i.c. is not the version specified in the Components list, this will almost certainly be the problem.

IN CLOSING

Among other things, this series has been a demonstration of some of the recent advances in electronics technology, and of the practical usefulness of such advances.

This series also illustrates good examples of using capacitance as the primary source of power (with the solar panel, of course, replenishing the capacitor).

May your "perpetual project", whichever one you choose, give life-long and trouble-free service. □

COMPONENTS

REGISTER

Resistors

R5, R8	33M metal film (2 off)	
R6, R9	10k carbon film (2 off)	
R7	1k carbon film	
R10	39Ω carbon film	
R11, R12	22M metal film (2 off)	

All 0·25W 5% or better

See SHOP TALK page

Capacitor

C3, C4	47n polyester film (2 off)

Semiconductors

D3, D5	1N4148 signal diode (2 off)
D4	5mm extreme brightness red l.e.d.
D6	5mm extreme brightness green l.e.d.
IC1	MC14093BCP quad 2-input NAND Schmitt trigger

Miscellaneous

S1	touch-switch – see text

Printed circuit board (Uniboard) available from the *EPE PCB Service*, code 305; multistrand connecting wire; link wires; solder pins; solder etc.

Note: Component designations run on from the Solar-Powered Power Supply and Voltage Regulator *described in the July '01 issue.*

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INTERFACE

Robert Penfold

SINGLE-CHIP 32-BIT OUTPUT PORT

PREVIOUS *Interface* articles have described analogue-to-digital and digital-to-analogue converters that use a form of serial interfacing. This method has the advantage of providing eight or 12-bit resolution using only about three lines to provide the interfacing to the PC.

The same basic method can be applied where simple interfacing is required but a large number of digital inputs or outputs are required. It is an output port that is featured here, but similar techniques could no doubt be applied to a digital input port.

Of course, you do not get something for nothing by using serial interfacing. The price that is paid for the lack of wires from the PC to the interface is added complication in the software and a lack of speed. Where an application needs to update the output port every microsecond or so the serial approach is unlikely to be suitable. Of course, in many practical applications the output ports are only altered relatively infrequently, and the serial method is then eminently suitable.

Single Chip

The circuit featured here uses a three-line interface to a PC printer port and provides some 32 output lines. Furthermore, the circuit uses just two components, and one of these is a supply decoupling capacitor!

This is made possible by using the UCN5818AF serial interfacing chip, which is essentially just a 32-bit shift register. It would probably be cheaper to use CMOS or TTL shift registers to provide the same function, but the UCN5818AF provides a very neat and reliable way of handling things. This chip is produced by Allegro Microsystems Inc. and is available in the UK from the usual RS outlets.

The pinout configuration for the UCN5818AF is shown in Fig.1. Pin 40 is the normal supply pin while pin 1 is the load supply input. This chip is primarily intended for operation with vacuum fluorescent displays where it is necessary to control loads operating at relatively high voltages.

However, it can operate at normal 5V logic levels throughout, and it is just a matter of connecting both supply pins to the 5V logic supply. The current consumption of the chip itself is only a few milliamps, but overall current drain is somewhat higher if the outputs are used to provide significant output currents.

Data from the PC is applied to the serial input at pin 39. There is also a serial output at pin 2 that permits two or more devices to be cascaded if 32 outputs are not enough. There are three control inputs, but in normal operation only two of these are used.

The timing diagram of Fig.2 helps to illustrate the normal method of interfacing this chip. First the Data input is set at the correct logic level for the first bit of data, which in this example is logic 1. A pulse is then supplied to the Clock input, and it is on the low to high transition that the data is clocked into the first cell of the shift register.

This process is repeated until all 32 bits have been clocked into the chip. For the sake of simplicity, in the example of Fig.2 there are only four bits of data, with the first two at logic 1 and the second two at logic 0.

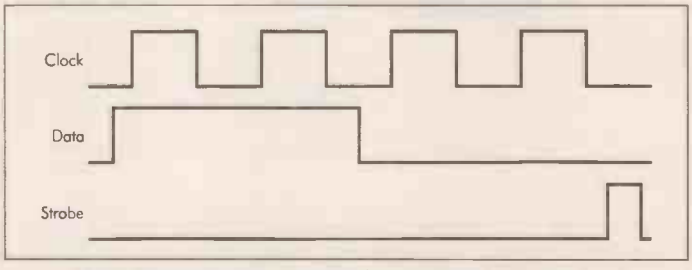


Fig.2. Simplified timing diagram for the UCN5818AF.

All Change

As each bit of data is clocked into the chip, the data already in the shift register is moved one place further along. The first bit of data therefore appears on output 1 (pin 38) initially, but has worked its way along the line to output 32 (pin 3) by the time the thirty-second bit has been clocked in.

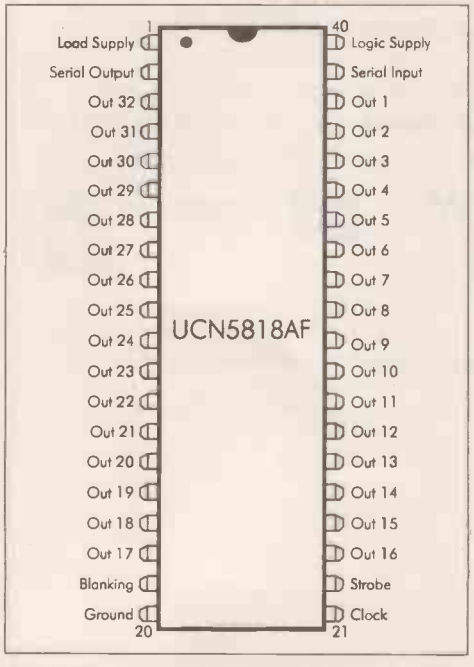


Fig.1. The UCN5818AF 32-bit latched serial input source driver pinout details.

