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ISSN 0262 3617
PROJECTS . . . THEORY . . . NEWS . . .
COMMENTS . . . POPULAR FEATURES . . .

VOL. 29. No. 10 OCTOBER 2000

EVERYDAY PRACTICAL ELECTRONICS

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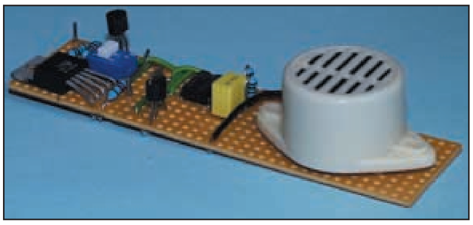
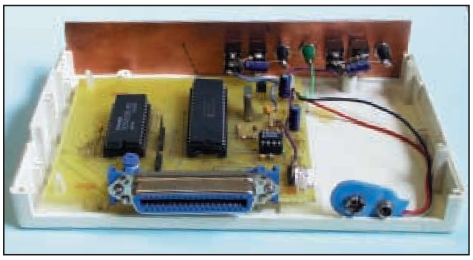
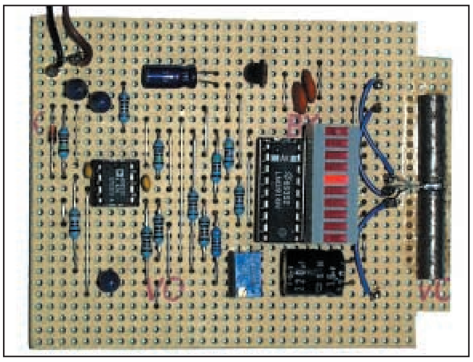
Projects and Circuits





Series and Features



Regulars and Services

NOTE NEW PUBLISHING DATE
November issue on sale
Thursday October 12

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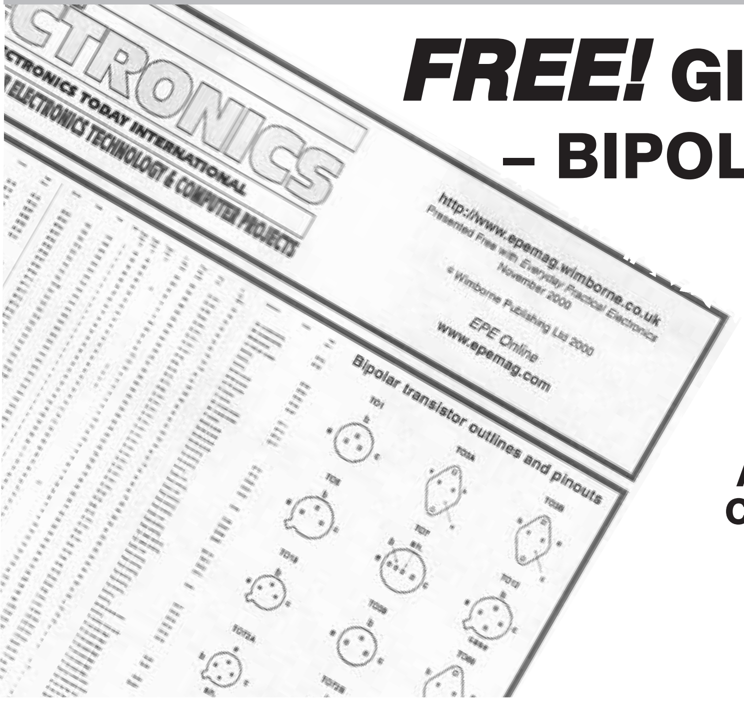
Our November 2000 issue will be published on Thursday, 12 October 2000. See page 715 for details

NEXT MONTH



FREE! GIANT DATA CHART

– BIPOLAR TRANSISTORS –

PAST, PRESENT AND PINOUTS! AROUND 500 TRANSISTORS AND THEIR CHARACTERISTICS

COVERS *NPN*, *PNP*, SILICON, GERMANIUM, EQUIVALENTS, COMPLEMENTS, FUNCTIONS AND OUTLINES. TABLING VOLTAGE, CURRENT, FREQUENCY AND POWER FACTORS

GIANT SIZE – 57cm x 77cm. THE IDEAL PINOUT PIN-UP FOR ANY WORKSHOP OR CLASSROOM!

Top Tenner

SAMPLE AND HOLD MODULE

An add-on unit for your multimeter which works equally well with analogue or digital types. As the name suggests, its function is to sample a changing voltage and hold it to give you time to read its value. Reading a changing voltage is difficult with a digital meter because the final two or three figures of the reading may be changing too fast to be seen.

Typically, the meter takes several samples per second so it is not possible to read each sample individually. We can only read a value when it is reasonably steady, perhaps varying only in the least significant digit. An analogue meter is easier to read with a rapidly changing voltage, because the eye can average out the changes over a small interval of time. There is also the inertia of the needle and coil unit to help steady the readings. Whether you have a digital or analogue meter, there are occasions when you might want to sample and read the voltage at a precise instant, or to sample it and read it at regular intervals of time. This project helps you do this.

OPTO-ALARM

An optically balanced light alarm for general purpose security applications. The alarm is triggered by increasing light level. Alarm activation occurs when the light level increases rapidly. Varying light levels from cloud movement, 50Hz mains flicker from fluorescent lamps, dusk to dawn light changes and total darkness situations, will not cause false alarms.

The Opto-Alarm incorporates an exit delay indicated by a green l.e.d. to allow departure from the protected area, and to allow time to set the system for required operation, a red l.e.d. indicates any triggering whilst setting up. When time-out occurs, the exit l.e.d. extinguishes and further triggering will activate a warning tone, followed by full siren activation for a pre-set period, after which the alarm will fully reset until activated further.

NOTE NEW PUBLISHING DATE

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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 £24.90**
● **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 £16.95; BOX (for mains operation) 2026KT £8.50**
● **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 £29.90**
● **ANIMAL SOUNDS** Cat, dog, chicken & cow. Ideal for kids farmyard toys & schools. **SG10M £5.50**
● **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 £12.95**
● **IR REMOTE TOGGLE SWITCH** Use any TV/VCR remote control unit to switch onboard 12V/1A relay on/off. **3058KT £9.95**
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 £14.95**
● **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 £44.95**

NEW PRODUCT FEATURE

Introduction to L.C.D.s and More!

Kit teaches you to understand and use l.c.d.s. First, you learn how to connect the 2 x 16 l.c.d.s to a PC and how to make the l.c.d. display messages typed on the PC keyboard. It will show you how to process this data. Second, there is an on-board DS1620 to measure temperature (°F or °C). Control is provided for you to set breakpoints to turn a thermostat on/off. Once the DS1620 is programmed it may be removed and placed in another device for temperature control Many web references are provided. All software code & DS1620 data sheets provided on disk. **3134KT £26.95**

● **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 £7.95**
● **MUSIC BOX** Activated by light. Plays 8 Christmas songs and 5 other tunes. **3104KT £6.95**
● **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 £11.95**
● **TRAIN SOUNDS** 4 selectable sounds : whistle blowing, level crossing bell, 'clickety-clack' & 4 in sequence. **SG01M £5.95**

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Full details of all X-FACTOR PUBLICATIONS can be found in our catalogue. N.B. Minimum order charge for reports and plans is £5.00 PLUS normal P&P.

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● **LOCKS** - How they work and how to pick them. This fact filled report will teach you more about locks and the art of lock picking than many books we have seen at 4 times the price. Packed with information and illustrations. **R008 £3.50**
● **RADIO & TV JOKER PLANS**
We show you how to build three different circuits for disrupting TV picture and sound plus FM radio! May upset your neighbours & the authorities!! DISCRETION REQUIRED. **R017 £3.50**
● **INFINITY TRANSMITTER PLANS** Complete plans for building the famous Infinity Transmitter. Once installed on the target phone, device acts like a room bug. Just call the target phone & activate the unit to hear all room sounds. Great for home/office security! **R019 £3.50**
● **THE ETHER BOX CALL INTERCEPTOR PLANS** Grabs telephone calls out of thin air! No need to wire-in a phone bug. Simply place this device near the phone lines to hear the conversations taking place! **R025 £3.00**
● **CASH CREATOR BUSINESS REPORTS** Need ideas for making some cash? Well this could be just what you need! You get 40 reports (approx. 800 pages) on floppy disk that give you information on setting up different businesses. You also get valuable reproduction and duplication rights so that you can sell the manuals as you like. **R030 £7.50**

● **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 £29.95**
● **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 £13.95**
● **PC DATA ACQUISITION/CONTROL UNIT** Use your PC to monitor physical variables (e.g. pressure, temperature, light, weight, switch state, movement, relays, etc.), process the information & use results to control physical devices like motors, sirens, relays, servo & stepper motors. Inputs: 16 digital & 11 analogue. Outputs: 8 digital & 1 analogue. Plastic case with printed front/rear panels, software utilities, programming examples & all components (except sensors & cable) provided. 12VDC. **3093KT £89.95**
● **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 £14.95**
● **PC SERIAL PORT ISOLATED I/O BOARD** Provides eight 240VAC/10A relay outputs & 4 optically isolated inputs. Designed for use in various control & sensing applications e.g. load switching, external switch input sensing, contact closure & external voltage sensing. Controlled via serial port & a terminal emulator program (built into Windows). Can be used with ANY computer/operating system. Plastic case with printed front/rear panels & all components (except cable) provided. **3108KT £49.95**
● **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 £49.95**

SURVEILLANCE

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).

ROOM SURVEILLANCE

● ***MTX*** **- MINIATURE 3V TRANSMITTER**
Easy to build & guaranteed to transmit 300m @ 3V. Long battery life. 3-5V operation. Only 45x18mm. ● **3007KT £5.95 AS3007 £10.95**
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 £6.95 AS3018 £11.95**
HPTX **- HIGH POWER TRANSMITTER**

High performance, 2 stage transmitter gives greater stability & higher quality reception. 1000m range 6-12V DC operation. Size 70x15mm. **3032KT £8.95 AS3032 £17.95**
● ***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 £7.95 AS3051 £13.95**
● ***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 £9.95 AS3028 £22.95**
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 £13.95 (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 £7.95 AS3013 £19.95**

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 £7.95 AS3016 £13.95**
● ***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 £7.95 AS3033 £16.95**
● ***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 £10.95 AS3055 £19.95**
● **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. £23.95**
● **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 configuration antennas. 12-18VDC. PCB 70x220mm. SWS meter needed for alignment. **1021KT £69.95**
● **SIMILAR TO ABOVE BUT 25W Output. 1031KT £79.95**

● **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 £6.95**
● **STEREO VU METER** shows peak music power using 2 rows of 10 LED's (mixed green & red) moving bar display. 0-30db. **3089KT £10.95**
● **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 £9.95**
● **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 £16.90**
● **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 £9.95**
● **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 £8.95**
● **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 £8.95**
● **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 £10.95**
● **LED FLASHER 1** 5 ultra bright red LED's flash in 7 selectable patterns. **3037MKT £4.95**
● **LED FLASHER 2** Similar to above but flash in sequence or randomly. Ideal for model railways. **3052MKT £4.95**
● **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 £21.95**
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● **'PICALL' SERIAL & PARALLEL PIC PROGRAMMER** for all 8/18/28/40 pin DIP parallel AND serial PICs. Includes fully functional & registered software (DOS, W3.1, W95/8). **3117KT £59.95**
● **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 £34.95**
● **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 £4.95**

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● **STABILISED POWER SUPPLY 2-30V/5A** As kit 1007 above but rated at 5Amp. Requires a 24VAC/5A transformer. **1096KT £29.95. Custom Designed Box 2096 £34.95**
● **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 £5.95**
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● **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 £9.95**
● **COMBINATION LOCK** Versatile electronic lock comprising main circuit & separate keypad for remote opening of lock. Relay supplied. **3029KT £9.95**
● **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 £12.95**
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 £11.95**
● **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 £19.95**
● **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 £54.95**

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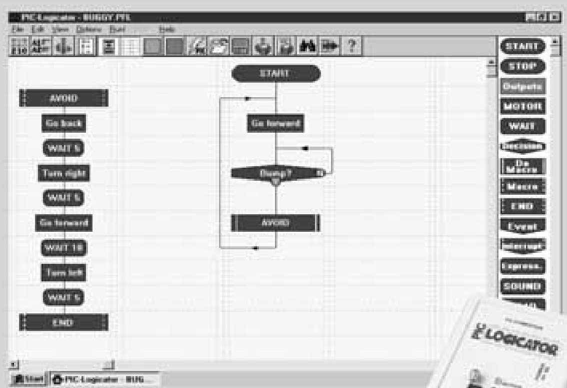

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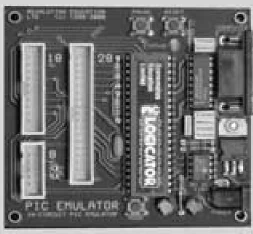

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- **Anritsu MG 3601A** Signal Generator 0·1–1040MHz ... £1250
- **Anritsu ME 462B** DF/3 Transmission Analyser ... £2500
- **Anritsu MG 645B** Signal Generator 0·05–1050MHz ... £750
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- **Boonton 93A** True RMS Voltmeter ... £195
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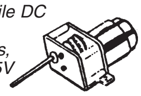

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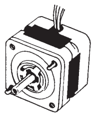

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INCLUDES 1-PIC16F84 CHIP SOFTWARE DISK, LEAD CONNECTOR, PROFESSIONAL PC BOARD & INSTRUCTIONS

EXTRA CHIPS:
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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.

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

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- WITH PROGRAMMED 16F84 AND DISK WITH SOURCE CODE IN MPASM
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Full kit includes PIC16F84 chip, top quality p.c.b. printed with component layout, turned-pin PIC socket, all components and software*
*Needs QBASIC or QUICKBASIC

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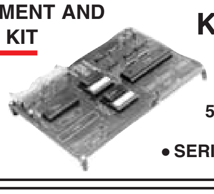

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- **PIC TUTOR Board with Switches, l.e.d.s, and on board programmer**

PIC TUTOR BOARD KIT

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- INCLUDES SOFTWARE AND PIC CHIP

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4.7	---	---	£0.05	£0.05	£0.06	---	---	---	£0.13	---	---	£0.41
10	£0.05	£0.05	£0.05	£0.05	£0.09	£0.12	---	£0.12	£0.13	£0.17	£0.40	£0.67
22	£0.05	£0.05	£0.05	£0.07	£0.11	£0.12	£0.13	£0.14	£0.15	£0.21	£0.52	£1.06
33	£0.05	---	£0.05	---	---	---	---	---	---	---	---	---
47	£0.05	£0.05	£0.08	£0.11	£0.19	£0.13	£0.13	£0.15	£0.19	£0.32	£0.57	---
100	£0.07	£0.08	£0.10	£0.13	£0.26	£0.14	£0.16	£0.19	£0.26	£0.44	---	---
220	£0.09	£0.09	£0.13	£0.28	---	£0.19	£0.20	£0.25	£0.39	£0.48	---	---
330	£0.09	---	£0.19	---	---	---	---	---	---	---	---	---
470	£0.13	£0.17	£0.24	£0.33	---	£0.24	£0.28	£0.41	£0.53	---	---	---
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I have often referred to supply problems associated with components but now we are facing one associated with the magazine. To put it briefly the major retail chains in the UK simply cannot carry all the available magazines in their shops, so they are restricting the range of titles they carry. You may find it increasingly difficult to obtain your copy of *EPE* (and many other specialist magazines) off the shelf, particularly if you do not live in a large town or city.

There is little we can do to overcome this problem but there are ways in which ***you*** can overcome it. If you normally buy your magazine off the shelf it may be worthwhile placing an order with your supplier so that he will "shop save" an issue for you. Since all issues supplied to retailers are on Sale Or Return you do not have to buy the magazine when you get to see it, your newsagent can always return it to his wholesaler. Elsewhere in this issue you will find a Newsagent Order Form (page 768) which will allow you to request that your newsagent reserves or delivers your copy of *EPE* each month.

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Please don't believe the "not yet published", "never heard of it mate", "it's late coming out this month" stories we get reported to us. We have not published an issue late, or missed an issue, in the last 20 years, so we don't intend to start now. You should, however, note our **new publishing date** which, from next month onwards, will be **the second Thursday** in the month – the November issue will be out on October

Mike Kenward

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Constructional Project

WIND-UP TORCH

THOMAS SCARBOROUGH

An occasional twist of a knob provides light without battery power.

A COMMON problem with small torches is the short life-span both of the batteries and the bulb. The batteries of a small "penlite" torch will commonly last only two to three hours, and many bulb filaments burn no more than a few weeks before fusing. Besides this, torch batteries can sometimes be hard to come by, especially when camping or visiting remote areas.

The idea for a better torch was born a few years ago when the author was caught in a violent tropical storm on a remote dirt track, and his penlite torch rapidly faded and died.

LIGHTING THE WAY

With new light emitting diode (l.e.d.) technology, it is now possible to build a torch that quite adequately lights the way five to ten metres in front. In fact, since power consumption is so small, it is possible to power the light for a considerable length of time from a few turns of a small generator with a capacitor "reservoir" – the sole source of power for this torch (no batteries).

In addition to this, the white l.e.d. used in the circuit has a life expectancy of years, not weeks as in the case of a standard filament bulb.

While the light output of the Wind-up Torch is modest in comparison with some modern torches, it matches several candlepower at medium power, and is thus quite serviceable. It will provide ample light around a camp table, for walking on a footpath, or for reading.

The light output of the torch is continuously variable, and its expected service from each full wind is as follows:

- Book-light 90 minutes
- Medium-power beam 40 minutes
- Beam for walking 15 minutes

readily and cheaply obtainable second-hand or as surplus goods.

The a.c. voltage from the stepper motor is full-wave rectified, regulated, and fed into a two Farad (2F) reservoir capacitor. Since a capacitor's characteristics are very different to those of an ordinary power supply, a special regulator is required between the reservoir and the l.e.d.

Unlike a battery, which gradually discharges, a capacitor releases a surge of power, which becomes a weaker and more steady flow with time. This may be likened to a breach in a dam wall: an initial surge of water becomes, after a while, a weaker and more steady stream.

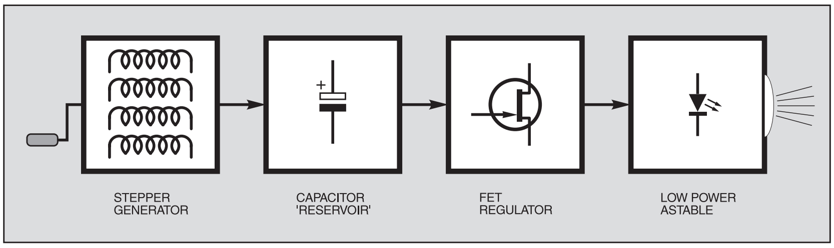


Fig.1. Schematic block diagram for the Wind-up Torch.

TORCH OPERATION

The block diagram of the Wind-up Torch is given in Fig.1.

Power is provided by a generator based on a stepper motor. A stepper motor was chosen for two reasons: such motors produce a good a.c. voltage at fairly low revs, thus obviating the need for complicated gearing. Also, since the demise of floppy disk drives, these motors are

The regulator is based on a field effect transistor (f.e.t.), which draws just a few microamps, and provides a very steady voltage from the falling voltage of the reservoir capacitor.

The final stage incorporates a very low power astable circuit, which pulses the white l.e.d. so as to conserve power. A compromise was sought that reduces power consumption to a minimum, while not reducing light level too noticeably, or causing any visual disturbance through the pulsed light. By pulsing the light, power consumption is greatly reduced, and torchlight extended more than ten times.

GENERATOR

A wide range of 12V stepper motors may be used for the generator and they come in various shapes and sizes. If they are purchased new, they can be costly. However, if an old floppy disk drive (working or non-working) is purchased and the stepper motor removed, the cost may be reduced considerably.

It is unlikely that a floppy disk drive has failed due to stepper motor failure, so even if a motor has been removed from a non-working drive, it is still likely to be sound. The stepper motor in the circuit was removed from an old 5·25-inch floppy disk drive.

More often than not, the four windings of a stepper motor are commoned, with the common (+VE) lead coloured red. It is easy to test with a multimeter which is the common lead. Measure the resistances across every combination of leads – if the resistances from one lead to all the rest are less than every other resistance measured, this is the common lead. If, on the other hand, some combinations of leads indicate open circuit, the motor's windings are likely to be separate.

The voltage produced by both types of motor is a.c., which needs to be converted to d.c., using full-wave rectification, as shown in Fig.2.

The circuit in Fig.2a illustrates how the four windings of a stepper motor are wired if it has commoned leads. Fig.2b shows the circuit if the motor has separate windings.

Since commoned windings are by far the most usual arrangement with stepper motors, the component layout of the Wind-up Torch (Fig.4 later) is designed specifically for such motors.

MAIN CIRCUIT DIAGRAM

The main circuit diagram for the Wind-Up Torch is shown in Fig.3.

The rectified d.c. output from the stepper motor circuit is fed into capacitor C1, which serves to smooth the fluctuating output of the generator.

From C1, the voltage is fed via rectifier diode D1, which prevents reverse leakage of current, into two 1F (one Farad) reservoir capacitors, C2 and C3. These are "memory retention" (back-up) types and need to be treated with care, since they are both pricy and easily damaged.

The rectified d.c. voltage from the stepper motor will vary considerably, depending on its type and the speed at which it is turned. Since the maximum voltage rating of C2 and C3 is 5·5V, a 5·1V Zener diode regulator (D2) is incorporated into the supply line following diode D1. The Zener used has a 5W rating, although a 1·3W type was tested thoroughly without failure. Charge current is around 15mA on a moderate wind.

CIRCUIT OPERATION

The main regulator section of the circuit is based on f.e.t. TR2. This holds a very steady voltage as the reservoir voltage falls, and will likely show a marginal rise in voltage for some time.

When the Wind-up Torch is adjusted for use as a book-light (3V), it maintains over 95 per cent of voltage for about 90 minutes. At the highest brightness setting (3·6V), it maintains over 95 per cent of voltage for 15 minutes. The regulator was tested up to 5V without failure of the l.e.d. – however, this is not advised, and the circuit disallows it.

Originally, a simple resistor was tried as a regulator between the reservoir capacitor and astable IC1. This limited current consumption and was found to double the life of the reservoir voltage. Assume, however, that the resistance could be automatically reduced as capacitor voltage falls – this would further extend the reservoir's life.

In fact, by substituting a f.e.t. (TR2) for the resistor, and controlling its conductance, the circuit used here outperforms the simple "resistor regulator" by a factor of 10. Total power consumption of the regulator is just 15µA.

A f.e.t. was chosen for the task since, unlike a bipolar transistor which is current controlled, it is voltage (or field effect) controlled, and draws a minute current – a very necessary feature of this application. A negative voltage applied to the gate of the f.e.t. creates a field effect, and "pinches off" current travelling from drain to source – while a positive voltage at the gate increases conductance.

Bipolar transistor TR1, potentiometer VR1 and resistor R4 form a voltage divider which determines the conductance of the f.e.t. As the voltage (and therefore current) declines across capacitors C2 and C3, so TR1 becomes less conductive, the potential at its collector rises, and TR2's conductance increases. Therefore TR2 provides a very steady supply to IC1 and l.e.d. D3.

Note that transistor TR1 has an "A" suffix. This is important, and refers to the low gain of the transistor. Equivalents should be chosen carefully. The considerably larger BD241C may be used as a replacement, if transistors R1 and R2 are paralleled in the R1 position, and a link wire is substituted in the R2 position on the circuit board.

The purpose of capacitor C4 is to maintain a steady power supply for astable IC1, reducing peak current passing through TR2, which has a maximum rating of about 20mA.

The astable circuit is very straightforward, being based on an ICM7555IPA timer, IC1. The importance of using this particular device is that it has a supply

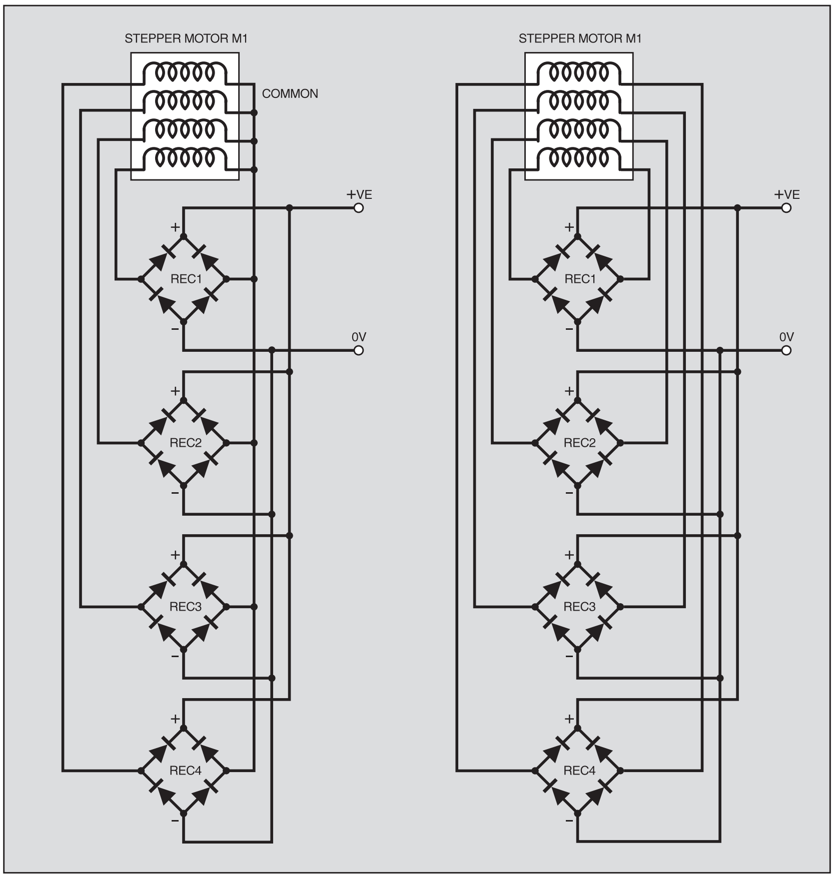


Fig.2. Bridge rectifying the stepper motor windings, (a) if the stepper motor has four common windings, and (b) if the motor has separate windings.

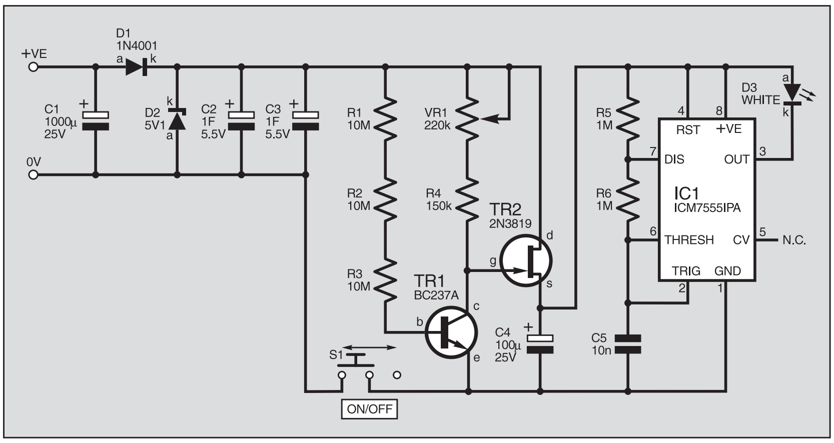


Fig.3. Main regulator circuit diagram for the Wind-up Torch. Power input terminals marked +VE and 0V are joined to one of the identical output points on the stepper motor diagrams in Fig.2.

current of just 60μA, and will operate effectively down to 2V. It also has an output sink current of 100mA, which is more than adequate for the present application. A standard 555 timer should not be used, due to its vastly greater current consumption.

High values have been chosen for resistors R5 and R6, so as to keep power consumption to a minimum.

The timer (IC1) is used in oscillator mode and outputs a square wave at pin 3, the peak amplitude being the same as the voltage powering the i.c. This output drives l.e.d. D3, pulsing it on for the duration that the output is low. A ballast resistor is not required for the l.e.d. since the effective current flow is limited by the control circuit.

The high brightness white l.e.d. used is the product of recent advances in semiconductor technology, having been commercially available for about two years. It has a 400mcd output, which, when focussed, gives a beam of several candlepower. If focussed into a tight beam with a quality lens, it will light up objects at a distance of about 30 metres.

If a white l.e.d. is unobtainable, a high brightness coloured l.e.d. may be used in its place, although their light is not as effective, or as pleasing to the eye.

CONSTRUCTION

The Wind-up Torch circuit is built on a piece of stripboard having 15 holes by 24 copper strips. Details of the topside component layout, together with the underside details, are shown in Fig.4.

Commence construction by cutting a standard piece of stripboard down to size using a hacksaw. A small indentation may be cut in the stripboard at positions O15-P16 to pass wires if desired. Create the breaks in the underside of the stripboard with a drill or other appropriate tool.

Space is at a premium, but all the components should fit into place without difficulty, provided you use a miniature plate ceramic capacitor for C5, miniature radial capacitors for C1 and C4, and the specified bridge rectifiers.

Solder the wire links and solder pins (double-ended pins serve best), then the 8-pin dual-in-line socket. Continue with the resistors, diodes D1 and D2, and the four rectifiers (one for each motor winding), followed by the capacitors and transistors. Be careful to observe the correct polarity of the bridge rectifiers, transistors, diodes and electrolytic capacitors.

Solder in l.e.d. D3, leaving it with long legs for later adjustment, and be sure to orientate it parallel with the board for the best optical results.

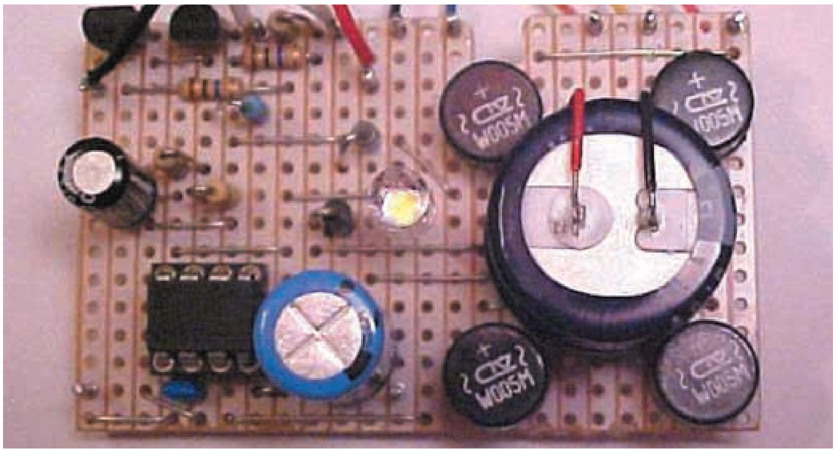
Capacitor C3 is piggy-backed on top of C2 to conserve space. Additional memory retention capacitors could be used to extend torch life, but this would make winding more time-consuming.

Prepare four sheathed wires 10cm long, and solder them to potentiometer VR1 and switch S1, and then back to the stripboard. Finally, attach the stepper motor leads to the solder pins, and insert IC1, observing its correct orientation.

CASING

The Wind-Up Torch is built into a plastic case with slotted walls, but more adventurous constructors might wish to choose a case of their own preferred shape and size.

In order to keep construction as simple as possible, the generator is operated simply by turning a small knob, attached to the motor spindle, between index finger and thumb (a larger knob necessitates movement of the wrist, and is not as convenient).



Complete prototype circuit board. Reservoir capacitors C2 and C3 are mounted one on top of the other. This construction differs slightly from the final version.

COMPONENTS

Resistors

R1 to R3	10M (3 off)	See SHOP TALK page
R4	150k	
R5, R6	1M (2 off)	
All 0·25W 5% carbon film		

Potentiometer

VR1	220k rotary carbon, lin

Capacitors

C1	1000μ radial elect, 25V
C2, C3	1F, memory retention, 5·5V (2 off)
C4	100μ radial elect, 16V
C5	10n resin dipped plate ceramic

Semiconductors

D1	1N4001 rectifier diode
D2	5V1 Zener diode, 5W
D3	white l.e.d., 400mcd
REC1 to REC4	W005 50V 1·5A bridge rectifier (4 off)
TR1	BC237A *npn* transistor (see text)
TR2	2N3819 *n*-channel f.e.t.
IC1	ICM7555IPA low power timer

Miscellaneous

M1	12V four-phase stepper motor (see text)
S1	s.p.s.t. (or d.p.d.t.) sub-min. slide switch

Lens (see text); plastic case, 104mm x 54mm x 42mm (see text), small knobs with fixing nuts (2 off); stripboard, 0.1in, 15 holes by 24 strips; 8-pin d.i.l. socket; solder pins, double-sided; solder, etc.

Approx. Cost Guidance Only £18 excluding motor and lens

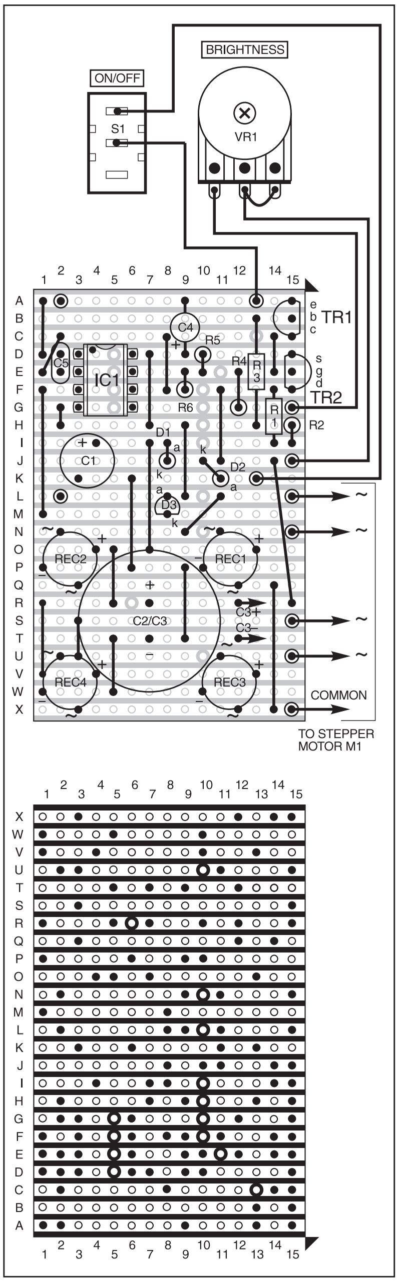


Fig.4. Wind-up Torch stripboard component layout, interwiring and details of breaks required in the underside copper tracks.

The knob should have a fixing nut to prevent any slippage. A regular stepper motor will easily produce sufficient charge in this way – more ambitious constructors could construct a crank handle with the help of a brazing iron or Meccano parts.

The motor is housed at one far end of the case, with its shaft pointing face downwards, and protruding through a hole in the case. If the motor has a mounting bracket, this may be used to brace it. Or, particularly if it is square in shape, it may be wedged into place with wooden wedges on each side, and glued into position.

If a stepper motor has been salvaged from a floppy disk drive, it is likely to have a large, bulbous head. In such an instance, the head may be removed fairly easily with a hacksaw, or a knob may be mounted over the head.

Holes are prepared in one of the narrow sides of the case to receive slider switch S1 and potentiometer VR1 (mounting on the flat side of the case may interfere with the light beam). A large hole is prepared for the lens at the opposite end to the motor. S1 is a slide switch, so as to prevent accidental switching when packed into a suitcase or rucksack. Prepare the holes for S1 and VR1 after having established the position of the lens or lenses.

LENS

The light of the white l.e.d. is fairly diffuse, and needs to be focussed into a beam. In order to focus it, a convex lens with short focal length (a short focussing distance) is required. A focal length of 30mm to 60mm is ideal. At any rate, the focal length should not exceed the available space in the case.

The lens diameter should also be large enough to catch sufficient light from the l.e.d., otherwise the torch's brightness will be compromised. Lenses may also be twinned in order to shorten the focal length. It may be necessary to crop the sides of a larger lens to fit it into the case. Lenses may be glued to a "slide" and slotted into the case, or may be glued at their edges to the inside of the case.

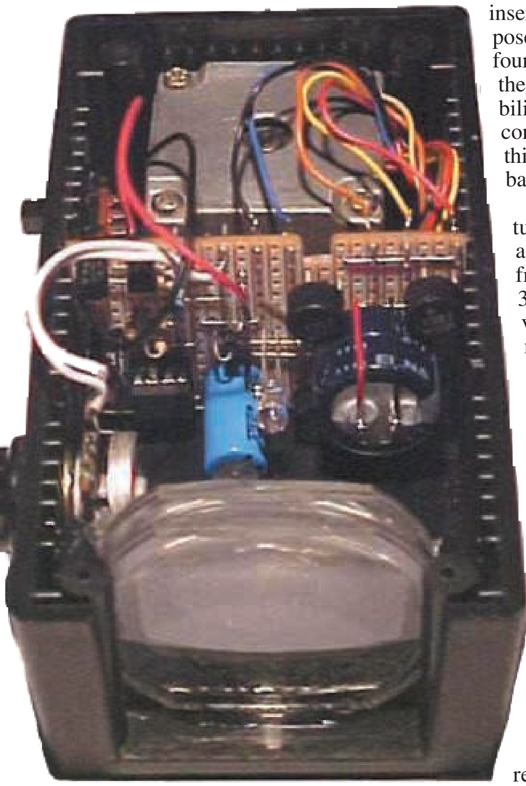
If ordered from a specialist supplier, lenses can be pricy. However, the author found adequate plastic lenses in a nearby toy shop. Those employed in this design were taken from two cheap "bug viewers" and twinned. Suitable lenses may also be found at fetes or in junk shops.

