THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

EVERYDAY JULY 2005

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LF AND VLF CONVERTER

Receives zero to 350kHz transmissions/ whistlers etc

MULTI-CLAP SWITCH

A refined clap counting project

PLUS

BACK TO BASICS - 4

Doorchime - Electronic Dice

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Colour CCTV camera, 8mm lens, 12vdc200m a 582X628 Res 380 lines Automatic aperture lens Mirror function PAL Back Light Comp MLR, 100x40x40mm ref EE2 £75.90

Built in Audio .15lux CCD camera 12vdc 200ma 480 lines s/n ratio >48 db 1v P-P output 110x60x50mm ref EE1 £108.90

Metal CCTV camera housings for internal or external use. Made from aluminium and plastic they are suitable for mounting body cameras in Available in two sizes 1-100x70x170mm and 2-100x70x280mm Ref EE6 £22 EE7 £26 Multi position brackets Ref EE8 £8.80

Excellent quality multi purpose TV/TFT screen, works as just a LCD colour monitor with any of our CCTV cameras or as a conventional TV ideal for use in boats and caravans 49.75mhz-91.75mhz VHF channels 1-5, 168.25mhz-222.75mhz VHF channels 6-12, 471.25mhz-869.75mhz, Cable channels 112.325mhz-166.75mhz Z1-Z7, Cable channels 224.25mhz-446.75mhz Z8-Z35 5" colour screen, Audio output 150mW, Connections, external aerial, earphone jack, audio/video input, 12vdc or mains, Accessories supplied Power supply Remote control Cigar lead power supply Headphone Stand/bracket. 5" model £139 Ref EE9.

Self cocking pistol plcr002 crossbow with metal body. Selfcocking for precise string alignment Aluminium alloy construction High tec fibre glass limbs Automatic safety catch Supplied with three bolts Track style for greater accuracy Adjustable rear sight 50lb draw weight 150ft sec velocity Break action 17" string 30m range £23.84 Ref PLCR002

Fully cased **IR light source** suitable for CCTV applications. The unit measures 10x10x150mm, is mains operated and contains 54 infra red LEDs. Designed to mount on a standard CCTV camera bracket. The unit also contains a daylight sensor that will only activate the infra red lamp when the light level drops below a preset level. The infrared lamp is suitable for indoor or exterior use, typical useage would be to provide additional IR illumination for CCTV cameras £53.90 ref EE11

Colour CCTV Camera measures 60x45mm and has a built in light level detector and 12 IR leds .2 lux 12 IR leds 12vdc Bracket Easy connect leads £75.90 Ref EE15

A high quality external colour CCTV camera with built in Infra red LEDs measuring 60x60x60mm Easy connect leads colour Waterproof PAL 1/4" CCD542x588 pixels 420 lines .05 lux 3.6mm F2 78 deg lens 12vdc 400ma Built in light level sensor. £108.90 Ref EE13

3km Long range video and audio link complete with transmitter, receiver, 12.5m cables with pre fitted connectors and aerials. Acheive up to 3km. Cameras not included Ideal for stables, remote buildings etc. Mains power required £299

A small colour CCTV camera just 35x28x30mm Supplied with bracket, easy connect leads. Built in audio. Colour 380 line res, PAL 0.2 lux +18db sensitivity Effective pixels 628x582 6-12vdc Power 200mw £39.60 Ref EE16

Complete wireless CCTV sytem with video. Kit comprises pinhole colour camera with simple battery connection and a receiver with video output 380 lines colour 2.4ghz 3 lux 6-12vdc manual tuning Available in two versions, pinhole and standard £79 (pinhole) Ref EE17, £86.90 (standard) Ref EE18

Peltier module. Each module is supplied with a comprehensive 18 page Peltier design manual featuring circuit designs, design information etc etc. The Peltier manual is also available separately Maximum watts 56.2 40x40mm Imax 5.5A Vmax 16.7 Tmax (c-dry N2) 72 £32.95 (inc manual) REF PELT1, just manual £4.40 ref PELT2

GASTON SEALED LEAD ACID BATTERIES

1.3AH 12V @ £5.50 GT1213
3.4AH 12V @ £8.80 GT1234
7AH 12V @ £8.80 GT127
7AH 12V @ £19.80 GT1217

All new and boxed, bargain prices. Good quality sealed lead acid batteries

COMPAQ 1000mA 12vdc power supplies, new and boxed. 2 metre lead DC power plug 2.4mmx10mm £5.25 each, 25+ £3.50 100+ £2.50

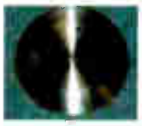
1.2ghz wireless receiver Fully cased audio and video 1.2ghz wirelessreceiver 190x140x30mm, metal case, 4 channel, 12vdc Adjustable time delay, 4s, 8s, 12s, 16s. £49.50 Ref EE20

The smallest PMR446 radios currently available (54x87x37mm). These tiny handheld PMR radios look great, user friendly & packed with features including VOX, Scan & Dual Watch. Priced at £59.99 PER PAIR they are excellent value for money Our new favourite PMR radios! Standby: - 35 hours Includes:- 2 x Radios, 2x Belt Clips & 2 x Carry Strap £59.95 Ref ALAN1 Or supplied with 2 sets of rechargeable batteries and two mains chargers £93.49 Ref Alan2

The TENS mini Microprocessors offer six types of automatic programme for shoulder pain, back/neck pain, aching joints, Rheumatic pain, migraines headaches, sports injuries, period pain. In fact all over body treatment. Will not interfere with existing medication. Not suitable for anyone with a heart pacemaker. Batteries supplied. £21.95Ref TEN327 Spare pack of electrodes £6.59 Ref TEN327X

Dummy CCTV cameras These motorised cameras will work either on 2 AA batteries or with a standard DC adapter (not supplied) They have a built in movement detector that will activate the camera if movement is detected causing the camera to 'pan' Good deterrent Camera measures 20cm high, supplied with fixing screws. Camera also has a flashing red led. £10.95 Ref CAMERAB

INFRA RED FILM 6" square piece of flexible infra red film that will only allow IR light through. Perfect for converting ordinary torches, lights, headlights etc to infrared output using standard light bulbs Easily cut to shape. 6" square £16.50 ref IRF2 or a 12" sq for £34.07 IRF2A



THE TIDE CLOCK These clocks indicate the state of the tide, Most areas in the world have two high tides and two low tides a day, so the tide clock has been specially designed to rotate twice each lunar day (every 12 hours and 25 minutes) giving you a quick and easy indication of high and low water. The Quartz tide clock will always stay calibrated to the moon. £23.10 REF TIDEC

LINEAR ACCTUATORS 12-36VDC BUILT IN ADJUSTABLE LIMIT SWITCHES POWDER COATED 18" THROW UP TO 1,000 LB THRUST (400LB RECOMMENDED LOAD) SUPPLIED WITH MOUNTING BRACKETS DESIGNED FOR OUTDOOR USE These brackets originally made for moving very large satellite dishes are possibly more suitable for closing gates, mechanical machinery, robot wars etc. Our first sale was to a company building solar panels that track the sun! Two sizes available, 12" and 18" throw. £32.95 REF ACT12,

Samarium magnets are 57mm x 20mm and have a hole (5/16th UNF) in the centre and a magnetic strength of 2.2 gauss. We have tested these on a steel beam running through the offices and found that they will take more than 170lbs (77kgs) in weight before being pulled off. With keeper. £21.95 REF MAG77

New transmitter, receiver and camera kit. £69.00

Kit contains four channel switchable camera with built in audio, six IR leds and transmitter, four channel switchable receiver, 2 power supplies, cables, connectors and mounting bracket. £69.00 Wireless Transmitter Black and white camera (75x50x55mm) Builtin 4 channel transmitter (switchable) Audio built in 6 IR Leds Bracket/ stand Power supply 30 m range **Wireless Receiver** 4 channel (switchable) Audio/video leads and scart adapter Power supply and Manual £69.00 ref COP24

This miniature **Stirling Cycle Engine** measures 7" x 4-1/4" and comes complete with built-in alcohol burner. Red flywheels and chassis mounted on a green base, these all-metal beauties silently running at speeds in excess of 1,000 RPM attract attention and create awe wherever displayed. This model comes completely assembled and ready to run. £106.70 REF SOL1

High-power modules using 125mm square multi crystal silicon solar cells with bypass diode Anti reflection coating and BSF structure to improve cell conversion efficiency: 14%. Using white tempered glass, EVA resin, and a weatherproof film along with an aluminum frame for extended outdoor use. system Lead wire with waterproof connector. 80 watt 12v 500x1200 £315.17, 123w 12vdc 1499x662x46 £482.90
165 w 24v 1575x826x46mm £652.30

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Ultra-compact, lightweight, easy to use and comfortable to hold, the new NVMT is unique for a night scope in offering a tactile, suregrip plastic bodyshell and, for extra protection grip, partial rubber armouring. Currently the top of the range model, the NVMT G2+ features a 'commercial' grade' Gen 2+ Image Intensifier Tube (IIT). The NVMT has a built-in, powerful Infrared (IR) Illuminator for use in very low light/total darkness. Power for the scope and IR is provided by 1 x 3V Lithium CR123A battery (not supplied) A green LED next to the viewfinder indicates when the Image Intensifier Tube is switched on while a red LED indicates when the IR Illuminator is switched on.Type Gen Weight Size Lens Mag 2x, Weight 400g, 125x82x35mm angle of view 30 deg, built in infra red, rang 3 - 400m. supplied with batteries £849 ref COB24023.

55 - 200 WATT INFRA RED TORCHS

Search guard 1 infrared torch Plastic bodied waterproof infrared rechargeable lamp. 100mm diameter lens, 200mm body length. 55 watt bulb, 1,000,000 candle power (used as an indication of relative power) Supplied complete with a 12v car lighter socket lead/charger and a 240v mains plug in charger. £49 REF sguard 1 Also available, 70watt @ £59, 100 watt @ £79, 200watt @ £99.

AIR RIFLES FROM £24.70

B2 AIR RIFLE Available In .177 and .22• 19" Taperec Rifled Barrel• Adjustable Rear Sight• Full Length Wooden Stock• Overall Length 43" approxBarrel Locking Lever • Also available in CARBINE Grooved for Telescopic Sight model with 14" barrel - no front sight for use with scope. Weight approximately 6lbs Extremely Powerful .22 £28.90, .177 £24.70. pellets (500) £2.55, sights 4x20 £6.80, 4x28 £15.32 Other models available up to £250 www.airpistol.co.uk

12V SOLAR PANELS AND REGULATORS
9 WATT £58.75
15 WATT £84.25
22 WATT £126.70
Regulator up to 60 watt £21.25
Regulators up to 135 watt £38.25

The combination of multi-crystal cells and a high-reliability module structure make this series of solar panels the ideal solar module. For large-scale power generation hundreds or even thousands of modules can be connected in series to meet the desired electric power requirements. They have a high output, and highly efficient, extremely reliable and designed for ease of maintenance. Separate positive negative junction boxes and dual by-pass diodes are a few examples of some of its outstanding features. Supplied with an 8 metre cable. Perfect for caravans, boats, etc. Toughened glass.

LOCK PICK SETS 16, 32 AND 60 PIECE SETS

This set is deluxe in every way! It includes a nice assortment of balls, rakes, hooks, diamonds, two double ended picks, a broken key extractor, and three tension wrenches. And just how do you top off a set like this? Package it in a top grain leather zippered case. Part: LP005 - Price £45.00

This 32 piece set includes a variety of hooks, rakes, diamonds, balls, extractors, tension tools ... and comes housed in a zippered top grain leather case. If you like choices, go for this one! Part: LP006 - Price £65.00

If your wants run toward the biggest pick set you can find, here it is. This sixty piece set includes an array of hooks, rakes, diamonds, balls, broken key extractors, tension wrenches, and even includes a warded pick set! And the zippered case is made, of course, of the finest top grain leather. First Class! Part: LP007 - Price £99.00

Mamod steam roller, supplied with fuel and everything you need (apart from water and a match!) £85 REF 1312 more models at www.mamodspares.co.uk

Mamod steam roller, supplied with fuel and everything you need (apart from water and a match!) £130 REF 1318 more models at www.mamodspares.co.uk

PEANUT RIDER STIRLING ENGINE This all metal, black and brass engine with red flywheel is mounted on a solid hardwood platform, comes complete with an alcohol fuel cell, extra wick, allen wrenches, and Owner's Manual.Specifications: Base is 5-1/4" x 5-1/4", 4" width x 9" height, 3/4" stroke, 3-1/2" flywheel £141.90

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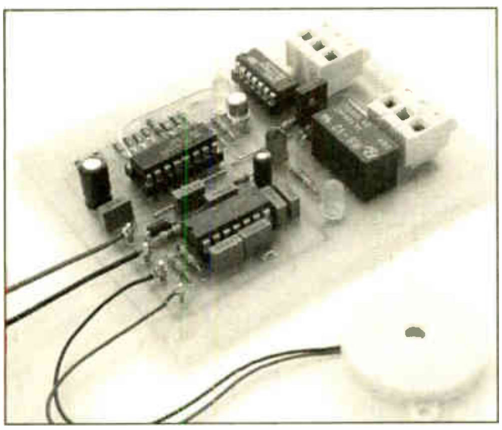
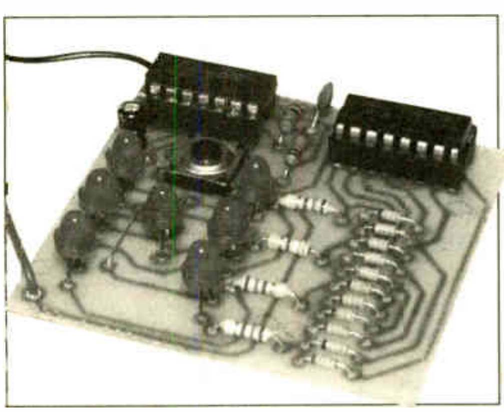


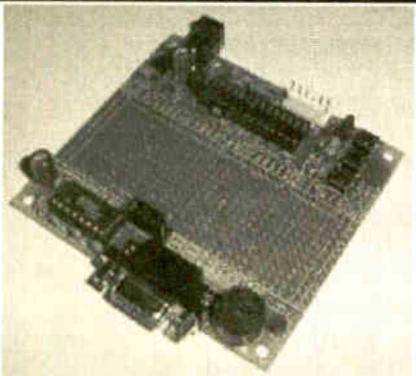


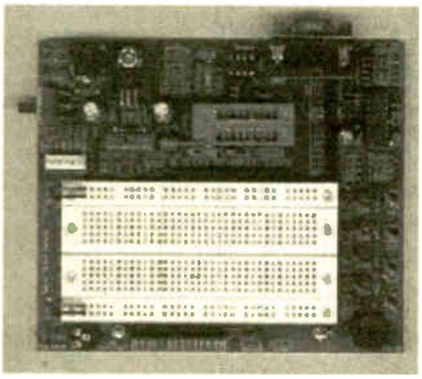
Projects and Circuits

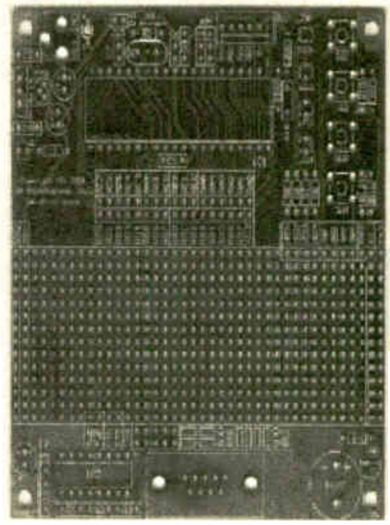
Series and Features

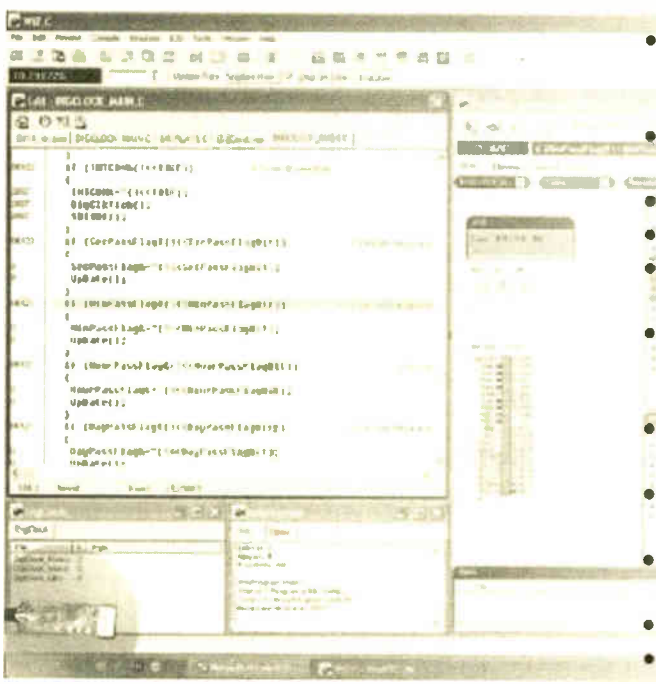
Regulars and Services

Our August 2005 issue will be published on Thursday, 14 July 2005. See page 451 for details









NEXT MONTH

PAIN MONITOR AND LOGGER

In response to the suggestion of a Consultant Anaesthetist, this unit has been designed as a patient welfare logger. It also has applications for other occasional event logging requirements, as in sailing, golfing or wildlife watching, for example.

It has the following specifications:

- *Line of 10 pushbutton switches representing and recording pain threshold values*
- *Two pushbutton switches to record presence or absence of other patient conditions, such as nausea or itch*
- *13 l.e.d.s to visually indicate conditions selected*
- *Additional general purpose l.e.d.*
- *PIC microcontroller controlled*
- *Real-time clock chip, non-volatile*
- *Serial EEPROM (non-volatile memory), with 32K byte storage*
- *Serial interface to PC (any current Windows platform) via RS232 device*
- *PC file generated to suit viewing and analysis via Windows Excel*
- *PIC monitors switch presses, records which switch and the time pressed*
- *Provision for monitoring up to 99 patients on the same unit*
- *L.C.D. displays latest recorded patient data*
- *Unit can be switched off without memory loss*
- *Battery powered*
- *Optional audio output via buzzer*

AUDIO SYSTEMS – COMMUNICATIONS

A preamplifier with automatic gain control and a power amplifier with switched audio filtering

With a preamplifier based around discrete components this project should overcome the problems of specialist i.c.s. disappearing from the market that has dogged previous projects over the years.

The design is sensitive enough to permit the direct connection of dynamic microphones. effective in compressing dynamic range and has low noise and distortion levels. This inexpensive project also describes an audio amplifier with switched filtering and the combination of the two circuits will considerably improve the performance of simple communications receivers and, when used with electret microphones, will ensure good performance for surveillance purposes.

MOTOR AMPLIFIER UNIT

Originally designed for a Robot Wars *robot this unit will provide "bomb-proof" power for electric motors from standard radio control speed controllers. Based on high power f.e.t. drivers, the unit was designed to drive 150W permanent magnet d.c. motors and in "standard" form will withstand up to 150A stall current. The design should be capable of driving motors of up to 500W rating without modification.*

BACK TO BASICS - 5

Two more projects using CMOS logic i.c.s. –

- ***Room Thermostat***
- ***Kitchen Timer***

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PIC & ATMEL Programmers

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

Programmer Accessories:
40-pin Wide ZIF socket (ZIF40W) £15.00
18VDC Power supply (PSU010) £19.95
Leads: Parallel (LDC136) £4.95 / Serial (LDC441) £4.95 / USB (LDC644) £2.95

NEW! USB 'All-Flash' PIC Programmer

USB PIC programmer for all 'Flash' devices. No external power supply making it truly portable. Supplied with box and Windows Software. ZIF Socket and USB Plug A-B lead not incl.
Kit Order Code: 3128KT – **£34.95**
Assembled Order Code: AS3128 – **£44.95**

Enhanced "PICALL" ISP PIC Programmer

Will program virtually ALL 8 to 40 pin PICs plus certain ATMEL AVR, SCENIX SX and EEPROM 24C devices. Also supports In System Programming (ISP) for PIC and ATMEL AVRs. Free software. Blank chip auto detect for super fast bulk programming. Requires a 40-pin wide ZIF socket (not included)
Assembled Order Code: AS3144 – **£54.95**

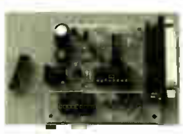
ATMEL 89xxx Programmer

Uses serial port and any standard terminal comms program. 4 LEDs display the status. ZIF sockets not included. Supply: 16VDC.
Kit Order Code: 3123KT – **£29.95**
Assembled Order Code: AS3123 – **£34.95**

NEW! USB & Serial Port PIC Programmer

USB/Serial connection. Header cable for ICSP. Free Windows software. See website for PICs supported. ZIF Socket and USB Plug A-B lead extra. 18VDC.
Kit Order Code: 3149KT – **£34.95**
Assembled Order Code: AS3149 – **£49.95**

Introduction to PIC Programming



Go from a complete PIC beginner to burning your first PIC and writing your own code in no time! Includes a 49-page step-by-step Tutorial Manual, Programming Hardware (with LED bench testing section), Win 3.11–XP Programming Software (will Program, Read, Verify & Erase), and a rewritable PIC16F84A that you can use with different code (4 detailed examples provided for you to learn from). Connects to PC parallel port.
Kit Order Code: 3081KT – **£14.95**
Assembled Order Code: AS3081 – **£24.95**

ABC Maxi AVR Development Board

The ABC Maxi board has an open architecture design based on Atmel's AVR AT90S8535 RISC microcontroller and is ideal for developing new designs.
Features:
8Kb of In-System Programmable Flash (1000 write/erase cycles) • 512 bytes internal SRAM • 512 bytes EEPROM
• 8 analogue inputs (range 0-5V)
• 4 Opto-isolated Inputs (I/Os are bi-directional with internal pull-up resistors)
• Output buffers can sink 20mA current (direct l.e.d. drive) • 4 x 12A open drain MOSFET outputs • RS485 network connector • 2-16 LCD Connector
• 3·5mm Speaker Phone Jack
• Supply: 9-12VDC.
The ABC Maxi STARTER PACK includes one assembled Maxi Board, parallel and serial cables, and Windows software CD-ROM featuring an Assembler, BASIC compiler and in-system programmer.
Order Code ABCMAXISP – **£99.95**
The ABC Maxi boards only can also be purchased separately at £79.95 each.

Controllers & Loggers

Here are just a few of the controller and data acquisition and control units we have.
See website for full details. Suitable PSU for all units: Order Code PSU445 – **£8.95**

Rolling Code 4-Channel UHF Remote

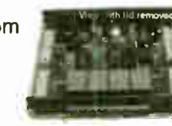
State-of-the-Art. High security. 4 channels. Momentary or latching relay output. Range up to 40m. Up to 15 TXs can be learned by one Rx (kit includes one Tx but more available separately). 4 indicator LEDs.
Rx: PCB 77x85mm, 12VDC/6mA (standby).
Two & Ten Channel versions also available.
Kit Order Code: 3180KIT – **£41.95**
Assembled Order Code: AS3180 – **£49.95**

Computer Temperature Data Logger

Serial port 4-channel temperature logger. °C or °F. Continuously logs up to 4 separate sensors located 200m+ from board. Wide range of free software applications for storing/using data. PCB just 38x38mm. Powered by PC. Includes one DS1820 sensor and four header cables.
Kit Order Code: 3145KT – **£19.95**
Assembled Order Code: AS3145 – **£26.95**
Additional DS1820 Sensors – **£3.95 each**

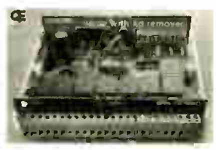
Most items are available in kit form (KT suffix) or pre-assembled and ready for use (AS prefix).

NEW! DTMF Telephone Relay Switcher



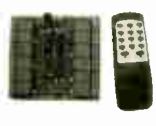
Call your phone number using a DTMF phone from anywhere in the world and remotely turn on/off any of the 4 relays as desired. User settable Security Password, Anti-Tamper, Rings to Answer, Auto Hang-up and Lockout. Includes plastic case. 130 x 110 x 30mm. Power: 12VDC.
Kit Order Code: 3140KT – **£39.95**
Assembled Order Code: AS3140 – **£49.95**

Serial Port Isolated I/O Module



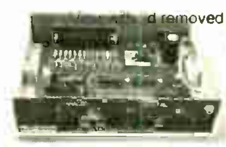
Computer controlled 8-channel relay board. 5A mains rated relay outputs and 4 opto-isolated digital inputs (for monitoring switch states, etc). Useful in a variety of control and sensing applications. Programmed via serial port (use our new Windows interface, terminal emulator or batch files). Serial cable can be up to 35m long. Includes plastic case 130 x 100 x 30mm. Power: 12VDC/500mA.
Kit Order Code: 3108KT – **£54.95**
Assembled Order Code: AS3108 – **£64.95**

Infra-red RC 12-Channel Relay Board



Control 12 on-board relays with included infra-red remote control unit. Toggle or momentary. 15m+ range. 112 x 122mm. Supply: 12VDC/0·5A.
Kit Order Code: 3142KT – **£41.95**
Assembled Order Code: AS3142 – **£51.95**

PC Data Acquisition & Control Unit



Monitor and log a mixture of analogue and digital inputs and control external devices via the analogue and digital outputs. Monitor pressure, temperature, light intensity, weight, switch state, movement, relays, etc. with the apropriate sensors (not supplied). Data can be processed, stored and the results used to control devices such as motors, sirens, relays, servo motors (up to 11) and two stepper motors.

Features
- 11 Analogue Inputs – 0·5V, 10 bit (5mV/step)
- 16 Digital Inputs – 20V max. Protection 1K in series, 5·1V Zener
- 1 Analogue Output – 0-2·5V or 0-10V. 8 bit (20mV/step)
- 8 Digital Outputs – Open collector, 500mA, 33V max
- Custom box (140 x 110 x 35mm) with printed front & rear panels
- Windows software utilities (3·1 to XP) and programming examples
- Supply: 12V DC (Order Code PSU203)

Kit Order Code: 3093KT – **£69.95**
Assembled Order Code: AS3093 – **£99.95**

STORE YOUR BACK ISSUES ON MINI CD-ROMS

VOL 12 NOW AVAILABLE

ONLY £14.45 each including VAT and p&p

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

VOL 1: BACK ISSUES – January 1999 to June 1999
Plus some bonus material from Nov and Dec 1998

VOL 2: BACK ISSUES – July 1999 to December 1999

VOL 3: BACK ISSUES – January 2000 to June 2000

VOL 4: BACK ISSUES – July 2000 to December 2000

VOL 5: BACK ISSUES – January 2001 to June 2001

VOL 6: BACK ISSUES – July 2001 to December 2001

VOL 7: BACK ISSUES – January 2002 to June 2002

VOL 8: BACK ISSUES – July 2002 to December 2002

VOL 9: BACK ISSUES – January 2003 to June 2003

VOL 10: BACK ISSUES – July 2003 to December 2003

VOL 11: BACK ISSUES – January 2004 to June 2004

VOL 12: BACK ISSUES – July 2004 to December 2004

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

WHAT IS INCLUDED

All volumes include the *EPE Online* editorial content of every listed issue, plus all the available **PIC Project Codes** for the PIC projects published in those issues.

Note: Some supplements etc. can be downloaded free from the Library on the *EPE Online* website at **www.epemag.com**.
No advertisements are included in Volumes 1 and 2; from Volume 5 onwards the available relevant software for *Interface* articles is also included.

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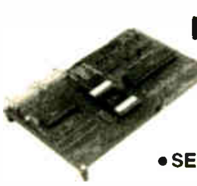

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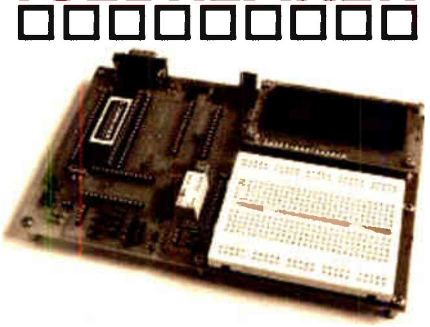

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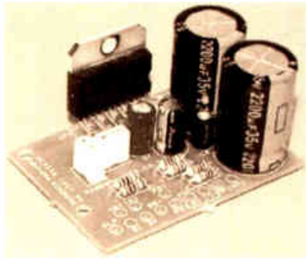

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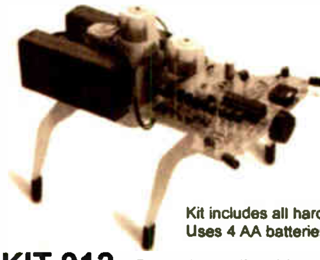

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Testing-Testing

It is possible to successfully build electronic projects without the use of any test equipment but more often than not the ability to make some basic measurements is required, even if it is simply to check supply voltages etc. Of course, if your project fails to work first time it is often difficult to sort out what is wrong without some way of at least measuring voltage, current and perhaps resistance etc.

Most of our "components" advertisers can supply a range of multimeters that start at just a few pounds and go up in price depending on specification and quality. One of the basic ones will get you started and I always keep a £6 digital meter in my toolbox that gets used for everything from testing fuses and mains connections when d.i.y-ing to setting up projects. These basic digital meters have a wide range of functions, are fairly rugged and are certainly accurate enough for general hobby use.

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Once your constructional abilities move on the need for more equipment like variable power supplies, signal generators, frequency meters and oscilloscopes grows. Many of these items can now be provided by a computer plus a suitable front end interface and these are advertised in our pages. Often one unit will provide a range of functions and the storage and display abilities of the PC can add to the functions.

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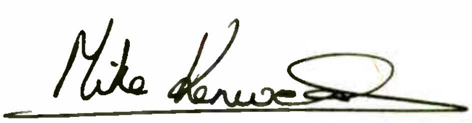

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Constructional Project

Cybervox

John Becker

How to linguistically challenge those evil Daleks in their own dialect

SO THE DOCTOR'S BACK! Surely we don't hear the question of "which doctor"? Of course not, there's only one Doctor as far as his fans are concerned – Dr Who! After a long absence, travelling up and down the time-lines no doubt, his adventures are again being told on BBC TV. Reliable sources inform us that he will continue to be challenged up and down the timelines by the Daleks, whose one aim in all of eternity is to "ExTeRmInAtE!" everything in sight of their lethal sink plungers!

And what better way to commemorate the return of these Great Sagas than to provide you with the vocal armament to challenge the dastardly Daleks in their own language. Suspend your disbelief – over the years we and others have periodically equipped you with Dalek voice emulators and the like. Though it's probably 20 years since the author and *Everyday (Practical) Electronics* teamed resources on behalf of humanity in these apocalyptic adventures.

Time-Lining

Whilst the technology sported by the Daleks has evolved, so too has our ability to challenge it in its own language – the noble family of PIC microcontrollers is now at our translational beck and call!

Here, then, is the Cybervox, a linguistic cyborg challenger that is tunable to many Dalekesque dialects, all selectable at the twist of a few knobs.

To this end, the Cybervox has been equipped with the essential undulating vocal modulator, and a variable cavernous multi-spacial timeline echo delay such as befits a Time Lord's confrontation of the evil creatures inhabiting the asynchronastic parafundibulum.

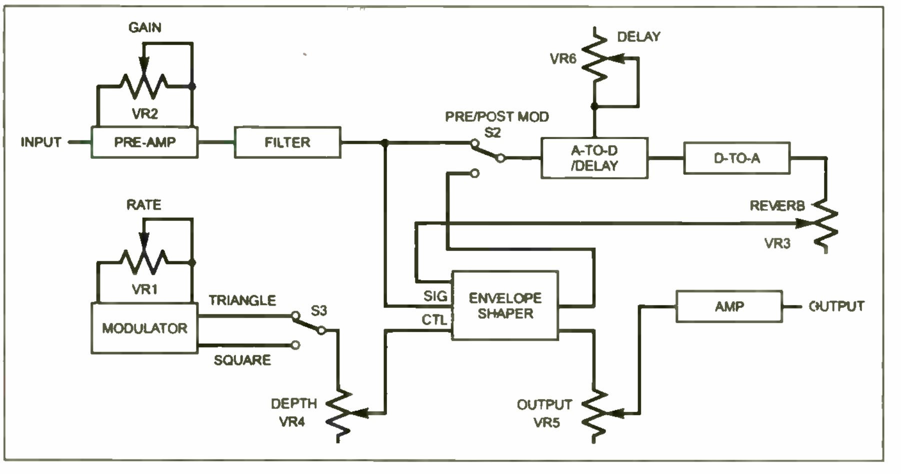


Fig.1. Block diagram of the Cybervox

Down to Earth

Part of the secret of this hi-tech vibrant module – keep it to yourselves – is revealed by the block diagram given in Fig.1, and its controlling circuit diagram in Fig.2. At its heart is one of the newer PIC family, a PIC18F252 device. This has been chosen for its much larger memory bank than we are used to with many other PICs – 1536 bytes. The PIC16F877, for example, has 368 bytes, and the PIC16F84 a mere 68.

This large memory bank and its ease of access without recourse to Bank and Block manipulation, makes it ideal for use in any design that needs a large area of memory for frequent temporary data storage. Such data storage is a vital requirement for the Cybervox, which basically requires an analogue audio signal to be sampled at speed, converted to its binary equivalent and stored in memory for recall following a period of delay.

The audio source is discussed in a moment, but its changing voltage levels are sampled by the PIC's internal analogue-to-digital converter (ADC) at a variable rate up to about 64kHz. The ADC has 10-bit resolution, but for this application, only the upper eight bits are used and stored to memory as a byte.

As each byte is stored, so the PIC's internal counter is incremented automatically without a separate software counter, as would be required with a 16F device. The 18F method was discussed by Malc Wiles in his *PIC 18F Microcontroller Family* introduction of April '05.

No memory bytes are needed for storage of program variables, and so the full 1536 memory bytes are available for sampled data storage. Once each full block has been filled, the cycle recommences from its beginning.

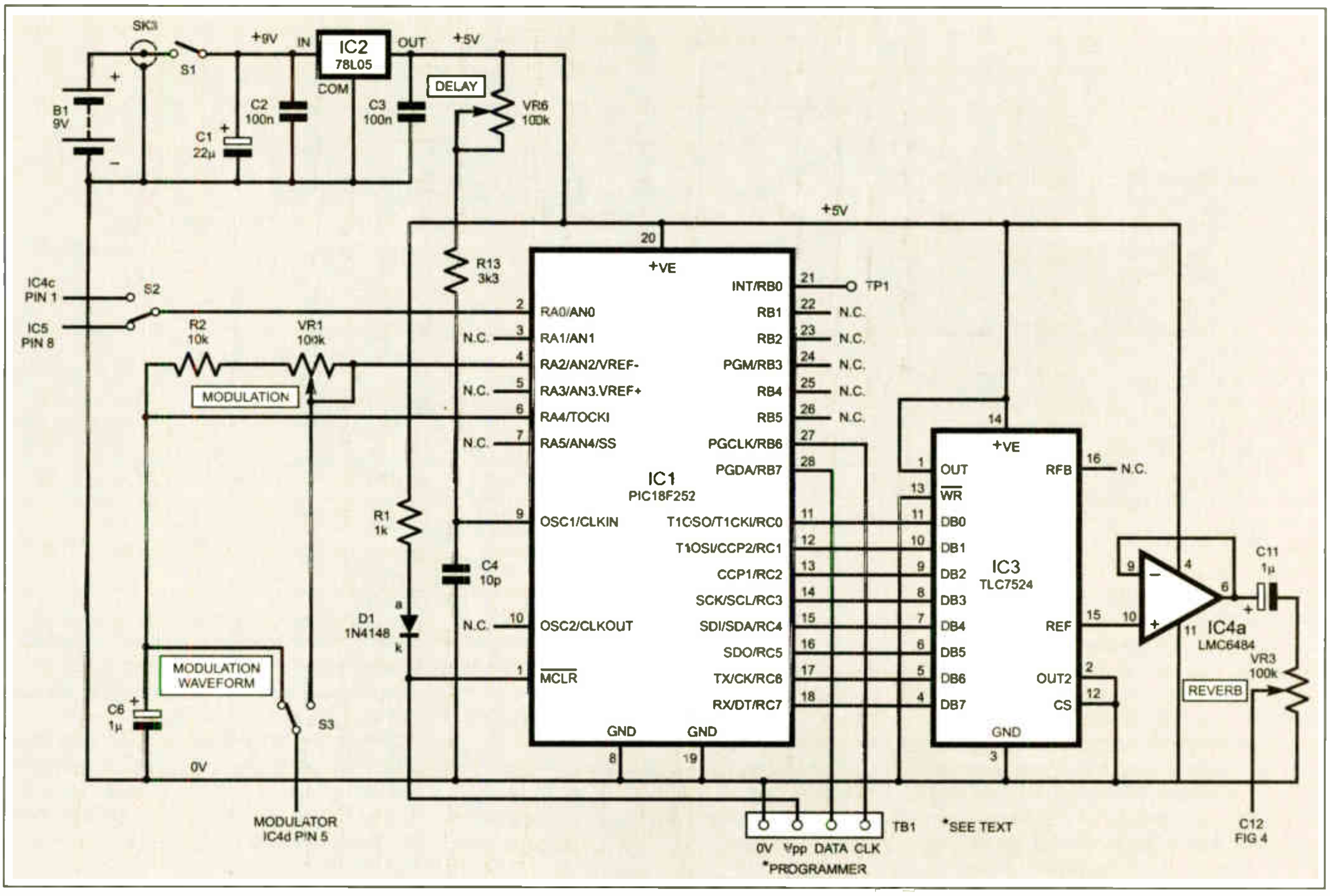


Fig.2. Circuit diagram for the Cybervox controller

The basic software routine which samples, stores and recalls the data has only 17 commands. Listing 1 and its notated command lines show the looped sequence.

Delay Length

The length of delay between the first and last data bytes being recorded depends on the sampling rate of the system. It is this delay which is used to create the echo/reverberation effects that this unit provides. The PIC is clocked in RC (resistor-capacitor) mode, as set by C4, R13 and potentiometer VR6, and the sampling rate is determined by this clock rate. The range is from 64kHz to about 2·4kHz.

Immediately prior to each byte being recorded and the recording counter automatically incremented, the memory contents at the address currently pointed to is read back. This byte was recorded 1536 samples earlier, i.e. with a 64kHz sampling rate, about 24·6ms earlier.

If the live and delayed signals are mixed and replayed together, the human ear can just about distinguish this delay as a brief echo. The delay becomes even more apparent if the sampling rate is slowed or the memory bank length increased. The latter is not possible in this design, but the rate can be changed, using VR6 as said above.

The more the delay is extended – to about 565ms with a sampling rate of 2·4kHz – the greater the reverberation/echo chamber effect. The effect becomes even more pronounced if the delayed signal is partially fed back to the original sampling input (see later).

LISTING 1

```
WAITAD0: btfsc ADCON0,GO,A        ; is A-D conversion complete?
         goto WAITAD0             ; no
         movf INDF1,W,A           ; get echo data from current memory address
         movwf PORTC,A            ; output to PORTC
         movf ADRESH,W,A          ; get ADC MSB val
         movwf POSTINC1,A         ; store to current mem address & inc counter
         movf FSR1H,W,A           ; is address counter equal max limit?
         xorlw 6
         btfsc STATUS,Z,A
         lfsr FSR1,MEMORYBANK     ; yes, reset counter to start address
         incf PORTB,F,A           ; RB0 used for freq counting in prototype
                                  ; true rate twice Hz value counted
         btfsc PORTA,4,A          ; toggle RA2 depending on status of RA4
         bcf PORTA,2,A            ; (modulation waveform generation)
         btfss PORTA,4,A
         bsf PORTA,2,A
         bsf ADCON0,GO,A          ; restart data conversion
         goto WAITAD0             ; repeat
```

The inherent drawback of reducing the sampling rate is that the system's upper frequency response is reduced. This is of no real significance in this design as it is intended only for use with speech. Until comparatively recently, public telephone lines had an upper limit of about 300Hz, catering just for normal speech bandwidths. Such a limit cannot be described as being "hi-fi", and neither can the Cybervox – the system is not really suitable for music effects use.

The Nyquist theory of sampling rate in relation to signal frequency states that the absolute minimum rate:frequency ratio is 2:1 to allow the sampled signal's minimum and maximum peaks to be reproduced. In practice, a ratio of 3:1 is more commonly considered the minimum acceptable.

Buckets of Delay

Although special delay chips for echo and reverb generation are still around, they are far less commonly used in hobbyist projects now than they used to be. Some older readers will no doubt recall with affection the "bucket-brigade" devices (BBDs) such as the TDA1022, SAD1024 and their later derivatives which came to dominate the audio effects scene for a decade or two from the mid 1970s.

These devices contained a long series of interconnected capacitive charge cells. In response to a clock signal of several tens of kilohertz, the chips sampled an audio input voltage, storing its immediate amplitude as a charge on the first capacitor. At the next clock signal this charge was transferred to the second capacitor and the first one loaded with a new charge from the input.