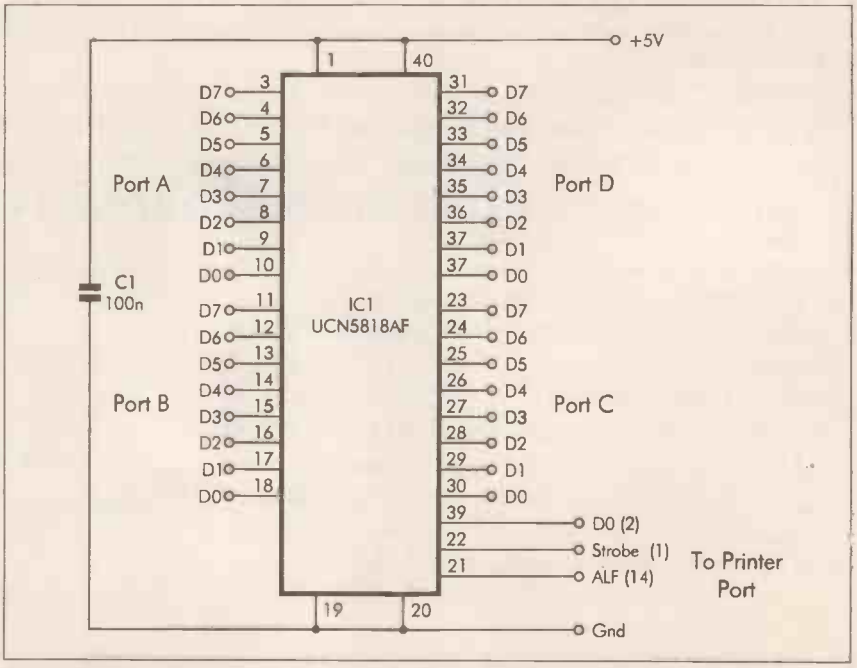


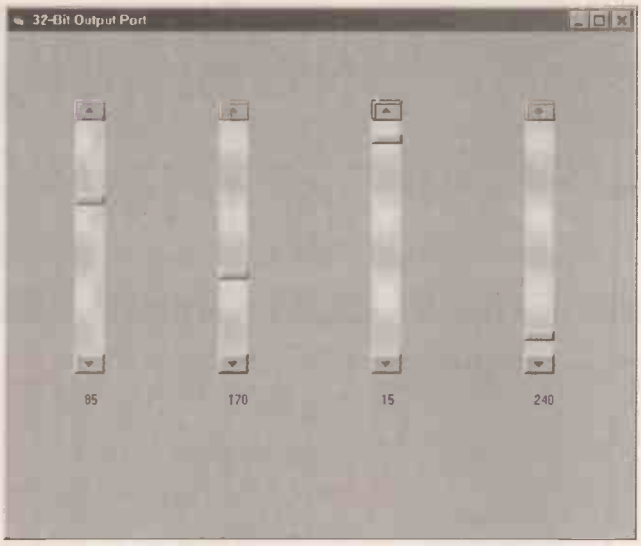
Fig.3. The complete circuit diagram for the 32-bit Output Port. The only external component is capacitor C1.

The data in the shift register is not valid until the final bit in a set of 32 has been clocked into the chip, and it must not be placed on the output pins until then. One solution is to hold the Blanking input at pin 19 high while data is being fed into the chip. This switches on the current sink at each output and switches off the current sources, setting every output low.

In most applications this is no better than allowing the shift register to drive the outputs, since the data on the outputs will still be invalid. For most purposes it is best to tie the Blanking input to ground so that the outputs always operate normally.

Internal latches and the Strobe input are then used to ensure that the data on the outputs of the shift register is not transferred to the output pins until fully valid data is available. This is achieved by having the Strobe input held low until a full set of 32 bits has been clocked into the chip.

A pulse is then applied to the Strobe input to transfer the new data to the output pins and latch it there. Any changes on the outputs of the shift register then have no effect on the output pins until another set of data has been clocked in and another strobe pulse is generated.



Screen shot of the demonstration program in operation.

Versatile Output

The circuit diagram for the 32-bit output port appears in Fig.3. The accompanying software uses the 32 outputs as four 8-bit output ports, but they can be used as two 16-bit ports, a single 32-bit type, 32 single bit outputs, or any other set-up that requires no more than 32 output lines.

In order to keep the software straightforward the Data input is driven from D0 of the printer port, while the Strobe and Clock inputs are respectively driven by the printer port's Strobe and ALF handshake outputs. This conveniently places the data and control outputs at separate output addresses, but with suitably clever software it should be possible to use any three outputs of the port.

The 5V supply is not available from the printer port, but methods of obtaining a 5V supply from a PC have been covered in many previous articles. The connections to the printer port are made via a 25-way male D-connector. Connection details are provided in Fig.4.

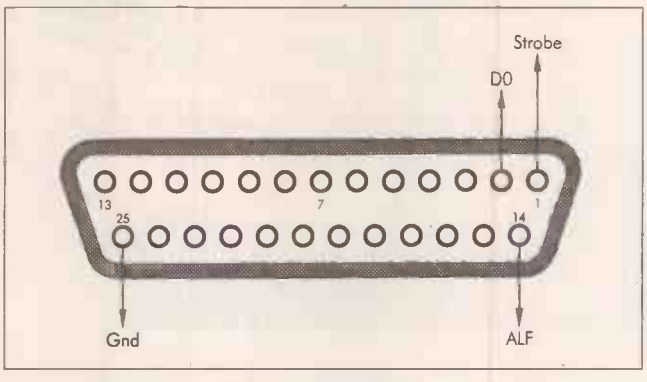


Fig.4 (left). The connections to the printer port are via the 25-way male D-connector. Pins 18 to 25 all connect to ground.