Once the motor and the lens have been installed, and holes for S1 and VR1 prepared, the circuit board is inserted into a slot inside the case. It may be secured with dabs of general purpose glue.

IN FOCUS

You will need to establish the correct distance from the circuit board to the lens, so as to obtain a beam of ideal width. It was found that if the torch's beam was too narrow, it was of little use in illuminating a page, or the full width of a path. A good compromise may be found as follows:

Aim the torch at a white wall, from a distance of about two metres. Adjust the distance between the circuit board and lens so as to find the most compact spot of light on the wall. Then shift the lens closer to the circuit board, until the diameter of the beam is about 50cm on the wall. It may even be necessary to adjust the position of the l.e.d. slightly on the circuit board.



Close-up view of the "beam window" showing the lenses slotted into p.c.b. retaining guide slots. The circuit board is positioned further back in the slots, see photograph below.

The optical characteristics of the l.e.d. are such that banding (a bright circle of light) may occur at the perimeter of the beam. This may be cured by adding a strong, small convex lens (having a very short focal distance) directly in front of the l.e.d. to give an even distribution of light.

CALIBRATION

To check that the regulator is working correctly, measure the voltage across capacitor C4 (two solder pins have been inserted on the circuit board for this purpose at positions A2 and L2). Wire up four AA batteries (6V) across C1 until the voltage at C4 seems to have stabilised. Do not leave the AA batteries connected for any length of time, since this places heavy demands both on the batteries and on Zener diode D2.

As Brightness control VR1 is turned through its full range, the voltage across capacitor C4 should vary from less than 3V to higher than 3·6V, but not higher than 4V. If the voltage rises above 4V, resistor R4 needs its value to be increased; if it does not rise above 3·6V, then R4 needs to be decreased. Differences in the tolerances of transistors TR1 and TR2 may in exceptional circumstances necessitate such modification.

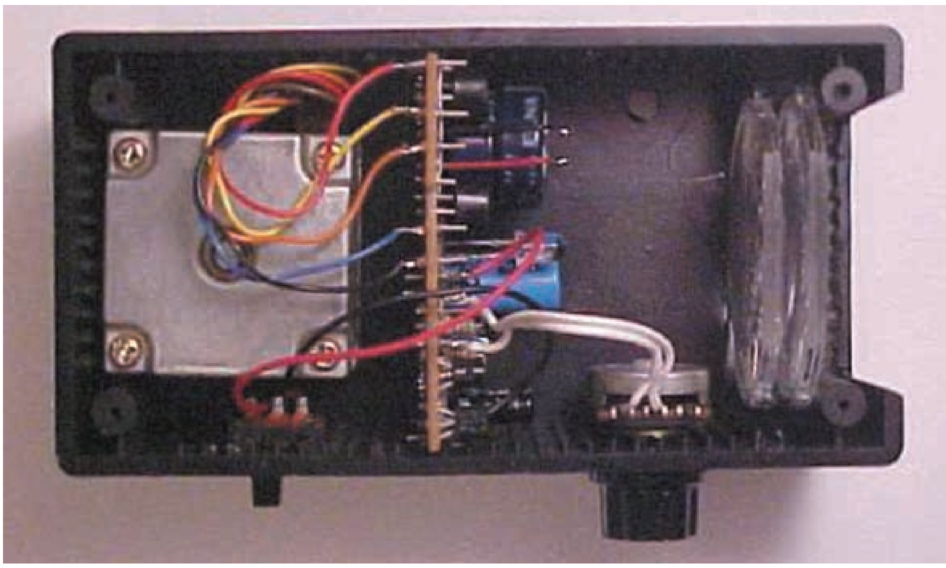
Mark off the 3V, 3·3V, and 3·6V settings on the outside of the case for reference.

IN USE

Set the Brightness control VR1 to 3V (book-light brightness). Turn the generator knob briskly between index finger and thumb (it may be turned in either direction).

Generally speaking, once a residual charge exists in the reservoir capacitors, a good wind of half a minute will fully charge the torch, and small "in between" charges will keep it going almost effortlessly. Note, however, that the very first time the Wind-up Torch is used, it may need up to five minutes to reach full charge, and one or two minutes of winding before the l.e.d. even illuminates. Do not despair – once a residual charge exists in the reservoir, subsequent charges will require only a fraction of the effort.

Assuming you begin with no charge at all in the reservoir capacitors, at first no light will be seen; then the light will pulsate in sync with your turning. Finally a steady light will shine. The Wind-up Torch will be fully charged a little while after a steady shine is observed.



General positioning of components inside the case. The Brightness control and On/Off switch are mounted on one of the narrow side panels.

JUMP START

Instead of such initial effort, the torch may also be "jump-started'' by connecting four AA batteries (6V) across C1 until the l.e.d. begins to illuminate (as suggested for the calibration test). Then disconnect the batteries and continue winding. Be careful to observe the correct polarity. You may even wish to incorporate small batteries and a pushbutton switch into the design, attached to C1, to jump-start the torch after long periods of disuse.

The torch may also be wound up whilst it is switched off, then switched on at a later time. When switched off, it will hold its charge for a day before requiring recharging. If the torch's light has faded, and it is not likely to be used again immediately, switch it off so as not to lose what residual charge is in the capacitors.

Small adjustments of VR1 can mean large extensions of life, and vice versa. The torch's life shortens rapidly at higher light intensities, yet lengthens exponentially at dimmer settings. □

The author may be contacted at:
scarboro@iafrica.com.

Completed Wind-up Torch showing the small wind-up knob and l.e.d. lens beam window.

SHOP TALK
with David Barrington

PIC Dual-Chan Virtual Scope

Although using a PIC microcontroller does cut down on the component count, you would think that it is almost inevitable that with a project like this month's *PIC Dual-Chan Virtual Scope* that some of the components would appear to be a bit special and will cause local sourcing problems.

Not so! Nearly all the components used in the prototype model are RS types and readers should be able to order these through any *bona-fide* RS stockist in their area. Alternatively, they can be ordered through **Electromail** (☎ ***01536 304555*** or ***http://rswww.com***), their mail order outlet.

Starting with the Maxim MAX492 dual, rail-to-rail, op.amp, this carries the RS order code of 182-2738. (Maxim can be found on the web at: ***www.maxim-ic.com***).

Regarding the Toshiba TC55257-85L 32Kbyte SRAM, of the several versions listed, either of the following will be OK for this circuit. The TC55257DPL-85L is listed as code 298-190 and the TC55257DPI-85L is coded 317-007.

The 20MHz version of the PIC16F877 is now quite plentiful and should be easy to obtain. However, for those readers unable to program their own PICs, a ready-programmed PIC16F877-20P can be purchased from **Magenta Electronics** (☎ ***01283 565435*** or ***www.magenta 2000.co.uk***) for the inclusive price of £10 (overseas readers add £1 for p&p). For those who wish to program their own PICs, the software is available from the Editorial offices on a 3·5in. PC-compatible disk, see *PCB Service* page. it is also available *free* via the *EPE* website: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/PICvscope**. The software is written in TASM.

The rest of the components are standard shelf items. If you wish to use the same RS case, this is listed as 267-2720. The printed circuit board is available from the *EPE PCB Service*, code 275 (see page 788).

Wind-up Torch

The first item we would like to cover concerning parts for the *Wind-up Torch* project is the 12V stepper motor. Some good news here, one which closely resembles the one used in the prototype is currently being advertised by **Magenta** (☎ ***01283 565435*** or ***www.magenta 2000.co.uk***), order code MD38. Also, we understand that a Philips 12V mini stepper motor advertised recently by **J&N Factors** (☎ ***01444 881965***) is still available and is a "bargain" at just £2 each; quote order ref. 2P457. These two motors have not been tried in the model.

Note that the BC237 transistor must be the one with an "**A**" suffix. This is important as it refers to the required low gain version. The only listing for the BC237**A** appears to be from **Cricklewood** (☎ ***020 8452 0161***, Fax ***020 8208 1441***). The author advises that the BD241C may be used as a replacement, but you will have to parallel resistors R1 and R2 in R1's position on the p.c.b. and add a link wire in R2's position.

The 1 Farad 5·5VW d.c. "memory back-up" capacitors are fairly expensive items and it might pay to shop around before buying, try **Greenweld, Bull Electrical**, **Cricklewood** and **J&N Factors** to name a few. The ones in the model came from **Maplin**, code JR01B and will set you back nearly £6 each plus p&p. They can also supply the following: plastic case (code YU52G) and the 5W Zener diode (code AY65V).

The high brightness "white light" l.e.d. used in the model also came from the last mentioned company and is the 5mm 400mcd version, code NR73Q. Although not tried, the author informs us a much brighter one has just been introducd in Germany (Conrad Elec., code 153745-11). This same company keeps focussing lenses for l.e.d.s, code 183621-11. Conrad's web site is at: **www.conrad.de**. However, you may still find that copying the author and extracting plastic lenses from toys is your cheapest approach here.

Fridge/Freezer Alarm

Only the temperature sensor chip is likely to be a problem when sourcing parts for the *Fridge/Freezer Alarm,* this month's "Top Tenner" project.

The TelCom TC622 single trip-point temperature sensor comes in two versions: the TC622VAT has a temperature range of –40°C to +125°C, with a claimed precision of ±1°C; and the slightly cheaper TC622EAT which has a range of –40°C to +85°C, with the same precision. Both types are suitable for this project and can be purchased from **Maplin** (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code NU41U (TC622EAT) and NU42V (TC622VAT).

The latest news we have concerning the sensors is that stocks are running at around 150 pieces of the TC622EAT and about 300 of the TC622VAT. We understand that once stocks are exhausted they will not be replaced.

The *n*-channel power MOSFET device should be readily available, but if any readers do have trouble finding the VN10KM MOSFET it is currently listed by **Electromail** (☎ ***01536 304555*** or ***http://rswww.com***) code 655-537 and Maplin, code QQ27E.

Most of our component advertisers will be able to suggest a suitable 6V or 12V solid-state buzzer for this project. The prototype used the Maplin 6V round buzzer, code FK81C. If you opt for a higher supply voltage, try the 12V version, code FK82D.

EPE Moodloop Field Strength Indicator

Some readers may experience difficulty in purchasing the AD8532 dual op.amp called for in the *EPE Moodloop Field Strength Indicator* project. This is intended for low voltage operation and has rail-to-rail outputs, ideal for this application. The one in the model came from **Maplin** (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code OA16S.

Although the author states that the linear Hall Effect device is inexpensive and widely available, we have not found it so. The only listing for the type UGN3503U we came across was from the above company, code GX09K.

The LP2950 micropower 5V regulator was chosen as it is claimed to be better suited to battery operation than the standard 78L05 voltage regulator, has a smaller quiescent current and can operate with an input to output voltage difference of just 100mV. The LP2950 regulator also came from the above source, code AV35Q, but most of our components advertisers should be able to help regarding the 10-l.e.d. bargraph and the small handheld case, with battery compartment. Remember, it is the bargraph with individual l.e.d.s that is required. Maplin supplied the bargraph (code BY65V) and case (type HH2–code ZB16S) used in the prototype.

PLEASE TAKE NOTE

Remote Control IR Decoder *Sept '00*

Source code (.ASM) files were added to the ftp site and *EPE* Disk 3 on 12 Aug '00.

News . . .

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

SUPER CCD SHARPENS PHOTOS

Octagonal sensor pixels pack more closely and collect more light. Barry Fox reports.

ENGINEERS working for Fuji Photo Film in Japan have taken time off from making digital cameras to look at nature, and decided that the electronics industry has been doing things the wrong way. Whereas natural views contain mainly vertical and horizontal lines, the sensor chips used in digital cameras are best suited to capturing diagonal lines. Fuji is now changing the shape and angle of its sensors to let a digital camera take sharper pictures in lower light.

Matrixed Pixels

Digital cameras have a conventional lens which focuses the scene to be photographed on a charge coupled device (CCD) instead of photo film. The CCD is a matrix of tiny photo-diodes and electrical connectors, arranged in horizontal lines like the scanning lines of a TV picture. The diodes convert light into electricity which digitally codes the image, and the code is stored in a memory chip.

Each diode represents one picture point or pixel and modern CCDs cram two million onto a rectangular chip, a few centimetres wide. If the diodes are made smaller, to make room for more and increase resolution, they collect less light. So the camera can only be used in bright sunlight or with electronic flash. The practical limit for conventional CCDs is around three million pixels.

Fuji spent three years analysing a wide range of photographs and saw that, largely because of gravity, most natural and man-made objects have vertical and horizontal edge details. The horizontal alignment pattern of the CCD pixels creates linear gaps in which horizontal and vertical detail is lost.

Honeycomb Mosaic

Because still picture cameras are not tied to TV line structures, Fuji's new Super CCD can use diodes which are octagonal, instead of rectangular, and arranged in a honeycomb mosaic, along 45 degree diagonals. This allows larger diodes to be packed closer together, with no linear gaps to lose natural detail.

The larger diodes gather more light energy so need less ambient light to take a picture. The first Super CCD chips have a sensitivity equivalent to photographic film with an ISO rating of 800. The honeycomb arrangement gives 2·5 million octagonal pixels the resolution of four million rectangles.

Super CCD recently made its debut in Fuji's new FinePix 4700 camera, costing around £700/$1000.

SURFACE SOUND

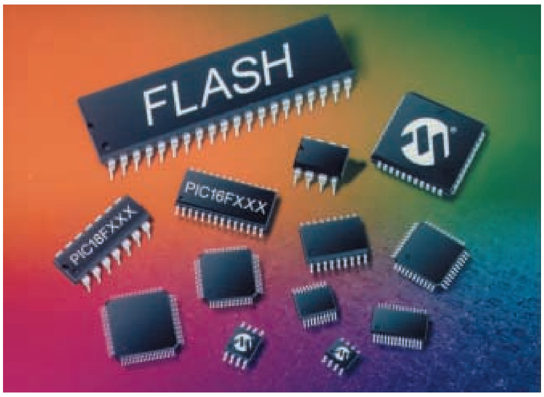
YOU are probably aware that British company NXT invented SurfaceSound flat panel loudspeaker technology. This technology has revolutionised the way in which loudspeaker units can be manufactured, moving totally away from the time-honoured concept that such items must have large internal dimensions in order to allow the enclosure to satisfactorily reproduce the audio spectrum.

Flat panel speakers are in use in many venues, frequently unrecognisable as such, being "disguised'' as pictures hanging on the wall, the sound generated across their surface, and without internal depth. Restaurants and hotels are typical users.

The domestic market is now being appealed to by NXT's latest involvement. LG Electronics of Korea has launched its first TV which features motorised NXT panels on each side. The TV can be used with the panels folded in or out.

For more information contact New Transducers Ltd, 37 Ixworth Place, London SW3 3QH. Tel: 020 7343 5050. Fax: 020 7343 5055. E-mail: marketing@nxtsound.com. Web: www.nxtsound.com.

MORE PICS DUE



Microchip tell us that they will be adding 37 devices to their PIC16Fxxx and PIC18Fxxx Flash microcontroller families over the next several months.

The new microcontrollers feature 1K to 64K words of Flash program memory, up to 4K bytes of data SRAM, and up to 256 bytes of data EEPROM. Available in 8-pin to 84-pin configurations, these devices provide features such as 10-bit 12-channel A/D converters, comparators, capture/compare/pulse-width modulation, phase locked loop, 8 x 8 hardware multiply, and USB and CAN communications capability.

Microchip have also released their Analogue Design Pack CD-ROM, a complete compilation of technical documentation on their analogue microcontrollers and development tools etc.

For more information contact Arizona Microchip Technology Ltd., Dept. *EPE*, Microchip House, 505 Eskdale Road, Winnersh Triangle, Wokingham, Berks RG41 5TU. Tel: 0118 921 5858. Fax: 0118 921 5835. Web: www.microchip.com.

SKY'S 2001 CATALOGUE

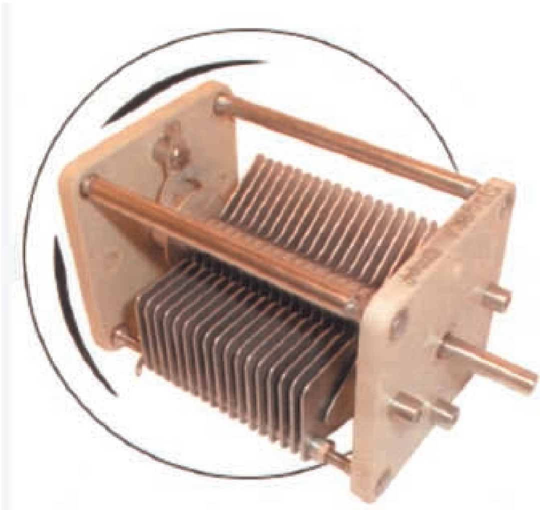
THE Sky Tronic brand of electronic products is now successfully established in nine European countries and is regarded as a major brand in consumer electronics. The products are well itemised and displayed in the 240 pages of the new 2000/2001 catalogue received from Sky Electronics.

The catalogue is superbly produced with full-colour photographs of the enormous range of products, which are so numerous we can only summarise the general categories: audio and video, disco, car hi-fi, communication, time and temperature, CCTV and security, electrical, hobby electronic kits, computer accessories, test equipment, power supplies, tools, connectors, cables, speakers, PA systems.

The catalogue is free to callers, or send stamps to the value of £1.85 to cover postage.

Sky Electronics are at 40-42 Cricklewood Broadway, London NW2 3ET. Tel: 020 8450 0995. Fax: 020 8208 1441. Web: www.skyelectronics.co.uk.

JACKSON VARIABLE CAPACITORS



VARIABLE capacitors of the type used in applications such as radio transmission and reception, and other frequency-tuning circuits, are covered in depth within the latest Jackson Bothers catalogue.

Specifications for all types are detailed and well-presented, and include colour photographs which are superbly clear, being printed on a glossy art paper. Ball drives, dials, universal couplings and other accessories are covered too. You may recall that the original Jackson Brothers company suffered severe problems a while back, but were rescued from disaster by Mainline Electronics. The quality of the products shown in the new catalogue confirms how well the business has recovered. Interestingly, a brief history of Jacksons is given in the catalogue.

For more information contact Mainline Electronics, Dept. *EPE*, PO Box 235, Leicester LE2 9SH. Tel: 0116 277 7648. Fax: 0116 247 7551. E-mail: sales@mainlinegroup.co.uk.

WAP WAY OUT?

By Barry Fox.

THE much hyped WAP (Wireless Application Protocol) cellphone system is on its way out. The phones are so hard to set up, the stripped-down online content so unexciting and the 9.6Kbps data speed so slow that the manufacturers have sold less than half the half million they hoped. The networks are giving WAP phones away in the hope that users will generate revenue by playing with them.

BT Cellnet gives away the Motorola Talkabout WAP phone pre-loaded with a strategic selection of accessible sites (like BT's Genie) and no instructions on how to go through the very tricky process of altering the selection. Those who try to change the settings must go online and spend on calltime while struggling.

Motorola says it is ready to sell new phones which use the General Packet Radio Service, and since 1994 has been building GPRS capability into network control equipment. Cisco Systems is providing software. T-Mobil in Germany and BT Cellnet in the UK are supposedly up and running, although how to get a phone and service remains unclear.

GPRS works ten times faster with full-featured Internet Protocol. Users are charged for data transferred, not time connected.

New GPRS phones, such as Motorola's Accompli, should handle WAP if anyone still wants it, but WAP phones cannot use GPRS.

PIC Programming CD-ROM

IN June's *News* we reported favourably on Eric Edward's CD-ROM *Let's Do It – The Practical Electronics Book*. Well, Eric's been enjoying himself again, this time writing a CD-ROM called *Let's Do It – PIC Programming*.

Eric is really devoted to sharing with you, in his own inimitable and enthusiastic style, his knowledge and experience of electronics and "all that sails with her". Once again Eric has written the CD-ROM in the style of a "book", with chapters and indexes. It can be read through Adobe Acrobat which, if you do not already possess it, can be installed from the CD-ROM itself (Adobe V4.05).

The "book" is dedicated to PIC BASIC, although there is an introduction to machine code and mnemonics. You will need a PIC BASIC compiler because, as Eric says, one cannot be included on the CD-ROM for copyright reasons. He gives a short list of recommendations on obtaining one inexpensively (or free!).

Included on the CD-ROM is an enormous selection of text files of the examples and projects which Eric discusses, and which you can compile to suitable HEX files with your PIC BASIC compiler. We reckon you'll thoroughly enjoy Eric's offerings if you prefer to take the PIC BASIC route to PIC software development.

This CD-ROM costs £10, plus £1 p&p (£1.95 Europe, £2.95 rest of world). Send for your copy to Eric Edwards GFW8LJJ, 11 Old Vicarage Road, Barry, Vale of Glamorgan, CF62 6RA. Tel: 01446 740498. E-mail: gw8ljj@tesco.net.

SMART FOOD

By Barry Fox

SUPERMARKET chain Sainsbury's will soon trial a new smart radio labelling system that lets a warehouse or store identify goods, by date or batch.

Philips has developed disposable sticky labels which sandwich a memory and 13·56MHz transceiver chip between layers of paper. Product identification data is loaded into the labels before they are stuck to crates, pallets or individual items. The labels then use the power from interrogation signals to transmit identifying code.

Sainsbury's will first use the system on frozen foods to identify use-by dates. If there is a health scare, with infected beef or poisoned food, the labels allow rapid recall. The labels will later allow shoppers hands-free checkout.

RAPID'S CATALOGUE

RAPID Electronics' latest components catalogue has landed (heavily!) on the Editorial desk. It is Rapid's largest issue to date and features over 19,000 product lines across nearly 700 pages.

We periodically say that some catalogues are an absolute *must* for all electronics hobbyists, Rapid's is certainly one of them. There are all the regular components included that we all need from time to time, passives, semiconductors, switches, sensors, transducers and the like. There are also the larger equipment-type products, plus tools, technical publications and service aids.

Being a leading BSI Registered Supplier, Rapid say they are committed to total customer service and their friendly staff will be delighted to help you with any enquiry, and ensuring that orders are despatched on the day of receipt. There is no minimum order value and orders over £30 are carriage free, with £2.50 carriage charged for orders below that value. Since May this year Rapid have been operating out of a purpose built distribution centre.

For more information contact Rapid Electronics, Dept. *EPE*, Heckworth Close, Colchester CO4 4BF. Tel: 01206 751166. Fax: 01206 751188. E-mail: rapidelec.co.uk. Web: www.rapidelectronics.co.uk.

HANDS-FREE DEBATE

IN the July issue Barry Fox advised that *Which?* magazine's research report brought into question the safety of mobile phone earpieces in respect of possible increased radiation hazard.

A press release from the Department of Trade and Industry (DTI) has added to the debate. E-Minister Patricia Hewitt has published a report which "confirms that using Personal Hands-Free (PHF) kits with mobile phones reduces exposure to electromagnetic fields . . . compared to the normal use of mobile phones".

However, the DTI communication goes on to state that "the Independent Expert Group on Mobile Phones and Health (IEGMP) . . . recommended further work".

For more details, access:
www.iegmp.org.uk,
www.dti.gov.uk/cii/mobile_resp.htm,
www.dti.gov.uk/cii/sartest.pdf,
www.sartest.com.

KWIK-I-E PROBE

HERE'S a handy tool for the DIY-er, a non-contact probe that can measure both voltage and current without the need to strip or break wires. Manufacturers Amprobe have introduced their KWIK-I-E probe (also known as K-1) that has a two-range bargraph display to indicate voltage from 6V to 600V and current from 0·6A to 60A.

It is small, compact, easy to use and can be carried in the pocket. It is also CE and UL approved. Priced at £69 plus VAT, the probe is available from Professional Instrument Distributors, Dept EPE, 3 Brackenley Court, Embsay, N. Yorks BD23 6PX. Tel: 01756 799737.

EASY-PC V3

FOR many years one of the leading popular printed circuit design software packages has been Easy-PC. Version 3 for Windows has recently been released as an upgrade for Easy-PC ProXM users. A demo disk is available which allows you to try all of the options, including the autorouter.

For more information contact Number One Systems, Dept. *EPE*, Oak Lane, Bredon, Tewkesbury, Glos GL20 7LR. Tel: 01684 773662. Fax: 01684 773664. E-mail info@numberone.com. Web: www.numberone.com

POWER-LESS L.C.D.S

ZBD Displays Ltd are a subsidiary of DERA, the Defence Evaluation and Research Agency, and are to commercialise a new type of liquid crystal display, known as ZBD and invented by DERA.

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In principle, ZBD displays with thousands of lines are feasible at resolutions equivalent to desk top printing. DERA's press release suggests a range of potential applications, including mobile phones, credit and smart cards, supermarket labels, electronic books. Currently the displays are monochrome but colour versions are likely to be developed.

For more information browse:
www.dera.gov.uk and
www.zbddisplays.com.

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INTERFACE

Robert Penfold

DIGITAL AND ANALOGUE TEMPERATURE PC INTERFACE

A FEW of the previous designs featured in this series utilized the TLC548IP 8-bit analogue-to-digital converter. This was used in conjunction with a QBASIC or GW-BASIC program, but this converter will work just as well with Delphi or Visual BASIC software.

The design featured this month is a simple temperature interface based on the TLC548IP, together with software written in Visual BASIC 6 that provides digital and analogue displays. The temperature sensor is an LM35CZ, which gives the system a useful measuring range of 0 to 100 degrees Celsius. The 8-bit converter gives the system 0·5 degree resolution.

The unit connects to the printer port of the host PC, and as only three of the handshake lines are used it is not necessary for the port to be a bidirectional type. The unit requires a 5V stabilised supply, and it is usually possible to obtain this from a games port, USB port, or keyboard port, as described in several previous articles.

Data Flow

The full circuit diagram for the Temperature Interface appears in Fig.1. IC4 is the converter chip, and it can interface to the PC via just three lines plus an earth (0V) connection due to the use of a simple serial interface.

To start a conversion the chip select input at pin 5 of IC4 is taken low, and the conversion is completed no more than 17 microseconds later. The converter is a successive approximation type, incidentally.

Once the conversion has been completed the most significant bit of data can be read from pin 6. A clock pulse is then applied to pin 7 and the next bit of data is read from pin 6. This process is continued until all eight bits of data have been read. The chip select input is then returned to the high state so that the unit is readied for the next conversion. Software is used to reconstruct the 8-bit value from the individual bits of data.

A reference voltage applied to pin 1 of IC4 sets the full-scale sensitivity, and in this case resistors R4 and R5 set the reference at about half the supply potential, or 2·5V in other words.

Temperature Sensor

The temperature sensor (IC2) provides an output voltage that is equal to 10 millivolts per degree Celsius, which would only give a resolution of one degree. Op.amp IC3 is therefore used to boost the output from IC2 by a factor of approximately two so that the resolution is increased to a more worthwhile 0·5 degrees. In practice preset potentiometer VR1 is adjusted for the voltage gain that gives optimum accuracy, and the unit should be calibrated against an accurately known temperature of around 25°C to 100°C.

For optimum results IC2 requires a negative supply for load resistor R1, and IC3 also requires a negative supply. A supply potential of almost –5V is produced from the positive supply by way of a simple switch-mode supply based on IC1. The total current drain on the +5 volt supply is only a few milliamps. The connections to the printer port are made via a 25-way male D-connector, and the required connections are shown in Fig.2.

Software

The Visual BASIC 6 program compiles to a small .EXE file, but note that it will only run if it is supported by the freeware file called **inpout32.dll**. Both files are available from the *EPE* web site. This provides the Inp and Out instructions used to communicate with the interface.

These commands are built into QBASIC and GW-BASIC, but are absent from Visual BASIC. This file should be in the same directory as the program file, or in the /Windows/System directory. Note that the program will run under Windows 95 and 98, but *not* using Windows 3.1, NT, or 2000.

The main routine is assigned to a timer component so that regular readings are taken. Initially the timer is disabled, but operating one of the command buttons (see Fig.3) sets the port address range and starts the timer. Printer ports 1 and 2 are normally at base addresses of H378 and H278.

Main Routine

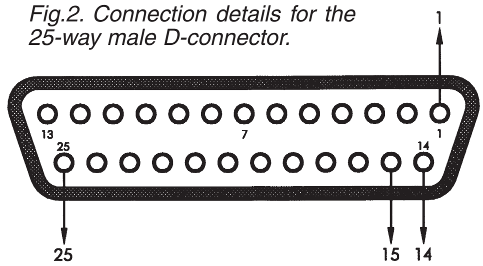
The main routine starts by setting up the two output lines and initialising a conversion. The first bit of data is then read, and either 128 or 0 is added to the value stored in the variable called Reading, depending on whether the input line is high or low. A clock pulse is then generated and the input line is read again. This time 64 or zero is added to the value stored in Reading, depending on whether the input line is high or low.

This process is repeated with the other bits of data, with the appropriate value or zero being added to Reading each time. The value stored in Reading is then identical to the 8-bit value read by the converter.

It is only necessary to divide the value stored in Reading by two in order to produce the correct value for the digital display. The analogue display requires rather more manipulation of the value before it is ready for use as the Y2 co-ordinate of Line1, which is the line that provides the tube of red alcohol in the virtual thermometer. This co-ordinate has a value of 500 at 100 degrees, increasing to 4500 at 0 degrees.

Multiplying the value in Reading by 20 gets the scaling right, and adding

Fig.2. Connection details for the 25-way male D-connector.



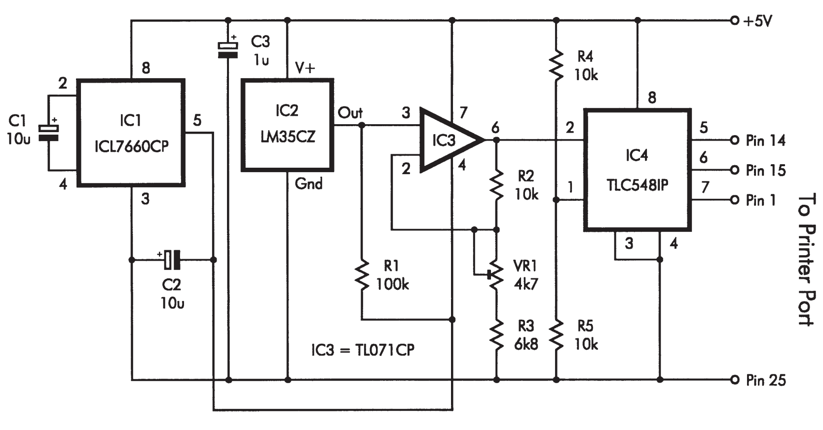


Fig.1. Full circuit diagram for the Temperature Interface.

500 takes care of the offset. Deducting this value from 5000 provides the required inversion so that the value goes from 4500 at 0 degrees to 500 at 100 degrees.

In Use

If the interface is used with liquids it is essential to ensure that the liquids are kept away from the leads of IC2. The usual solution is to fit the temperature sensor in something like a small glass test-tube. A plastic tube is not a good choice if the unit will be used with hot liquids, since it might melt.

Some heatsink compound can be used to provide a good thermal contact between the temperature sensor and the test-tube. Due care and adequate safety precautions must be taken if the unit is used with hot liquids.

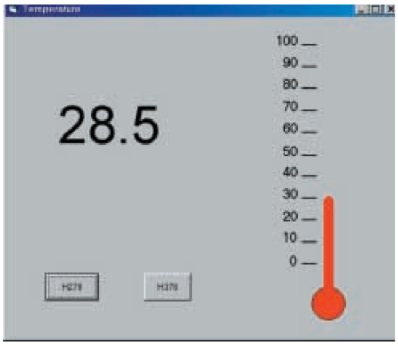


Fig.3. The program has digital and analogue readouts.

Listing 1: Temperature interface program

```
Dim Port1 As Integer
Dim Port2 As Integer
Dim Port3 As Integer

Private Sub Command1_Click()
Port1 = 632
Port2 = 633
Port3 = 634
Timer1.Enabled = True
End Sub

Private Sub Command2_Click()
Port1 = 888
Port2 = 889
Port3 = 890
Timer1.Enabled = True
End Sub

Private Sub Timer1_Timer()
Out Port3, 1
Out Port3, 3
Out Port3, 2
For D = 1 To 2000
Next D
Dta = Inp(Port2) And 8
If Dta = 8 Then Reading = 128
Else Reading = 0
Out Port3, 3
Out Port3, 2
Dta = Inp(Port2) And 8
If Dta = 8 Then Reading =
Reading + 64
Out Port3, 3
Out Port3, 2
Dta = Inp(Port2) And 8
If Dta = 8 Then Reading =
      Reading + 32
Out Port3, 3
Out Port3, 2
Dta = Inp(Port2) And 8
If Dta = 8 Then Reading =
      Reading + 16
Out Port3, 3
Out Port3, 2
Dta = Inp(Port2) And 8
If Dta = 8 Then Reading =
      Reading + 8
Out Port3, 3
Out Port3, 2
Dta = Inp(Port2) And 8
If Dta = 8 Then Reading =
      Reading + 4
Out Port3, 3
Out Port3, 2
Dta = Inp(Port2) And 8
If Dta = 8 Then Reading =
      Reading + 2
Out Port3, 3
Out Port3, 2
Dta = Inp(Port2) And 8
If Dta = 8 Then Reading =
      Reading + 1
Out Port3, 3
Out Port3, 1
Label1.Caption = Reading / 2
Reading = Reading * 20
Reading = Reading + 500
Reading = 5000 – Reading
Line1.Y2 = Reading
End Sub
```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EPE/ETI Tutorial Series

TEACH-IN 2000

Part Twelve – 7-segment Displays, L.C.D.s, Digital-to-Analogue, Miscellany

JOHN BECKER

Doesn't time fly when you're having fun? Incredibly, here we are at the final part of *Teach-In 2000*. At the beginning of the series, back in the last Millennium, we promised that we would lead you through the fascinating maze of what electronics is all about. We assumed that you knew nothing about the subject and proceeded to examine the basic building blocks, encouraging you to experiment with them to reinforce your understanding.

There are still two subjects that we wish to tell you about (actually, many more, but the space-time continuum doesn't allow it!). The first is displays, 7-segment and liquid crystal, telling you about the theory but without experiments. The other is digital-to-analogue conversion, for which we do have some hands-on practice. We conclude by telling you how to continue exploring your electronics interest.

WITH your breadboard experiments throughout much of the *Teach-In 2000* series, you have frequently been illustrating the response of digital gate outputs by using light emitting diodes (l.e.d.s) as the display devices.

As you are probably well aware, there are many types of more sophisticated display devices manufactured, allowing numerals, alphabet and other characters to be displayed.

We are not going to ask you to experiment with any of these other display types. They are too numerous and you might never find a future application for any particular type which we might recommend. Consequently we do not feel justified in putting you to the expense of buying one.

However, we can illustrate the basic principles through five computer demos. First we shall describe the principle behind the type known as a *7-segment* display. We shall discuss it initially from the point of view of a device constructed using l.e.d.s as the illumination source.

7-SEGMENT DISPLAYS

From your main menu select Displays – Menu, then from the sub-menu offered select 7-Segment Display – Basics. Note that you can only return to the menu from this demo by using the <ENTER> key.

As the name implies, a 7-segment display has seven internal structures which are arranged as seven bars (segments). The segments are visible through the top surface of the display. In the case of an l.e.d. type, each segment has an l.e.d. behind it, seven l.e.d.s in all.

You already know that an l.e.d. can be turned on by supplying it with a current-limited voltage. If the voltage is absent, the l.e.d. is turned off. To use digital logic terminology, logic 1 (voltage high) turns the l.e.d. on, logic 0 (zero voltage) turns it off.

On your screen display when you first enter it (see also Photo 12.1) you will see the seven segments arranged as a figure-of-eight. Each segment is allocated an identity letter (A to G) and the order of this lettering is an "industry standard'', i.e. these letters always refer to the same segment irrespective of the display's manufacturer (although they might be in either capital or lower case letters).

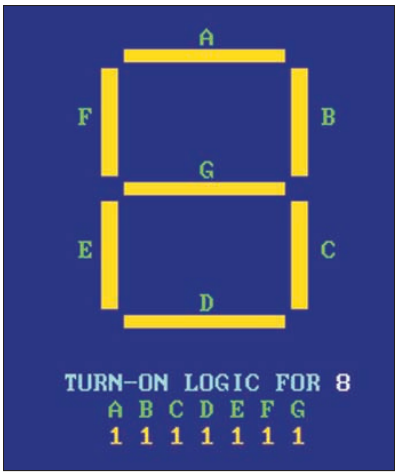


Photo 12.1. Screen dump section from the interactive 7-segment display demo.

In the screen display, your eyes tell you that numeral 8 is displayed when all seven segments are turned on (it's an optical illusion, of course, but we are accustomed to interpreting incomplete patterns as though they were complete).