The process continued indefinitely, each capacitor transferring its charge to the

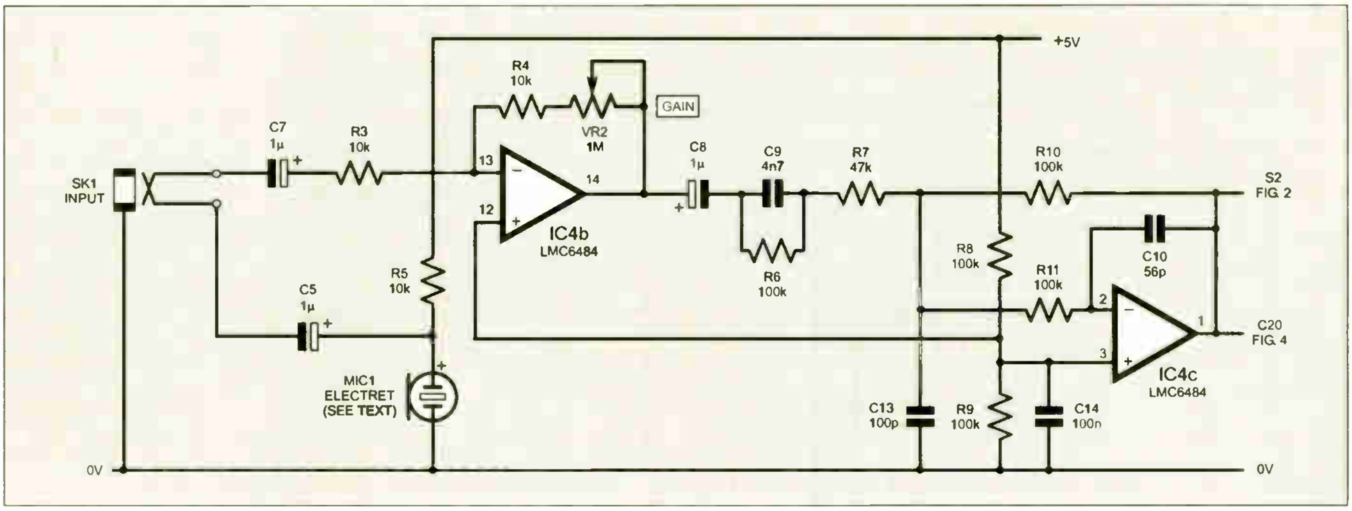


Fig.3. Circuit diagram for the audio input stage

next, until the charge finally "emerged" from the final capacitor as the output signal. Typically, such delay chips provided around a thousand delay cells, although chips having larger quantities became available (the TDA4096 had 4096 stages).

As proved by this Cybervox design, the PIC18F family with its extended memory can now replicate the bucket-brigade technique and help reproduce some of the audio effects for which the TDA1022 etc became famous. The principle difference, though, is that sampled data is not physically shifted along capacitive storage cells, but is stored digitally in consecutive memory bytes.

The effect of this is that the final output replay value must be converted from a digital format to an analogue equivalent. This requires the addition of a digital-to-analogue converter (DAC), which in the case of the Cybervox is provided by IC3, a Texas Instruments TLC7524 8-bit device. As used here, the TLC7524 produces an output voltage of 0V for a digital input of binary 00000000, and a 5V output (supply line level) for a binary input of 11111111.

Internally, the DAC's analogue voltage is generated across a ladder network of resistors and the final output must be buffered to prevent this ladder being undesirably "loaded". Op.amp IC4a provides this unity gain buffering. It is a rail-to-rail device, so it too has an output that can swing fully between 0V and the +5V line voltage.

The output from IC4a is fed via reverberation level control VR3 to the audio envelope modulator stage in Fig.4, which is discussed shortly.

Modulation Waveform

The PIC is also responsible for generating the audio modulation waveform. The waveshaping and rate generation components are capacitor C6 plus resistor R2 and rate control VR1.

The software initially sets RA2 as a logic high output pin. Capacitor C6 starts to charge via R2 and VR1. The voltage on C6 is monitored by pin RA4. This pin is used as a Schmitt trigger input. When the software recognises that its input voltage level from C6 has reached the upper trigger threshold value, pin RA2 is set to 0V.

Capacitor C6 now starts to discharge via R2 and VR1. Now, when the lower Schmitt threshold has been reached, RA2 is again set high. The process continues indefinitely, the result being a reasonable triangular waveform across C6. The four commands associated with RA2's toggling are shown towards the end of Listing 1.

Either the triangular waveform across C6, or the square wave at RA2, can be fed via switch S3 to buffer op.amp IC4d in Fig.4. The resulting output voltage is routed to Modulation Depth control VR4 and fed via R21 to the control input, pin 1, of the transconductance op.amp IC5. This device is used as the audio signal envelope shaper, as described presently.

The modulation rate set by VR1 is variable between about 10Hz and 70Hz. It may be changed by amending the value of C6.

Input Stage

The circuit diagram in Fig.3 is that for the Cybervox audio input stage.

The circuit has been designed with several possible audio input sources in mind. It was felt that, like the majority of audio effects units, the Cybervox will be used between an existing microphone-coupled preamp and a

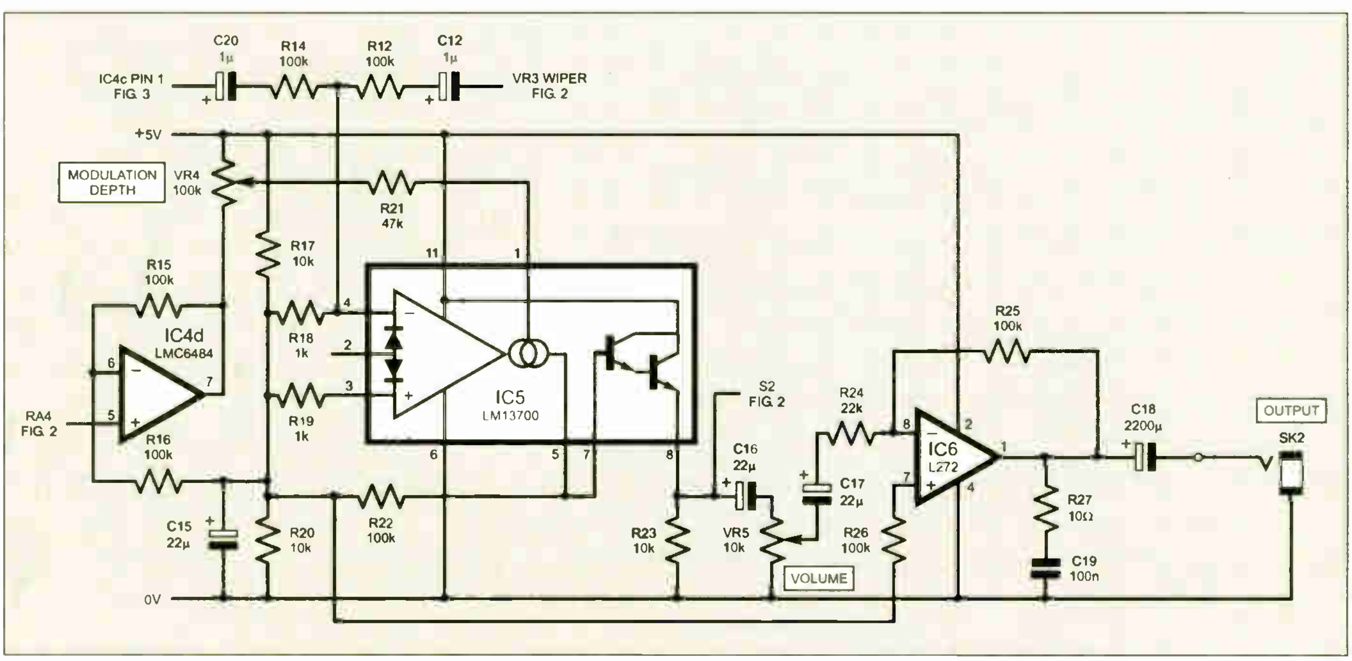


Fig.4. Circuit diagram for the envelope modulation and power amp output stages

main power amplifier. However, alternatives to this setup have been provided.

Via socket SK1, a line-level signal, or that from an external high-output microphone, can be input via a.c. coupling capacitor C7 to the op.amp stage around IC4b. Gain control VR2 allows the signal gain to be varied between about x1 and about x100.

The op.amp's output is capacitively coupled by C8 to the filter stage around IC4c, limiting the frequency range seen by the ADC (beyond the scope of this article to discuss).

The output from IC4c is routed in two directions. The path notated as being via switch S2 can be routed to the PIC in Fig.1 at its RA0 analogue input. The other route is to the modulated envelope shaping circuit shown around IC5 in Fig.4.

Provision for an optional built-in electret microphone module, MIC1, to be used has also been provided. This is powered via resistor R5 and coupled via capacitor C5 to the secondary (switched) signal terminal of SK1. When SK1 does not have an external signal source plugged in, the electret's signal is switched by SK1's contacts to connect with input capacitor C7.

Resistors R8 and R9 provide midway bias (2.5V) to IC4b and IC4c, with capacitor C14 providing smoothing.

Envelope Shaper

The audio signals from IC4c in Fig.3, and IC4a/VR3 in Fig.2, are fed to envelope shaper IC5 in Fig.4, where they are mixed. They are applied to the inverting input at pin 4, having been severely attenuated by the action of R12, R14 and R18, as required by this transconductance stage. The non-inverting input at pin 3 is biased at half line level (2·5V) as set by R17 and R20.

As the input control current at pin 1 swings high and low in response to the modulating waveform fed it, so the signal amplitude at pins 5 and 7 rises and falls. Since the amplitude is also dependent on the value of resistor R22, the signal needs to be buffered by the Darlington transistor within IC5.

The transistor is emitter-coupled to load resistor R23, and the output signal here is capacitively coupled via C16 to volume control VR5. From VR5, the signal is fed to the mini-power amplifier stage around IC6. This device is powered at the full battery voltage, nominally 9V, and can deliver up to 1A into a loudspeaker load of 4Ω upwards. The speaker may be replaced by a pair of headphones if preferred.

COMPONENTS

Resistors

R1, R18, R19	1k (3 off)
R2 to R5, R17, R20, R23	10k (7 off)
R6, R8 to R12, R14 to R16, R22, R25, R26	100k (12 off)
R7, R21	47k (2 off)
R13	3k3
R24	22k
R27	10Ω

All 0·25W 5% carbon film or better

See SHOP TALK page

Potentiometers

VR1, VR3, VR4, VR6	100k lin, panel mounting (4 off)
VR2	1M lin rotary, panel mounting
VR5	10k log, panel mounting

All pots may be min. round preset if preferred (see text)

Capacitors

C1, C15 to C17	22µ radial elect. 16V (4 off)
C2, C3, C14, C19	100n ceramic disc, 5mm pitch (4 off)
C4	10p ceramic disc, 5mm pitch
C5 to C8, C11, C12, C20	1µ radial elect. 16V (7 off)
C9	4n7 ceramic disc, 5mm pitch
C10	56p ceramic disc, 5mm pitch
C13	100p ceramic disc, 5mm pitch
C18	2200µ radial elect. 16V

Semiconductors

D1	1N4148 signal diode
IC1	PIC18F252 microcontroller, pre-programmed (see text)
IC2	78L05 +5V 100mA voltage regulator
IC3	TLC7524 8-bit digital to analogue converter
IC4	LMC6484 quad op.amp, rail-to-rail
IC5	LM13700 dual transconductance op.amp
IC6	L272 dual power amplifier

Miscellaneous

MIC1	electret microphone insert (optional – see text)
SK1	switched mono jack socket, size to suit
SK2	mono jack socket, size to suit
SK3	power supply socket, type of choice (see text)
S1	s.p.s.t. min. toggle switch
S2, S3	s.p.d.t. min. toggle switch (2 off)

Printed circuit board, available from the *EPE PCB Service*, code 514; 8-pin d.i.l. socket; 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket; 28-pin d.i.l. socket; knobs for rotary potentiometers (see text) (6 off); 9V battery and clip; metal case 225mm × 125mm × 60mm; connecting wire; solder, etc.

Approx. Cost Guidance Only **£40** *excl case & batts*

Returning to Fig.1, switch S2 allows the signal being input to the PIC to come directly from the input stage at IC4c, as said earlier, or from the output of the envelope shaper IC5 at pin 8. This option allows pre- or post-modulation signals to be switched to the delay circuit, so enhancing the audio effects that can be produced.

Beware that the dreaded "feedback howl" can occur in post-modulation mode if Reverb control VR3 is turned up too far.

Other Aspects

The circuit is intended for powering from a 9V battery. This voltage is fed directly to the output stage around IC6. It is also regulated down to +5V by IC2 to suit the PIC, and the analogue circuits which feed into and from it.

An external 9V d.c. power source may be used, bringing it into the case via socket SK3, which may have any style of your choosing. A 3.5mm jack socket is the type used in the prototype.

As usual with the author's designs, connector TB1 allows the PIC to be programmed in situ by those who have suitable PIC programming facilities, such as *Toolkit TK3*.

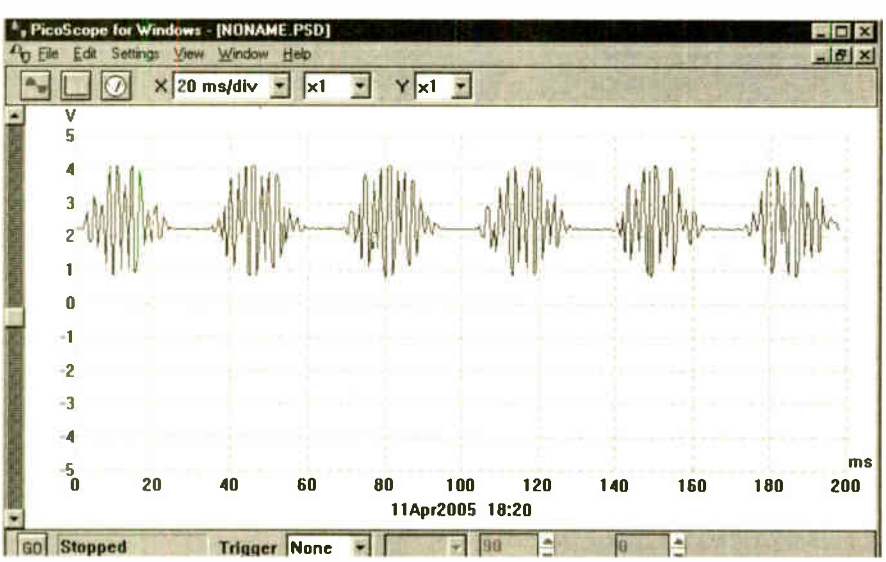


Fig.5. Example of a modulated signal created by the Cybervox. It was produced using the Pico Picoscope for Windows PC interface

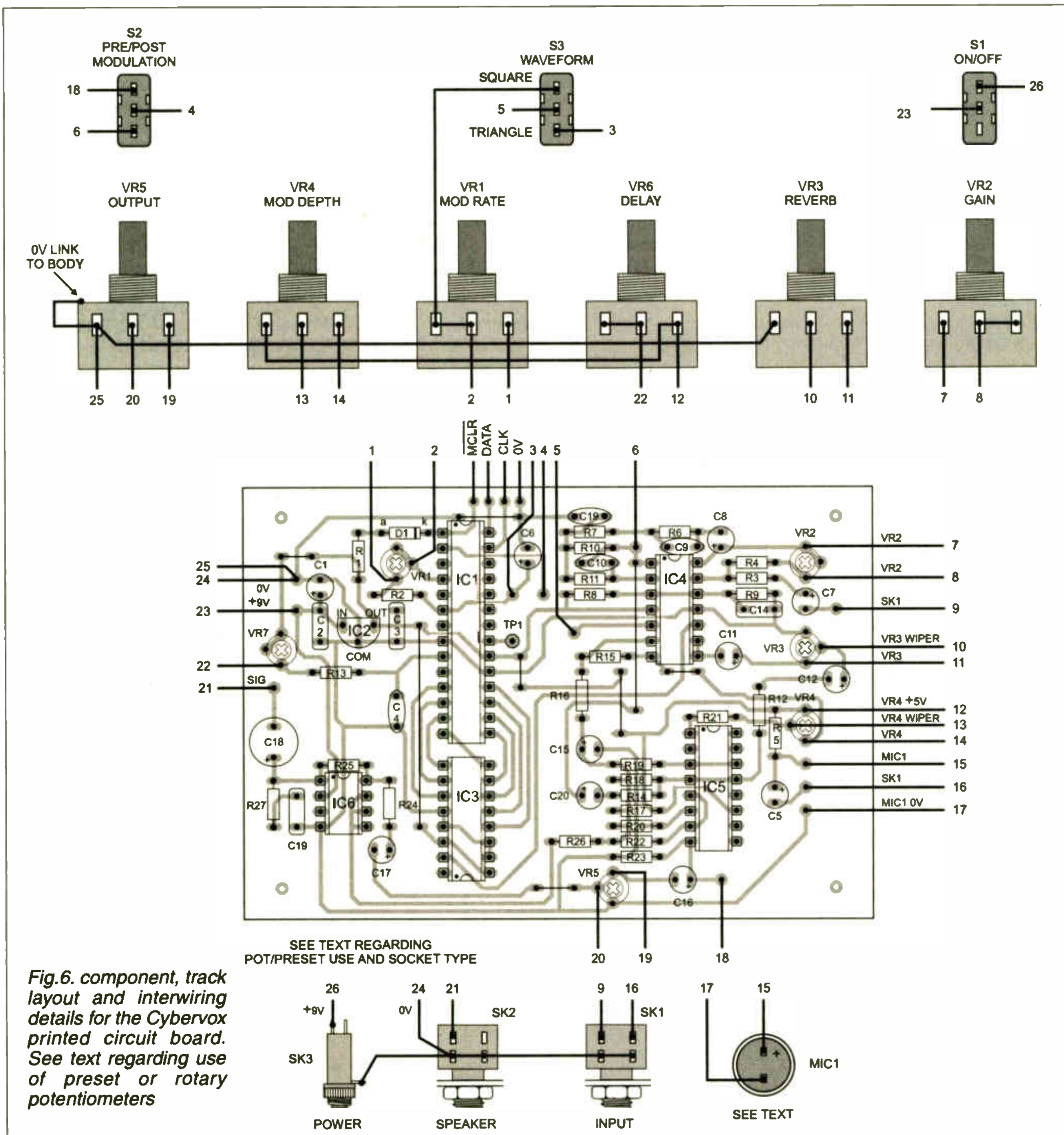
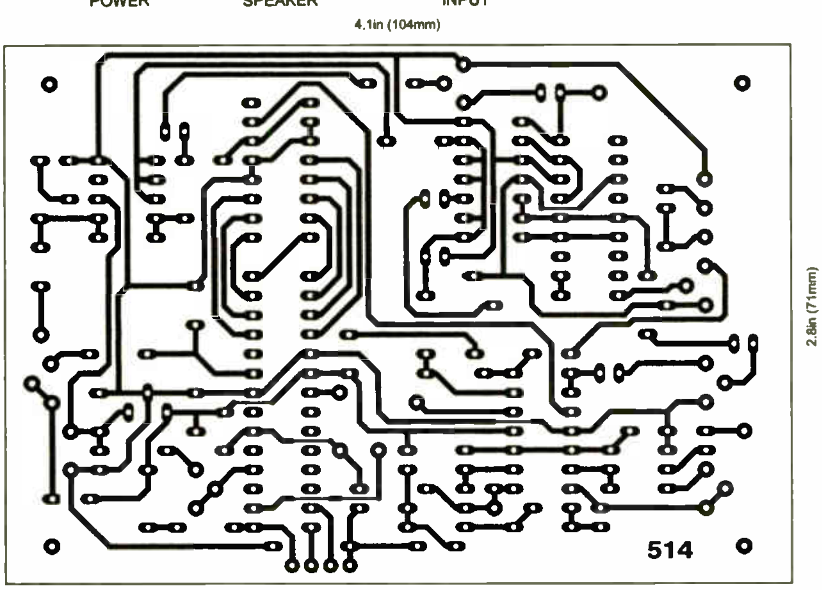
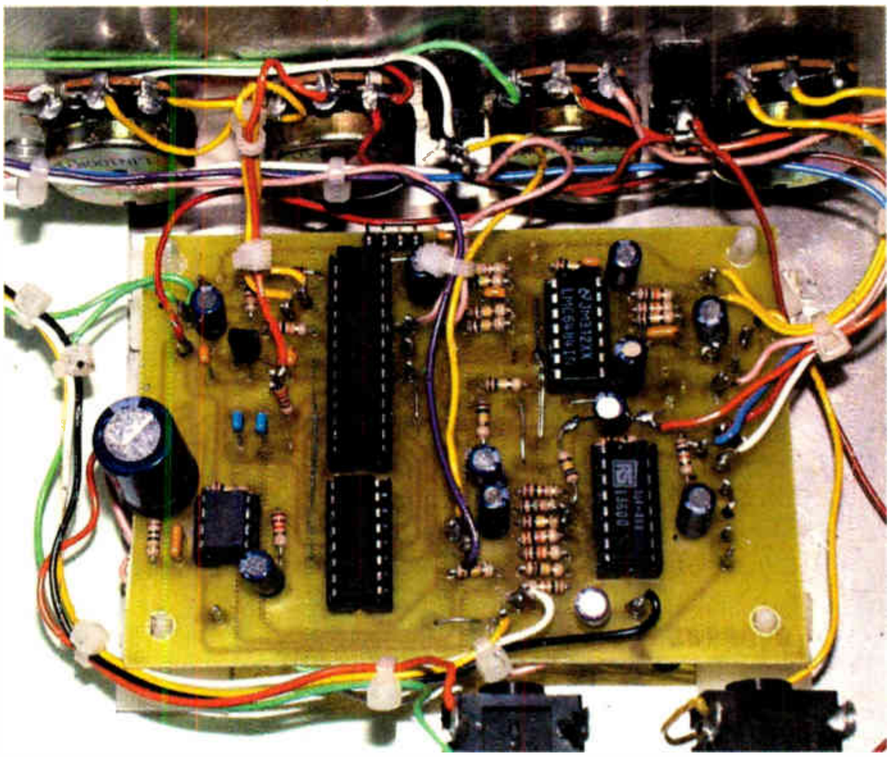


Fig.6. component, track layout and interwiring details for the Cybervox printed circuit board. See text regarding use of preset or rotary potentiometers





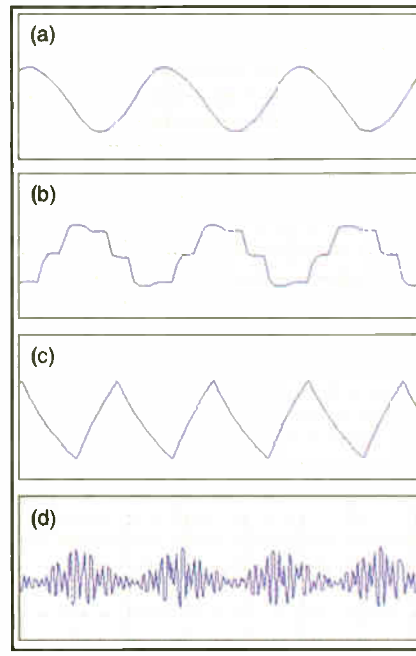


Fig.7. Waveforms recorded on the Cybervox – details in text

Construction

Printed circuit board component and track layout details are shown in Fig.6. This board is available from the *EPE PCB Service*, code 514.

The board has been designed for panel mounted or preset potentiometers to be used. This allows a compact unit to be assembled for dedicated use in a Dalek-type voice context, or as a unit with wider applications. Choose the pot type suited to your intentions. If the preset pot version is built, ignore the panel-mounted potentiometer wiring shown in Fig.6.

Assemble in the usual order of ascending component size, from link wires upwards. Use sockets for the d.i.l. (dual-in-line) i.c.s, but do not insert these i.c.s. until the completed assembly has been fully checked for accuracy, and the correctness of the +5V regulated power line proved.

All polarised components must be positioned with the correct orientation as shown in Fig.6.

A metal case was used to house the prototype, measuring approximately 225mm × 125mm × 63mm. Drill holes for the panel mounted components as suggested by the photographs.

Make sure that the metal case is earthed to the 0V line of the power supply. In the prototype this was done by soldering a 0V connection to the "lug" of the output Volume potentiometer, VR5. It may be necessary to roughen the tag before it will take the solder.

If using panel mounted potentiometers, take a photocopy of Fig.6 and tick each connecting wire once connected to avoid risk of incorrect connection.

Testing

On first power switch-on, without d.i.l. i.c.s inserted, check that the output from regulator IC2 is correctly at 5V, within a few millivolts. If all is well, switch off and insert the d.i.l. i.c.s., including the pre-programmed PIC (see later), rechecking the regulator's output again following power switch-on.

Turn the Delay control fully clockwise, and all other potentiometers fully anticlockwise. Plug in the speaker and an external sound source, preferably a speech source – ignore the electret microphone at this time.

Turn up the output Volume control VR5 a bit, and if necessary turn up the Gain control VR2 until an audio output signal is heard. Leave Reverb control VR3, and Modulation Depth control VR4 turned down for the moment.

Once an output signal is heard, turn up Modulation Control VR4 to about midway, then adjust Modulation Rate control VR1 until the audio output is heard being modulated at a reasonable rate. Ultimately VR1 and VR4 should be adjusted to the rate which you think best represents the Dalek modulation effect (browsing the web reveals that there is no definitive opinion on this).

Turn down the Modulation Depth control, and slowly turn up the Reverb control, VR3. As the setting is gradually turned up, so the reverberation effect should become apparent.

Now adjust Delay Rate control VR6 and listen to the changes in the echo/reverb effect so produced.

Waveforms

For interest, four waveforms monitored on the Cybervox are shown in Fig.7. They represent:

a) sinewave sampled at fastest sampling rate.

b) the same sinewave sampled at an extremely slow sampling rate. Note how the sampling steps are clearly visible.

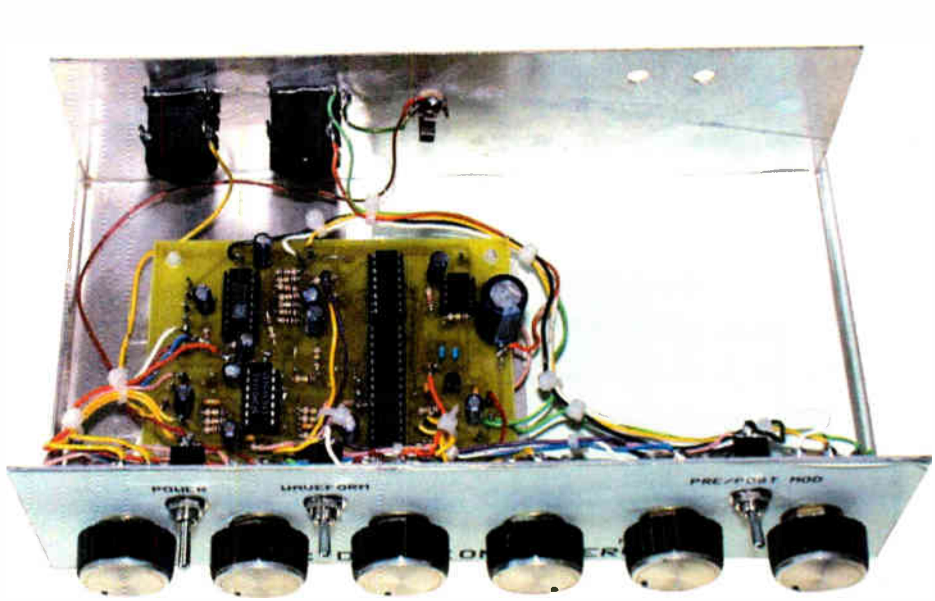
c) triangular modulation waveform

d) audio waveform moderately modulated by triangular waveform (the similar image shown in Fig.5. was heavily modulated). All the waveforms were recorded using the PicoScope for Windows PC interface module.

Into the Timely Affray

Before concluding, there are a few peripheral points worth mentioning.

First, 20-odd years ago the author spoke to the BBC's radiophonics workshop about Dalek voice creation – Dick Mills is the



name that comes mind over this. The technique then being used was to employ a ring modulator for the modulation control, as the author then did with his analogue Dalek voices at that time.

In the Cybervox, principally conceived of as a digital design based on a PIC, it proved impossible to simulate a ring modulator through software, the coding overhead being so great that it slowed down the audio sampling rate too much. Instead, a comparable effect is produced by the use of the reverberation and amplitude-modulation controls.

Secondly, there is widespread diversity in the perceived opinions of what a Dalek voice should actually sound like! Indeed, web browsing revealed intense discussions about which actor produced the best Dalek accent. Well, why shouldn't Daleks also have regional accents as we do?

What was clear, though, was that creating a good Dalek voice is as much down to the actor's performance as to the modulation effect. It is also clear that there were never any specified settings for the modulator and variation was invariably introduced in the actors' voices.

So Whosit fans, it's entirely up to you to decide how best you use the Cybervox and your vocal skills as you now enter into the Dalexion realms of cybertimelines.

It just remains to caution you to "take care" if you join the *Tardis* in its travels, and to only exterminate the enemy, whatever form it takes!

Definitive plans for a PIC-controlled Sonic Screwdriver have not yet been finalised – but the author's thinking on it ...

Resources

Software, including source code files, for the Cybervox is available on 3.5inch disk from the Editorial office (a small handling charge applies – see the *EPE PCB Service* page) or it can be downloaded *free* from the *EPE* Downloads site, accessible via the home page at **www.epemag.co.uk**. It is held in the PICs folder, under Cybervox. Download all the files within that folder.

This month's *Shoptalk* provides information about obtaining pre-programmed PICs.

The PIC program source code (ASM) was written using *EPE Toolkit TK3* software (also available via the Downloads site) and a variant of the TASM dialect. It may be translated to MPASM via *TK3* if preferred. The run-time assembly is supplied as an MPASM HEX file, which has PIC18F configurations embedded in it. If you wish to program the PIC yourself, simply load this HEX file into the PIC using your own PIC programming software and hardware. □

News . . .

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

COPY DEFEATING PATENTS

As long as rip-offs continue, so too will attempts to defeat them. Barry Fox reports

IT does not matter how much clever digital encryption Hollywood uses to stop people copying movies from DVDs or TV, cable or satellite receivers, says British technology company Dwight Cavendish. People can still defeat it by the simple expedient of taking the analogue signal intended for the TV screen and feeding it to the "capture" circuitry in a modern PC. The PC obligingly converts the analogue signal into a digital signal, without any protection. So it can be copied or sent over the Internet.

US company Macrovision has patented some solutions but provocatively DC says that they are "not effective" (WO 2004/110060). Dwight Cavendish's new system relies on circuitry in next generation receivers and players which intermittently increases the strength of the pulses which are routinely used in all TV signals to keep pictures steady on a screen.

"Unexpectedly", says DC, this upsets the capture card and makes the captured pictures suffer "irritating" changes in brightness. So they are not worth copying or putting on the Internet. But a TV screen ignores the spurious variations because it is already designed to cope with the poor quality signals that many viewers get from their aerials.

Another solution, says Philips's Research Lab in Briarcliff Manor, NY (WO 2004/102951), is for PC makers deliberately to slightly degrade the analogue signal from the disk drive, in a way that plays havoc with the digital circuitry in a DVD recorder.

Random noise, like finely-detailed, fast-moving snow, is added to the picture signal. The snow is not visible on the PC screen, but the recorder wastes so many digital bits trying unsuccessfully to record it faithfully, that the overall picture recorded looks like a coarse mosaic, and breaks up when there is fast action on screen.

Ring It Yourself!

Cellphone users round the world spend a billion dollars a year on downloading musical ringtones. So the music industry may not be too pleased with a new "fun way to save serious money" by making ringtones "in seconds ... without fees, subscriptions or downloads".

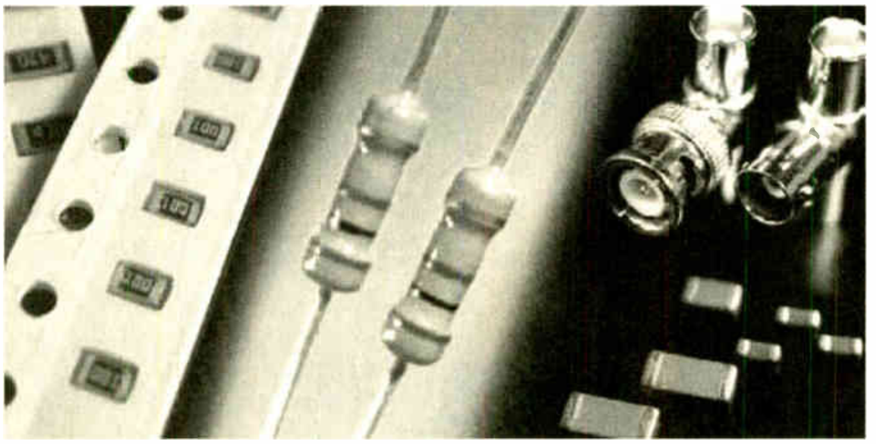
Magix Ringtone Maker is a £20 PC program that rips music from a CD or MP3 file, converts it to ringtone format and dumps it direct into a phone (**www.fasttrak.co.uk**). The software also allows editing to cut a song down to ringtone length.

"It makes an ideal present for teenagers", says FastTrak. But to stay legal users should obtain 'express permission' from record companies before ripping."

Barry Fox

FastTrak only supply within the UK mainland. For other destinations browse: **www.magix.com**. *Ed.*

Fast Components Add New Kits



Fast Components have been offering a more convenient way to buy components for the last year and have recently extended their range with four new products. "The Spring 2005 line-up now includes SMD capacitor and resistor kits in 1205, 0805, and 0603 sizes", says Thomas Arundel, one of the product designers behind the company. "Curiously, when prototyping, we found that our bench-top supply of components would always run out of a key value just before an important deadline. Restocking was always a pain (and slow), so we started sourcing sets of components, and eventually realised that others had the same problem!".

Tsuyoshi Kihara, the co-founder who sources the sets, adds "Since the successful launch of our leaded resistor and capacitor sets last year, we have updated them all to include extra values, and have now launched a 0·5W metal film resistor set, a 1205/0805 SMD resistor set, a 1205/0805/0603 SMD capacitor set and a BNC r.f. connector set". The BNC and electrolytic/ceramic/polyester leaded capacitor sets sell for £4.99, both metal film leaded resistor sets, £9.99, and the resistor and capacitor SMD sets for £12.99 and £14.99 respectively. In addition to the convenience, the sets also represent excellent value for money.

"All our components are brand new and of the highest quality. Within a set, values are packed individually with easy-read labels which makes finding individual values a breeze!", states Thomas.

Customers can order direct via Fast Components' website, mail order or phone (credit cards, cheques, postal orders). Comprehensive datasheets of all kits are available on the website. Postage and Packaging are charged at cost, with no minimum order charge.

For more information contact Fast Components Ltd, Winchester House, Winchester Road, Walton On Thames, Surrey, KT12 2RH. Tel: 0870 750 4468. Fax: 0870 137 6005.

Email: sales@fastcomponents.co.uk.

Web: **www.fastcomponents.co.uk**

Maplin Opens Poole

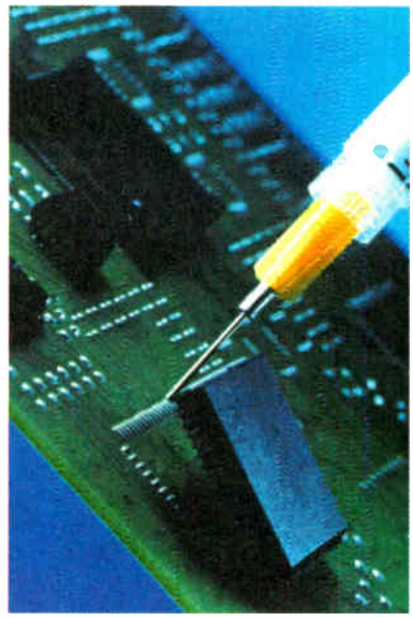
Maplin Electronics have recently opened yet another store, this time in Poole. not far from the B&Q superstore. Maplin stores are to be found nationwide in the UK and this is their 101st. A full list can be read via Maplin's website.

You no-doubt know the variety and quality of the components and other electronic products that Maplin have provided over the years. So if you live near Poole, you'll be pleased to know that you now have Maplin on your doorstep. Opening hours are normally 9am to 8pm Mon-Fri, 9am to 6pm Sat, 11am to 5pm Sun.

The store is at Unit 1B(A), Wessexgate East Retail Park, Willis Way, Poole BH15 2BN. Tel: 01202 660026. Fax: 01202 660078. Nationally Maplin can be contacted via 0870 429 6000.

Web: **www.maplin.co.uk**.

COLD SOLDERING



Tra-Con, a National Starch & Chemical Company, say they have long been supplying the industry standard in conductive epoxies and have sent us brief details of their Tra-Duct 2902. This is an electrically conductive silver-filled epoxy compound in a two-part smooth paste formulation of refined pure silver and epoxy, and which is free of solvents, copper and carbon additives.

The epoxy develops strong, durable, electrically and thermally conducting bonds and coatings between many materials, such as metals, ceramics, glass, and plastic laminates. It can also be heat or room temperature cured. It can be used as a cold solder for heat sensitive components where hot soldering is impractical. It can also be used for the assembly and repair of electrical modules, p.c.b.s., waveguides, flat cables and high frequency shields. Free samples are available.

For more information about Tra-Duct 2902 and other products contact: Tra-Con Inc, 45 Wiggins Avenue, Bedford, Massachusetts 01730 USA. Tel: 1-800-872-2661. Web: **www.tra-con.com**.

Viewing Flash Memory

Once a memory card has been taken out of a digital camera there is no way of knowing how many pictures are stored on it, and how much free space is left. Researchers at Eastman Kodak's labs in Rochester NY have been doing some experiments that should change this (US 2004/0212710).

They were playing with nematic liquid crystal material and found that hitting it with a 3ms pulse of 100V semi-permanently changed the optical state from transmissive to reflective. A 3ms pulse at 40V then changed it back to transmissive. So they stuck a simple l.c.d. display on the top surface of a memory card.

Digital cameras already have flash circuits onboard that store well over 100V. So the memory card is given a quick shock from the flash before it is taken out of the camera. The l.c.d. then displays the card's contents by reflecting ambient light, until cleared by another shock when the card is put back into the camera.

Barry Fox

Ingenuity Unlimited

WIN A PICO PC BASED OSCILLOSCOPE WORTH £586

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

If you have a novel circuit idea which would be of use to other readers then a Pico Technology PC-based oscilloscope could be yours. Every 12 months, Pico Technology will be awarding a PicoScope 3205 digital storage oscilloscope for the best IU submission. In addition a DrDAQ Data Logger/Scope worth £59 will be presented to the runner up.

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

One-Way Broken Beam Alarm *Route Master*

THE "broken beam alarm" is well known. This is a so-called "active" device which monitors a fixed light level (the beam), typically emitting a beep when someone breaks the beam, for example, by entering or exiting a doorway or safety zone. However, in certain situations, one might wish to be alerted to persons *entering* a doorway, but not exiting.

With this in mind, the One-Way Broken Beam Alarm circuit diagram shown in Fig.1 detects movement only one way through an entrance or exit. It is strictly speaking a "passive" device, in that it is not dependent on a fixed level of light. In practice, however, it works more like the traditional "active" broken beam alarm, in that it works ideally with a light, or light beam, at the other side of the door.

Nonetheless, it has a little more flexibility than the standard "active" alarm, in that it doesn't need to be adjusted exactly to the intensity of the beam, and is therefore a little easier to set up. The prototype worked well with two "naked" light dependant resistors (l.d.r.s) and an incandescent bulb, if ambient light level was not too high.

The circuit consists of two almost identical CMOS 7555 monostable timers, IC1 and IC2. Their trigger inputs (pin 2) are biased through preset potentiometers VR1 and VR2 to keep the potential at these inputs just above triggering.

Light dependant resistors R1 and R6 may be mounted a few centimetres apart horizontally – perhaps at either side of a door jamb – and may be illuminated by one and the same light at the other side of the doorway. They can be housed in short, dark plastic tubes, aimed at the light, or light beam, and should be able to work without lenses.

Resistors R2 and R7 would ideally have resistances of around one-third of the values of the two l.d.r.s when these are illuminated by the beam. The l.d.r.s themselves would ideally have low values (e.g. the popular NORP12). Certain phototransistors would work equally well in this circuit.