Software

The demonstration program for the 32-bit output port was written using Visual BASIC 6 and it requires **inpout32.dll** in order to run. It uses four vertical slider controls (VScroll1 to VScroll4) to provide values from 0 to 255 that are output to the ports (see photograph above). The main routine is applied to a timer that sends a new set of data to the ports every 50 milliseconds.

The whole listing is too long for inclusion here, but all the files for this program are available from the *EPE* web site. (It is also available on the *Interface Disk 1* – see *EPE PCB Service* page.) This includes the compiled program.

Data is sent to the four ports using what is basically the same routine for each port. This is the last of these four routines:

```
If (VScroll4.Value And 128) = 128 Then
Out Prn1, 1 Else Out Prn1, 0
  Out Prn3, 1
  Out Prn3, 3

If (VScroll4.Value And 64) = 64 Then
Out Prn1, 1 Else Out Prn1, 0
  Out Prn3, 1
  Out Prn3, 3

If (VScroll4.Value And 32) = 32 Then
Out Prn1, 1 Else Out Prn1, 0
  Out Prn3, 1
  Out Prn3, 3

If (VScroll4.Value And 16) = 16 Then
Out Prn1, 1 Else Out Prn1, 0
  Out Prn3, 1
  Out Prn3, 3

If (VScroll4.Value And 8) = 8 Then Out
Prn1, 1 Else Out Prn1, 0
  Out Prn3, 1
  Out Prn3, 3

If (VScroll4.Value And 4) = 4 Then Out
Prn1, 1 Else Out Prn1, 0
  Out Prn3, 1
  Out Prn3, 3

If (VScroll4.Value And 2) = 2 Then Out
Prn1, 1 Else Out Prn1, 0
  Out Prn3, 1
  Out Prn3, 3

If (VScroll4.Value And 1) = 1 Then Out
Prn1, 1 Else Out Prn1, 0
  Out Prn3, 1
  Out Prn3, 3
  Out Prn3, 2
  Out Prn3, 3
```

Prn1 and Prn 3 are variables that are set at 898 and 890 respectively earlier in the program. These are normally the output addresses for the data lines and handshake outputs of printer port 1. Both values must be changed if you are using a different port or if your PC uses different addresses for port 1.

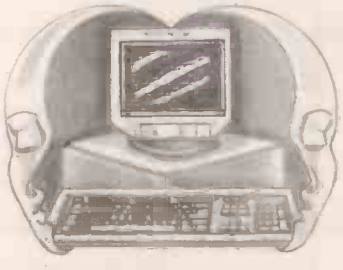
The routine starts by checking the state of bit 7 in the value read from the slider control. This is achieved using the normal bitwise AND method. Output D0 of the printer port is set high if this bit is at logic 1, or low if it is not. The next two lines generate the clock pulse that loads this bit into the shift register.

The same basic process is then used to check the other bits, write the appropriate value to bit D0 of the printer port, and then clock the data into the serial register. The value in each bitwise operation is changed to suit the bit being tested.

Adaptable

Two extra Out instructions are used at the end of the routine, and these generate a pulse on the Strobe output so that the data is latched onto the 32 output pins. Note that these two instructions are only used at the end of the fourth routine, when all 32 bits of the new word of data are available. The program includes lines that print the current value for each port below the slider control so that it is easy to check that the outputs of the ports are responding properly to the slider settings.

It should not be difficult to adapt the software to suit practical applications. The values for the ports can be written to variables that are then used in place of VScroll1.Value, etc. It is not necessary to use all 32 output pins, but 32 bits of data must always be written to the UCN5818AF to prevent things getting "out of sync". Dummy data *must* therefore be written to any outputs that are not used.



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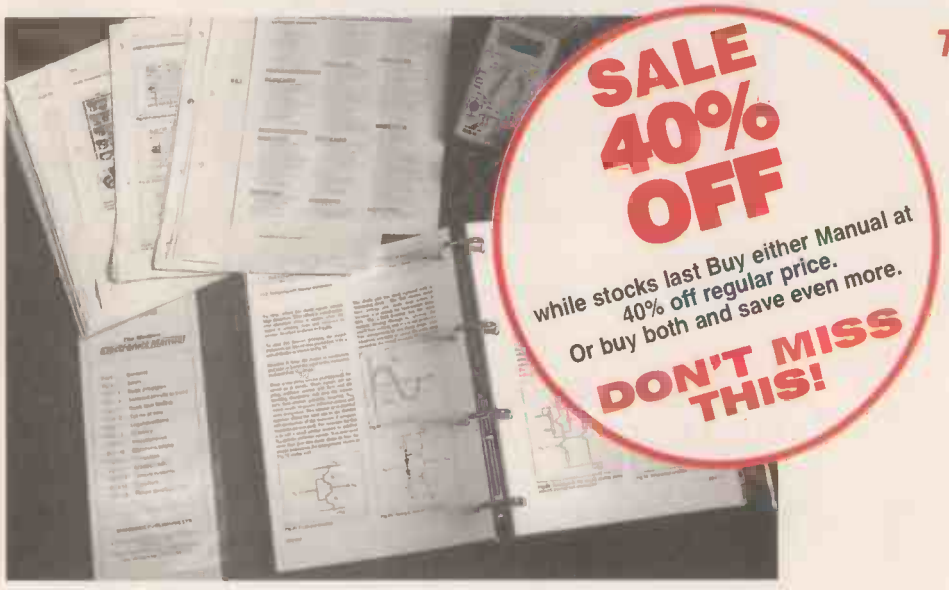

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The whole of the 12-part *Teach-In 2000* series by John Becker (published in *EPE* Nov '99 to Oct 2000) is now available on CD-ROM. Plus the *Teach-In 2000* interactive software covering all aspects of the series and Alan Winstanley's *Basic Soldering Guide* (including illustrations and Desoldering).