Below the display, the turn-on logic is shown, a 1 appearing beneath each of the seven letters, 1111111 representing the logic for numeral 8.

From your keyboard, press <0>. Segment G has now disappeared (the l.e.d. has been turned off) and numeral zero is displayed. The logic line has changed to read 1111110.

Press any of the other numeral keys and observe the display results and their logic.

Your own mental logic will tell you that while numerals can be constructed using seven segments, to display alphabet and other characters presents a problem. There are *some* alphabet letters, though, which can be displayed if you use a bit of visual imagination, but by no means all letters, and some of them only work if lower-case rather than capitals are acceptable.

The program allows you to press any keyboard key to see what letters can be generated using seven segments. Try with the full set of capital and lower case letters. When a letter cannot be constructed, the screen tells you so.

COMMON LOGIC

There are two basic types of 7-segment l.e.d. display manufactured, known as *common cathode* and *common anode*. Select sub-menu option 7-Segment LED Display – Detail. Again note that you can only return to the menu by pressing <ENTER>.

On the screen revealed (see also Photo 12.2) are two blocks of l.e.d.s, shown with ballast (current limiting) resistors for each l.e.d. The left-hand block shows that all the l.e.d. cathodes (*k*) are *commoned* and connected to the 0V line. The logic which controls each l.e.d. is brought into each anode (*a*) separately via its own resistor.

This construction is known as a *common cathode* display, because all the cathodes have been commoned together. The logic which controls this arrangement is that which we illustrated via the previous display screen.

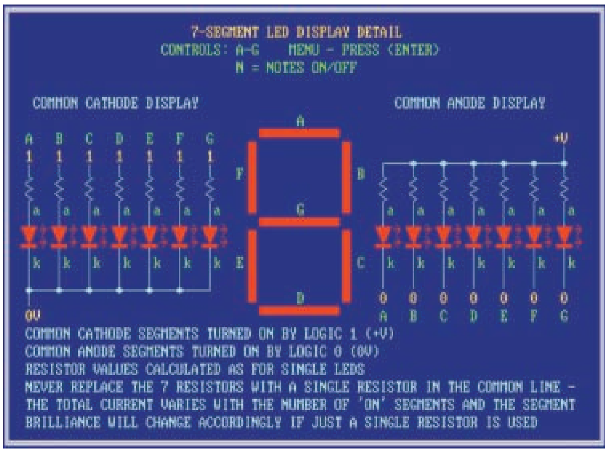


Photo 12.2. Screen dump of the interactive 7-segment l.e.d. display demo.

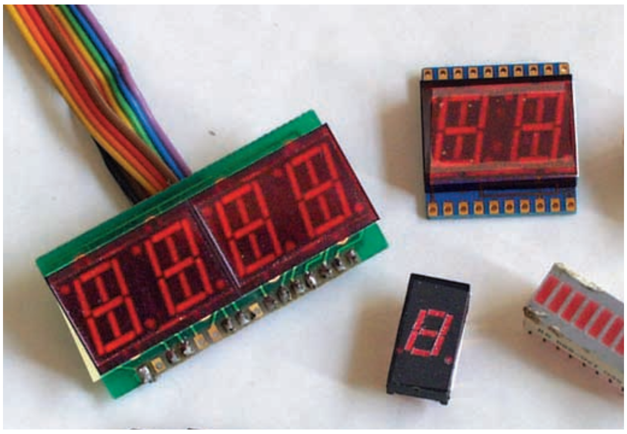


Photo 12.3. Typical l.e.d. 7-segment display, 4-digit, 2-digit and single digit (with part of a bargraph display just visible). This is an enlarged section of Photo 4.3 in Part 4.

The right-hand block of seven l.e.d.s shows that all the anodes (a) have been connected to the positive (+V) line via the ballast resistors, while the control logic is connected to each l.e.d. cathode separately. This type of display arrangement is known as a *common anode* display.

Note, however, that in a real common anode display, the anodes would literally be commoned together within the device, and the resistors would be connected between the cathodes and the 0V line.

Because the controlling voltage is applied to the cathodes, you will spot that logic 1 on any of them will turn that segment *off*, because logic 1 is the same voltage as applied to the resistors (i.e. no current can flow through the resistor-diode path). It is now *logic 0* which turns on a segment.

Experiment by pressing any of the keys <A> to <G> (representing the segment letters) to turn the l.e.d.s on and off. Observe how the common anode logic is the opposite of that for the common cathode.

It is important to note that common anode and common cathode displays cannot be interchanged in a circuit because of the opposite controlling logic.

ALWAYS RESIST IT

With 7-segment l.e.d. displays, the same rules apply for calculating ballast resistor values in respect of the supply voltage as for single l.e.d.s (see Part 4).

NEVER use a single resistor to provide current to all seven segments simultaneously via the common line. Each segment MUST ALWAYS have its own ballast resistor.

You will occasionally see designs produced by inexperienced constructors in which a single resistor is used. *Do not follow their example.*

The problem is that each l.e.d. requires a certain amount of current to produce a given amount of brightness when turned on. The total current drawn from the power supply therefore varies depending on how many segments are turned on simultaneously.

If a single resistor provides the current to all seven segments, the current passed through each l.e.d. will vary with the number of other l.e.d.s turned on. Consequently, overall segment brightness will change accordingly. For example, numeral 1 (two segments) will thus appear brighter than numeral 8 (seven segments).

MULTIPLEXED DISPLAYS

You have probably seen that displays are available which have several 7-segment digits embodied in the same device, probably two or four (Photo 12.3).

With these devices it is common for just one set of seven segment-controlling lines to be used, these feeding to *all* of the digits simultaneously. Each digit, though has a separate power line feeding to its common anode or common cathode pin.

These devices work by only turning on a digit's power line when the other digits' power lines are turned off. The 7-bit data logic code is output to all digits simultaneously, but only the digit which has power applied shows that data.

With the data and digit power lines controlled at a sufficiently fast rate, the eye is deceived into thinking that all digits are turned on at the same time, but with each showing its own data. This system is known as *multiplexing*.

The principle is illustrated through submenu option 7-Segment LED Display – Multiplex.

On entry to the display (see also Photo 12.4), four digits are shown, displaying four numerals, 3456. Above them are the logic codes which represent each digit's power line being turned on and off. They may appear just as a blur with faster computers. A common anode display is assumed.

This part of the program has been written so that you are deceived into thinking that all four digits are on simultaneously. However, press <F>.

The display is now shown at a much slower rate and you can see each digit being turned on while the others are turned off (see Photo 12.5). The power control logic above the digits is seen to be alternating between 0 and 1. A digit is only turned on if the power control is set at logic 1.

Photo 12.4. Screen dump of the interactive 4-digit l.e.d. display being multiplexed at a fast rate, all digits appear visible.

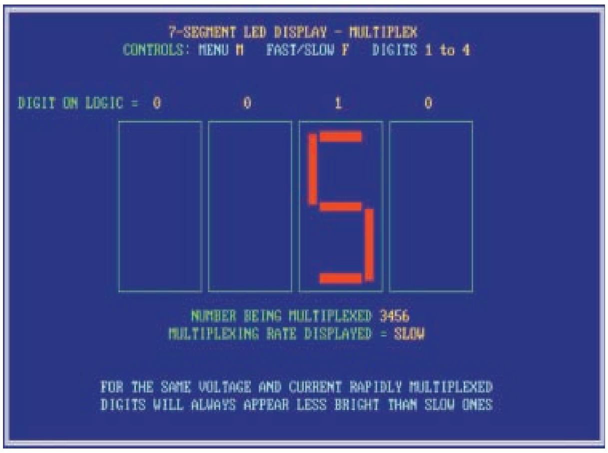


Photo 12.5. Screen dump of the interactive 4-digit l.e.d. display being multiplexed at a slow rate, only one digit is seen at a time.

You will also see that each digit now appears much brighter than it did when all four were displayed simultaneously. This illustrates a problem with multiplexed displays.

Because (in this case of four digits) the time for which each digit is turned on is only a quarter of the total time between each occasion that this digit is turned on, when the multiplexing rate is fast the eye responds as though the digit is much less bright than if it were on continuously or multiplexed slowly. Press <F> a few times to alternate between fast and slow multiplexing.

If a 2-digit multiplexed display is used, the brilliance would appear to be half that of a continuous display. Likewise, the brilliance would appear to fall to one-eighth for an 8-digit multiplexed display.

To increase the apparent brilliance, lower values of ballast resistor can be used, provided that the specified current limit of each digit is not exceeded. There are also high-brightness displays available which are better suited to providing adequate brilliance without large current flow.

Be aware that a real-life multiplexed l.e.d. display may show a much reduced brilliance at faster rates than the demo screen would imply. We have cheated with the demo and just used two different colours for the fast/slow displays.

Use numeral keys <1> to <4> to increase the value displayed in each digit. The display behaves like a counter when digit roll-over to zero occurs.

MATRIXED DISPLAYS

Another type of display technique is commonly encountered, known as a *matrixed* display. The principle is similar to that used for 7-segment displays, but it uses more segments. In fact, the segments are typically formed as small squares rather than bars and are usually known as *pixels* (picture screen elements).

Such devices as alphanumeric displays and your computer screen use this technique (so does a dot-matrix printer). Select sub-menu option Matrixed Displays – Basics, and also refer to Photo 12.6.

Matrixed displays use a block of pixels, varying in quantity depending on the application. The alphanumeric l.c.d.s used in some recent *EPE* projects have 35 pixels per character, arranged as five across by seven down (a 5 × 7 matrix). The computer screen mode being used by the *Teach-In 2000* software (QBasic/QuickBASIC screen mode 9) uses an 8 × 14 matrix for each standard text character.

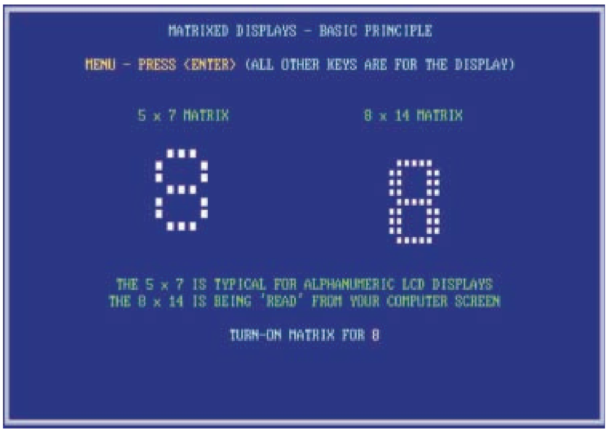


Photo 12.6. Screen dump of the interactive matrixed displays demo.

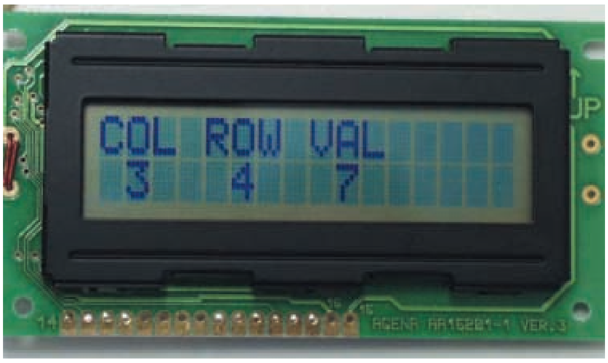


Photo 12.7. Typical alphanumeric l.c.d. screen. This one has two lines, each of 16 character cells.

The demo screen shows exaggerated examples of both matrix formats. As with 7-segment displays, information is generated by turning the pixels on or off.

On first entry, the screen displays the pixels used to generate numeral 8, but the great advantage of matrixed displays is that they can be used to generate an enormous variety of characters, right across the full alphanumerical range and beyond, including various patterns. The 8 × 14 matrix, though, allows a greater variety than the 5 × 7.

Press any of the keys on the keyboard and see the equivalent data displayed in the two large matrixed formats. At the right of the final screen text line (e.g. Turn-on Matrix for 8), the same character selected (in this case 8) is also shown as a normal screen character. Cursor control keys do not generate a display.

In fact, the large 8 × 14 matrix is generated by the program actually scanning the screen area at the end of the final text line and "reading" the pixels which are used to display the selected character. It then re-interprets those same pixels and creates the larger pixel-representing squares that illustrate how the character is made up. If you examine the screen with a magnifying glass, you will see the truth of this.

ANOTHER CHALLENGE

The information displayed in the 5 × 7 matrix zone, however, has been created by using a look-up table. Being of an occasionally devious nature, the author felt that he would get you to create some of the data for that table!

Consequently, you will find as you press various keys, that although the equivalent 8 × 14 matrix is shown, the 5 × 7 is not. Your challenge is to add the necessary format data to the look-up table in order to create the missing characters. We'll give more information in the Experimental section.

LIQUID CRYSTAL DISPLAYS

Unlike light emitting diodes (l.e.d.s), liquid crystal displays (l.c.d.s) do not emit light and operate on a very different principle. When switched on, the internal crystal structure polarises incident light (light shining on them) preventing it from passing through. When switched off, they allow the light to pass unhindered.

In the former case, the crystals appear dark compared to their background. In the latter, they appear almost invisible. By varying their darkness, the crystals can be made to form visible images, such as those demonstrated in the previous Matrixed Display section, or even pictures with some (expensive) graphic types.

Most l.c.d.s provide monochrome displays (effectively black and white). As you will probably know, though, l.c.d. colour displays are also manufactured (for laptop computer screens, for example).

Practically no current is required to flow through l.c.d.s, consequently they can be controlled without significant power consumption and are ideal for connecting to modern digital integrated circuits, such as those you have been using for this *Teach-In* series (but see important proviso later).

The advantages of low power consumption, though, are offset by certain disadvantages:

- Controlling signals need to be square waves
- An external lighting source is needed, either daylight or artificial
- The operating temperature range is limited (they can turn dark on a hot day, for example)
- The response time is slow – they typically operate at between 30Hz and 50Hz.

However, as the main advantage of low power consumption outweighs the disadvantages, l.c.d.s find use in numerous applications, from electronic meters and calculators to computer and TV screens.

They are available in many forms in which the quantity and shape of the segments or pixels can be manufactured so that letters, numbers and graphics can be displayed.

L.C.D. CONTROL PRINCIPLES

An l.c.d. is constructed with a *backplane* (BP) that is common to all segments and to which a square wave is applied. The segments or pixels are then indirectly controlled by the same square wave source but via their own pins. This aspect of the square wave can be set to be either *in phase* or *out of phase* (inverted) with respect to the backplane square wave.

When both signals have the same phase, i.e. both are at a positive level at the same time and then both are low at the same time, the l.c.d. crystals do not polarise the light and appear to be absent (turned off).

When both signals are out of phase, however, i.e. when one is high and the other is low, the individual segment to which the control line is connected then changes its crystalline orientation so that the light becomes polarised, in other words the segment is turned on (appears dark).

As you may have guessed, each segment has to be connected to its own control line, which can result in very large numbers of control lines being connected. With a simple 7-segment display with can show numbers from 0 to 9, seven control lines are needed for *each* digit, plus one for the backplane. Additional lines are needed if colons and decimal points are also required.

Very complex l.c.d.s have their controlling lines and circuits connected to them during manufacture, although simpler numeric displays need to be connected by the user, generally speaking in conjunction with a specially designed printed circuit board.

The sophistication of some l.c.d.s is such that "intelligent" integrated circuits are soldered directly to them to comprise a module which not only allocates the correct phase to various segments or pixels, but also contains a memory storage area for data sent by a computer or microcontroller. See Photos 12.7 and 12.8.

Many examples of the use of "intelligent" alphanumeric l.c.d.s have been published in recent *EPE* constructional projects. A forthcoming article discusses graphics l.c.d.s.

In circuit diagrams and constructional charts there are no specific symbols which are internationally recognised for l.c.d.s. Their representation depends on the whim of the circuit designer or the illustrator, although consistency of style is frequently observed by both.

The nature of the l.c.d. is usually obvious from the illustration and from written descriptions associated with it. An example circuit diagram symbol for a typical 4½-digit 7-segment l.c.d. is shown in Fig.12.1. There are countless variations. The control lines (40 of them) for the one shown each have to be connected by the user, usually in conjunction with special control devices (i.c.s).

L.C.D. DEMO SCREEN

Select LCD Displays – Principle from your sub-menu and we'll illustrate the principle of l.c.d. control. See also Photo 12.9.

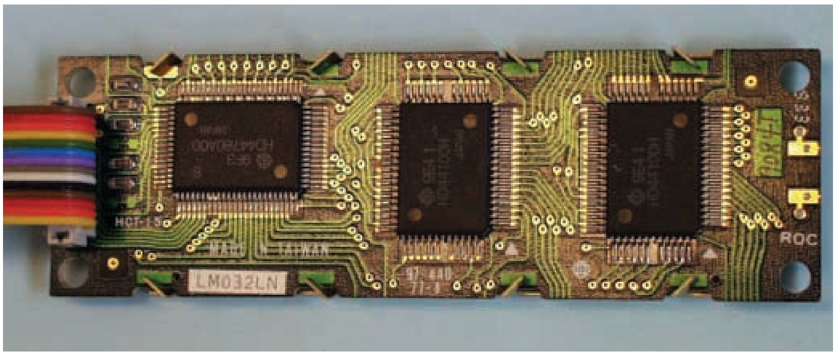


Photo 12.8. Control electronics on the rear of a 2-line by 20 (per line) character alphanumeric l.c.d., with 1400 pixels. It can be externally controlled by just six connections (plus power lines).

The screen demo shows the representation of a single l.c.d. 7-segment digit, but we only demonstrate the control of one segment, the top one. Although not shown, the same segment letters apply as for the l.e.d. version.

Note the two connections made to the digit, one to the top segment and one to the surrounding backplane. An XOR gate (discussed in Part 6) is shown controlling the segment. To the XOR gate at one input is connected the same backplane signal line, and a controlling signal line is connected to the other input.

The logic level at the XOR gate's inputs and output is indicated numerically and by coloured "flags" (for fun!). The backplane logic is seen to be alternating between high and low, representing the controlling square wave.

Notice how all seven segments are the same light grey colour and that the logic level of the backplane and top segment are the same. In this condition, the controlled segment is turned off. In a real l.c.d. the background, shown here as dark grey, would appear to be a much lighter shade and the turned off segments would probably not be apparent.

To turn on the top segment, the backplane and segment control logic levels need to oppose each other, as said earlier. You can cause this to happen by pressing the <+> key. You will see that this changes the segment logic level as applied to the input of the XOR gate.

When this input is high, the XOR gate causes the output to be inverted compared to the alternating square wave backplane logic. In this condition, of course, the segment and backplane have different signal polarities, and the segment is turned on, illustrated on screen by it turning white.

Logical truth tables (discussed in Part 6) for the XOR gate and the l.c.d. segment response are shown on screen.

Repeatedly press the <+> key to control the selected segment.

Remember that *each* segment or pixel of an l.c.d. requires control in the fashion similar to that illustrated. Consequently, such displays are complex to control unless special chips are used.

It is MOST IMPORTANT to stress that l.c.d.s must NEVER be operated directly using d.c. control signals. The signals must ALWAYS be square waves.

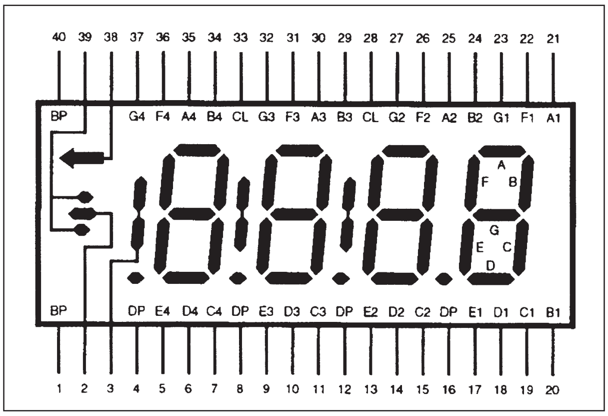


Fig.12.1. Example of a symbol for an l.c.d. module; there are many variations. This one shows a 4½-digit module.

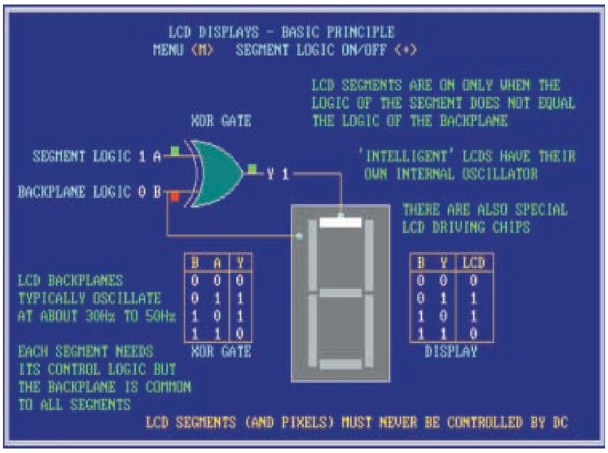


Photo 12.9. Screen dump of the interactive l.c.d.s control demo. Just one segment's control is illustrated, the other segments are identically controlled.

MISCELLANY

During this *Teach-In* series we have occasionally had to omit small items of information for space reasons, saying that we would discuss them at a later date. Now's the time for it!

TEMP-CO

In Part 1 reference was made in passing to a resistor's power and temperature coefficients.

You've no doubt deduced it by now, but a component's power rating is expressed in watts (W) or fractions of a watt, e.g. milliwatts (mW). It refers to the amount of power (volts × amps) which that component can safely handle without becoming overheated. Since heat can affect the characteristics of components, wattage ratings should be chosen to be higher than that calculated for normal operation.

Where a manufacturer quotes the temperature coefficient of a component, this parameter states the typical amount by which a component's nominal value will change in response to a change in its temperature. It may be quoted as a value in parts per million (ppm) or as a percentage of its value related to a given temperature change unit, i.e. one per cent per degree Celsius (1%/°C).

Such components as resistors and capacitors always have this coefficient quoted by the manufacturer. Temperature ratings can also be of significance regarding some aspects of more sophisticated components, such as transistors and integrated circuits, for example.

The term *temperature coefficient* is sometimes abbreviated to *tempco* or *temp-co*.

PANEL 12.1. SPEED AND FREQUENCY

To expand a bit on Frequency which we covered in Part 5, here are just a few additional comments:

Data sheets for integrated circuits (i.c.s) may quote several speed factors, each of them referring to different aspects of an i.c.'s operation. Values relating to speed and frequency may seem to be similar factors, but there is a significant difference between them.

Speed may be quoted with regard to how quickly an i.c. responds to a single event, i.e. how quickly it can respond to a change in voltage at one of its inputs, say from 0V to 5V. Other inputs on the same i.c. may be quoted as having different rates of response.

Frequency response, though, in this context of an i.c., is the rate at which the component can handle and process repeated changes on all inputs and through subsequent internal operations. Although a frequency value can be calculated for a given speed at which an input responds, this should not be taken as the frequency at which the whole device can operate.

Frequency is also quoted in other contexts, with regard to capacitors, transistors, coils etc. Here the frequency value is usually the maximum that the component will respond to or allow to pass through without degradation of the signal amplitude and/or waveform shape.

Components can often *seem* to be theoretically capable of handling higher frequencies, but examination of the resulting waveforms on a oscilloscope may show, for example, that square waves have become more like sine waves and that the peak-to-peak voltage is far less than the original input value.

FAN-OUT

In Part 2 we suggested that you should note the actual output voltage of a logic gate when different load values were placed on it. All integrated circuits have a limit on the amount of power that can be drawn from (*sourced*) or drawn by (*sunk*) their outputs.

In extreme circumstances of excess current flow, the i.c. could die, but it is more usual in many modern components for the output to limit the amount of current flow being required of it. The result is that often the output voltage will either fall below the usual maximum when sourcing, or rise above the usual minimum when sinking.

In such cases when digital logic is concerned, the logic voltage swing may be insufficient to be recognised as a logic change by the ensuing circuit(s). In many cases, data sheets will state the amount of current which a logic output can handle before the trigger thresholds are not reached.

Data sheets may sometimes quote a *fan-out* value. Fan-out states the number of similar logic devices which a particular device can control. The limitation is caused by the fact that the inputs of the controlled devices may require a small but significant amount of current flow. With that factor specified, the manufacture calculates the fan-out value accordingly.

Modern CMOS digital logic devices have inputs which usually require hardly any current, being formed from *field effect transistors* (f.e.t.s), see Part 7.

OSCILLOSCOPES

We had hoped to describe the features which you might expect on an oscilloscope. Sadly, there is no space to include this subject.

Instead, we refer you to the *EPE* two-part feature article on oscilloscopes, *More Scope for Good Measurements* of June/July '96. Whilst technology has moved on somewhat since then, you should find that the basic discussion is informative.

We strongly recommend that you purchase an inexpensive standard oscilloscope or computer controlled *virtual* oscilloscope as soon as funds permit. We would also recommend that you read *How To Use Oscilloscopes and Other Test Equipment* – available from the *EPE Direct Book Service*, see page 785.

Since you have proved by following this *Teach-In* series that you are interested in electronics, obtaining a 'scope of some sort is the next vital step you should take. Whereas our simple real-time computer 'scope displays will have shown you a fair bit about waveforms, the detail has been too coarse and slow to be of use when you progress to more sophisticated circuit designing or construction and testing.

If you study adverts carefully, you could even purchase a reasonable second-hand 'scope inexpensively. But do generally find out about what 'scopes can do before you buy.

ONWARDS

That's all for this final Tutorial, but do move on to the Experimental section. We shall then generally wind-up the *Teach-In 2000* series in a brief concluding section.

TEACH-IN 2000 – Experimental 12

THE first part of this concluding Experimental section illustrates the function of a *digital-to-analogue converter* (DAC). You will recall that *analogue-to-digital* conversion (ADC) was discussed and demonstrated in Part 5. As part of the screen demo you were also shown an example of a DAC in operation.

In Part 1 we recommended that you obtained a DAC device type DAC0800. Some of you may have been supplied with a DAC08, which is just as acceptable and has the same pin order.

We shall now demonstrate a DAC in real life by connecting it to the outputs of your computer's printer port, via breadboard connections OUT0 to OUT7.

Set up your breadboard according to Fig.12.2, the equivalent circuit diagram for which is given in Fig.12.3. (The power supply needs will be discussed presently.)

Ensure that the eight connections from the DAC to the printer port interface are insulated from each other. They need to be about 8cm long. The order of the interface pins was originally shown in Part 4. The existing connections to the ADC (IC2) can remain in place.

DAC NATURE

The basic nature of a DAC is quite simple. Typically they have eight digital inputs, and thus can accept 256 different binary input values, between 0 and 255 (as discussed when examining 8-bit binary logic in Part 6).

Internally, the DAC connects those inputs to a ladder-type arrangement of resistors such that a binary code of 11111111 (decimal 255) causes a maximum output voltage to be produced, whereas a binary code of 00000000 (zero) causes a minimum output voltage. DAC devices often allow those minimum and maximum voltages to be preset via reference pins.

The voltage difference between each input step change from 0 to 255 is the difference between the maximum and minimum voltages divided by 255. For example, suppose that the reference voltages have been set so that the output is 0V for an input code of zero and 2·55V for an input of decimal 255. The voltage step difference

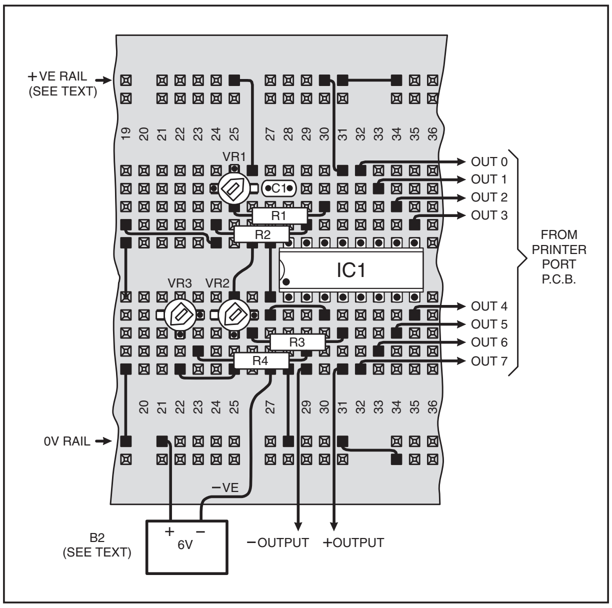


Fig.12.2. Breadboard layout for the digital-to-analogue experiment.

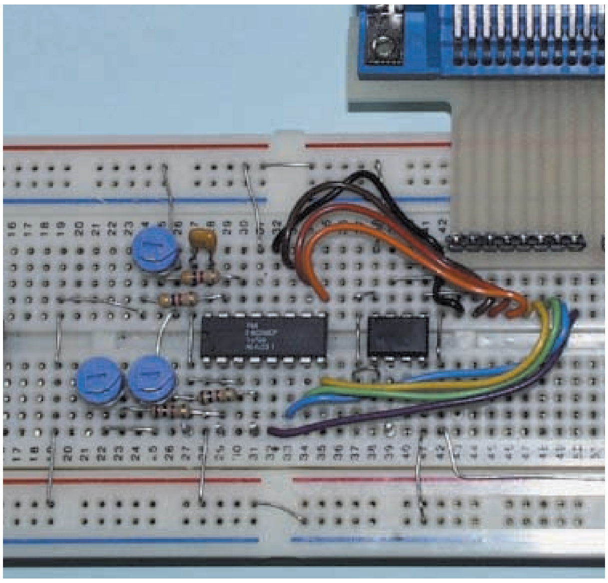


Photo 12.10. Detail of the DAC circuit, showing connections to port interface board.

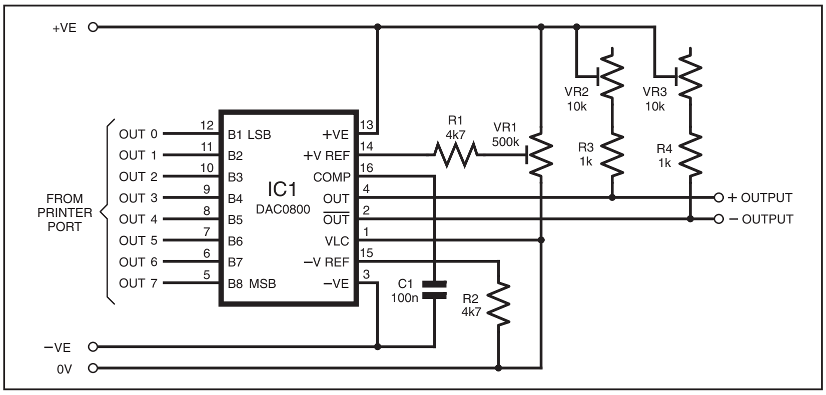


Fig.12.3. Circuit diagram for the digital-to-analogue experiment.

between consecutive input values is thus 2·55V / 255 = 0·01V.

The DAC used now has a slightly more complicated structure, however. The upper and lower references against which the D-to-A conversion is compared are actually set by currents flowing at pins 14 and 15.

The negative reference current is fixed by resistor R2. The positive reference is set by R1 and preset VR1, in order to simulate the voltage control that would be used in other types of DAC.

There are two outputs at which it is also changes in current flow (sink) into them that are produced in respect of the binary input values, rather than changes in voltage.

Current increases occur on the positive output (pin 4) with increases in input code, while decreases in current simultaneously occur on the negative output (pin 2). You already know that increases in current through a resistor cause a change in voltage across it (discussed particularly in Part 9 – transistors).

Consequently, as you did with transistor collectors, all you need to do to convert the current to a voltage level is to insert a resistor between each of the DAC's outputs and the positive line. To allow you the opportunity to experiment, presets VR2 and VR3 are used in series with resistors R3 and R4.

There are DACs which directly produce an output voltage rather than a current, but the DAC0800 was chosen because it is probably the least expensive.

DAC POWER SUPPLY

The DAC0800 is normally used with a positive voltage on pin 13, 0V on pin 1 and a negative voltage on pin 3. Ideally the positive and negative supplies should be symmetrical with reference to 0V, i.e. +5V/0V/–5V. The device can in fact operate at between +4·5V/0V/–4·5V and +18V/0V/–18V.

For our demo, however, we want you to use either +6V/0V/–6V or +5V/0V/–6V. For the former (±6V) you will need a second 6V battery. Those of you who built the regulated supply described in Part 11, can use that supply for +5V, and use your existing 6V battery to provide –6V.

Note that although we described in Part 11 how a negative supply could be generated from a positive supply, the current available by that method is insufficient to power the DAC0800's negative pin.

RELATIVITY MATTERS

Make sure that the battery supplying –6V is connected as shown in Fig.12.2, i.e. its positive terminal (+) connected to the 0V rail of the breadboard, and its negative terminal (–) to the point indicated. Connect the positive supply in the same way you have been doing in previous parts of *Teach-In*.

The equivalent power supply circuit is shown in Fig.12.4a. It is worth noting how two batteries can be connected in series to provide either a +VE/0V/–VE supply, or a supply that is the total of the two battery voltages (Fig.12.4b), depending on which terminal is regarded as the 0V (common) connection. Other power sources (e.g. mains operated power supplies) can sometimes be treated similarly, depending on how they are constructed. It's *relativity* again.

Set VR1 fully clockwise to provide the maximum reference current from the positive rail. Set VR2 and VR3 fully anticlockwise to provide the minimum resistance between the positive rail and the respective output pins.

Connect your meter to read the voltage at the positive output terminal pin, and connect the breadboard to the computer via the printer cable.

COMPUTER-TO-DAC

From the main program menu now run Parallel Port Data Display/Set. Since the original software was released with Part 1, a minor change has been made to this option and is included with the V1.1 software released with Part 7.

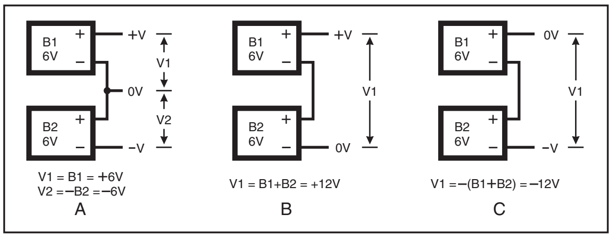


Fig.12.4. Effective battery output voltages are relative to which terminal is nominated as the 0V (ground) connection.

At the bottom right-hand side of the screen the option to increment or decrement an 8-bit counter (counting range 0 to 255 decimal) has been included (using keys <+> and <–>). The counter outputs its 8-bit value to the printer port, and thus to the DAC.

Consequently, you can control the DAC from your computer either by changing the output byte bits by number or at an incremental rate via the new output counter option.

Set the output byte for 00000000 (zero) and note the meter voltage reading, which will probably be about 1V below the positive power rail voltage (i.e. +4V for a +5V supply). Press the minus key (–) on the keyboard to set the output byte to 11111111 (255). The meter will probably now show a reading close to the positive supply rail voltage.

Hold the minus key pressed, causing the output byte value to progressively decrease, observing your meter while you do so. Note how the voltage falls with decreasing byte values, eventually back to the original lowest point when the byte reaches zero. The process is repeated when the roll-over from 0 to 255 has occurred.

Now monitor the negative output of the DAC and repeat the same tests. This time you will see voltages vary in the opposite direction, e.g. +4V for 255 and +5V for zero.

Now set the output byte at 255 and with your meter still monitoring the negative output, slowly adjust VR3 clockwise. Observe how the output progressively falls, well into the negative voltage region. Press the plus key (+) for an output byte value of zero. The meter reading should now show the maximum value you previously obtained.

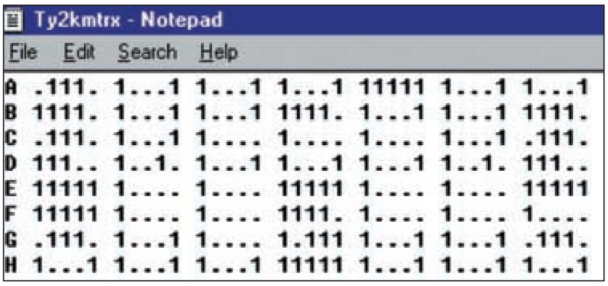
Do the same test with the positive output (using VR2) and observe the voltage changes.

These two tests show how the output voltage can be changed not only by the digital value fed to the DAC, but also by the output resistance value in relation to the current, just as you found when experimenting with transistors.

Note, though, that different settings of VR2 and VR3 in relation to each other can cause an interactive response within the DAC and affect the output voltages.

Set VR2 and VR3 fully anticlockwise again and now experiment by changing the setting of VR1 and with different output byte values. Then do the same with different settings for VR2 and VR3 as well.

These tests should show you how changes in various controllable factors of the DAC affect the output voltages. All of which illustrates examples of how you might use your computer (or another digital circuit) to control d.c. voltages in a design of your own invention.



Ty2kmtrx - Notepad

File Edit Search Help

```
A .111. 1...1 1...1 1...1 11111 1...1 1...1
B 1111. 1...1 1...1 1111. 1...1 1...1 1111.
C .111. 1...1 1.... 1.... 1.... 1...1 .111.
D 111.. 1..1. 1...1 1...1 1...1 1..1. 111..
E 11111 1.... 1.... 11111 1.... 1.... 11111
F 11111 1.... 1.... 1111. 1.... 1.... 1....
G .111. 1...1 1.... 1.111 1...1 1...1 .111.
H 1...1 1...1 1...1 11111 1...1 1...1 1...1
```

Photo 12.11. Screen dump showing the coding technique used for generating the 5 × 7 matrix demo displays.