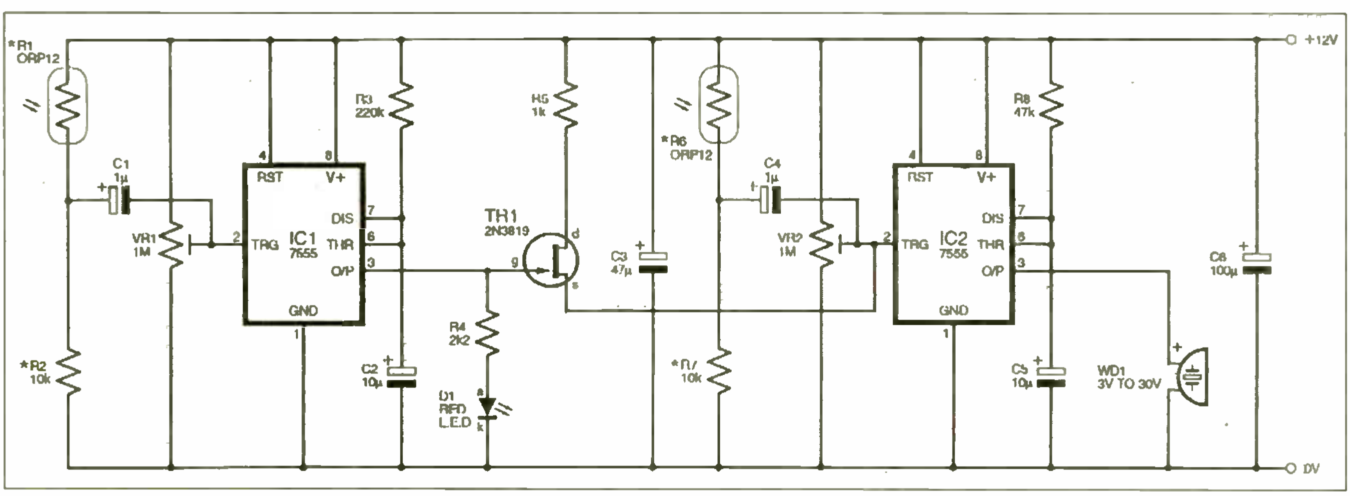


Fig.1. Circuit diagram for the One-Way Broken Beam Alarm

TV Standby Monitor *Telly's End Lighting*

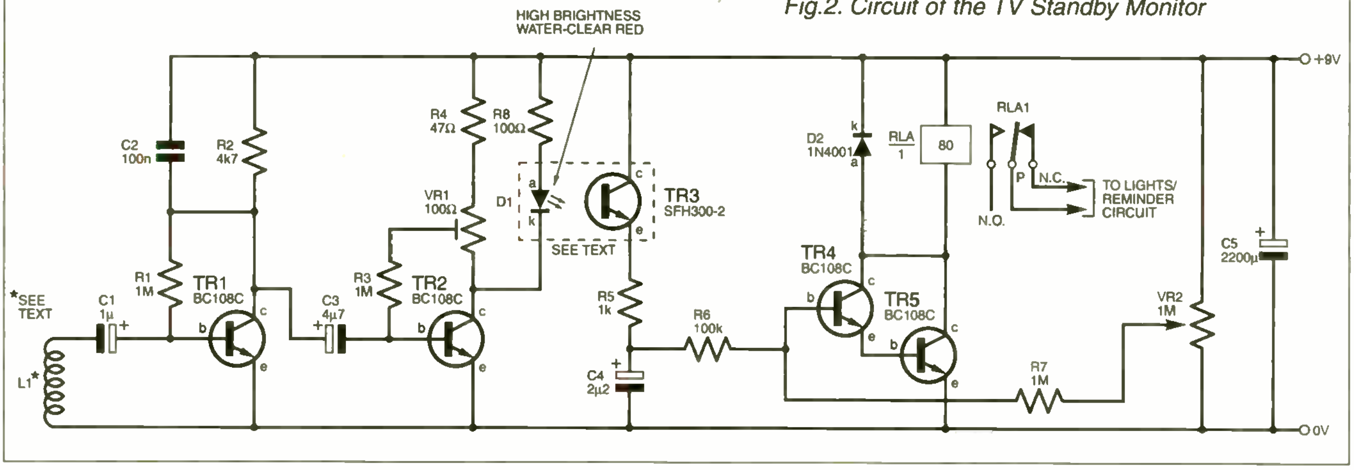


Fig.2. Circuit of the TV Standby Monitor

MANY people leave their TV set in standby mode overnight, having forgotten to switch it off. Others like to watch films in darkened rooms, then having to fumble for a light switch later.

The circuit shown in Fig.2 detects when a TV set has been put into standby mode and then operates a relay to switch on some lights. There are no electrical connections to the TV. It works by sensing the magnetic field surrounding the TV's mains flex, which changes in intensity depending upon whether the TV is fully on or in standby mode.

The pick-up coil is the 20kΩ winding of an Eagle LT44 audio driver transformer which has had all its laminations removed. A small a.c. voltage is induced into the coil when it is put against one of the flat sides of the mains flex. This is passed to a simple two-stage audio frequency amplifier based around TR1 and TR2.

High-brightness l.e.d. D1 is controlled by TR2's collector and buffered by R8. Adjustment of TR2's gain, and the response of the l.e.d., is made by preset VR1 to suit the current drawn by different TVs. When VR1 is correctly adjusted, the amplified alternating voltage across the l.e.d. is high enough to cause it to glow with the TV in the fully-on mode, but not in standby mode.

In the prototype, the l.e.d. is held against opto-sensor TR3 by black insulating tape, and the pair form a home-made opto-coupler. Sufficiently large pulses output at TR3's emitter keep capacitor C4 charged, thus turning on Darlington pair TR4 and TR5 via buffer resistor R6. This causes relay RLA to turn on and so open its n.c. (normally-closed) contacts.

If the detected current signal is too small, C4 will slowly discharge, turning off TR4/TR5 and the relay. The relay's n.c. contacts then re-close, turning on whatever you choose to have turned on by that action.

A.D. Beech and M. Robertson, Chasetown

Note that the circuit requires good supply decoupling, for which purpose capacitors C3 and C6 are employed – each being wired close to each i.c. For this reason also, two CMOS 7555 timer i.c.s are used instead of a single 7556.

Potentiometers VR1 and VR2 are 25-turn cermet preset types which are adjusted so that the potentials at the two trigger inputs, pins 2, are held just a little higher than triggering (about one-third of the supply voltage). When the circuit has been positioned together with the beam as required, start by adjusting VR1 so that l.e.d. D1 safely extinguishes. At this point, sounder WD1 (which should be of the type that includes an integral oscillator) may or may not be sounding.

Now adjust VR2 until WD1 just stops sounding. Then re-adjust VR1 until l.e.d. D1 just extinguishes again. At this stage, the circuit is set up and ready for use.

If someone walks past l.d.r. R1 first, monostable timer IC1 is triggered, causing field effect transistor TR1 to conduct, which causes IC2 trigger input pin 2 to go "high". Monostable timer IC2 therefore admits no further input pulses at trigger input pin 2, and the sounder fails to sound. However, if someone should walk in the *opposite* direction, l.d.r. R6 sends a pulse to IC2 trigger input pin 2 before IC1 is able to disable the input, and the sounder is activated.

Depending on the positioning of the l.d.r.s, and on the speed of persons passing by, resistor R3 may require some adjustment to hold IC2 trigger input pin 2 "high" for a longer period. That is, if someone walking in the wrong direction should trigger the sounder, the value of R3 likely needs to be increased. Also, if sounder WD1 should sound when l.e.d. D1 was first illuminated and continued to be illuminated, a slight reduction in sensitivity should cure the problem. Alternatively, improve supply decoupling.

Capacitors C1 and C4, and presets VR1 and VR2, may be omitted from the circuit to create a strictly "active" device, while the junctions of the l.d.r.s and their attendant resistors (ideally variable resistors) are taken to the trigger inputs of IC1 and IC2.

Thomas Scarborough, Cape Town, South Africa.

TECHNO-TALK MARK NELSON

SQUINTING ON PURPOSE

In humans squinting has a negative connotation, but when it comes to beaming radio signals round corners, squinting is a highly desirable technique

As children in the playground we always wanted to try squinting although heaven knows why, probably because our parents told us it was bad for us. The medical definition of squinting refers to a "turn" in the eye, also known as strabismus, and describes the situation where one (normal) eye fixates on the object of interest and the other (the squinting eye) points elsewhere.

As a condition it is clearly undesirable, although the ability to look in more than one direction has always fascinated people, chiefly for the strategic advantage it gives in a confrontational situation. Periscopes are a good example; they have uses in battle and as playthings.

Even more exciting (for youngsters at least) is (or was) the Seebackroscope, a device with which you could see backwards, for instance to peer at the antics of a courting couple sitting on a park bench behind you (enter Seebackroscope on **www.Google.com** if you think I'm making this up!)

Mecca for Adolescents

The Seebackroscope used to be advertised widely in children's comics fifty years ago (I'm showing my age now!) and it was marketed by Ellisdon's of Holborn (the shop was just round the corner from Holborn Kingsway tube station, almost opposite the Bassett Lowke shop (mecca for model railway enthusiasts; it later became Beatties) and only five minutes from another prolific advertiser, Headquarter & General Supplies (remember their transistor radio with audio that ranged from a whisper to a roar that would fill a concert hall?).

But let's leave misspent youth behind and get back to serious business. Where radio communication is concerned, squinting is a very desirable capability. Reverting to my theme of juvenilia for a moment, were this a kids' comic the next frame in the comic strip would have a speech bubble with the words "Reader's voice: Why?" And why indeed?

Because radio transmission achieves maximum efficiency when it is directional; there's no point in squirting a signal into places with no-one to hear you. This applies particularly at VHF, UHF and microwave frequencies: Band II (FM) and III (DAB) broadcasters direct their transmitting antennas to send signals towards the horizon rather than skywards. Cellular operators beam their signals even more tightly, concentrating the signal in a fan-shaped beam to fill just one sector of an accurately defined cell.

For transmitters with a static reception zone this is all fine and dandy but what if your reception area is a moving target? Radar systems scan the horizon a strip at a time and traditionally they have used moving antenna arrays rotated by huge motors.

On a physically smaller scale radio amateurs and DX-ers do the same thing, using rotators to direct their Yagi beams to "illuminate" just a narrow sector of the radio horizon. Moving parts require mechanical maintenance, however, and have an unfortunate propensity to seize up at the most inconvenient moment.

Purists Look Away Now

Eliminating this weakness was the motivation half a century ago or more for developing antennas that could "squint" or beam in more than one direction without physical motion. Put simply, this involved arranging multiple antenna elements in an array that was phased electronically to activate them sequentially to simulate a moving antenna. Purists and experts will probably wince at this description but I hope it will give a simple explanation to how the system works.

Recent applications of state-of-the art technology to this old problem have resulted in a new breed of so-called smart antennas. And whereas the main market for squinting antennas was defence radar systems, the driving force today is satisfying demands for increased capacity and better quality of service for cellular radio. Smart antenna arrays are an attractive solution; they deliver numerous benefits but also have digital signal processing requirements that are many orders of magnitude greater than single antenna implementations, calling for some novel and powerful processing systems to support the deployment of these arrays.

In a recent issue of the trade magazine *Wireless Europe* Malachy Devlin (Chief Technology Officer of computing solutions provider Nallatech) explains that smart antenna arrays comprise several antennas working in conjunction with an intelligent system that processes the received and transmitted data. This processing can be realised in hardware or software and allows arrays to focus beams in specific directions.

Sectorised

This is a significant improvement over conventional antennas, which as we noted earlier have a fixed radiation pattern. Most of the power transmitted by a conventional antenna is not received by the user and can cause interference to other users and base stations. Smart antenna arrays provide a much more effective solution than the traditional three 120-degree sectorised beam antennas by focusing the transmitted power towards the user and only looking in the direction of the user for the uplink signal. This ensures that the user receives the optimum quality of service and maximum coverage from a base station.

There are two main types of smart antenna arrays, continues Devlin: switched-beam arrays and adaptive arrays. Switched-beam arrays provide several predefined beams, with a control system that switches between the beams, then selects the antenna that provides the maximum signal response for a given user. Adaptive antenna arrays on the other hand exploit an altogether more intelligent control system that monitors the radio environment and, in particular, the characteristics of the signal path between the user and the base station. This information is used to adjust the gain of the antenna array to maximize the quality of the uplink and downlink signals, also attenuate signals from interfering sources.

Pay More, Get More

Fully adaptive solutions cost more but also deliver more. The cost comes from the considerable increase in digital signal processing of as many data streams as antenna elements employed. Even in the simple system quoted by Devlin using just four antennas, we are talking about a half-billion data elements per second, which would soon exhaust the capabilities of a digital signal processor (DSP). His company has addressed these processing challenges by developing an eight-channel data acquisition system, which uses field-programmable gate arrays (FPGA) for high-performance digital signal processing operations.

A simpler, halfway house, system has been introduced by communications infrastructure specialist AlanDick. Again it is aimed at cellular operators needing to refine network coverage but in this case remote-controlled actuators optimise base station antenna beam patterns to boost signal strength, under precision software control from a network control centre possibly hundreds of miles or kilometres distant.

"The antennas move but your technical staff don't," states David King, Group Marketing Manager. "At the touch of a button, cellular base station antennas can be realigned and coverage optimised in an instant – day or night, rain or shine. No site visits, no callouts, no fuel bills, no vehicle mileage, no climbing, no risk."

Applications go beyond fine-tuning of base station fixed coverage. Explains Mr King, "Operators can reconfigure their networks dynamically, for instance directing maximum power into a football stadium while an international match is being played there. Coverage can also be optimised in business areas during the daytime but into nearby residential districts at night." Perhaps this will start a new spotting craze, watching for cellsite antennas that move!

READOUT

Email: john.becker@wimborne.co.uk

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

All letters quoted here have previously been replied to directly.

WIN AN ATLAS LCR ANALYSER WORTH £69

An Atlas LCR Passive Component Analyser, kindly donated by Peak Electronic Design Ltd., will be awarded to the author of the *Letter Of The Month* each month.

The Atlas LCR automatically measures inductance from 1μH to 10H, capacitance from 1pF to 10,000μF and resistance from 1Ω to 2MΩ with a basic accuracy of 1%.

★ LETTER OF THE MONTH ★

Rally Components

Dear EPE,

Over the many years I have been reading your fabulous magazine, I have also been attending various "radio rallies", the main purpose of which is to pick up bargains. Recently I have had a few experiences which have forced me to re-think whether or not I should buy at these rallies.

For instance, I had some surface mount capacitors marked 20V, but which went up in smoke at 15V, also some triacs which were defective. Add to this a recent investigation into cheap counterfeit components, then you can see why I am thinking about this issue.

So are these rally bargains worth having, and how can I tell if the components are ok or not? It seems to me that it depends on several factors, including where you are on the hobby ladder (beginner or experienced), what components you are talking about, what the components are to be used for, to name but a few.

Stocking Up

If you are a beginner, then rallies are a good way to build up your stock of basic components at a cheap price, but you do not want defective components creeping into your projects as it will be disastrous (especially as a beginner, but even for a more advanced hobbyist).

The main reason for buying at rallies is the cost savings as opposed to buying new, so to decide which route to go you need to know the cost of new components (which is easy with the internet – a few clicks will give you a good idea of the cost for a particular component), then when faced with a decision whether to buy a bargain, you at least know what the gamble is.

Additionally, is it worth buying used components (populated p.c.b., already desoldered), or supposedly new parts at knock down prices? Well, again there are many issues to consider – if the parts are already in a p.c.b., then you can assume that they were once working, but is the p.c.b. scrap due to the component you want being defective?

Removals

Also, maybe the p.c.b. has been stressed or you will damage the component when trying to remove it with a soldering iron. SM devices are difficult to handle in this respect. I use a blow torch on the opposite side of the p.c.b. to release these components - but again if your design does not work as calculated, then will it cause more problems than the cost of a new component?

Scrap p.c.b.s are a very cheap way of getting a board full of parts, but you have to remove them from the p.c.b. yourself, and this can be a messy and time consuming chore. Again the main consideration is cost, so if you know you stand to gain a considerable amount by buying used, then you can evaluate the situation and maybe even buy two p.c.b.s as part of the gamble. If on the other hand you feel that buying unused is the way you want to go, then there are other considerations – are the parts scrap from manufacture (i.e. do not perform to specification), are they counterfeit, or are they just genuine?

Quality

In terms of counterfeit parts, sometimes you can tell by the weight of the component (but you would need to know what a proper part feels like), or by the markings, but otherwise it is going to be difficult to tell. You could of course take a measuring device around with you and do a quick check before deciding, which may be able to help, but you will not be able to do a full performance check even with the simple resistor, let alone anything more complicated.

On the one hand components which are very cheap may be suspicious, but on the other hand with components which are only marginally cheaper than new, the gain may not be worth the risk. With me, this decision also depends on whether the parts will be used in a quality (precise or critical performance) design.

Considerations

Other issues which affect my decision are, do I need the part immediately, is the part a quality part, is it on my list of wants etc. I am now much more choosy about what I buy because if I am not going to use it for an immediate project, then I just end up having a lot more junk lying around and it possibly may not be used ever (despite my intentions), or by the time I come to work on the particular project, the component has been superseded by something even better.

With semiconductors, you tend to find that parts from rallies are generally not cutting edge or up to date, but maybe a little bit older, so this has to be borne in mind as well. This also means that because they are history, they will be cheaper from new – again you need to know what the new price is to be able to decide.

There are lots of things you can do to try and help you to decide – you could carry a multimeter, have a wants list, know your new prices, maybe have an up to date catalogue in the car to check on prices in case of any additional discoveries, have a general idea of what components are good for you and your projects.

Working Order

Rallies are fun and you can get good bargains, but buyer beware – I never consider any item as fully working unless it can be proven to me there and then, and I have a written guarantee with a clear way to enforce that guarantee (credit card etc). So almost all of the offerings will therefore be considered as scrap, with prices and risk factor that are appropriate.

My general approach is only to buy what I need for an immediate project, what are good general components which I will always be using, what I have on my wants list, top quality parts, hard to get hold of parts, and very cheap parts knowing that the risk is very low (cheap).

Finally, I do test all second hand components as best as I can before they are used – as if it is my own designed project that I am building for the first time, I have no absolute guarantee that the circuit design, p.c.b. layout etc are fully correct and tested, and so dodgy components will make the task of making it all work that much harder.

Hopefully by sharing these thoughts it may help others in their thinking on this subject, and I include some web links concerning counterfeit parts:

http://sound.westhost.com/counterfeit.htm
www.designchainassociates.com/
www.kamaka.de/deutsch/service/counterfeit-parts-listing.htm

Ian Cornish, via email

Those are interesting thoughts, Ian, and well worth readers taking to heart, thank you.

Whilst I have never been to a radio rally, I would like to comment that I *actually learned a great deal about electronics in my early days as a hobbyist, in the early 1960s, by using secondhand and scrap components.*

I used to buy scrap TV sets from Church Street market, not a stone's throw from the electronics mecca, as was, of the Edgware Road, London. They cost me about five shillings (25p).

Often I would try, sometimes successfully, to get them working (feelings of horror now that I recognise that I was dabbling in a potentially lethal activity, having little knowledge about what I was doing). Failing that, I would strip them for their components.

I was also given several hundred p.c.b.s which had been part of a college's computer that was being replaced. Those boards were so primitive by today's standards that they did not even have transistors or integrated circuits – the computer had been based on valves and germanium diodes, and with ferromagnetic cores as the memory devices. Some even had Nixie tubes as the data displays. These boards also got stripped.

Those stripped components taught me to understand what such components could do (but not necessarily why*), and how to check whether or not they were faulty and what values unmarked passive devices might have. With the aid of the electronics mags which then proliferated, I would experiment with the simpler published circuits, of which many used valves, and which I often had from the TVs. I even built a valve tester to check them.*

I learned a lot that way, and it did not actually matter that I perhaps never completed any design, but I did enjoy the fun of the experimenting and learning from it all.

At this point I must stress that if anyone wishes to build a published design and expect it to work, they should only use new components that are guaranteed to live up their specifications. Furthermore, anyone designing something for possible publication should only use components which are in current production and as such are readily available.

However, I heartily support the concept of buying components from rallies if you are intent on learning and experimenting, and getting to know what components do. But do keep in mind the cautions that Ian highlights.

Figuring Out CADs

Dear EPE,

Could you please tell me the maker and name of the software you use to create the circuit diagrams in *EPE*, and the component and stripboard layouts? I assume that this will be a professional package and hence very expensive, so perhaps you may be able to suggest other alternatives? Any relevant web sites would be useful!

Robert B. Fairbairn, via email

We have freelance technical artists who do our drawings for us, Robert. They use CorelDraw in order to provide us with style consistency. I've not used Corel so cannot tell you how easy it is to learn. The p.c.b. track layouts, though, are not done by our artists, but by the authors themselves, providing us with printouts from their own CAD packages, which we then scan in and use as are. The component positioning details are again done by our artists.

I suggest you could do a search via **www.google.com** *for CorelDraw. I don't know of alternatives to it. Does any reader know?*

Lightening Strikes

Dear EPE,

I had a wry smile when reading Thomas Scarborough's *Thunderstorm Monitor* (Nov '04). If Thomas thinks the Cape is dangerous, he should live up here for a season (I live in a remote village in north NSW, near Taree). Recently we had a pile-driver of a storm that put down a dozen really heavy strokes within 500m over half an hour. Local storm watchers rated it a "10" and admitted that for once, like me, they took cover too.

A while back I was less than 10m from a strike to a power pole, and last month a number of people witnessed a "leader" come in a kitchen window and miss someone by only a metre. A friend's place got hit last year and he was treated to two or three seconds of ball lightning about the size of a golf ball about 10cm off a corner of his stove. I really wish I'd been there to see it myself.

The lightning toll on electronic gear is pretty high, and anything connected to power and phone, computer, fax, TAM, cordless, is at particular risk. After seeing a phone lead chopped into many equal short lengths I realised I was dealing with microwave standing waves, r.f., so we have been applying series inductors to equipment power and phone feeds, and after several years those people haven't lost any gear so I think it does give some protection. A systemic problem is that the HV protection tends to put it back up the LV earth/neutral to rampage around the house.

You might also be interested to know that lately I've been luthiering guitars more than anything, and have discovered that what started out as trying to make one of my bands sound better with properly intonated instruments, has turned into a reputation that is bringing sick guitars and valve amps from hundreds of miles away. You just quietly dither away fixing things for years and one day you look up and the workshop is empty. You're all alone. Nobody fixes things any more.

You are not just redundant, your whole attitude is redundant. So with a sense of loss you try to at least write some of it down for posterity if nothing else. You vainly put it on the web just in case somebody out there just might be interested.

Then a trickle of email starts that tells you there are others like you out there, and many more who still need our knowledge to make a loud noise, and some who want to know what we know to help others make a loud noise too. So I'm getting some really interesting technical questions these days which stretch the brain and I'm quite enjoying it.

You might care to browse my web site: **http://rolyroper.elands.com/ozvalveamps/tone.htm**

Roly Roper, NSW, Australia, via email

Your storms sound formidable, Roly, there's a whole lot of Nature out there at times! And confirmed by that photo of the Quoll or Tiger Cat on your home page. That's one mean looking beast! You are obviously into a wide variety of interests. More power to you – but only at low voltage!

Luthiering – had to do a Google on that one, from which I found it means string instrument maker – from the old word "luth" which became corrupted to become "lute". And I thought I knew a bit about music – obviously not!

Yes, throw-away society really is to the fore on so much. Even I don't often bother to repair, but nip down to the store for a new CD, video, whatever. Sad really.

DAB Aerial

Dear EPE,

Just a word to say thanks to you all at *EPE*. I have just made two DAB aerials from the information in your May '05 issue, one for a friend. We are both in poor areas for DAB but after I made and fitted we have 100% reception. The aerials are indoors and we both live in flats.

We call them modern art if people ask what they are. So thanks to Mr Stef Niewiadomski for this design. We now enjoy DAB a lot more.

Allan Bland and friend, via email

Thanks Allan, we're are pleased to know you are pleased!

Deed of the Day

Dear EPE,

I received my May '05 issue and as always avidly read it cover to cover, noting Alan Jones' letter. I have never been into radio, being ever the digital and VB man, but I came across this site purely by accident whilst hunting down a robot circuit from *RC* back in 1972. This page may well fill some gaps for Alan:

www.spontaflex.free-online.co.uk/

I just hope I've done my good deed for the day! Cheers 'n' beers

Keith Anderson, via email

Thanks Keith, I'll drink to that!

Net Fraud

Dear EPE,

I read with great interest Alan's *Net Work* column about net fraud in the April issue. Most useful was the phone number for Paypal. I have received four emails saying my Paypal account has been suspended. After receiving the first I drew £500 the next day from my supposedly suspended Paypal account, which at the time struck me as being a bit odd.

Now after talking directly to Paypal I find the suspension emails are a scam to get you to go to a website and enter personal details. The guy on the phone asked me if any of the emails contained my name, which they did not, and he told me "we know who you are and will always address you by name, if you receive an email which does not have your name on it, do not reply at all as it is a scam, but forward it on to the Paypal fraud team". Which I did and they are now investigating.

Also on the subject of fraud, I currently receive in the order of 10 emails a week offering a very low cost mortgage by clicking on a web address. Every single email contains the same exact wording but comes with a different sender's name on it, now I am not sure what the scam is but it would seem to me that these are ready-made scams that you buy and just put your name to.

Michael Dranfield,
Buxton, Derbyshire,
via email

Alan replied to Michael:

Glad you find the *Net Work* column of interest. I have received plenty of scam emails for cheap loans or mortgages, based in the USA. I guess it is just spam, trying to drum up loan business, or, it could be spammed by a competitor who is hoping to damage a loan provider's image by giving them a bad reputation as a serial spammer.

I have also had an extremely authentic looking Paypal scam email, but as they all say, no bank or building society will ever email you asking you to log in and re-confirm your passwords etc.

The May '05 issue had more on phishing and spyware.

Alan Winstanley,
via email

To which I would add to also ignore those emails which tell you that several million US dollars are available for transfer to the UK due to financial/political situations in a particular country (I've recently been contacted from the Phillipines over one such), and could you assist in this, for which you would receive a substantial share. Balderdash! It's another scam – and you actually end up by sending them money to assist in the process, and which you never hear of again.

There was a splendid tale that could be accessed via our Chatzone a while back in which someone (I forget who) had followed this up, but added his own twists to it, and did actually persuade the scam originator to part with some money, £60 or so! It was hilarious to read, all the shenanigans that were employed by both sides!

Spontaflex

With reference to your *Letter of the Month* on the *Spontaflex Radio*, May '05, I can confirm that the article was by Sir Douglas Hall and ran through *Radio Constructor* issues Mar '66, Jan '68, May '68, Jun '69, Dec '69, Jun '71 and Feb '72.

Incidentally, my "library" of *RC* magazines covers from Aug '65 to Jul '75. I am sorry to say that I may soon have to "get rid" of some of these to make room for future issues of *EPE*. I also have *Practical Wireless, Practical Television* and *Practical Electronics* between then and 1982.

Thank you for the excellent way that the *EPE* team is helping hobbyists like myself. I have been having this since May '86 to the present, so please keep up the good work.

Alan Clayton,
via email

Thanks Alan. Mike says that in fact all Sir Douglas' designs are on the web. If any reader expresses any interest in your mags I'll copy their email to you.

PIC EEPROM Refresh

Dear EPE,

In my article on the PIC18F series (Apr '05), I asked if any reader could explain an apparent contradiction in section 6.8 of the PIC18Fxx2 datasheet, which describes refreshing data EEPROM. I'm obliged to Peter Hemsley for the following:

"The physical implementation of memory is not linear, it's an X-Y matrix for best use of chip space. To erase/write a bit or byte a high voltage Vpp is applied to the appropriate X and Y lines of the matrix. However, there are also other bits on the selected X and Y lines that are not at the X-Y intersection, so do not get programmed. Applying Vpp puts "stress" on these other bits due to a small amount of capacitance to the chip substrate which is at 0V potential.

In this way the logic level of some bits that are not written is degraded slightly every time Vpp is applied. So after specification D124 (worst case, one million) writes, long term and constant data will need to be rewritten to restore the levels to a good threshold margin. The easiest way to do this is an "array refresh" which is simply to read every byte and write back the same data. My recommendations are:

1. You have unlimited read cycles.

2. If you are using EEPROM for short term data then store constant data in program memory.

3. Avoid mixing long term and short term data in the same EEPROM unless you are prepared to do an occasional array refresh."

Malcolm Wiles,
via email

Thanks Malc and Peter, readers interested in longterm PIC code stability will find your comments useful.

Super-Ear

Dear EPE,

Regarding the parabolic dish in the *Super-Ear Audio Telescope* (Jun '05) – ideally I like to be able to see the beam of the parabolic dish used, a task which at first seems rather daunting. It is, however, much simpler than you may think. My dish is simply a car spotlight with the glass and bulb removed.

Before you dismantle the spotlight switch it on outside on a dark night and you will see the beam produced. When the reflector is used for capturing the sound that is within the beam window, the same focal point is used as for the bulb filament.

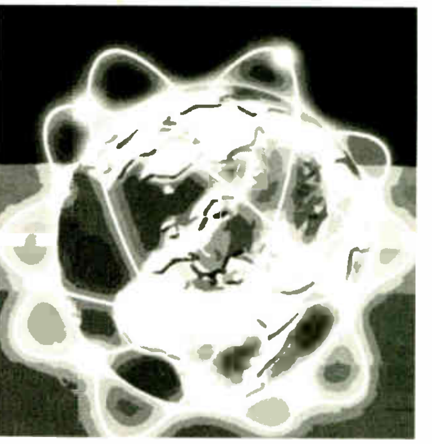
If you look straight into the spotlight (with it turned off) from about two feet or so (a bit under a metre) you will again see the focal point (filament) very clearly. If you build a small frame to support a microphone in exactly the same position as the filament then it should pick up any sound that is within the beam. The sound will be amplified at the focal point. You should have seen this amplification (magnification) when you looked into the spotlight, the filament appearing much larger.

Colin Smith DSDA Beith,
via email

Thanks for that Colin. It's worth pointing out that you should never stare directly into any high-intensity light beam for any length of time as this could damage your eyesight.

Constructional Project

LF and VLF Converter



Raymond Haigh

Simple practical circuits for exploring the lower reaches of the electromagnetic spectrum

FOLLOWING on from the popular series on *Practical Radio Circuits* (June '03 to Jan '05), a number of readers have asked for a further article dealing specifically with reception on low (LF) and very low frequencies (VLF). This additional material has been prepared in response to their request and, as before, the emphasis is on practical circuits for experimenters.

The simple converter unit outlined here will allow a high performance receiver to tune into transmission from below 10kHz to 350kHz. Also, alternative aerial systems are described.

What's There?

Britain, Ireland, France, Germany and Russia, operate high-power broadcast transmitters in what is known as the long-wave band, covering 150kHz to 350kHz. An amateur band is centred on 136kHz and various other transmissions are radiated from 150kHz to below 10kHz. In the 1kHz to 20kHz region whistlers or howlers can be found – these are a natural electromagnetic phenomenon caused by distant lightning.

Longwave broadcasting did not take hold outside Europe. In the Americas, Canada, Australia and New Zealand, frequencies below 550kHz are allocated for time signals, military, government and commercial data, and marker beacons used primarily by the aviation industry.

As the frequency is lowered, electromagnetic waves penetrate water and earth to an increasing depth. Frequencies below 10kHz are used by the military for communicating with submarines. On a more peaceful note, localized communications with cavers or potholers are achieved on a frequency of 874Hz (the Molefone).

Whistlers

Natural electromagnetic phenomena, known as whistlers or howlers, occur at frequencies between 1kHz and 20kHz. Electromagnetic waves, caused by distant lightning, are distorted as they travel around the earth, and this produces a whistling or howling sound at the receiver. Greatest activity is usually during the summer months, between sunset and dawn.

Whistler receivers are no more than sensitive audio amplifiers connected to a short aerial. They incorporate filtering to exclude higher radio frequencies, and to curtail the response of the amplifier to mains hum and its harmonics. Despite these measures, whistler receivers must be battery powered and operated some distance from mains wiring and power lines.

Listening In

Receiving signals radiated at low (LF) and very low frequencies (VLF) presents no major difficulties, and the add-on circuits described here will extend the coverage of the two high performance receiver designs, Regenerative and Superhet, included in the *Practical Radio Circuits* series.

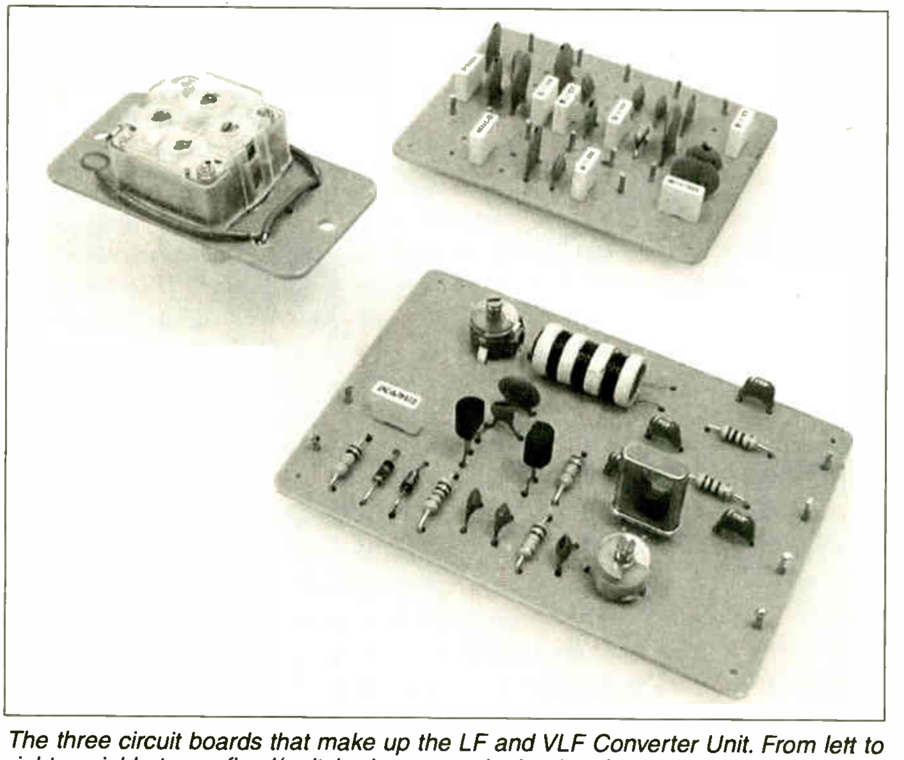
Serious listeners often use commercial communications receivers, again with add-on units to extend coverage and/or improve performance. The circuits presented in this article are equally suitable for equipment of this kind.

The tuning circuits must, of course, contain much more inductance and capacitance to resonate at the lower frequencies. Wire aerials, even when physically quite long, are only a small fraction of a wavelength. Because of this, they terminate at a high impedance which needs to be matched to the receiver.

Man-made and natural electrical disturbances result in comparatively high noise levels at low frequencies. The problem is inevitably worse in urban areas, and is often the limiting factor in resolving very weak signals.

Converter Unit

Some communications receivers can be tuned to the lowest reaches of the spectrum, but most end their coverage at or above 100kHz. Many incorporate broadband input filters, and performance deteriorates at low frequencies. Even if the receiver has fully variable front end tuning, there is



The three circuit boards that make up the LF and VLF Converter Unit. From left to right: variable tuner, fixed/switched tuner, and mixer/oscillator

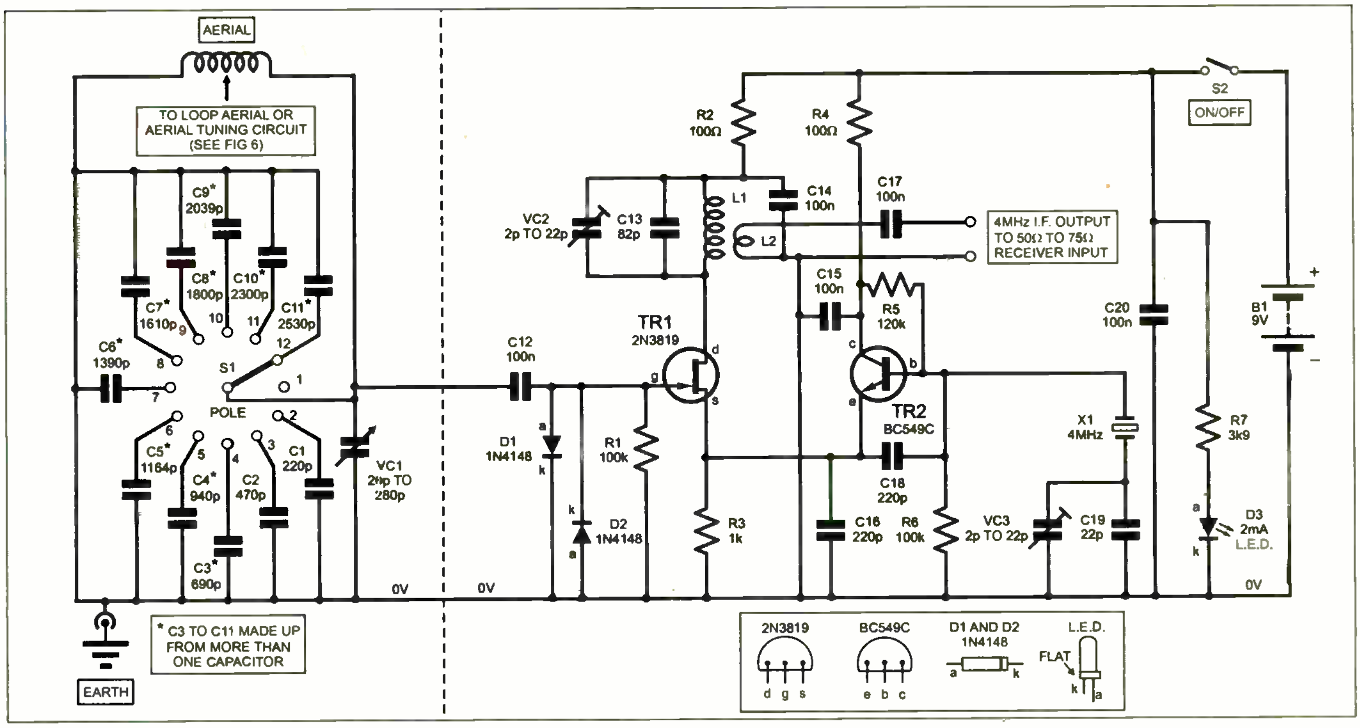


Fig.1. Full circuit diagram for the LF/VLF Converter. The circuit is split in two sections; tuning and mixer/oscillator

often a considerable mismatch to the aerial on longwaves, and signal transfer is less than optimum.

A step-up converter, which changes the frequency of incoming signals to, say, 4MHz, overcomes the problem of coverage. With appropriate input circuits, signal losses due to broad tuning and aerial mismatch can be reduced significantly.

All Change

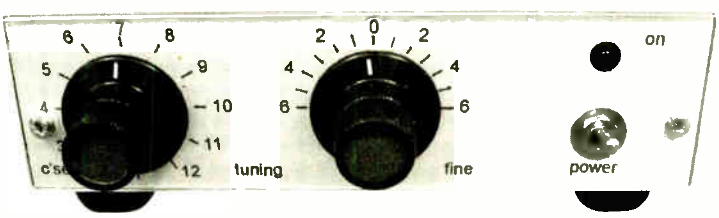
Frequency changing, which is fundamental to superhet receivers, was covered at length in the "Radio" series (June'03 to Jan'04). In brief, a locally generated oscillation is combined with the incoming signal in a mixer stage, and the difference between the two, known as the intermediate frequency, is selected by a tuned circuit connected to the mixer's output port.

The intermediate frequency (i.f.) is usually fixed, and the receiver tuned by altering the oscillator frequency and adjusting the input circuits. When only a narrow band of frequencies has to be covered, it is often more convenient to fix the oscillator frequency and tune the system by varying the intermediate frequency instead.

The entire VLF/LF spectrum is located within a band of frequencies no more than 350kHz wide, and a single 4MHz i.f. transformer, "damped" by the mixer and the feeder to the receiver, will tune broadly enough to accommodate it. The precise i.f. is varied by sweeping the communication receiver's tuning from 4MHz to 4·350MHz, which gives a signal frequency coverage from zero to 350kHz.

LF/VLF Converter Circuit

The circuit diagram for the LF/VLF Converter is shown in Fig.1, where the fixed tuning capacitors, C1 to C11 are selected by rotary switch S1. The switched increments of capacitance are smaller than the maximum value of the variable tuning capacitor, VC1, and the arrangement thus provides a continuously variable capacitance swing of around 20pF to 2800pF.



Front panel controls of the Converter

Details of an inductor (coil), which completes the tuned circuit, are given later, together with details of a Loop Aerial.

Mixer

The received signal is applied, via d.c. blocking capacitor C12, to the gate (g) of the field-effect transistor mixer stage TR1. High impedance at the gate minimizes damping on the input tuned circuit.

Diodes D1 and D2 shunt signals in excess of around 0·6V and protect the transistor against static damage. (Long wire aerials and high value tuning inductors increase the vulnerability of the unit).

The gate (g) of TR1 is connected to the 0V rail via resistor R1 in order to ensure correct biasing.

Oscillator

Transistor TR2 is configured as a Colpitt's oscillator. The operating frequency is fixed, with a high degree of accuracy and stability, by quartz crystal X1.

The crystal is loaded by capacitor C19 and trimmer VC3: the latter permits the frequency of oscillation to be set at precisely 4MHz. Readers who do not require the main receiver's dial reading to be very precise can delete VC3 (the dial readings will still be accurate enough for all but the most demanding applications).

Positive feedback, from TR2 emitter (e), is injected via capacitors C16 and C18, and resistors R5 and R6 set the bias on the base (b) of TR2. The oscillator output is developed across emitter resistor R3. This component also acts as the source bias resistor for transistor TR1, and the local oscillation is thereby injected directly into the mixer.

The stage is decoupled from the supply rail by resistor R4 and capacitor C15.

I.F. Output

The tuned circuit formed by coil L1, trimmer capacitor VC2 and capacitor C13, selects the 4MHz i.f. output (it passes a band of frequencies from 4MHz to 4·350MHz, see earlier) Matching to the low impedance input of the communications receiver is achieved by coil L2, and C17 acts as a d.c. blocking capacitor (some receivers can have d.c. voltages on their input circuitry).

The mixer stage, TR1, is decoupled from the supply by resistor R2 and capacitor C14.

Powering Up

Current drain is very modest, around 4mA plus the current taken by the optional l.e.d., D3, On indicator and its ballast resistor, R7.

A PP3 type battery is, therefore, an appropriate and convenient means of powering the Converter. Switch S2 connects power to the circuit and bypass capacitor C20 ensures stability and consistent operation as the battery ages.