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For a further selection of books see the next two issues of *EPE*.

Robotics

INTRODUCING ROBOTICS WITH LEGO MINDSTORMS
Robert Penfold

Shows the reader how to build a variety of increasingly sophisticated computer controlled robots using the brilliant Lego Mindstorms Robotic Invention System (RIS). Initially covers fundamental building techniques and mechanics needed to construct strong and efficient robots using the various "click-together" components supplied in the basic RIS kit. Then explains in simple terms how the "brain" of the robot may be programmed on screen using a PC and "zapped" to the robot over an infra-red link. Also, shows how a more sophisticated Windows programming language such as Visual BASIC may be used to control the robots.

Details building and programming instructions provided, including numerous step-by-step photographs.

288 pages – large format Order code BP901 £14.99

MORE ADVANCED ROBOTICS WITH LEGO MINDSTORMS – Robert Penfold

Covers the Vision Command System

Shows the reader how to extend the capabilities of the brilliant Lego Mindstorms Robotic Invention System (RIS) by using Lego's own accessories and some simple home constructed units. You will be able to build robots that can provide you with 'waiter service' when you clap your hands, perform tricks, 'see' and avoid objects by using 'bats radar', or accurately follow a line marked on the floor. Learn to use additional types of sensors including rotation, light, temperature, sound and ultrasonic and also explore the possibilities provided by using an additional (third) motor. For the less experienced, RCX code programs accompany most of the featured robots. However, the more adventurous reader is also shown how to write programs using Microsoft's VisualBASIC running with the ActiveX control (Spirit.OCX) that is provided with the RIS kit.

Detailed building instructions are provided for the featured robots, including numerous step-by-step photographs. The designs include rover vehicles, a virtual pet, a robot arm, an 'intelligent' sweet dispenser and a colour conscious robot that will try to grab objects of a specific colour.

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The contents include an Overview of State-of-the-Art Robots; Robotic Locomotion; Motors and Power Controllers; All Types of Sensors; Tilt; Bump; Road and Wall Detection; Light; Speech and Sound Recognition; Robotic Intelligence (Expert Type) Using a Single-Board Computer Programmed in BASIC; Robotic Intelligence (Neutral Type) Using Simple Neural Networks (Insect Intelligence); Making a Lifelike Android Hand; A Computer-Controlled Robotic Insect Programmed in BASIC; Telepresence Robots With Actual Arcade and Virtual Reality Applications; A Computer-Controlled Robotic Arm; Animated Robots and Androids; Real-World Robotic Applications.

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Radio

BASIC RADIO PRINCIPLES AND TECHNOLOGY
Ian Poole

Radio technology is becoming increasingly important in today's high technology society. There are the traditional uses of radio which include broadcasting and point to point radio as well as the new technologies of satellites and cellular phones. All of these developments mean there is a growing need for radio engineers at all levels.

Assuming a basic knowledge of electronics, this book provides an easy to understand grounding in the topic.

Chapters in the book: Radio Today, Yesterday, and Tomorrow; Radio Waves and Propagation; Capacitors, Inductors, and Filters; Modulation; Receivers; Transmitters; Antenna Systems; Broadcasting; Satellites; Personal Communications; Appendix – Basic Calculations.

263 pages Order code NE30 £15.99

PROJECTS FOR RADIO AMATEURS AND S.W.L.S.
R. A. Penfold

This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

The circuits covered include: An aerial tuning unit; A simple active aerial; An add-on b.f.o. for portable sets; A wavetrap to combat signals on spurious responses; An audio notch filter; A parametric equaliser; C.W. and S.S.B. audio filters; Simple noise limiters; A speech processor; A volume expander.

Other useful circuits include a crystal oscillator, and RTTY/C.W. tone decoder, and a RTTY serial to parallel converter. A full range of interesting and useful circuits for short wave enthusiasts.

92 pages Order code BP304 £4.45

AN INTRODUCTION TO AMATEUR RADIO
I. D. Poole

Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century. This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

150 pages Order code BP257 £5.49

SIMPLE SHORT WAVE RECEIVER CONSTRUCTION
R. A. Penfold

Short wave radio is a fascinating hobby, but one that seems to be regarded by many as an expensive pastime these days. In fact it is possible to pursue this hobby for a minimal monetary outlay if you are prepared to undertake a bit of d.i.y., and the receivers described in this book can all be built at low cost. All the sets are easy to costruct, full wiring diagrams etc. are provided, and they are suitable for complete beginners. The receivers only require simple aerials, and do not need any complex alignment or other difficult setting up procedures.

The topics covered in this book include: The broadcast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple t.r.f. receivers; Single sideband reception; Direct conversion receiver.Contains everything you need to know in order to get started in this absorbing hobby.

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Computers and Computing

MULTIMEDIA ON THE PC
Ian R. Sinclair

In this book, you'll find out what a CD ROM is, how it works, and why it is such a perfect add-on for a PC, allowing you to buy programmes, text, graphics and sound on a CD. It also describes the installation of a CD ROM drive and a sound card, pointing out the common problems that arise, and then shows how to use them to create a complete multimedia presentation that contains text, photos, a soundtrack with your own voice recorded as a commentary, even animation and edited video footage.

184 pages Order code PC112 £12.95

HOW TO BUILD YOUR OWN PC
Morris Rosenthal

More and more people are building the own PCs. They get more value for their money, they create exactly the machine they want, and the work is highly satisfying and actually fun. That is, if they have a unique beginner's guide like this one, which visually demonstrates how to construct a state-of-the-art computer from start to finish.