YOU AND THE MATRIX

We said earlier that we would like you to add additional data for use with the Matrixed Displays demo screen, allowing the creation of characters and symbols not already included. Here's what you do:

Through text editor MS-DOS Edit or Windows Notepad, load text file **TY2KMTRX.TXT** held in the *Teach-In 2000* directory (folder) **TY2KPROG**.

The first lines of the text in this file are shown in Photo 12.11. Each line holds the data used by the program to generate the matrixed display for the letter preceding it.

In each line, the pixels required to be seen as active are indicated by a 1. Those that are to be blank have a decimal point (representing logic 0).

There are seven groups of five pixels represented in each line. The first group being that for the top line of the 5 × 7 matrixed display. The identity letter at the beginning of each line is followed by a single space. Each 5-bit pixel group is also separated by a single space.

What we would like you to do is to add additional lines to the end of the text file (following on after the data for numeral 9) which provide the data for any letters or characters which the matrix display tells you are not yet available. The new lines can be in any alphanumeric order you like (the program automatically sorts them).

Before you start, make a backup copy of the file just in case you get it messed up (although you could reload the file from your original disk or Net download if you needed to). We suggest a backup name of **TY2KMTRX.BAK**.

To help you create a character, it is probably best if you use a sheet of paper on which you have drawn dots for a 5 × 7 matrix. Then more heavily mark those dots which you think are needed by the character you are trying to create. The data line needed in the text file can then be keyed in from your keyboard, using the "dots and ones" format that represents the paper sketch.

Save the text file in the normal way (under its **TY2KMTRX.TXT** name) when you have finished (you will prompted if you try to exit the Edit/Notepad program without doing so). Then re-run your *Teach-In* program and see how your newly created data is interpreted on screen.

If it does not look right, return to the text editor program and amend the data.

You will find this experience useful should you ever wish to create special symbols for use with an alphanumeric or graphics l.c.d.

Have fun – that's the last of our *Teach-In 2000* experimentals!

TEACH-IN 2000 – *Over to you*

WELL, after these many months (12 for you, but around 24 for the author in preparation) we have come to the end of the *Teach-In 2000* series. It's not that we have no more to teach you, we have, but the space allocated has run out (we've already run over by two issues!)

We know you have enjoyed this series. We hope you have learned a great deal from it and now have the confidence to play around with inventing design ideas using some of the many building blocks we have discussed.

A summary of the subjects which we have covered in *Teach-In 2000* is given in Table 12.1.

ELECTRONICS BOOKS

There are many books which will help you to increase your knowledge further, but too numerous to mention by name. There are many featured in our *Direct Book Service* pages, for which the subjects are changed on a repeating cycle of three issues. Books are frequently being added.

There is also the *Modern Electronics Manual* to which we refer you, and is another sister publication to *EPE*. It is advertised in each issue.

The first hundred pages or so of *MEM* are written by your friendly *Teach-In 2000* author and expand on the information given in this series, plus offering a great deal more. Several well-respected authors have written the other 900 or so pages, and they go into greater technical detail about electronics and its applications. It is a publication for which Supplements are published quarterly.

CATALOGUES

No electronic constructor's workroom is complete without a good selection of catalogues. There are masses of sources, not just through *EPE's* advert pages, but also through the Internet.

Many sources specialise in specific areas; a fair number of them, though, are general distributors and retailers. Those in the UK which have the largest general catalogues which are a MUST to possess for any user of electronic components, are those from RS Components (trade only) or Electromail (the retail division of RS), Farnell Electronic Components, Maplin Electronics and Rapid Electronics.

However, do not overlook other suppliers whose catalogues may be smaller but who may have ranges and prices which compete favourably with larger companies. Indeed some of them stock components which the larger suppliers do not.

KEEPING INFORMED

Also keep reading *EPE* – remember that we are the leading hobbyist electronics publication and place a heavy emphasis on electronics education.

Other sources of information are available on CD-ROM and Video as listed each month in *EPE*. Also, if you have Internet access, take a browse through the *EPE* On-line Web Site (**www.epemag.com**), from where a number of informative feature articles can be downloaded covering a variety of electronics subjects.

Make use, too, of our web site at **www.epemag.wimborne.co.uk**, through which you can access many other sources of information, and exchange views with other electronics enthusiasts through our Chat Zone. You will also find Alan Winstanley's excellent illustrated *Basic Soldering Guide* and the *History of EPE* here.

HERE'S WISHING YOU . . .

We hope that your increasing study and knowledge of electronics will not only provide you with designing and constructional pleasure, but that it might also lead to career opportunities for some of you. This has happened for many *EPE* readers over the years.

Whilst it's goodbye for this series, we'll meet again through our other pages! □

Table 12.1. Teach-In Subjects

Part	*Issue*	*Subject*
1	Nov 99	Colour codes Resistors
2	Dec 99	Capacitors – general Capacitors – RC timing Inverter gate Inverter gate oscillator Schmitt trigger
3	Jan 00	Potentiometers Sensor resistors Ohm's Law
4	Feb 00	Diodes and l.e.d.s Schmitt trigger oscillator Computer interface construction
5	Mar 00	Waveforms Sine wave relationships Frequency and time Analogue-to-Digital converter
6	Apr 00	Logic gates Binary and hexadecimal Binary and decimal counters
7	May 00	Op.amps – general
8	Jun 00	Op.amps – Comparators, Mixers, Audio and Sensor Amplifiers
9	Jul 00	Transistors
10	Aug 00	Power supplies – Transformers, Rectifiers
11	Sep 00	Power supplies – Voltage regulation Variable Power supply, +5V regulator assembly Capacitors – Integration, Differentiation
12	Oct 00	7-segment displays Liquid crystal displays Digital-to-Analogue converter Miscellany

New Technology Update

IBM's proposed multiple processor architecture has self-healing properties and could perform one quadrillion operations per second. Ian Poole reports.

COMPUTING has come a long way in the last few years, but new developments that are under way at IBM may mean that computing technology will take a quantum leap in the next few years. Recently they have announced a new development that will ultimately lead to a computer that is capable of performing one quadrillion operations per second (one petaflop).

This project is being funded by IBM themselves and is not a government development programme, and this is quite unusual for a programme of this size. Taking about five years in total, the development adopts a radical new approach to computer design. Both the technology to be used and the approach are revolutionary, and this will enable the programme to be undertaken so quickly. The time estimated is about a third that would normally be expected under normal project conditions.

Called Blue Gene, the programme has resulted from a requirement to study the immensely complicated human proteins. It is expected that when the project is complete, the computer will be able to provide significant help in increasing our knowledge of the way in which proteins are structured and in particular the way in which they fold. This will be an important step in the future of healthcare and medicine.

Smash

The new computer is based around a new architecture called SMASH. This stands for Simple, MAny and Self-Healing. This gives an insight into the way in which it works. In fact the new technology appears to be one of the largest revolutions in computer science since the mid-1980s.

To give an idea of the extent of the performance of the new computer it is estimated to be 500 times more powerful than the most powerful computer in existence, and typically two million times more powerful than the high performance PCs in use today.

To achieve these levels of performance the new architecture has three particular features. It greatly simplifies the number of instructions that each processor has to carry out. Not only does this allow them to operate faster, but in doing so it reduces the power requirements that would otherwise be needed. Secondly it enables a far greater degree of parallel processing to be undertaken.

Typically the system will be capable of handling more than eight million different computational threads. This is a major advance when compared to a maximum of around 5000 using current technology.

The third new feature is possibly one of the most interesting because the computer will be self-stabilising and healing. This feature will enable the computer to recognise and overcome failures by avoiding faulty areas like processors and computing threads. With a computer of this complexity, this type of feature is of particular importance, and it is one that should become more important as technology becomes more complex in the years to come.

Thread Unit

The core item in the Blue Gene computer is an item called the thread unit. This is basically a RISC processor that has been reduced to the bare minimum. Having an instruction set of 57 instructions it has been designed to produce the maximum throughput for the minimum amount of silicon.

Further analysis of the actual architecture needed for the new units revealed that floating point functions were only required on a small proportion of the operations. To maximise the efficiency of the whole processor eight thread units are grouped together with two 500MHz floating point processors. One of these units is used for add and subtract and the other for multiply and divide functions.

Additionally, half a megabyte of memory is provided in each processor group and this has been made possible by the use of IBM's recently developed memory-in-logic process. The whole combination of the eight thread units, two floating-point units, memory and some additional logic combines to produce a one Gflop processor.

However, this is only part of a single chip that will be used in Blue Gene. Around thirty of these processors will be incorporated into a chip. The exact number still needs to be finalised and will depend on a number of factors relating to the performance and the removal of heat.

One of the other major areas to be addressed is that of inter-processor communication. To achieve the best performance from each of the processors communication will need to be very efficient. It will use two bi-directional 128-bit data rings. There will be one between each row and column of processors on the chip.

Using these, data is tagged and can be transferred internally between the processors, or it can be transferred off the chip via six external busses. The speed of this will be kept down to 500MHz to enable the chips to operate within their required power rating. Although it is anticipated they could operate at speeds up to 1GHz, this would increase the overall power consumption to a point that would be unacceptable.

Manufacturing

Each chip will measure 21mm × 21 mm. This is a significant advance over anything currently in production today. The main problem will be yield. Using current technology the yield on chips of this complexity would be very low. However, the self-healing aspects of the architecture can be used to advantage, and chips with up to two defective processors will be used. This will enable costs to be kept within reasonable bounds

There are six external busses and these will operate at speeds of one or two Gbytes per second. These provide interconnectivity with external chips and they are organised in a three dimensional matrix with 30 processors at each node.

Physically, the chips will be mounted on boards containing a total of around 36 chips. The actual design of this board is quite challenging because the chip to chip busses will need to be kept below 150mm to ensure that delays do not rise to levels that cannot be tolerated. These boards will then be able to provide a throughput equivalent to 900 Gflops.

In turn these boards will be arranged in a matrix 16 boards by 16 boards in the horizontal plane and five boards high to give a total of 1280 boards and the final performance of over one Pflop.

Failures

With the phenomenal number of processors in the computer it is estimated that random failures will occur about every four days. In addition to this random soft errors caused by cosmic rays will also be a problem. To resolve these problems the processors will operate in a master-slave configuration so that the results can be checked. If incorrect they will be recalculated.

This mode of operation means that the whole system is very resilient, and significant amounts of the system could fail or be removed and the system would still work, albeit rather more slowly.

This new computer is a particularly exciting development. Although not complete yet, it paves the way for the future. Not only does it promise to provide a way of analysing proteins for research into better healthcare, but it also maps out the way for the future of computers as well.

Further information can be found at **www.ibm.com** and search on Blue Gene.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PIC PROGRAMMER

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

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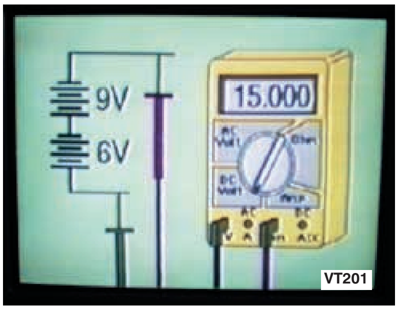

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Order Code VT102

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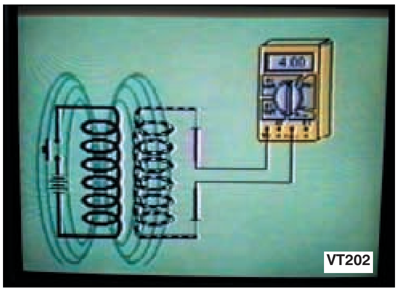

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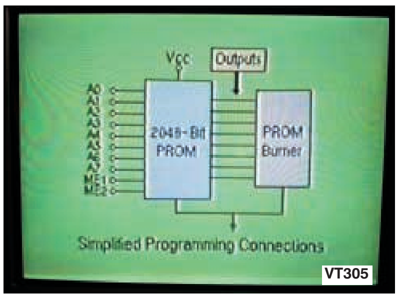

Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier. We are the worldwide distributors of the PAL 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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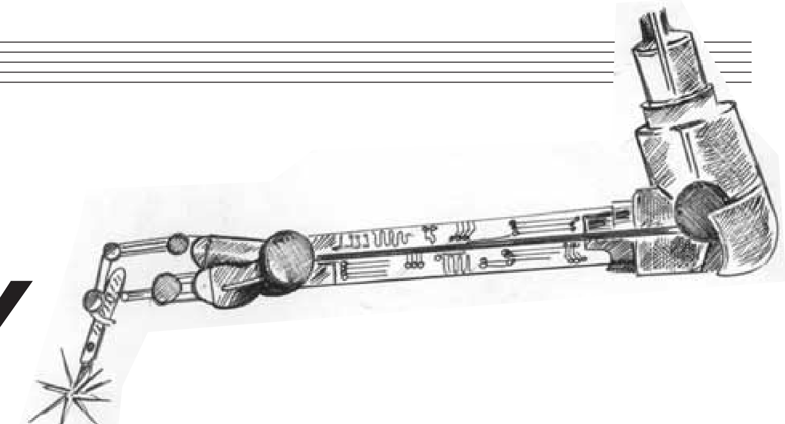


CIRCUIT SURGERY

ALAN WINSTANLEY and IAN BELL

A few practical reminders about testing transistors the quick and easy way are discussed in this month's column of reader's queries.

Keep Soldering On

I am building a tube amplifier kit that uses "eyelet" fibre circuit boards. The instructions say to heat the eyelet and then put the solder to the tip.

My concern is that there is a brown residue (from the rosin?) left on the solder afterwards. I understood that the rosin burns away, but on my boards it is still visible. The joints seem solid. Am I doing something wrong? **A. Harris** via E-mail.

The purpose of flux in a solder is to help the molten solder to flow better, by removing oxides and deposits. What you are seeing is the remainder of the rosin flux contained within the solder.

It does mostly burn away (which is where the smoke comes from) but there will be some left on the board afterwards. You can clean it off using a proprietary aerosol cleaner if you like, but on a "turret board" or eyelet board it won't make any difference whatsoever on performance.

Reminds me of the managing director of an electronics company I worked for many years ago, who gave me a rocket for "using far too much solder" claiming that I had probably shorted out the entire board. He was actually referring to the flux residue which he thought conducted electricity! *ARW.*

Check Those Transistors

I have a bit of trouble with a metal-cased 2N3055 power transistor – I can't seem to find which of the two pins is the collector/emitter! The only thing I found was that when doing a continuity test across the pins, I get a reading one way but not the other. I'm not sure what conclusion to draw from that. ***Mark,*** via the Net.

A quick and easy transistor test is one of those things worth reminding readers about. With experience you'll learn that the metal case of most power transistors is wired to the collector (c). The two pins are for the base (b) and emitter (e) connections.

You can hook up to the collector in a number of ways, e.g. if screwing the transistor to a heatsink, use a solder tag under one of the mounting bolts. It is sometimes important to ensure that nothing else comes in contact with the collector, so an insulated mounting kit should be used.

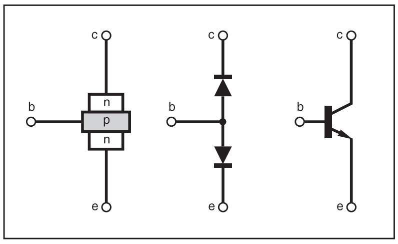


Fig.1. How an npn *transistor is formed internally of two back-to-back diodes. These can be checked with a Multimeter on an Ohm's or diode range.*

A bipolar transistor, including the metal-cased 2N3055, can be considered as equivalent to two back-to-back diodes. How bipolar transistors are formed this way using an *n-p-n* sandwich structure is shown in Fig.1. An *npn* transistor appears to contain two cathodes (emitter and collector) and one anode (base), and you can see how the base is common to both diodes. The opposite conditions pertain to *pnp* transistors.

By using an ordinary moving coil multimeter you can perform some quick tests to help identify the pinouts, and also to help test the integrity of the device. A digital multimeter may have a diode check range which can also be used to test bipolar transistors, see later.

Take Note

The first thing to note is that a moving-coil multimeter has an internal battery needed for measuring resistance, and the meter's positive terminal actually *sinks* current, i.e. *current comes out of its negative terminal.* (The opposite seems to be true of digital types.)

An ordinary silicon diode can soon be given a "go-no-go" check using the resistance range. Diodes have a high resistance in one direction only. Obviously a high resistance in both directions indicates open circuit whilst a low resistance indicates a short.

A random 1N4148 diode measured 5kΩ (5 kilohms) when forward biased: the ***negative*** lead therefore being connected to the ***anode***. This can be used as the basis for testing transistors and it's handy to know how to run a quick check on a suspect or unmarked device.

A sample 2N3055 power transistor was tested (see photos) and the following results were obtained, remembering that when a terminal is positively biased, this means it is connected to the ***negative test lead*** of a moving-coil meter. The pinout details are shown in Fig. 2.

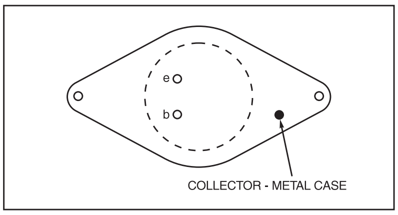


Fig.2. Pinout configuration of a metal-cased 2N3055 power transistor.

A low resistance of about 4k was read, a high resistance about 800k. If the emitter-collector test shows a low or high resistance in both directions, this indicates a short or open circuit respectively, and you can consign it to the bin.

		Positive Bias:		
		Base	**Emitter**	**Collector**
Negative Bias	**Base**	X	High resistance	High resistance
	Emitter	Low resistance	X	High resistance
	Collector	Low resistance	High resistance	X

Source of Leaks

The leakage current of an *npn* bipolar transistor can also be quickly checked. Simply hook the resistance meter negative lead (+supply) to the collector and the emitter to the positive terminal (–supply), leaving the base unconnected. This should indicate a high resistance. Any noticeable deflection in the reading hints at a leaky transistor.

Leakage current actually rises with temperature, so you can try heating it with a hot air gun (a hot air blower on my gas-powered iron was ideal) to see what happens. After about a minute or so the leakage current will rise substantially. Experiment with some old surplus devices as well.

When using an auto-ranging digital multimeter, the preceding go-no-go testing method won't work on the resistance range as the DMM has a very high impedance, but you can still use a diode check function to measure and identify the internal diodes of bipolar transistors (see photos). Just remember that this time, the DMM's positive lead is a ***source*** of current. A "good" diode will have a forward voltage of roughly 0·45V upwards as shown on my AVO meter, and its anode will be connected to the positive lead. *ARW.*

Earthy feelings

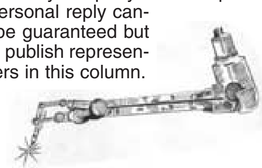
I was a test engineer for an electrical contractor for many years, and reading Circuit Surgery *in* EPE *September 2000 issue I noted that Fernando Bentes de Jesus is receiving electric shocks from his dishwasher which does not appear to be earthed – any voltage appearing on the metal case would otherwise flow to earth and not though him. All electrical installation must be earthed for the RCD* [GFCI in the USA] *to protect life and property.*

The RCD works by sensing the imbalance between the phase "live" *and neutral, with current flowing phase to earth, or neutral to earth. It will not protect against phase to neutral. As you rightly say, the RCD should trip out in 40 milliseconds. Ideally, it should be tested with a RCD tester that will pass the rated current and measure the trip time; the test button on the RCD only tests the mechanical side of the trip.* ***Tony Hitchings, Hereford*** via E-mail.

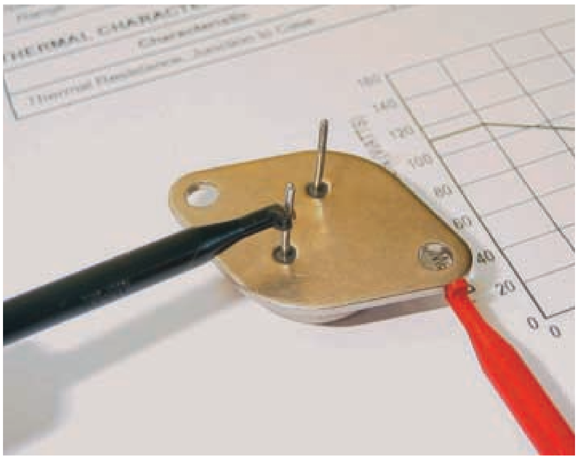
Thanks for the valuable advice. *ARW.*

CIRCUIT THERAPY

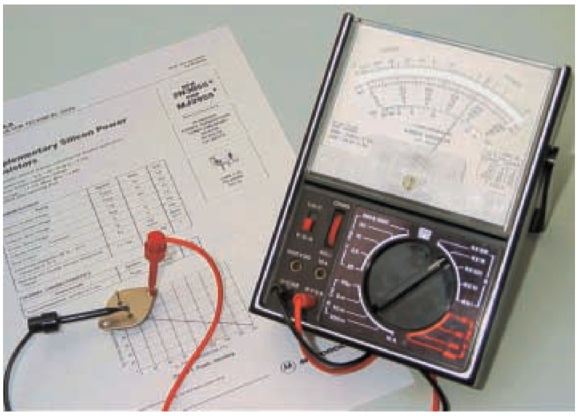
Circuit Surgery is your column. If you have any queries or comments, please write to: Alan Winstanley, *Circuit Surgery,* Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail (no attachments) **alan@epemag.demon.co.uk**. Please indicate if your query is not for publication. A personal reply cannot always be guaranteed but we will try to publish representative answers in this column.



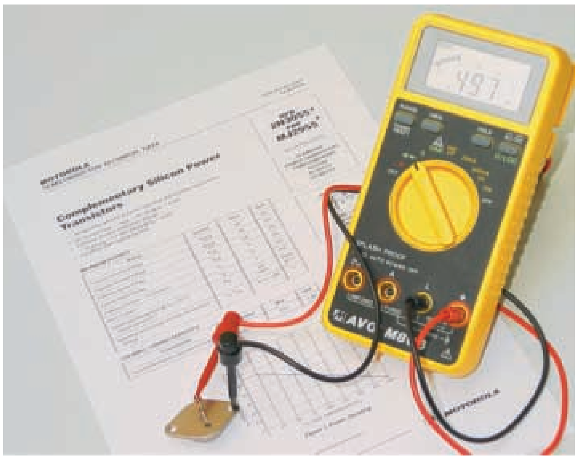
Quick and Easy Go-No-Go Testing Using Your Multimeter



The collector of a 2N3055 is connected to the metal case of the device. Use multimeter test probes to check the internal diodes.



Using a moving coil meter set to its resistance range to test the transistor. Note that current flows out of the negative lead. The device will have a low resistance (4k to 5k) when forward biased.



The diode test range of a digital multimeter can be used to measure the forward voltage of a transistor diode. A good reading is in the region of 0·45V to 0·9V.

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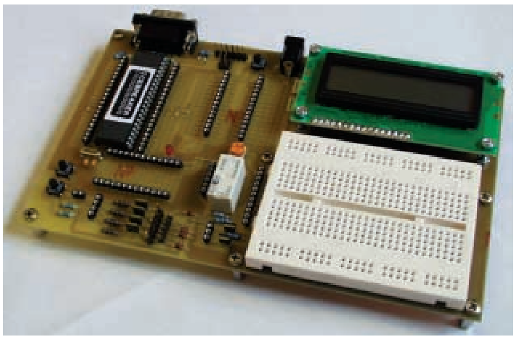

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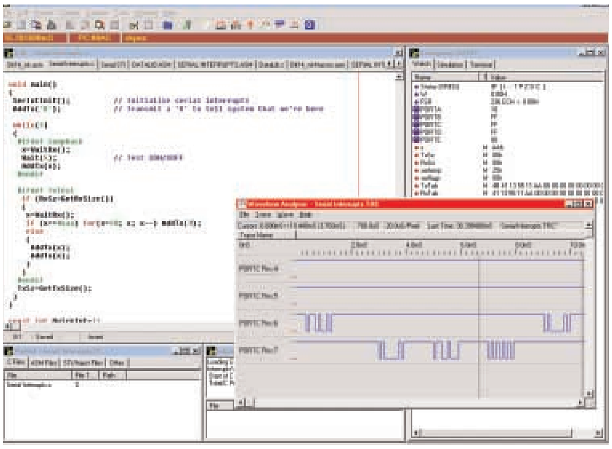

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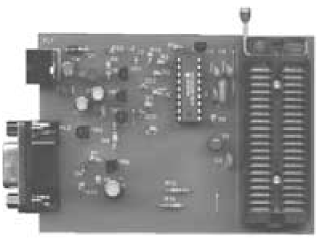

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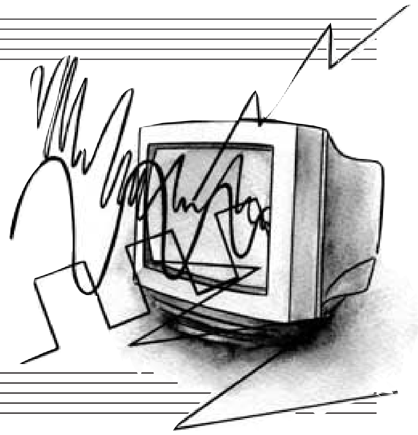
Constructional Project

PIC DUAL-CHAN VIRTUAL SCOPE



JOHN BECKER

A virtual oscilloscope for monitoring audio frequency waveforms via your computer.

MID-RANGE is perhaps a reasonable opening description of this design. At one end of the scale of *EPE* virtual oscilloscope designs is the simple Analogue Input Waveform Display computer interface used with the *Teach-In 2000* series. At the other end is the sophisticated and versatile *EPE Virtual Scope* of Jan/Feb '98.

With the *TI* interface, analogue waveforms from a single source are digitised under elementary computer control and displayed on screen. The sampling rate depends heavily on the rate at which the computer operates. A maximum signal frequency of perhaps 1kHz can just be displayed using a 120MHz computer.

The *TI* unit's simplicity of construction and use make it an ideal "eye-opener" for electronic novices, enabling them to gain an insight into what happens with electronic circuits and waveforms.

The *V-Scope*, on the other hand, uses a very complex set of electronic circuits to convert two analogue channels simultaneously for computer display at frequency rates up to several megahertz. It uses a mixture of QuickBASIC routines which access high-speed machine code assemblies. Operation is principally under mouse control. Its circuit complexity, however, makes it unsuitable for building by inexperienced constructors.

PIC V-SCOPE

Sitting between these two designs is the *PIC V-Scope* described here. It provides waveform display of two signals simultaneously at rates much higher than the *TI* design offers, although lower than *V-Scope* can handle. It is considerably easier to construct than *V-Scope*. With care, even less-experienced hobbyists should stand an excellent chance of constructing it successfully.

In order to use the design, however, you need a PC-compatible computer capable of running QBasic or QuickBASIC and for it to "read" mouse controls via those programming dialects. As discussed later, the controlling program allows you to check on both points before purchasing any components. The author has run the prototype under Windows 3.1, 95 and 98.

Many of the functions offered by this design are closely similar to those offered by *V-Scope*. Indeed, the controlling software is a cut-down version of that design.

CIRCUIT DIAGRAM

The complete circuit diagram for the *PIC V-Scope* is shown in Fig.1. Both input channels are identical and are formed around op.amps IC1a and IC1b.

Taking just Channel 1, the signal is brought into socket SK1 and to switch S1, at which a choice of gain is offered, ×1 (unity) or ×10, as set by resistors R1 and R2 in relation to the value of R3. Other gains may be preset by changing the values of the resistors during assembly.

From R1/R2, the signal is routed to a.c. coupling capacitor C1, which can be bypassed via switch S2 for d.c. operation. The signal is then fed to the inverting input of IC1a, from where it is output to the PIC microcontroller, IC2, a PIC16F877 device.

Mid-rail bias (2·5V) for both op.amps is set by the potential divider formed across R9 and R10, with smoothing provided by capacitor C3. This bias must be taken into account when monitoring d.c. signals.

The PIC16F877 microcontroller, as discussed in several previous *EPE* issues, has eight inputs which can be used for analogue-to-digital conversion. In this design, only inputs RA0 and RA1 are used. All other active PIC port pins are used in conventional digital input or output mode.

The basic role of the PIC is to perform the A-to-D conversion and output the result to the computer via socket SK4, either immediately on conversion, or after storing it temporarily in memory chip IC3.

PORTD is used for the memory data routing, while PORTC outputs the data to the computer. As is frequently the case with *EPE* designs, the computer's parallel printer port handshake lines are used for the data output. Read/write control of IC3 is via the RA4/$\overline{\text{OE}}$ and RA5/$\overline{\text{WE}}$ connection pairs.

Communication from the computer to the PIC is via computer data lines DA0 to DA3, also connected through socket SK4.

SPECIFICATIONS . . .

- PIC microcontroller performs analogue-to-digital conversion, buffer memory storage/recall and output to PC-compatible computer for display
- Computer control of all PIC program modes
- Selectable dual channel or either channel individually
- Two signal display modes, analogue and digital
- Waveform gain switchable for ×1 or ×10
- Input impedance 10kΩ and 100kΩ
- Maximum input signal level before display clipping 5V pk-pk, or 50V if ×10 scope probe used
- Input switchable for a.c. or d.c.
- Waveform synchronisation (sync) selectable on/off by channel, with controllable trigger levels
- Waveform shift vertically for each channel
- Frequency range: nominally audio, but extending well below 1Hz and above 10kHz
- Frequency counting and waveform amplitude monitoring for each channel, selectable on/off
- Frequency count accuracy presettable from screen for fine tuning, with automatic recall of settings on start-up
- Three sampling modes: via 2Kbyte or 32Kbyte buffer memory, or immediate
- Screen grid on/off
- Waveform display hold on/off
- Waveform data output to disk, on demand or automatic, date and time stamped
- Waveform data input from disk files
- Disk files selectable by mouse from on-screen directory
- Operation via parallel printer port
- Port address selectable on-screen, with automatic recall on start-up
- Screen dump to printer, date and time stamped
- All functions mouse-selectable
- Additional keyboard control for some options
- Power supply, d.c., nominally 9V, but 7V to 15V acceptable, approx 6mA average, on-board 5V regulator

Resistors R12 to R15 bias the PIC's respective input pins to 0V when the computer is not connected.

The PIC is operated at 5MHz, as set by crystal X1, and use of the 20MHz version (PIC16F877-20) is recommended. Whilst the author has successfully "over-run" a standard PIC16F877-4 (nominally 4MHz max.) in this circuit, satisfactory results cannot be guaranteed for other assemblies.

The PIC may be programmed on-board by those who have suitable programmers (e.g. *PIC Toolkit Mk2* of May/June '99). Terminal strip TB1 provides the access connections.

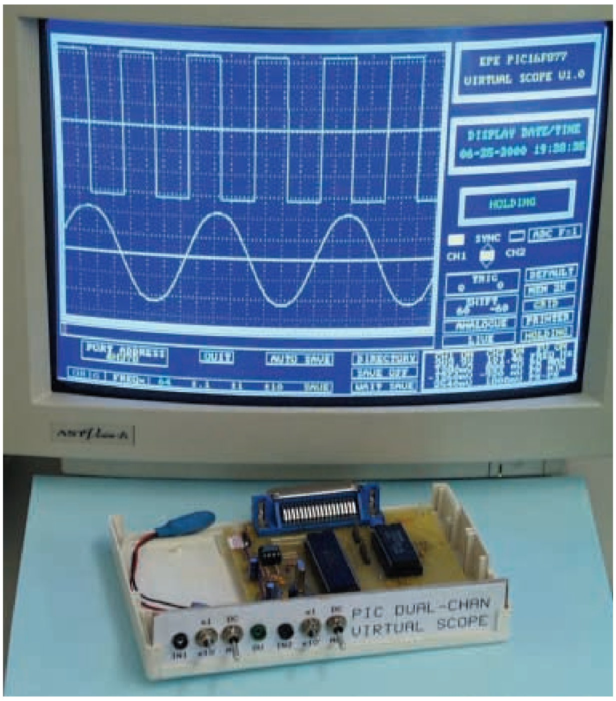
The prototype is powered at 9V d.c., with connection via a PP3 battery clip. A power supply socket could be used instead. The circuit may be powered at between 7V and 15V d.c., with an average current consumption of about 6mA.

Full software, including source code, is available on 3·5-inch disk (for which a nominal handling charge applies) or *free* via the *EPE* web site. Pre-programmed PICs are also available from an external supplier. For more details see this month's *Shoptalk* page.

PROGRAM OPERATION

Whether the PIC is instructed by the computer to sample with or without using the buffer memory, the basic process is the same. It samples the analogue input signals as fast as it can, converts them to digital format which it sooner or later outputs to the computer.

A series of handshake commands are exchanged between the PIC and computer in order to maintain the correct sequence of events. The 8-bit data is output as two 4-bit nibbles, which are re-assembled by the computer software to a single byte and plotted on screen according to the value of the signal voltage. The entire sequence of data input and plotting is performed by a set of machine code routines.



This simple but powerful tool allows two signal waveforms to be viewed on a PIC-compatible computer screen.

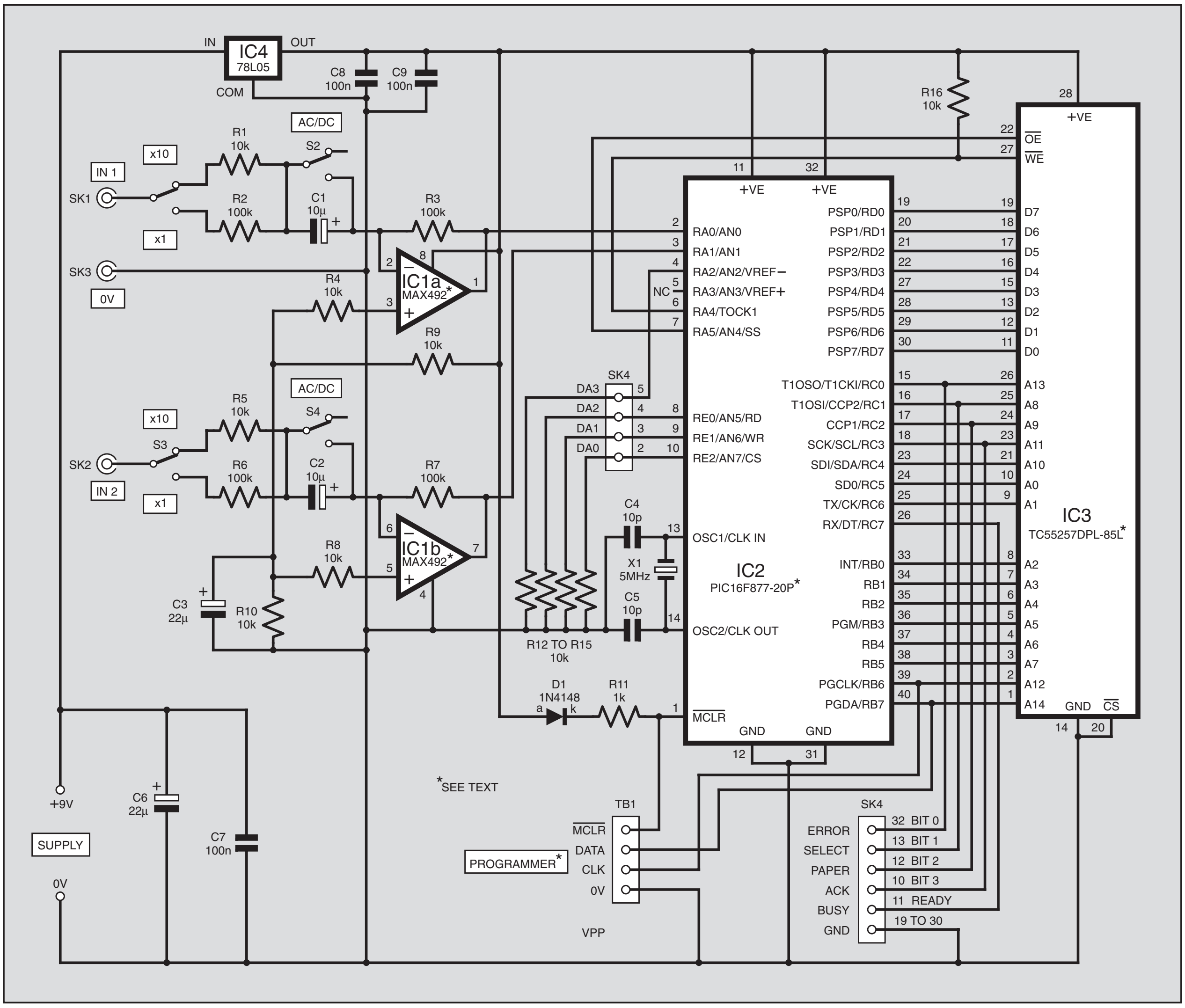


Fig.1. Complete circuit diagram for the PIC Dual-Chan Virtual Scope.

During this process, the computer software assesses the data for display synchronisation, in which repeating signal traces commence on screen at the same relative waveform amplitudes. The sync trigger thresholds can be set under mouse control, both for amplitude levels, and whether positive or negative-going triggering is required. Sync control may be turned on or off via the mouse.