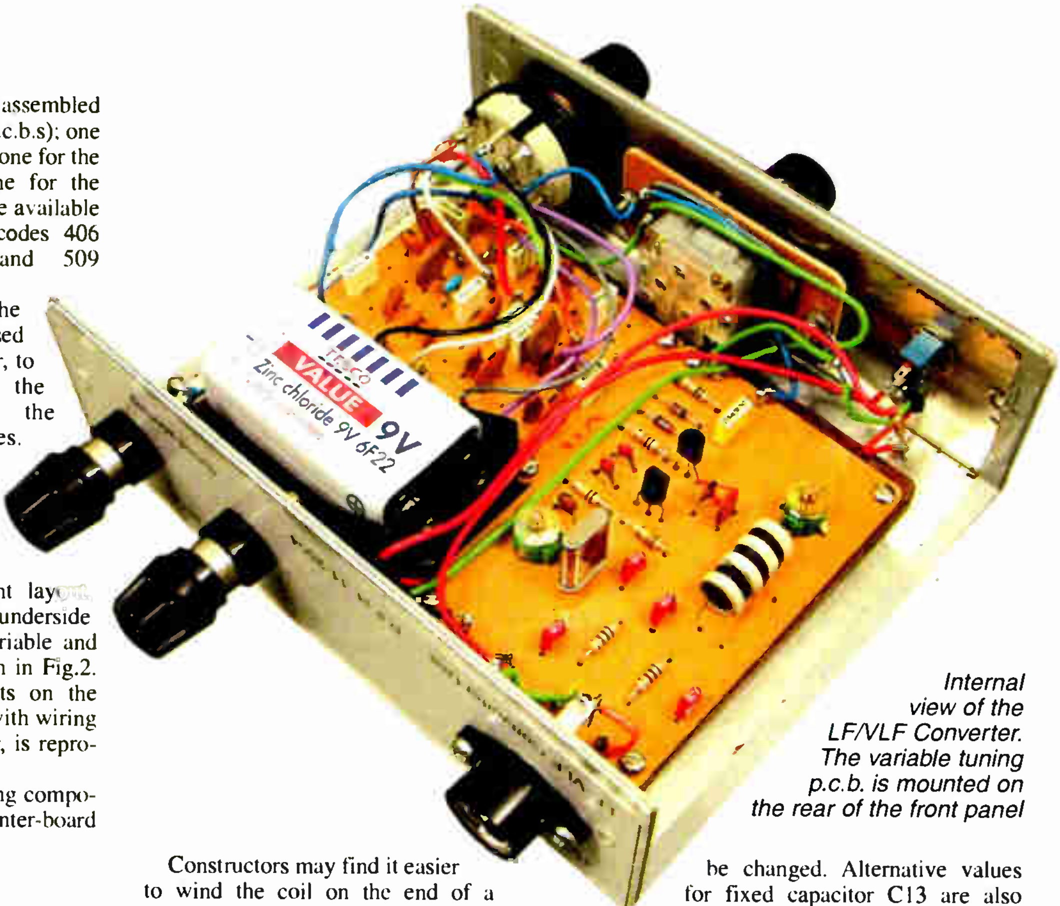
Construction

The LF/VLF Converter unit is assembled on three printed circuit boards (p.c.b.s): one for the variable tuning capacitor, one for the fixed tuning capacitors and one for the mixer/oscillator. These boards are available from the *EPE PCB Service*, codes 406 (Tun.cap), 508 (Fix.cap) and 509 (Mix./Osc) respectively.

This arrangement permits the tuning capacitor system to be used with the simple Buffer Amplifier, to be described later, or with the Regenerative Receiver from the *Practical Radio Circuits* series. Further, readers who have air-spaced tuning capacitors in their spares boxes can substitute them for the polythene dielectric types.

The topside p.c.b. component layout, interwiring details and full-size underside copper track masters for the variable and fixed capacitor boards are shown in Fig.2. The arrangement of components on the mixer/oscillator board, together with wiring details and full-size track master, is reproduced in Fig.3.

General guidance on assembling components on the boards, and the inter-board wiring, is given later.



Internal view of the LF/VLF Converter. The variable tuning p.c.b. is mounted on the rear of the front panel

I.F. Transformer

Intermediate frequency transformer, L1/L2, is produced by winding 36s.w.g. (32a.w.g.) enamelled copper wire onto an 18mm (3/4in) long former, cut from a piece of scrap 6mm (1/4in) diameter plastic potentiometer spindle. Full details of the coil winding and construction are given in Fig.4.

Constructors may find it easier to wind the coil on the end of a longer spindle off-cut and then remove the unwanted material after completing the coil construction.

Alternative I.F.s

Some receivers may not tune to 4MHz, and the intermediate frequency will need to be changed. Alternative values for fixed capacitor C13 are also given in Fig.4 to enable coil L1 to be tuned to other crystal frequencies within the range of 4MHz to 10MHz.

The precise value of the crystal is not important, but the use of a "round figure" unit makes it easier to relate dial setting to reception frequency.

COMPONENTS

CONVERTER

See **SHOP TALK page**

Resistors

R1, R6	100k (2 off)
R2, R4	100Ω (2 off)
R3	1k
R5	120k
R7	3k9

All 0·25W 5% carbon film or better

Capacitors

C1	220p low-k ceramic
C2	470p low-k ceramic
C3	690p low-k ceramic (220p plus 470p)
C4	940p low-k ceramic (470p plus 470p)
C5	1164p (1000p polyester plus 82p plus 82p low-k ceramic)
C6	1390p (1000p polyester plus 390p low-k ceramic)
C7	1610p (1000p polyester plus 390p plus 220p low-k ceramic)
C8	1800p (1000p polyester plus 470p plus 330p low-k ceramic)
C9	2039p (1000p plus 1000p polyester plus 39p low-k ceramic)
C10	2300p (2200p polyester plus 100p low-k ceramic)
C11	2530p (2200p polyester plus 330p low-k ceramic)
C12	100n polyester
C13	82p low-k ceramic
C14, C15, C17, C20	100n ceramic (4 off)
C16, C18	220p low-k ceramic (2 off)
C19	22p low-k ceramic
VC1	20p to 280p 4-gang a.m./f.m. polyvaricon tuning capacitor
VC2,VC3	2p to 22p min. film dielectric trimmer (2 off)

Semiconductors

D1, D2	1N4148 signal diode (2 off)
D3	2mA low current l.e.d., red
TR1	2N3819 *n*-channel field-effect transistor
TR2	BC549C *npn* transistor

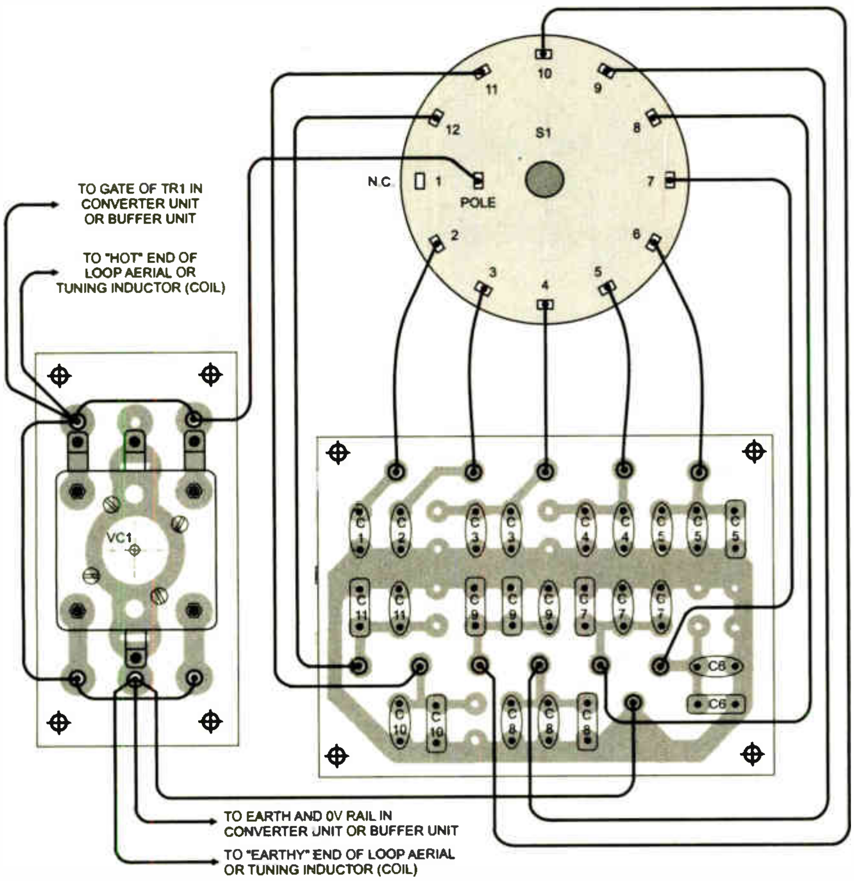
Miscellaneous

L1/L2	2 metres (6ft) 36s.w.g. (32a.w.g.) enamelled copper wire. Masking tape and short length of 6mm (1/4in) diameter plastic spindle off-cut (see text)
X1	4MHz crystal unit in HC49/U or U4 style case
S1	1-pole 12-way rotary switch
S2	single-pole, single-throw toggle switch
B1	9V PP3 type battery, with clips

Printed circuit boards available from the *EPE PCB Service* codes 406 (Tune Cap), 508 (Switch Cap) and 509 (Mix/Osc); aluminium case, size 133mm (5.25in.) x 102mm (4in.) x 38mm (1·5in.); coaxial socket; screw terminal (2 off); plastic knob (2 off); l.e.d. holder; battery holder; multistrand connecting wire; p.c.b. stand-off pillars (10 off); self-adhesive feet (4 off); card and thin Perspex sheet for case front panel; spindle extender for polyvaricon capacitor; nuts; bolts; washers; solder pins; solder etc.

Approx. Cost Guidance Only **£25** *excl case hardware & batts*

LF/VLF
TUNING AND CONVERTER BOARDS



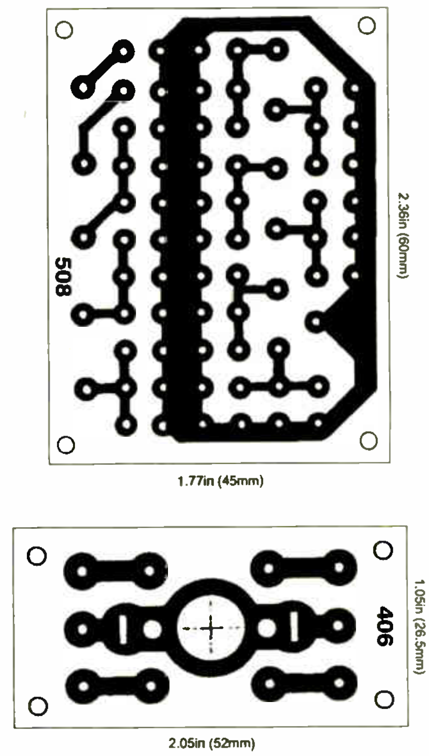
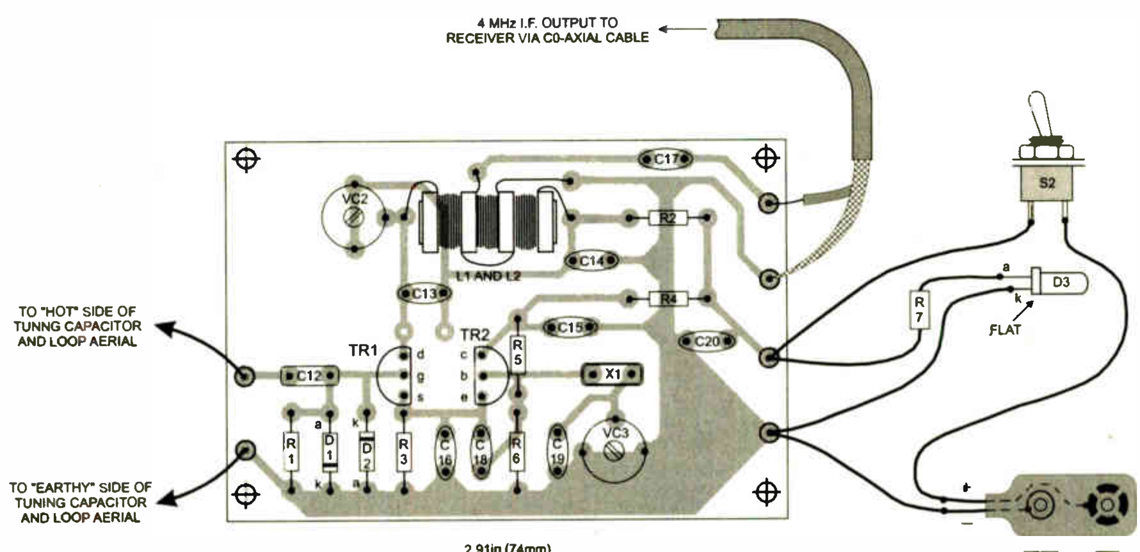


Fig.2. Printed circuit board component layouts (above) and full-size copper track masters (above right) for the variable and switched tuning circuits



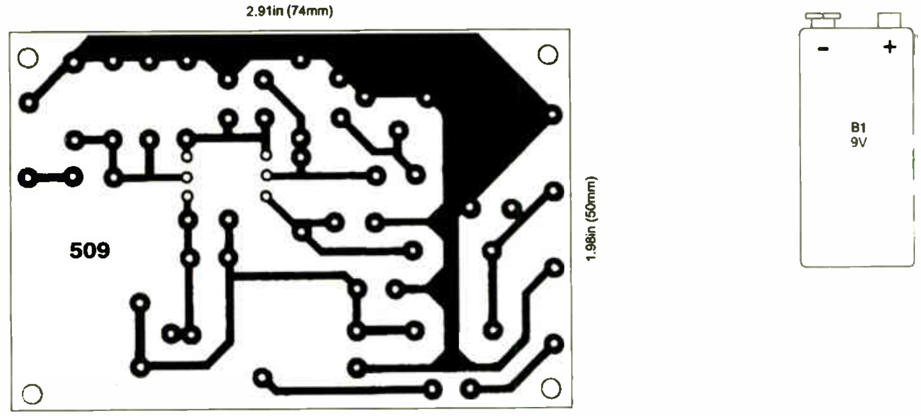
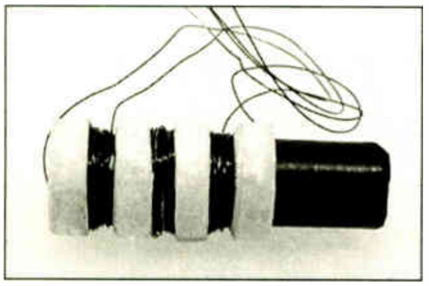


Fig.3. Printed circuit board component layouts, wiring details and full-size copper track master for the mixer/oscillator circuit



Completed i.f. transformer. The excess plastic spindle should be trimmed back to the bobbin cheek

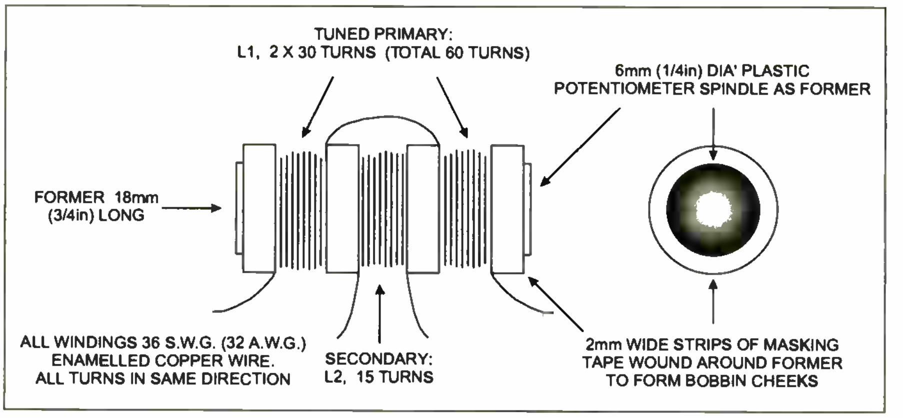


Fig.4. Converter i.f. transformer construction and winding details. Wind the central secondary section first to permit loop-over between the two primary sections. Primary is tuned with a 2p to 22p trimmer plus a fixed capacitor – see Fig.1. Fixed capacitor values for various i.f. frequencies are as follows: 4MHz 82p; 6MHz 39p; 8MHz 10p; 10MHz nil

Table 1: LF/VLF Tuning Inductor Coil
Measured Inductance Values

Tapping No	*No of Turns*	*Inductance mH*
1	100	1·3
2	200	3·9
3	300	7·7
4	400	12·8
5	500	19·9
6	600	27·2
7	700	36·0
8	800	44·8
9	900	54·6
10	1000	64·4
11	1100	74·7
12	1200	85·5
13	1300	95·2

Notes:
(1) See Fig.6 for details of coil.
(2) Inductance values will be slightly lower if unused windings are shorted out.

TAPPED INDUCTOR – YOU WILL NEED

Reel (50g – 2oz) of 36s.w.g. (32a.w.g.) enamelled copper wire; plastic overflow pipe for coil former, length 125mm (5in.) with 21mm (7/8in) outside diameter; ferrite rod, 9mm (3/8in) diameter × 125mm (5in) long; thin card (postcard); masking tape; Durofix adhesive, or similar; small pieces of plywood or MDF; 19-way tagstrip (see Fig.6); screws.

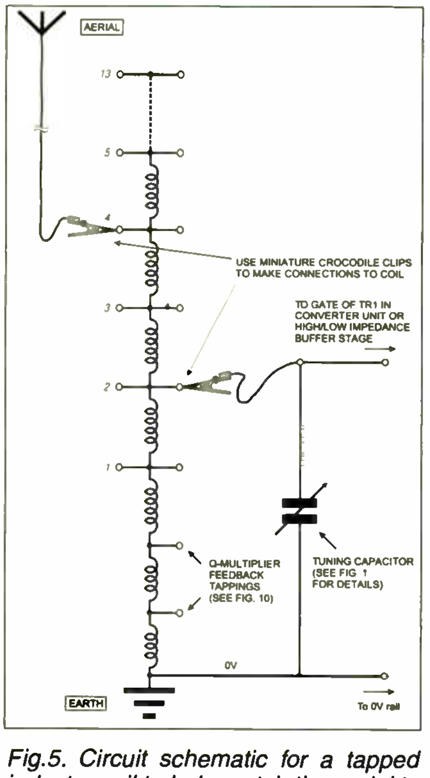


Fig.5. Circuit schematic for a tapped inductor coil to help match the aerial to the receiver. See Table 1 for schedule of inductance values

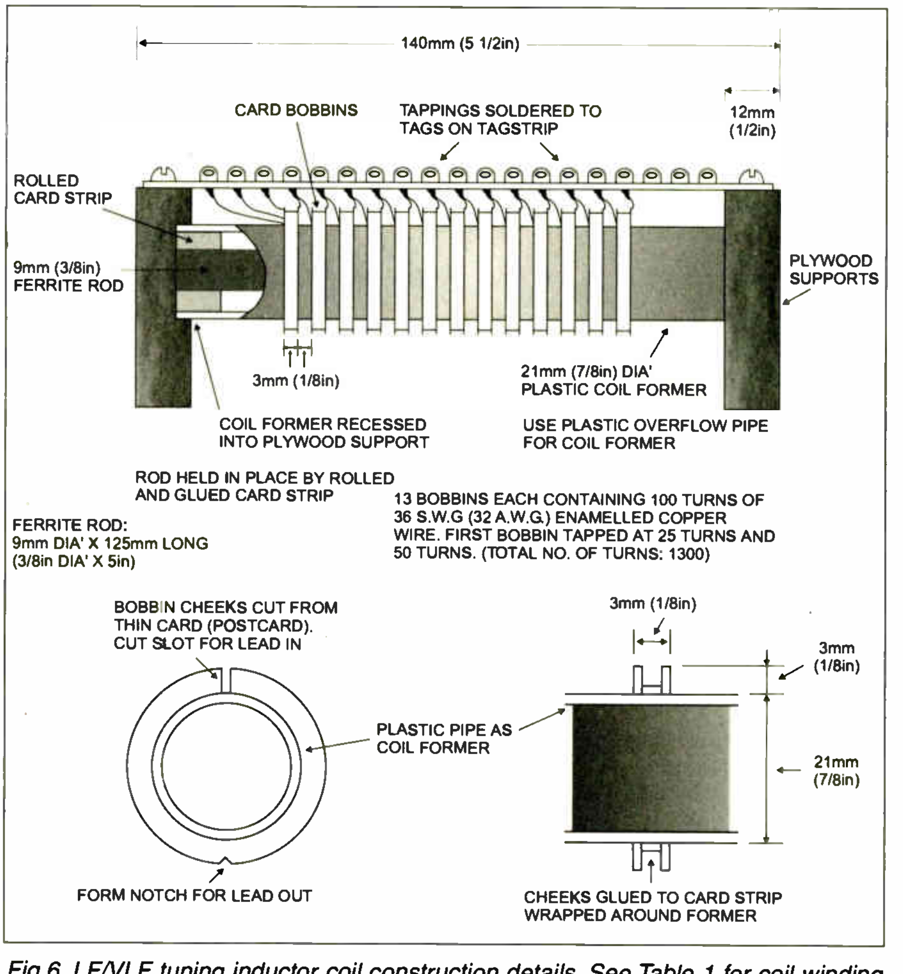


Fig.6. LF/VLF tuning inductor coil construction details. See Table 1 for coil winding turns information. Tappings at the start of the coil are for injection of positive feedback to produce Q-multiplication (see text)

Tuning Inductors (Coils)

The formulae relating inductance, capacitance and frequency in a tuned circuit are given in the accompanying panel. They have been expressed in the units normally encountered at these frequencies. If the value of the inductance is known, it is a simple matter to calculate the capacitance required to tune it to a desired frequency, and vice versa.

The only commercial coils currently available to home constructors are those manufactured by Toko. A CAN1A350EK longwave aerial coil, with both windings connected in series and the ferrite core screwed fully down, presents an inductance of 4·4mH. Teamed with the tuning capacitor unit already described, this will permit coverage down to 45kHz.

A longwave ferrite loop aerial coil, placed at the centre of its rod, will have an inductance of approximately 5mH, and the capacitor arrangement will tune this down to 42kHz. If the medium wave winding (usually part of the rod aerial) is placed in series with it, and both are located centrally on the ferrite rod, the combined inductance will increase to around 7mH, permitting tuning down to 36kHz.

From the foregoing, it will be appreciated that suitable inductors (coils), with tappings for the injection of positive feedback, are not difficult to find. The addition of more capacitance will, of course, tune them to lower frequencies.

Ratios

A reasonable ratio between capacitance and inductance has to be maintained, however, or performance will suffer. Large values of capacitance should not be placed in parallel with a low value of inductance to tune to the desired frequency.

A very rough rule of thumb is to try and keep the inductance, expressed in microhenries (μH), equal to or more than the capacitance, expressed in picofarads (pF).

Aerial Matching

Long wire aerials, connected to Earth via the receiver's input circuitry, become resonant when they are a quarter of a wavelength long. They then present a low impedance. A quarter of a wavelength at 100kHz is 750 metres (approximately 2500ft). Few readers will have the space (or the inclination) to erect so much wire, but impedance increases as length reduces below this ideal.

Under these conditions, signal transfer and performance can be improved by connecting an inductance in series with the aerial. This has the effect of lengthening the wire electrically, and the amount required is best determined by trial and error.

FORMULAE RELATING RESONANT FREQUENCY TO THE INDUCTANCE AND CAPACITANCE IN A TUNED CIRCUIT

When inductance (**L**) is measured in millihenries (**mH**), Capacitance (**C**) is measured in microfarads (**μF**), and frequency (*f*) is measured in kilohertz (**kHz**), the following formulae apply:

$$f = \frac{5{\cdot}033}{\sqrt{LC}} \qquad L = \frac{25{\cdot}33}{f^2C} \qquad C = \frac{25{\cdot}33}{f^2L}$$

0·001**μF** = 1000**pF** 1**mH** = 1000**μH**

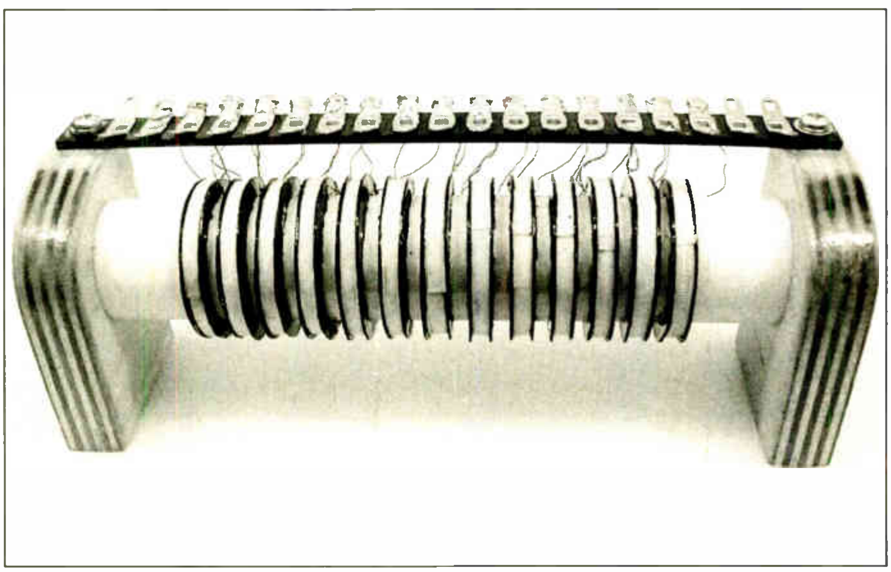
Example:

What value capacitor is required to tune a 3mH inductor to 200kHz?

$$C = \frac{25{\cdot}33}{200 \times 200 \times 3}$$

$$= 0{\cdot}000211\mu F$$

$$= 211pF$$



Assembled LF/VLF aerial-to-receiver matching tapped inductor coil

Tapped Coil

An inductor which can be tuned down to a low frequency, and which assists in the matching of aerial to receiver, is illustrated in Fig.6 and its circuit schematic diagram is shown in Fig.5.

Thirteen sections (coils) are connected in series, and there are additional tapping points at the "earthy" end for the injection of Q-multiplying positive feedback, should this be required. The aerial and receiver are connected to the coil tappings by miniature crocodile clips and, unless the aerial is comparatively long, feeding the aerial to a "higher" tapping point than transistor TR1's gate will usually improve signal transfer and selectivity (see Fig.5).

Combining the coil with a simple buffer amplifier results in the signal input to the receiver being increased by some 20dB.

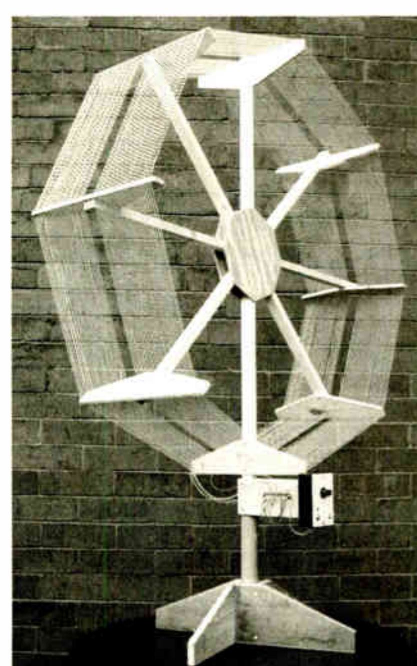
Inductance values at the various coil tapping points are given in Table 1. Using half of the coil (36mH) and the capacitor described earlier, tuning can be extended down to 16kHz. The remaining sections of the coil can be used to improve matching to an electrically very short aerial.

Coil Construction

The inductor coil sections are wound between card bobbins spaced along a former cut from a length of 21mm (7/8in.) diameter plastic overflow pipe. The inductance and Q-factor are increased by the use of a 9mm (3/8in.) dia. × 125mm (5in.) length of ferrite rod as a core.

Full details of the inductor coil construction are given in Fig.6, and little needs to be added. A modeling knife is useful for cutting out the card cheeks, and Durofix, or a similar quick setting adhesive, is best for sticking the cheeks to card strips, wrapped around the former, to construct the bobbins.

Dip the bobbins in cellulose or shellac to harden them after the glue has set. The windings can be protected by a thin strip of masking tape, but they should not be impregnated.



Loop Aerial

A tuned (resonant) loop aerial has much to commend it for low frequency reception. Provided its diameter is greater than one metre (3ft), signal pick-up usually exceeds that from the 20 metres (65ft) or so of wire that can be accommodated in most gardens.

More important, a loop exhibits a pronounced null in pick-up when its axis is pointing towards a noise or signal source. This property can be used to almost completely eliminate local interference.

Loop Construction

A suggested design for a 104cm (41in) diameter loop aerial is given in Fig.7. The completed loop is shown in the accompanying photographs.

Eight radial arms support the windings, which are spaced and held in place by horizontal comb pieces. Although a little more difficult to construct than a simple square, the octagon is closer to the ideal circular form, and the increased number of supports is desirable for the sixty-turn winding.

Again, little needs to be added to the information given on the drawing. Materials and methods of construction are not hard and fast, and readers will have their own ideas for assembling the support framework. A plastic stand from an old typist's chair makes an ideal base if the castors are removed.

The gauge and type of wire used for the loop windings are not critical, but the specified weight of 24s.w.g. enamelled copper wire will be enough for 60 turns with a little to spare.

LOOP AERIAL – YOU WILL NEED

Reel (500g – 1lb) of 24s.w.g. (23a.w.g.) enamelled copper wire (NB 1lb is tight at the thicker a.w.g., and American readers might wish to play safe and purchase 1lb of their slightly thinner 24a.w.g.); softwood strip, 31mm × 21mm (1 1/4in. × 3/4in.), 6 metres (20ft); sheet of 6mm (1/4in.) plywood for plates and combs, 1000mm × 600mm (3ft × 2ft); softwood, 150mm × 18mm (6in. × 3/4in.) 1500mm (48in.).

Plastic waste pipe, 41mm (1 1/2in.) outside diameter; glue; screws; rubber feet; nylon ball from deodorant bottle; tag strip.

Completed home-brewed loop aerial

The measured inductance of a half winding (30 turns) is 1·65mH and of the full winding (60 turns) around 4·74mH. The calculated self-capacitance of the full winding is 60pF, and this should be taken into account when estimating the capacitance needed to tune to higher frequencies within the band.

Buffer Amplifier

Readers who have a communications receiver that can be tuned below 100kHz, or who wish to use a regenerative receiver, will need a simple buffer amplifier to match the tuned circuits just described to the aerial input terminals on their sets.

Circuit Details

The circuit diagram for a Simple Buffer Amplifier is shown in Fig.8. Field-effect transistor TR1 is configured as a source follower (common drain) stage.

Its high input impedance minimizes damping on the signal-frequency tuned circuit, and its low output impedance ensures a good match to the receiver's input circuitry. There is no voltage gain, but the impedance transformation results in some power gain.

The output is developed across source load preset potentiometer VR1. Making this a variable preset enables the output to be reduced to avoid overloading the receiver. If desired, a standard rotary potentiometer can be substituted as a front panel control, but the leads to the printed circuit board, if longer than 75mm (3in), must be screened.

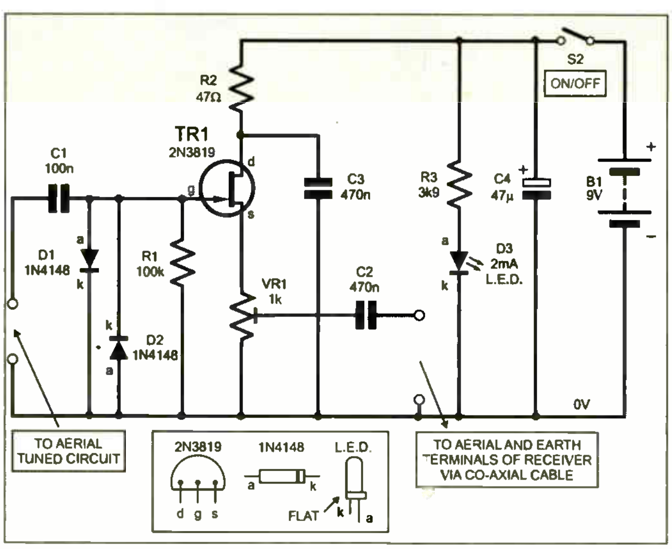


Fig.8. Circuit diagram for a high/low impedance Buffer Amplifier. This will match high impedance LF/VLF tuned circuits to the low impedance aerial input of a communications receiver

Together with preset VR1, gate resistor R1 ensures the correct biasing of transistor TR1; C1 is a d.c. blocking capacitor and diodes D1 and D2 protect TR1's gate (g) from high voltages. The stage is decoupled by R2 and C3, and C2 functions as a d.c. blocking capacitor in the output feed.

The l.e.d. On indicator, D3, with its dropping resistor R3 is optional. Stability with ageing batteries is ensured by capacitor C4, and switch S1 connects the battery to the circuit.

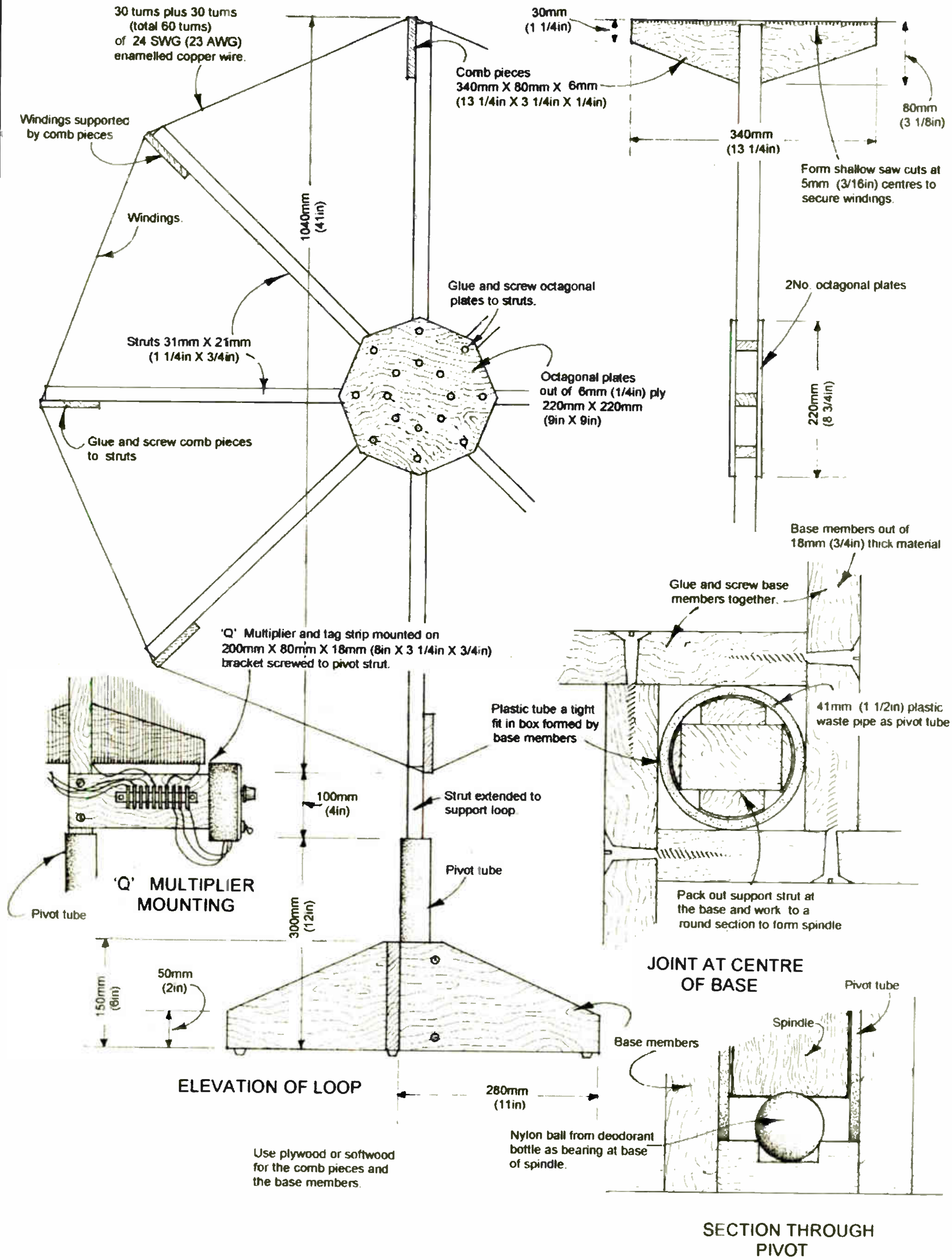


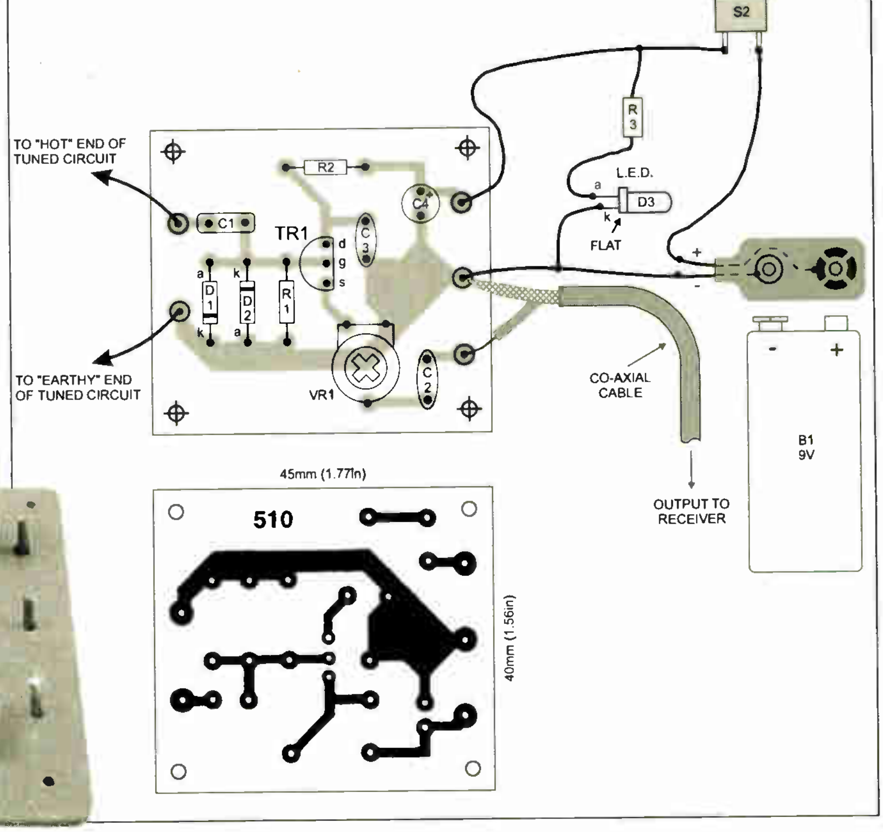
Fig.7. Constructional details for an LF/VLF Loop Aerial with optimal Q-Multiplier. Eight radial arms support the 24s.w.g. enamelled copper wire windings

These drawings are not to scale

Construction

With the exception of l.e.d. D3, R3 and S1, the various components are assembled on the small printed circuit board as illustrated in Fig.9. Details of the off-board wiring and a full-size copper track master are also included in this diagram.

Fig.9. Buffer Amplifier printed circuit board component layout, interwiring and full-size underside copper foil master



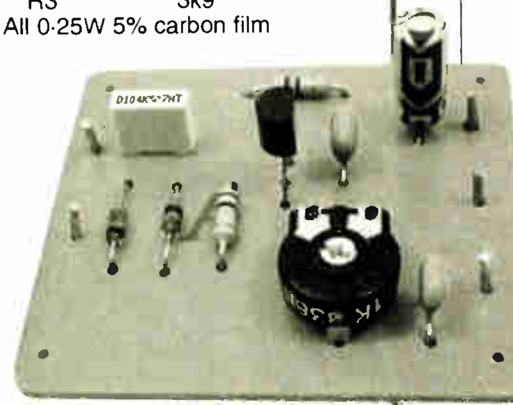
COMPONENTS

BUFFER AMPLIFIER

Resistors

R1	100k	See **SHOP TALK** page
R2	47Ω	
R3	3k9	

All 0·25W 5% carbon film



Potentiometers

VR1	1k enclosed preset, horiz.

Capacitors

C1	100n polyester
C2, C3	470n ceramic (2 off)
C4	47µ radial elect. 25V

Semiconductors

D1, D2,	1N4148 signal diode (2off)
D3	2mA low current l.e.d., red
TR1	2N3819 *n*-channel field-effect transistor

Miscellaneous

S1	single-pole, single-throw toggle switch.
B1	9V PP3 type battery, with clips

Printed circuit board available from the *EPE PCB Service*, code 510; l.e.d. holder; battery holder; screw terminal (2 off); coaxial socket; multistrand connecting wire; p.c.b. stand-off (4 off); nuts, bolts and washers; solder pins; solder etc.

NB. This unit would be normally be mounted in a metal case, together with the tuning capacitor arrangement.

Approx Cost Guidance Only **£9** *excl case & batts*

Q-Multiplier

The relationship between the Q-factor and tuned circuit magnification was discussed in Parts One and Two of the *Practical Radio* series mentioned earlier. In brief, the Q-factor is a figure of merit that defines the ability of a tuned circuit to resonate sharply, and to magnify signal voltages at its resonant frequency. Put simply, and assuming resonance, a signal of 10mV applied to a tuned circuit with a "Q" of 100 will be magnified to 1V.