Through 150 crisp photographs and clear but minimal text, readers will confidently absorb the concepts of computer building. The extra-big format makes it easy to see what's going on in the pictures. For non-specialists, there's even a graphical glossary that clearly illustrates technical terms. The author goes "under the hood" and shows step-by-step how to create a socket 7 (Pentium and non-intel chipsets) and a Slot 1 (Pentium II) computer, covering: What first-time builders need to know; How to select and purchase parts; How to assemble the PC; How to Install Windows 98. The few existing books on this subject, although badly outdated, are in steady demand. This one delivers the expertise and new technology that fledgling computer builders are eagerly looking for.

224 pages – large format Order code.MGH2 £21.99

PIC YOUR PERSONAL INTRODUCTORY COURSE SECOND EDITION John Morton NEW

Discover the potential of the PIC microcontroller through graded projects – this book could revolutionise your electronics construction work!

A uniquely concise and practical guide to getting up and running with the PIC Microcontroller. The PIC is one of the most popular of the microcontrollers that are transforming electronic project work and product design.

Assuming no prior knowledge of microcontrollers and introducing the PIC's capabilities through simple projects, this book is ideal for use in schools and colleges. It is the ideal introduction for students, teachers, technicians and electronics enthusiasts. The step-by-step explanations make it ideal for self-study too: this is not a reference book – you start work with the PIC straight away.

The revised second edition covers the popular reprogrammable EEPROM PICs: P16C84/16F84 as well as the P54 and P71 families.

270 pages Order code NE36 £13.99

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold (Revised Edition)

If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!

128 pages Order code BP282 £5.45

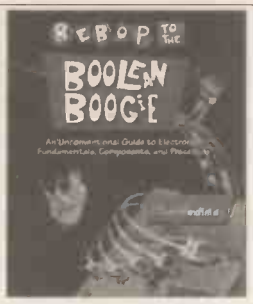
Theory and Reference

Bebop To The Boolean Boogie

By Clive (call me Max) Maxfield

Specially imported by *EPE* – *Excellent value*

An Unconventional Guide to Electronics Fundamentals, Components and Processes



This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more (including a recipe for a truly great seafood gumbo!). Hundreds of carefully drawn illustrations clearly show the important points of each topic. The author's tongue-in-cheek British humor makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate. A great reference for your own shelf, and also an ideal gift for a friend or family member who wants to understand what it is you do all day. . . .

470 pgs – large format **Order code BEB1** **£26.95**

DIGITAL ELECTRONICS – A PRACTICAL APPROACH

FREE SOFTWARE

With **FREE** Software: Number One Systems – EASY-PC Professional XM and Pulsar (Limited Functionality)

Richard Monk

Covers binary arithmetic, Boolean algebra and logic gates, combination logic, sequential logic including the design and construction of asynchronous and synchronous circuits and register circuits. Together with a considerable practical content plus the additional attraction of its close association with computer aided design including the **FREE** software.

There is a 'blow-by-blow' guide to the use of EASY-PC Professional XM (a schematic drawing and printed circuit board design computer package). The guide also conducts the reader through logic circuit simulation using Pulsar software. Chapters on p.c.b. physics and p.c.b. production techniques make the book unique, and with its host of project ideas make it an ideal companion for the Integrative assignment and common skills components required by BTEC and the key skills demanded by GNVQ. The principal aim of the book is to provide a straightforward approach to the understanding of digital electronics.

Those who prefer the 'Teach-In' approach or would rather experiment with some simple circuits should find the book's final chapters on printed circuit board production and project ideas especially useful.

250 pages (large format) **Order code NE28** **£17.99**

ELECTRONICS MADE SIMPLE

Ian Sinclair

Assuming no prior knowledge, *Electronics Made Simple* presents an outline of modern electronics with an emphasis on understanding how systems work rather than on details of circuit diagrams and calculations. It is ideal for students on a range of courses in electronics, including GCSE, C&G and GNVQ, and for students of other subjects who will be using electronic instruments and methods.

Contents: waves and pulses, passive components, active components and ICs, linear circuits, block and circuit diagrams, how radio works, disc and tape recording, elements of TV and radar, digital signals, gating and logic circuits, counting and correcting, microprocessors, calculators and computers, miscellaneous systems.

199 pages **Order code NE23** **£13.99**

SCROGGIE'S FOUNDATIONS OF WIRELESS AND ELECTRONICS – ELEVENTH EDITION

S. W. Amos and Roger Amos

Scroggie's Foundations is a classic text for anyone working with electronics, who needs to know the art and craft of the subject. It covers both the theory and practical aspects of a huge range of topics from valve and tube technology, and the application of cathode ray tubes to radar, to digital tape systems and optical recording techniques.

Since *Foundations of Wireless* was first published over 60 years ago, it has helped many thousands of readers to become familiar with the principles of radio and electronics. The original author Sowerby was succeeded by Scroggie in the 1940s, whose name became synonymous with this classic primer for practitioners and students alike. Stan Amos, one of the fathers of modern electronics and the author of many well-known books in the area, took over the revision of this book in the 1980s and it is he, with his son, who have produced this latest version.

400 pages **Order code NE27** **£21.99**

GETTING THE MOST FROM YOUR MULTIMETER

R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages **Order code BP239** **£3.45**

DIGITAL GATES AND FLIP-FLOPS

Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

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QUICK GUIDE TO ANALOGUE SYNTHESIS

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Even though music production has moved into the digital domain, modern synthesisers invariably use analogue synthesis techniques. The reason is simple – analogue synthesis is flexible and versatile, and it's relatively 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 essential 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 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.

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Ian Waugh

MP3 files, the latest digital music format, have taken the music industry by storm. What are they? Where do you get them? How do you use them? Why have they thrown record companies into a panic? Will they make music easier to buy? And cheaper? Is this the future of music?