Data is also analysed for signal frequency and amplitude, with the results output to the screen at the end of each waveform traversing the display area. Frequency is quoted in Hertz (Hz). Amplitude is quoted in three values, maximum and minimum peaks, and the absolute difference between the two (peak-to-peak), in volts. This analysis sequence may also be turned on and off via the mouse.

The PIC microcontroller can be instructed to sample either two channels in parallel (the second channel sampled a few microseconds after the first), or either channel individually.

MEMORY

There are two basic sampling modes, immediate or buffered. In the immediate mode the PIC samples and converts the analogue data to digital and immediately outputs it to the computer. The process, however, is slowed by the fact that handshaking and sample taking are interlinked, the PIC and the computer waiting for each other's response before the next sample is taken.

This method is more suited to sampling lower frequency waveforms, of a few tens of hertz or less.

The fastest method is achieved by using the memory buffer, IC3. Samples are taken as in the immediate mode but immediately stored in IC3. Handshaking is not required and the process is entirely under PIC control.

Each sample is output to IC3 via PORTD and with IC3's $\overline{\text{OE}}$ (output enable) pin held high, the $\overline{\text{WE}}$ (write enable) pin is toggled low then high again, an action which causes the data to be stored.

The memory's data address is controlled by PORTB and PORTC, providing a 15-bit (32768 bytes) address range. After each sample is written to IC3, the address count is updated, ready for the next sample.

TWIN BUFFERS

There are two memory buffer modes, 32Kbyte and 2Kbyte, respectively allowing 32768 and 2048 samples to be stored. In dual-channel mode, alternate addresses are used for each channel, with a maximum sample quantity of 16K and 1K per channel. In single channel mode the full allocated block is used by that channel.

When the memory count reaches 2K or 32K, as appropriate, the PIC signals to the computer that the data is now ready to be transferred.

A slightly cut-down version of the sampling routine for one channel is shown in Listing 1. In the actual program, another routine is also called, to determine whether or not the mode needs to be changed.

To read data back from the memory in the same order, the counters are reset, IC3 $\overline{\text{WE}}$ is set high and $\overline{\text{OE}}$ set low with the commands:

MOVLW %00100000
MOVWF PORTA

Data is then recalled from each address via PORTD, with the command **MOVF PORTD,W**. The data is output to the computer, after which the counter is updated and the next sample recalled. The data transfer uses the same handshake protocol as for the immediate mode. The routines are too complex to be listed here.

This buffered technique allows samples to be taken far more rapidly than the immediate mode. There is, though, a brief delay between each sample batch being displayed on screen, but this is usually almost unnoticeable.

The choice of sampling mode is mouse-controlled, the computer sending the mode commands to the PIC via data lines DA0 to DA3.

A summary of the sampling modes is as follows:

- Single channel (A or B): Immediate, continuous, no batch limit
- Single channel (A or B): Buffered, 2048 or 32768 samples per batch
- Dual channel (A + B): Immediate, continuous, no batch limit
- Dual channel (A + B): Buffered, 1024 or 16384 samples per channel per batch

MODE RATES

To simplify programming and, more particularly, to speed data acquisition, separate routines are used in the PIC program for each mode.

There is also a choice of the rate at which the PIC actually does the analogue-to-digital conversion. As detailed in Table 11.1 of the PIC16F87x data book, the maximum rate (**Tosc**) at which the PIC can perform its A/D conversion is dependent upon the frequency at which the PIC is operated.

LISTING 1. Single channel data sampling and storage

```
DX0:        BSF ADCON0,GO        ; start conversion for 1st sample
            PAGE1
            CLRF TRISD           ; PORTD as outputs
            PAGE0
            MOVLW %00110000      ; set WE hi (bit 4), OE hi (bit 5)
            MOVWF PORTA
            CLRF PORTB           ; reset PORTB counter

            MOVF LIMIT,W         ; set limit value into PORTC

            MOVWF PORTC
WAITAD0:    BTFSC ADCON0,GO      ; wait until conversion flag is set
            GOTO WAITAD0
            MOVF ADRESH,W        ; get ADC val
            BSF ADCON0,GO        ; start conversion for next sample
            MOVWF PORTD          ; put it out to mem
            BCF PORTA,4          ; toggle mem WE down
            BSF PORTA,4          ; toggle mem WE up
            INCFSZ PORTB,F       ; inc PORTB counter, is it 0?
            GOTO WAITAD0         ; no, get next sample
            DECFSZ PORTC,F       ; yes, dec PORTC counter, is it 0?
            GOTO WAITAD0         ; no, get next sample
            (end of routine)     ; yes, so end of batch storage
```

COMPONENTS

See SHOP TALK page

Resistors

R1, R4, R5, R8 to R10, R12 to R16	10k (11 off)
R2, R3, R6, R7	100k (4 off)
R11	1k

All 0·25W 5% carbon film or better.

Capacitors

C1, C2	10µ radial elect, 16V (2 off)
C3, C6	22µ radial elect, 16V (2 off)
C4, C5	10p ceramic disc, 5mm (2 off)
C7 to C9	100n ceramic disc, 5mm (3 off)

Semiconductors

D1	1N4148 signal diode
IC1	MAX492 dual op.amp, rail-to-rail (see text)
IC2	PIC16F877-20P microcontroller, pre-programmed (see text)
IC3	TC55257DPL-85L 32Kbyte SRAM (see text)
IC4	78L05 +5V 100mA voltage regulator

Miscellaneous

S1 to S4	min.s.p.d.t. toggle switch (4 off)
SK1 to SK3	2mm single socket (3 off) (see text)
SK4	36-way Centronics socket, right-angle, p.c.b. mounting
TB1	4-way 1mm pin-header strip (see text)
X1	5MHz crystal

Printed circuit board, available from the *EPE PCB Service*, code 275; plastic case, 180mm x 120mm x 40mm; 8-pin d.i.l. socket; 28-pin d.i.l. socket; 40-pin d.i.l. socket; PP3 battery clip (see text); p.c.b. supports, self-adhesive, low profile (4 off); connecting wire; solder, etc.

Approx. Cost Guidance Only* £33 *excluding case

For a 5MHz clock, as used in this design, register **ADCON0** has a maximum recommended **ADCS1:ADCS0** (bits 7 and 6) value of binary 01 (**8Tosc**). However, on experimentation, it was found that the **2Tosc** rate (binary 00) worked perfectly satisfactorily, providing a four-times increase in A/D conversion speed.

Because this higher operating rate cannot be guaranteed for all devices, the PIC software has been given the option for either rate to be selected from the computer (see later). **ADCON0** bit 7 is held low and bit 6 is toggled between high and low to alternate between **8Tosc** and **2Tosc** (respectively).

DELAY CALLS

In the author's *PIC16F87x Mini Tutorial* (Oct '99), an example of A/D conversion was illustrated in which a delay was imposed during multiple sampling routines, in order to allow time for the PIC to fully acquire each analogue value before the conversion is performed.

The PIC16F87x data book discusses this timing subject, but presents a complicated formula for establishing the optimum value. In the *Tutorial* example, delays of 256 clock cycles were given.

Further experience with the PIC16F87x in several other applications, however, shows that this length of delay can be considerably reduced. In the *PIC V-Scope* routine for single channel sampling, the delay caused simply by the number of commands in the routine is all that is required.

For dual channel sampling, though, an additional delay routine is called (**DELAYB**) which, with the **CALL** command itself, introduces a delay of nine clock cycles in addition to that caused by the sampling routine itself.

Without this additional delay, it was found that small amounts of each channel's sampling were superimposed on the other channel's sampling. The reason being that the channels are sampled alternately throughout the full cycle and the PIC uses the same internal conversion circuit for all sampling. The effect was most noticeable when one channel was sampling a 5V logic waveform while the other sampled a lower amplitude analogue waveform.

The sample source inputs are alternated between RA0 and RA1 by toggling **ADCON0** bit 3. The **DELAYB** routine is called immediately following the change of this bit, and eliminates the effect. In fact a delay of only six clock cycles also cured it, but another three were included to allow for tolerance variations between devices.

BEFORE YOU BUILD

Through feedback from readers it is apparent that not all PC-compatible computer systems and their software are capable of running a QuickBASIC or QBasic program with the type of machine code routines that are an integral part of this design.

It is strongly recommended that *before* you purchase any components for this circuit, you obtain and run its program as a test of your computer's suitability.

First though, check that your computer has either QuickBASIC or QBasic already installed. If it has not, the chances are that you have QBasic available on your Windows 95/98 CD ROM. Recent correspondence in *Readout* says that it is to be found in one of the following directories:

Win95: **\other\oldmsdos**
Win98: **\tools\oldmsdos**

There are two files, **QBASIC.EXE** and **QBASIC.HLP**, being the program and its Help file. Make a directory (folder) called **QBASIC** on your hard drive and copy both files into it. To run the program, just type **QBASIC**.

Your *PIC V-Scope* files must all be copied into the same directory that holds QBasic or QuickBASIC. From either version of Basic, then load and run program **PVSCOPE.BAS** (which may also be called via the **PVSCOPE.BAT** file).

It is important to note that *QuickBASIC* must be loaded and run with the command **QB/L**, which additionally loads a QuickBASIC library routine that allows machine code to be run with a Basic program. The *PIC V-Scope* program will crash if the QB library routine is not loaded. *QBasic* has this routine automatically included and does not require (or accept) the **QB/L** command.

On entry, the *PIC V-Scope* screen should appear similar to that in the photographs, except that it will say that it is waiting for a response from the circuit, and will be without signal trace lines. Ignore this statement and check that the mouse cursor arrow is visible and that you can move it around the screen. Additionally check that when you left-click it on the values in the TRIG and SYNC boxes they increment, and decrement if you right-click.

Note that throughout this text the terms *left-click* and *right-click* mean pressing the left-hand and right-hand mouse buttons, respectively. If *click* is used on its own, either button will perform the required action.

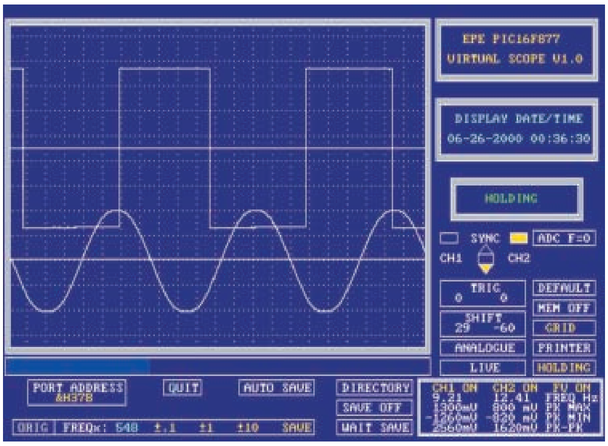
Also check that when either mouse button is held down and any keyboard key (except Q) is pressed, the TRIG or SYNC values continue to change.

If the mouse performs these actions, your computer should be capable of running the rest of the program and controlling the *PIC V-Scope* circuit. Sadly, if it does not do these things, your computer is incapable of controlling the circuit.

QUITTING THE PROGRAM

Pressing Q causes a Quit (exit) from running the program. Left-clicking on the box labelled QUIT causes the computer to "bleep" and a screen statement appears asking if you are sure you want to quit. Left-click if you wish to quit, or right-click if you wish to continue running the program.

If the program has initially been run from the **PVSCOPE.BAT** command, quitting will return you to the screen from which the command was originally given. If the program has been loaded and run from the Basic menu, the program will stop, telling you to "press any key", and then show the program listing within the Basic editing environment. To exit from Basic in this instance, press in turn **ALT, F, X** (the usual exit command keys).



Twin low-frequency waveforms sampled in immediate mode, with negative-going sync applied to Channel 2.

CONSTRUCTION

First a note on the op.amp (IC1) and memory (IC3). A MAX492 dual op.amp having rail-to-rail outputs was used in the prototype. It is likely that other dual rail-to-rail op.amps could be used if this Maxim device is hard to locate (see *Shoptalk* page). Alternatively, a more universal op.amp such the LM358 or TL072 could be used, although their outputs do not swing fully between the power line voltages.

Whilst the TC55257DPL-85L 32Kbyte SRAM (static random access memory) device used for IC3 is readily available, the 85ns access time (as indicated by the 85L suffix) is faster than actually needed and the 100ns version would be acceptable.

Printed circuit board component layout and tracking details are shown in Fig.2. This board is available from the *EPE PCB Service*, code 275.

Assemble the board in order of component size, starting with the link wires, and noting that two go under the IC3 position. Sockets must be used for IC1, IC2 and IC3. Do not insert these dual-in-line (d.i.l.) devices until the correctness of the power supply regulator circuit around IC4 has been proved. The d.i.l. devices are CMOS and require the usual anti-static handling precautions, e.g. touching an earthed (grounded) item before handling them.

Note that some components are mounted directly on the switches. Sockets SK1 to SK3 are 2mm single types in the test model but other types may be substituted if preferred (e.g. BNC sockets for use with proper scope probes).

Use 1mm terminal pins for the off-board connections to the battery clip and front panel components. A 4-pin 1mm pitch pin-header was used for TB1 allowing the author to plug in *PIC Toolkit Mk2* via an existing connector (for on-board PIC programming – see later).

In the photograph of the p.c.b., two additional pin-header strips plus a preset pot are visible. These were purely for the author's use during program development (an l.c.d. was used to monitor various aspects) and are not required for the published version. Ignore the unused holes seen in the p.c.b. component layout.

The plastic case used has detachable front and rear panels and measures 180mm × 120mm × 40mm. A source part number is quoted on this month's *Shoptalk* page. In the prototype, the front panel components are positioned 12·5mm (0·5in) apart. The rear panel was omitted, allowing easy access to the computer connection socket, although a suitable slot could be cut if preferred.

If the unit is to be used with an external power supply rather than a 9V battery, a socket could be added to the front or rear panel.

FIRST CHECKS

Having thoroughly checked the complete assembly for satisfactory solder joints and component positioning, apply power and check that +5V is available at the output of regulator IC4, and at other principal points shown in the circuit diagram.

If all is well, the PIC can be programmed on-board, via the TB1 connector. The *PIC Toolkit Mk2* programmer is ideal for this. The configuration settings required by the PIC before loading it with the program itself are those shown in Table 1. Insert IC1 and IC3 after the PIC has been programmed.

Table 1. PIC16F877 configuration settings

CP1	CP0	DBG	NIL	WRT	CPD	LVP
1	1	1	1	1	1	0
BOR	CP1	CP0	POR	WDT	OS1	OS0
0	1	1	0	0	1	0

PORT REGISTER

Any PC might have any one of three possible parallel printer port register pairs set as the active input/output address. In hex, the addresses are 378/379, 278/279, 3BC/3BD. The *PIC V-Scope* program must be set to use the same address pairs as set within the computer's own system configuration.

When the *PIC V-Scope* Basic program is run, the "waiting response from circuit" message will initially be shown, but should disappear when the unit is plugged in and switched on, providing the correct port address applies. The initial port address default value is for 378/379.

If the message does not disappear, click on the PORT ADDRESS box at the bottom left of the screen. The value will change from showing &H378 to &H278 (&H being the prefix recognised by QB as meaning hex). If the message still does not disappear, click again to show &H3BC. A third click returns to &H378. The program automatically deduces the secondary address (e.g. &H379) from the primary.

If none of these addresses cause the computer to recognise that *PIC V-Scope* is connected and powered, recheck your assembly and its connections.

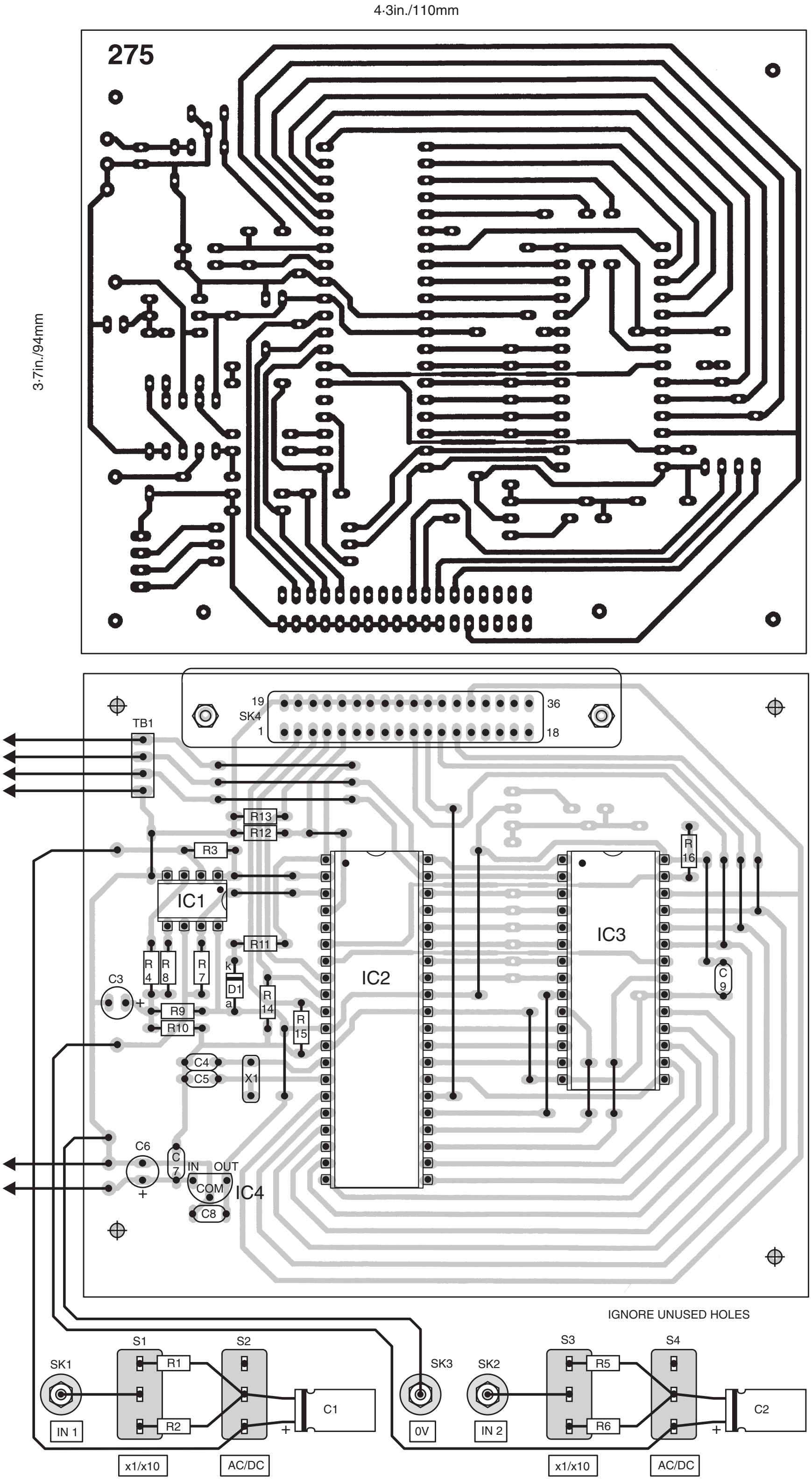


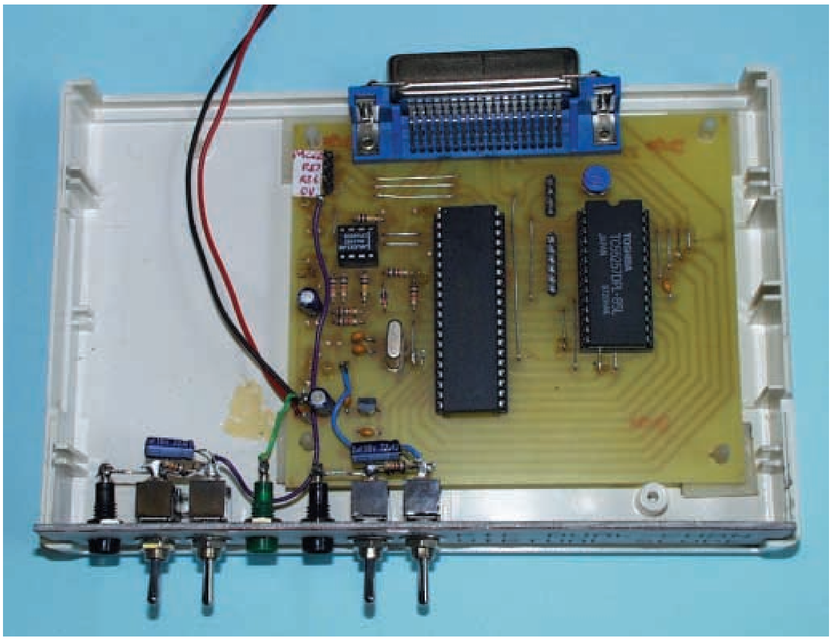
Fig.2. Printed circuit board full size copper foil master pattern and component layout. Ignore unused holes (see text).

When the message disappears, the display area fills with a grid and two horizontal lines. The program and unit are now successfully operational.

The selected port register address value is automatically stored on disk (file **PSCOPATH.TXT**) and is recalled when the program is next loaded and run.

USING THE SCOPE

With the *PIC V-Scope* connected and powered, on entry to the program screen the dual-channel mode is operational. Without signals being input to the circuit, two continuous horizontal lines will be seen across the display area. They are the signal trace lines for Channel 1 (upper) and Channel 2 (lower).



Details of the assembled prototype. Ignore the preset pot and extra pin-header strip seen on the p.c.b. (see text).

There are in fact two continuous lines in each position, the second indicating the 2·5V midway reference for that channel. Due to component tolerances in the circuit, there may be a slight displacement between the trace and reference lines. The latter is generated by the computer as the reference level, the other depends on the actual midway voltage as seen by the PIC's ADC.

You may also just be able to make out a third line, which is dotted. This is the synchronisation trigger line, showing the level at which sync and frequency values are referenced.

Move the mouse pointer above the left-hand TRIG value (0 at present) and repeatedly left-click on this value. The dotted trigger line will be redrawn slightly higher up the screen on each click, immediately recommencing from the left even if the trace has not reached the right of the display. Right-clicking will lower the line position. The TRIG value in the box will increment or decrement accordingly on each click.

Clicking on the right-hand TRIG value similarly alters Channel 2.

As said earlier, pressing any keyboard key (except Q) while a mouse button is held pressed, progressively changes the TRIG value. The redrawing of the screen data, however, waits until the key has been released.

Clicking on the SHIFT values changes the relative positions of all three lines for the selected channel.

Connect a signal generator to input 1, with an output frequency of about 1kHz, and with any reasonably uniform waveform shape. Set the input switches for ×1 and AC.

Note that if *PIC V-Scope* is battery powered, there must be a connection between its common (0V) socket SK3 and the common (ground) line of the signal generator or its power supply.

Increasing the amplitude of the input waveform from zero, observe the waveform similarly increasing on the screen display. Experiment with shifting the display up and down, and with changing the input frequency.

Clicking in the column headed CH2 ON at the bottom right of the display turns off Channel 2, with the heading changing to CH2 OFF. Channel 1 is now displayed on its own, more centrally on the screen. As the PIC is now only sampling one channel, the process is quicker and the waveform on screen is seen to be expanded horizontally – fewer cycles across its width.

Clicking on CH2 OFF restores Channel 2, with Channel 1 returning to its previous position and cycles per width.

Column CH1 ON behaves in the reverse fashion in respect of Channel 1. The program prevents both channels being switched off at once.

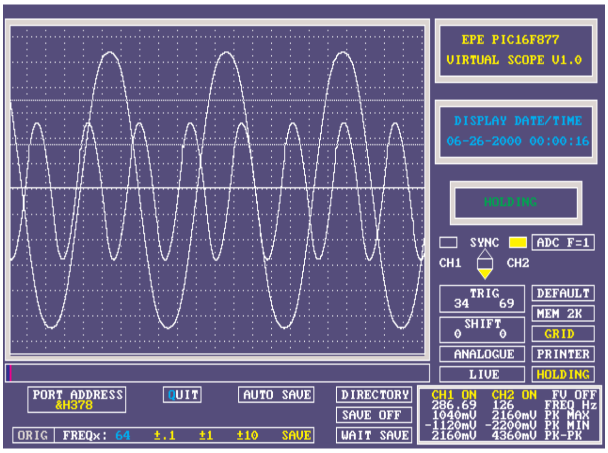
MEMORY BOX

The PIC is currently sampling with the buffer memory set for 2K bytes. A right-hand screen box confirms this, stating MEM 2K. Left-clicking on this box sets the buffer memory for 32K bytes, confirmed in the box as MEM 32K.

The waveform is now plotted at the end of this much longer sample batch, each screen-full consisting of consecutive sections of the memory. There is a brief pause when the memory has been down-loaded and the next batch is sampled.

A blue bargraph below the display area shows the progress of the sampling and display.

Left-clicking on the MEM 32K box puts the program into immediate mode, in which the buffer memory is not used, confirmed as MEM OFF. Waveforms are now much more closely spaced since the sampling and output process is slower, as stated earlier.



Twin waveforms sampled in MEM 2K mode. Note the dotted sync trigger lines, with the larger waveform negatively triggering just after its peak.

Left-clicking on MEM OFF returns the mode to MEM 2K. The MEM box can be right-clicked to select the options in the reverse order. The process is fully cyclic.

SYNC

So far you will have found that each waveform screen-full has started at different points in the waveform. Using SYNC stabilises the display so that repeating waveforms start at similar amplitude points.

Centre-right of the screen are the sync control boxes. The box to the left of the word SYNC is shown as yellow, indicating that sync is switched for Channel 1. However, the 3-box "lozenge" has its centre section in yellow, indicating that sync is turned off.

Clicking in the upper or lower triangles turns them yellow instead, indicating that sync is now active, triggering on the upwards or downwards edges, respectively. Clicking on the central box again turns sync off. Clicking in the box to the right of SYNC allocates sync to Channel 2.

The position in the waveform at which sync is triggered is changeable via the TRIG box, as described earlier. Note that if the value is set outside the amplitude range of the signal, the display will freeze because the trigger amplitude is not being found. There is a narrow "window" of values through which the waveform has to pass for the sync level to be recognised.

Sync may be turned off while the display is frozen. There might be a brief pause before the mouse button is responded to due to a time-out routine while a sync level is being sought from the input signal.

DISPLAY HOLD

Clicking on the RUNNING box (lower right) causes the display to hold once it has reached the right-most point, upon which the word HOLDING is shown. Pressing any key (except Q) steps the display onto the next batch of samples. Clicking on HOLDING restores the program to RUNNING mode.

SCREEN GRID

Clicking on GRID (lower right) toggles the display grid on and off. Each vertical grid square represents approximately 400mV. The full screen height represents about 5V. The program does not allow signal amplitudes to be "tuned" precisely. This would have required extra processing commands (and thus time) both for the PIC and the data acquisition program, slowing down the display.

For a similar reason, the horizontal grid squares are not time/frequency related. Both vertically and horizontally, the grid should be used only as a guide to the relative positions of waveform points.

WAVEFORM SAVING

Waveforms can be saved to disk (in the same current QB directory/folder on the hard drive), under automatic or manual control. For the manual saving option, click on SAVE OFF (lower centre) to reveal SAVE ON. When a full batch of samples has been received, the WAIT SAVE box changes to SAVE NOW.

Left-clicking on the SAVE NOW box causes the raw waveform data (numerical values) to be saved with a unique coded time and date file name, which is displayed at the top of the screen until the next batch is waiting to be saved.

Right-clicking on WAIT SAVE aborts the save option for the current batch.

Clicking on SAVE ON turns off the saving mode.

Clicking on AUTO SAVE causes each batch of data to be saved upon completion, again with timed and dated file names. This mode automatically sets the buffer memory for 32K if it is currently in 2K mode. In MEM OFF mode, 32K samples are always saved. All saved files hold 32K samples.

SAMPLE RECALL

Saved sample files can be recalled via the DIRECTORY or LIVE boxes. Left-clicking on either clears the display screen to show a directory of the sample files on disk. If there are no files yet saved, the screen tells you so, reverting to the display screen once the mouse button is released.

Files are listed with their coded names and can be selected via the mouse. Moving the mouse causes a highlight bar to shift over the file names. Left-clicking on a name reveals a lower screen line which asks if you wish to load that file, showing its code name and the time and date it was saved. To accept the file either left-click or press "Y''. Doing so loads it and returns to the display screen, showing the loaded waveforms.

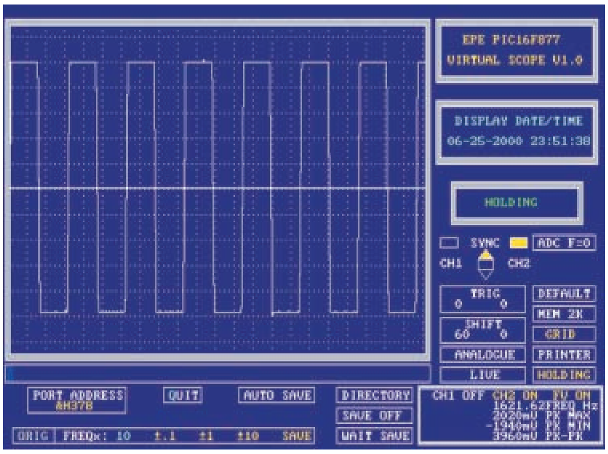
Right-clicking or pressing "N" at this time allows you to choose another file.

Before a file name is selected, the directory can be exited by right-clicking. The highlight can move across most of the screen, but only a proper file name can be accepted, except any shown in the first line.

The first line shows the file name of the current replay waveform (if loaded). It also shows, at top left, the most recent file name selected by the mouse. This name cannot be selected from this position, the location is used by the program when reading the screen data. (Reading from the screen for directory purposes is quite complex, as a study of the program's source code will reveal.)

During replay mode, the LIVE box changes to show REPLAY. The SYNC, TRIG and SHIFT values become those at the time of recording. These and some other boxes become coloured red. The memory mode and save options are inoperative during replay.

To revert from replay mode to live sampling, right-click on DIRECTORY or REPLAY.



Displaying a single square waveform via Channel 2, with Channel 1 turned off.

FILE NAME CODING

Saved waveform file names are coded in exactly the same fashion as used with the original *V-Scope*. The following is an example:

File name = 07913713.Y00

Imagine it split as 07 9 1 37 13 .Y00

Digits 1 and 2 = day of month (7)
Digit 3 = month number in hex from 1 to C (9 = September)
Digit 4 = hour in hex-fashion – 0 to 9 followed by A to N (0 to 23), in this case 1 = 1 a.m. (post-midnight oil and toil in the workshop yet again!)
Digits 5 and 6 = minutes in decimal (37)
Digits 7 and 8 = seconds in decimal (13)
.Y00 = year 2000 (who cares about Millennium Compliancy in this instance!)

The example file name thus decodes as 7 September 2000 at 1:37.13 a.m. and would be shown as 07SEP00 1:37.13 if selected.

Saved files can only be deleted from DOS or Windows.

FREQUENCY COUNTING

While waveform batches are being input, they are analysed for signal frequency. There must be at least three waveform cycles displayed for frequency to be calculated. The total number of amplitude changes above and below the trigger threshold is counted and at the end of the batch input this value is related to the number of sample bytes and then to a conversion value depending on the channel and buffer memory modes in use.

As explained earlier, the data acquisition rate changes depending on these modes and in relation to the speed at which the PIC and the computer process data.

Since these factors will be different for individual users, an on-screen correction facility has been provided.

The long oblong box at the bottom left of the screen is the area from which the values can be changed. The word FREQx: is followed by the value (in blue) by which the basic frequency count result is to be multiplied. Initially, this is the default value used by the author with the prototype. To the right of this value are three increment/decrement options. Clicking on these will change the multiplying value by the same amount, left-click upwards, right-click downwards.

Frequency factor correction needs to be done for each channel mode and using different settings of the frequency generator (which should be calibrated or have a frequency count display). Table 2 shows the modes and their suggested alignment frequencies for ADC F = 0 and ADC F = 1 (see later).

For each mode, change the screen's frequency multiplying value until the frequency box at the bottom right shows close to the same frequency value(s) being input. Exact matching of the values should not be expected due to the nature of the sampling and analysis process.

During frequency alignment, a "Save when done'' message is shown above the box. When you have finished alignment, click on SAVE in the box. The new factors will be stored in file **PSCOPATH.TXT** and will automatically be recalled when the program is next loaded and run.

Table 2. Suggested channel alignment modes and frequencies.

CHAN 1	CHAN 2	MEM	FREQ (F=0)	FREQ (F=1)
On	Off	Off	200Hz	200Hz
Off	On	Off	200Hz	200Hz
On	On	Off	200Hz	200Hz
On	Off	2K	10kHz	4kHz
Off	On	2K	10kHz	4kHz
On	On	2K	2kHz	1kHz
On	Off	32K	10kHz	4kHz
Off	On	32K	10kHz	4kHz
On	On	32K	2kHz	1kHz

The word ORIG is at the left of the box. Clicking on this recalls the author's default values, which you then have the option of saving in place of your own if you wish.

Correction of the frequency values can be done on any occasion you want.

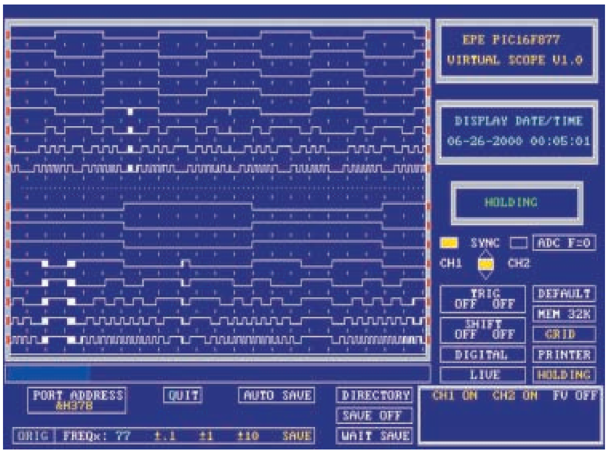
DIGITAL DISPLAY

So far the sampled data has been displayed as analogue waveforms. There are two other modes available, Digital and Lissajous.

Left-click on the ANALOGUE box (lower right). It changes to DIGITAL and a whole mass of waveforms appear on screen, up to 16. They are in two groups of eight, representing the eight bits of each channel's samples. The bits are in ascending order on the screen, bit 0 (LSB) lowest in each block, bit 7 (MSB) highest.

The digital display option was principally used in the original *V-Scope* to display 8-bit digital signals via separate input lines, but it seemed worthwhile leaving the mode in *PIC V-Scope* even though the input channels are analogue.

Frequency and voltage analysis are turned off in this mode, as is their display box at bottom right. Channels may still be turned on or off in this mode.



Digital display screen showing the 8-bit logic levels for two analogue input waveforms.

LISSAJOUS

Left-clicking on DIGITAL moves the display on to LISSAJOUS mode. Lissajous is that mode in which one channel provides vertical deflection while the other controls the horizontal. In a real scope it can be useful in visual comparison of frequency and phase between two signals.

It was written for the original *V-Scope* in which the sampling repetition rates are fast. Frankly, though, it has no realistic use in *PIC V-Scope*, other than as a visual curiosity. However, it seemed a pity to delete it and it has been retained purely for that reason.

Left-clicking on the display mode box (now showing as LISSAJOUS), returns the display to analogue mode. Right-clicking reverses the mode display order of selection.

PRINTER OUTPUT

The use of the PRINTER box (lower right) is the same as with the original *V-Scope*, and requires the printer port cable to be temporarily removed from the unit.

When the screen is HOLDING, its display can be output to some types of printer by clicking on PRINTER. The machine-code routine was originally written for an Epson ESC/P2 compatible 24-pin dot-matrix printer but has been found to also work with an Epson stylus Photo 750 ink-jet printer.

It seems probable that other similar Epson printers can also be used. Nothing is known about laser printers in this context – reader feedback to the Editorial office will be appreciated, for possible inclusion in *Readout*.

The entire screen display is printed (in monochrome), including the boxes as well as the waveforms.

Once the print is complete, reconnect the cable to the unit and click on DEFAULT, as discussed in a moment.

Do not click on PRINTER if the printer is not ready to receive data. Doing so could cause a **Device Fault** error from the computer and a program crash.

You may be able to recover from the crash by ensuring the printer is ready and then pressing the <ENTER> key on the screen error display word OK. This will reveal the program listing at the point at which the error occurred. Now press function key <F5>.

If the computer finds that all is well, it will resume the program at the point where it crashed and send the screen data to the printer. Failing that, you will need to fully restart the program by using <shift-F5>.

If you are running the *PIC V-Scope* program through Windows, you can produce screen dumps which can be printed in colour (if you have a colour printer!). When ready, with the program Holding, press the keyboard's <Print Screen> key. The screen will momentarily flicker as data is copied into the Windows clipboard. Now exit the program.

From the Windows desktop screen left-click the Windows Start icon to reveal the Start menu. Select Programs, select Accessories and then select Paint. Within Paint click on Edit and then on Paste. The image stored in the clipboard will be placed on screen. It can be saved under whatever name you choose, as well printed out to paper.

If the program is being run under MS-DOS, the <Print Screen> key works differently. The screen's text data is output directly to the printer, but not the graphics data (unless you have a DOS Graphics routine installed and active – consult your MS-DOS handbook).