The "Q" of a tuning coil can be increased by the application of positive feedback, and a simple Q-Multiplier and Loop Aerial circuit is shown in Fig.10. Field-effect transistor TR1 functions here as a Hartley oscillator. Its gain, and hence the amount of positive feedback, is controlled by potentiometer VR3, which varies the voltage on its drain (d) terminal. Bypass capacitor C2 decouples the stage and eliminates potentiometer wiper (moving contact) "noise".

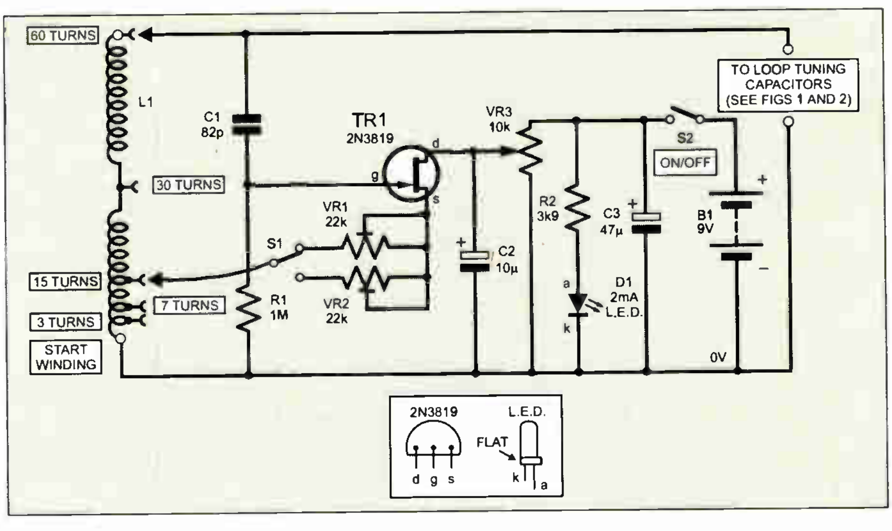
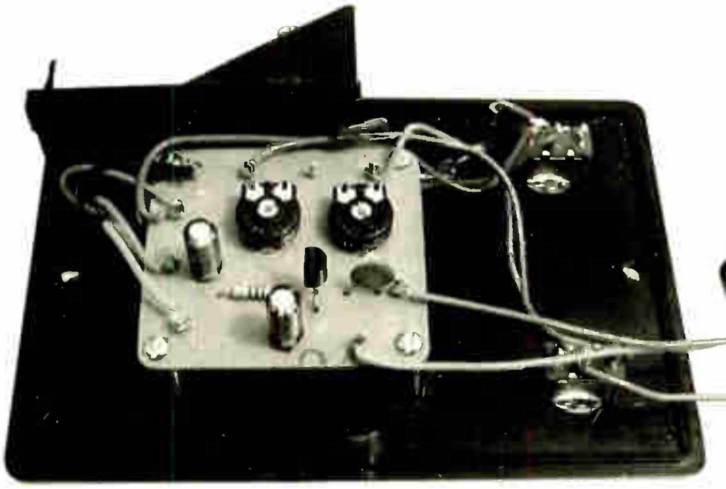


Fig.10. Circuit diagram for the Q-Multiplier and Loop Aerial. The Q-Multiplier can be used with any LF/VLF turning coil and ferrite-cored loops



Q-Multiplier circuit board mounted on the lid of the case

Front panel layout of the Q-Multiplier

The multiplier is connected to the "hot" end of the tuned circuit via capacitor C1. Resistor R1 ensures the correct biasing of the transistor.

Feedback is preset by selecting the required tapping on the coil and by adjusting TR1's source (s) presets VR1 and VR2, wired as variable resistors. One or other of these presets is switched into circuit by switch S1. This arrangement ensures the smooth operation of the Q-Multiplier control VR3 at all settings of the switched tuning capacitor p.c.b.

The purpose of the remaining components will be evident from earlier circuit descriptions.

Construction

The printed circuit board component layout, off-board component interwiring details and a full-size underside copper foil master pattern for the Q-Multiplier are shown in Fig.11. This board is available from the *EPE PCB Service*, code 511. Also shown are the lead-off wires to the loop or tuning coil, including the feedback tapping lead.

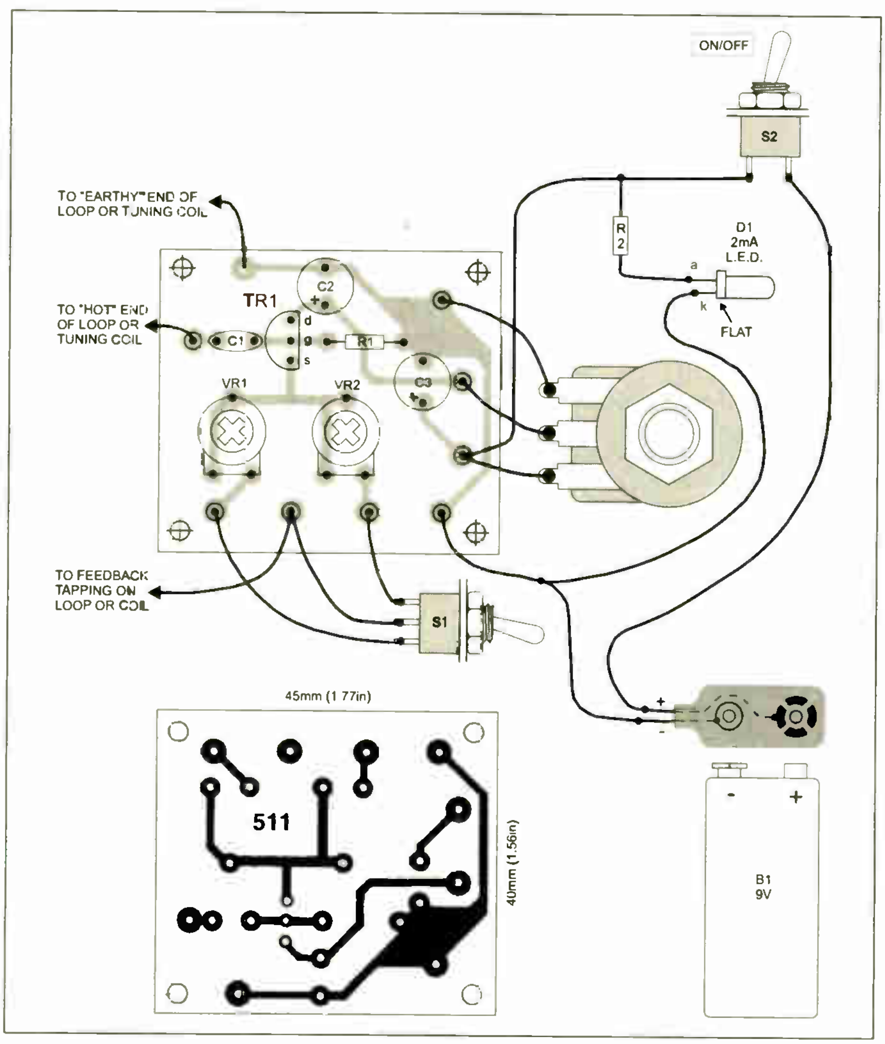


Fig.11. Q-Multiplier printed circuit board component layout, wiring to off-board components and full-size copper foil masters

COMPONENTS

Q-MULTIPLIER

Resistors
R1 1M
R2 3k9
All 0·25W 5% carbon film

See SHOP TALK page

Potentiometers
VR1,VR2 22k enclosed preset, hor. (2 off)
VR3 10K rotary carbon, lin.

Capacitors
C1 82p low-k ceramic
C2 10µ radial elect. 25V
C3 47µ radial elect. 25V

Semiconductors
D1 2mA low current l.e.d. red
TR1 2N3819 *n*-channel field-effect transistor

Miscellaneous
S1 single-pole, double-throw toggle switch
S2 single-pole single-throw toggle switch
B1 9V PP3 type battery, with clips

Printed circuit board available from the *EPE PCB Service*, code 511; small plastic case, size 102mm(4in.) x 76mm (3in.) x 40mm (1.57in.); l.e.d. holder; plastic knob; battery holder; multistrand connecting wire; p.c.b. stand-off (4 off); card and thin Perspex sheet for front panel; nuts, bolts and washers; solder pins; solder etc.

NB. When used with the Aerial Loop, this unit is mounted on the frame pivot and wired directly to the loop tag-strip.

Approx. Cost Guidance Only **£10** *excl case & batts*

Components

Almost any *n*-channel junction field-effect transistor should be suitable for these circuits. But check base connections as some are bound to vary. Similarly, almost any small-signal *npn* bipolar transistor should function as the oscillator, TR2, in the Converter unit. However, reliable oscillation and a decent input to the mixer will be ensured by the use a device with good h_{fe} and f_T figures, especially if the i.f. frequency is increased to 10MHz.

Close tolerance polystyrene capacitors are the preferred components for the switched tuning system. High value examples are, however, expensive and bulky. With this in mind, low-k ceramic capacitors have been specified for values up to 470pF, and polyester components for the 1nF and 2·2nF units. Do not use high value ceramic capacitors. Their "Q" factor and stability can be low, and they are unsuitable for use in tuned circuits.

All four sections of an a.m./f.m. polyvaricon tuning capacitor are connected together to produce the 20pF to 280pF capacitance swing required for the variable tuning element. Most small polyvaricons will have maximum capacitance values of this order, and some greater.

Assembly

Almost all of the components for the LF and VLF Converter are mounted on small printed circuit boards. Solder pins, inserted at the lead-out points, will simplify off-board wiring, and they should be inserted into the board first.

When populating the Converter p.c.b., mount the i.f. transformer, L1/L2, next, after inserting the solder pins. It can be secured to the board by a drop of Superglue (cyanoacrylate adhesive).

Follow this with the resistors, then the capacitors, smallest first. The semiconductors and the crystal should be soldered onto the board last in order to avoid the repeated heating of these components. It is good practice to use a miniature crocodile clip as a heat shunt when mounting the field-effect transistor.

The optional l.e.d. On indicators, and their dropping resistors, are wired between the On/Off switch and/or the appropriate pins on the boards.

Setting Up and Testing

Check all the printed circuit boards for poor soldered joints and bridged tracks. Double-check the placement of components on the p.c.b.s and the orientation of semiconductors and electrolytic capacitors. If all is in order, proceed as follows:

Converter Unit

Starting with the Converter Unit, connect a fresh 9V battery. Current consumption should be approximately 4mA (excluding the current drawn by any l.e.d. indicator).

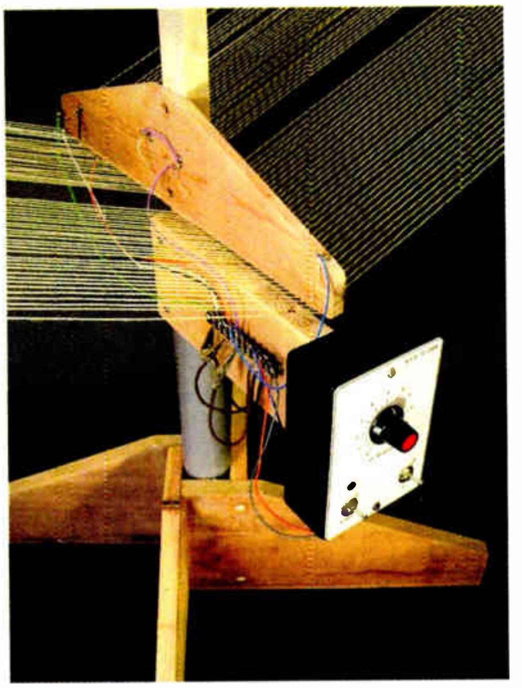
Connect the unit to the Receiver via a short (no more than 1 metre or 3ft) length of coaxial cable and set the dial of the receiver to 4MHz (4000kHz) plus the frequency of some powerful longwave transmitter. BBC Radio 4 on 198kHz is ideal in many parts of the UK, and this would require a receiver dial reading of 4198kHz.

Connect an aerial to capacitor C12 (the input is not tuned for this initial test). The chosen station should now be heard. Adjust the i.f. transformer tuning capacitor VC2 for highest reading on the receiver's signal strength meter.

Note that provision is made, on the p.c.b., for the insertion of an additional fixed capacitor in order to refine the tuning of coil L1. If the coil is constructed as specified, it should come to resonance with trimmer VC2 at about mid-swing, and the need for an additional, or two smaller capacitors, is most unlikely.

Tuning Capacitors

The 10 per cent tolerance of the larger capacitors in the switched bank tuning board can exceed the overlap between the ranges. If the constructor has some means of measuring capacitance, the continuity of change should be checked. A check carried out on the prototype, which was assembled without selecting capacitors, revealed a short-fall of 20pF between the penultimate and the highest range.



Q-Multiplier mounted on the LF/VLF Loop Aerial

With up to 2800pF in circuit at this point, the short-fall is not particularly serious. However, constructors who can carry out a check will no doubt wish to do so, and the p.c.b. has provision for the insertion of addition capacitors, on most of the higher ranges, in order to refine values.

Connect the capacitor tuning bank across a suitable inductor (coil), and connect the resulting tuned circuit to the converter. Tune in a weak signal on the receiver (remember, the receiver dial setting is 4000kHz plus the frequency of the wanted station). Connect an aerial and adjust the variable and fixed capacitors to tune the input circuits to the chosen long-wave station. The receiver's signal strength meter should reveal the effects of tuning the input.

Inductors (Coils)

Readers who have some means of measuring inductance may wish to establish the inductance of the tapped coil and the loop aerial. Otherwise, all that can be done is to carry out a continuity and resistance check.

The measured resistance of individual sections of the prototype tapped coil is around 7·4 ohms, and the resistance of the entire winding totals 96 ohms.

Loop Aerial

Tuning capacitors are sometimes mounted directly on the loop aerial and the loop connected to the receiver via a low impedance coupling winding. With this design, the tuning capacitors are enclosed with the Converter or Buffer Amplifier, and the loop is connected to them via separate and short (no more than 600mm or 2ft) unscreened leads. This makes for easier operation of the system.

If any interference is encountered, rotate the loop to null it out. Orientation for strongest signal is quite broad, but the position for deepest null is critical.

Readers seeking the deepest possible nulls on distant stations should consider a gimbal mount so the loop can be tilted, as well as turned. With additional tuning capacitance, the loop performs well down to 14kHz.

Buffer Amplifier

Turning to the Buffer Amplifier, connect a 9V battery and switch on. Current consumption should be approximately 2mA, (excluding any l.e.d. indicator).

Set preset VR1 for maximum output (fully clockwise), and connect the buffer to the receiver via a short (not more than 1 metre or 3ft) length of coaxial cable (see Fig.9). Connect a tuned circuit and an aerial to the buffer input, and set the receiver tuning to a weak station.

When the buffer stage tuning has been correctly adjusted, the rise in signal strength at the receiver should be very apparent. If strong signals overload the receiver, VR1 can be backed-off to reduce the output from the Buffer.

Q-Multiplier

Connect the Q-Multiplier across a tuned circuit formed by the fixed capacitor board and the coil or loop aerial already described. The tapping point for the feedback connection should be spaced between ten and twenty-five percent of the total number of turns up from the "earthy" end of the winding. The Multiplier is, of course, used in conjunction with, not in place of, the Converter or the Buffer Amplifier.

Connect a 9V supply to the circuit board. Current consumption, excluding any l.e.d. indicator, should be in the region of 2mA.

Set the Q-multiplier control, VR3, to mid-travel, tune in a station, and advance preset VR1 or VR2 until the stage almost oscillates. Refine the tuning, which should now be quite sharp. The receiver's signal strength meter should show a dramatic rise: up to 40dB on weak transmissions.

Spend some time adjusting the tapping point and presets VR1 and VR2. With care, the operation of the Q-Multiplier control can be made smooth and completely free from backlash at all settings of the tuning capacitor. □

PRACTICALLY SPEAKING

Robert Penfold looks at the Techniques of Actually Doing It!

Over the years I have often stated that many of the tools used when building electronic projects are the type of thing that can be found in the average handyman's toolbox. Things change though, and I suppose that these days there are relatively few project builders who build their own wooden or metal cases. Probably few of today's projects require cases that are large enough to merit the carpentry and metal bashing antics that were once a normal part of project construction.

This does not mean that no tools in the average toolkit will be useful, and that you need to equip yourself with a totally new set of tools in order to build some useful projects. Even if you do not build your own project cases, it will still be necessary to do some drilling and cutting. Tools such as hacksaws, pliers, centre punches and drills are still an essential part of project building.

Hole Truth

Practically any hand or power drill can be used for drilling holes in cases, but some are much better than others. An important point to bear in mind is that most projects are quite small, and that they are often housed in cases that are made from a fairly soft plastic. Metal cases or plastic cases that have metal front panels are also popular, but the metal is usually aluminium. This is also quite soft. A powerful electric drill is ideal for making large holes in brick walls, but using it for most project work is definitely a case of "using a sledgehammer to crack a nut".

Unless you are happy with a project that looks like it was made by someone who had one drink too many, you must use a drill that will enable the holes to be made carefully and with precision. Any power drill mounted in a good quality stand should give excellent control and make it relatively easy to obtain precise results. Failing that, it is probably best to keep it simple.

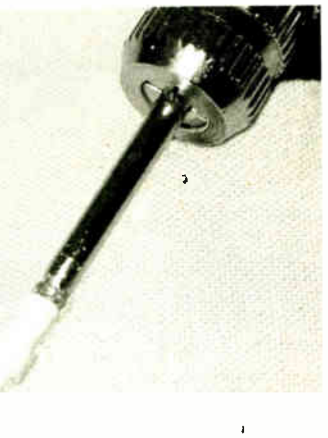


Fig.1. High drill speeds and most plastics do not go well together

Small cordless electric drills are well suited to most electronic project work. One that has a slow speed setting or a variable speed control is better. Drilling plastic using a high-speed drill is not a good idea. The plastic tends to melt, usually producing very rough results and caking the drill with plastic. A hand drill may seem a bit old-fashioned, but it is an excellent choice for plastic cases due to the slow drilling speed and the high degree of control it permits.

At one time it was possible to produce most projects using drill bits of just three or four well chosen sizes. These days components come in all shapes and sizes, making it necessary to have drills in a wide range of sizes. If you do not already have a set of HSS drills from about one millimetre to 10 millimetres in diameter then it is certainly worthwhile buying one. It is probably best to avoid the cheapest sets, since they are prone to snapping and blunt quickly. On the other hand, top quality drills are not essential if you will mainly be drilling plastic and aluminium panels.

Ordinary files are very useful for project building, but a set of miniature ("needle") files is probably even more useful. Using these files it is possible to convert a round hole into a rectangular type, cut slots in panels, and make the odd shaped cut-outs required by some components. They are also useful for elongating holes slightly when things do not quite fit. An error of a millimetre is not enough to worry about with most do-it-yourself projects, but with electronic projects it is usually sufficient to ensure that things will not go together properly. A small amount of work using a miniature round file should cure any problems of this type.

Hot Property

A soldering iron suitable for electronic work is something that is probably not found in the average toolbox. A small electric iron having a rating of about 15 to 20 watts is the most popular choice for project building. Experience suggests that it is advisable to avoid the very cheap irons. They seem to be short-lived or simply do not generate enough heat to do the job properly. Some barely get hot enough to melt solder! At the other extreme, an expensive temperature controlled iron will do the job very well, but is perhaps a bit "over the top" for occasional project building.

Antex irons are widely available in the UK, and the Antex name is synonymous with soldering. When I started building radios in the 1960s I used an Antex iron from their "C" series, and I still use a couple of Antex "C" series irons today – see Fig.2. I think it is fair to say that an Antex iron represents a safe choice.

Fig.2. The Antex C15 15W soldering iron

There is a lot of useful information about soldering and soldering irons on their web site **(www.antex.co.uk)**. One of their soldering iron kits provides an easy way to get started. The kit includes an iron, some solder, instructions, and the all-important stand for the iron. The stand keeps the hot iron safe when you are not using it, and also acts as a heatsink that helps to prevent the iron from overheating.

Desoldering

We all make mistakes, and the need for a desoldering tool will probably arise sooner rather than later. Having tried a number of desoldering methods over the years, the only inexpensive type that works really well is a desoldering pump. With one of these you first use the soldering iron to melt the solder, and then use the spring powered pump to suck the molten solder from joint. Even the cheaper desoldering pumps seem to go on working efficiently for a long time provided they are not allowed to get seriously clogged with bits of solder.

While the average toolbox will contain a selection of screwdrivers, it is likely that they will generally be too large for electronic work. A blade width of only two or three millimetres is needed for some tasks, such as tightening the grub screws in control knobs. Good quality screwdrivers for electrical use do not cost very much, so there is no point in buying very cheap ones with blades that tend to twist and break.

Stripped for Action

Do not be tempted to use scissors or penknives for cutting wires or removing the plastic insulation from connecting wires. Using scissors to cut wire will not give adequate precision, and will soon render the scissors useless for cutting anything. Stripping plastic

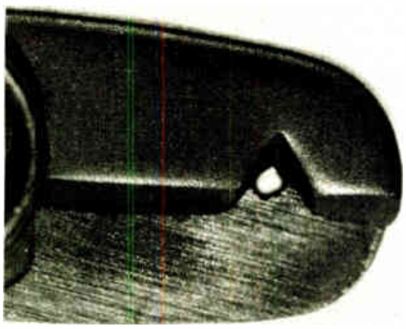


Fig.3. The notched blades of wire strippers should prevent damage to the wires

insulation using anything other than proper wire strippers tends to damage and seriously weaken the wire.

A tool that combines wire stripping and cutting is the cheapest option that will work reasonably well. These tools are first rate at stripping insulation, but are not always perfect at cutting very fine wires. However, you can always add a pair of small wire cutters later, should the need arise. Wire strippers have notched blades that leave an aperture for the wire (Fig.3). The idea is to almost cut through the insulation so that the unwanted section is easily broken away, leaving the wire undamaged.

Wire strippers can be adjusted to suit various wire gauges. In Fig.4 there is a bolt which can be loosened, slid to a suitable setting, and then tightened again. This method is a bit awkward if you need to make frequent changes, but has the advantage of not getting accidentally knocked to a different setting. In Fig.5 there is a simple rotary control disc that is calibrated with a range of wire gauges.

Wire gauge calibration is not really very helpful, since multi-strand connecting wire is used in most projects. In other words, inside the insulation there are several fine wires rather than one thick one. This makes the lead more flexible and less prone to breaking. The best setting has to be found using the "suck it and see" method. The optimum setting is the biggest aperture that enables the insulation to be removed easily.

Flexible Friend

Most pastimes seem to have their so-called "born again" enthusiasts who return to the hobby after many years. There certainly seems to be a strong element of this in electronic project construction, and I suppose it has traditionally been a hobby that people tend to take up either when very young or in later life. A problem for "silver solderers" is that electronic components and the projects that use them have "shrunk" over the years. This can make life a bit difficult for those having eyesight that is "not as good as it used to be".

There are magnifying glasses of various types that are designed to make life easier for those pursuing a hobby that involves intricate work. Having tried a few of these in recent years it is clear that some of them do not really work that well when applied to soldering. The type that has a magnifying glass on a flexible arm is certainly worth trying. They are produced by The Daylight Company, and are apparently made primarily for those who do cross-stitching.

One of the smaller versions is adequate for soldering work. One type has a heavy base so it can stand on the worktop, and another type is designed to clip onto the edge of the worktop (Fig.6). Either will do the job well, but the clip-on type is less easily knocked over. The magnification is only about 2X, but this should be sufficient.

Some have a small but more powerful lens inset into the main lens. This is potentially useful, but it is worth buying an 8X or 10X loupe to use when searching for short-circuits on circuit boards, trying to read minute lettering on semiconductors, etc. There are more elaborate magnifiers available, including units with built-in lamps. Having some extra light on the work-piece is very helpful, but combined lamps and magnifiers are relatively expensive.

There is a popular "Helping Hands" gadget which combines a magnifier with an arm and crocodile clips to hold the work-piece in place. It is a very useful device that costs very little. It no doubt has plenty of uses in the electronics workshop, but it is a bit too small to accommodate the majority of circuit boards.

Using a magnifier gives you a better view of things and makes it easier to produce good soldered joints, but it can take a while to get used to working with an enlarged but narrower view of things. It is a good idea to try some "dry runs" with a cold iron before attempting any joints. Bear in mind that magnifiers often have plastic lenses that will come to grief if they get in contact with the soldering iron.

Tweezers

Another problem with the small physical size of many modern components, but particularly resistors and capacitors, is that it can be difficult to pick them up. It can be even more difficult to accurately manoeuvre them into place. If your fingers are not as nimble as they used to be, or you simply have large hands, a pair of tweezers will make life much easier when dealing with tiny components. I managed for many years without tweezers, but now regard them as an essential part of my toolkit.

Practically any small tweezers should do the job well. The fancier types that

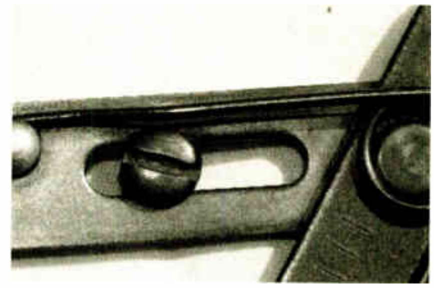


Fig.4 Loosening the bolt enables it to be slid to a new position and tightened again. This method of adjustment is fine if only occasional readjustment will be needed

Fig.5 A simple rotary control enables the setting to be changed quickly, but it is easily knocked onto a different setting

have angled ends are good for getting things precisely into position, but it can be difficult to get a reliable grip on components like resistors that have round bodies. It is probably best to avoid plastic tweezers. They often seem to lack strength and might melt if used to hold something that gets hot.

Finally

Before starting your first project it is advisable to make sure that you at least have the basic tools for the job. Building a project will not be much fun if you have to keep stopping in order to go out and buy a miniature screwdriver, some more solder, and so on. On the other hand, it is probably a mistake to get carried away and buy a massive collection of tools and gadgets, some of which may never be needed. Only buy the more obscure and expensive tools if and when you need them.

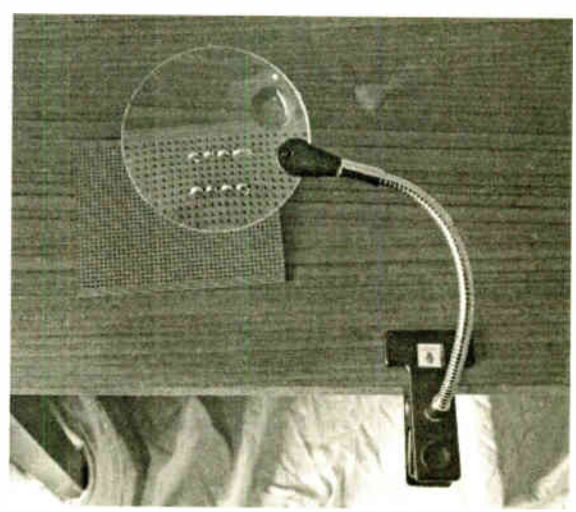


Fig.6 A magnifier on a flexible arm makes it easier to work on intricate circuit boards

Constructional Project

Multi-Clap Switch

Thomas Scarborough

A far more controllable and responsive unit than conventional designs

OVER the years, the simple clap switch has become something of a staple of electronics magazines and tutorials, and today a good number of kits are available through various suppliers. However, the "stock standard" clap switch has a number of distinct shortcomings. The author's son has one in his room. Throw a ball against the wall, or sneeze, and the light goes out! Similarly, a bump in the night can turn the light on. Any number of sharp sounds can switch the clap switch either on or off. This is disadvantage number one. You need only one sharp sound to trigger the switch.

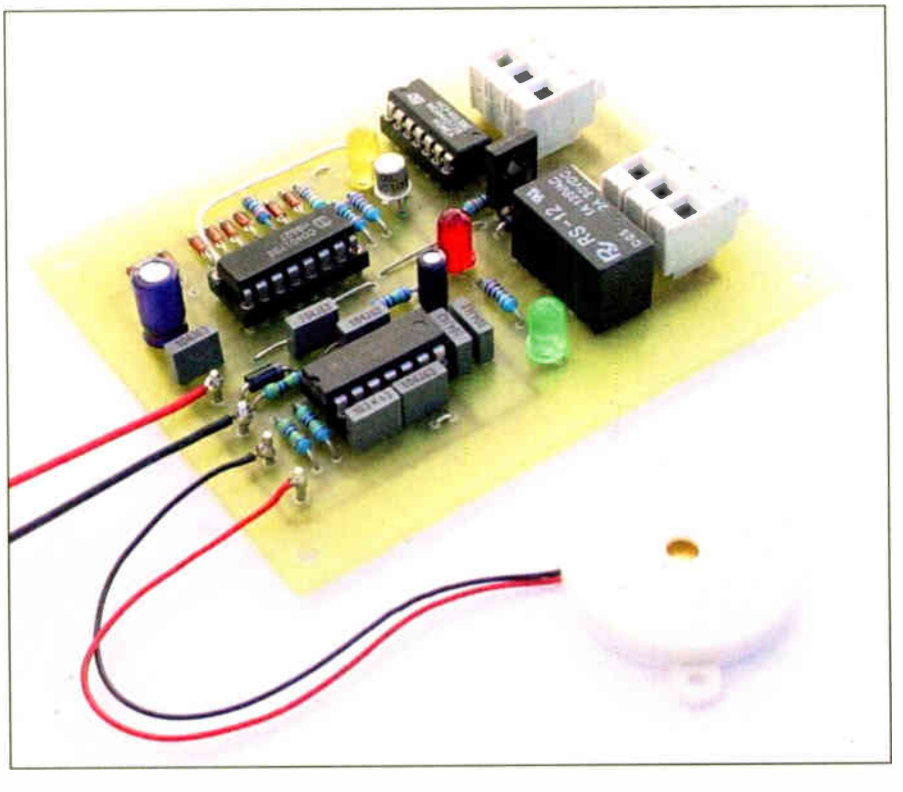
A second shortcoming is that, unless a clap switch is adjusted to respond only to hard, sharp claps, it is likely to be triggered by a variety of unwanted sounds. This also means that "lighter" sounds, such as clicking one's fingers, or tapping a pencil on a desk, are less likely to trigger a "stock standard" clap switch. Instead, far louder, disruptive sounds are required.

A third shortcoming is that the standard clap switch offers little security. Anyone who can clap, or even click their fingers or shout, can trigger the switch. While this might not seem at first to hold much of a disadvantage, it significantly limits the possibilities of the switch.

In Consideration

Consider that an estimated 5% of all car drivers lock their keys in their cars every year. Add to this the (unknown) number of people who find themselves without their house keys, or various other keys or access codes. Then imagine what a secret knock-knock code could achieve.

In fact a number of companies now market sophisticated clap (or tap) switches to circumvent precisely these problems. Tap a code on your car window, and the door locks open – or knock on your front door in a predetermined sequence, and you regain access to your home. All this the Multi-Clap Switch can do, albeit more basically.



In brief, the Multi-Clap Switch may be activated with one to nine claps, as preferred. The same number of claps is required to switch it off again. This it does with more than the usual sensitivity. The precise "speed" of the claps may also be set, so that clapping either too fast or too slowly will reset the switch.

In Concept

The author felt that the "stock standard" clap switch had been done so many times that he wanted to steer clear of all the designs he had perused, and create something new. Instead of using an analogue preamplifier (such as an op.amp), he chose a digital i.c. instead – the 4069 *unbuffered* (suffix UB) hex inverter. Also, instead of amplifying a signal presented to the input as is usually done, he chose to place a piezo disc in the feedback path of a gate (see later).

Ultimately, the amplified signal produces a square-wave output capable of clocking a CMOS decade counter i.c. The decade counter sequences through nine separate stages, of which any one may be selected to clock a D-type flip-flop, wired as a binary divider (divide-by-two). This causes a relay to switch either on or off after each sequence of claps.

The circuit was at first far more complicated than the one shown here. This is because the author wired each of the decade counter's outputs so that it would separately time-out. That is, if a single clap in the sequence was delayed too long, the clap switch would reset. It soon occurred to him, however, that this could be done far more simply.

If just one clap was delayed, this would of course delay the entire sequence, and the entire sequence would time-out. Therefore instead of having nine "time-out" circuits for a sequence of nine claps, only one is necessary, and tens of components are saved.

On the other hand, the minimum pause between claps is arranged just as simply. Each clap instantly charges a small capacitor at the decade counter's clock input. However, this capacitor takes a little longer to discharge, thus momentarily disabling the clock input by holding it high. A clap that follows too closely on a previous clap will simply keep the capacitor pumped up, and will fail to further clock the counter. Thus the entire sequence is delayed, and a reset is again inevitable.

Notice also that this takes care of any "overshoot". At first the author pondered over how he might prevent a sequence of claps from shooting past the point required to switch the relay, thus upsetting the overall count (a simple reset is not the answer). This is taken care of automatically by controlling the minimum and maximum "duration" of claps as described.

During tests, if tight margins were selected for the circuit, even when people tried to imitate just three claps that the author showed them, they were generally unable to do so. However, for practical purposes, the component values shown here are chosen to make the Multi-Clap Switch charitable towards the user.

The piezo sensor is particularly suited to gluing to surfaces such as a door, in which case it converts the Multi-Clap Switch into a very sensitive "tap switch".

Finally, the author was faced with the choice as to whether to make this an "all bells and whistles" design, or something more spartan. He decided that a clap switch is generally set up and used for months if not years at a time without adjustment, and that the addition of various knobs and dials would considerably complicate the design.

Therefore he decided to make this an "experimenter's project", which could be tweaked and modified in various ways (see later). Such modifications may by all means include the "all bells and whistles" option.

Circuit Diagram

The complete circuit diagram for the Multi-Clap Switch is shown in Fig.1.

The preamplifier is based on unbuffered hex inverter IC1, of which stages IC1a and IC1b are biased into their linear region by resistors R1 and R2 respectively.

A cheap piezo sounder without integral electronics is used for the microphone. This generates a small voltage when a sound is picked up. This unsettles the potential at IC1a's input, and thus that at its output, passing this instability (and amplifying it) down the chain of inverter gates, IC1b to IC1f.

The final stage, IC1f, has its input biased normally-high by resistor R3. This maintains IC1f's output in a low state in the absence of an input signal.

Notice that all of IC1's gates are separated by d.c. blocking capacitors. This prevents any slight d.c. bias at an early input from being magnified through the chain.

The preamplifier has a higher sensitivity than usual for a clap switch, and if a blunter response is desired, the values of resistors R1 and R2 may be reduced to 10kΩ each, or less. Alternatively, holes are provided on the printed circuit board (p.c.b.) for "leapfrogging" inverter gates IC1c and IC1d (taking them out of circuit) as shown by the dotted line, to *decrease* the gain.

This may be necessary where there is noise in an environment, e.g. a motor running in the background. There is also the possibility of *increasing* gain, by adding a feedback resistor, R11, to gate IC1c and having a value of 4M7Ω.

Clocking On

The next part of the circuit, comprising D3, C8 and R4, is intended to convert an amplified clap to a clock pulse suitable for triggering decade counter IC2. Although a clap might sound like a single event to the human ear, to a fast electronic circuit it is a multiple event, switching the circuit many times – see the oscilloscope trace in Fig.2a. Capacitor C8 thus combines the multiple waveform into a single pulse, as in Fig.2b.

The diodes at the outputs of IC2 ensure that each one of these outputs, when "high", charges capacitor C9 through resistor R7, without permitting it to discharge. When charged, C9 takes IC2 Reset pin 15 "high", thus resetting the circuit and taking output Q0 high. This switches transistor TR1 via buffer resistor R6, thus rapidly discharging C9, so that the Multi-Clap Switch is almost instantly reset for another sequence of claps.

Bistable (flip-flop) IC3a performs a divide-by-two operation. Its input pin 3 may be connected to any of IC2's Q1 to Q9 outputs so that it is triggered after a predetermined number of claps. Via buffer resistor R10, IC3a's $\overline{Q1}$ output controls transistor TR2, which in turn controls the relay, RLA.

Transistor TR2 is shown as an IRF510 power MOSFET, although almost any similar MOSFET will suit. Note that TR2

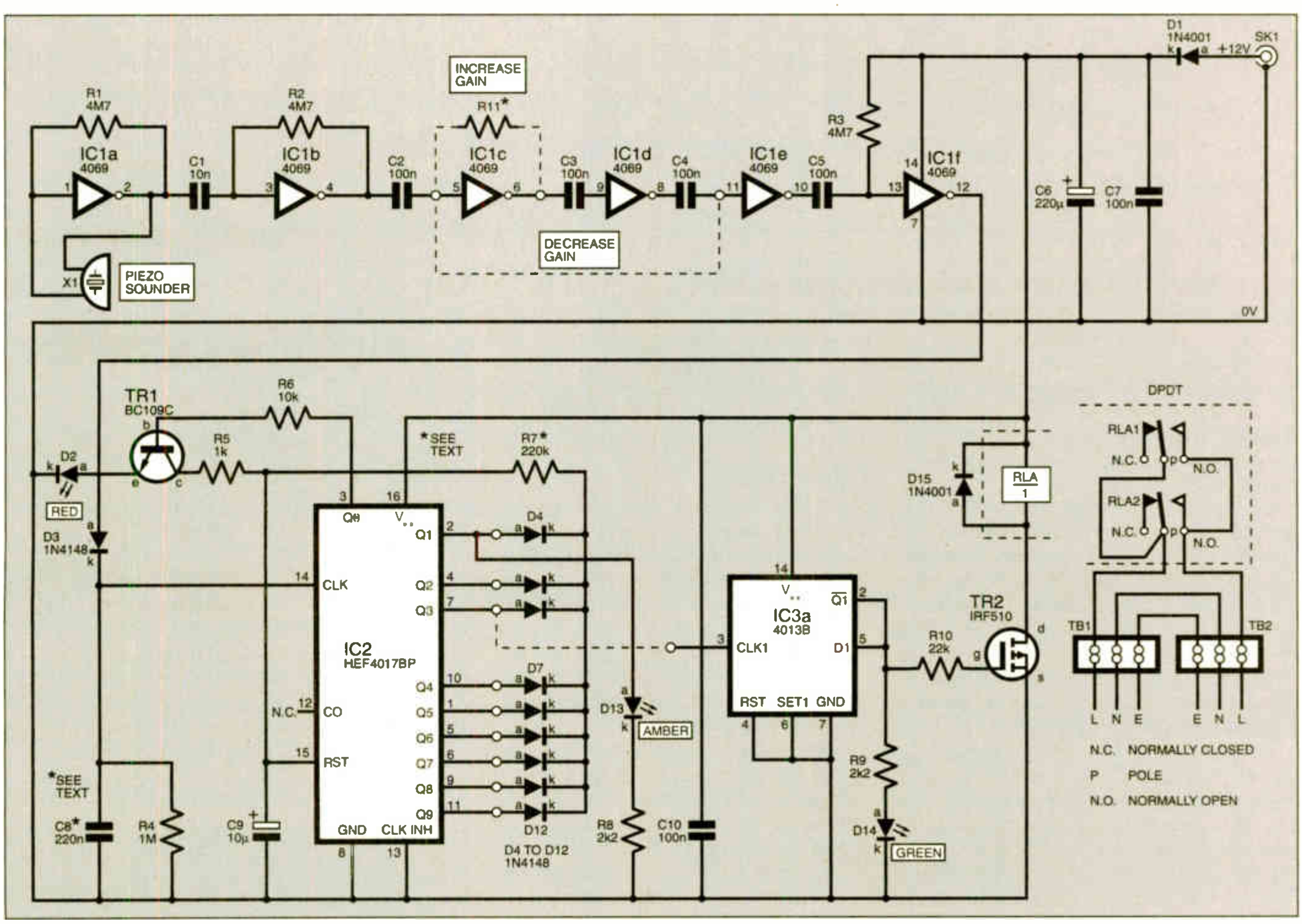


Fig.1. Complete circuit diagram for the Multi-Clap Switch

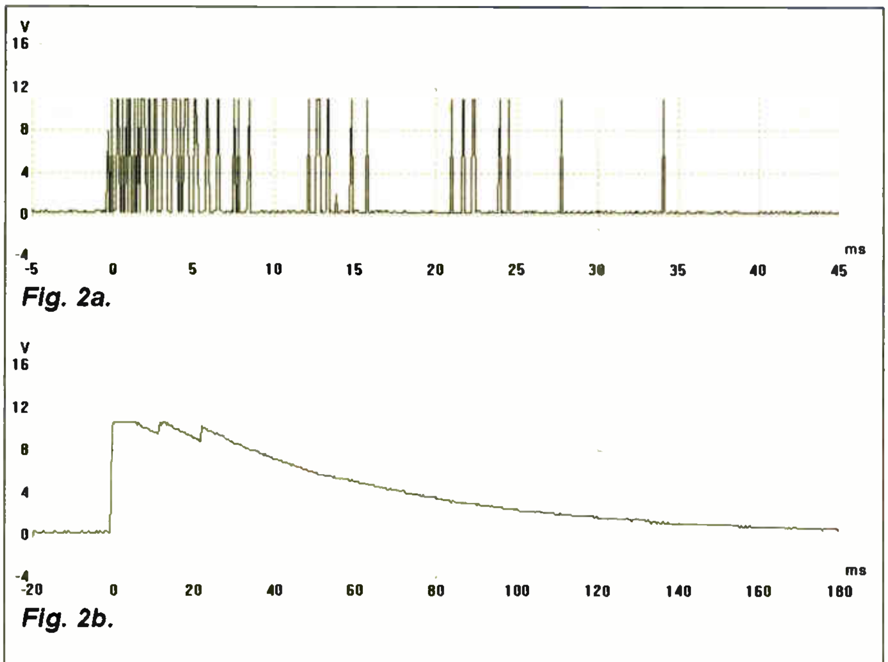


Fig.2. Oscilloscope traces showing the multiple event (a) and combining the multiple waveform into a single pulse (b)

will switch several amps of power directly – on condition that diode D1 in the positive power line is suitably rated, and that back-e.m.f. remains within acceptable limits. Diode D15's purpose is to inhibit such back-e.m.f. pulses.