All these questions and more are answered in this concise and practical book which explains everything you need to know about MP3s in a simple and easy-to-understand manner. It explains:

How to play MP3s on your computer; How to use MP3s with handheld MP3 players; Where to find MP3s on the Web; How MP3s work; How to tune into Internet radio stations; How to create your own MP3s; How to record your own CDs from MP3 files; Other digital audio music formats.

Whether you want to stay bang up to date with the latest music or create your own MP3s and join the on-line digital music revolution, this book will show you how.

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AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN

V. Capel

This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him – or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.

148 pages **Temporarily out of print**

ELECTRONIC MUSIC AND MIDI PROJECTS

R. A. Penfold

Whether you wish to save money, boldly go where no musician has gone before, rekindle the pioneering spirit, or simply have fun building some electronic music gadgets, the designs featured in this book should suit your needs. The projects are all easy to build, and some are so simple that even complete beginners at electronic project construction can tackle them with ease. Stripboard layouts are provided for every project, together with a wiring diagram. The mechanical side of construction has largely been left to individual constructors to sort out, simply because the vast majority of project builders prefer to do their own thing in this respect.

None of the designs requires the use of any test equipment in order to get them set up properly. Where any setting up is required, the procedures are very straightforward, and they are described in detail.

Projects covered: Simple MIDI tester, Message grabber, Byte grabber, THRU box, MIDI auto switcher, Auto/manual switcher, Manual switcher, MIDI patchbay, MIDI controlled switcher, MIDI lead tester, Program change pedal, Improved program change pedal, Basic mixer, Stereo mixer, Electronic swell pedal, Metronome, Analogue echo unit.

124 pages **Order code PC116** **£10.95**

THE INVENTOR OF STEREO – THE LIFE AND WORKS OF ALAN DOWER BLUMLEIN

Robert Charles Alexander

This book is the definitive study of the life and works of one of Britain's most important inventors who, due to a cruel set of circumstances, has all but been overlooked by history.

Alan Dower Blumlein led an extraordinary life in which his inventive output rate easily surpassed that of Edison, but whose early death during the darkest days of World War Two led to a shroud of secrecy which has covered his life and achievements ever since.

His 1931 Patent for a Binaural Recording System was so revolutionary that most of his contemporaries regarded it as more than 20 years ahead of its time. Even years after his death, the full magnitude of its detail had not been fully utilized. Among his 128 patents are the principal electronic circuits critical to the development of the world's first elecronic television system. During his short working life, Blumlein produced patent after patent breaking entirely new ground in electronic and audio engineering.

During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H2S' – blind-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirty-ninth birthday.

420 pages **Order code NE32** **£15.99**

VIDEO PROJECTS FOR THE ELECTRONICS CONSTRUCTOR

R. A. Penfold

Written by highly respected author R. A. Penfold, this book contains a collection of electronic projects specially designed for video enthusiasts. All the projects can be simply constructed, and most are suitable for the newcomer to project construction, as they are assembled on stripboard.

There are faders, wipers and effects units which will add sparkle and originality to your video recordings, an audio mixer and noise reducer to enhance your soundtracks and a basic computer control interface. Also, there's a useful selection on basic video production techniques to get you started.

Complete with explanations of how the circuit works, shopping lists of components, advice on construction, and guidance on setting up and using the projects, this invaluable book will save you a small fortune.

Circuits include: video enhancer, improved video enhancer, video fader, horizontal wiper, improved video wiper, negative video unit, fade to grey unit, black and white keyer, vertical wiper, audio mixer, stereo headphone amplifier, dynamic noise reducer, automatic fader, pushbutton fader, computer control interface, 12 volt mains power supply.

124 pages **Order code PC115** **£10.95**

PC MUSIC – THE EASY GUIDE

NEW

Robin Vincent

How do I make music on my PC? Can I record music onto my PC? What's a sequencer? How can I get my PC to print a music score? What sort of a soundcard do I need? What hardware and software do I need? How do I connect a keyboard to my PC?:

Just a few of the questions you've probably asked. Well, you'll find the answers to all these questions, and many more, in this book. It will show you what can be done, what it all means, and what you will need to start creating your own music on your PC. It's an easy read, it's fully illustrated and it will help you understand how a computer can be used as a creative music tool.

It covers soundcards, sequencers, hard disk digital audio recording and editing, plug-ins, printing scores with notation software, using your PC as a synthesiser, getting music onto and off the Internet, using Windows, sample PC music set-ups, FAQs, a glossary, advice on hardware and software, and a list of industry contacts.

116 pages **Order code PC117** **£11.95**

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION

R. A. Penfold

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96 pages **Order code BP277** **£4.49**

Circuits, Data and Design

PRACTICAL ELECTRONIC FILTERS
Owen Bishop
This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.

The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rythm sequencer and a multi-voiced electronic organ.

Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.

88 pages Order code BP299 £5.49

ELECTRONIC HOBBYISTS DATA BOOK
R. A. Penfold
This book should tell you everything you are ever likely to want to know about hobby electronics, but did not know where to ask or refer. Comprehensive contents pages makes it easy to quickly locate the data you require.

The subjects covered include: Common circuits, and related data (including helpful graphs and tables of values); Colour codes for resistors, capacitors and inductors; Pinout details for a wide range of CMOS and TTL devices, plus basic data on the various logic families; Pinout details and basic data for a wide range of operational amplifiers; Data and leadout information for a wide range of transistors, FETs, power FETs, triacs, thyristors, diodes, etc; General data including MIDI message coding, radio data, ASCII/Baudot coding, decibel ratios, etc.

242 pages Order code BP396 £6.45

50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components – the light-emitting diode (LED). Also includes circuits for the 707 common anode display.