OTHER OPTIONS

FREQ OFF

The frequency and amplitude analysis routine may be turned off or on by clicking in the FV ON column at bottom right. This does not affect the rate at which the PIC samples data, but does increase the rate at which each sample batch is displayed.

DEFAULT

If *PIC V-Scope's* power is interrupted while the display program is running, the PIC's mode setting data will be lost and it will revert to 2K 2-channel mode when reconnected. The same thing could happen if the printer port lead is disconnected (as is necessary when screen-dumping to a printer).

In this situation, once power or the printer lead are reinstated, it is necessary to click on the DEFAULT box to restore the PIC's mode values to those being used by the display program.

ADC BOX

The ADC box, middle right, can be clicked to alternate between F = 1 and F = 0. This toggles the **Tosc** sampling rate value discussed earlier.

DATE/TIME BOX

Towards screen top right is the Display Date/Time box. This is updated on each completion of a waveform plotted across the screen. It should not be regarded as a true real-time clock since it is not updated while sampling is taking place, nor when the display is being Held, nor when the printer routine is in use.

INFO BOXES

The top-right box shows the program identity and version number. The current version is V1.0. This number will be updated should any program modifications be introduced (which will be reported in *EPE* if they are).

The third box down on the right was originally introduced for the author's development information. Regard it as you wish – it has no significant user value!

OTHER READING

Discussing how to get the best out of any type of scope is beyond the reach of this article. However, the *EPE* feature article *More Scope for Good Measurements* (June/July –96) is a useful text to read. See the *Back Issues* pages.

May you too find *more scope* for improving your understanding and successful construction of electronic circuits through using *PIC V-Scope* (and continuing to read *EPE*)! □

READOUT

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 ★

TRIALS AND TRIBULATIONS

Dear EPE

Greetings from Zimbabwe. I have been a keen follower of *EPE* for the past four years and have built some of your projects. One of them has helped me earn a National Certificate in Electronics Servicing from the Ministry of Higher Education and Technology.

I have been a student at a government college, studying Radio and Television Servicing for the last three years. One component of our syllabus required us to construct a project and write explanatory notes on it. All this had to be done in 10 supervised two-hour lessons a month before we sat for our final exams.

Due to the easy availability of *EPE* I chose the *Variable Dual Power Supply* by Tony Sercombe (Sept '99). I found it to be a very useful piece of equipment for a future technician like myself. Simple as the project seemed it had its trials and tribulations during its construction.

First of all, the town I was residing in didn't have a reputable electronics shop, so I had to source a lot of components from old circuit boards and scrap radios. I got all the resistors and capacitors, but had difficulties in getting the LM301 and TIP142/7 devices and had to travel to the capital city (Harare), 300km away.

After all the components had been sourced it was now time to etch the p.c.b. and assemble the project. There was to be one etch resist pen and 100ml of ferric chloride (provided by the college) which was to be used to etch all the 13 p.c.b.s of my class. By the time it was my turn to etch my board, the etching pen had been used up, for my classmates had been making mistakes on their boards and re-doing them again. The etching solution was now saturated with copper and it was taking up to a day to etch a 10cm² board. So I now had to use gloss enamel paint as etch resist and had to boil the etching acid to speed up the etching. It came out just fine.

After the project had been assembled and cased it was submitted and ready for assessment by the responsible authorities and it was now time for me to revise all my work, for it's rather unfortunate (or is it?) that our courses run for three years and are examinable in only three hours. So I had to read all I had learnt in the past three years in three weeks and had to be prepared to write four three-hour exams.

It was here that I fully appreciated your magazine and would like to extend my sincere gratitude and appreciation to Ian Bell, Rob Miles, Alan Winstanley and John Becker and everyone else at *EPE* for the *Teach-In 1998* and *Teach-In 2000* series. These two proved to be easy reference notes as they covered almost my entire electronics syllabus and were easy to understand with the short time I had to prepare for my exams.

I sat for my final exams in a happy mood thanks to *EPE*. I do believe that yours is quite an understandable magazine, although as of late I have been noticing that you are moving towards PICing everything. This, however, might disadvantage a lot of readers from Africa for these PICs are not available in many government institutions like ours.

I would also like to extend my sincere thanks to Mr A.G. Edwards who provided me with an electronics design assistant disk which I used fully during my studies. It was great that I got hold of *EPE* through my course and from that day on I have treasured this magazine more than any other electronics magazine. I have graduated from college with a certificate and am ready to face any challenges and jobs that come my way and part of the credit goes to you at *EPE*.

Innocent Mutasa,
Mkoba, Gweru, Zimbabwe

We are delighted to hear of your success and that you pay tribute to us for helping you achieve it. Your letter also brings home how fortunate we are in the UK to have components so readily available, usually by return of post mail order, but also by nipping round to a local electronics store in some cases. Having to travel 300km to buy components must really sort out the committed electronics enthusiasts from the dabblers.

In theory, of course, mail ordering from the UK should work for wherever people live worldwide. What, though, is the general experience of overseas readers who are not necessarily living in cities? Is the postal service in your country speedy and reliable? Share your experiences with us.

FREUND PULLING

Dear EPE,

I have been reading your interesting magazine for a few months now. I started computing, with the Acorn Electron, in 1986 when I was 14. I subscribed to the *Electron User* and the contacts I won through it helped to improve my English a lot. Unfortunately, most contacts have been lost and I would like to make new contacts again.

Could you please print this letter in *Readout*? My interests are microcontroller programming, electronics, music listening and general interest in almost anything. I look forward to hearing from anybody who wants to write!

Oliver Debus, St. Ulrich Str. 12,
85354 Pulling, Germany

Nice to hear from you Oliver. We do not recall being asked to publish pen-friend requests before and hope that you have success making many new contacts.

PIANO TUNING

Dear EPE,

As a pianist as well as subscribing to *EPE*, do you know of, or could suggest where to approach for a tried and trusted digital system, if it exists, for tuning one's own piano?

F.J. Misson, via the Net

You might consider PIC-a-Tuner *of* EPE *May 1997.*

SINCLAIR ZX

Dear EPE,

The many letters on using Basic are very interesting, as is Peter Gardner's letter about the Sinclair ZX computer (July '00). Unfortunately, the Sinclair ZX was the best and last computer to use a good Basic, and many owners learnt Z80 machine code on it. I have always been surprised that nobody ever brought out a program to enable the PC to handle a proper Basic and let it deal with machine code in the excellent way the ZX did, which means among other things, the reclaiming of empty memory space each time and not just bunging programs into next available memory area.

I currently use Turbo Basic, which compiles into machine code before running. Again this is no longer available and I am looking for an alternative, as this is still very slow and seriously well past its sell by date. I have used it to make platform shoot-em-up games and simple programs to check the lottery, but I need something better.

In the days of Sinclair ZX computing, users took a genuine interest in how their computer worked and a huge number of people learnt ZX assembler language for speed. Sadly the majority of users switched to being just games players. This in the short term increased computer sales. In the long term it meant less and less people capable of writing computer programs (in Basic or code) and the eventual demise of genuine computing. The PC, although basically a business computer, was in great danger of heading into oblivion as far as the home user was concerned, but was rescued just in time by the build-up of the Internet.

The only way now is to use QBasic, as it is available. You cannot hope to use it properly without a book on it, or print out the very lengthy Help pages held in your computer. Learning 8086 code would help as you could use it for any parts of your program you need to do at speed. This is not the easiest of languages to learn, but if you learnt another computer language in the past, learning a new one is surprising easy.

G. A. Bobker,
Unsworth, Bury, Lancs

Curiously, I never got on with Sinclair machines but did take to the Commodore PET 32K and C64. It was with the PET I learned 6502, which was to hold me in good stead when upgrading to PCs and 8086 machine code. The latter still forms part of any of my QBasic/QuickBASIC programs that require machine code for high speed sub-routines, using the excellent shareware A86/D86 assembler/disassembler. However, I must admit that I have not yet cracked how to fully integrate the machine code with Basic, although I have evolved a workable "good-bodge" solution (as a study of such programs will reveal, e.g. the PIC V-Scope PC interface in this issue).

But, yes, you are right, learning a new programming language is easier if you have had experience with others. This is a fact I point out to readers who want to get into PIC programming – if they have already proved they have the logical thinking capabilities required for programming, migrating to PICs is a doddle!

CANUTE TIDE DISPLAY

Dear EPE,

Following your instructions in *EPE* June '00, I embarked on putting together one of the *Canute Tide Predictors*. I took the easy route and got almost all the components from Magenta, including a pre-programmed chip.

It has been many years since I carried out such a project but the idea of a tide predictor had me enthralled. Happily, I got everything together last weekend and *bingo* everything seemed to work as described. Unfortunately, only five days passed and the display started to lose its contrast. A quick adjustment to the variable resistor restored clarity, but a day later it faded again. Please advise what is the life expectancy of a PP3 battery operating such a tide predictor 24 hours a day, and what current should the unit be drawing? I would like to leave the unit on all the time but a PP3 per week seems a little steep.

Richard Berney, via the Net

Canute's *current consumption was quoted at just under 6mA. I believe a typical alkaline PP3 is rated at about 550mA/hours, so in a worst-case situation you might get close to 100 hours per battery. However, you are likely to get a bit more life since* Canute's *regulator can accept down to 7V and still provide a 5V output.*

But, having quoted 6mA current, it was assumed that readers would recognise that for long term use Canute *should be run from a mains adaptor (9V battery eliminator). Only if a circuit draws a few microamps should long term battery use be ever considered.*

Incidentally, it is aggravating that not all battery suppliers quote the charge capacity of their products. It is appreciated that the amount of charge a battery can deliver is subject to conditions of use and storage etc, but a guide to life expectancy under broad typical conditions would seem to be an essential requirement.

Surely this is something that the EU should investigate. As a consumer, this matter is of far more significance to me than whether or not measurements are quoted in Imperial or metric.

The figure of 550mA/hours was quoted unconditionally in Farnell's and Rapid's catalogues in respect of Duracell alkaline PP3. Maplin's had the decency to quote a condition of "0·55Ah at 470Ω for 36 hours to 4·8V" for seemingly the same battery. No mention of capacity could be found in the RS catalogue or CD-ROM.

Lithium PP3 batteries appear to have twice the capacity, but at twice the price. Rechargeable NiCad PP3 types are a bit cheaper but have a capacity quoted at only 110mA.

MOODLOOP

Dear EPE,

I read with some concern the description of the *MoodLoop* (Aug '00). I have recently been doing some casual research into the effects of low frequency electric and magnetic fields on biological systems, and I have come across a wealth of published research papers which all clearly indicate that extremely weak, ultra-low frequency (ULF) magnetic fields have profound effects on cell growth and metabolism in most organisms, from the viral level upward.

In general, the effects are difficult to quantify but many indicate that pulsed or alternating magnetic fields of only a few nano-Tesla, particularly in the range of 1Hz to 100Hz can, depending on frequency, either profoundly inhibit or stimulate cell processes like DNA replication, mitogenic division, RNA transcription and protein and enzyme synthesis. Some reports indicate that nT intensity fields in the range of 16Hz to 18Hz have various effects (both stimulatory and inhibitory) on human T-lymphocytes which are one of the body's primary defences against cancer.

Many studies also indicate that the effects are most pronounced and unpredictable on growing organisms and many researchers believe there is a definite link between childhood leukaemia, miscarriages, foetal deformities, cot death and weak ambient ULF magnetic fields.

I am sure that you and Andy Flind, the designer of the unit, were not aware of this and I am sure very few people are. However, under the circumstances I believe you owe a duty to your readers to publish a health warning that clearly explains that the fields produced by this device (and possibly earlier variants as well) may potentially cause serious health risks and may be particularly dangerous to pregnant women and children.

For the record, I applaud Andy Flind for his work and your magazine for publishing innovative designs.

Aubrey Scoon,
Bracknell, Berks, via the Net

Our understanding of the information periodically sent to us by the National Radiological Protection Board (NRPB) is that there is no proven evidence of human health risk from electrical and magnetic fields, although they continue to actively research the situation.

Nonetheless, we bring your comments to the attention of readers and have sent a copy to Andy Flind. Also relevant, perhaps, is Andy's Magnetic Field Detector *in this issue.*

QB-DRIVEN

Dear EPE,

After reading the letters from Bob Allan and Peter Gardner, prompting your reply in *Readout* July '00, I thought it too much of a coincidence not to send you a reply via E-mail.

I'll explain myself. Back in the mid-eighties when computing was new to the great unwashed, I did a fair amount of programing in Basic with a Commodore 64. Over a period of time I became proficient enough to do some programing that could be put to useful practical work, at my daytime job (I was, and still am, an LGV Driver). Anyway to get to my point quickly, after many years of doing other things in my spare time (getting a life and a wife and in 1999 a PC for her work), I gradually started messing around with computers again. My, how the world had moved on.

Confused by so much choice I messed my brain up with a little bit of this language and a little bit of that, getting nowhere fast. To re-orientate myself, I invested in a book I picked up in desperation, called *Writing your First Computer Program, Your Shortcut to Success*, published by IDG Books Worldwide (ISBN 0764585231). In chapter four, it confirms Alan S. Raistrick's E-mail referred to in your reply, namely that QBasic is included on every CD-ROM with Windows 95 and 98.

Michael Moxon, via the Net

Thanks Michael for this useful further confirmation. We are much relieved to find that all PC users can have the benefit of using QBasic; so much of our software is written for QB (as well as PICs), such as the PC interface for the PIC V-Scope *in this issue, for example.*

PIC TUTORIAL

Dear EPE,

I have been following with interest the recent correspondence in your magazine regarding difficulty with parallel ports. Some while back I purchased the *PICtutor* CD to go alongside the *EPE PIC Tutorial* and a PIC board. After many fruitless hours I could not get programs to download to the board, and moved on to pastures new.

However, after reading July's *Readout* I tracked down a copy of Basic on my Windows 95 CD, and tried the troubleshooting method as suggested in the *EPE Tutorial*, with my oscilloscope connected to D0 and D1 of the PIC. This worked fine, and when I reconnected the board, magically I could download programs.

Chuffed to bits, I merrily started working on the Tutorials, this lasted for three happy evenings, but next time when I came to use the board, yet again no joy. I tried reconfiguring the PIC, still with no joy. The PIC accepted the TUTCLR program but wouldn't accept anything else.

However, I believe I've sussed it out. I borrowed a laptop off my neighbour to use the board, and hey-presto the PIC downloaded and ran the program with no problems. Checking the differences between the PCs. I found that my PC maintains lines D0 and D1 at 5V, unlike the laptop (0V). Changing the printer drivers made no difference, still both lines were at 5V. The PIC seemingly will not accept a program when these lines are at a background 5V.

To overcome this, I now send a file (e.g. a Word document) to print. This document is automatically held in the pause mode. If I take it out of the mode (by unticking the "pause printing" selection in the printer menu), I get a dialogue box warning of a print error and asking to re-try etc, but, in doing so, it takes the two lines D0 and D1 to 0V. If I now ignore this dialogue box (don't close it, as it deletes the print-job, thus taking the lines back to 5V), I can then happily download programs to the PIC.

My info may be of help to your readers. I use a Time 200MHz Pentium MW machine.

Phill Davies, via the Net

Thanks Phill. It's curious how "PC-compatibility" can be so diversely interpreted! It seems also that interfaces via some parallel printer ports really need buffering I/O devices included, as I provided with the Toolkit Mk2 *programmer.*

ISOLATING TRANSFORMERS

Dear EPE,

I am writing as a result of glancing through *Teach-In 2000* Part 10 (Aug '00), covering transformers and rectifiers.

Years ago, whilst attending a TOPs course at a small London training college, my teacher mentioned in passing that a particular piece of electronic equipment should incorporate a 1:1 isolating transformer, in order that the equipment should not be connected directly to the electrical mains. Although you describe an 1:1 isolating transformer, you do not say how it provides safety through isolating equipment from the mains supply.

Even more years ago, whilst working for a company which was involved in the manufacture of infra-red emitting diodes and integrated circuits, I first learned of the rectifying (diode) bridge and imagined that all power supplies used this device. Much later, whilst attending the previously-mentioned training college, I learned about other types of diode and transformer rectifiers, such as the ones which you discuss. Why, if the diode bridge is such a good device, do other circuits exist, at all?

M.P. Hopkins,
Barnes, London

The basic safety provided by an isolating transformer is that its output windings are not connected to the mains earth. They are said to be "floating" with respect to it. In other words, if you touch a terminal of "floating" winding, you are not completing a circuit between it and the mains supply. You will recall that in order for current to flow, there must be a path between the positive and negative terminals of the current generator. You will only complete an electrical path across the secondary winding of an isolating transformer if you touch both its terminals simultaneously.

Expediency dictates what form of power supply rectification is used. The considerations include whether voltage or current is the most important (see the Demo software formulae), relative expense of diodes and bridges (especially on a commercial scale), and also space available on a p.c.b., to name but a few.

For more information on mains a.c. generation and supply, read Alan Winstanley's interesting two-part article Power Generation from Pipelines to Pylons *(Aug/Sep '99).*

SURVEILLANCE

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To increase the security of the transmission the audio is subcarrier modulated. Receiver now requires the decoder module (SCDM) connected to allow monitoring. Size 20mm x 67mm, 9V operation, up to 1000m range. ***£24.95***

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Connects to earphone socket on receiver and provides decoded audio output to headphones. Size 32mm x 70mm, 9-12V operation. . . ***£27.95***

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STLX High-performance Telephone Transmitter
High-performance transmitter with buffered output for greater stability and range. Connects onto telephone line and switches on and off automatically as phone is used. Both sides of conversation transmitted up to 1000m. Powered from line. Size 22mm x 22mm. ***£16.95***

PTS7 Automatic Telephone Recording Interface
Connects between telephone line (anywhere) and normal cassette recorder. Automatically switches recorder on and off as phone is used. Both sides of any conversation recorded. 9V operation, size 20mm x 67mm. ***£21.95***

CD400 Pocket Size Bug Detector/Locator
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CD600 Professional Bug Detector/Locator
Multicolour bargraph LED readout of signal strength with variable rate bleeper and variable sensitivity allows pinpointing of any signal source. When found, unit is switched into AUDIO CONFIRM mode to distinguish between bugging devices and legitimate signals such as pagers, cellphones etc. Size 70mm x 100mm. 9V operation. ***£59.95***

QTX180 Crystal Controlled Room Transmitter
Narrow band FM crystal transmitter for ultimate in privacy. Output frequency 173.225 MHz. Designed for use with QRX180 receiver unit. Size 20mm x 67mm, 9V operation, range up to 1000m ***£44.95***

QLX180 Crystal Controlled Telephone Transmitter
Specifications as per QTX180 but connects onto telephone line to allow monitoring of both sides of conversations. ***£44.95***

QSX180 Line Powered Crystal Telephone Transmitter
Connects onto telephone line, switches on and off as phone is used. Power is drawn from line. Output frequency 173.225 MHz. Designed for use with QRX180 receiver. Size 32mm x 37mm. Range up to 500m. ***£39.95***

QRX180 Crystal Controlled FM Receiver
Specifically designed for use with any of the SUMA 'Q' range kits. High sensitivity design. Complex RF front end section supplied as pre-built and aligned sub-assembly so no difficult setting up. Headphone output. PCB size 60mm x 75mm. 9V operation. ***£69.95***

TKX900 Signalling/Tracking Transmitter
Transmits a continuous stream of audio bleeps. Variable pitch and bleep rate. Ideal for signalling, alarm or basic tracking uses. High power output. Size 25mm x 63mm, 9-12V operation, up to 2000m range. ***£23.95***

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Connects to headphone socket of CD player, Walkman or Hi-Fi and broadcasts your favourite music around house and garden up to 250m. Size 27mm x 60mm, 9V operation. ***£22.95***

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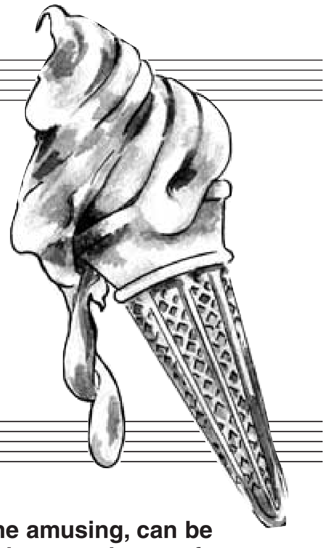
Top Tenners

FRIDGE/FREEZER ALARM



OWEN BISHOP

Project 3

This short collection of projects, some useful, some instructive and some amusing, can be made for around the ten pounds mark. The estimated cost does not include an enclosure, for many of them work just as well as an open board.
All of the projects are built on stripboard, and have been designed to fit on to boards of standard dimensions. All of the projects are battery-powered, so are safe to build. In a few cases in which, by its nature, the project is to be run for long periods, power may be provided by an inexpensive mains adaptor. Again, the cost of such a unit is not included because most spares boxes contain a few of these, possibly pensioned off from obsolete electronic gadgets.

MANY people have a sizeable amount of capital tied up in their deep-freeze. A long power cut or a failure of the freezer itself can lead to significant financial loss, not to mention the prospect of losing the delicious smoked trout from last summer's fishing holiday.

There are also accidents. If the lead on the freezer is a little too short, someone catching their foot in it by chance may drag the plug from the socket without noticing.

Usually, the disaster is not discovered until later, when it's too late to do anything about it. Similar remarks apply to the contents of a refrigerator, though it may be more a matter of disappointment than loss when somebody (who was it?) leaves the door ajar and the chilled lemonade warms up on a summer's day.

This simple alarm project circuit sits in the freezer and simply waits for the temperature to rise above a preset limit. Then it turns on a loud buzzer, one that is loud enough to be heard with the freezer door shut.

It runs from a 9V battery pack and, since the circuit takes only 200µA when not sounding, the battery should last about 100 days. However, there is no "flat battery'' warning on this project, so test the battery once a month and replace it when the voltage starts to drop.

CIRCUIT DETAILS

The full circuit diagram for the Fridge/Freezer Alarm is shown in Fig.1. The circuit is based on a useful semiconductor device known as a single trip point temperature sensor, IC1.

This is the TC622 integrated circuit, which comes in two versions. The TC622VAT has a temperature range of –40°C to +125°C, with a precision of ±1°C. The slightly cheaper TC622EAT has a more limited range of –40°C to +85°C with the same precision. Either type is suitable for this project.

TRIP POINT

The principle of the TC622 is that its output at pin 1 is high when the temperature is below the trip point and falls sharply as the temperature rises above this. The i.c. has a built-in hysteresis of 2°C. This means that, if it is set for a trip point at say –18°C, its output does not rise again until the temperature has fallen below –20°C. This hysteresis is very important because, if the temperatures at which it falls and rises were both close to –18°C, the alarm would chatter like a magpie for as long as the temperature stayed near that level.

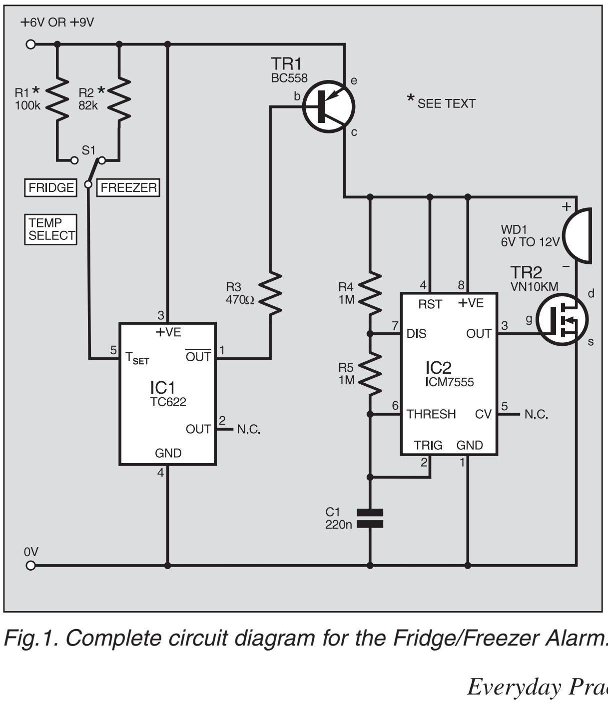


Fig.1. Complete circuit diagram for the Fridge/Freezer Alarm.

The trip point is set by connecting a resistor between the positive supply rail and pin 5 (T_{SET}). The equation for calculating the value of the resistor is:

$$R_{SET} = 0{\cdot}6 \times t^{2{\cdot}1312}$$

In this equation, *t* is the absolute temperature in Kelvin. For example, to set the trip point to 6°C, add 273 to the temperature in degrees Celsius to obtain the equivalent in Kelvin:

$$t = 6 + 273 = 279\text{K}$$

$$R_{SET} = 0{\cdot}6 \times 279^{2{\cdot}1312} = 97774\Omega$$

A 97k6 0·1% resistor from the E96 series would be ideal. The nearest "standard'' resistor from the E24 series is 100k, which would give a temperature trip point of around 9°C. Connecting a 4M7 resistor in parallel with 100k would produce 97k9 and a trip temperature just above 6°C.

TWO LEVELS

In this project, we have made the temperature switchable to two levels, 9°C for the refrigerator and –16°C for the freezer.

These are practicable levels that should not cause a false alarm every time some fresh unchilled food is put in the fridge or freezer. Incidentally, if you want to make a device that sounds the alarm when the temperature falls, use the output at pin 2. This works in the opposite sense to pin 1.

The next point to consider is the alarm. This is to be switched on when the output from pin 1 of IC1 falls to almost zero. A *pnp* transistor, TR1, can be switched by a low-going input so we have used a BC558 and powered the sounder circuit with the current flowing from its collector (c).

An intermittent tone is always much more noticeable than a continuous tone so the next stage in the circuit is an astable based on a 7555 timer (IC2). The values of the resistors R4 and R5 and the capacitor C1 are chosen to give a frequency of just over 2Hz. This produces an "urgent" rate of beeping that is easily heard from outside the freezer.

The output at pin 3 of the timer IC2 goes to a MOSFET, TR2. This type of transistor was used for switching instead of a bipolar transistor in order to maximise the voltage drop across the warning device WD1. There is already a voltage drop of 0·6V across TR1, and a further drop of 0·6V across a bipolar TR2 would mean that there was only 7·8V across WD1. It would be only 4·8V if we used a 6V supply. Under-running WD1 reduces its loudness, an important consideration when it is inside a thick-walled enclosure.

COMPONENTS

Resistors

R1	100k (see text)
R2	82k (see text)
R3	470Ω
R4, R5	1M (2 off)

All 0·25W, 1% metal film

See SHOP TALK page

Capacitor

C1	220n polyester film, p.c.b. mounting

Semiconductors

TR1	BC558 *pnp* transistor
TR2	VN10KM n-channel power MOSFET
IC1	TC622 single trip-point temperature sensor
IC2	7555 CMOS timer

Miscellaneous

S1	2-way s.p.d.t. d.i.l. switch
WD1	6V to 12V solid-state round buzzer

Stripboard 0·1 inch matrix, size 10 copper strips by 39 holes; 8-pin d.i.l. socket; AA size cells with holder – see text; battery clips, double-sided adhesive pad; multistrand connecting wire; 1mm solder pins (2 off); solder, etc.

Approx. Cost Guidance Only £9.50 *excluding batts.*

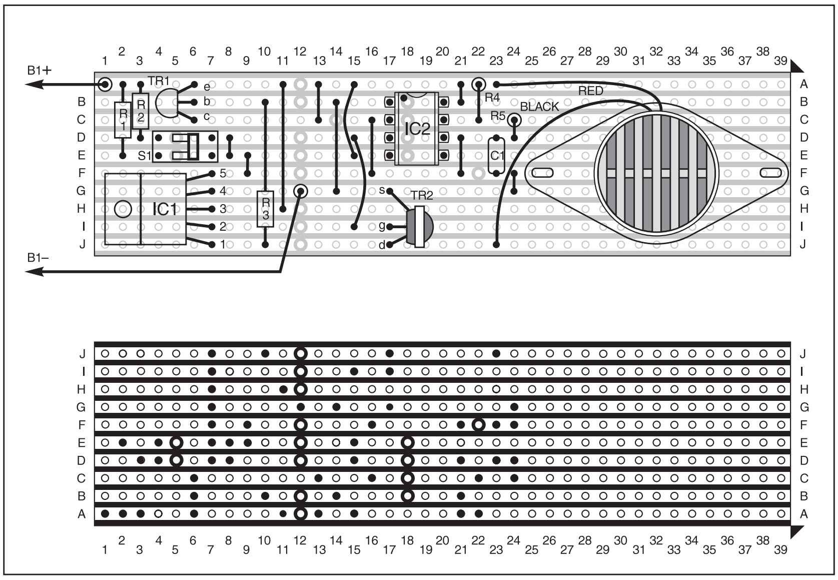


Fig.2. Fridge/Freezer Alarm stripboard component layout and details of breaks required in the underside copper tracks.

CONSTRUCTION

The Fridge/Freezer Alarm can conveniently be run on a 9V supply, but you can run it on 6V or 12V if you prefer. Using a battery holder with four AA type cells or larger will mean that the battery needs renewing less often.

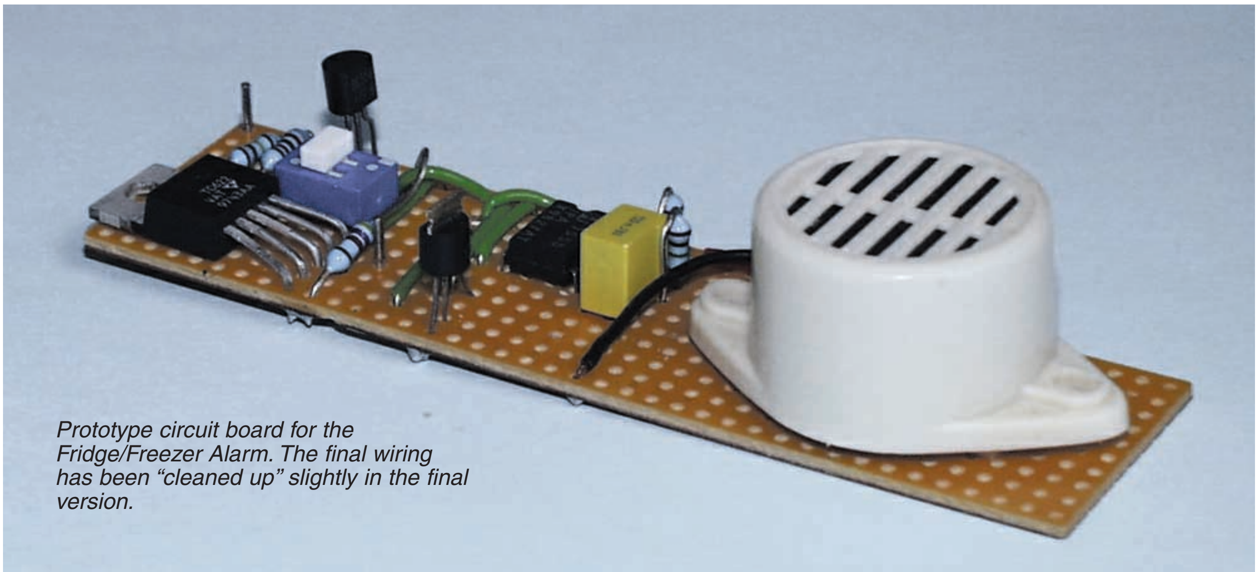
Once completed, the circuit board should be enclosed in a container but, if you are trying to keep costs down, this need not be a regular "enclosure". A used plastic food container with a snap-on lid will do almost as well. It is just a matter of keeping the integrated circuits away from the frozen chops!

The circuit is built up on a small piece of stripboard, size 10 strips × 39 holes. The component layout and details of breaks required in the underside copper tracks are shown in Fig.2. Construction should commence by making the track cuts (15 off) and inserting the wire links (11 off) and the two solder pins.

Next, assemble the alarm circuit section, which is everything to the right of column 13 in Fig.2. The warning buzzer WD1 has two lugs for bolting it to the board, but it is easier to fix it in place using a double-sided adhesive pad. Temporarily connect its power-input point (A13) to the positive power supply. The buzzer should produce its note as a series of bleeps, about two per second.

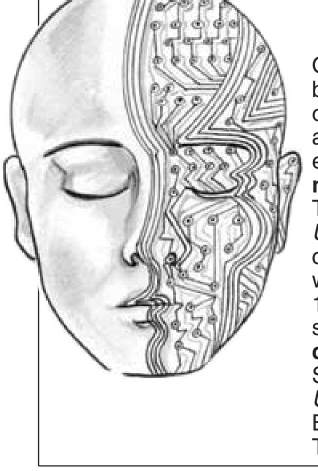
Now assemble the remainder of the circuit. If you prefer at first to test it outside the freezer, temporarily wire a 10 kilohms (10k) resistor in series with R1 and switch to the Fridge setting. The total resistance of 110 kilohms gives a trip point of about 22°C, a more comfortable temperature for trials.

Finally, place the completed unit in the fridge or freezer with switch S1 switched to the appropriate resistor and no battery connected. Leave it for 15 minutes or more to cool. When you connect the battery, the warning buzzer should stay silent. Remove it from the fridge or freezer and very soon the bleeping should begin. □



Prototype circuit board for the Fridge/Freezer Alarm. The final wiring has been "cleaned up" slightly in the final version.

INGENUITY UNLIMITED



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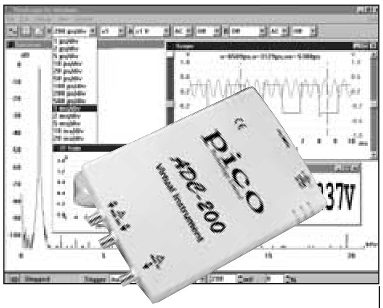

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Anti-Tamper Loop Alarm – On Your Bike

The circuit diagram of Fig.1 was designed as an anti-tamper bike alarm using a screened phono to phono (RCA plug) audio lead as the loop wire. The heart of the circuit is the SR latch based around two NOR gates IC1a and IC1b. This latches high at pin 4 when Set goes high and latches low when Reset goes high.

The anti-tamper feature is implemented by using both the inner signal wire and the screen of the cable. The outer screen carries almost 5V via two 510 ohm resistors R1 and R2. The SR latch Set (S) terminal is pulled high by resistor R5. The inner wire is a loop between resistor R4 (in series with the Set terminal) and R3 to ground (0V). Under normal conditions the Set pin is grounded via the loop.

If the loop cable is completely cut (severing the screen and inner core) then the Set terminal is no longer pulled low via resistor R3 and is pulled high by R5 instead. This "sets" the latch and the alarm buzzer WD1 sounds until the alarm is turned off and on again.

No Short-cuts

If the would-be thief attempts to "hot wire" the loop by bridging it with his own cable before cutting the loop through the bike, he is probably only likely to bridge the outer screen by mistake and the alarm will still sound when the inner core is cut.

However, if he cuts through to the inner loop wire in order to try and bridge it then he is likely to short the outer screen to the inner loop in which case resistors R1 and R2 are connected to R3 and R4. This forms a potential divider as shown in circuit Fig.2. The resistor values were chosen so that under these circumstances Set (V_T) is pulled high to 0·887Vcc, equivalent to a logic high so the latch is set and the alarm sounds. The value of 0·887 is derived from standard potential divider theory:

$$V_T = R3 / \; R3 + [(R4 + R5) // (R1 // R2)] \; .$$

The circuit is powered from a 9V battery and armed through keyswitch S1. By placing a normally-closed microswitch (not shown) in series with resistor R4, the alarm can be made to sound when the lid of the circuit housing is removed. Consider gold-plated phono connectors for higher reliability.

(Footnote: in industry I once came across a simple commercial cycle alarm (a thyristor and sounder) which Nottingham Police later informed me was easily hotwired by the local cycle-stealing population. So well done for addressing these aspects comprehensively. ARW)

Alan Bradley,
Belfast, Northern Ireland.

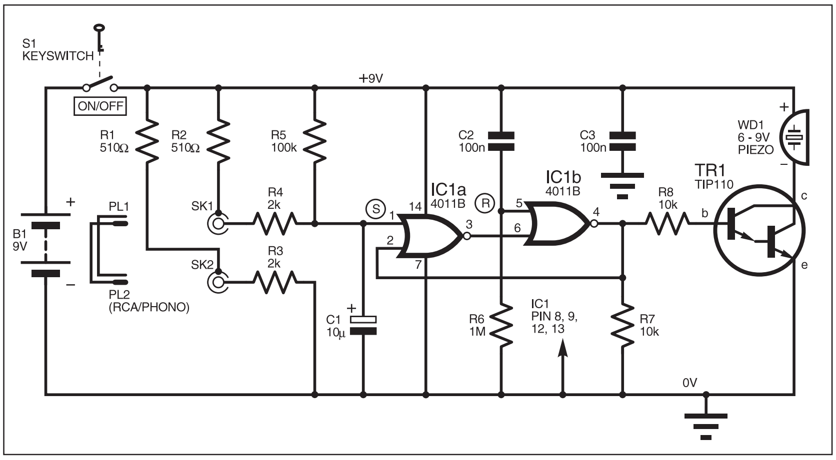

Fig.1. Circuit diagram for the Anti-Tamper Loop Alarm.