The circuit draws nearly 20mA on standby, with the result that it ideally requires a mains-to-d.c. power supply. This would likely be necessary anyway, since a clap switch usually sees continual service. Since this is a sensitive audio circuit, a quality plug-pack is required. A sub-standard plug-pack may create ripple which the circuit interprets as sound, thus causing it to reset as described earlier.

Transformation

The circuit shown in Fig.1 switches the relay either on or off with three brisk claps – but not too brisk, and not too slow. As shown, it allows a good margin of freedom, with the result that the switch is not difficult to use.

Three l.e.d.s are provided on the p.c.b. to give a visual readout as to what is happening inside the circuit. Without these l.e.d.s, it would be an awkward exercise to estimate what the circuit is "thinking", particularly if modifications are made

Green l.e.d. D14 indicates whether TR2 and the relay are "on" or "off". It therefore changes state at the end of each full sequence of claps, illuminating when relay RLA engages. Red l.e.d. D2 illuminates every time the circuit resets. This is useful to show precisely when a sequence of claps "times-out", and whether the value of R7 needs to be increased to allow more time for a full sequence – or vice versa.

Amber l.e.d. D13 indicates when IC2 output Q1 is high. Thus the very first clap of a sequence causes D13 to illuminate. This extinguishes when the circuit resets, or when a further clap moves the decade counter on to further stages (Q2 to Q9). This l.e.d. is useful in particular for determining whether one is clapping too fast. If so, it will remain illuminated after the first clap, indicating that C8 was unable to discharge before a further clock pulse was received at IC2 pin 14.

Inverter Considerations

All makes of 4069UB i.c. should work in this circuit. However, it was specifically designed around the Philips HEF4069UBP. Since this circuit uses the 4069UB in a less than common situation, the make of i.c. does make a difference. Any i.c. other than the Philips could be found to have a different effect on the circuit, with tweaking being required as described.

Further, the Philips HEF4017BP i.c. is recommended for IC2. The reason for this is that it has clean switching at its outputs. By way of comparison, other makes were found to emit spikes at the outputs as the i.c. was reset to output Q0, with the National Semiconductor i.c. (prefix CD) being the worst offender, and the Motorola (prefix MC) being barely suitable.

However, these i.c.s could be used with a low-pass RC filter at IC3 input pin 3, to kill any spikes. This is a good example of how components may appear on paper to "fit the bill", yet in practice behave unexpectedly.

Construction

If this circuit is intended for controlling a.c. mains powered appliances, it should only be constructed by those who are suitably qualified or supervised, and it must be housed in a metal case, which *must* be earthed.

Component and track layout details for the Multi-Clip Switch are shown in Fig.3. This board is available from the *EPE PCB Service*, code 515.

Since the i.c.s are all CMOS devices, dual-in-line (d.i.l.) sockets are used throughout, and normal antistatic precautions are advised (in particular, discharge your body to earth before handling them).

It needs to be noted that IC1 is used here as a sensitive preamplifier, therefore any unsound joints may disrupt its operation far more easily than would normally be the case. Any trouble-shooting should put this possibility high on the list.

Begin p.c.b. assembly by soldering the six link wires. **Note that the link wire situated between terminal blocks TB1 and TB2 needs to be suitably rated for the mains current expected.** Continue assembly in ascending order of component size. Take care that electrolytic capacitors and

COMPONENTS

Resistors — See SHOP TALK page

R1, R2, R3	4M7 (3 off)
R4	1M
R5	1k
R6	10k
R7	220k (see text)
R8, R9	2k2 (2 off)
R10	22k
R11	4M7 (see text)

All 0·25W 5% carbon film or better

Capacitors

C1	10n ceramic disc, 5mm pitch
C2 to C5, C7, C10	100n ceramic disc, 5mm pitch (6 off)
C6	220µ radial elect. 16V
C8	220n ceramic disc, 5mm pitch (see text)
C9	10µ radial elect. 16V

Semiconductors

D1, D15	1N4001 rect. diode (2 off)
D2	red l.e.d.
D3 to D12	1N4148 signal diode (10 off)
D13	amber l.e.d.
D14	green l.e.d.
TR1	BC109C *npn* transistor
TR2	IRF510 or similar *n*-channel power MOSFET
IC1	4069UB (*not* 4069B) hex inverter (see text)
IC2	4017 decade counter
IC3	4013B dual D-type flip-flop

Miscellaneous

RLA	12V relay, contact ratings to suit (see text)
X1	piezo sounder (see text)
SK1	d.c. power socket, panel mounting, to suit power source
TB1, TB2	3-way terminal block, 5mm pitch (2 off)

Printed circuit board, available from the *EPE PCB Service*, code 515; case to suit application (see text); 16-pin d.i.l. socket, 14-pin d.i.l. socket (2 off), 1mm terminal pins; connecting wire; solder, etc.

Approx. Cost Guidance Only **£14** *excl case & power supply* the semiconductors are positioned the correct way round as indicated. Do not insert the i.c.s until the board has been fully checked after completion.

The p.c.b. has been designed for a standard Telecom relay pinout, and such relays should be freely available at up to 60W per set of contacts, 120W total in this design. Select one that is rated for your application and which has the same pinouts. Do not exceed the ratings of the selected relay.

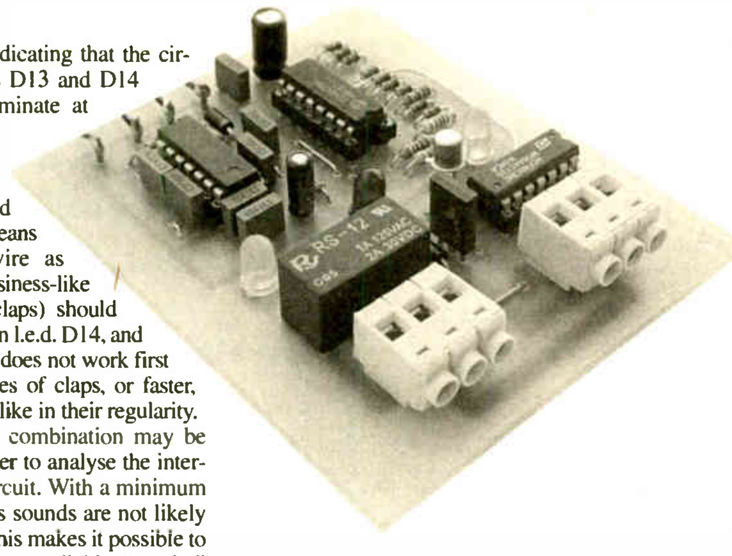
In the prototype the d.c. power socket is a panel-mounting type mounted on the case. The piezo sounder is mounted behind a hole in the case with the help of a little glue. Make sure that the 12V power supply has the correct polarity, although the circuit is protected against reversed polarity by rectifier diode D1.

In Use

Attach a 12V battery or d.c. power supply. Red l.e.d. D2 should illuminate immediately, fading for a moment – then it should again illuminate snappily, indicating that the circuit has reset. L.E.D.s D13 and D14 may or may not illuminate at first.

If the component values shown in Fig.1 are selected, and wired up for three claps by means of the connecting wire as described, a fairly business-like clap-clap-clap (three claps) should change the state of green l.e.d. D14, and switch the relay. If this does not work first time, try a slower series of claps, or faster, making them machine-like in their regularity.

The three l.e.d.s in combination may be used as described earlier to analyse the internal operation of the circuit. With a minimum of three claps, spurious sounds are not likely to trigger the switch. This makes it possible to create a switch that is more reliable, "gentler" to use, and more versatile than the "thug" of a clap switch we have all come to know.



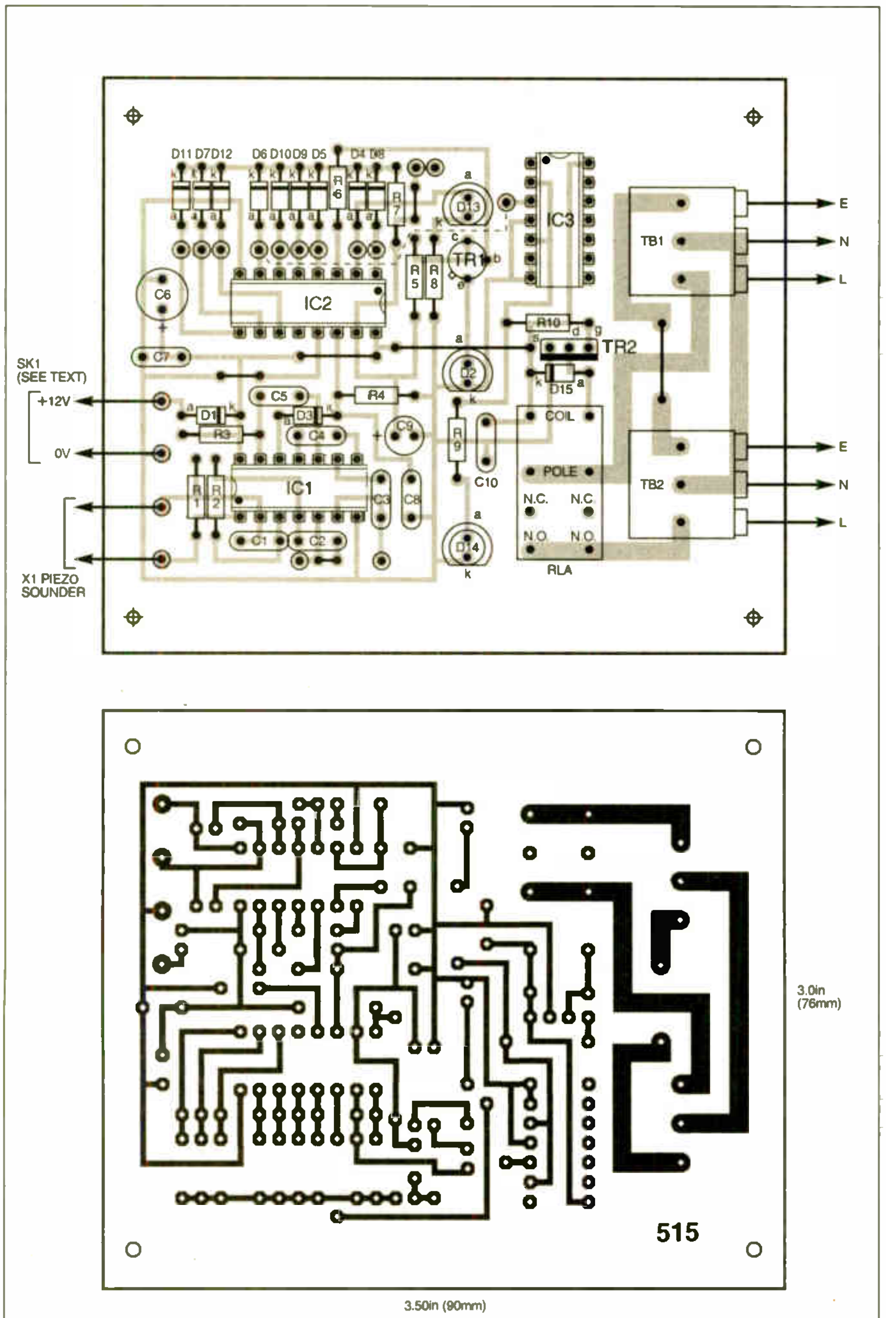


Fig.3. Printed circuit board component layout, wiring details and full size copper foil master for the Multi-Clap Switch. Note the "bridging" link between the Earth tracks

Like the Clappers

In order to change the number of claps in a sequence, the wired connection from IC2 Q3 (pin 7) to IC3 clock input pin 3 can be connected to any of IC2's output stages Q1 to Q9. Terminal holes in the p.c.b. are provided for this purpose.

As an example, for a full nine claps, the wired connection would be moved to IC2 Q9. Note that if the sequence of claps is lengthened like this, the value of the "time-out" resistor R7 will need to be increased, to allow more time to complete the sequence – and vice versa. Again, the red "time-out" l.e.d. D2 will assist in selecting the correct value for R7.

On the other hand, the required pause between claps is set by the value of C8. If this is increased to, say, 1μF, the circuit will require very slow claps to sequence decade counter IC2. By balancing the values of R7 and C8, one may set such tight "margins" for the circuit that no untrained person should be able to trigger it.

The component most likely to require adjustment is R7, therefore holes are provided on the p.c.b. for a multiturn preset potentiometer to replace R7 if desired.

A 1MΩ preset potentiometer should suffice for a sequence of one to nine claps, unless the sequence should be particularly slow. Note that the photographs differ slightly from the final layout in Fig.3. Once the preset has been adjusted as preferred, the value of C8 may be increased if desired, to make the timing of the claps more stringent. Alternatively, begin by selecting a value for C8, then adjust the value of R7.

If desired, and you are prepared to modify the p.c.b., the total number of claps could be doubled, to a maximum of 18. This could be done by incorporating the spare D-type flip-flop IC3b between IC2 and IC3a. This would require a second series of claps to trigger the switch – say nine claps, then time-out, then a further nine claps.

In this case, the chosen output of IC2 would be taken to IC3b clock input pin 11. IC3b pins 8 and 10 would be taken to 0V, and pins 9 and 12 would serve as the output, to be taken to IC3a clock input pin 3.

Finally, the possibility exists for triggering an alarm if the circuit should be presented with a wrong sequence of claps. This was not included in the circuit, for the reason that it would make it intolerant to spurious sounds, and would also require a good many more components. □

PIC N' MIX

ANDREW JARVIS

Our periodic column for your PIC programming enlightenment

Code Reuse with Application Wizardry

QUITE often you'll write the same code over and over, or at least do a "cut-and-paste" job on the best bits. Be honest, how many times have you lifted l.c.d. initialisation or delay routines from one file to another? This isn't exactly what the software engineers mean by code reuse, but I guess it gets the job done in the short term.

Librarian Link

For MPLAB users at least, there are some more structured alternatives to the paste buffer. The MPLINK object linker and MPLIB object librarian combine to make the job of maintaining reusable code modules much easier. Using these you can write your favourite routines in their own easy to manage **.ASM** or **.C** file, then arrange them into neat little functional groups like "math" or "delay" or whatever else they represent, to be used whenever your latest program demands. The beauty is that you write and test once, but use many times.

Put simply, the linker (MPLINK) combines code that is generated from multiple assembler (or "C" compiler) output files into a single hex file. The librarian (MPLIB) makes it easy to group together many such related files into one "library" that conveys greater meaning.

For example you might choose to implement the l.c.d. code in a couple of separate files, say **lcd_init.asm**, and **lcd_generic.asm**, and from there create an overall library called **lcd.lib**. Anytime you want to use an l.c.d. routine you would simply "link" your library and let the software figure which bits it needs to make the program work.

Of course it's not quite so straightforward in practice. To benefit from these tools you need to think about writing relocatable code and understanding linker scripts. If this interests you, MPLINK and MPLIB are a part of the free MPLAB IDE download, available from the Microchip website (**www.microchip.com**), version 7.10 at the time of writing.

There is no linker or librarian with *EPE Toolkit TK3*, but you can still use it in conjunction with MPLAB by taking the final hex file produced by the linker and choosing the "Send Hex" feature to program the PIC.

Application Maestro

Sitting somewhere between the cut-and-paste job and the linker/librarian ideal is Application Maestro, another free download from Microchip. This tool is effectively a code generator that lets you configure "pre-written" code supplied (and tested I guess) by Microchip. You then include it into your own projects, rather like the component gallery or application wizards you might find with PC development using Microsoft Visual Studio, for example. However, instead of dealing with windows controls, Application Maestro includes modules for USART, I²C, CAN and l.e.d.s amongst many others.

Each module is accompanied by a **readme** file that describes in detail the functions that are available to you and how to use them in a project. When you choose to generate the code, you also get example test code to demonstrate its use in addition to the implementation files that you need to include in the project. Depending on the module you choose, you can get either **.ASM** or **.C** files produced.

Using the software is straightforward enough. Fig.1 shows Application Maestro after launching from the desktop. As can be seen, it is a standalone program with a simple interface that does not integrate with the MPLAB IDE.

should make it possible to get something on-screen fairly quickly.

Ground Rules

Reading the documentation for XLCD, a few important ground rules for compatibility with the *TK3* l.c.d. interface are pleasingly confirmed. The first is support for the 4-bit interface and choice of upper or lower nibble. *TK3* hardware uses RB0 to RB3. Second is the ability to choose any port and pin for data transfer and control signals. *TK3* hardware uses PORTB. Next is the ability to choose whether to use delay functions or wait for busy flags to be cleared between commands. *TK3* has to use delay functions because it cannot read from the l.c.d. via its hardware.

Finally, there is a facility to ground the R/W pin where read is not required. The *TK3* l.c.d. header has the R/W connection tied to ground – which is why reads are not possible. (Interestingly, the Magenta board differs slightly here. It uses a pull down resistor, which is easy to remove and adapt if you wanted read ability).

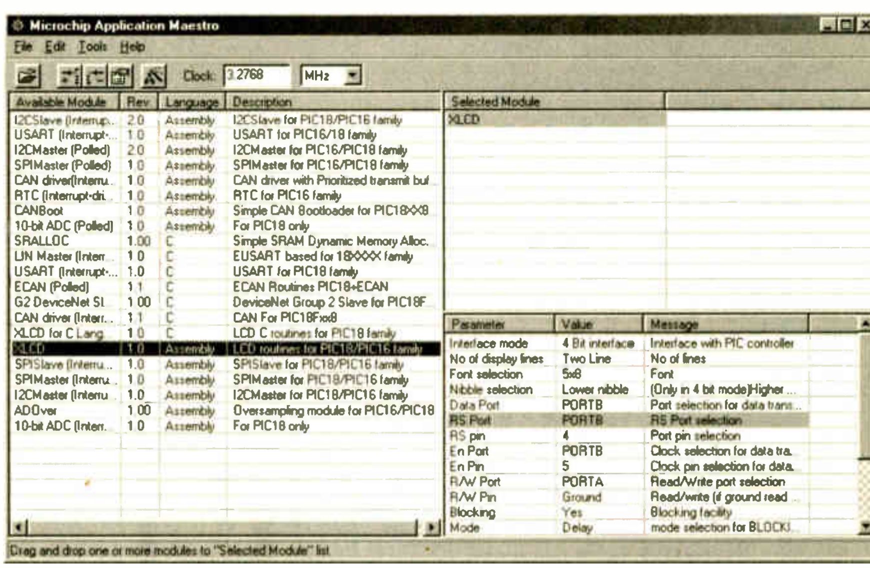


Fig.1. Microchip's Application Maestro software. Available modules are shown on the left, configuration parameters for the selected XLCD module on the right.

Modules are chosen from the "available" list on the left of the screen, then dragged into the "selected" list on the right. Selected modules can then be configured to your own requirements before the code is generated for you.

Continuing the l.c.d. theme, The XLCD (external l.c.d.) module was chosen for a quick look to see how easy this all really is. Using *EPE Toolkit TK3* as the programmer (on permanent standby next to the PC!), and MPLAB to assemble the module,

Note these hardware caveat's are only relevant if you are specifically using the l.c.d. header on the *TK3* board. You can of course program your PIC in-circuit as an alternative and wire up the display however you want.

The XLCD documentation goes on to describe what functions are available to optimise development effort, and they all look pretty self explanatory – for example XLCDInit, XLCDClear and mXLCD SendMessage (m for macro).

The screen shot in Fig.1 shows the XLCD module selected and ready for configuration. *TK3* l.c.d. users should choose the following:

Interface mode:	4-bit interface
Nibble selection:	lower nibble
Data Port:	PORTB
RS Port:	PORTB
RS Pin:	4
En Port:	PORTB
En Pin:	5
R/W Pin	ground
Mode	delay

The defaults should be fine for the rest of the configuration options (like number of lines, cursor status, blink etc). Before generating any code, be sure to set the clock to whatever value you are using. Fig.1 shows that mine happened to be 3.2768MHz, for a PIC16F877.

Interestingly, Microchip haven't provided a way to store preferred module settings, which means that every time you start Application Maestro you have to re-enter the *TK3* options.

Listing 1 shows the test code that was quickly put together to use the XLCD module. Apart from the "usual" initialisation of PORTB, the important bits are the addition of the **include** file for the XLCD module and the calls to the "free" code we generated. **XLCDInit** initialises the l.c.d. using the configuration options selected in the Application Maestro software, and **mXLCDSendMsg** is a macro that displays the string stored in program memory.

The "code" directives are used by MPASM to determine the beginning of program sections for relocatable code, which is what Application Maestro produces – when the project was built using MPLAB, it was necessary to include a standard linker script for the 16F877.

That was all it took to create some easy to use l.c.d. code. It's more convenient than looking through source code archives for relevant bits and pieces, but it would still have to be done all over again next time.

LISTING 1

```
list p=PIC16f877,f=INHX32,r=hex
        #include <p16f877.inc>
        #include <xlcd.inc>
        __CONFIG h'3F31'

origin  code    0x0
        goto    start
begin   code
start
        banksel TRISB
        clrf TRISB
        banksel PORTB
        clrf PORTB
        pagesel XLCDInit
        call XLCDInit
        mXLCDSendMsg hello
main    goto main

hello   dt "Hello World",0

        end
```

SHOP TALK

with David Barrington

Cybervox

For those readers unable to program their own PIC18F252 PIC microcontroller for the *Cybervox* project, a fully programmed chip can be purchased from **Magenta Electronics** ***(☎ 02083 565435*** or ***www.magenta2000.co.uk)*** for the inclusive price of £10 each (overseas add £1 for p&p). The software, including source code files, is available on a 3.5in. PC-compatible disk (Disk 8) from the EPE Editorial Office for a sum of £3 each (UK), to cover admin costs (for overseas charges see page 517). The software is also available for free download via the Downloads link on our website at **www.epemag.co.uk.**

The 8-bit digital-to-analogue converter type TLC7524 was originally purchased from **RS Components** and can be ordered directly (credit card only) from them at ***☎. 01536 444079*** or ***rswww.com***, code 650-087. It can also be ordered locally through any *bona-fide* RS stockist.

The 8-pin L272 dual power amp i.c. is currently listed by **Squires** ***(☎ 01243 842424*** or ***www.squirestools.com)***, their order code 750-140. The rest of the semiconductor devices should be readily available. The author purchased his components through RS.

A suitable miniature electret microphone insert should be stocked by most of our component advertisers. The Cybervox printed circuit board is available from the *EPE PCB Service*, code 514 (see page 517). We believe **Quasar** (see page 452) may produce a kit for this project if there is sufficient interest.

LF/VLF Converter

If you wish to use the Toko CANTA350EK coil mentioned in the LF/VLF Converter article, instead of winding your own, it can be obtained from **JAB Electronic Components** ***(☎ 0121 682 7045*** or ***www.jabdog.com)*** mail order only. They are also able to supply small quantities of enamelled copper wire.

The polyvaricon (polythene dielectric) variable capacitor will normally be found listed as a "transistor radio" type and consists of antenna and oscillator sections, plus trimmers. They are currently stocked by **ESR Components** ***(☎ 0191 251 4363*** or ***www.esr.co.uk)***, code 896-110 and **Sherwood Electronics** (see page 520), code CT9. The tuning capacitor used in the model came from **Maplin** ***(☎ 0870 264 6000*** or ***www.maplin.co.uk)***, code AB11M.

The printed circuit boards are available from the *EPE PCB Service*, codes 508 (Switch/Cap), 509 (Mix/Osc), 510 (Buff Amp), 511 (Q-Multi) and 406 (Tune Cap – optional).

Multi-Clap Switch

Apart from the author's comments highlighting that you must use an unbuffered (UB) 4069UB hex inverter i.c. for the *Multi-Clap Switch* project, we do not expect any component buying problems to be encountered. However, you should checkout the relay contact pinout arrangement and rating before you purchase this item. It may not fit directly on the p.c.b. and the alternative is to "hard wire" it to the board.

The printed circuit board is available from the *EPE PCB Service*, code 515 (see page 517).

Back to Basics – Part 4 Doorchime/Electronic Dice

Looking through the component lists that make up the *Doorchime* and *Electronic Dice*, this month's *Back to Basics* projects, we cannot see any items that may cause local sourcing problems. The miniature (40mm to around 66mm diameter) Mylar cone loudspeaker seems to be the most popular one stocked by our components advertisers. The two printed circuit boards are available from the *EPE PCB Service*, codes 512 (Doorchime) and 513 (Dice).

PLEASE TAKE NOTE

Crossword Solver *(May 05)*
In Fig.1, page 317, J3-1 should connect to l.c.d pin 5 (R/W) and J3-2 to l.c.d. pin 6 (E).

Back to Basics – Pt 4 Scarecrow *(June 05)*
Pages 431/432, Fig 3.1 and Fig 3.2. The drain (d) and source (s) notations of TR2 and TR4 should be swapped over (the orientation of the transistors on the p.c.b. should be rotated accordingly).

Product Reveiw

Discovering PICs Reviewed

Robert Penfold

Robert takes a look at a basic introduction to PIC project building and programming

AS the title of this educational material indicates, it is designed to help the user make a start with designing gadgets based on PIC processors. *Discovering PICs* is available as a book and CD-ROM, or as a complete package that includes a hardware kit that enables the user to gain some "hands-on" experience with PICs. The *Discovering PICs* book is at the heart of the system and it therefore makes sense to start with this.

The book has 190 ring-bound A4 size (297 by 210 millimetres) pages. Where appropriate, colour is used for diagrams, tables, and charts. The paper and print quality are quite good, everything is laid professionally, and good use is made of the large page size. In general, it is all clear and easy to follow even if, like me, your eyesight is "not as good as it used to be".

Discovering PICs is aimed at beginners, and it therefore starts at quite a low level. No knowledge of microcontrollers or programming is assumed, but some knowledge of electronics would be a definite asset. The first chapter covers the basic concept of a microcontroller, the fundamentals of a PIC based circuit, and using the MPLAB program. There is no PIC programmer included in the system, so MPLAB together with PICSTART Plus or a similar unit will be needed if the user wishes to "blow" programs into a PIC processor.

Further chapters introduce binary, the basic building blocks of digital circuits and the architecture of a simple microprocessor. Things then become more PIC-specific, with chapters covering PIC architecture, the instruction set, the PIC memory map, and the special registers. The PIC processor used as the basis of practical examples is the PIC16F627. However, the PICs are RISC processors that are based on what is essentially the same set of thirty or so instructions. Having learnt about the PIC16F627 processor it should be reasonably painless to move on to other PIC processors.

Real World Programming

With the fundamentals out of the way, at Chapter 7 the topics of real-world programming and PIC circuits are introduced. The suggested method of programming follows along conventional lines with a flowchart being produced first, with code then being produced for each segment of the program. The examples use the MPLAB assembler and the MPSIM simulator. Instructions for programming PIC chips are included. An MPLAB compatible programmer is needed in order to do this.

Four simple projects are covered in chapters 8 to 11, and these are an electronic dice, a wavy wand, a games timer, and a pulse monitor. There are printed circuit designs for the finished projects, but there are also solderless breadboard layouts along the way so that users can try out various ideas that are used in the final designs. Of course, it is not essential to actually build any of the designs or to try any of the experiments. However, it would be advisable to do so in order to gain the maximum benefit from the book.

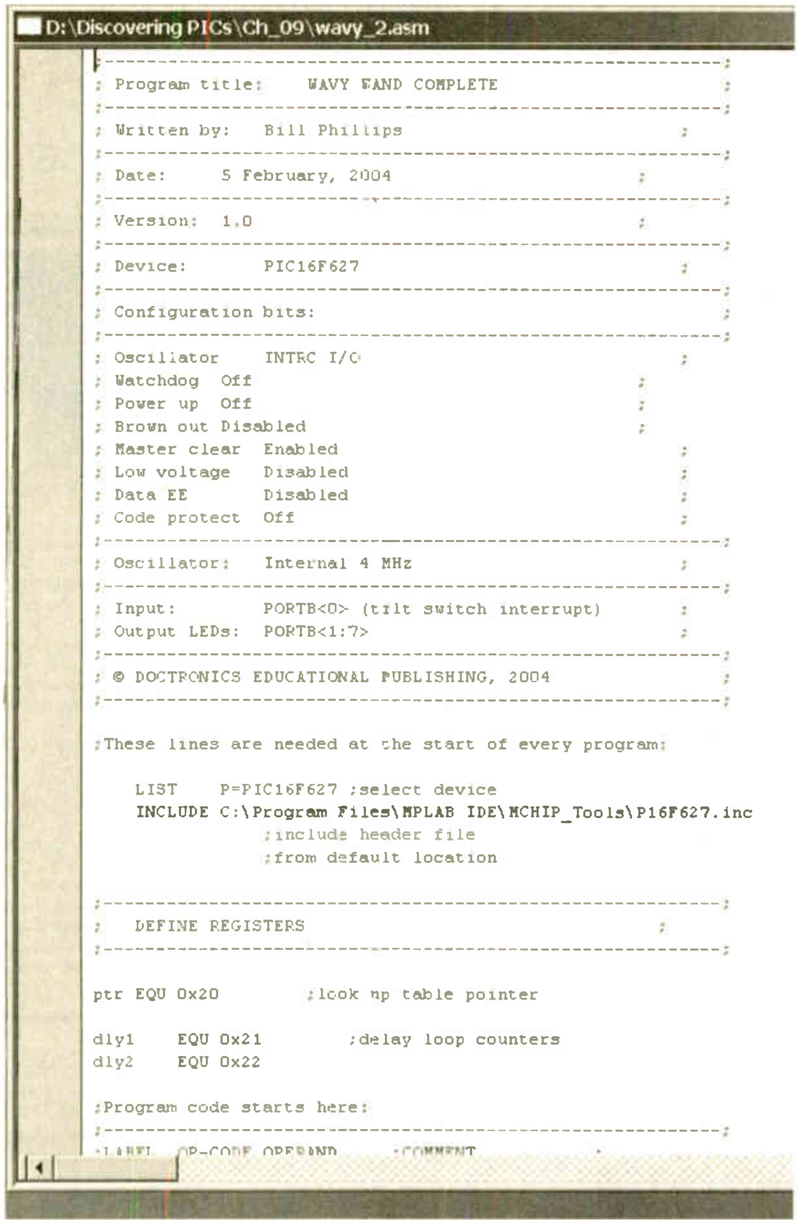
The short final chapter has advice on how to go it alone, sources of further information, and other helpful advice. It is a pity that there is no index, and the Contents section at the beginning of the book only lists the chapters. Sub-headings within chapters do not get a mention here. This can make it time consuming to look up specific topics, although the logical layout of the book should help.

The Discovering PICs book, CD-ROM and Wavy Wand kit

CD-ROM

The CD-ROM is a CD-R disc that my PCs had no problems in reading. The CD-ROM will auto-run under Windows XP, but it is otherwise a matter of running the index page in a browser or Windows Explorer. Either way, the initial page is obtained. This explains what is on the disc and how the contents can be accessed. I was expecting the CD-ROM to have some interactive content, which seems to be the norm these days. However, it contains no interactive material and its sole purpose is to provide support files for the book.

The contents include the entire book in the form of a PDF file for each chapter. PDF files can be read using the free Adobe Acrobat Reader program. Most PC users probably have this program already, but for the benefit of those that do not it is included on the disc. All the programs covered in the book are included on the disc as assembler (ASM) files that can be loaded into MPLAB, as in the example of Fig.1. This clearly makes life much easier for those wishing to "blow" the programs into a PIC processor, build and simulate them in MPSIM, or simply experiment with and modify the programs.




```
;-----------------------------------------------------------;
; Program title:    WAVY WAND COMPLETE                      ;
;-----------------------------------------------------------;
; Written by:   Bill Phillips                            ;
;-----------------------------------------------------------;
; Date:      5 February, 2004                        ;
;-----------------------------------------------------------;
; Version:   1.0                                     ;
;-----------------------------------------------------------;
; Device:        PIC16F627                               ;
;-----------------------------------------------------------;
; Configuration bits:                                       ;
;-----------------------------------------------------------;
; Oscillator     INTRC I/O                               ;
; Watchdog  Off                                      ;
; Power up  Off                                      ;
; Brown out Disabled                                 ;
; Master clear   Enabled                                 ;
; Low voltage    Disabled                                ;
; Data EE        Disabled                                ;
; Code protect   Off                                     ;
;-----------------------------------------------------------;
; Oscillator:    Internal 4 MHz                          ;
;-----------------------------------------------------------;
; Input:         PORTB<0> (tilt switch interrupt)        ;
; Output LEDs:   PORTB<1:7>                              ;
;-----------------------------------------------------------;
; © DOCTRONICS EDUCATIONAL PUBLISHING, 2004                 ;
;-----------------------------------------------------------;

;These lines are needed at the start of every program:

    LIST     P=PIC16F627 ;select device
    INCLUDE C:\Program Files\MPLAB IDE\MCHIP_Tools\P16F627.inc
                    ;include header file
                    ;from default location

;-----------------------------------------------------------;
;   DEFINE REGISTERS                                     ;
;-----------------------------------------------------------;

ptr EQU 0x20        ;look up table pointer

dly1    EQU 0x21        ;delay loop counters
dly2    EQU 0x22

;Program code starts here:
;-----------------------------------------------------------;
;LABEL  OP-CODE OPERAND     ;COMMENT
```

Fig. 1 Header code for the Wavy Wand program

Last and by no means least, the CD-ROM has a folder that contains two versions of the MPLAB program, plus the instruction manuals in PDF format. There are also ten PDF data sheets for PIC processors, but most of these cover a family of PIC chips rather than a single device, so a fair range of devices are covered. All the contents of this folder are available as free downloads from the Internet, but it is clearly much more convenient to have it all included on the CD-ROM. The Acrobat Reader program makes it easy to print out individual pages or complete data sheets via any Windows compatible printer.

The Hardware

The hardware kit makes up into a device the designer calls the "Wavy Wand", which is the project featured in Chapter 9 of the book. Projects of this type have been featured in the pages of *EPE*, and the idea is that the wand spells out a word or short message via a line of l.e.d.s when it is waved through the air. It is switched on automatically by a tilt switch when it is moved through the air. The PIC has to flash each of the seven l.e.d.s in the appropriate sequence in order to produce the correct series of letters.

The kit is supplied with a pre-programmed PIC16F627A chip, so it is not necessary to have a PIC programmer in order to successfully complete the project. Of course, a programmer is required in order to reprogram the chip and produce your own message. The printed circuit board is tough and nicely made. There is no component overlay, but with a project as simple as this it is still quite easy to get everything fitted in the right place.

An instruction leaflet is included with the kit, and using this is handier than referring to the book for the component layout, etc. No case is included in the kit, but you do not really need one in order to test or use the finished unit. Assembling the kit did not produce any problems, and it worked first time. The Wavy Wand provides an easy introduction to PIC processors, but in order to get the most out of it you really need a programmer so that you can "do your own thing" with the message.

Conclusion

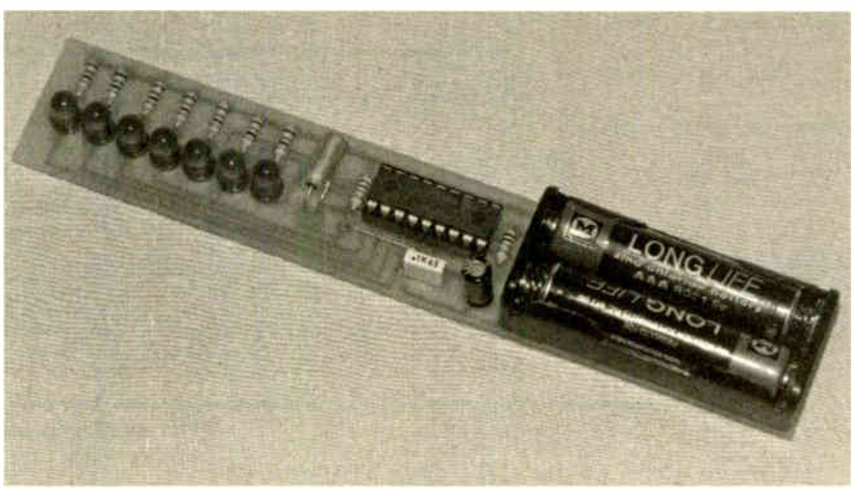
Discovering PICs is certainly a good introduction to PIC microprocessors, with the book and CD-ROM package providing a convenient way of obtaining everything you need to get started. Buying a beginners PIC book and downloading the MPLAB software and data yourself might save a few pounds, but any savings are unlikely to be spectacular. It is essentially a book plus support files. It will be necessary to look elsewhere if you require an interactive CD-ROM.

This is not a "Teach Yourself Everything About PICs in 30 minutes" type of book, and only the basics of PIC programming are covered. However, covering the basics well is a better approach than trying to cover too much and doing an inadequate job. Having thoroughly learnt the fundamentals of PICs it should be easy to progress further. No previous knowledge of microcontrollers is required in order to use this book, but some previous experience with electronic circuits would be more than a little useful.

The Wavy Wand kit seems to be well worth the additional cost, and the full package is perhaps the most attractive option. It provides an opportunity for some "hands on" experience with PICs. If you go on to buy a programmer it is then possible to experiment with the supplied program and "do your own thing". You can build and modify the projects at the end of the book, plus those featured in *EPE*. □

Discovering PICs book and CD-ROM £22-00
Discovering PICs complete package £28-50

Both prices include post and packing.
Available from the *Everyday Practical Electronics Direct Book Service* – see page 512
www.epemag.co.uk



The finished Wavy Wand project

EPE IS PLEASED TO BE ABLE TO OFFER YOU THESE

ELECTRONICS CD-ROMS

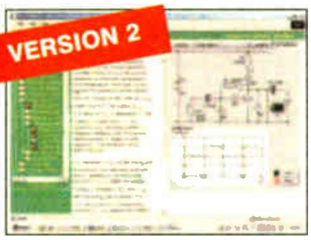
ELECTRONICS PROJECTS

Logic Probe testing

Electronic Projects is split into two main sections: **Building Electronic Projects** contains comprehensive information about the components, tools and techniques used in developing projects from initial concept through to final circuit board production. Extensive use is made of video presentations showing soldering and construction techniques. The second section contains a set of ten projects for students to build, ranging from simple sensor circuits through to power amplifiers. A shareware version of Matrix's CADPACK **schematic capture, circuit simulation** and **p.c.b. design** software is included.
The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

ELECTRONIC CIRCUITS & COMPONENTS V2.0

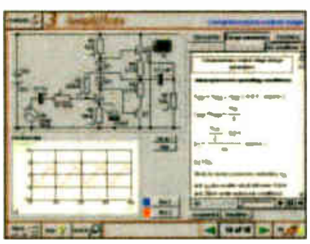
VERSION 2



Circuit simulation screen

Provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Version 2 has been considerably expanded in almost every area following a review of major syllabuses (GCSE, GNVQ, A level and HNC). It also contains both European and American circuit symbols. Sections include: ***Fundamentals:*** units & multiples, electricity, electric circuits, alternating circuits. ***Passive Components:*** resistors, capacitors, inductors, transformers. ***Semiconductors:*** diodes, transistors, op.amps, logic gates. ***Passive Circuits. Active Circuits.*** *The Parts Gallery* will help students to recognise common electronic components and their corresponding symbols in circuit diagrams.
Included in the Institutional Versions are multiple choice questions, exam style questions, fault finding virtual laboratories and investigations/worksheets.

ANALOGUE ELECTRONICS

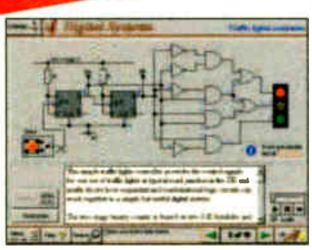


Complimentary output stage

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

DIGITAL ELECTRONICS V2.0

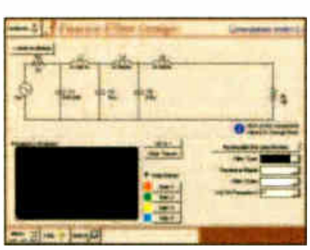
VERSION 2



Virtual laboratory – Traffic Lights

Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.
Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units. Sections on Boolean Logic and Venn diagrams, displays and chip types have been expanded in Version 2 and new sections include shift registers, digital fault finding, programmable logic controllers, and microcontrollers and microprocessors. The Institutional versions now also include several types of assessment for supervisors, including worksheets, multiple choice tests, fault finding exercises and examination questions.

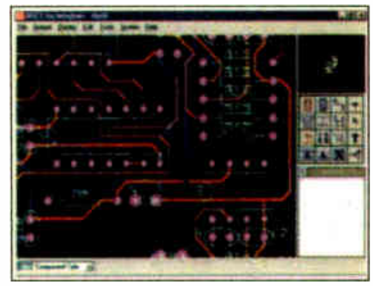
ANALOGUE FILTERS



Filter synthesis

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

ELECTRONICS CAD PACK



PCB Layout

Electronics CADPACK allows users to design complex circuit schematics, to view circuit animations using a unique SPICE-based simulation tool, and to design printed circuit boards. CADPACK is made up of three separate software modules. (These are restricted versions of the full Labcenter software.) **ISIS Lite** which provides full schematic drawing features including full control of drawing appearance, automatic wire routing, and over 6,000 parts. **PROSPICE Lite** (integrated into ISIS Lite) which uses unique animation to show the operation of any circuit with mouse-operated switches, pots. etc. The animation is compiled using a full mixed mode SPICE simulator. **ARES Lite** PCB layout software allows professional quality PCBs to be designed and includes advanced features such as 16-layer boards, SMT components, and an autorouter operating on user generated Net Lists.