64 pages Order code BP42 £2.99

CIRCUIT SOURCE BOOK 1
A. Penfold
Written to help you create and experiment with your own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is given.

The circuits covered in this book are mainly concerned with analogue signal processing and include: Audio amplifiers (op.amp and bipolar transistors); audio power amplifiers; d.c. amplifiers; highpass, lowpass, bandpass and notch filters; tone controls; voltage controlled amplifiers and filters; triggers and voltage comparators; gates and electronic switching; bargraphs; mixers; phase shifters, current mirrors, hold circuits, etc.

Over 150 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.

182 pages **Temporarily out of print**

A BEGINNER'S GUIDE TO TTL DIGITAL ICs
R. A. Penfold
This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world".

142 pages Order code BP332 £5.45

HOW TO USE OP.AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

160 pages Order code BP88 £4.49

CIRCUIT SOURCE BOOK 2
R. A. Penfold
This book will help you to create and experiment with your own electronic designs by combining and using the various standard "building blocks" circuits provided. Where applicable, advice on how to alter the circuit parameters is provided.

The circuits covered are mainly concerned with signal generation, power supplies, and digital electronics.

The topics covered in this book include: 555 oscillators; sinewave oscillators; function generators; CMOS oscillators; voltage controlled oscillators; radio frequency oscillators; 555 monostables; CMOS monostables; TTL monostables; precision long timers; power supply and regulator circuits; negative supply generators and voltage boosters; digital dividers; decoders, etc; counters and display drivers; D/A and A/D converters; opto-isolators, flip/flops, noise generators, tone decoders, etc.

Over 170 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.

192 pages Order code BP322 £5.45

Project Building & Testing

ELECTRONIC PROJECTS FOR EXPERIMENTERS
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AN ACTIVE SUB BASS AMPLIFIER WITH A TRUE 100W RMS OUTPUT. SUPERB CONSTRUCTION WITH THE FACILITIES TO INTEGRATE SEEMLESSLY INTO MOST HI-FI OR HOME CINEMA SETUPS. USE THIS PANEL PLUS ONE OF OUR LOUDSPEAKERS TO MAKE YOUR OWN SUB WOOFER THAT WILL MATCH OR BEAT MOST COMMERCIALLY AVAILABLE SUB WOOFERS.

FEATURES:- * 100W RMS INTO 8 OHMS * HIGH AND LOW LEVEL INPUTS * TOROIDAL TRANSFORMER * SHORT CIRCUIT PROTECTION * D.C. SPEAKER PROTECTION * FREQUENCY ROLL OFF, LOWER 10Hz, UPPER 60Hz TO 240Hz (FULLY ADJUSTABLE) * AC3 COMPATIBLE FILTER CAN BE BYPASSED FOR 5-1 FORMATS. * AIRTIGHT CONSTRUCTION * TENS OF THOUSANDS OF OUR PANELS ALREADY IN USE. * COMPLETE WITH LEADS

SPECIFICATIONS:-* POWER 100W RMS @ 8 OHMS *FREQ RESP. 10Hz 15KHz -3dB * DAMPING FACTOR >200 * DISTORTION 0.05% * S/N A WEIGHTED >100dB * SUPPLY 230V A.C. *WEIGHT 2.7Kg * SIZE H254 X W254 X D94mm

THERE ARE 2 VERSIONS OF THE ABOVE PANEL AVAILABLE :-BSB100/8 8 OHM VERSION BSB100/4 4 OHM VERSION BOTH PANELS ARE PRICED AT £117.44 + £5.00 P&P INCL. V.A.T

VISA — EUROCARD MasterCard

DELIVERY CHARGES:- PLEASE INCLUDE AS ABOVE, TO A MAXIMUM AMOUNT £30.00. OFFICIAL ORDERS FROM SCHOOL, COLLEGES, GOVT., PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. CREDIT CARD ORDERS ACCEPTED BY POST PHONE OR FAX.

ibl FLIGHTCASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of latest loudspeaker technology and enclosure designs. All models utilise high quality studio cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands. The FC15-300 incorporates a large 16 X 6 inch horn. All cabinets are fitted with the latest Speakon connectors for your convenience and safety. Five models to choose from.

WEDGE MONITOR

PLEASE NOTE:- POWER RATINGS QUOTED ARE IN WATTS R.M.S. FOR EACH INDIVIDUAL CABINET ALL ENCLOSURES ARE 8 OHMS
15=15 Inch speaker
12=12 Inch speaker

ibl FC15-300 WATTS Freq Range 35Hz-20kHz,Sens 101dB, Size H695 W502 D415mm
Price:- £299.00 per pair

ibl FC12-300 WATTS Freq Range 45Hz-20kHz, Sens 96dB, Size H600 W405 D300mm
Price:- £249.00 per pair

ibl FC12-200 WATTS Freq Range 40Hz-20kHz, Sens 97dB, Size H600 W405 D300mm
Price:- £199.00 per pair

ibl FC12-100 WATTS Freq Range 45Hz-20kHz, Sens 100dB, Size H546 W380 D300mm
Price:- £179.00 per pair

ibl WM12-200 WATTS Freq Range 40Hz-20kHz, Sens 97dB, Size H418 W600 D385mm
Price:- £125.00 Each

SPECIALIST CARRIER DEL:- £12.50 per pair, wedge monitor £7.00 each
Optional Metal Stands PRICE:- £49.00 per pair Delivery:- £6.00

10 INCH AND 12 INCH 100W RMS SUB BASS LOUDSPEAKERS

TWO SUPERB SUB WOOFER LOUDSPEAKER DRIVERS TO ACCOMPANY OUR SUB BASS AMPLIFIER PANEL BELOW. BOTH DRIVERS OFFER GOOD BASS RESPONSE AT A REASONABLE COST. THE BSB12-100 HAS BEEN USED FOR MANY YEARS IN AN AWARD WINNING SUB BASS SYSTEM