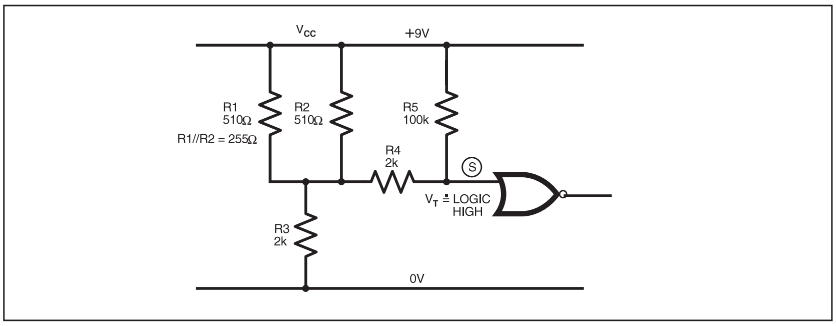

Fig.2. Equivalent circuit when inner core and outer screen are shorted together.

Doorbell Extension and Entry/Exit Indicator – On Call

USING piezo sounders together with an existing doorbell, the circuit of Fig.3 provides a doorbell extension to the garden or patio (for example) and in the author's system the kitchen, porch and other locations too. Also, and using the same extension units, the circuit can provide an indication of whenever the front door is opened or closed, while other circuitry (optional) mutes the extension/s as darkness falls, thereby reducing the disturbance to neighbours whenever their windows are left open during the summer.

Operation

In Fig.3a, closing the doorbell pushbutton S1 operates the gong solenoid as normal together with relay RLA in the main unit, both devices being powered by the four 1·5V cells in the gong. Relay contacts RLA1 (Fig.3b) close which turns on transistor switches TR1 and TR2 and relay RLB. Capacitor C1 also charges up.

The relay contact RLB2 applies 9V to the remote piezo sounder unit WD1 (Fig.3c), announcing the presence of a caller. When the doorbell button is released relay contact RLA1 reverts to its open state, disconnecting the base of transistor TR1 from the 9V supply.

However, TR1 still conducts and relay RLB remains latched because TR1 base current is now drawn from capacitor C1. When C1 discharges (at a rate determined by potentiometer VR1, wired as a variable resistor) the entire circuit returns to its dormant state until next time. This means the piezo sounder operates for a preset period.

Refinements

Whenever the front door is opened or closed a permanent magnet attached to the door passes a reed relay (S2) and triggers it. The reed contacts briefly apply 9V to the collector (c) of transistor TR3 and the *RC* network C2/R6, so TR3 switches on momentarily as capacitor C2 quickly discharges via resistor R5. As a result the piezo sounders emit a short tone signifying the opening or closing of the door. The value of resistors R5 and R6 may be adjusted to alter the duration of the tone.

As an optional refinement, the light dependent resistor (l.d.r.) R7, together with R8 and TR4, allow a piezo sounder to emit its tone at full volume during daylight only. In the author's system an l.d.r. associated with the corresponding sounder (e.g. in the kitchen) is arranged so that daylight from the kitchen window falls upon it and light from the kitchen lamp falls upon it as well; the sounder is enabled at night-time if someone is using the kitchen.

An l.d.r. in the porch is positioned to do the same thing with its associated sounder while the l.d.r. in the garden/ patio area allows the sounder there to operate during daylight only. Many of the component values are flexible, and some experimentation may be necessary to achieve the desired result.

C. Embleton,
Northallerton,
N. Yorks.

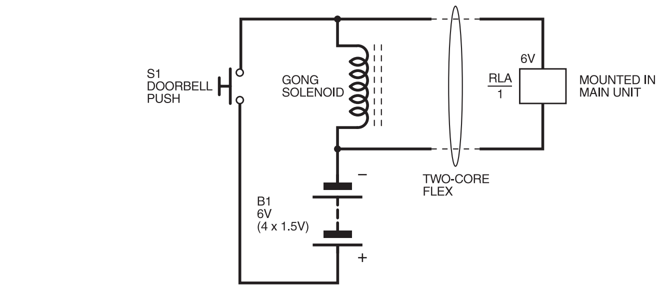

Fig.3a. Modification to the bell circuit.

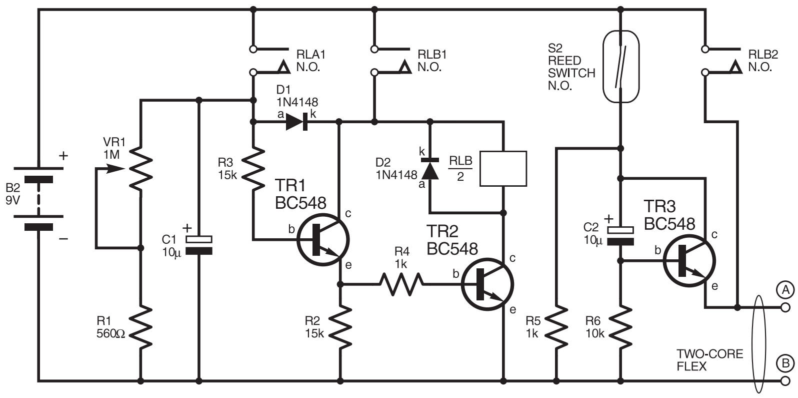

Fig.3b. Main circuit diagram for the Doorbell Extension and Entry/Exit Indicator.

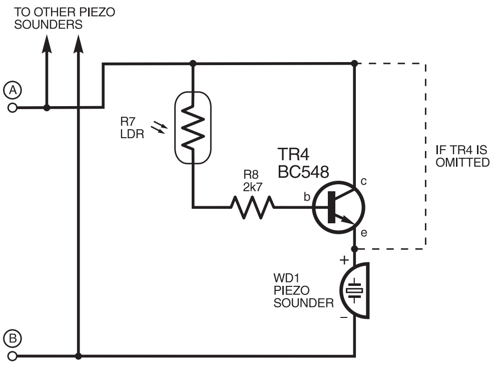

Fig.3c. Adding an l.d.r. to the remote sounder unit to give daylight operation only.

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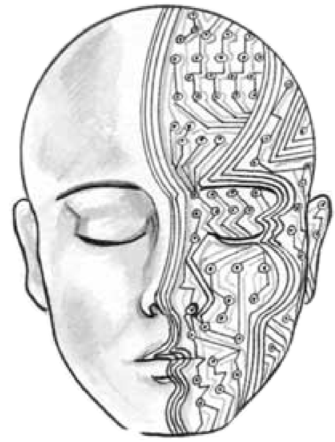

Mini Photo Slave Flash – Flashback

A CIRCUIT diagram for a simple Mini Photo Slave Flash trigger is shown in Fig. 4. It has evolved over more than thirty years from an design originally published in October 1967 *Practical Electronics (thanks for sending the fascinating reprint – ARW)* to the miniature version presented today.

The circuit uses a TIL78 phototransistor (the original used a Mullard OCP71) which conducts when light from the main flash gun falls on it. A pulse is sent through the capacitor C1 which causes the thyristor CSR1 to conduct, thereby triggering the slave flash either through the sync lead or through the hot shoe. The thyristor should be rated 300V or more. *(If the thyristor does not trigger the flash, try reversing the connections – ARW)*

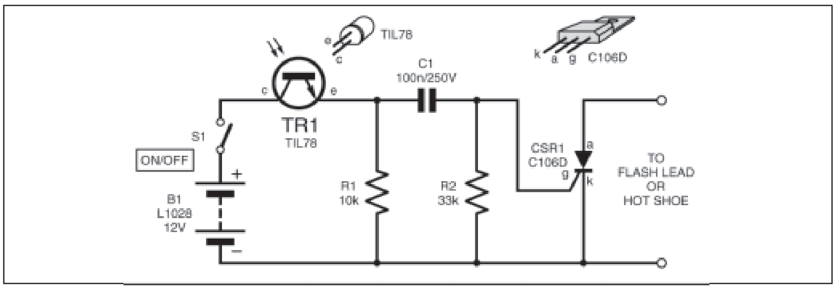

Fig.4. Mini Photo Slave Flash circuit diagram.

A miniature 12V "remote key fob" battery type L1028 powers the circuit, which is built on a tiny piece of stripboard 5 strips × 11 holes. A translucent 35mm film canister has proved ideal as a diffuser/housing for the circuit.

Syd Mercer,
Retford, Notts.

Colour TV Tester Add-On – Right Stripes

THE circuit diagram shown in Fig. 5 is an add on for my TV Test Pattern Generator (*Ingenuity Unlimited* Sept '99) to display vertical alternate black & white lines which help in setting up a TV's width and horizontal linearity. Also, if this pattern is recorded on a well aligned VCR it can be used to check back tension during servicing.

The circuit consists of a quad Schmitt NAND gate. Its function is to remove/blank the 1MHz square wave clock, which produces the vertical lines, during the sync pulse and colour burst so they aren't corrupted. A delay formed via the resistor R1, preset VR1 and capacitor C1 allows the length of clock blanking to be adjusted.

With an oscilloscope triggered from the line sync pulses, adjust the preset VR1 so that the 1MHz clock signal is removed at the output during both the sync pulse and colour burst. Alternatively, adjust for satisfactory sync/colour on a TV/monitor.

Preset VR2 is used to adjust the output level for 1V peak-to-peak or alternatively for correct contrast on a TV, and should be routed to the Red, Green and Blue inputs of the CXA1145P i.c. simultaneously by linking the bases of transistors TR2, TR3 and TR4 or the three sections on the Pattern selector switch S2.

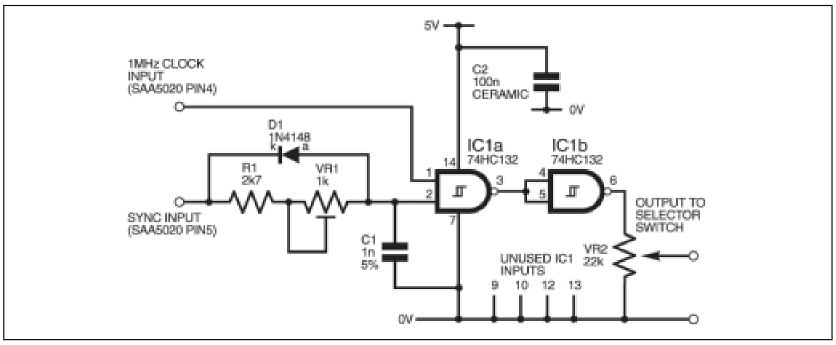

Fig.5. Circuit diagram for the Colour TV Tester Add-On.

Only two of the gates in the 74HC132 package are used and the remaining two gates should be disabled by grounding their inputs as shown at the bottom of the circuit diagram. Also, a decoupling capacitor of about 100nF should be located as close to the i.c. as possible to reduce interference on the output signal.

Lee Archer, Wigan, Lancs.

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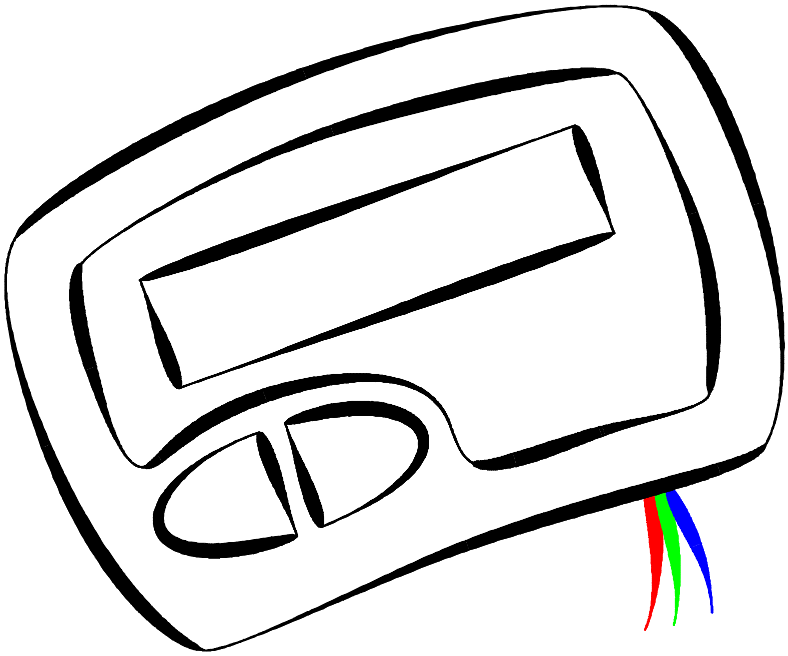

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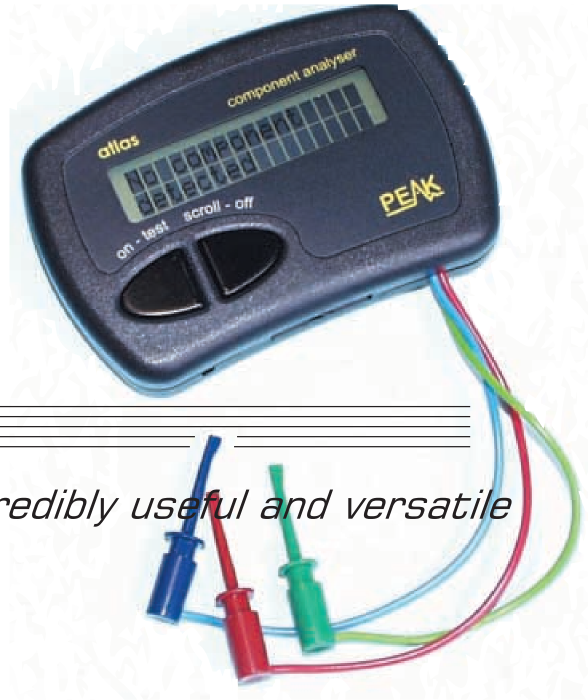
PEAK ATLAS COMPONENT ANALYSER

ANDY FLIND



It may be small, but Atlas is an incredibly useful and versatile little tester, reports Andy Flind.

THE "Atlas'' Component Analyser from Peak Electronics is a pocket-sized semiconductor tester. On opening the box, first impressions were of a very neat and simple-to-operate piece of equipment. Pleasant in appearance, the contoured case fits comfortably into the hand and could easily be carried in a shirt pocket. It has just two control buttons marked "On-Test'' and "Scroll-Off'' plus a two-line sixteen-character l.c.d. and it sports three leads coloured red, blue and green with matching test clips for connection to the component to be tested.

The small manual supplied is clear and easy to follow, and in addition to explaining what the unit can do is honest about its limitations, which is refreshing. Despite its simplicity the Atlas is surprisingly powerful, able to test a wide range of semiconductor devices from simple diodes right up to power MOSFETs and triacs.

INSIDE STORY

Before trying out the Atlas, a quick inspection was made of its construction. Removal of three self-tapping screws allows the back of the case to be removed, officially for battery replacement, but the p.c.b. can also be simply lifted out for examination. To enable it to fit into the slim case the board has two cut-outs to accommodate a small 12V battery and the l.c.d. display, an intelligent type with COB (Chip-On-Board) controlling i.c.s.

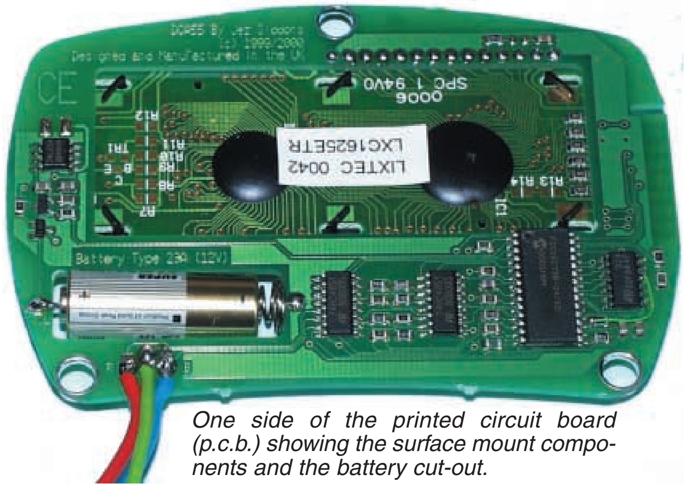
The main circuit is implemented mainly with surface-mount components, some easily recognisable ones being a 78L05 voltage regulator, two 74HC4051 "one-of-eight'' electronic switches and an LM324 quad op.amp. The main processing unit is a PIC16C73, one of the more powerful members of the PIC microcontroller family with 4K of program memory and up to five analogue-to-digital converters.

Of interest to users is the fact that if the three connection leads became damaged replacement would be a fairly simple matter since they are soldered to relatively large pads on the board. Changing the battery might be a bit fiddly but would be well within the capabilities of most *EPE* readers. The overall impression was of neat and tidy construction.

ON TRIAL

Following the physical inspection the unit was tried out on a wide variety of semiconductors. To use it, either two or all three test leads are connected to the device to be tested. They may be applied in any order, which makes connection rapid and simple. The "On-Test'' button is then pressed and the unit displays *"The Peak Atlas is analysing . . . ."* for a second or two, following which the first data screen appears.

In the case of a bipolar transistor, for example, it may tell you that the device is an *"NPN transistor''*, following which successive presses of the "Scroll-Off'' button will bring up further screens, showing firstly which colour leads are connected to the emitter (e), the base (b) and the collector (c), then the current gain (H_{fe}), the collector test current used, the base-emitter voltage (V_{be}) and the test current used to determine this. Further scrolling returns to the first screen so if the user wishes to see a particular screen again repeated pressing of the scroll button soon brings it back into view.



One side of the printed circuit board (p.c.b.) showing the surface mount components and the battery cut-out.

The Peak Atlas
is analysing....

NPN bipolar
transistor

The actual testing is completed in one go at the start, so the tested semiconductor may be disconnected whilst the various screens are read. It can be turned off ready for the next test by holding the "Scroll-Off" button for a couple of seconds, or it will shut down automatically thirty seconds after the last button press, allowing ample time to make notes of the data if required.

The unit was tried with a large range of components, old and exotic types as well as standard modern components, and by and large gave an excellent account of itself. Amongst the diodes tested were germanium and Schottky types as well as various silicon ones, plus diode combinations such as bridge rectifiers, and l.e.d.s including two and three lead bi-colour types.

Germanium diodes have a recognisable low forward voltage, Schottkys lower still. It recognises l.e.d.s from their higher forward voltage drops (try three silicon diodes in series and it will tell you that it has found an l.e.d.!) and bi-colours are determined from their differing forward voltage drops.

Though it doesn't actually tell you which diode is which colour, it gives their forward voltages and the manual gives the likely corresponding colours. L.E.D.s, by the way, flicker briefly as the test current is applied, which shows they are working and gives the colour for clear-bodied types.

UP THE JUNCTION

Transistors of most varieties can be checked. Bipolar *npn*s and *pnp*s of all kinds, including power types, will have their polarity shown, leads identified, and gain figure displayed. Some old germanium transistors, such as OC44 and AC127, were tested satisfactorily.

Darlington types will be clearly identified as such and their high gain can also be measured and displayed. Special features such as internal protection diodes and shunt resistors may also be indicated on the l.c.d. screen. Enhancement mode MOSFETs of both polarities and high and low power can be checked as easily as bipolar transistors. At the time of testing a *p*-type MOSFET was not available, so the internal ones in a CMOS 4007B i.c. were substituted for this and were checked out by the unit with no problems.

A couple of types the unit cannot test are junction f.e.t.s and uni-junction transistors, but these will at least be identified as two diodes with a common anode or cathode, which of course they are from a practical point of view. At least it gives a clue as to which lead is which.

BEING SENSITIVE

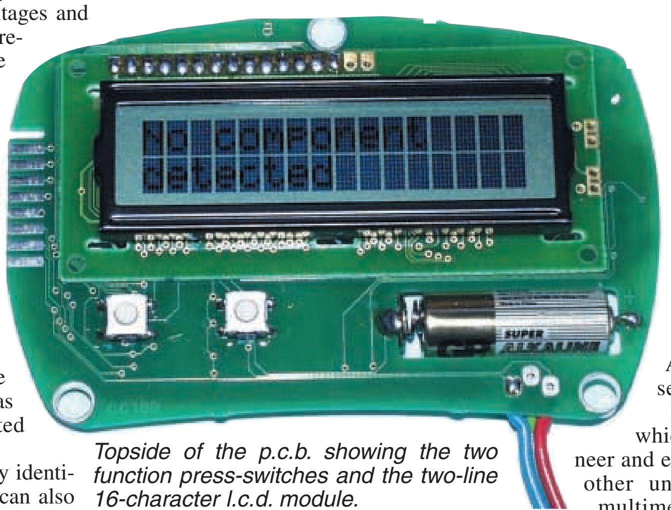
With thyristors and triacs the practical tests were slightly less successful. To be fair the manual does state that only "sensitive or low power" types can be tested, but in practice it was found that most of the ones tried, including some normally classed as "sensitive" produced an uninspiring *"Faulty/Unknown Component"* message.

Rather sad this, because when it does recognise one the information is just as clear as for transistors, with the gate, the cathode and anode or the MT1 and MT2 connections clearly identified. It seems likely that the problem is due to the high threshold voltages of some of these devices, perhaps combined with the minimum "holding" current required by some of them.

IN CONCLUSION

The verdict on the Atlas is that despite the limitation described above, it is an incredibly useful and versatile little tester, well worth the current asking price of £60 including postage and VAT. Many readers will have large collections of old or unidentified semiconductors which could be easily put to use if analysed with this unit.

For those with poor memories (like the author!) it can save much time searching through data sheets for device connection and polarity data. A classic example came when a medium power *pnp* transistor was required for a switching application during a design session.



Topside of the p.c.b. showing the two function press-switches and the two-line 16-character l.c.d. module.

RED GREEN BLUE
Base Coll Emit

Some ZTX653 and ZTX 753s were available, but the author was quite unable to remember which was the *pnp*, let alone which lead was which. This would previously have required a trip to the office to fetch a catalogue, followed by five minutes locating the device in the data sheets, but the Atlas resolved the problem in seconds.

It's the kind of instrument which should be on every engineer and enthusiast's bench, along with other universal items such as the multimeter. All in all, it can be thoroughly recommended.

The Atlas Component Analyser cost £60 all inclusive and for more information contact: ***Peak Electronic Design Ltd., Dept EPE, West Road House, West Road, Buxton, Derbyshire, SK17 6HF.*** Tel. 01298 70012, Fax 01298 22044, E-mail **sales@peakelec.co.uk**. More information and data is also available at the Peak Web site at **www.peakelec.co.uk**. □

Forward voltage
Vf=0.67V

Enhancement mode
N-Ch MOSFET

The reviewer would like to thank the Handy Shop of Taunton, Somerset, for their help and the loan of components used to test the Atlas Component Analyser.

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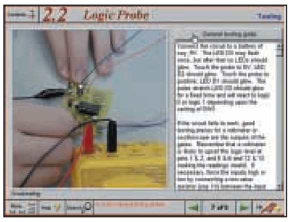
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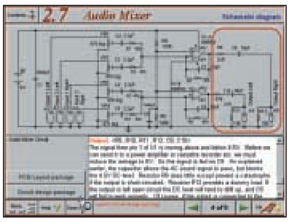
Audio Mixer circuit description

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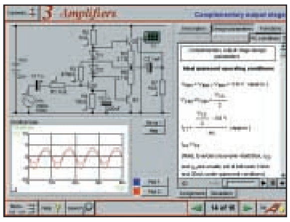
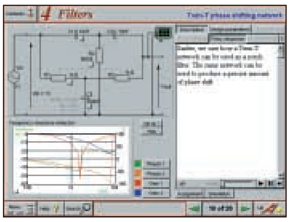
The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

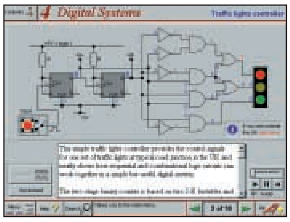
ANALOGUE ELECTRONICS

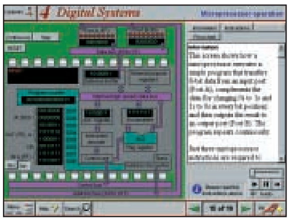

Complimentary output stage


Twin-T phase shifting network

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.

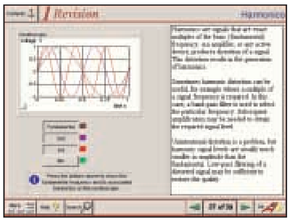
DIGITAL ELECTRONICS

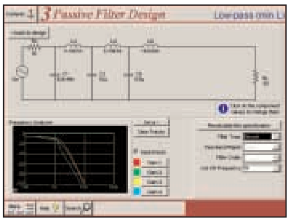

Virtual laboratory – Traffic Lights


Microprocessor

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 and their operation, 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 and their parameters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units.

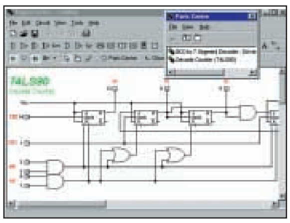
FILTERS

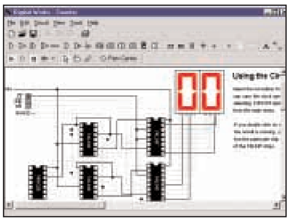

Filter Theory


Active filter synthesis

Filters is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed. It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev op.amp filters.

DIGITAL WORKS 3.0


Macro screen


Counter project

Digital Works Version 3.0 is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability.

- Software for simulating digital logic circuits
- Create your own macros – highly scalable
- Create your own circuits, components, and i.c.s
- Easy-to-use digital interface
- Animation brings circuits to life
- Vast library of logic macros and 74 series i.c.s with data sheets
- Powerful tool for designing and learning

PRICES
Prices for each of the CD-ROMs above are:

Hobbyist/Student ....£45 inc VAT
Institutional (Schools/HE/FE/Industry)..............£99 *plus* VAT
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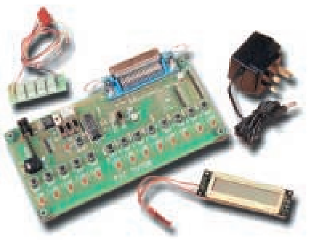
Interested in programming PIC microcontrollers? Learn with PICtutor by John Becker

The Virtual PIC



Deluxe PICtutor Hardware

This highly acclaimed CD-ROM, together with the PICtutor experimental and development board, will teach you how to use PIC microcontrollers with special emphasis on the PIC16x84 devices. The board will also act as a development test bed and programmer for future projects as your programming skills develop. This interactive presentation uses the specially developed **Virtual PIC Simulator** to show exactly what is happening as you run, or step through, a program. In this way the CD provides the easiest and best ever introduction to the subject.
Nearly 40 Tutorials cover virtually every aspect of PIC programming in an easy to follow logical sequence.

HARDWARE

Whilst the CD-ROM can be used on its own, the physical demonstration provided by the **PICtutor Development Kit**, plus the ability to program and test your own PIC16x84s, really reinforces the lessons learned. The hardware will also be an invaluable development and programming tool for future work.
Two levels of PICtutor hardware are available – Standard and Deluxe. The **Standard** unit comes with a battery holder, a reduced number of switches and no displays. This version will allow users to complete 25 of the 39 Tutorials. The **Deluxe** Development Kit is supplied with a plug-top power supply (the **Export** Version has a battery holder), all switches for both PIC ports plus l.c.d. and 4-digit 7-segment l.e.d. displays. It allows users to program and control all functions and both ports of the PIC. All hardware is supplied **fully built and tested** and includes a PIC16F84.

PICtutor CD-ROM

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Institutional 10 user (Network Licence) .£199 *plus* VAT

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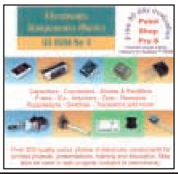

ELECTRONIC COMPONENTS PHOTOS

A high quality selection of over 200 JPG images of electronic components. This selection of high resolution photos can be used to enhance projects and presentations or to help with training and educational material. They are royalty free for use in commercial or personal printed projects, and can also be used royalty free in books, catalogues, magazine articles as well as worldwide web pages (subject to restrictions – see licence for full details).
Also contains a **FREE** 30-day evaluation of Paint Shop Pro 6 – Paint Shop Pro image editing tips and on-line help included!

Price £19.95 inc. VAT

ELECTRONIC CIRCUITS & COMPONENTS + THE PARTS GALLERY

Provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Sections include: ***Fundamentals:*** units & multiples, electricity, electric circuits, alternating circuits. ***Passive Components:*** resistors, capacitors, inductors, transformers. ***Semiconductors:*** diodes, transistors, op.amps, logic gates. ***Passive Circuits . Active Circuits***

The Parts Gallery will help students to recognise common electronic components and their corresponding symbols in circuit diagrams. Selections include: ***Components, Components Quiz, Symbols, Symbols Quiz, Circuit Technology***

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MODULAR CIRCUIT DESIGN

This CD-ROM contains a range of tried and tested analogue and digital circuit modules, together with the knowledge to use and interface them. Thus allowing anyone with a basic understanding of circuit symbols to design and build their own projects.
Essential information for anyone undertaking GCSE or "A" level electronics or technology and for hobbyists who want to get to grips with project design. Over seventy different Input, Processor and Output modules are illustrated and fully described, together with detailed information on construction, fault finding and components, including circuit symbols, pinouts, power supplies, decoupling etc.

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Minimum system requirements for these CD-ROMs: PC with 486/166MHz, VGA+256 colours, CD-ROM drive, 32MB RAM, 10MB hard disk space. Windows 95/98, mouse, sound card, web browser.

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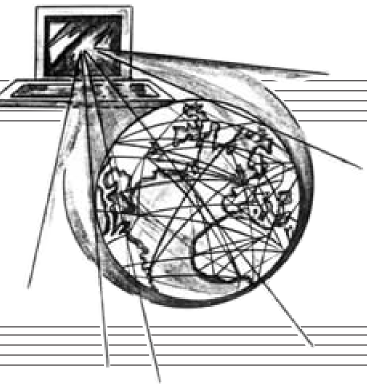
NET WORK

ALAN WINSTANLEY



With no sign of the breakthrough we all hoped for concerning unmetered access – more ISPs seem to be back-pedalling or pulling out at the present time than offering an unmetered service – this month's column discusses some practical aspects of using multiple Internet Service Providers.

Multiple Choice Mail

These days it's quite common to use more than one Internet Service Provider, especially if you have to manage several domain names or web sites at the same time. Users often utilise more than one Internet account – whether a paid-for professional dial-up account or a free one – and also it is common to fetch mail from several different mailboxes. You might want to use multiple ISPs for various reasons, perhaps running one as a back-up for the other.

You can usually FTP your files (e.g. a web site) to any server regardless of which dial-in service you choose, although there may be exceptions to this rule: some ISPs may demand that you use their own access number when FTPing to their server, other ISPs may insist that you route a minimum number of hours' worth of calls per month through their own access number instead.

When running several ISPs, trying to manage E-mail can be quite a headache. With a little thought, however, you can streamline and refine your set-up to make the most of multiple ISP management. This month's *Net Work* focuses on collecting and sending mail from multiple mailboxes using several ISPs.

As far as incoming E-mail is concerned, this is usually handled in one of two ways:

- through a "multiple address'' mailbox in the form of **<anyone>@yourname.co.uk**. All your incoming mail is routed into this mailbox by your ISP.
- use separate POP3 mailboxes such as **tom@yourname.co.uk**, **fred@yourname.co.uk**, **sales@anothername.com** etc.

In the first method, your E-mail software (e.g. Microsoft Outlook Express 5, Eudora or Turnpike) can be used to fetch all the E-mail in one batch, and place it into an "incoming'' folder or Inbox. Depending on how elaborate a system you want, you could then use sort rules and filters to re-route those incoming mails into more folders on your computer system. In Outlook Express 5.0, for example, you can right-click the Inbox icon and then create and name a New Folder. Then go Tools/Message Rules/Mail . . . and create new routing rules which will sort the mail from the inbox into the new folder. This takes a little bit of thinking about but is actually quite a reasonable "plain English'' approach to creating sort rules once you get used to it. You could also sort mail by sender, for example, so that mail from a particular person (e.g. the Boss) is routed to its own folder. The added benefit of this system (unlike the second method) is that you don't need the intervention of the ISP to set up any more usernames, because your software handles the sorting. In the second system, mail can only be addressed to that individual user (tom, fred or sales) and is routed to that folder.

Incoming E-mail is usually handled by a POP3 mailserver, and the ISP will advise you of the appropriate POP3 address. Often it's something like "**pop3mail.your-isp.co.uk**''. In Outlook Express 5, the mail server addresses are configured using the Tools/ Accounts . . . menu. You can check your set-up by clicking the Mail tab for the ISP (or "Account'') being configured. Under the Mail tab, look for Properties then Servers: in the two dialogue boxes you can enter the mail server details.

Problems Addressed

Your outgoing mail is usually sent through an SMTP (Simple Mail Transfer Protocol) server. Your ISP will tell you its address, and obviously you must configure your E-mail software so that it sends mail to the correct server. At this point, however, things become messy if you are using multiple Internet Service Providers. I mentioned earlier that you can often use virtually any Internet connection in order to, say, connect to an FTP server or to collect E-mail from all your mailboxes. Your software will contact the mailserver address followed by the specific mailbox login and password to fetch any mail back onto your system. Outlook Express displays a bargraph showing what it's doing: each server will be addressed in turn and incoming E-mail will be fetched from the POP server configured for that Account.

At the same time, outgoing mail will be sent to the corresponding SMTP server. The question is, what if you have another ISP as well? For example you might run a Freeserve account in tandem with your main dial-up account.

The important point here is that unlike incoming mail which can usually be checked using any connection, the outgoing mail server you configured must correspond with the ISP through which you connect to the Internet. So if you've connected through Demon Internet for example, you can usually fetch all your incoming E-mails from all your mailboxes (no matter which ISP provides them) without a problem. However, you can only use Demon's SMTP mail server to send out your outgoing mail. You couldn't use Demon's dial-up service to send outgoing mail out through, say, Freeserve's mail server. Your configuration should reflect this.

Imagine what would happen if you could use anyone's outgoing mail server: the entire system would soon choke, because bulk unsolicited E-mails (spam and so forth) could be broadcast using any ISP's mail server. By rights, if you connect through a specific ISP you shouldn't have the privilege of using another ISP's outgoing mail server. Sometimes, badly-configured mail servers do allow open access accidentally (called open relaying), a problem I discussed in previous articles.

Outlook Choice

When it comes to sending E-mail and accessing multiple ISP accounts, Outlook Express will offer you a choice: after finishing with the first ISP's mail servers Outlook will prompt you to hang up and dial another ISP (which is a nuisance), or it will try to "use the existing connection'' to search for the second ISP's mail servers. If you allow it to use the existing connection, you will probably get an error message caused by Outlook's failure to send outgoing mail.

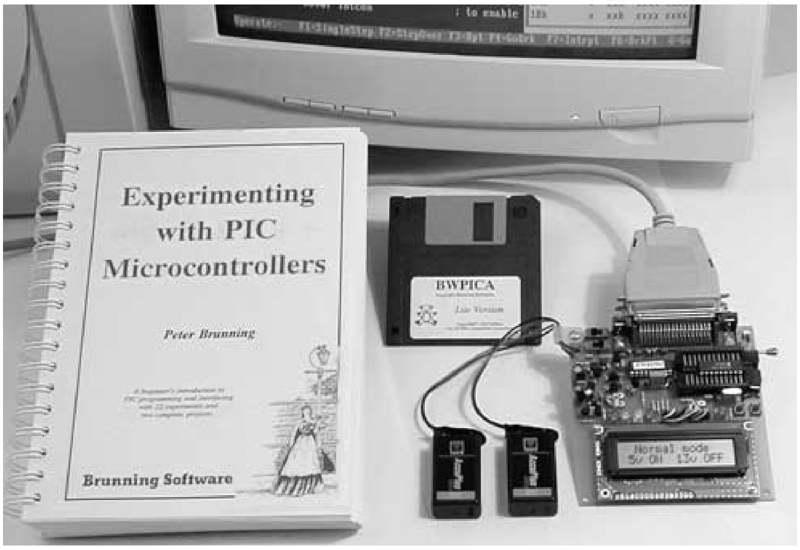
This happens because the first ISP's dial-up account is now being used to talk to another ISP's outgoing mail server. A workaround is to ensure that the same SMTP server address is configured on all Accounts, then dial in using that corresponding account. In this example, I would dial in using ISP1, so the server addresses would be set as follows:

ISP 1 – **smtp.mailISP1.co.uk** and **pop3.mailISP1.co.uk**
ISP 2 – **smtp.mailISP1.co.uk** and **pop3.mailISP2.co.uk**

Then go to Tools/Options/Connections, and tick the box which says "Ask before switching dial-up connections''. If you set up Outlook Express in this way, when you dial through your regular ISP, the software will send all your E-mail through that SMTP server, then it will switch connections without complaint. You can therefore operate two ISPs in tandem without having to hang up and redial.

Of course, if you decide to dial in through your second ISP instead, then you're back to square one, only worse: you wouldn't be able to send any E-mail at all! You would have to point to the second ISP's SMTP server. At least this system allows you to configure multiple ISPs and use Outlook Express to work with them without getting error messages or needing to redial. The last thing to check is under Options/Connection: Hang up after sending and receiving. You might want to disable this option if you intend to use your web browser.

Learn The Easy Way!