ROBOTICS & MECHATRONICS

Case study of the Milford Instruments Spider

Robotics and Mechatronics is designed to enable hobbyists/students with little previous experience of electronics to design and build electromechanical systems. The CD-ROM deals with all aspects of robotics from the control systems used, the transducers available, motors/actuators and the circuits to drive them. Case study material (including the NASA Mars Rover, the Milford Spider and the Furby) is used to show how practical robotic systems are designed. The result is a highly stimulating resource that will make learning, and building robotics and mechatronic systems easier. The Institutional versions have additional worksheets and multiple choice questions.

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

PRICES

Prices for each of the CD-ROMs above are:

(Order form on third page)

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

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

PICmicro TUTORIALS AND PROGRAMMING

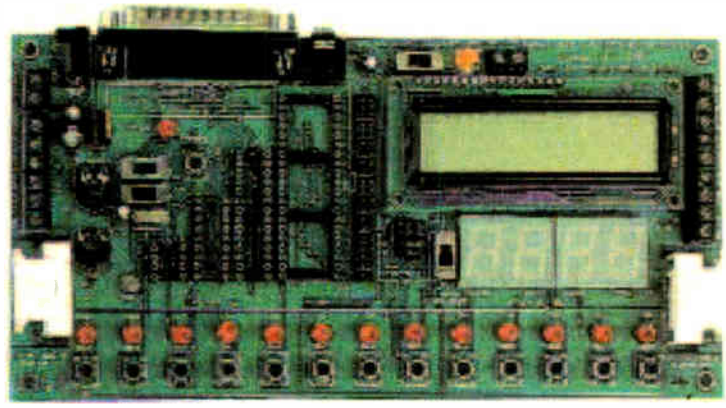
HARDWARE

VERSION 2 PICmicro MCU DEVELOPMENT BOARD

Suitable for use with the three software packages listed below.

This flexible development board allows students to learn both how to program PICmicro microcontrollers as well as program a range of 8, 18, 28 and 40-pin devices. For experienced programmers all programming software is included in the PPP utility that comes with the development board. For those who want to learn, choose one or all of the packages below to use with the Development Board.

- Makes it easier to develop PICmicro projects
- Supports low cost Flash-programmable PICmicro devices
- Fully featured integrated displays – 13 individual l.e.d.s, quad 7-segment display and alphanumeric l.c.d. display
- Supports PICmicro microcontrollers with A/D converters
- Fully protected expansion bus for project work
- All inputs and outputs available on screw terminal connectors for easy connection



£145 including VAT and postage

12V 500mA plug-top PSU (UK plug) £7

25-way 'D' type connecting cable £5

SOFTWARE

Suitable for use with the Development Board shown above.

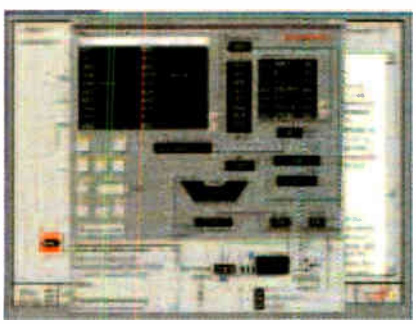
NEW V3

ASSEMBLY FOR PICmicro V3

(Formerly PICtutor)

Assembly for PICmicro microcontrollers V3.0 (previously known as PICtutor) by John Becker contains a complete course in programming the PIC16F84 PICmicro microcontroller from Arizona Microchip. It starts with fundamental concepts and extends up to complex programs including watchdog timers, interrupts and sleep modes. The CD makes use of the latest simulation techniques which provide a superb tool for learning: the Virtual PICmicro microcontroller. This is a simulation tool that allows users to write and execute MPASM assembler code for the PIC16F84 microcontroller on-screen. Using this you can actually see what happens inside the PICmicro MCU as each instruction is executed which enhances understanding.

● Comprehensive instruction through 45 tutorial sections ● Includes Vlab, a Virtual PICmicro microcontroller: a fully functioning simulator ● Tests, exercises and projects covering a wide range of PICmicro MCU applications ● Includes MPLAB assembler ● Visual representation of a PICmicro showing architecture and functions ● Expert system for code entry helps first time users ● Shows data flow and fetch execute cycle and has challenges (washing machine, lift, crossroads etc.) ● Imports MPASM files.



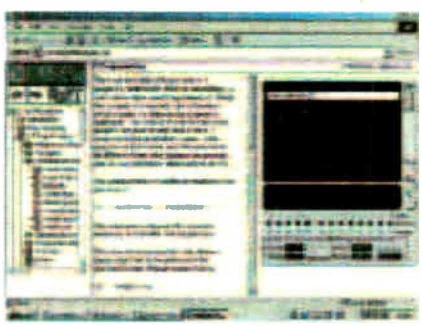
Virtual PICmicro

'C' FOR PICmicro VERSION 2

The C for PICmicro microcontrollers CD-ROM is designed for students and professionals who need to learn how to program embedded microcontrollers in C. The CD contains a course as well as all the software tools needed to create Hex code for a wide range of PICmicro devices – including a full C compiler for a wide range of PICmicro devices.

Although the course focuses on the use of the PICmicro microcontrollers, this CD-ROM will provide a good grounding in C programming for any microcontroller.

● Complete course in C as well as C programming for PICmicro microcontrollers ● Highly interactive course ● Virtual C PICmicro improves understanding ● Includes a C compiler for a wide range of PICmicro devices ● Includes full Integrated Development Environment ● Includes MPLAB software ● Compatible with most PICmicro programmers ● Includes a compiler for all the PICmicro devices.



Minimum system requirements for these items: Pentium PC running Windows 98, NT, 2000, ME, XP; CD-ROM drive; 64MB RAM; 10MB hard disk space.

FLOWCODE FOR PICmicro V2

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

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

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

● Requires no programming experience ● Allows complex PICmicro applications to be designed quickly ● Uses international standard flow chart symbols (ISO5807) ● Full on-screen simulation allows debugging and speeds up the development process ● Facilitates learning via a full suite of demonstration tutorials ● Produces ASM code for a range of 18, 28 and 40-pin devices ● Professional versions include virtual systems (burglar alarm, buggy and maze, plus RS232, IrDa etc.).

Burglar Alarm Simulation

PRICES

Prices for each of the CD-ROMs above are:

(Order form on next page)

Hobbyist/Student	£45 inc VAT
Flowcode V2 Hobbyist/Student	£57 inc VAT
Institutional (Schools/HE/FE/Industry)	£99 *plus* VAT
Flowcode Professional	£99 *plus* VAT
Institutional/Professional 10 user (Network Licence)	£300 *plus* VAT
Site Licence	£599 *plus* VAT

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

TEACH-IN 2000 – LEARN ELECTRONICS WITH EPE

Sine wave relationship values

FREE BOOK WITH TEACH-IN 2000 CD-ROM

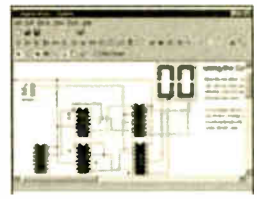
EPE's own *Teach-In* CD-ROM, contains the full 12-part *Teach-In* series by John Becker in PDF form plus the *Teach-In* interactive software (Win 95, 98, ME and above) covering all aspects of the series. We have also added Alan Winstanley's highly acclaimed *Basic Soldering Guide* which is fully illustrated and which also includes *Desoldering*. The *Teach-In* series covers: Colour Codes and Resistors, Capacitors, Potentiometers, Sensor Resistors, Ohm's Law, Diodes and L.E.D.s, Waveforms, Frequency and Time, Logic Gates, Binary and Hex Logic, Op.amps, Comparators, Mixers, Audio and Sensor Amplifiers, Transistors, Transformers and Rectifiers, Voltage Regulation, Integration, Differentiation, 7-segment Displays, L.C.D.s, Digital-to-Analogue. Each part has an associated practical section and the series includes a simple PC interface (Win 95, 98, ME **ONLY**) so you can use your PC as a basic oscilloscope with the various circuits.

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

£12.45 including VAT and postage. Requires Adobe Acrobat (available free from the Internet – **www.adobe.com/acrobat**).

FREE WITH EACH TEACH-IN CD-ROM – *Electronics Hobbyist Compendium* 80-page book by Robert Penfold. Covers Tools For The Job; Component Testing; Oscilloscope Basics.

DIGITAL WORKS 3.0



Counter project

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

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

ELECTRONICS IN CONTROL

Two colourful animated courses for students on one CD-ROM. These cover Key Stage 3 and GCSE syllabuses. **Key Stage 3:** A pictorial look at the Electronics section featuring animations and video clips. Provides an ideal introduction or revision guide, including multi-choice questions with feedback. **GCSE:** Aimed at the Electronics in many Design & Technology courses, it covers many sections of GCSE Electronics. Provides an ideal revision guide with Homework Questions on each chapter. Worked answers with an access code are provided on a special website.

Single User £29 inc. VAT. Multiple User £39 plus VAT
Student copies (available only with a multiple user copy) £6 plus VAT
(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

MODULAR CIRCUIT DESIGN

VERSION 3

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. Version 3 includes data and circuit modules for a range of popular PICs; includes PICAXE circuits, the system which enables a PIC to be programmed without a programmer, and without removing it from the circuit. Shows where to obtain free software downloads to enable BASIC programming.

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.

Single User £19.95 inc. VAT. Multiple User £34 *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

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

CD-ROM ORDER FORM

Please send me:

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

Version required:

- ☐ **Hobbyist/Student**
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- ☐ **Institutional/Professional 10 user**
- ☐ **Site licence**

- ☐ **PICmicro Development Board V2 (hardware)**
- ☐ **Development Board UK plugtop power supply**
- ☐ **Development Board 25-way connecting lead**

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

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ALL PRICES INCLUDE UK POSTAGE

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

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

Net Work

Alan Winstanley

Let's Get Chatting Again!

Regular users of our web site (**www.epemag.co.uk**) will have noticed the re-introduction of the *EPE* Chat Zone message board. Our online forum has been completely rebuilt following an outage of the previous web board which, although it had served readers well in the past, had become a real dinosaur in terms of usability, maintenance, security and reliability.

This month's *Net Work* is devoted to introducing some of the features of the new message board. It can be accessed at the same address as before (using the Chat Zone buttons on the main web site) or you can navigate directly to the new URL at **www.chatzones.co.uk**. I am grateful to Malcolm Wiles for assisting with final testing during April 2005.

The new forum is open to all web users and any visitor can view the messages with a modern web browser. In order to post a message, it is necessary to register using an authentic email address. You can choose your own **Username** (no spaces) and password, noting that the Username is the one thing that cannot be subsequently edited.

Your Username will appear in your messages, and when users click on your Username link, your Profile will be displayed, noting that you can choose as much or as little information as you want to be shown.

After logging in with your Username and password, by clicking the Profile icon you can access your personal settings, and it is worth spending five minutes examining the options available. Your "Real Name" can be anything you like and does not have to be your real-life full name; some users make their Username and Real Name the same (or different). Your *email address* must be a current live address, but it will *not* be available to other users except when you opt to display it in your profile: if you edit your email address, a re-authentication key will be sent to the new address, which will enable your membership to be re-activated. You can choose the level of Additional Personal Information, if any, (e.g. occupation or location) that you want to share with other users.

It is easy to set *Additional E-mail Notification* settings. You can opt to have copies of your messages and any replies emailed to you, though you will need to log in to the forum to post a message. This is a useful way of tracking topics without constantly checking in to the forum. (Also try the "Check New Messages" link near the log-in box and the "Tree View" option.)

The Preferences section of your Profile is worth checking out. Most privacy-related options are already enabled for you by default, including: Do Not Display my real email address, Do Not Display my Profile in the [Member] List and Do Not Send me "Private Message" emails from other board users. The "Private Message" function, where recipients agree to receive them, permits a limited quantity of brief messages to be sent to other Usernames via the Chat Zone's, mail server. There are a number of anti-flood filters and logs built in to help prevent abuse.

You can choose to upload a small Picture (avatar) of no more than 80 pixels, in JPG or GIF format. Lastly, you can change your password or even delete your account, all within the Profile.

Start New Thread

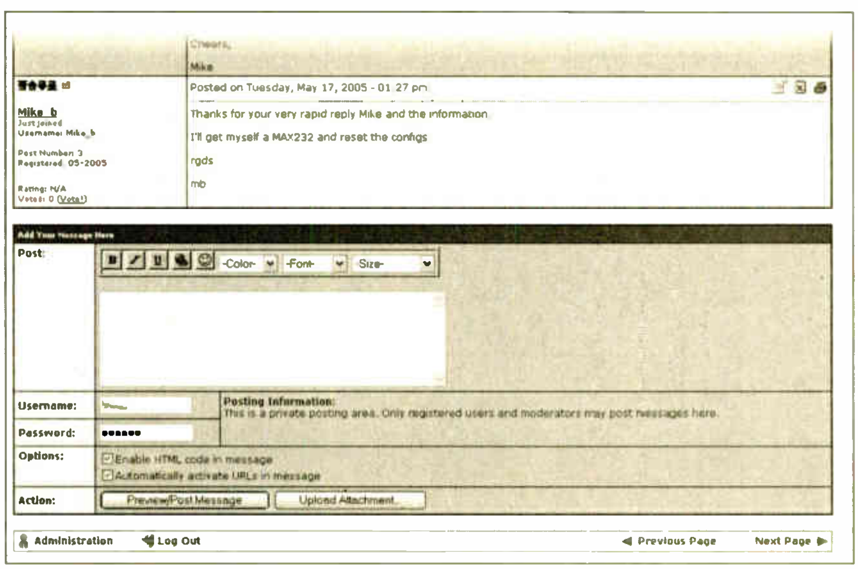
Let's now turn to the posting features of the *EPE* Chat Zone. The way in which threads and messages are displayed is very different from the former CZ. Use the Navigation bar along the top to select either *EPE* Chat Zone or *Radio Bygones* message board. A list of topics is displayed with the newest (or most active) at the top. Latest messages appear in chronological order at the end of the thread. So far, most CZ users appear happy with this arrangement, as the principle of "top posting" is not at all universally liked.

To add your message to the end, simply fill in the message entry box underneath. (It is important to note that if instead you click "Start New Thread" then you are creating a sub-branch off the main thread.) Now there are some interesting new options available to you: you can style your text for size, bold, italics, colour and font. You can add hyperlinks, and you can include inline graphics (e.g. a circuit diagram) with your message. Separate files can be uploaded to the server (max. 30kB) so you can share code, patches and more.

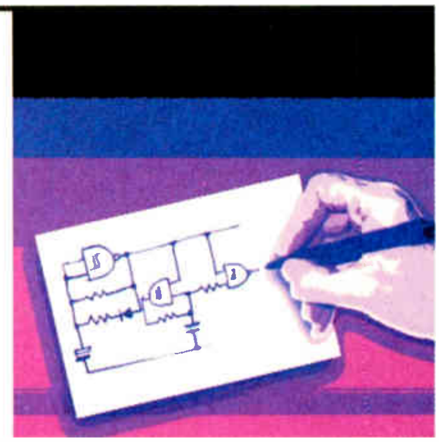
By using exclusive mark-up tags, you can format your message in many ways, as one reason for selecting this forum software was its ability to cater for scientific and technical notation. Special characters, tables, lists, Greek and mathematical equations can also be formatted. Details of the formatting codes are contained in the formatting guide, located under the Help button.

Most importantly, you can (and you have to) **Preview** your message before Posting it. After that, you have five minutes to delete a post, and up to 30 minutes to edit it again before it is permanently posted. No self-respecting forum is complete without emoticons (smileys), and I have included a range of smileys and small graphics for you to brighten up your messages (having fun is allowed, after all!). As another feature, older posts are automatically archived and will appear in special archive links at the bottom of the forum.

So that you can experiment a little, a Test Area enables you to Start a New thread and try some of the features available. So log on now to **www.chatzones.co.uk** – we look forward to seeing you there!



Back to Basics – CMOS Logic Devices



Bart Trepak

Part 4 – Doorchime and Electronic Dice

This short series of articles illustrates how useful circuits can be designed simply using CMOS logic devices as the active components

THE days when a simple door knocker or bell was used to signal the arrival of a visitor to our door has seemingly long gone. Nowadays, microprocessor controlled tune generators which can play dozens of different tunes are common.

This simple circuit is less versatile, playing only nine notes, but can still be programmed to generate the *Westminster Chimes*, or even your own composition which is probably not yet available already programmed into a commercial doorchime!

Unlike commercial doorchimes, the notes are not stored digitally in a memory but are tuned individually by nine preset resistors so that any sequence of notes can be played. This makes it easy to change the tune when the current one becomes boring, and even the latest top ten hit could be preset – or at least the first nine notes of it.

Circuit Diagram

The complete circuit diagram for the Doorchime is shown in Fig.4.1.

The tone generating oscillator is formed around Schmitt trigger NAND gate IC1c, which has its basic frequency set by capacitor C3 in conjunction with the current flowing into it via resistor R4. This is determined by which resistor/diode path is selected by a particular output of decade counter IC2.

Counter Trigger

The counter is triggered by the oscillator formed around Schmitt trigger NAND gate IC1a, The oscillation frequency is set by capacitor C1 and resistor R1. The output frequency is fed to the counter's clock enable (CE) input. Note that in this circuit the normal clock input (CLK) is tied high to the positive rail (see later).

When the bellpush, switch S1, is pressed, a positive-going pulse is developed across resistor R2 and capacitor C2, resetting the counter. Once the pulse has ended, the counter starts to respond to the incoming pulses from IC1a, its outputs in turn going high and then low on successive pulses.

To the counter outputs, preset potentiometers VR1 to VR9 are connected as variable resistors, and are used in series with diodes D1 to D9. As each counter output is triggered in sequence, a different note is generated, depending on the value of the resistance set by the respective preset resistor. The diodes prevent the low outputs from affecting the high output path.

Capacitor C3 is charged via the preset resistor, but discharged into IC1c's output pin 4 via resistor R5 and diode D10. The diode ensures that C3's charging time is independent of the value of R5. The output of IC1c therefore spends a fixed time in the low state (while C3 discharges through R5 and D10 from the upper to the lower input threshold voltage), but a varying time, depending on the value of the selected preset and R4, in the high state.

Thus, although the output mark space ratio is not equal (which is not important in this application), the total charge-discharge period, and hence the resultant frequency, will change depending on the value of the preset resistor.

Audio frequencies output from the tone oscillator are fed via buffer resistor R6 to the base (b) of *pnp* transistor TR1, which activates audio sounder WD1. With the prototype, the output is loud enough to be heard in an average sized house and no further amplifier was required.

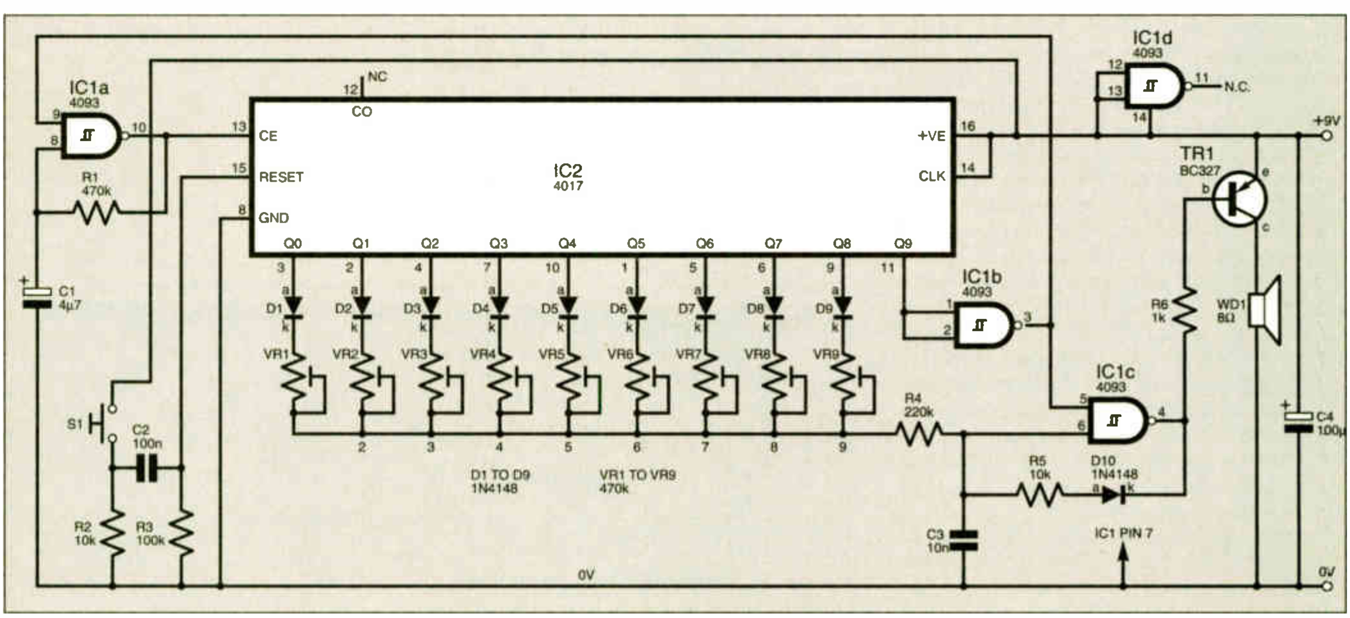


Fig.4.1. Complete circuit diagram for the Doorchime. Note IC1d is not used

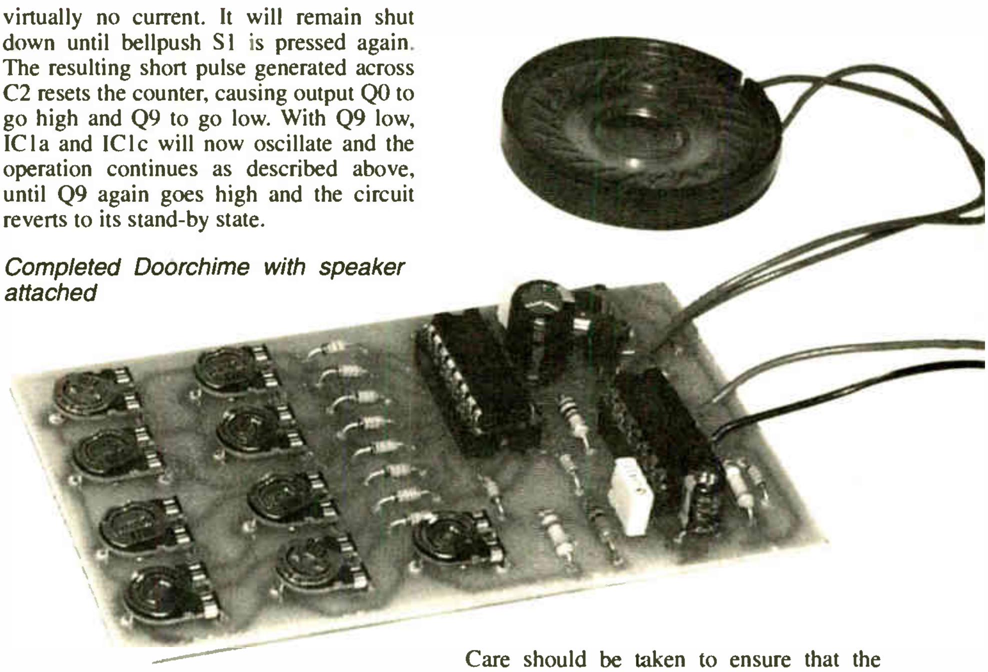
As this transistor only switches on for short periods and, despite the low impedance of the load, its dissipation was low enough in the prototype that a heatsink was not required.

When counter output Q9 eventually goes high, this causes the output of inverting gate IC1b to go low, forcing the outputs of IC1a and IC1c to go high, stopping them oscillating. Transistor TR1 is therefore switched off and, since IC1a no longer oscillates, the counter will not be advanced further, causing Q9 to remain high.

Note that since the output of IC1a is forced high at this time, it is important in this circuit that the counter is advanced by a negative-going pulse, rather than a positive-going one, as would normally be the case in other applications. This prevents the final transition from being counted. Hence the counter's CE (clock enable) pin is used to advance the counter instead of the more usual CLK (clock input) pin.

After the last note has been played, the circuit effectively shuts down and draws virtually no current. It will remain shut down until bellpush S1 is pressed again. The resulting short pulse generated across C2 resets the counter, causing output Q0 to go high and Q9 to go low. With Q9 low, IC1a and IC1c will now oscillate and the operation continues as described above, until Q9 again goes high and the circuit reverts to its stand-by state.

Completed Doorchime with speaker attached



COMPONENTS

DOORCHIME

Resistors

R1	470k	See
R2, R5	10k (2 off)	SHOP
R3	100k	TALK
R4	220k	page
R6	1k	

All 0·25W 5% carbon film or better

Potentiometers

VR1 to VR9 — 470k open skeleton preset (9 off)

Capacitors

C1	4µ7 radial elect. 16V
C2	100n polyester or ceramic
C3	10n polyester or ceramic
C4	100µ radial elect. 16V

Semiconductors

D1 to D10	1N4148 signal diode (10 off)
TR1	BC327 *pnp* transistor
IC1	4093 quad Schmitt trigger NAND gate
IC2	4017 decade counter

Miscellaneous

S1	push-to-make switch (see text)
WD1	min. 8 ohm loudspeaker

Printed circuit board, available from the *EPE PCB Service*, code 512; 14-pin d.i.l. socket; 16-pin d.i.l. socket; plastic case of choice; PP3 battery and clip; connecting wire; solder, etc.

Approx. Cost Guidance Only **£12** *excl speaker, case & batts*

Construction

The printed circuit board and track layout details for the Doorchime are shown in Fig.4.2. This board is available from the *EPE PCB Service*, code 512.

In common with all the circuits in this series, low profile components such as resistors and diodes should be fitted and soldered in position first before fitting components such as capacitors and transistors.

Care should be taken to ensure that the diodes, transistor and electrolytic capacitors (C1 and C4) are fitted the correct way around before they are soldered.

This also applies to IC1 and IC2, for which sockets should be used. Only insert the i.c.s. after all of the other components have been soldered and the assembly checked for accuracy.

As usual with CMOS i.c.s, precautions should be taken to avoid damaging them by static electricity discharge. Touch an earthed metal item (such as a central heating

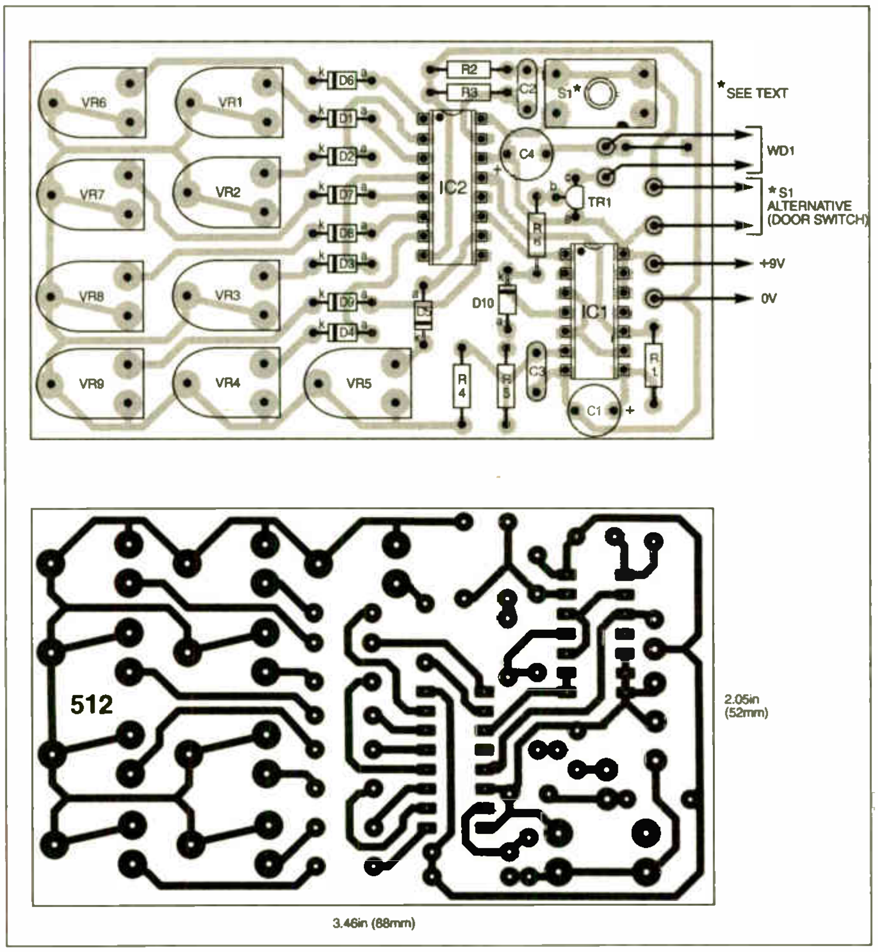


Fig.4.2. Printed circuit board component layout wiring details and full-size underside copper foil master pattern

radiator) to discharge any static from your body prior to handling the devices.

Although switch S1 will normally be mounted on the doorframe, the board has been designed to enable a switch to be mounted on it. This enables the circuit to be tested and set up as a unit without the need for a door mounted switch. Once the circuit has been set up, this switch may be removed or left in place, as preferred, and the door switch connected instead.

The speaker should be connected to the pads on the board using suitable lengths of wire. It should be mounted in a small plastic box of your choice, along with the p.c.b. and the battery.

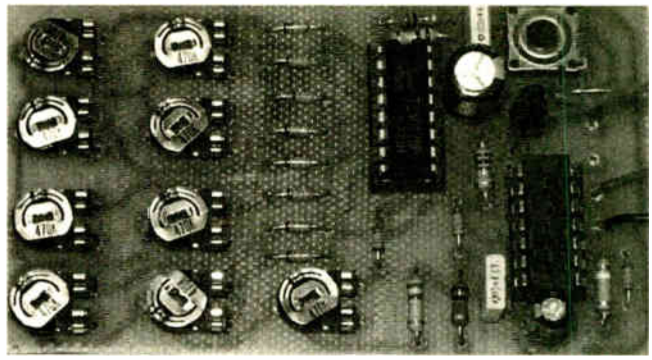
A small PP3 9V battery is sufficient to power the circuit and no separate on/off switch is required. The battery connector should be soldered directly to the pads provided on the p.c.b.

Tuning Up

Once construction is complete, the "tune" must be set up by adjusting the presets, VR1 to VR9. Ideally, a good ear for music is required, but it's not essential (unless your visitors tell you so)!

The tune is initiated by pressing switch S1 and each preset must be adjusted to produce the required note, with VR1 controlling the pitch of the first note, VR2 the second, and so on. Where a space is required (as after the first four notes in the *Westminster Chime* for example) the preset and/or diode should be removed or not fitted.

As the presets fitted are skeleton types (i.e. not enclosed) it will be found easier to adjust them if an *insulated* screwdriver is used. This is not for safety reasons as the circuit only operates from 9V, but a metal blade may pick up mains hum and cause unwanted frequency modulation of the tone, making it difficult to set the required frequency.



Layout of components on the Doorchime circuit board

The values of the presets (470kΩ) should allow a reasonably large frequency range to be obtained. If a lower frequency is required for a particular note, the value of the associated preset may be increased, or a 470kΩ fixed resistor added in series.

The speed at which the notes are played depends on the values of resistor R1 and capacitor C1. This may be varied by altering either component. When setting the tune, it may be useful to slow down the sequence to allow more time to set each note, and this may be done by soldering an additional large-value capacitor in parallel with C1 on the back of the board, observing its correct polarity.

Alternatively, the notes may be set individually by removing IC2 from its socket and connecting the Q9 output pin 11 to 0V to enable the oscillators. This is done most easily by inserting a wire link between pins 8 and 11 on the socket.

The frequency of each note may now be adjusted by connecting each output pin to +9V (IC2 socket pin 16) in turn. Thus the first note can be set by connecting pin 3 to pin 16 and adjusting VR1, the second by connecting pin 2 to pin 16 and adjusting VR2 and so on.

The remaining output pins in the sequence are pins 4, 7, 10, 1, 5, 6 and 9 respectively. Once this has been done, IC2 may be replaced in its socket and the circuit should generate the set tones in sequence when it is triggered. Note that, to prevent damage to the circuit, the battery should be disconnected before removing or inserting any i.c. or changing any connections.

Electronic Dice

SOME people consider that it is their skill rather than luck which decides the outcome of board games. The conventional dice supplied with games can become the source of many misunderstandings if it does not "roll for them". This electronic dice is impartial to the supposed skill or luck of a player!

Basic Operation

The basic requirement is for a circuit which will produce a random count of between one and six and provide a display of some sort. The simplest way to produce a random count is to use a high frequency oscillator and count the pulses in a counter circuit. By allowing the count to proceed only during the time when a switch is pressed, the final number will depend on the starting number and the length of time for which the button is pressed.

Even small differences in the time for which the button is pressed will result in very different counts so that the player will not be able to influence the final display in any way. To make this even more certain, and also to save on battery power, the display in this design is blanked out during the counting process.

A conventional dice has six states so that a divide-by-six counter is required, with six distinct output states. These then have to be decoded to display the familiar dot pattern on seven l.e.d.s, as shown in Fig.4.3. The l.e.d.s are wired in four groups (labelled A, B, C and D) and these must be activated in the combinations shown to display the six possible states. Thus to display the pattern for five for example, the four corner l.e.d.s plus the centre one are required, and this means that groups A, B and C must be selected.

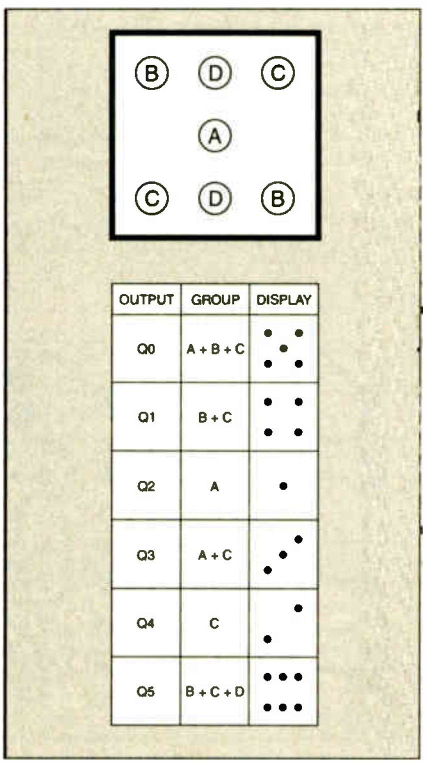


Fig.4.3. Display decoding sequence using seven l.e.d.s

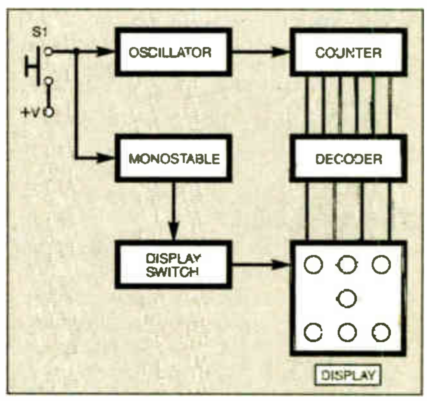


Fig.4.4. Block diagram for the Dice

The block diagram of the circuit which achieves the required decode and display states is shown in Fig.4.4. When the switch is pressed, the oscillator oscillates; when it is released, the oscillator stops and a monostable is triggered. This turns on the display, revealing the count reached. Following a short period, the display is turned off again to save battery power.

Circuit Diagram

The complete circuit diagram for the Electronic Dice is shown in Fig.4.5. It is based on a 4017 decade counter, IC2, configured as a divide-by-six counter by connecting output Q6 to the Reset input.

The counter is controlled by the high speed oscillator formed around Schmitt trigger NAND gate IC1a. The oscillation frequency is set by capacitor C1 and resistor R2. Normally, with switch S1 unpressed, resistor R1 holds one input of IC1a low, preventing oscillation. When S1 is pressed, the gate oscillates and its output pulses are fed to the counter's clock (CLK) input.

Each clock pulse triggers the counter's output high in turn, turning off the preceding output at the same time. Only one output can ever be high at the same time. Normally this cycle would repeat for every ten pulses. In this design, however, output Q6 is connected to the Reset input. When the count reaches Q6 and it goes high, the counter is automatically reset to zero, Q6 immediately goes low and the count resumes again. Consequently, only outputs Q0 to Q5 are available for controlling the l.e.d.s, thus providing the required six output states.

COMPONENTS

ELECTRONIC DICE

Resistors

R1, R2	10k (2 off)	See **SHOP TALK page**
R3	220k	
R4	330Ω	
R5 to R7	220Ω (3 off)	

All 0·25W 5% carbon film

Capacitors

C1	1n ceramic disc
C2	10µ axial elect. 16V

Semiconductors

D1 to D7	red l.e.d. (7 off) (see text)
D8 to D18	1N4148 diode (11 off)
IC1	4093 quad Schmitt NAND gate
IC2	4017 decade counter

Miscellaneous

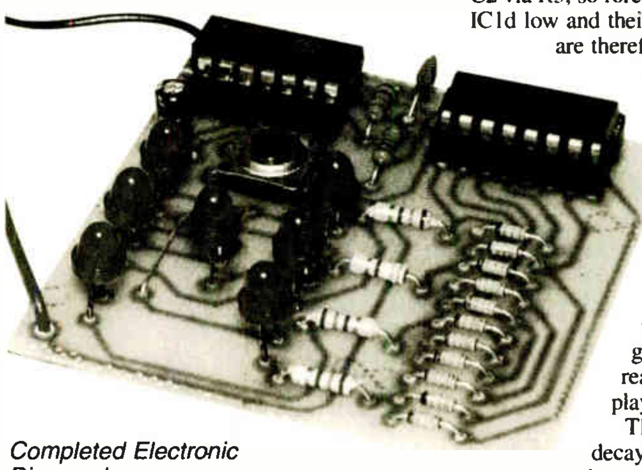
S1	push-to-make switch (see text)

Printed circuit board, available from the *EPE PCB Service*, code 513; 14-pin d.i.l. socket; 16-pin d.i.l. socket; plastic case of choice; PP3 battery and clip; connecting wire; solder, etc.

Approx. Cost Guidance Only **£10** *excl case & batts*

On Display

These outputs are "decoded" by diodes D8 to D18 to light the l.e.d.s. (D1 to D7) These are physically arranged on the printed circuit board in the familiar dot pattern. Thus when Q0 is high for example, diodes D8, D9 and D10 ensure that l.e.d. groups A, B and C are selected, while if output Q5 is high the groups B, C and D will be selected instead.



Completed Electronic Dice p.c.b.

The monostable and display switch blocks are formed by IC1b, IC1c and IC1d, in conjunction with capacitor C2 and resistor R3. When switch S1 is pressed, not only does this enable the oscillator, but also triggers the monostable via IC1b connected as an inverter. This gate's output goes low, discharging C2 via R3, so forcing the inputs of IC1c and IC1d low and their outputs high. The l.e.d.s are therefore prevented from being turned on as their cathodes are now held high.

When S1 is released, the oscillator is stopped and the output of IC1b goes high. The resulting pulse across C2 takes the inputs of IC1c and IC1d with it. The output of these gates therefore goes low and the value reached by the counter is displayed on the l.e.d.s.