FOR TH/SM SPECIFICATIONS VIEW OUR WEB SITE AT http://www.bkelec.com

12 INCH LOUDSPEAKER BSB12-100

POWER	100W
IMPEDANCE	8 OHMS
SENSITIVITY	90dB
WEIGHT	3.0Kg
PRICE	£24.95
CARRIAGE	£5.00

10 INCH LOUDSPEAKER BSB10-100

POWER	100W
IMPEDANCE	8 OHMS
SENSITIVITY	89dB
WEIGHT	2.3Kg
PRICE	£19.99
CARRIAGE	£5.00

OMP MOS-FET POWER AMPLIFIER MODULES

SUPPLIED READY BUILT AND TESTED

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market .ie. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heatsink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output Power 110 watts R.M.S. into 4 ohms,frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. 110dB. Size 300 x 123 x 60mm.
Price:- £42.85 + £4.00 P&P

OMP/MF 200 Mos-Fet Output Power 200 watts R.M.S. into 4 ohms,frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Size 300 x 155 x 100mm.
Price:- £66.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output Power 300 watts R.M.S. into 4 ohms,frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Size 330 x 175 x 100mm.
Price:- £83.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output Power 450 watts R.M.S. into 4 ohms,frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti Thump Delay. Size 385 x 210 x 105mm.
Price:- £135.85 + £6.00 P&P

OMP/MF 1000 Mos-Fet Output Power 1000 watts R.M.S. into 2 ohms, frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti Thump Delay. Size 422 x 300 x 125mm.
Price:- £261.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV,BANDWIDTH 100kHz OR PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BANDWIDTH 50kHz **ORDER STANDARD OR PEC**

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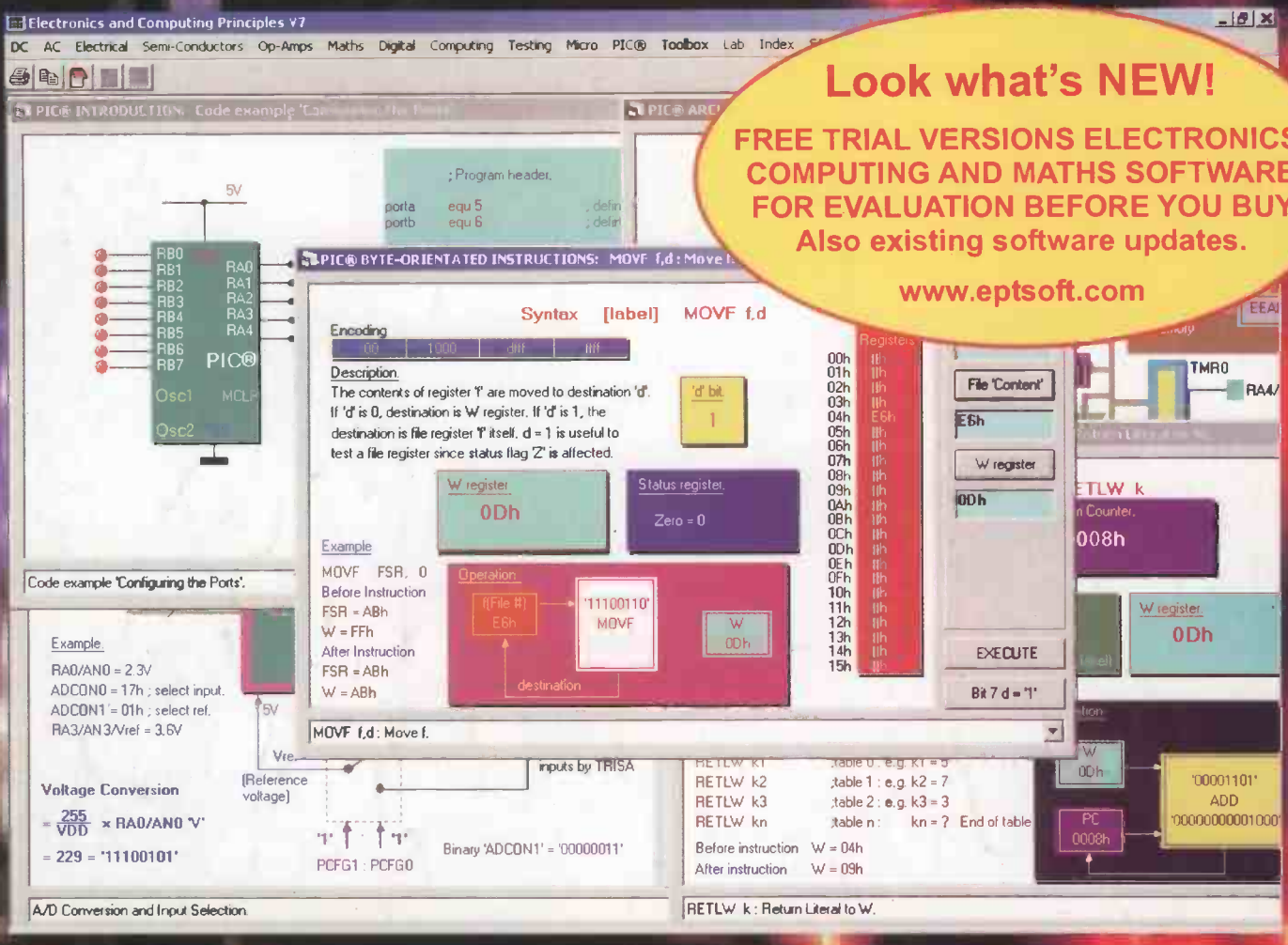

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