Experimenting with PIC Microcontrollers

This third release in our series teaches how to programme and interface to the PIC16F84 and PIC16C711 microcontrollers, and consists of the book, an integrated suite of programmes to run on a PC, and a programmer/experimental module.

The book with its abundance of flow diagrams and circuit diagrams is the heart of the system, and the software is the brains. A text editor with word processing power is the key stone supporting the assembler, disassembler, simulator, and programming software. As the text is typed in the assembler works in the background testing each line so that errors are immediately highlighted. When the typing is done the simulator can be used to single step or run the programme. Boxes pop up showing the contents of registers and the result of any text written to a standard 2 line by 16 character display. If it works correctly plug the programmer/experimental module onto the end of your printer lead and test it using a real live PIC. All operations work directly from the assembler text in the editor.

The experiments are all performed using the programmer/experimental module which is already wired with LEDs, push buttons, and an alphanumeric liquid crystal display. Flashing LEDs, text display, real time clock, period timer, beeps and music, including a rendition of Beethoven's *Für Elise*. Then there are two projects to work through; building a sinewave generator covering 0.2Hz to 20kHz in five ranges, and investigating measurement of the power taken by domestic appliances. In the space of 24 experiments, two projects and 56 exercises the system works through from absolute beginner to experienced engineer level.

Kit or Ready Built

The programming/experimental module can be purchased built, tested and ready to use, or in kit form. The ready built module verifies first at normal 5 volts then with ±10% volts applied, and uses the built in display to show programming messages. The kit version uses a simplified design which verifies only at normal 5 volts and where the display is dedicated to the test PIC (the status is indicated using 2 LEDs).

The kit consists of two parts. PIC3u-a contains the PCB, control PIC, 2 slide switches, software suite, and a booklet containing a full parts list and construction details. PIC3u-b contains all the other items to build the programmer/experimental module and includes a test PIC.

The system will also programme similar PICs (83, 710, 71, 620, 621 etc). The made up module is supplied with a test PIC fitted. Two PP3 batteries are also required, these are not supplied.

Assembler

The first book *Experimenting with PC Computers* with its kit is the easiest way ever to learn assembly language programming, simple circuit design and interfacing to a PC. 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.

C & C++

The second book *Experimenting with C & C++ Programmes* uses a similar approach. It teaches the user to programme by using C to drive the simple hardware circuits built using the materials supplied in the kit of parts. The experimental 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.

The Kits

The 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 first experiment. The 'unmade' Kits require the prototyping board and leads to be assembled and soldered before you can start. The 'top up' kit CP2t is for readers who have purchased a kit to go with the first book, and contains all the components and programming software but not the prototyping board or leads.

Hardware required

All three systems assume you have a PC (386 or better) and a printer lead.

Mail Order Form

Please make your cheque/PO payable to *Brunning Software* and send with this form to Brunning Software, 138 The Street, Little Clacton, Clacton-on-sea, Essex, CO16 9LS. Your order will be processed as soon as your cheque arrives. Despatch is usually the same day. Software supplied on 3.5" HD discs. *The kits do not include the book.*

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JUNE '99

PROJECTS ● Clipping Video Fader (Starter Project) ● PC Audio Frequency Meter ● Musical Sundial ● PIC Toolkit Mk2–2.
FEATURES ● Alan Dower Blumlein ● Circuit Surgery ● Interface ● PhizzyB Computers–8 ● Ingenuity Unlimited ● Edison 3 Review ● Net Work – The Internet.

JULY '99

PROJECTS ●12V Lead-acid Battery Tester ● L.E.D. Stroboscope ● EPE Mood Picker ● Intruder Deterrent.
FEATURES ● Practical Oscillator Designs–1 ● Practically Speaking ● Circuit Surgery ● Ingenuity Unlimited ● New Technology Update ● Net Work – The Internet.

AUG '99

PROJECTS ● Ultrasonic Puncture Finder ● Magnetic Field Detective ● Freezer Alarm ● 8-Channel Analogue Data Logger–1 ● Sound Activated Switch.
FEATURES ● Practical Oscillator Designs–2 ● Power Generation from Pipelines to Pylons–1 ● Ingenuity Unlimited ● Circuit Surgery ● Interface ● Net Work – The Internet.

SEPT '99

PROJECTS ● Loop Aerial SW Receiver ● Child Guard ● 8-Channel Analogue Data Logger–2 ● Variable Dual Power Supply.
FEATURES ● Practical Oscillator Designs–3 ● Power Generation from Pipelines to Pylons–2 ● Practically Speaking ● Circuit Surgery ● Ingenuity Unlimited ● New Technology Update ● Net Work.

OCT '99

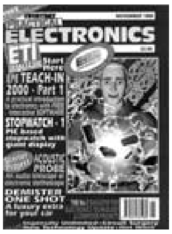
PROJECTS ● Interior Lamp Delay ● Mains Cable Detector ● QWL Loudspeaker System ● Micro Power Supply.
FEATURES ● PIC16F87x Mini Tutorial ● Practical Oscillator Designs–4 ● Circuit Surgery ● Interface ● Ingenuity Unlimited ● Net Work – The Internet.

NOV '99

PROJECTS ● Acoustic Probe ● Vibralarm ● Ginormous Stopwatch–1 ● Demister One-Shot.
FEATURES ● Teach-In 2000–Part 1 ● Ingenuity Unlimited ● Practically Speaking ● Practical Oscillator Designs–5 ● Circuit Surgery ● New Technology Update ● Net Work – The Internet *FREE* Identifying Electronic Components booklet.

DEC '99

PROJECTS ● PIC Micro-Probe ● Magnetic Field Detector ● Loft Guard ● Ginormous Stopwatch – Giant Display–2.
FEATURES ● Teach-In 2000–Part 2 ● Practical Oscillator Designs–6 ● Interface ● Ingenuity Unlimited (Special) ● Circuit Surgery ● Network–The Internet ● 1999 Annual Index.



JAN '00

PROJECTS ● Scratch Blanker ● Versatile Burglar Alarm ● Flashing Snowman ● Vehicle Frost Box.
FEATURES ● Ingenuity Unlimited ● Teach-In 2000–Part 3 ● Circuit Surgery ● Practically Speaking ● Tina Pro Review ● Net Work – The Internet.

FEB '00 Photostats Only

PROJECTS ● PIC Video Cleaner ● Voltage Monitor ● Easy-Typist Tape Controller ● Find It – Don't Lose It!
FEATURES ● Technology Timelines–1 ● Circuit Surgery ● Teach-In 2000–Part 4 ● Ingenuity Unlimited ● Interface ● Net Work – The Internet.

MAR '00

PROJECTS ● EPE ICEbreaker ● High Performance Regenerative Receiver–1 ● Parking Warning System ● Automatic Train Signal.
FEATURES ● Teach-In 2000 – Part 5 ● Practically Speaking ● Technology Timelines–2 ● Ingenuity Unlimited ● Circuit Surgery ● New Technology Update ● Net Work – The Internet.

APRIL '00

PROJECTS ● Flash Slave ● Garage Link ● Micro-PICscope ● High Performance Regenerative Receiver–2.
FEATURES ● Teach-In 2000–Part 6 ● Ingenuity Unlimited ● Technology Timelines–3 ● Circuit Surgery ● Interface ● Telcan Home Video ● Net Work – The Internet.

MAY '00

PROJECTS ● Versatile Mic/Audio Preamplifier ● PIR Light Checker ● Low-Cost Capacitance Meter ● Multi-Channel Transmission System–1.
FEATURES ● Teach-In 2000–Part 7 ● Technology Timelines–4 ● Circuit Surgery ● Practically Speaking ● Ingenuity Unlimited ● Net Work – The Internet ● *FREE* Giant Technology Timelines Chart.

JUNE '00

PROJECTS ● Atmospheric Electricity Detector–1 ● Canute Tide Predictor ● Multi-Channel Transmission System–2 ● Automatic Nightlight.
FEATURES ● Teach-In 2000 – Part 8 ● Technology Timelines–5 ● Circuit Surgery ● Interface ● New Technology Update ● Ingenuity Unlimited ● Net Work – The Internet.

JULY '00

PROJECTS ● g-Meter ● Camera Shutter Timer PIC-Gen Frequency Generator/Counter ● Atmospheric Electricity Detector–2.
FEATURES ● Teach-In 2000–Part 9 ● Practically Speaking ● Ingenuity Unlimited ● Circuit Surgery ● PICO DrDAQ Reviewed ● Net Work – The Internet.

AUG '00

PROJECTS ● Handy-Amp ● EPE Moodloop ● Quiz Game Indicator ● Door Protector
FEATURES ● Teach-In 2000–Part 10 ● Cave Electronics ● Ingenuity Unlimited ● Circuit Surgery ● Interface ● New Technology Update ● Net Work – The Internet.

SEPT 00

PROJECTS ● Active Ferrite Loop Aerial ● Steeplechase Game ● Remote Control IR Decoder ● EPE Moodloop Power Supply.
FEATURES ● Teach-In 2000–Part 11 ● New Technology Update ● Circuit Surgery ● Ingenuity Unlimited ● Practically Speaking ● Net Work – The Internet Page.

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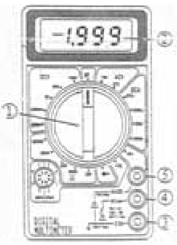

It measures DC volts up to 1000 and AC volts up to 750, DC current up to 10A and resistance up to 2 megohms, also tests transistors and diodes and has internal buzzer for continuity tests. Comes complete with test prods, battery and instructions, is yours for only £5.99. Order Ref: 6P65.

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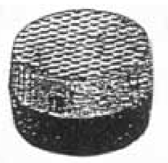

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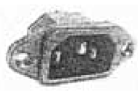

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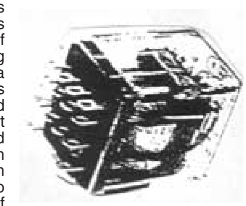

We have thousands of relays of various sorts in stock, so if you need anything special give us a ring. A few new ones that have just arrived are special in that they are plug-in and come complete with a special base which enables you to check voltages of connections of it without having to go underneath. 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:
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12V DC	2-pole changeover	£1.50	FR11
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

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Constructional Project

EPE MOODLOOP FIELD STRENGTH INDICATOR

ANDY FLIND

Check your "loop" is working. Will also sniff out unwanted sources of high levels of 50Hz field from mains-powered equipment.

APART from the beneficial effects that may be experienced, there is no quick way to ascertain whether the *EPE Moodloop* (Aug. '00) project is actually working, let alone check that it is working correctly. Various output arrangements can be used with it; the prototype used two loops constructed with a single length of 15-way ribbon cable which were connected in parallel to produce the required impedance of about 10 ohms.

If one of these loops were to fail the field strength would obviously drop, but there would be no immediate indication of this to the user. Since plug and socket connections are used and the cable is fairly long and easy to damage this is quite a likely occurrence so a means of checking the field strength is clearly needed.

This difficulty was spotted during the original "loop" design and consideration was given to the possibility of fitting some form of l.e.d. indication of the output current, but the various disadvantages of adding this to the circuit led to the idea being dropped at the time. However, indication is definitely required and this little project should fill that need.

COMPASS READING

To begin with, it is not strictly necessary to build an electronic indicator at all, since the field can be checked with nothing more technical than a compass! The method is to measure and note the field strength of the *EPE Moodloop* during correct operation so that any subsequent changes, indicating possible fault conditions, can be seen.

To do this it should be ensured that the *Moodloop*'s output voltage and the impedance of the output inductive loop connected to it are both correct so that it is reasonably certain that the output current and hence field strength are as they should be. A section of the output loop should then be positioned in a North-South direction with a compass positioned above it as shown in Fig.1.

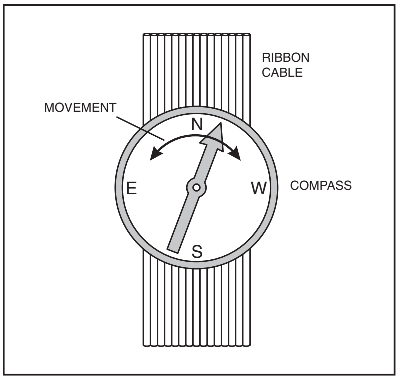


Fig.1. Checking the EPE Moodloop *with a compass.*

If the lowest output frequency is selected, the compass needle will deflect East and West in time with the generated magnetic field. In all probability it will swing much too far and may even start to rotate, a good example of a simple brushless electric motor!

The trick is to place something of suitable thickness between the cable and the compass, such as a paperback book, so that the compass deflects to about fifteen or twenty degrees in either direction. This setup may then be repeated at any time in the future when any change in the field strength should show up as a change in deflection. A fluid-damped compass is preferable for this exercise as a non-damped one will probably be too "lively" to be read easily.

FIELD STRENGTH INDICATOR

However, that's a cheapskate's solution! Readers of *EPE* can apply their knowledge to construct a much better indicator, which will operate at higher frequencies and in any position. It may also be used to locate and indicate other sources of magnetic field, particularly those at 50Hz which are considered by some to be a health hazard.

A block diagram for the Field Strength Indicator is shown in Fig.2. It uses an inexpensive linear Hall Effect sensor to detect the field, an a.c. coupled amplifier to give a voltage gain of about 270 over a bandwidth from 0·5Hz to 100Hz, and an l.e.d. bargraph display to indicate the intensity and frequency of the sensed field. A.C. coupling is used to eliminate the effects of standing fields such as those of the earth and any permanent magnets in the vicinity of the unit, and also the effects of temperature which causes appreciable output voltage drift with most Hall devices.

The bargraph display output is configured as "dot mode" where only one segment is illuminated at any time and is arranged so that this is around the centre and deflects to the left for one polarity of field and to the right for the other. This means that the overall width of deflection indicates field strength and the rate at which it moves from side to side indicates frequency, for low frequencies at least. At higher frequencies it becomes more of a

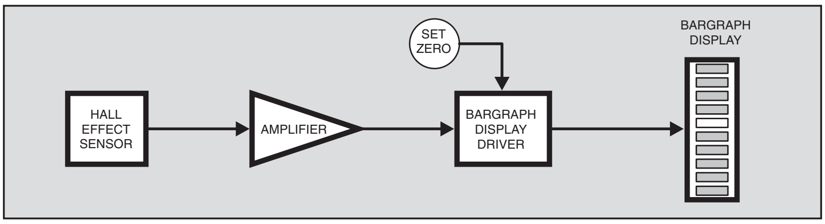


Fig.2. Block diagram for the EPE Moodloop Field Strength Indicator.

blur, but with practice it is possible to recognise most of the *Moodloop*'s frequency range and fifty Hertz fields are usually fairly obvious.

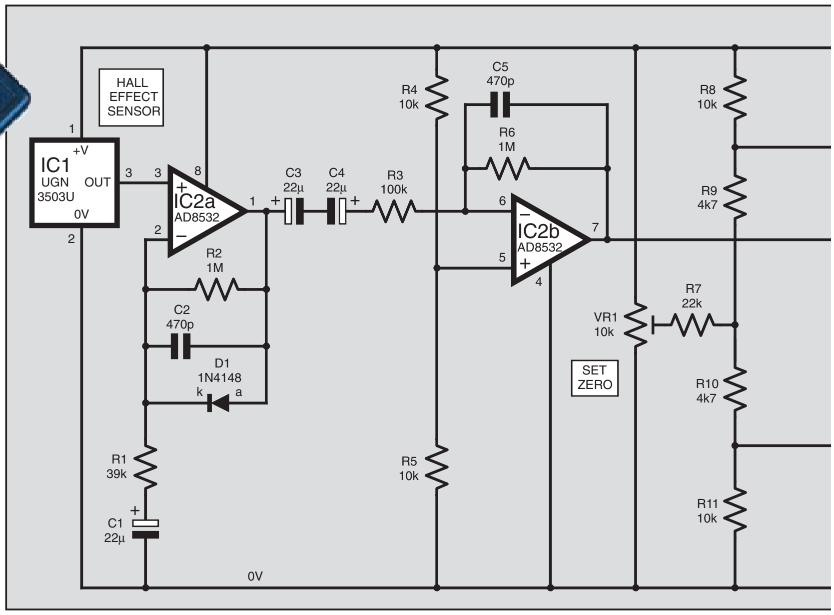


Fig.3. Full circuit diagram for the EPE Moodloop Field Strength Indicator.

CIRCUIT DETAILS

The full circuit diagram of the *EPE* Moodloop Field Strength Indicator project is shown in Fig.3. The Hall device IC1 is a UGN3503U which is inexpensive, robust and widely available. Unless exposed to extremely strong fields the output is about half the supply voltage so this is used to set the working point for IC2a, one half of an AD8532 dual op.amp. The AD8532 is intended for low voltage operation and has rail-to-rail outputs which makes it ideal for this application.

Configured as a non-inverting amplifier, IC2a produces a voltage gain at the working frequency of about 27. The d.c. gain is unity, the low-frequency roll-off being set by the value of capacitor C1. At switch-on, the large value of this capacitor leads to a fairly long settling time which diode D1 reduces slightly. IC2b is used as an inverting amplifier with a voltage gain of about ten.

The output signal from IC2a is a.c. coupled through capacitors C3 and C4, which are connected back-to-back so that swings of either polarity may be accommodated, to IC1b inverting input pin 6. These two capacitors also have some effect in setting the low frequency roll-off point. Capacitors C1, C3 and C4 are tantalum bead types, chosen for their low leakage. The high frequency roll-off is set by capacitors C2 and C5 to about 100Hz.

The quiescent output voltage, or working point, of IC2b is set by resistors R4 and R5 to half the supply or about 2·5V. The overall voltage gain of these two stages is approximately 270 over a bandwidth extending from 0·5Hz to about 100Hz which is adequate to cover the range of alternating magnetic fields it is intended to detect.

ON DISPLAY

The output signal from IC2b is applied to the input of IC3, a linear l.e.d. bargraph driver used in "dot" mode. The input range of this is set to about 1V overall by the resistor network R8 to R11 with an adjustment of the centre point from about 2V to 3V made possible by preset VR1. When calculating the values for these resistors the effect of the internal resistor chain between "div. high'' and "div. low'' in IC3 has to be taken into account, this has a value of about 10 kilohms (10k).

Although IC3's internal 1·2V voltage reference is not used in this design the current drawn from it sets the output currents to the l.e.d.s D2 to D11 in the bargraph display. These are about ten times the current drawn from the reference, so a value of 1·2 kilohms (1k2) for resistor R12 sets the l.e.d. current to about 10mA. Preset potentiometer VR1 is used to adjust the bargraph so that the quiescent display centres around the two middle l.e.d.s.

The voltage regulator IC4 is an LP2950 which is better suited to battery operation than the standard 78L05 type as it has a much smaller quiescent current and can operate with an input to output voltage difference of just 100mV. The usual decoupling capacitors C6 to C9 are included to ensure stability.

CONSTRUCTION

The Moodloop Field Strength Indicator is constructed on a piece of 0·1 inch matrix stripboard having 28 strips of 36 holes. The component layout and the copper side, showing breaks, are shown in Fig.4.

There are fifty breaks to be made on the copper side and as usual careful inspection of these with a strong magnifying glass is recommended to ensure no tiny whiskers of copper remain around their edges. If the specified case is used a couple of small cutouts will be required at one end as shown to give clearance for two pillars.

Following this there are 27 links (the lowest link on the board "earths'' the strip adjacent to the one carrying the input signal), which is not as bad as it sounds since nine of them are the angled ones to the right of the display and bridge just one hole each. These connect all the bargraph l.e.d. anodes (a) to the battery positive supply.

After this, the remaining components can be fitted in order of physical height, diode D1 followed by the resistors, ceramic capacitors and the three tantalum bead capacitors C1, C3 and C4. Care should be taken to ensure that these are fitted the right way round, as their polarity markings are sometimes difficult to read. Capacitors C6 and C9 are fitted horizontally to obtain a low profile.

Preset VR1 and regulator IC4 should be fitted last. IC2, IC3 and the sensor are not fitted at this stage as they will be added during testing.

A careful inspection of the completed board for solder "bridges'' between tracks is recommended as this happens all too easily with stripboard. D.I.L. sockets are recommended for IC2, IC3 and also the bargraph display. This makes testing easier, and in the case of the display, raises it physically above the other components so that it can be fitted flush with the surface of the case.

A multiturn component was used for VR1, although the adjustment is not particularly critical and a cheaper single-turn type could be used instead. The multiturn type does have the adjustment screw conveniently situated on the top, however.

TESTING

Testing begins with the connection of a 9V supply to the board followed by a check for the 5V regulated supply. This should appear across the upper two sensor connections, the top one being positive. It should also appear at pin 4(–) and pin 8(+) of the socket for IC2.

Bargraph driver IC3 is powered from the 9V supply voltage so this should appear at pin 3 of its socket. It should also be present at all ten anode pins on the right-hand side of the bargraph display socket. Following an initial surge as capacitors C6 and C9 charge, a check on the current drawn at this stage should reveal a drain of about 0·5mA.

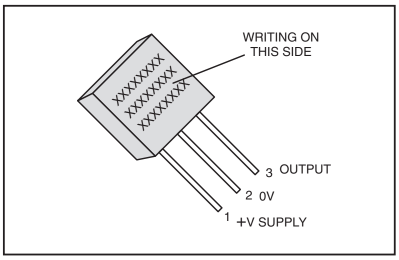
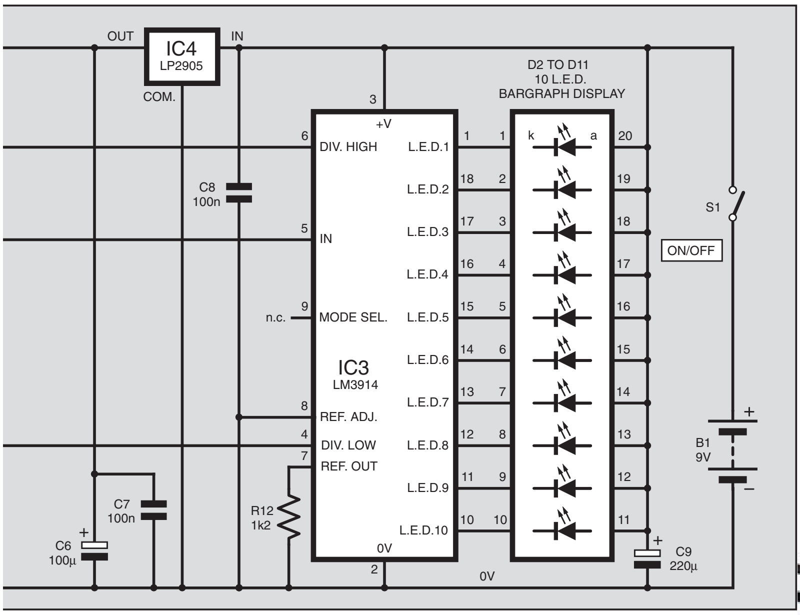
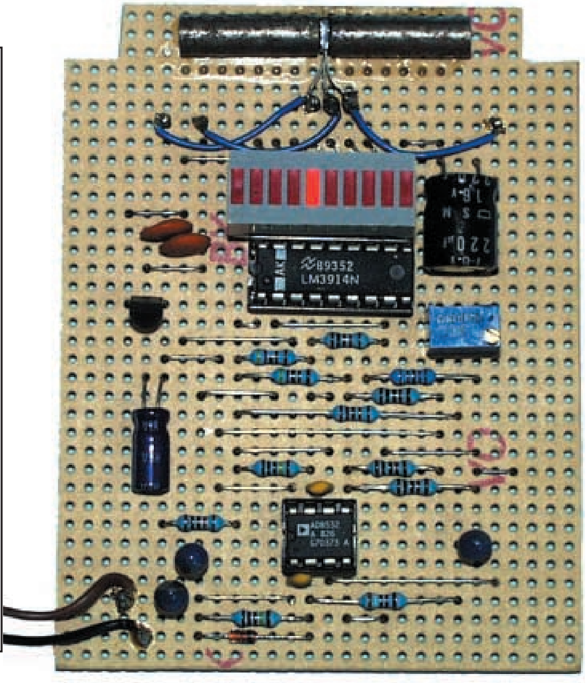


Fig.5. Pinout connection details for the UGN3503U Hall Effect sensor.





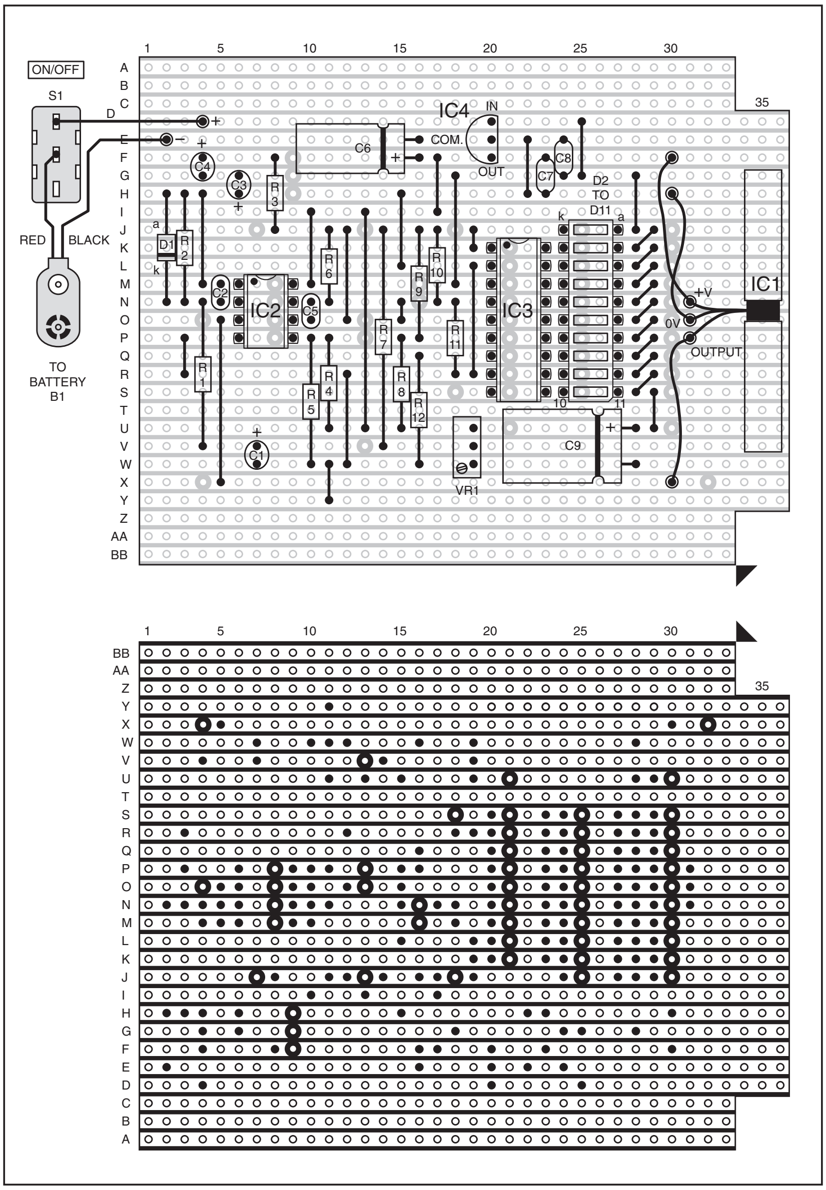


Fig.4. Stripboard component layout, details of breaks required in the underside copper tracks and wiring to the on/off switch and battery connector.

COMPONENTS

See SHOP TALK page

Resistors

R1	39k
R2, R6	1M (2 off)
R3	100k
R4, R5, R8, R11	10k (4 off)
R7	22k
R9, R10	4k7 (2 off)
R12	1k2

All 0·6W 1% metal film.

Potentiometer

VR1	10k 22-turn cermet preset (see text)

Capacitors

C1, C3, C4	22µ tantalum bead, 16V (3 off)
C2, C5	470p ceramic (2 off)
C6	100µ radial elect. 10V
C7, C8	100n ceramic (2 off)
C9	220µ radial elect. 16V

Semiconductors

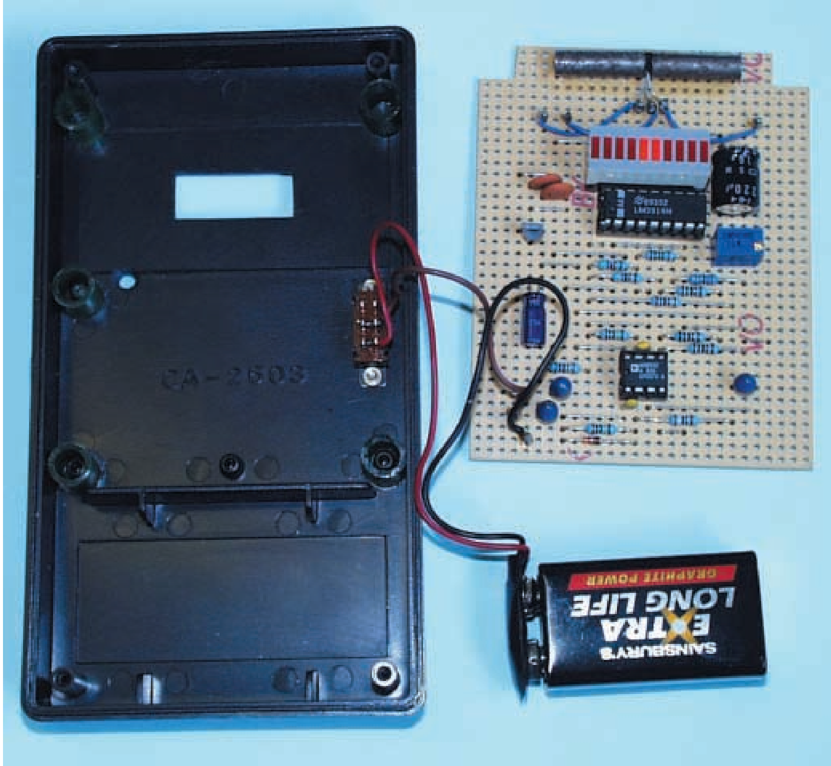
D1	1N4148 silicon diode.
D2 to D11	10-segment l.e.d. bargraph array, red
IC1	UGN3503U linear Hall Effect sensor
IC2	AD8532 dual op.amp
IC3	LM3914 linear bargraph display driver
IC4	LP2950 micropower 5V positive regulator

Miscellaneous

S1	sub-min. changeover slide switch

Stripboard, 0·1 inch matrix, size 28 strips x 36 holes; handheld case, (145mm x 80mm x 34mm), with battery compartment; 8-pin d.i.l. socket; 18-pin d.i.l. socket; 20-pin d.i.l. socket; PP3 type battery connector; multistrand connecting wire; solder pins; solder etc.; iron nail, approx 5mm dia. (see text).

Approx. Cost Guidance Only £19 excl. batt. & case



Once the wiring is completed, the circuit board is flipped-over to rest on the plastic tubular supports glued inside the case lid. These supports should allow the bargraph to fit flush in the display window cutout.

The Hall Effect sensor IC1 should be temporarily connected next. Provided there are no strong magnets close by, its output should be about 2·5V. This can be conveniently measured at pin 3 of the socket for IC2. The current drain will now have risen to about 10mA.

Next, IC2 can be inserted and the circuit powered again. It will raise the drain to about 11mA. About 15 seconds should be allowed for the circuit to settle, after which the voltages at pin 1 and pin 7 should both be about 2·5V. The voltage at pin 7 should also appear at pin 5 of the socket for IC3, and moving a magnet close to the sensor should result in visible fluctuations.

Finally, IC3 and the bargraph should be inserted. The bargraph in the prototype has a small bevel on one corner which denotes bottom right, but if there are any doubts it may be advisable to check polarity of this component.

The circuit board should now be powered again and allowed time to settle thoroughly, after which preset VR1 should be adjusted so that the two centre segments of the bargraph are flickering, due to circuit noise, with about equal intensity. The total operating drain of the complete circuit will be about 30mA.

SENSOR

The method of fitting the Hall Effect sensor (IC1) to the board can be seen in Fig.4, whilst details of its connections are shown in Fig.5. The prototype uses solder pins for external connections and three more of these were added for securing the sensor and connected to their points on the board with short lengths of wire.

Originally it was thought that the inexpensive UGN3503 sensor would not be sensitive enough for this application, but the inclusion of a short length of soft iron to either side of it concentrates the magnetic field passing through it which produces a huge increase in sensitivity. These pieces of soft iron, about 20mm in length and 5mm diameter, were cut from a large nail, about 120mm long. The ends were hand filed as flat and square as possible, and they were then pressed tightly against the sensor and glued in place. This simple notion made this project possible and may well find many other applications using this type of sensor.

CASING UP

The prototype was constructed as a self-contained handheld unit in a small plastic box, 145mm × 80mm × 34mm which has a separate compartment for a PP3 battery. This allows it to be used for checking other sources of alternating magnetic field, in particular sniffing out high levels of 50Hz field from mains-powered equipment using transformers.

The circuit board is shaped to fit neatly into the circuit compartment in the case and rests on five pillars cut from some old plastic tubing and glued into place. These are just high enough to bring the top of the bargraph flush with the top of the case when the board is in position. Some polyurethane foam (of the stiffer type) presses it firmly into place when the case is screwed together. A small hole was drilled to allow external access to the multiturn preset VR1, but in practice this has not required any further adjustment.

IN USE

When switched on the unit takes about twelve seconds to settle. Initially the display remains "off" for a couple of seconds, then the light travels across from left to right, then slowly settles back to the centre two segments. It looks deceptively like a sophisticated self-test routine! It is sensitive enough to respond to the earth's field if rotated rapidly relative to this.

Using it to check the *EPE Moodloop* is similar to the method described for a compass, except that it doesn't have to be aligned North to South. It can be simply placed over a section of the loop with a spacer such as a paperback book such that the moving light just about reaches the ends of the display.

Subsequent placement in the same position will reveal any changes in field strength. The speed at which the light travels from end to end will clearly indicate the frequency being used, right up to the highest rate.

The unit can be operated from any supply between 6V and 15V. An alternative to the handheld construction described would be to fit it into the *Moodloop* project's case and power it directly from the 13V supply.

If a longer wire is used to connect one of the *Moodloop*'s p.c.b. outputs to its socket, this could be given a turn or two close to the sensor, which could easily be physically placed to obtain full bargraph deflection for normal output. This would then indicate output current for any load connected to the *Moodloop*.

There is a slight chance that the 5V regulator IC4 might run slightly hot if this is done, since with a 13V supply and a 30mA output current it would be dissipating around 240mW. This could easily be cured with the inclusion of a suitable resistor however, about 100 ohms to 150 ohms should be suitable. This would give the unit an attractive built in monitoring display. □

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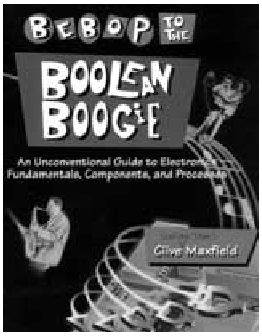

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Covers binary arithmetic, Boolean algebra and logic gates, combination logic, sequential logic including the design and construction of asynchronous and synchronous circuits and register circuits. Together with a considerable practical content plus 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.

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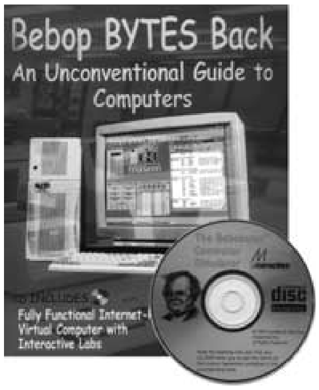

This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where “Bebop I” left off, guiding you through the fascinating world of computer design. . . and you’ll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the accompanying CD-ROM (for Windows 95 machines only) contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the book contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers.

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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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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 **Order code BP256** **£3.99**

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 MIIDI 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.

138 pages **Order code PC116** **£9.95**

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.

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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.

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Robert Charles Alexander

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Alan Dower Blumlein led an extraordinary life in which his inventive output rate easily surpassed that of Edison, but whose early death during the darkest days of World War Two led to a shroud of secrecy which has covered his life and achievements ever since.

His 1931 Patent for a Binaural Recording System was so revolutionary that most of his contemporaries regarded it as more than 20 years ahead of its time. Even years after his death, the full magnitude of its detail had not been fully utilized. Among his 128 patents are the principal electronic circuits critical to the development of the world’s first electronic television system. During his short working life, Blumlein produced patent after patent breaking entirely new ground in electronic and audio engineering.

During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become ‘H2S’ – blind-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirty-ninth birthday.

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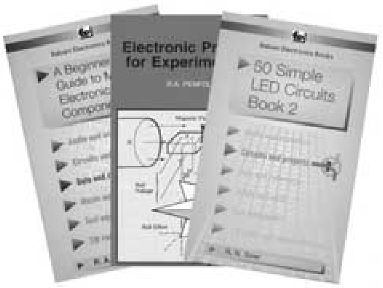

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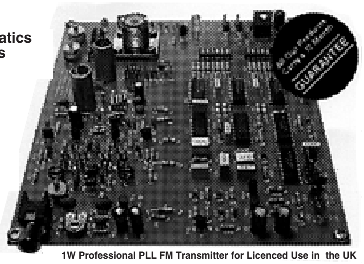

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