The charge on C2 now decays via R3 until eventually the voltage at the inputs of IC1c

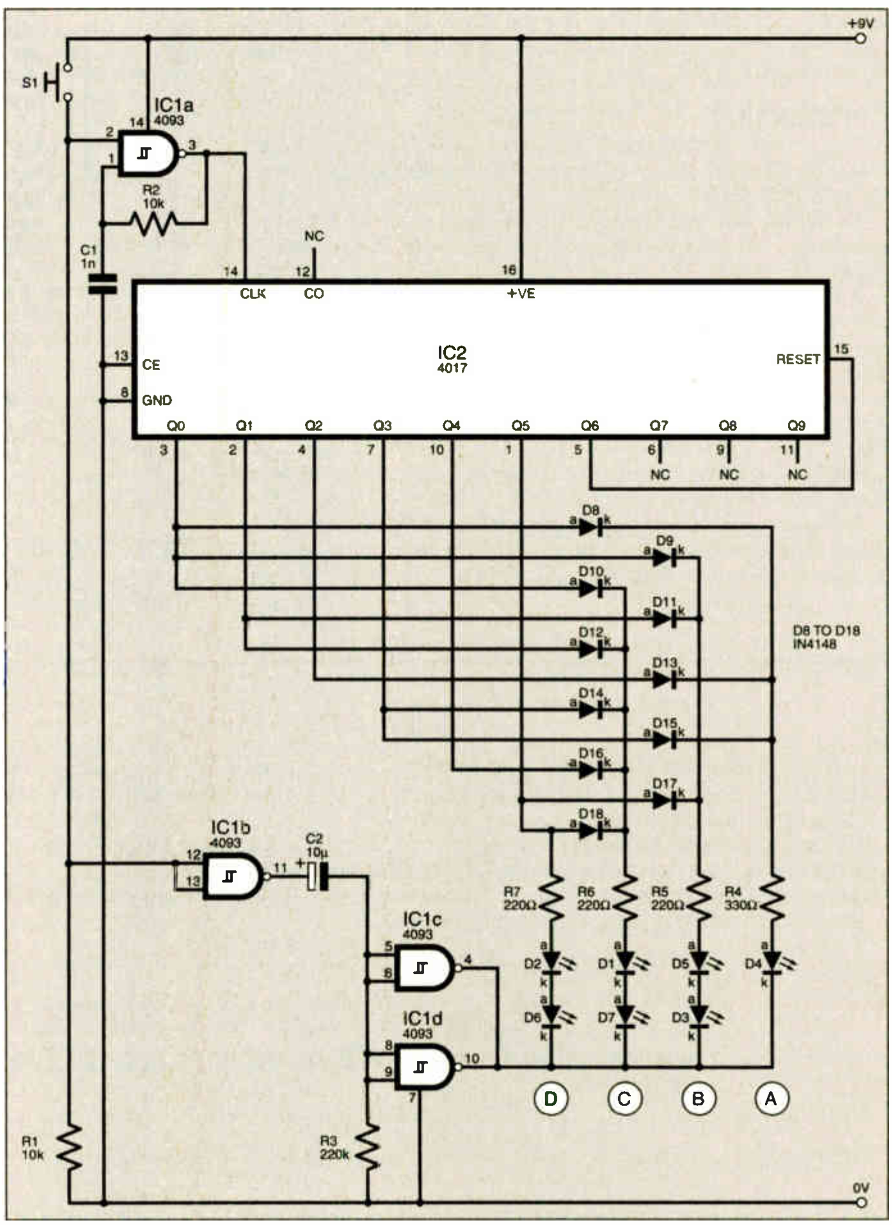
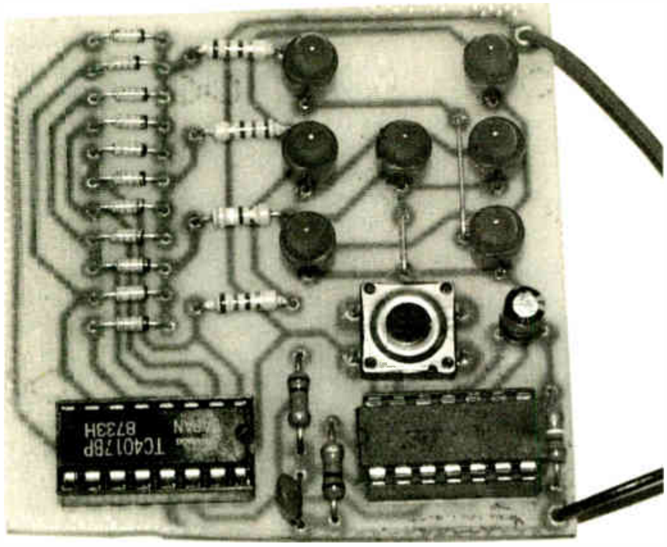


Fig.4.5. Full circuit diagram for the Electronic Dice



Layout of components on the completed circuit board

and IC1d falls below the low logic threshold, at which point the outputs of IC1c and IC1d switch high again, turning off the display. In this state the current drawn by the circuit is negligible.

Gates IC1c and IC1d are connected in parallel to reduce their output resistance, and thus enable them to sink the maximum l.e.d. current presented to them. The time for which the display remains lit is about three seconds, but may be easily extended by increasing the value of C2 or R3.

Construction

The printed circuit board and track layout details for the Electronic Dice are shown in Fig.4.6. This board is available from the *EPE PCB Service*, code 513.

As before, assemble the board in the usual order of ascending component size, and do not insert the i.c.s. until the assembly's accuracy has been checked. Take the normal anti-static precautions.

If high brightness l.e.d.s are used, the values of ballast resistors R4 to R7 will probably be found to be satisfactory but with some l.e.d.s there may be a noticeable variation in brightness. This is due to the fact that groups B, C and D each consist of two series connected l.e.d.s, while group A contains only one. As well as this, some outputs of the counter have to drive two or three chains simultaneously while others drive only one. Any difference in the l.e.d. brilliance can be rectified by altering the values of the appropriate resistors.

The push-button switch can be mounted on the board, but if the circuit is to be built into a box complete with battery, a panel mounted switch will be required. This will need to be connected to the p.c.b. by flying leads.

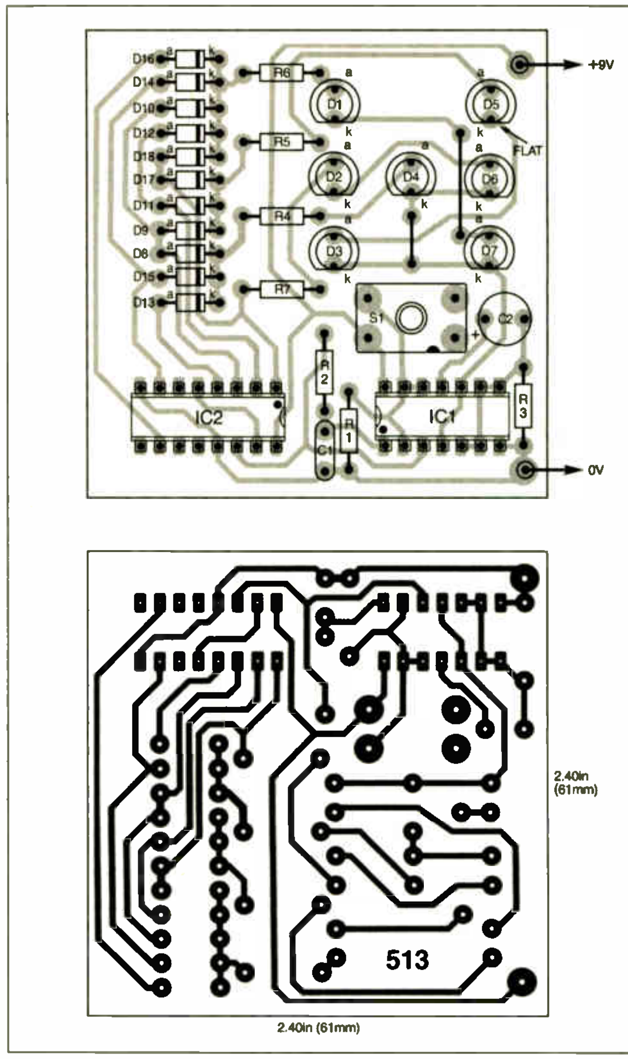


Fig.4.6. Topside printed circuit-board component layout and full-size underside copper foil master

The circuit can be powered by a 9V PP3 battery and as the circuit draws virtually no current when the display is off, no on/off switch is required.

The unit is simple to use and involves simply pressing and releasing switch S1, allowing players to concentrate on the game!

Next Month

In Part 5 next month we present a Kitchen Timer and a Room Thermometer.

Regular Clinic

Circuit Surgery

Alan Winstanley and Ian Bell

We continue with our primer on CompactFlash (CF) cards, with more pointers and snippets of code intended for experienced microcontroller enthusiasts.

Going HyperTerminal

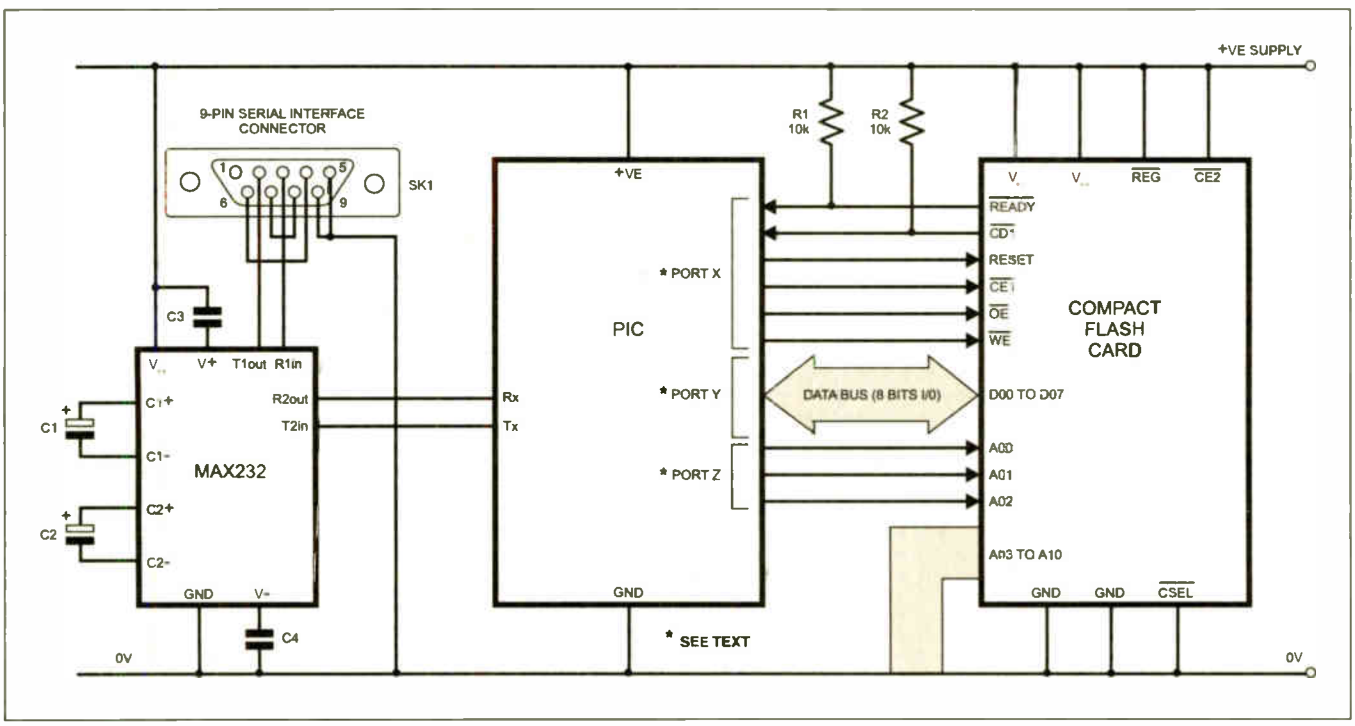
Last month we looked at the electrical interface to the CompactFlash card, with a detailed description of the key pins used in the PC Memory Mode of operation. We also suggested a circuit for connecting a CompactFlash card to a microcontroller such as a PIC, and we offered a CF experimental p.c.b. that would enable experienced users to hook up a CF card to a prototype circuit. This month we will start looking at what the microcontroller has to do in order to actually use the memory card. This basically comes down to issuing a suitable command to the card by writing a command code to it. Where appropriate this is followed by reading or writing the card's data buffer.

A good way to get started with experimenting with a microcontroller, such as a PIC, and a CompactFlash card is to set up a serial link to a PC to control the circuit. A suggested circuit for doing this is given in Fig.1 (an extended version of last month's circuit). Serial connection to the PC is provided by using a MAX232 chip (to provide RS232 level conversion) connected to the PIC's UART pins. You could also use a USB link as described in previous *Circuit Surgery* articles.

Note that in Fig.1 we have labelled the PIC ports X, Y, and Z. In our case PORTX is used for control signals, PORTY is the data bus and PORTZ is for addressing. The actual ports (usually labelled A, B, C etc.), or parts of ports used will depend on the PIC device used and what other I/O facilities are required from the device. We have successfully used a PIC18F452 with PORTD for data, PORTE for address and six pins from PORTB for control.

Running the HyperTerminal program on the PC then provides an easy way for data to be sent to the PIC, and received data to be observed. HyperTerminal will be found under Accessories/Communications from the Windows XP "All Programs" menu. HyperTerminal deals with text so your PIC code may have to translate binary bytes it needs to send into two ASCII characters for ease of reading. Of course, you can also write your own code to run on the PC and communicate with the circuit via the serial link, allowing you to handle data in any format you like.

When the PIC receives serial data it can be configured to jump to an interrupt service routine and read the incoming bytes. For CompactFlash Card experiments the first byte or two can be use to select an action to perform (e.g. write to card, read from card, identify card etc.) and may be followed by data to be used (read/write address, data to write, number of bytes to read etc). Once you have developed the experimental code and are confident that you can control the CompactFlash card, the routines you have developed can be included in specific projects.



CompactFlash cards are removable so code running on the PIC should check for the presence of a card before attempting to access it. This is simply a matter of checking the level of the Card Detect line (CD1) which will be low if the card is present. CompactFlash cards in PC-Memory mode can be hot swapped, that is inserted and removed with the power on. If a port with interrupt-on-change is used for CD1 then card insertion could be detected via an interrupt service routine.

The card is designed so that power is applied to it before the signals make contact when the card is inserted; however, it is still possible for transients on the card's outputs during the 100ms or so after insertion to cause problems, or even damage to the microcontroller. The PIC should wait this period after detecting a card before accessing it or making any of its connections to the card act as outputs. Obviously, removing the card while access is occurring will cause problems and an l.e.d switched via a PIC port (not shown in the schematic) could be used to indicate that card is in use and should not be unplugged.

Play your cards write

To use the CompactFlash Card we need to know about the commands it accepts. There are over 40 commands listed in the CompactFlash specification document and detailed description takes about 50 pages. Some of the commands are listed in Table 1 to give you an idea of what is available, but actually you need very few commands to make basic use of the card. Table 1 excludes non-recommended commands, commands that in effect do nothing with a CompactFlash card, but are part of the ATA specification and used with other types of device (such as hard drives). Table 1 also excludes security commands.

Table 1: Some CompactFlash Memory Card Commands

Command	*Code (hex)*
Check Power Mode	E5 or 98
Execute Drive Diagnostic	90
Erase Sector(s)	C0
Flush Cache	E7
Identify Device	EC
Idle	E3 or 97
Idle Immediate	E1 or 95
Initialize Drive Parameters	91
NOP	00
Read Buffer	E4
Read DMA	C8
Read Multiple	C4
Read Sector(s)	20 or 21
Read Verify Sector(s)	40 or 41
Request Sense	03
Set Features	EF
Set Multiple Mode	C6
Set Sleep Mode	E6 or 99
Standby	E2 or 96
Standby Immediate	E0 or 94
Translate Sector	87
Write Buffer	E8
Write DMA	CA
Write Multiple	C5
Write Multiple w/o Erase	CD
Write Sector(s)	30 or 31
Write Sector(s) w/o Erase	38
Write Verify	3C

When writing the PIC program it is a good idea to define equivalence values for the commands you use rather than putting the hex values straight into your code. For example in PIC assembly:

```
IDENTIFY_CMD      EQU   0xEC
WRITE_SEC_CMD     EQU   0x30
READ_SEC_CMD      EQU   0x20
SLEEP_MODE_CMD    EQU   0xE6
```

Also, we should define names for the card register addresses (these were listed in Table 2 last month). Note that some addresses are used for two different registers depending on whether we are reading or writing.

Similarly we can define the PIC ports we are using for data, address and control, as in the first block of Listing 1.

Note that the code will at some point have to correctly configure the pins on all the ports used as either inputs or outputs as required. The values of the control outputs (RSET, $\overline{OE}$, $\overline{WE}$ and $\overline{CE}$) must be set to their inactive values during program initialisation.

The direction of the data port will change depending on the action being performed. The bits on the control port need to be manipulated individually, so we can define values to identify the individual bits used. Here bits 1 to 6 are used (so bits 0 and 7 are free for other purposes if this is an 8-bit port). Your code would be different from that below if you used different pins for different functions.

Identify Yourself

One quick way to get the CompactFlash card to do something is to issue the Identify Device command and then read data from the card. The values read provide useful data about the card (which may be needed in developing other bits of the code). A sophisticated program would use this data to control how it interacted with the card. You can of course hardwire your code to work with a particular card, or assume the commonest or default values to make things easier but less adaptable.

For an initial experiment, to prove that your circuit is working, issue the Identify Device command, read the data and send it over the serial link. Up to 256 words (512 bytes – the usual buffer size) can be read, but they do not all contain useful data. The first few useful words are listed in Table 2. For full details refer to the CompactFlash specification document. Just sending the first couple of bytes should give you 84 8A (hex) the signature for CompactFlash cards.

Code Example

The code in Listing 2 provides a sketch of what you might write, but is not a complete program. This issues the Identify

Listing 1

```
CF_DATA_REG       EQU   0x00    ; Data register
CF_ERROR_REG      EQU   0x01    ; Error register
CF_FEATURES_REG   EQU   0x01    ; Features register
CF_SEC_CNT_REG    EQU   0x02    ; Sector count register
CF_SEC_NUM_REG    EQU   0x03    ; Sector number register
CF_CYL_LO_REG     EQU   0x04    ; Low cylinder register
CF_CYL_HI_REG     EQU   0x05    ; High cylinder register
CF_HEAD_REG       EQU   0x06    ; Head/drive register
CF_STATUS_REG     EQU   0x07    ; Status register
CF_COMMAND_REG    EQU   0x07    ; Command register

CF_CONTROL        EQU   PORTX   ; change X,Y,Z to actual ports used
CF_DATA           EQU   PORTY
CF_ADDR           EQU   PORTZ

CD1               EQU   1       ; CF Card Detect (input)
RSET              EQU   2       ; CF Reset (output)
OE                EQU   3       ; CF Output Enable (output)
WE                EQU   4       ; CF Write Enable (output)
RDY               EQU   5       ; CF Ready (input)
CE1               EQU   6       ; CF Enable (output)
```

Table 2: Some of the data provided by the Identify Device command

Word Address	*Default Value*	*Total Bytes*	*Information*
0	848Ah	2	General configuration – signature for the CompactFlash Storage Card
1	XXXXh	2	Default number of cylinders
3	00XXh	2	Default number of heads
6	XXXXh	2	Default number of sectors per track
7-8	XXXXh	4	Number of sectors per card (Word 7 = MSW, Word 8 = LSW)
10-19	aaaa	20	Serial number in ASCII (right justified)
22	0004h	2	Number of ECC bytes passed on Read/Write Long Commands
23-26	aaaa	8	Firmware revision in ASCII. Big Endian Byte Order in Word
27-46	aaaa	40	Model number in ASCII (left justified) Big Endian Byte Order in Word

Device command and reads the device information from the card. We assume that the program has already initialised the ports and that the address and data ports are currently set as outputs. The code first sets the address port to the command register address then outputs the Identify Device command code (EC hex) on the data port.

The next section of code waits for the card to be ready. This is done in a simple way here and will get stuck if the card is absent or never becomes ready. Once the card is ready we issue the command by strobing $\overline{WE}$ low to write to the card. We may need to introduce a delay to make sure $\overline{WE}$ is low for long enough, two or three NOPs may be sufficient, but a delay loop subroutine may be needed for fast microcontrollers employing the same approach.

Next we change the address to that of the data register and the direction of the data port to input. Then we loop to read the data. Note that each data word is 16 bits and we are using 8-bit data transfer so we have to do two reads per word.

The data has to be read in order, so for example if we want the serial number at words 10 to 19 we have to read and ignore words 0 to 9 first. The read process strobes $\overline{OE}$ low and transfers the value from the data port to an internal register. Again we have to insert delays to ensure correct timing.

In a real program the Card Ready check and Read/Write strobing would be better written as subroutines as they are likely to be used several times.

Reading and writing follows a similar pattern, but is slightly more complex. We have to set the base data address for our read or write by writing to the cylinder and sector registers, then set the number of sectors to read or write and issue the Sector Read or Sector Write command. Then the data is read or written byte by byte as in the above example. We will look at reading and writing data in more detail next month. I.M.B.

Listing 2

```
    movlw    CF_COMMAND_REG        ; Address the command register
    movwf    CF_ADDR

    movlw    IDENTIFY_CMD          ; Use the Identify command
    movwf    CF_DATA

CHECK_READY1                       ; Wait for the card to be ready
    btfss    CF_CONTROL,RDY
    goto     CHECK_READY1
    nop
                                   ; Write the command to the card
    bcf      CF_CONTROL,WE         ; i) Write enable line low

    ; Insert delay here

    bsf      CF_CONTROL,WE         ; ii) Write enable line high

    ; Insert delay here

                                   ; Read the data register
    movlw    CF_DATA_REG           ; Address the data register
    movwf    CF_ADDR

    movlw    0xFF                  ; PORT Y – data bus – as inputs
    movwf    TRISY                 ;
    clrf     CF_DATA               ; Clear data lines

    ; Start a loop here to read multiple bytes

CHECK_READY2                       ; Wait for the card to be ready
    btfss    CF_CONTROL,RDY
    goto     CHECK_READY2
    nop

    bcf      CF_CONTROL,OE         ; OE control line LOW

    ; Insert delay here

    movf     CF_DATA,0             ; Get first byte

    ; Process byte (e.g. send over serial link)

    bsf      CF_CONTROL,OE         ; OE control line HIGH

    ; Insert delay here

    ; Read and process the second byte

    ; End of loop
```

Onwards, Ever Onwards

As *Circuit Surgery* readers will have discovered in recent articles, we have devoted some space to discussing miniaturised components such as CompactFlash and surface-mount technology (SMT) chips. Many readers can be deterred by the lack of use of traditional dual-in-line devices. In industry, though, it is not always feasible for manufacturers to produce discrete dual-in-line i.c.s of the type that have graced our project pages for decades. The increasing level of integration and the rising numbers of pinouts, the need for economies of scale and the drive towards miniaturisation and low power means that the surface mount style may be the only way to produce complex devices.

All is not lost for the hobbyist though, as demonstrated by the use of microcontrollers that are available in traditional dual-in-line packages. Much can be achieved with a dual-in-line microcontroller coupled to a handful of traditional discrete components and it can all be built easily with traditional p.c.b. techniques.

Of course, allied to this step-change in our hobby is the use of personal computers – now becoming as essential to own as, say, an oscilloscope – along with the need to use software to program microcontrollers effectively. *EPE* leads the market with generously-supported educational features and constructional articles that utilise PIC devices to produce sophisticated-feature projects that can be built relatively easily, reducing the frustration of constructional errors at the same time.

There is plenty more for the hobbyist to experiment with as well, and series such as our *Back To Basics* articles use traditional CMOS logic chips that are in plentiful supply and easy to solder – unlike their surface mount counterparts!

Nevertheless, there is a lot more that experienced constructors can achieve if they are confident enough to use miniature SMT devices, such as a CF card or the FT232B USB serial converter chip that we discussed in Feb '05 *Circuit Surgery*. (John Waller also examined this chip in his *USB to PIC Interface* article of Apr '04. *Ed.*)

One challenge is actually buying such parts in small quantities rather than in enormous reels used in industry, but the second problem is in successfully soldering them into a circuit board without using expensive rework or hot air tools that are beyond the reach of constructors.

Our CF Experimenter's p.c.b. (last month) highlights the dexterity needed to solder miniature surface-mount style parts successfully. It can be done, but some practise is needed to develop the right technique, using fresh materials for reliable soldering.

The chip maker FTDI who produce the FT232B USB converter chips have an online shop at **www.ftdichip.com** where you can buy using a credit card. Click on "web shop". We also spotted some dual-in-line style DIP modules that interface with the surface-mount chip. We heartily commend any manufacturer that makes interesting components available to enthusiasts in this way. A.R.W.

FREE *Electronics Hobbyist Compendium* book with Teach-In 2000 CD-ROM

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The whole of the 12-part *Teach-In 2000* series by John Becker (published in *EPE* Nov '99 to Oct 2000) is now available on CD-ROM. Plus the *Teach-In 2000* interactive software (Win 95, 98, ME and above) covering all aspects of the series and Alan Winstanley's *Basic Soldering Guide* (including illustrations and Desoldering).

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Robotics

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Shows the reader how to build a variety of increasingly sophisticated computer controlled robots using the brilliant Lego Mindstorms Robotic Invention System (RIS). Initially covers fundamental building techniques and mechanics needed to construct strong and efficient robots using the various "click-together" components supplied in the basic RIS kit. Then explains in simple terms how the "brain" of the robot may be programmed on screen using a PC and "zapped" to the robot over an infra-red link. Also, shows how a more sophisticated Windows programming language such as Visual BASIC may be used to control the robots.

Details building and programming instructions provided, including numerous step-by-step photographs.

288 pages – large format **Order code BP901** **£14.99**

MORE ADVANCED ROBOTICS WITH LEGO MINDSTORMS – Robert Penfold

Covers the Vision Command System

Shows the reader how to extend the capabilities of the brilliant Lego Mindstorms Robotic Invention System (RIS) by using Lego's own accessories and some simple home constructed units. You will be able to build robots that can provide you with 'waiter service' when you clap your hands, perform tricks, 'see' and avoid objects by using 'bats radar', or accurately follow a line marked on the floor. Learn to use additional types of sensors including rotation, light, temperature, sound and ultrasonic and also explore the possibilities provided by using an additional (third) motor. For the less experienced, RCX code programs accompany most of the featured robots. However, the more adventurous reader is also shown how to write programs using Microsoft's VisualBASIC running with the ActiveX control (Spirit.OCX) that is provided with the RIS kit.

Detailed building instructions are provided for the featured robots, including numerous step-by-step photographs. The designs include rover vehicles, a virtual pet, a robot arm, an 'intelligent' sweet dispenser and a colour conscious robot that will try to grab objects of a specific colour.

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The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order to your door. Full ordering details are given on the last book

For a further selection of books see the next two issues of *EPE*.

Radio

BASIC RADIO PRINCIPLES AND TECHNOLOGY
Ian Poole

Radio technology is becoming increasingly important in today's high technology society. There are the traditional uses of radio which include broadcasting and point to point radio as well as the new technologies of satellites and cellular phones. All of these developments mean there is a growing need for radio engineers at all levels.

Assuming a basic knowledge of electronics, this book provides an easy to understand grounding in the topic.

Chapters in the book: Radio Today, Yesterday, and Tomorrow; Radio Waves and Propagation; Capacitors, Inductors, and Filters; Modulation; Receivers; Transmitters; Antenna Systems; Broadcasting; Satellites; Personal Communications; Appendix – Basic Calculations.

263 pages **Order code NE30** **£18.99**

PROJECTS FOR RADIO AMATEURS AND S.W.L.S.
R. A. Penfold

This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

The circuits covered include: An aerial tuning unit; A simple active aerial; An add-on b.f.o. for portable sets; A wavetrap to combat signals on spurious responses; An audio notch filter; A parametric equaliser; C.W. and S.S.B. audio filters; Simple noise limiters; A speech processor; A volume expander.

Other useful circuits include a crystal oscillator, and RTTY/C.W. tone decoder, and a RTTY serial to parallel converter. A full range of interesting and useful circuits for short wave enthusiasts.

92 pages **Order code BP304** **£4.45**

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I. D. Poole

Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century. This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

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Computers and Computing

THE INTERNET FOR THE OLDER GENERATION
Jim Gatenby

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This book explains how to use your PC on the Internet and covers amongst other things: Choosing and setting up your computer for the Internet. Getting connected to the Internet. Sending and receiving emails, photographs, etc., so that you can keep in touch with family and friends all over the world. Searching for and saving information on any subject. On-line shopping and home banking. Setting up your own simple web site.

228 pages **Order code BP600** **£8.99**

HOW TO BUILD YOUR OWN PC – Third Edition
Morris Rosenthal

More and more people are building their own PCs. They get more value for their money, they create exactly the machine they want, and the work is highly satisfying and actually fun. That is, if they have a unique beginner's guide like this one, which visually demonstrates how to construct a state-of-the-art computer from start to finish.

Through 150 crisp photographs and clear but minimal text, readers will confidently absorb the concepts of computer building. The extra-big format makes it easy to see what's going on in the pictures. For non-specialists, there's even a graphical glossary that clearly illustrates technical terms. The author goes "under the hood" and shows step-by-step how to create a socket 7 (Pentium and non-intel chipsets) and a Slot 1 (Pentium II) computer, covering: What first-time builders need to know; How to select and purchase parts; How to assemble the PC; How to install Windows 98. The few existing books on this subject, although badly outdated, are in steady demand. This one delivers the expertise and new technology that fledgling computer builders are eagerly looking for.

224 pages – large format **Order code MGH2** **£20.99**

PIC YOUR PERSONAL INTRODUCTORY COURSE SECOND EDITION John Morton

Discover the potential of the PIC microcontroller through graded projects – this book could revolutionise your electronics construction work!

A uniquely concise and practical guide to getting up and running with the PIC Microcontroller. The PIC is one of the most popular of the microcontrollers that are transforming electronic project work and product design.

Assuming no prior knowledge of microcontrollers and introducing the PIC's capabilities through simple projects, this book is ideal for use in schools and colleges. It is the ideal introduction for students, teachers, technicians and electronics enthusiasts. The step-by-step explanations make it ideal for self-study too: this is not a reference book – you start work with the PIC straight away.

The revised second edition covers the popular reprogrammable EEPROM PICs: P16C84/16F84 as well as the P54 and P71 families.

270 pages **Order code NE36** **£15.99**

eBAY FOR BEGINNERS
Cherry Nixon

There are two kinds of people, those who are trading on eBay and the rest who are missing out. Though eBay has been embraced by entrepreneurs all over the world, it remains the peoples' site and offers the largest market for the smallest fee.

eBay presents an opportunity for everyone, the trick is to master it. This book shows you how to start trading on eBay UK. It also offers advice on getting organised and tips to put you ahead.

The book has been developed from Cherry's popular hands-on course "Buying and Selling on eBay for Technological Simpletons". In addition to fully explaning eBay and how to trade on it there are sections on Paypal, producing pictures of your sale items, fees and accounts, safety and security including what to do when things go wrong and what protection is provided.

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Howard Anderson, Mike Tooley

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Theory and Reference

BEBOP TO THE BOOLEAN BOOGIE
Second Edition
Clive (Max) Maxfield

BOOK PLUS CD-ROM

This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more. The author's tongue-in-cheek humour makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate. Comes with a free CD-ROM which contains an eBook version with full text search plus bonus chapter – An Illustrated History of Electronics and Computing.

Contents: Fundamental concepts; Analog versus digital; Conductors and insulators; Voltage, current, resistance, capacitance and inductance; Semiconductors; Primitive logic functions; Binary arithmetic; Boolean algebra; Karnaugh maps; State diagrams, tables and machines; Analog-to-digital and digital-to-analog; Integrated circuits (ICs); Memory ICs; Programmable ICs; Application-specific integrated circuits (ASICs); Circuit boards (PWBs and DWBs); Hybrids; Multichip modules (MCMs); Alternative and future technologies.

500 pages **Order code BEB1** **£27.50**

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Clive (Max) Maxfield and Alvin Brown

CD-ROM

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Over 800 pages in Adobe Acrobat format

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SCROGGIE'S FOUNDATIONS OF WIRELESS AND ELECTRONICS – ELEVENTH EDITION
S. W. Amos and Roger Amos

Scroggie's Foundations is a classic text for anyone working with electronics, who needs to know the art and craft of the subject. It covers both the theory and practical aspects of a huge range of topics from valve and tube technology, and the application of cathode ray tubes to radar, to digital tape systems and optical recording techniques.

Since *Foundations of Wireless* was first published over 60 years ago, it has helped many thousands of readers to become familiar with the principles of radio and electronics. The original author Sowerby was succeeded by Scroggie in the 1940s, whose name became synonymous with this classic primer for practitioners and students alike. Stan Amos, one of the fathers of modern electronics and the author of many well-known books in the area, took over the revision of this book in the 1980s and it is he, with his son, who have produced this latest version.

400 pages **Temporarily out of print**

GETTING THE MOST FROM YOUR MULTIMETER
R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages **Order code BP239** **£5.49**

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A unique hands-on guide for anyone working with valve (*tube* in USA) audio equipment – as an electronics experimenter, audiophile or audio engineer.

Particular attention has been paid to answering questions commonly asked by newcomers to the world of the vacuum tube, whether audio enthusiasts tackling their first build, or more experienced amplifier designers seeking to learn the ropes of working with valves. The practical side of this book is reinforced by numerous clear illustrations throughout.

368 pages **Order code NE40** **£21.99**

QUICK GUIDE TO ANALOGUE SYNTHESIS
Ian Waugh

Even though music production has moved into the digital domain, modern synthesisers invariably use analogue synthesis techniques. The reason is simple – analogue synthesis is flexible and versatile, and it's relatively easy for us to understand. The basics are the same for all analogue synths, and you'll quickly be able to adapt the principles to any instrument, to edit existing sounds and create exciting new ones. This book describes: How analogue synthesis works; The essential modules every synthesiser has; The three steps to synthesis; How to create phat bass sounds; How to generate filter sweeps; Advanced synth modules; How to create simple and complex synth patches; Where to find soft synths on the Web.

If you want to take your synthesiser – of the hardware or software variety – past the presets, and program your own sounds and effects, this practical and well-illustrated book tells you what you need to know.

60 pages **Order code PC118** **£7.45**

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Ian Waugh

MP3 files, the latest digital music format, have taken the music industry by storm. What are they? Where do you get them? How do you use them? Why have they thrown record companies into a panic? Will they make music easier to buy? And cheaper? Is this the future of music?

All these questions and more are answered in this concise and practical book which explains everything you need to know about MP3s in a simple and easy-to-understand manner. It explains:

How to play MP3s on your computer; How to use MP3s with handheld MP3 players; Where to find MP3s on the Web; How MP3s work; How to tune into Internet radio stations; How to create your own MP3s, How to record your own CDs from MP3 files; Other digital audio music formats.

Whether you want to stay bang up to date with the latest music or create your own MP3s and join the on-line digital music revolution, this book will show you how.

60 pages **Order code PC119** **£7.45**

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.

124 pages **Order code PC116** ~~£10.95~~ **£5.45**

THE INVENTOR OF STEREO – THE LIFE AND WORKS OF ALAN DOWER BLUMLEIN
Robert Charles Alexander

This book is the definitive study of the life and works of one of Britain's most important inventors who, due to a cruel set of circumstances, has all but been overlooked by history.

Alan Dower Blumlein led an extraordinary life in which his inventive output rate easily surpassed that of Edison, but whose early death during the darkest days of World War Two led to a shroud of secrecy which has covered his life and achievements ever since.

His 1931 Patent for a Binaural Recording System was so revolutionary that most of his contemporaries regarded it as more than 20 years ahead of its time. Even years after his death, the full magnitude of its detail had not been fully utilized. Among his 128 patents are the principal electronic circuits critical to the development of the world's first elecronic television system. During his short working life, Blumlein produced patent after patent breaking entirely new ground in electronic and audio engineering.

During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H2S' – blind-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirty-ninth birthday.

420 pages **Order code NE32** **£17.99**

VIDEO PROJECTS FOR THE ELECTRONICS CONSTRUCTOR
R. A. Penfold

Written by highly respected author R. A. Penfold, this book contains a collection of electronic projects specially designed for video enthusiasts. All the projects can be simply constructed, and most are suitable for the newcomer to project construction, as they are assembled on stripboard.

There are faders, wipers and effects units which will add sparkle and originality to your video recordings, an audio mixer and noise reducer to enhance your soundtracks and a basic computer control interface. Also, there's a useful selection on basic video production techniques to get you started.

Complete with explanations of how the circuit works, shopping lists of components, advice on construction, and guidance on setting up and using the projects, this invaluable book will save you a small fortune.

Circuits include: video enhancer, improved video enhancer, video fader, horizontal wiper, improved video wiper, negative video unit, fade to grey unit, black and white keyer, vertical wiper, audio mixer, stereo headphone amplifier, dynamic noise reducer, automatic fader, pushbutton fader, computer control interface, 12 volt mains power supply.

124 pages **Order code PC115** ~~£10.95~~ **£5.45**

PC MUSIC – THE EASY GUIDE
Robin Vincent

How do I make music on my PC? Can I record music onto my PC? What's a sequencer? How can I get my PC to print a music score? What sort of a soundcard do I need? What hardware and software do I need? How do I connect a keyboard to my PC?:

Just a few of the questions you've probably asked. Well, you'll find the answers to all these questions, and many more, in this book. It will show you what can be done, what it all means, and what you will need to start creating your own music on your PC. It's an easy read, it's fully illustrated and it will help you understand how a computer can be used as a creative music tool.

It covers soundcards, sequencers, hard disk digital audio recording and editing, plug-ins, printing scores with notation software, using your PC as a synthesiser, getting music onto and off the Internet, using Windows, sample PC music set-ups, FAQs, a glossary, advice on hardware and software, and a list of industry contacts.

116 pages **Order code PC117** **£11.95**

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION
R. A. Penfold

Practical construction details of how to build a number of audio power amplifiers ranging from about 50 to 300/400 watts r.m.s. includes MOSFET and bipolar transistor designs.

96 pages **Temporarily out of print**

Circuits, Data and Design

PRACTICAL ELECTRONIC FILTERS
Owen Bishop

This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.

The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rythm sequencer and a multi-voiced electronic organ.

Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.

88 pages **Order code BP299** **£5.49**

DIGITAL ELECTRONICS – A PRACTICAL APPROACH
With FREE Software: Number One Systems – EASY-PC Professional XM and Pulsar (Limited Functionality)

FREE SOFTWARE

Richard Monk

Covers binary arithmetic, Boolean algebra and logic gates, combination logic, sequential logic including the design and construction of asynchronous and synchronous circuits and register circuits. Together with a considerable practical content plus the additional attraction of its close association with computer aided design including the FREE software.

There is a 'blow-by-blow' guide to the use of EASY-PC Professional XM (a schematic drawing and printed circuit board design computer package). The guide also conducts the reader through logic circuit simulation using Pulsar software. Chapters on p.c.b. physics and p.c.b. production techniques make the book unique, and with its host of project ideas make it an ideal companion for the integrative assignment and common skills components required by BTEC and the key skills demanded by GNVQ. The principal aim of the book is to provide a straightforward approach to the understanding of digital electronics.

Those who prefer the 'Teach-In' approach or would rather experiment with some simple circuits should find the book's final chapters on printed circuit board production and project ideas especially useful.

250 pages (large format) **Temporarily out of print**

A BEGINNER'S GUIDE TO TTL DIGITAL ICs
R. A. Penfold

This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world".

142 pages **Order code BP332** **£5.45**

MICROCONTROLLER COOKBOOK
Mike James

The practical solutions to real problems shown in this cookbook provide the basis to make PIC and 8051 devices really work. Capabilities of the variants are examined, and ways to enhance these are shown. A survey of common interface devices, and a description of programming models, lead on to a section on development techniques. The cookbook offers an introduction that will allow any user, novice or experienced, to make the most of microcontrollers.

240 pages **Order code NE26** **£23.99**

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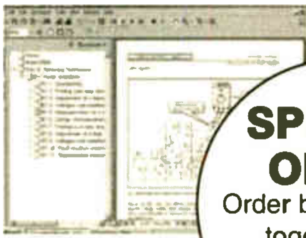

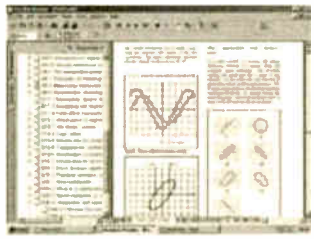

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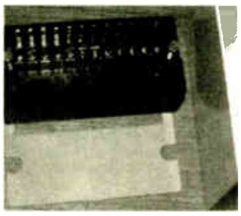

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SP38	15 x 47/25V radial elect caps
SP39	10 x 470/16V radial elect. caps.
SP40	15 x BC237 transistors
SP41	20 x Mixed transistors
SP42	200 x Mixed 0·25W C.F. resistors
SP47	5 x Min. PB switches
SP49	4 x 5 metres stranded core wire
SP101	8 Meters 22SWG solder
SP102	20 x 8-pin DIL sockets
SP103	15 x 14-pin DIL sockets
SP104	15 x 16-pin DIL sockets
SP105	4 x 74LS00
SP109	15 x BC557 transistors
SP112	4 x CMOS 4093
SP115	3 x 10mm Red LEDs
SP116	3 x 10mm Green LEDs
SP118	2 x CMOS 4047
SP124	20 x Assorted ceramic disc caps
SP126	6 x Battery clips – 3 ea. PP3 + PP9
SP130	100 x Mixed 0·5W C.F. resistors
SP131	2 x TL071 Op.Amps
SP133	20 x 1N4004 diodes
SP134	15 x 1N4007 diodes
SP135	6 x Miniature slide switches
SP136	3 x BFY50 transistors
SP137	4 x W005 1·5A bridge rectifiers
SP138	20 x 2·2/63V radial elect. caps.
SP140	3 x W04 1·5A bridge rectifiers
SP142	2 x CMOS 4017
SP143	5 Pairs min. crocodile clips (Red & Black)
SP144	5 Pairs min.crocodile clips (assorted colours)
SP146	10 x 2N3704 transistors
SP147	5 x Stripboard 9 strips x 25 holes
SP151	4 x 8mm Red LEDs
SP152	4 x 8mm Green LEDs
SP153	4 x 8mm Yellow LEDs
SP154	15 x BC548 transistors
SP156	3 x Stripboard, 14 strips x 27 holes
SP160	10 x 2N3904 transistors
SP161	10 x 2N3906 transistors
SP164	2 x C106D thyristors
SP165	2 x LF351 Op.Amps
SP166	20 x 1N4003 diodes
SP167	5 x BC107 transistors
SP168	5 x BC108 transistors
SP171	8 Meters 18SWG solder
SP172	4 x Standard slide switches
SP173	10 x 220/25V radial elect. caps
SP174	20 x 22/25V radial elect. caps
SP175	20 x 1/63V radial elect. caps.
SP177	10 x 1A 20mm quick blow fuses
SP178	10 x 2A 20mm quick blow fuses
SP181	5 x Phono plugs – asstd colours
SP182	20 x 4·7/63V radial elect. caps.
SP183	20 x BC547 transistors
SP187	15 x BC239 transistors
SP189	4 x 5 metres solid core wire
SP192	3 x CMOS 4066
SP195	3 x 10mm Yellow LEDs
SP197	6 x 20 pin DIL sockets
SP198	5 x 24 pin DIL sockets
SP199	5 x 2·5mm mono jack plugs
SP200	5 x 2·5mm mono jack sockets

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